Arkansas River Navigation Study
Arkansas and Oklahoma
Final Feasibility Report

EXECUTIVE SUMMARY

Study Authority:

The initial authorization, the River & Harbor Act of July 24, 1946, authorized the development of the Arkansas River and its tributaries for the purposes of navigation, flood control, hydropower, and recreation. Public Law 91-649 stated that the project would be known as the McClellan-Kerr Arkansas River Navigation System. For the purposes of this report, the navigation system and associated reservoirs are hereafter referred to as the "MKARNS". Subsequent acts authorized water supply, fish and wildlife, and agricultural water supply. Construction of the project began in 1957 and the current 9-foot navigation channel was opened to navigation in 1971 at a total cost of $1.3 billion. The authority for this study comes from a Resolution by the Committee on Public Works and Transportations of the United States House of Representatives, dated 11 March 1982, and referred to as the Arkansas River Basin Authority. Additional authority for this study comes from Section 216, 1970 FCA (P.L. 91-611) and Sections 103, 105, and 905; WRDA 1986, (P.L. 99-662).

Funds were appropriated in the Energy and Water Development Appropriations Act of 1999 to initiate and complete a reconnaissance study of flooding in unprotected areas outside the existing flood control levees at Fort Smith, AR. As a result of the reconnaissance study, a Section 905(b) (WRDA 86) Analysis, dated September 1999, was prepared and approved in January 2000. The analysis identified the current MKARNS operating plan as the cause of some of the flooding problems. Concurrently, the navigation industry was asking that the operating plan be re-evaluated to try to reduce the navigation losses due to high flows. The navigation industry also requested an investigation of increasing the channel depth from 9 feet to 12 feet. Based on an initial assessment of possible benefits, the reconnaissance study recommended a feasibility study to improve navigation conditions while incidentally improving flood control, hydropower, recreation, and fish and wildlife.

Additional language was included in Section 136 of the Energy and Water Development Appropriations Act of 2004, which authorized a project depth of 12 feet.

Study & Report:

The Environmental impact Study (EIS) and the Feasibility Report are a combined effort of Little Rock and Tulsa Districts and originally consisted of two phases: Phase I was to examine how to reduce flooding and expand the number of days that barges could operate on the MKARNS while balancing any changes against the needs of existing project purposes that includes navigation, flood control, water supply, hydropower, water quality, recreation, and fish and wildlife habitat. Phase II was to investigate deepening the channel over the entire system and

widening the Verdigris River in Oklahoma. Each phase was to have a separate feasibility report and environmental impact statement. However, in order to properly address cumulative environmental impacts it was subsequently determined that both phases as well as ongoing operations and maintenance of the existing 9-foot channel should be addressed in one report and E.I.S. Three features associated with the maintenance and improvements of the MKARNS are investigated in this report:

1) Navigation Channel Maintenance: The ongoing operation and maintenance of the existing 9-foot navigation channel on the MKARNS, entails the use of "river training structures" (dikes, revetments, and weirs) as well as periodic dredging at some locations within the navigation channel. Since the completion of the system in 1971, some approved dredged material disposal sites have reached capacity and new disposal sites are required to continue channel maintenance activities. Additionally, the construction of new river training structures would facilitate the maintenance of the 9-foot navigation channel.

2) Flow Management: Sustained high flows on the MKARNS have adversely influenced the safety and efficiency of commercial navigation operations and have resulted in flood damages along the river. The reliability and predictability of river flows affect navigation traffic utilization of the MKARNS.

3) Navigation Channel Depth: Commercial navigation is not at optimum productivity within the MKARNS since its 9-foot navigation channel limits towboat loads compared to the Lower Mississippi River's authorized 12-foot channel.

The feasibility study started in fiscal year (FY) 2000. To date, the total study cost is approximately $9.4 million. Since this is a navigation study for part of the inland waterway system, the feasibility study was conducted at full federal expense.

This feasibility report consists of an executive summary, main report, figures, tables, and separate appendices. A Final Environmental Impact Statement, dated August 2005, was prepared and is presented in a separate document.

Existing Project Background:

The Arkansas River Navigation Study geographically encompasses the MKARNS from the Port of Catoosa near Tulsa, Oklahoma downstream to its confluence with the Mississippi River in southeastern Arkansas, as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS.

The MKARNS is 445 miles in length and includes a series of 18 locks and dams (including Montgomery Point Lock and Dam) that provide for commercial navigation throughout its length. Beginning at the Mississippi River, the first 10 miles of the MKARNS is on the White River. At navigation mile (N.M.) 10 the system enters the Arkansas Post Canal and continues through the canal until it reaches the Arkansas River at approximately N.M. 19. The system changes from the Arkansas River into the Verdigris River at Muskogee, OK at N.M. 394 and terminates 50 miles upstream on the Verdigris at Catoosa, OK. The Corps maintains a minimum 9-foot channel on the system. Passage through MKARNS lock chambers is sized for a 3 by 3

configuration for 8 barges (195 feet long and 35 feet wide) and the towboat. Each of the 18 existing locks measures 110 feet wide and 600-feet long.

Navigation channel widths are 300 feet on the White River, Arkansas Post Canal and Lake Langhofer; 250 feet on the Arkansas River; 150 feet on the Verdigris River; and 225 feet on San Bois Creek.

Flows on the MKARNS are primarily influenced by the upper Arkansas River watershed upstream of its confluence with the Verdigris River (N.M. 394); as well as water storage and release from 11 reservoirs in Oklahoma. The 11 Oklahoma reservoirs are:

- Keystone Lake
- Oologah Lake
- Grand (Pensacola) Lake
- Lake Hudson
- Fort Gibson Lake
- Tenkiller Ferry Lake
- Eufaula Lake
- Kaw Lake
- Hulah Lake
- Copan Lake
- Wister Lake

Project purposes of these reservoirs include navigation, flood control, water supply, hydropower, water quality, recreation, and fish and wildlife habitat.

There are 5 major public port facilities on the MKARNS, along with 62 private ports and terminals. In 2004, the 12.9 million tons transported on the system included coal, petroleum products, fertilizers, grain, sand and gravel, and iron and steel products.

Inbound and outbound traffic that travels onto or off the MKARNS combine to account for 75 percent of total traffic. The regional flow of traffic between the MKARNS and Lower Mississippi amounts to 6.3 million tons which is 56 percent of the total tonnage.

Approximately 90 percent of the MKARNS is already 12-feet deep over a portion of the channel width.

Traffic on the Arkansas River in the twenty years before the construction of MKARNS generally ranged from 500,000 tons to 1 million tons a year. After construction of the MKARNS was completed in 1970, traffic increased rapidly through 1978 up to nearly 10 million tons a year. Traffic declined and then stabilized during the 1980s at a level of about 8 million tons. Traffic again increased in the 1990s to its current estimated level of 12.9 million tons in 2004. Current traffic on the MKARNS exceeds what was predicted in 1990 by the Corps of Engineers.

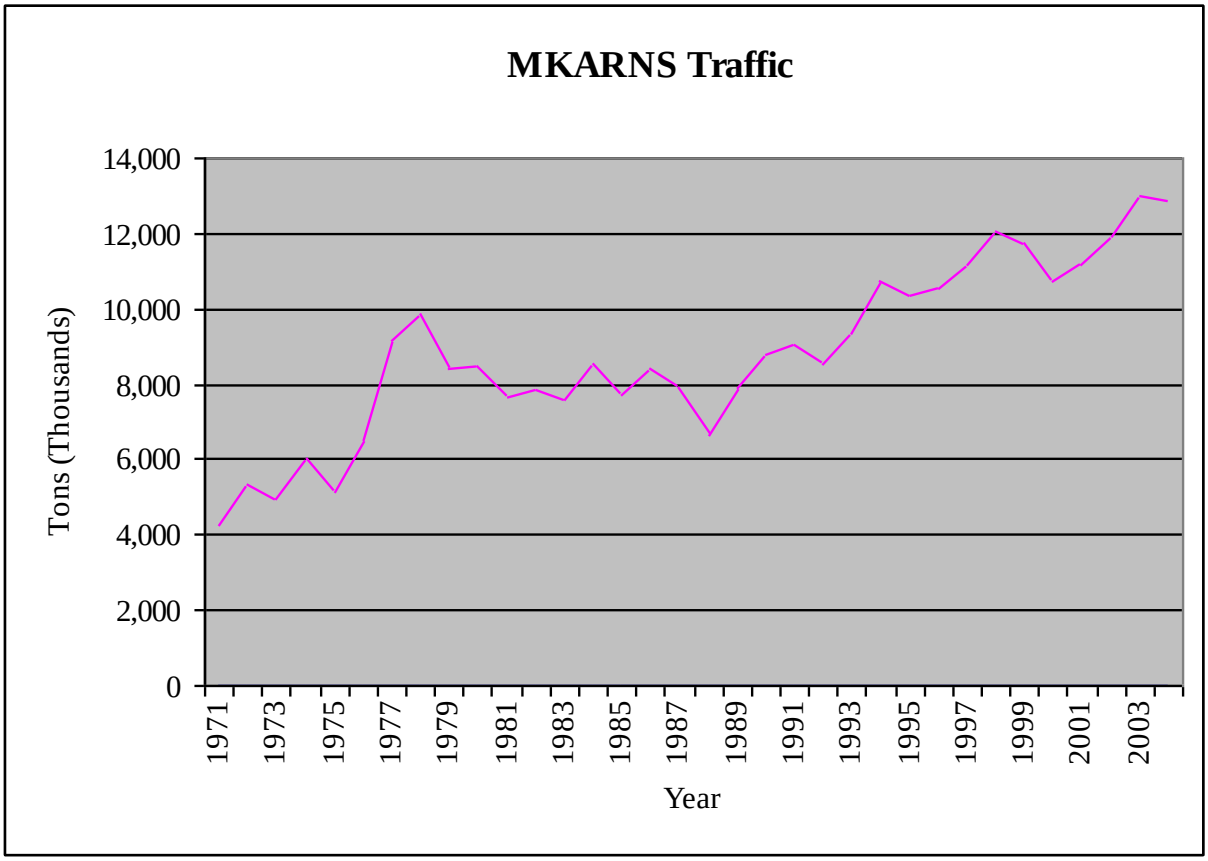

Figure E-1

The overall rates in traffic growth used in this study are listed in the E-1 below. The growth rates are highest for coal and industrial chemicals at annual rates of 1.5% or higher and lowest for forest products, petroleum products and "others" at 0.6% to 0.7%. The growth rate for the remainder of the commodity groups is between 0.9% and 1.2% with the overall growth rate at 1.1% a year.

Table E-1. Projected Growth Rates for Middle Set of Forecasts

	Annual Growth Rate		
	2003-2010	**2003-2030**	**2003-2060**
Farm Products	2.0%	0.9%	0.9%
Metals	2.0%	0.9%	0.9%
Coal	3.1%	1.4%	1.9%
Crude Petroleum	-	-	-
Non-Metallic Minerals	3.6%	1.4%	1.2%
Forest Products	0.9%	0.5%	0.6%
Industrial Chemicals	2.9%	1.3%	1.8%
Agricultural Chemicals	2.5%	0.9%	0.9%
Petroleum Products	1.3%	0.6%	0.7%
Others	2.6%	0.9%	0.6%
All Commodities	**2.8%**	**1.1%**	**1.1%**

Study Purpose:

The purpose of this study is to identify alternatives to maintain and improve the navigation system in order to enhance commercial navigation on the MKARNS, while maintaining the other project purposes of flood control, recreation, hydropower, water supply, and fish and wildlife. The proposed action for achieving the study objectives consists of three features that influence navigation on the system. As stated above, these three features are:

- Navigation Channel Depth Maintenance,
- Flow Management (Sustained High Flows), and
- Navigation Channel Deepening.

By making changes to the MKARNS, the system would become more reliable for navigation by modifying the flow management plan to reduce the number of high flow days. Changing the flow management plan is expected to significantly increase the average number of barges per tow and the efficiency of moving cargo by reducing a constraint that inhabits efficient tows: the possibility of flows over 60,000cf. Deepening the channel would make shipping on the system more compatible with the other deeper draft navigation systems such as the Lower Mississippi River and allow tow boats and barges to better employ their full capacity to carry and move cargo. The lower Mississippi has a 12-foot channel depth available approximately 85% of the time.

Preliminary Screening of Features and Components:

The formulation of alternatives began by identifying features and components within each feature that meet the planning objective of providing a safe, reliable, efficient, and sustainable navigation channel. Alternative formulation was started by identifying potential measures to achieve the study purpose and subjecting them to a screening process that resulted in the selection of the viable components that make up the alternatives. Both components and alternatives underwent detailed analysis.

The alternative development and analysis for this study included:

- Features. Features are broad actions that influence the attainment of the study purpose;
- Components. Components are one or more specific actions within a feature that address the attainment of the study purpose within a feature; and
- Alternatives. Alternatives are combinations of components, among one or more features, that specifically address the attainment of the study purpose.

<u>Navigation Channel Maintenance Feature:</u>
The proposed Maintenance Dredging and Disposal Action is to maintain the existing 9-foot navigation channel via the existing river training structure system and maintenance dredging.

As part of the ongoing operation and maintenance of the designated 9-foot navigation channel on the MKARNS, periodic dredging is required in some locations. Since the opening of the MKARNS in 1971, some approved dredged material disposal sites have reached capacity and new disposal sites are required to accommodate continued navigation channel maintenance activities. Other sites have sufficient capacity for continued maintenance dredging and disposal operations.

River training structures are also an important tool in maintaining navigation channel depth. The existing river training structure system on the MKARNS functions to reduce the need for maintenance dredging, however, new structures are periodically needed to facilitate the maintenance of the 9-foot navigation channel.

The screening process included the evaluation of a range of possibilities to determine the viable components to be considered for implementation. Based upon the review process, two components were selected for detailed analysis.

- Component 1: Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in Areas Approved in the 1974 O&M Plan (No Action Plan), and
- Component 2: Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in New Disposal Sites.

Common characteristics of these two components include:

- New disposal sites to accommodate continuing channel maintenance dredging (primarily in Oklahoma), and
- Construction of additional river training structures to facilitate the maintenance of the navigation channel (primarily in Arkansas).

Flow Management Feature:

On the MKARNS navigation traffic is severely restricted when flows reach 100,000 cubic feet per second (cfs) and tow owners generally reduce tow sizes when flows are above 60,000cfs. The proposed River Flow Management Action is to improve the safety and efficiency of commercial navigation operations by managing the MKARNS to limit periods of sustained high flows. This could be achieved by reducing the number of days when river flows exceed 100,000 cfs and the number of days exceeding 60,000cfs at Van Buren. In addition, other authorized project purposes, including flood control, recreation; hydropower; water supply; and fish and wildlife would be maintained.

The existing operation plan of the MKARNS has been in place since 1986. Key characteristics of the existing plan are:

- 150,000 cfs releases. When flood storage in the controlling reservoirs is above 10 percent in the spring or 18 percent the remainder of the year, releases from the reservoirs are set at approximately 150,000 cfs which corresponds to the 22-foot stage at Van Buren, AR.
- A 75,000 cfs bench. When the 11 controlling reservoirs' flood storage falls to within the range of 3 – 10 percent in the spring or 9 - 10 percent the rest of the year, the flow is held constant at 75,000 cfs at Van Buren, AR. The purpose of the bench is to accomplish water releases from flood storage while lowering the rate of release to below 80,000 cfs for the benefit of navigation and low-lying farms along the river.
- A taper operation of 40,000 cfs to 20,000 cfs. When the flood storage remaining in the 11 controlling reservoirs fall to below 3 percent in the spring, below 11 percent in the summer, or below 9 percent the remainder of the year; the target flow at Van Buren, AR is gradually reduced from 40,000 cfs to 20,000 cfs. Dredging operations can occur on the river to remove sediment deposited during high flows when flows fall below 40,000 cfs.

Twenty three possible components of the flow management feature were evaluated. These components were developed with input from local, State and Federal agencies, as well as the

public. These 23 components were compared using the USACE SUPER (Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System) Model. The SUPER Model program was run for each of the initial components. Key information derived by the model to screen each component included:

- River flow and duration,
- The 11 controlling reservoirs stage and duration, and
- Operational damages within the system (including to public and private lands)

Of the 23 river flow components, four operational components were evaluated in detail. With the exception of the No Action Component, the bench was changed from 75,000 cfs to 60,000 cfs. Flows of 60,000 cfs or less are considered optimum conditions for commercial navigation on the MKARNS. The river is still navigable even when there is no flow as a result of its pool designs. These components are summarized as follows:

- Component 1: No Action Component - This component would continue the existing operational plan as described above.
- Component 2: 175,000 cfs Component - This component would change the bench from 75,000 cfs to 60,000 cfs and increase the 150,000 cfs releases at Van Buren, AR to 175,000 cfs.
- Component 3: 200,000 cfs Component - This component would change the bench from 75,000 cfs to 60,000 cfs and increase the 150,000 cfs release at Van Buren, AR to 200,000 cfs.
- Component 4: Operations Only Component - This component would only change the 75,000 cfs bench to 60,000 cfs. By slowing releases from flood storage, this component would marginally increase the risk of exceeding capacity behind the dams in the event of repetitive high water rains.

Benefits for the flow management components were derived as follows: The first measure of shipper savings is the gain in efficiency resulting from a larger annual average tow size. The shipper savings benefit for navigation was computed for thirteen different towboat horsepower and tow size scenarios, representing the possible responses by the towing operators.

Interviews of the largest towing operators were conducted to determine if and how they would modify their towing operations under components 2, 3, and 4. The two largest operators, Jan Tran of Rosedale, MS, and Pine Bluff Sand and Gravel Company of Pine Bluff, AR represent more than 58% of the towing traffic by tonnage on MKARNS. Phone interviews were conducted with Jan Tran and Pine Bluff Sand and Gravel Company officials. The representatives of both firms stated that their tow configurations are sensitive to flows in the 60,000 – 80,000 cfs range. Jan Tran stated that when flows are below 60,000 cfs the company can increase tow size by a third. Pine Bluff Sand and Gravel stated that boats with an 8-barge configuration can increase to a 12-foot configuration below 75,000 cfs (measured at Little Rock, equivalent to 60,000 cfs at Van Buren). By reducing the frequency of flows above 60,000 cfs (measured at Van Buren), towing operators may have more stable water to depend upon and thus can operate more efficiently. According to historic data, the MKARNS provides sufficient flows at or below 60,000 cfs for approx 297 days per year. The proposed bench change from 75,000 cfs to 60,000 cfs would increase this by approximately 14 days per year.

Flow management benefits were calculated based on the anticipated increase in average tow configuration (barges per tow). Currently the average tow configuration for all traffic is 6.9 barges per tow, 9.3 for Jan Tran, and 9.4 for Pine Bluff Sand and Gravel Company. The formal calculation of potential benefits considered the benefit as if only Jan Tran and Pine Bluff Sand and Gravel added an average of three barges per tow during all efficient flows. This was further discounted in rounding the aggregate effect on river traffic from 1.42 to 1.0 (portrayed in Table E-2).

Table E-2. Calculating an Increase in Annual Average Tow Size		
Tow size Increase by JanTran and PBSG (tows)		3
Percent of MKARNS Tows	x	58%
MKARNS Tow size Increase During Efficient Flow		1.74
Percentage of Year with Efficient Flow	x	81%
Increase in Yearly Average Tow size for MKARNS		1.42
Current Yearly Average Tow size for MKARNS	+	6.9
New Yearly Average Tow size for MKARNS		8.32

The survey also asked operators if they would modify their towboat horsepower under the 2, 3, and 4 components. No towboat operators reported an expectation of shifting to higher or lower horsepower boats in response to the three flow management components.

Savings were calculated by multiplying the average transportation savings per ton that was estimated in the 2001 Flow Management Rate Study by the Tennessee Valley Authority (TVA) by the traffic forecasts. The average savings per ton for 2001 traffic was $0.49 although specific rates used varied by commodity. This savings per ton was multiplied by projected tonnage to compute the benefits of components 2, 3, and 4.

A second method for measuring the cost reductions from changes in the operating plan for the MKARNS is to measure the average number of navigation days gained by a new operating plan. At the present time, the MKARNS is closed between 20 and 40 days per year due to excessively high flow rates that stop navigation. A reduction in cost method was employed to estimate the towboat operator savings based upon a daily operator cost for tying up (lay-up) of the vessel and tow. Some of the components considered provide for flows above 150,000 cfs in order to reduce the number of days when navigation could not occur (100,000 cfs). Benefits for these high flows were based on the following formula.

Gained Days X (Daily Towboat + Barge Expense) X Number Boats = Annual Benefit

To calculate the total economic impact to navigation from flow management, the cost reduction from efficiency gain was added to the cost reduction from a change in operating days.

Component 1: No Action Component. The No Action component was considered in order to establish baseline conditions against which the other flow management components were evaluated and compared.

Component 2: 175,000 cfs Component (FM 175). There would be annual net benefits approximating $7.9 million under this component compared to No Action. Annual net benefits are defined as the total annual benefits minus total annual costs of the component. Positive economic benefits would be associated with navigation and hydropower. Negative economic impacts would be associated with real estate, tourism and recreation, non-agricultural and agricultural properties as a result of flooding from raising the release from 150,000 cfs to 175,000 cfs. Annual navigation benefits would approximate $9.2 million under this component, with the remaining annual benefits associated with hydropower ($1.3 million).

Tourism and recreation costs ($1.4 million) comprise over 50% the negative impacts under this component. Annual real estate costs would approximate an additional $0.7 million compared to No Action, while annual non-agricultural and agricultural property damages would approximate $0.5 million.

Component 3: 200,000 cfs Component (FM-200). There would be annual net benefits approximating $7.5 million under this component compared to No Action. Positive economic benefits would be associated with navigation and hydropower. Negative economic impacts would be associated with real estate, tourism and recreation, non-agricultural and agricultural properties as a result of flooding from the higher release. Annual navigation benefits would approximate $9.2 million under this component, with the remaining annual benefits associated with hydropower ($1 million).

Tourism and recreation costs ($0.8 million) comprise about 30% of the negative impacts under this component. Annual average real estate costs would approximate an additional $1.0 million compared to the No Action, while non-agricultural and agricultural property damages would approximate $1 million.

Component 4: Operations Only Component (FM-OPS). There would be annual net benefits approximating $8.8 million with the implementation of this component compared to No Action, and over $0.9 million greater annual net benefits than the 175,000 cfs component. Thus, Component 4 represents the flow management component that would provide the greatest annual net benefits. This is mainly because increased flows above 150,000 cfs would benefit navigation but at significant expense from increased flooding along the river basin.

Similar to 175,000 cfs and 200,000 cfs components, much of the net benefits would be associated with navigation and hydropower. Annual navigation benefits would approximate $8.4 million, comprising 95% of the benefits under this component. The remaining benefits would be associated with hydropower ($0.5 million).

Minor negative impacts would be associated with non-agricultural and agricultural properties, while there would be no change in economic impacts for real estate or tourism/recreation compared to No Action. Annual average non-agricultural and agricultural property costs would approximate only an additional $41,400 compared to No Action. This loss is due to briefly longer periods of inundation on a relatively small amount of low lying lands in Arkansas and Oklahoma.

Table E-3. Summary of Incremental Net Benefits and Costs Flow Management Components – Reaches 1 through 6 Average Annual Equivalent Values (July 2004 $) 5.375% Discount Rate, 50-year Period of Analysis			
	FM-175	**FM-200**	**FM-OPS**
Period of Analysis (years)	50	50	50
Construction Period (years)	1	1	1
Interest Rate (percent)	5.375%	5.375%	5.375%
Project First Costs[1, 2]	12,105,000	16,094,000	0
Interest During Construction	295,400	392,700	0
Total Project Cost	**$12,400,400**	**$16,486,700**	**$0**
Annual Costs:			
Interest	666,500	886,200	0
Amortization	52,500	69,000	0
Operations & Maintenance	0	0	0
Total Annual Costs	**$719,000**	**$955,900**	**$0**
Annual Benefits[3]:			
Navigation benefits	9,220,700	9,176,100	8,372,100
Recreation	-1,436,900	-790,200	0
Hydropower	1,340,000	1,056,000	466,000
Non-Ag. Property Damage			
Oklahoma	-1,800	-7,500	0
Arkansas	-171,200	-385,900	-17,100
Recreation Facilities OK	-76,500	-29,300	-5,500
Recreation Facilities AR	-13,800	-30,000	4,000
Ag. Property Damages			
Oklahoma	-119,500	-245,500	0
Arkansas	-144,800	-299,600	-18,800
Total Annual Benefits	**$8,596,200**	**$8,444,100**	**$8,800,700**
Net Benefits Compared to No Action	**$7,877,200**	**$7,488,119**	**$8,800,700**

[1] *Real Estate costs from Economic Appendix Table 4-1.*
[2] *Incremental Costs - costs in addition to those existing with current flow management.*
[3] *Incremental Benefits - benefits in addition to those existing with current flow management...*
Source: USACE, Tulsa and Little Rock Districts, Hydropower Analysis Center, Parsons.

Component 4, the Operations Only component, was the most favorable component among the flow management features. This component achieved the purpose with a positive benefit to cost ratio and minimal adverse environmental impacts. Implementation of this component is within the authority of the USACE Southwestern Division Commander. Additional meetings to acquire input from the public will be required prior to implementation but no additional analysis beyond

this report will be necessary. There are almost no costs associated with the implementation of this component. This is the only component of the flow management feature that was carried forward as part of the alternatives analyses and is a component of all dredging related alternatives.

While the component 4, Operations Only component, provides the greatest annual net benefits of the components analyzed, it should be noted that a part of the costs of this component is $18,800 of negative annual benefits to agricultural property in Arkansas. This component does not solve the problem of flooding in the unprotected areas outside the existing flood control levees at Fort Smith, Arkansas which was the purpose for conducting the original reconnaissance study. All examined components that solved the flooding problem were either cost prohibitive and/or created unacceptable impacts to other project purposes. It was determined that the areas being flooded in the Fort Smith Area should be examined under the Arkansas River Additional Land Acquisition Project for possible purchase of additional flowage easements or of the lands themselves. However, the Arkansas River Additional Land Acquisition Project was not funded in FY 05 and future funding appears doubtful. In the absence of funding, the possibility exists for some claims, although actual harm will be relatively small.

Navigation Channel Deepening Feature:

Navigation channel depth limits the potential efficiency and volume of commercial navigation operations on the MKARNS. The proposed Navigation Channel Deepening Action is to deepen the navigation channel to allow deeper draft tows to operate on the system. Other authorized project purposes, including flood control, recreation, hydropower, water supply, and fish and wildlife would be maintained.

This component set explores the options of deepening the navigation channel to 10, 11 or 12 feet and widening the Verdigris River portion of the system from 150 feet to 300 feet wide. To better assess the navigation channel deepening components, the MKARNS was divided into six river segments, from the mouth of the navigation system at the Mississippi River to the Port of Catoosa in Oklahoma. The six segments were selected based on locations of major ports and/or quarries. This makes analysis of the action comprehensive and flexible by providing the option of deepening the navigation channel only up to a certain segment on the system or the entire river, as appropriate.

The evaluation process for this feature included five components:

- Component 1: No Action
- Component 2: Navigation Channel Deepening to 10, 11, and 12 feet via Dredging and Training Structures,
- Component 3: Navigation Channel Deepening to 10, 11, and 12 feet via Pool Raising,
- Component 4: Navigation Channel Deepening to 10, 11, and 12 feet via a combination of Dredging, Training Structures, and Pool Raising, and
- Component 5: Verdigris River Navigation Channel Widening from 150 feet to 300 feet.

Component 1 - No Action. This component would take no action to deepen the channel or widen the Verdigris River.

Component 2 - Navigation Channel Deepening to 10, 11, and 12 feet via Dredging and Training Structures. These components consist of evaluating the deepening of the channel to 10, 11, or 12

feet at up to six separate segments of the MKARNS. Net benefits are defined as the total benefits minus total costs of the component. Negative net benefits indicate that total costs are greater than total benefits. Likewise, benefit to cost ratios (BCR) less than one indicate total costs are greater than total benefits. A BCR greater than one indicates that total benefits are greater than total costs. Total project cost for the 10, 11, and 12-foot channel is $97,053,100, $129,426,600, and $158,459,300, respectively. Table E-4 summarizes the net benefits of the channel deepening components.

Table E-4

Summary of Net Benefits of Final Channel Deepening Components

Navigation Depth	Mouth to River Segment					
	Mouth to Pine Bluff	**Mouth to Little Rock**	**Mouth to Dardanelle**	**Mouth to Fort Smith**	**Mouth to Muskogee**	**Mouth to Catoosa**
Component	N.M. 0.0 to N.M. 75.2 Reach 1	N.M. 0 to N.M. 119.5 Reaches 1-2	N.M. 0 to NM. 220.3 Reaches 1-3	N.M. 0 to N.M. 308.7 Reaches 1-4	N.M. 0 to N.M. 394.0 Reaches 1-5	N.M. 0 to N.M. 444.8 Reaches 1-6
No Action BCR Net Benefits ($)	 N/A N/A	 N/A N/A	 N/A N/A	 N/A N/A	 N/A N/A	 N/A N/A
10 Foot Channel BCR Net Benefits ($)	 0.15 -1,907,500	 0.18 -2,407,100	 0.28 -2,629,900	 0.23 -3,532,100	 0.20 -5,326,500	 0.51 -3,815,500
11 Foot Channel BCR Net Benefits ($)	 0.39 -1,475,900	 0.47 -1,693,100	 0.62 -1,613,300	 0.52 -2,649,800	 0.39 -5,319,100	 0.99 -33,700
12 Foot Channel BCR Net Benefits ($)	 0.46 -1,495,300	 0.56 -1,621,900	 0.66 -1,807,100	 .0.53 -3,266,900	 0.43 -6,097,600	 1.08 1,009,800

The following summarizes the findings:

- Economic benefits of deepening the navigation channel are achieved primarily by deepening the entire system and not portions of the system. Approximately two thirds of the benefits are realized in the upper most reach, Reach 6. The large quantity of grains going out of the Port of Catoosa and the large quantity of chemical fertilizers going into the Port of Catoosa are the main commodities that produce the benefits in Reach 6. Incremental deepening of the navigation channel on only lower portions of the MKARNS is not economically justified.
- Deepening the navigation channel to a depth of 10 feet is not economically justified as the BCR for this component is 0.56, which is below 1.0.
- Deepening the navigation channel by dredging and training structures to a depth of 11 feet achieves the purpose and there are no significant adverse impacts associated with this component. However, strictly interpreted this component is economically unjustified because it has a BCR of 0.99. Due to the limits of precise forecasting of feasibility level costs and benefits calculations it was assumed that this component of the navigation channel deepening features should be carried forward and would be included in the alternatives analyses.
- Deepening the navigation channel by dredging and training structures to a depth of 12 feet achieves the purpose, is economically justified with a positive BCR slightly above 1.0, and there are no significant adverse impacts associated with either component. Consequently,

this component of the navigation channel deepening features is also included in the alternatives analyses.

The disposal of dredge material associated with deepening the channel would occur frequently at existing approved disposal sites. However new disposal sites will be required at some locations along the MKARNS. The number of and area of new disposal sites for the 11 or 12-foot channel will be roughly the same for each depth, although the volume and rate of placement of dredge material placed in the disposal sites changes. It is estimated that initially 6.8 million cubic yard of material will need to be dredged to obtain a 11-foot minimum channel depth and the 11.0 million cubic yards of material will need to be dredged to obtain a 12-foot minimum channel depth. The anticipated amount of annual dredging for the 11 and 12-foot depths is , respectively. The number of new disposal sites within each river segment is as follows:

- 1-Mouth to Pine Bluff 2 new dredge material disposal sites
- 2-Pine Bluff to Little Rock 2 new dredge material disposal sites
- 3-Little Rock to Dardanelle 2 new dredge material disposal sites
- 4-Dardanelle to Fort Smith 0 new dredge material disposal sites
- 5-Ft Smith to Muskogee 20 new dredge material disposal sites
- 6-Muskogee to Catoosa 15 new dredge material disposal sites

Total MKARNS 41 new dredge material disposal sites

Dikes, revetments, and weirs have been used successfully as river training structures on the MKARNS for many years. Dikes and weirs are used to control the depth and location of the main channel thalweg. Dikes are used to maintain desired channel depths and weirs are used to maintain channel widths. Revetments are used to maintain the river channel alignment by stabilizing or protecting the channel bank line from erosion and caving. Dikes run perpendicular to the river while revetments run parallel. Currently, there are 1,314 existing river training structures and 295 revetments on the MKARNS. Under the 11 or 12-foot component there would be a 7% increase in the number of new river training structures and a 0.3% increase in the number of new revetments along the MKARNS. The number of new river training structures and revetments for the 10, 11, or 12-foot channel will be the same for each depth, although the size of the structures changes. The number of new and modified river training structures and revetments are as follows:

- 1-Mouth to Pine Bluff 4 new weirs and 21 modified dikes
- 2-Pine Bluff to Little Rock 30 new and 4 modified dikes
- 3-Little Rock to Dardanelle 5 and 34 modified dikes
- 4-Dardanelle to Fort Smith 6 and 28 modified dikes
- 5-Ft Smith to Muskogee 44 new and 0 modified dikes
- 6-Muskogee to Catoosa 0 new or modified dikes

Total MKARNS 4 new weirs and 85 new and 87 modified dikes

- 1-Mouth to Pine Bluff 0 new and 9 modified revetments
- 2-Pine Bluff to Little Rock 1 new and 0 modified revetments

- 3-Little Rock to Dardanelle 0 new and 1 modified revetment
- 4-Dardanelle to Fort Smith 0 new and 6 modified revetments
- 5-Ft Smith to Muskogee 0 new or modified revetments
- 6-Muskogee to Catoosa 0 new or modified revetments

Total MKARNS 1 new and 16 modified revetments

To assess the impacts of deeper draft barges on the existing locks, a prototype test at Lock 2 was conducted by the Corps' Engineering Research and Development Center (ERDC). This testing at Lock 2 led to the following findings: for barges that draft 11.5´ (the maximum draft on a 12-foot channel depth is 11.5 feet): (1) There will be a negligible chance of the barges striking the downstream lock sill when the minimum expected tailwater depth of 14´ occurs at the MKARNS projects. A minimum 14-foot depth over the lock sills is maintained at all times and is not affected by changes under consideration by this study. (2) It is highly unlikely that the barges will strike the downstream lock sill at Lock #2 due to surging in the canal (surging does not occur at locks outside the Arkansas Post Canal). (3) Some operational changes at Lock #2 will be required in order to reduce the chance of a barge striking the upstream miter gate. (4) With operational changes to slow the movement of heavier barges in and around the locks, the risk of increased damage from barge strikes is minimal. However additional analysis will be performed during the Pre-construction Engineering and Design (PED) phase (5) The current filling and emptying operations will be satisfactory for all the side port system locks, except the Ozark and Webbers Falls projects due to the greater lifts of 34´ and 30´, respectively. It is not anticipated that this will affect the potential for 11.5-foot draft traffic although further modeling will be required. ERDC recommends using the numerical models HAWSER and LOCKSIM to determine the impacts to hawser forces and lock filling and emptying times for these projects. This modeling will also be performed in the PED phase of the project.

Locks on the Arkansas part of the MKARNS have tow haulage systems. This equipment was not designed to pull the deeper draft barges. Additional costs are included in the cost estimates to account for the expected increase in operations and maintenance expenses.

Component 3 - Navigation Channel Deepening to 10, 11, and 12 feet via Pool Raising.
Opposition to raising the pool elevations to achieve additional navigation depth was one of the leading comments received during the public scoping meets for this study.

An evaluation of raising the pool elevations to achieve an additional 1, 2, or 3 feet of navigation depth showed this component to be more expensive at each pool as compared to dredging and training structures. The environmental consequences, based on additional land acquisition and subsequent environmental impacts, and the economic impacts due to additional land costs, costs of modifying the lock and dams to handle the increased pool elevation, and the costs to modify existing bridges to maintain required clearances are substantially higher than dredging and construction of training structures. Reallocation of the power pools in two navigation pools in Oklahoma to accommodate deeper draft vessels was also considered. However, the loss of hydropower would be significant. The minimal gains in depth in these pools that would be achieved through such a reallocation are surpassed by the value of the loss in power capacity and other costs. Therefore, navigation channel deepening via pool raising was eliminated from further consideration.

Component 4 - Navigation Channel Deepening to 10, 11, and 12 feet via a combination of Dredging, Training Structures, and Pool Raising. Navigation channel deepening via a combination of dredging and pool raising consists of additional dredging, additional river training structures such as dikes, and raising pool levels to achieve an additional depth of 1, 2, and 3 feet. A variety of combinations of dredging and pool raising were considered. Like the pool raising action alone, this would result in additional flooding in surrounding land upstream of each of the dams. Modifying the existing infrastructure and purchasing flooding easements along the river would be cost prohibitive. Therefore, a combined pool raising/dredging plan was not justified and was eliminated from further consideration.

Component 5 - Verdigris River Navigation Channel Widening from 150 feet to 300 feet. Preliminary estimates for widening the Verdigris River were $100,000,000 not including contingencies or real estate costs. The economic benefits of widening would involve reducing delays, which have been determined to be minimal under existing and near future conditions. Consequently, the preliminary economic costs greatly exceed any benefits that would be realized and widening the Verdigris River was eliminated from further consideration.

Formulation of Alternatives:

Alternatives were developed based upon the analyses of the features and components. Alternatives, including the No Action Alternative, were developed by combining components of the three features to achieve, in varying degrees, the proposed action. Table E-5 summarizes the components used in the five alternatives selected for evaluation.

Table E-5. Components of Decision Alternatives				
	Navigation Channel Maintenance*	**Flow Management Operations Only**	**Navigation Channel Deepening 11 Ft.**	**Navigation Channel Deepening 12 Ft.**
Alternative A No Action (Dredge disposal sites approved in 1974)	**X**			
Alternative B Maintenance Only (New dredge disposal sites including those in-stream)	**X**			
Alternative C Maintenance & Ops Only Flow Management	**X**	**X**		
Alternative D Maintenance & Ops Only Flow Management & 11 Foot Navigation Channel	**X**	**X**	**X**	
Alternative E Maintenance & Ops Only Flow Management & 12 Foot Navigation Channel	**X**	**X**		**X**

* Navigation channel maintenance activities would occur in the same manner under Alternatives B, C, D, and E. The Navigation channel depth to be maintained would be 9 feet for Alternatives A, B and C, 11 feet for Alternative D, and 12 feet for Alternative E.

Source: USACE 2005

As a result of comments made during the public review period of the draft EIS and feasibility report, the descriptions and definitions of Alternatives A and B have been clarified. The key purpose of the Arkansas River Navigation Study is to improve navigation efficiency in the MKARNS. The study analysis has been geographically extensive and involves many aspects of the navigation system that have been operating for decades. The MKARNS is part of an evolving ecosystem that includes a complex, intrinsically interrelated mosaic of riverine, riparian, wetland and floodplain habitats. Modifications to the MKARNS may come from engineering actions within the direct control of the Corps, or from actions or changes made outside the direct control of the Corps. All of the navigation efficiency improvements considered in the study may be implemented in compliance with existing environmental protection statutes and without additional congressional authority. Given the inherent degree of variation and complexity conditioning the natural and human-made environments in which modifications may be made, and also given the uncertainty about which changes may be made absent one of the actions proposed in the final array of alternatives, the Corps has determined that in this instance, it would best serve the purposes of the National Environmental Policy Act

to also present and to evaluate what may occur if none of the proposed actions are implemented. The clarified descriptions and definitions of Alternatives A, B, C, D, and E are as follows:

Alternative A – Navigation Channel Maintenance (No Action). Alternative A is based on measures that are currently in place and available for implementation with minimal additional administrative action. This alternative assumes that the existing 9-ft channel would be maintained throughout the period of analysis using dredging techniques and disposal areas described in the 1974 Operations and Maintenance Plan (O&M plan) for which an EIS was prepared and a ROD signed.

Subsequent to, and in accordance with the 1974 O&M plan, in-river disposal of dredge materials has been used in Arkansas with the exception of the White River Entrance Channel, where terrestrial sites are utilized. Terrestrial disposal sites have also been acquired for use as needed in Oklahoma. These designated sites are sufficient to contain the dredge material projected to be required through the 50-year period of analysis used in 1974. However, projections indicate that the currently used terrestrial sites in Oklahoma would not be adequate to meet disposal area needs through the 50-year period of analysis for the present study, i.e., 2010 through 2060. Additional currently unused disposal areas in Oklahoma that were approved in the 1974 O&M plan, would be needed to meet the projected dredge material disposal needs to maintain a 9-ft channel through 2060. Natural succession of habitats in these unused disposal sites has occurred for approximately three decades. These areas are now covered by substantial tracts of mature floodplain forests that are essential components to the region's complex mosaic of riparian, wetland, and floodplain habitats. Use of the previously approved sites would require additional NEPA documentation and additional coordination with Federal and state fish and wildlife management agencies because of the significant changes in the habitats of the dredge material disposal sites. Given the increased emphasis on the importance of high quality floodplain habitats since 1974, it is reasonable to assume that substantial mitigation would be necessary. In addition, under provisions of the Clean Water Act, the Oklahoma portion of the MKARNS has been designated an impaired stream. As a designated impaired stream, in-river dredge material disposal in the Oklahoma reach has been closely regulated by the State of Oklahoma, and rarely, if ever, allowed to occur. Alternative A assumes that the impaired stream designation is not likely to be changed in the immediate future, and also assumes that in-river dredge material disposal in the Oklahoma reach of the MKARNS would not be allowed by the State of Oklahoma. This alternative also assumes that disposal of dredge material on the Arkansas portion of the MKARNS would continue in accordance with the 1974 O&M plan.

Alternative A presents a projection of future conditions that accounts for and considers uncertainties about future changes in operation and maintenance of the navigation system, without the measures considered in the "with action alternatives" (Alternatives C, D and E). This scenario, although conservative, provides a reasonable perspective that accentuates the significance of adverse effects to the natural environment. Since no significant changes to the current approved 1974 O&M plan are proposed, Alternative A is titled and considered the "no action alternative." Key features and assumptions of Alternative A are:

- Maintenance of the 9-ft channel by dredging would continue throughout the MKARNS.
- There would be no change in reservoir releases or channel deepening.
- Dredge materials would be disposed in existing designated dredge material disposal sites.

- Upland dredge material disposal sites in Oklahoma and in-river sites in Arkansas would be extended in accordance with the approved 1974 O&M plan, and supplementing the Operations and Maintenance EIS.
- Modifications incidental to dredging operations of existing wing dikes, revetments, etc., would continue.
- Only measures within current authority and established practices would be considered.

Alternative B – Navigation Channel Maintenance. Alternative B includes consideration of all the measures included in Alternative A, except that it assumes that in-river disposal of dredge materials would be allowed in Oklahoma. Unused upland dredge material disposal sites, approved in the 1974 O&M plan, would not be utilized and the need to mitigate adverse effects to these now valuable sites would be avoided. Alternative B assumes that essentially all future disposal in Oklahoma would be in-river, in currently used terrestrial sites, or in newly identified terrestrial sites of low habitat value. Future disposal in Arkansas would continue to be instream except on the White River Entrance Channel where terrestrial sites are, and would continue to be utilized. Due to the higher expected mitigation costs and other environmental impacts of Alternative A, Alternative B is more likely to occur. Given this, Alternative B is the plan against which Alternatives C, D, and E, are compared economically. Key features and assumptions of Alternative B are:

- Maintenance of the 9 ft channel by dredging would continue throughout the system.
- There would be no change in reservoir releases or channel deepening.
- Dredge materials would be disposed in existing designated dredge material disposal sites to the extent practicable, consistent with current statutes, regulations, and policies.
- Upland dredge material disposal sites in Oklahoma and Arkansas would be extended or added by amending the approved 1974 O&M plan, and supplementing the Operation and Maintenance EIS.
- Modifications incidental to dredging operations of existing wing dikes, revetments, etc. would continue.
- Measures within current authority and established practices would be considered, and in-river disposal of dredge materials would be allowed in both Oklahoma and Arkansas.

Alternative C - Navigation Channel Maintenance and Operations Only Flow Management. Alternative C consists of adding new dredged material disposal sites in Oklahoma to further supplement disposal site capacity as described in Alternative B, which will reach capacity at some locations in the near future and replacing the existing flow management plan with the Operations Only Flow Management Plan. The existing depth of the navigation channel would remain unchanged. This alternative would also continue to construct and maintain dikes, revetments, and other training structures necessary to maintain the existing 9-foot channel depth.

Alternative D - Navigation Channel Maintenance, Operations Only Flow Management, and 11 Foot Navigation Channel. Alternative D consists of 1) adding new dredged material disposal sites in Oklahoma to further supplement disposal site capacity which will reach capacity at some locations in the near future, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 11 feet.

Alternative E - Navigation Channel Maintenance, Operations Only Flow Management, and 12 Foot Navigation Channel. Alternative E consists of 1) adding new dredged material disposal sites in Oklahoma to further supplement disposal site capacity which will reach capacity at some locations in the near future, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 12 feet.

Evaluation of Alternatives:

Alternative A – No Action: The following characterizes what would occur for each study feature/component under the No Action Alternative:

- Navigation Channel Maintenance: Existing dredging and disposal to maintain the 9' navigation channel would continue. Dredged material would continue to be disposed of at existing sites until they reached their holding capacity. Only disposal sites approved in the 1974 O&M plan would be used, with additional costs due to mitigation requirements.
- Flow Management: The existing river flow management plan would be used.
- Navigation Channel Depth: The current 9' navigation channel would be retained along the entire MKARNS.

In-stream disposal was not approved by the Oklahoma Department of Environmental Quality in Oklahoma when the Operation and Maintenance Program, 1974 EIS was approved. Therefore, future dredge material would have to be deposited in inactive terrestrial sites identified and approved in the 1974 EIS. Many of the terrestrial sites approved in the 1974 EIS have not been utilized since creation of the navigation channel and contain mature vegetation. Utilizing these sites would require significant reworking and additional mitigation for terrestrial impacts.

Alternative B – Navigation Channel Maintenance Only: This alternative, from an economic standpoint, is representative of the without project condition; the continuation of maintenance dredging and dredge disposal in existing sites, in new low habitat value sites, and in-stream are the most likely condition expected to exist in the future in the absence of this study. The future without project condition (Alternative B) constitutes the benchmark against which other alternatives are evaluated in the feasibility study.

Alternative C - Navigation Channel Maintenance and Operations Only Flow Management: Annual incremental net benefits would be $8.8 million with Alternative C compared to Alternative B. Much of the positive incremental net economic benefits would be associated with navigation and hydropower. Incremental net annual navigation economic benefits would approximate $8.4 million, comprising 95% of the annual incremental net economic benefits under this alternative. The remaining incremental net annual positive economic benefits would be associated with hydropower ($0.5 million). Table E-6 summarizes the information.

Table E-6. Summary of Incremental Net Benefits and Costs Alternative C Average Annual Equivalent Values (July 2004 $) 5.375% Discount Rate, 50-year Period of Analysis	
	Flow Management Operations
Period of Analysis (years)	50
Construction Period (years)	1
Interest Rate (percent)	5.375%
Project First Costs[1]	0
Interest During Construction	0
Total Project Cost	**$0**
Annual Costs:	
Interest	0
Amortization	0
Operations & Maintenance	0
Total Annual Costs	**$0**
Annual Benefits[2]:	
Navigation	8,372,100
Recreation	0
Hydropower	466,000
Non-Ag. Property Damage	
Oklahoma	0
Arkansas	-17,100
Recreation Facilities OK	-5,500
Recreation Facilities AR	4,000
Ag. Property Damages	
Oklahoma	0
Arkansas	-18,800
Total Annual Benefits	**$8,800,700**
Incremental Net Benefits for Flow Management Component	$8,800,700
Incremental Net Benefits for Alternative C over Alternative B	**$8,800,700**
Benefit-to-Cost Ratio for Flow Management Component	incalculable
Benefit-to-Cost Ratio for Alternative C	**incalculable**

[1] *Incremental Costs - costs in addition to those existing under Alternative B.*

[2] *Incremental Benefits - benefits in addition to those existing under Alternative B.*

Source: USACE, Tulsa and Little Rock Districts, Hydropower Analysis Center, Parsons.

Alternative D - Navigation Channel Maintenance, Operations Only Flow Management, and 11 Foot Navigation Channel: For Alternative D, annual benefits equal $19.0 million. Annual net benefits equal $8.8 million with the implementation of this alternative as compared to Alternative B. The major economic benefit would come from navigation savings. These savings result from lowering the transportation cost associated with commodities such as grains, chemical fertilizers, gravel, etc. that are able to capitalize on efficiencies by loading barges to a deeper depth. The remaining economic benefits would come from hydropower ($0.5 million).

For Alternative D, major costs are associated with the construction of new dikes and jetties ($28.1 million), dredging and rock removal ($24.1 million), construction of dredge disposal areas ($27.1 million), and environmental mitigation ($23.7 million). Increased O&M costs for Alternative D equal $2.2 million. Average annual costs for Alternative D equal $10.2 million, providing a benefit-to-cost ratio of 1.9. The benefit-to-cost ratio for the 11-foot channel deepening component alone is 0.99. Table E-7 summarizes the information.

Annual incremental net benefits would be $8.8 million with Alternative D compared to Alternative B.

Table E-7. Summary of Incremental Net Benefits and Costs Alternative D Average Annual Equivalent Values (July 2004 $) 5.375% Discount Rate, 50-year Period of Analysis			
	Flow Management Operations	**Channel Deepening 11′**	**Alternative D**
Period of Analysis (years)	50	50	
Construction Period (years)	1	4	
Interest Rate (percent)	5.375%	5.375%	
Project First Costs[1]	$0	$123,356,100	$123,356,100
Interest During Construction	0	13,568,500	$13,568,500
Associated Non-Federal Requirements:			
Local Facilities	0	530,000	$530,000
Local Facilities IDC	0	58,300	$58,300
Total Project Cost	**$0**	**$137,512,900**	**$137,512,900**
Annual Costs:			
Interest	0	$7,391,300	$7,391,300
Amortization	0	581,800	$581,800
Operations & Maintenance	0	2,234,100	$2,234,100
Total Annual Costs	**$0**	**$10,207,200**	**$10,207,200**
Annual Benefits[2]:			
Navigation	8,372,100	10,173,500	$18,545,600
Recreation	0	0	$0
Hydropower	466,000	0	$466,000
Non-Ag. Property Damage			
Oklahoma	0	0	$0
Arkansas	($17,100)	0	($17,100)
Recreation Facilities OK	($5,500)	0	($5,500)
Recreation Facilities AR	4,000	0	$4,000
Ag. Property Damages			
Oklahoma	0	0	$0
Arkansas	($18,800)	0	($18,800)
Total Annual Benefits	**$8,800,700**	**$10,173,500**	**$18,974,200**
Incremental Net Benefits for Components	$8,800,700	($33,700)	
Incremental Net Benefits for Alt. D over Alt. B			**$8,767,000**
Incremental Benefit-to-Cost Ratio for Components	incalculable	0.99	
Benefit-to-Cost Ratio for Alt. D over Alt. B			**1.9**

[1] *Incremental Costs - costs in addition to those existing under Alternative B.*

[2] *Incremental Benefits - benefits in addition to those existing under Alternative B.*

Source: USACE, Tulsa and Little Rock Districts, Hydropower Analysis Center, Parsons.

Alternative E - Navigation Channel Maintenance, Operations Only Flow Management, and 12 Foot Navigation Channel: For Alternative E, annual benefits equal $22.4 million. Annual net benefits equal $9.8 million with the implementation of this alternative as compared to Alternative B. The major economic benefit would come from navigation savings. These savings result from lowering the transportation cost associated with commodities such as grains, chemical fertilizers, gravel, etc. that are able to capitalize on efficiencies by loading barges to a deeper depth. The remaining economic benefits would come from hydropower ($0.5 million).

For Alternative E, major costs are associated with the construction of new dikes and jetties ($38.9 million), dredging and rock removal ($30.7 million), construction of dredge disposal areas ($31.7 million), and environmental mitigation ($23.7 million). Increased O&M costs for Alternative E equal $2.8 million. Average annual costs for Alternative E equal $12.5 million, providing a benefit-to-cost ratio of 1.8. The incremental benefit-to-cost ratio for the 12-foot channel deepening component alone is 1.08. Table E-8 summarizes the information.

Annual incremental net benefits would be $9.8 million with Alternative E compared to Alternative B. These annual incremental net benefits are composed of $8.8 million from the Flow Management Component and $1.0 million from the 12-foot Channel Deepening Component.

Table E-8. Summary of Incremental Net Benefits and Costs Alternative E Average Annual Equivalent Values (July 2004 $) 5.375% Discount Rate, 50-year Period of Analysis			
	Flow Management Operations	**Channel Deepening 12′**	**Alternative E**
Period of Analysis (years)	50	50	
Construction Period (years)	1	4	
Interest Rate (percent)	5.375%	5.375%	
Project First Costs[1]	$0	$148,966,200	$148,966,200
Interest During Construction	0	16,385,400	$16,385,400
Associated Non-Federal Requirements:			
Local Facilities	0	961,200	$961,200
Local Facilities IDC	0	105,700	$105,700
Total Project Cost	**$0**	**$166,418,500**	**$166,418,500**
Annual Costs:			
Interest	0	$8,945,000	$8,945,000
Amortization	0	704,100	$704,100
Operations & Maintenance	0	2,823,700	$2,823,700
Total Annual Costs	**$0**	**$12,472,800**	**$12,472,800**
Annual Benefits[2]:			
Navigation	8,372,100	$13,482,600	$21,854,700
Recreation	0	0	$0
Hydropower	466,000	0	$466,000
Non-Ag. Property Damage			
Oklahoma	0	0	$0
Arkansas	($17,100)	0	($17,100)
Recreation Facilities OK	($5,500)	0	($5,500)
Recreation Facilities AR	4,000	0	$4,000
Ag. Property Damages			
Oklahoma	0	0	$0
Arkansas	($18,800)	0	($18,800)
Total Annual Benefits	**$8,800,700**	**$13,482,600**	**$22,283,300**
Incremental Net Benefits for Components	$8,800,700	$1,009,800	
Incremental Net Benefits for Alt. E over Alt. B			**$9,810,500**
Incremental Benefit-to-Cost Ratio for Components	incalculable	1.08	
Benefit-to-Cost Ratio for Alt. E over Alt. B			**1.8**

[1] *Incremental Costs - costs in addition to those existing under Alternative B.*

[2] *Incremental Benefits - benefits in addition to those existing under Alternative B.*

Source: USACE, Tulsa and Little Rock Districts, Hydropower Analysis Center, Parsons.

Impacts/Mitigation:

Mitigation measures will be implemented by the USACE to eliminate or reduce the impact of adverse impacts as defined in 40 CFR 1508.20.

Biological Resources: Mitigation would be conducted for adverse impacts associated with implementing the proposed action. Mitigation for terrestrial and aquatic impacts would consist of a combination of avoidance, minimization, and compensation. The mitigation has been developed in coordination with the USFWS, Arkansas Game and Fish Commission (AGFC), and the Oklahoma Department of Wildlife and Conservation (ODWC). The terrestrial habitat mitigation plan has been thoroughly evaluated. The mitigation plan provides for significant further study of habitat to be used to adapt mitigation features in conjunction with close interagency coordination. Mitigation would be associated with:

- Terrestrial habitat loss associated with the disposal of dredged material;
- Aquatic resources impacts and habitat loss associated with dredging and dredged material disposal;
- Aquatic habitat loss associated with raising and extending dikes and revetments; and
- Federal threatened and endangered species.

Cultural Resources: USACE has determined that Feasibility Study-related activities may have a minor effect upon properties potentially eligible for inclusion in the National Register of Historic Places (NRHP), and has consulted with the Arkansas State Historic Preservation Officer (SHPO), the Oklahoma SHPO, and the Oklahoma Archaeological Survey (OAS). USACE and the Arkansas SHPO agree that subsequent to completion of the NEPA documentation, Programmatic Agreements (PA) shall be implemented to satisfy the USACE's Section 106 responsibility for all individual aspects of the Feasibility Study.

A PA will be prepared and implemented by the Little Rock USACE for the identification, evaluation and treatment of cultural resources adversely affected by the Proposed Action on the MKARNS in Arkansas. The PA is reproduced in Appendix D of this Environmental Impact Statement (EIS).

Implementation of the PA will serve as mitigation and as such will reduce the level of potential impact to cultural resources to below the significance threshold. Significant cultural resources are not expected to be discovered since most of the channel areas that will be subject to dredging have previously been dredged. Tulsa USACE, the Oklahoma SHPO, and the OAS will coordinate on a case by case basis and that will serve as mitigation in Oklahoma.

Mitigation Costs: The total estimated current cost for mitigation is $23.7 million for alternatives D and E and this is included in the project costs. The cost of mitigation is approximately the same for the 11 and 12-foot components because the extent of mitigation is based on the area to be dredged and not its volume.

National Economic Development (NED) Plan

The plan that reasonably maximizes net national economic development benefits, consistent with the Federal objective, is identified as the NED plan. Alternative E produces the highest annual net benefits of approximately $9.8 million. Alternative D produces annual net benefits of approximately $8.8 million; Alternative C produces annual net benefits of approximately $8.8 million. The plan that maximizes net NED benefits is Alternative E. Therefore Alternative E is identified as the NED plan.

Recommended Plan

In keeping with the NED objective of water resources planning, the plan that has the greatest excess benefits over cost, the NED plan, will be selected for implementation unless there are compelling reasons not to do so. Although Alternative B is the environmentally preferred plan since it would cause the least environmental impacts, Alternative E would fully mitigate for environmental impacts related to its implementation. There are no compelling reasons to select another alternative and therefore, the NED plan, Alternative E (Navigation Channel Depth Maintenance, Operations Only Flow Management, and 12´ Navigation Channel), is also the recommended plan. Given the large benefits of the flow management feature without costs, and the B:C ratio near unity of the deepening feature, it would be appropriate to adopt the flow management feature promptly, even if policy and funding consideration of the deepening feature is incomplete.

Risk and Uncertainty

Uncertainty and variability are inherent in water resources planning. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. Some future economic, hydrologic, and meteorological events are essentially unpredictable because they are subject to random influences. If there is a historical database that is applicable to the future, distributions can be described or approximated by objective techniques. If there is no such historical database, the probability of random future events can be described subjectively, based upon the best available insight and judgment. Conservative assumptions were generally used throughout this feasibility study and EIS where uncertainties were present to assure on balance that economic calculations do not overstate benefits and environmental calculations do not understate impacts.

Implementation:

Authority: Authority for project implementation is included in Section 136 of the Energy and Water Development Appropriations Act of 2004 (Section 136 of Public Law 108-137), which authorized a project depth of 12 feet. Since the MKARNS is designated as part of the Inland Waterway System, the initial construction costs for improving the MKARNS will be cost shared 50-50 with the Inland Waterway Trust Fund. The Federal Government will be responsible for operation and maintenance of the navigation channel. Port operators will be responsible for modifying and maintaining existing port facilities to realize the benefits offered by modifications to the MKARNS. The FY05 Omnibus Bill contained $7,000,000 of O&M funds to begin work

on deepening the channel; however, the Act incorrectly cited Public Law 108-357. Congress has since passed a technical correction citing the correct Public Law (P.L. 108-137). Once the feasibility report and EIS are final, and the ROD has been signed, these O&M funds will be used to initiate mitigation, dredging, and dike/revetment work. Work will begin to initiate the flow management changes as soon as the feasibility report and EIS are final and the ROD has been signed. Should additional funding not be forth coming for the project, it would still be appropriate to implement the new flow management plan due to its high benefit without new costs.

EIS: The Final EIS was produced in parallel with this feasibility study, dated August 2005, and was prepared in accordance with the requirements of the National Environmental Policy Act, regulations promulgated by the President's Council on Environmental Quality (40 CFR 1500-1508), and Engineering Regulations. The analysis of environmental consequences indicates that implementation of any of the alternatives would not produce net significant adverse effects to the human environment, either by itself, or through cumulative effects.

Schedule: A Director's Report is scheduled for completion in September 2005. Plans and specifications are scheduled to be initiated in September 2005. Construction can begin in October 2005. Assuming optimum funding, it is anticipated that construction will take a minimum of four years and will be based on the rate at which funds are provided. Longer periods of construction would result in cost increases. If construction of Alternative E were to extend beyond seven years the BCR would fall slightly below 1.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modification and will be afforded an opportunity to comment further.