Chapter 3
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ALTERNATIVES

3.1 Introduction

The proposed action is to maintain and improve the navigation channel in order to enhance commercial navigation on the McClellan Kerr Arkansas River Navigation System (MKARNS), while maintaining the other MKARNS 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 MKARNS. These three features are:

- Navigation Channel Depth Maintenance;
- River Flow Management; and
- Navigation Channel Deepening.

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 MKARNS navigation channel. Alternative formulation was an iterative process that started by identifying potential measures to achieve the proposed action. The initial analysis and formulation process focused on the ability of the components to achieve the features' goals. Environmental evaluation took place at the component and alternative stage. 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 proposed action;
- **Components.** Components are one or more specific actions within a feature that address the attainment of the proposed action within a feature; and
- **Alternatives.** Alternatives are combinations of components, among one or more features, that specifically address the attainment of the proposed action. Selection of the preferred alternative to implement the proposed action is the "Decision to be Made" by the US Army Corps of Engineers (USACE).

The following sections provide a description of this process for the evaluation of features and components and the development of alternatives for consideration to achieve the proposed action.

3.2 Features and Components Development and Evaluation

3.2.1 Navigation Channel Depth Maintenance Feature

3.2.1.1 Proposed Action

Current commercial navigation operation on the MKARNS requires the maintenance of a minimum 9-foot navigation channel throughout the system from the Port of Catoosa to the Mississippi River. The maintenance of the navigation channel is accomplished via 1) a series of "river training structures" and 2) navigation channel maintenance dredging at locations where sediment accumulates within the navigation channel to a point where the navigation channel would be less than 9 feet in depth without dredging. The proposed Maintenance Dredging and Disposal Action is to maintain the navigation channel via the existing river training structure system and maintenance dredging. In addition, other authorized project purposes, including flood control, recreation, hydropower, water supply, and fish and wildlife would be maintained.

As part of the ongoing operation and maintenance of the designated navigation channel on the MKARNS, periodic dredging is required in some locations within the river. Since the completion of the MKARNS in 1971, some authorized maintenance dredged material disposal sites have reached capacity and new disposal sites are required to accommodate continued navigation channel maintenance activities. While some authorized dredged material sites (primarily in Oklahoma) have reached capacity, many 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 may be warranted to facilitate the maintenance of the navigation channel.

3.2.1.2 Navigation Channel Depth Maintenance Components Considered

The components screening process included the evaluation of a range of components. The components include disposing of dredge material only in active disposal sites component, as well as two viable implementation components. This evaluation process considered the following component actions:

- Use of Only Active Disposal Sites; Eventual Cessation of Maintenance Dredging;
- Maintenance Dredged Material Disposal via Transportation to Selected Approved Sites;
- Maintenance Dredged Material Disposal at any Approved Sites in Original Operations and Management (O&M) Plan; and

- Maintenance Dredged Material Disposal at New Disposal Sites.

A description of each preliminary component considered is presented in the following paragraphs.

3.2.1.2.1 Use of Only Active Disposal Sites; Eventual Cessation of Maintenance Dredging

This component includes the cessation of maintenance dredging in navigation channel locations once the existing disposal area capacity of the river segment has been reached. Additional river training structures would then be constructed in an attempt to maintain the navigation channel at a minimum 9-foot depth in lieu of dredging.

This potential project component was evaluated for its ability to achieve the intent of the proposed action as well as its anticipated cost to implement. In consideration of the economic costs and the potential inability of this component to maintain a 9-foot navigation channel without maintenance dredging, the cessation of maintenance dredging component does not generate enough tangible and intangible benefits to merit further evaluation for development.

At this time, this component is not viable or practical and will not be evaluated as part of this study.

3.2.1.2.2 Maintenance Dredged Material Disposal via Transportation to Selected Approved Sites in Original O&M Plan

This component would involve the transportation of dredged material from locations on the river where disposal capacity has been reached to areas where sufficient capacity remains. Areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided wherever practical.

This potential project component was evaluated for its ability to achieve the intent of the proposed action as well as its anticipated cost to implement. In consideration of the economic and environmental costs associated with the transportation of dredged material by barge or truck from one location along the river to another, this component does not generate enough tangible and intangible benefits to merit further evaluation for further development.

At this time, the transportation of dredged material component is not viable or practical and will not be evaluated as part of this study.

3.2.1.2.3 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan

Under this component the disposal of dredged materials to maintain the navigation channel would continue at the existing approved disposal sites. After currently utilized disposal sites reach their capacity, dredged material would be disposed of at unused sections within areas approved in the 1974 O&M Plan and Environmental Impact Statement (EIS), regardless of the quality or type of habitat present. However, the distance that dredged materials would be transported would not exceed a one-mile radius of the site of removal.

In addition to the continuation of maintenance dredging operations, this component also includes the construction of new river training structures to facilitate the maintenance of the 9-foot navigation channel. This component was evaluated in detail in this EIS (see Chapter 3.3.3).

3.2.1.2.4 Maintenance Dredged Material Disposal in New Disposal Sites

Under this component existing dredging and disposal to maintain the navigation channel would continue. After currently utilized dredged material disposal sites reach their capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term Dredged Material Management Plan. Under this component, areas with high quality habitat such as forest, wetlands, and grassland would be avoided wherever practical. However, the distance that dredged materials would be transported would not exceed a one-mile radius of the site of removal.

In addition to the continuation of maintenance dredging operations, this component also includes the construction of new river training structures to facilitate the maintenance of the navigation channel. This component was evaluated in detail in this EIS (see Chapter 3.3.3).

3.2.1.3 Navigation Channel Depth Maintenance Components to be Assessed in Detail

Based upon the components review process detailed in the preceding pages, three components were selected for detailed analysis. The components include the No Action Component as well as two viable implementation components.

- Component 1: No Action Component;
- Component 2 Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan; and
- Component 3 Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in New Disposal Sites.

These components are described in detail in Section 3.3.1.

3.2.2 River Flow Management Feature

3.2.2.1 Proposed Action of the Flow Management Feature

Flows on the MKARNS are influenced by the release of water from upstream reservoirs. The multipurpose reservoirs are operated, in part, to maintain flow targets at the Van Buren gage. Van Buren is the critical control point in the system because it is the most downstream regulation station for the MKARNS. That is, all the upstream releases are adjusted based on what is happening at the Van Buren gage. Optimum river flows are defined as less than 61,000 cubic feet per second (cfs) at Van Buren, Arkansas. This definition correlates to optimum conditions for commercial navigation on the MKARNS. MKARNS navigation traffic is severely restricted when flows reach 100,000 cfs at Van Buren, Arkansas. The River Flow Management Feature is

proposed to improve the safety and efficiency of commercial navigation operations by managing the MKARNS to limit periods of sustained high flows. This would be achieved by reducing the number of days when river flows exceed 100,000 cfs at Van Buren. In addition, other authorized project purposes, including flood control, recreation; hydropower; water supply; and fish and wildlife would be maintained.

3.2.2.2 River Flow Management Components Considered

The components screening process included the evaluation of a range of river flow management components to determine which were the most viable components and would be considered for implementation. The component evaluation process considered 23 river flow management components that 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 river flow management component included:

- River flow and duration;
- Reservoir stages and duration; and
- Estimated operational damages within the system.

River flows influence commercial navigation and other uses of the MKARNS. River flows of approximately 60,000 cfs or less are considered optimum conditions for commercial navigation on the MKARNS. 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 conditions at Van Buren.

A summary of the 23 flow management components' SUPER Model screening results is presented in Table 3.1. Detailed information associated with the SUPER Model screening runs can be found in Appendix F.

3.2.2.3 River Flow Management Components to be Assessed in Detail

Based upon the components review process detailed in Table 3-1, four components were selected for detailed analysis. The components include the No Action Component as well as three viable implementation components. These components are described in detail in Section 3.3.2 and are highlighted in yellow in Table 3-1.

- Component 1: No Action Component;
- Component 2 175,000 cfs Component;
- Component 3 200,000 cfs Component; and
- Component 4 Operations Only Component.

Table 3-1. Initial Components Considered for the Flow Management Study Feature.

COMPONENT #	Potential Study Components	SUPER MODEL SCREENING RESULTS: Difference in Days above 60,000 cfs	Difference in Days above 100,000 cfs	Difference in Days above 137,000 cfs	Agricultural/Structural Damages (%)	Navigation Damages (%)	Pool Damages (%)	Recreation Damages (%)	Hydropower (Reservoirs) Damages (%)	Hydropower (River) Damages (%)	Reservoir Flood Pool Duration (%)*	Component Evaluation/Comments**	Component Selected for Detailed Analysis
	A01X16 Existing Operations Plan	0	0	0	0	0	0	0	0	0	0	Current Plan and Conditions (No Action Component)	Yes
1	A02X01 Existing Plan with a 60,00 cfs Bench	-18	+1	0	-0.5%	-0.3%	+2.8%	+3.6%	+0.6%	-1.1%	In	Increase in number of days with flows above 100,000 cfs. (-) Moderate increases in damages to pools and recreation. (-)	No
2	A02X03 Modified A02X01 with a 60,000 cfs Bench at 3% Lower System Storage	-13	+2	0	-0.3%	+0.4%	-0.2%	-1.2%	+0.1%	+0.2%	De	Increase in number of days with flows above 100,000 cfs. (-)	No
3	A02X04 Modified A02X01 with a 60,000 cfs Bench at 3% Higher System Storage	-22	-1	0	+0.1%	-0.9%	+0.5%	+9.6%	+0.7%	-2.5%	In	No meaningful decrease in number of days with flows above 100,000 cfs. (0) Notable increases in damages to recreation. (-) Decrease in the number of days with flow above 60,000. (+)	No
4	A02X13 Operation Plan Only Modified Existing Plan Bench 60,000 cfs and Filling Behind Flood	-15	+1	0	+0.4%	-0.3%	+0.2%	+1.1%	+0.7%	-0.7%	In	No meaningful changes in number of days with flows above 100,000 cfs. (0) No meaningful changes in damages within the system. (0) Decrease in the number of days with flows above 60,000 cfs. (+) Similar to Component 7 except Agricultural/Structural Damages are higher (-)	No
5	A02X05 Existing Plan with 75,000 cfs Bench at 18%	+4	-3	0	+0.5%	-0.4%	+2.9%	+4.2%	+0.6%	-0.9%	In	No meaningful decrease in number of days with flows above 100,000 cfs. (0) Increase in number of days with flows above 60,000 cfs. (-) Moderate increases in damages to pools and recreation. (-)	No
6	A02X06 Existing Plan with Hulah and Copan Reservoirs Removed from Water Control Operations	0	0	0	-0.1%	+0.3%	-0.3%	-0.7%	0	+0.1%	De	No change in number of days with flows above 60,000 cfs. (0) No change in number of days with flows above 100,000 cfs. (0)	No
7	A02X10 Modified A02X01 with 60,000 cfs Bench beginning at 3% lower system storage except during June 15-October 1	-14	+2	0	-0.5%	-0.1%	+0.5%	+1.8%	-0.1%	-0.3%	In	No meaningful changes in number of days with flows above 100,000 cfs. (0) No meaningful changes in damages within the system. (0) Decrease in the number of days with flows above 60,000 cfs. (+) Similar to Component 4 except Agricultural/Structural Damages are lower (+)	Yes
8	A02X07 Existing Operating Plan with 60,000 cfs – 20,000 cfs Taper	-18	+2	+1	-0.2%	-0.1%	+3.9%	+6.4%	+0.9%	-2.1%	In	Increase in number of days with flows above 100,000 cfs. (-) Increases in Pool and Recreational damage within the system. (-) Decrease in the number of days with flows above 60,000 cfs. (+)	No
9	A02X08 Existing Operating Plan with 60,000 cfs – 20,000 cfs Taper lowered 3%	-11	+2	0	-0.4%	-0.4%	+1.1%	+1.6%	+0.2%	-1.0%	In	Increase in number of days with flows above 100,000 cfs. (-) Increases in Pool and Recreational damage within the system. (-) Decrease in the number of days with flows above 60,000 cfs. (+)	No

Table 3-1. Initial Components Considered for the Flow Management Study Feature.

COMPONENT #	Potential Study Components	SUPER MODEL SCREENING RESULTS: Difference in Days above 60,000 cfs	Difference in Days above 100,000 cfs	Difference in Days above 137,000 cfs	Agricultural/Structural Damages (%)	Navigation Damages (%)	Pool Damages (%)	Recreation Damages (%)	Hydropower (Reservoirs) Damages (%)	Hydropower (River) Damages (%)	Reservoir Flood Pool Duration (%)*	Component Evaluation/Comments**	Component Selected for Detailed Analysis
10	A02X09 Existing Operating Plan with 75,000 - 60,000 cfs and 60.000 - 20,000 cfs Taper	-10	+1	0	-0.4%	-0.9%	+2.6%	+3.4%	+0.4%	-1.6%	In	No meaningful change in number of days with flows above 100,000 cfs. (0) Increases in Pool and Recreational damage within the system. (-) Decrease in the number of days with flows above 60,000 cfs. (+)	No
11	Van Buren 99,000 cfs above 75,000 cfs Bench	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No meaningful change in number of days with flows above 100,000 cfs. (0) No meaningful change in number of days with flows above 60,000 cfs. (0)	No
12	A01X24 Van Buren 300,000 cfs Sallisaw 300,000 cfs	+3	-19	-7	+23.9%	-0.5%	-5.1%	+0.2%	+1.4%	-2.3%	De	Decrease in number of days with flows above 100,000 cfs (+) Increase in number of days with flows above 60,000 cfs. (-) Notable increase in Agricultural/Structural damages. (-)	No
13	A01X25 Van Buren at 60,000 cfs target	-57	-32	-18	-28.8%	-6.1%	NA	+196.3%	-12.8%	-35.6%	In	Maximum reservoir storage component Decrease in number of days with flows above 100,000 cfs (+) Decrease in number of days with flows above 60,000 cfs. (+) Large increase in Recreational damages. (-)	No
14	A01X21 Van Buren 225,000 cfs Sallisaw 150,000 cfs	+5	-14	-2	+2.3%	-0.3%	+3.1%	+8.3%	+0.2%	-2.1%	In	Decrease in number of days with flows above 100,000 cfs (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Pool and Recreational damages. (-)	No
15	A01X22 Van Buren 225,000 cfs Sallisaw 225,000 cfs	+3	-17	-5	+9.7%	-0.5%	-0.6%	+3.4%	+0.9%	-2.2%	De	Decrease in number of days with flows above 100,000 cfs (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural and Recreational damages. (-)	No
16	A01X17 Van Buren 200,000 cfs Above 30%	+5	-13	-3	+2.0%	-0.3%	+3.2%	+8.1%	+0.2%	-2.1%	In	Decrease in number of days with flows above 100,000 cfs (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural, Pool, and Recreational damages. (-)	No
17	A01X18 Van Buren 200,000 cfs Sallisaw 200,000 cfs	+3	-16	-5	+6.7%	-0.5%	+0.6%	+3.8%	-0.9%	-2.2%	In	Decrease in number of days with flows above 100,000 cfs. (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural and Recreational damages. (-)	No
18	A02X12 Van Buren 200,000 cfs Sallisaw 200,000 cfs Bench 60,000 cfs lowered 3% except June15-October 1	-9	-17	-5	+7.0%	-0.6%	+1.1%	+5.6%	+0.8%	-2.8%	In	Decrease in number of days with flows above 100,000 cfs. (+) Decrease in number of days with flows above 60,000 cfs. (+) Increase in Agricultural/Structural and Recreational damages. (-)	Yes
19	A01X19 Van Buren 200,000 cfs Sallisaw 175,000 cfs	+4	-16	-4	+4.8%	-0.6%	+1.0%	+5.3%	+0.7%	-2.1%	In	Decrease in number of days with flows above 100,000 cfs. (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural and Recreational damages. (-)	No

Table 3-1. Initial Components Considered for the Flow Management Study Feature.

COMPONENT #	Potential Study Components	SUPER MODEL SCREENING RESULTS: Difference in Days above 60,000 cfs	Difference in Days above 100,000 cfs	Difference in Days above 137,000 cfs	Agricultural/Structural Damages (%)	Navigation Damages (%)	Pool Damages (%)	Recreation Damages (%)	Hydropower (Reservoirs) Damages (%)	Hydropower (River) Damages (%)	Reservoir Flood Pool Duration (%)*	Component Evaluation/Comments**	Component Selected for Detailed Analysis
20	A01X23 Van Buren 175,000 cfs Sallisaw 175,000 cfs	+4	-16	-4	+3.1%	-0.6%	+1.8%	+6.0%	-0.6%	-2.1%	In	Decrease in number of days with flows above 100,000 cfs. (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural and Recreational damages. (-)	No
21	A02X02 Modified A01X23 with a 60,000 cfs Bench	-13	-15	-3	+3.2%	-1.0%	+4.1%	+9.4%	+1.1%	-3.2%	In	Decrease in number of days with flows above 100,000 cfs. (+) Decrease in number of days with flows above 60,000 cfs. (+) Increase in Agricultural/Structural, Pool, and Recreational damages. (-)	No
22	A02X11 Van Buren 175,000 cfs Sallisaw 175,000 cfs Bench 60,000 cfs lowered 3% except June15-October 1	-9	-15	-4	+3.1%	-0.8%	+2.8%	+7.8%	+0.6%	-2.6%	In	Decrease in number of days with flows above 100,000 cfs. (+) Decrease in number of days with flows above 60,000 cfs. (+) Increase in Agricultural/Structural and Recreational damages. (-)	Yes
23	A01X20 Van Buren 175,000 cfs Sallisaw 150,000 cfs	+5	-13	-2	+1.3%	-0.2%	+3.4%	+8.3%	+0.1%	-2.1%	In	Decrease in number of days with flows above 100,000 cfs. (+) Increase in number of days with flows above 60,000 cfs. (-) Increase in Agricultural/Structural, Pool, and Recreational damages. (-)	No

* In = Increase in the amount of time reservoir elevations are within the designated flood pool. De = Decrease in the amount of time reservoir elevations are within the designated flood pool.

** (-) = Negative influence on project element, (+) = positive influence on project element, (0) = neutral influence on project element

Rows highlighted in yellow were selected for further, more detailed analysis.

3.2.3 Navigation Channel Deepening Features

3.2.3.1 Proposed Action

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

3.2.3.2 Navigation Channel Deepening Components Considered

The screening process included the evaluation of a range of components to determine the viable components to be considered for implementation. The component evaluation process considered four actions:

- 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.

Descriptions of each preliminary component considered are presented in the following paragraphs.

3.2.3.2.1 Navigation Channel Deepening via Dredging

Under this component additional dredging and river training structures such as dikes would be employed to deepen the navigation channel on the MKARNS and thereby improve navigation. The MKARNS would be dredged at necessary locations to achieve navigation depths between 10 and 12 feet along part of, or the entire navigation channel, making it compatible with the Mississippi River Navigation System. Additional river training structures would be constructed as necessary to facilitate maintaining the deeper navigation channel.

3.2.3.2.2 Navigation Channel Deepening via Pool Raising

Under this component, the locks and dams along the MKARNS would be modified to hold more water and thereby allowing raising the pool levels on the MKARNS between 1 and 3 additional feet. This would cause additional flooding in surrounding land upstream of each of the dams.

Operational changes to the navigation system could provide each segment of the navigation system with a deeper pool, which in turn could allow for navigation of deeper draft barges. Through a combination of controlled releases from upstream reservoirs and holding more water at each of the dams along the system, the channel could be deepened without (or at a reduced amount of) dredging of the channel. Raising the pools has a number of potential advantages and disadvantages including engineering, economic, environmental, and socio-economic

considerations. The considerations were used as criteria for preliminary screening of this potential component.

The most meaningful engineering advantage of a pool raise is that it would reduce or eliminate the need to dredge the channel. It would also reduce or eliminate the need to design, construct and maintain dredged material disposal sites at either upland or in-stream sites.

Even a one-foot pool rise would require structural modification to the locks on the system. Preliminary costs estimates indicate that the modifications to each lock would range from $300,000 to $1,800,000 per lock. Structural analysis indicates that a pool raise of greater than one foot would require major replacement of locks and modifications to dam structures. In simple terms, the structures are not designed to withstand the forces that would be caused by a two or three foot pool rise. The costs of such modifications to any one of the structures on the system would be in the hundreds of millions of dollars. Such modification would cause disruption to existing navigation traffic for at least one year, which would directly affect businesses relying on the system for transportation of goods. Consequently, the raising of the pools above 1-foot are not evaluated further and considered not practical or economically justified.

Project Design Memorandum, Number 5-2, "Navigation Channel and Appurtenance: Bridge Clearance" specifies that the Arkansas River Navigation System includes utilities and bridges intersecting the waterway at a minimum of 52 feet vertical clearance relative to the 2 percent flow line. This criterion was developed on the basis of economic and safety factors. Utilizing that criterion in the present study indicates that raising the pool one foot would require at least two bridges to be relocated. Based on a recent repair to the I-40 Bridge, its replacement would be in excess of $50 million and result in major disruption to vehicular traffic.

A pool rise would also result in additional lands being inundated. A 1-foot rise in pool elevation when the flow on the river is at 150,000 cubic feet per second (cfs) at Van Buren gage would result in approximately 5,000 additional acres in Oklahoma being inundated that are currently not inundated at that river flow. The acreage in Arkansas is estimated to be much higher than that. The cost of having to purchase a flowage easement would be substantial. It should be also noted that landowners along the waterway have continually expressed concerns about impact of river flows on their properties.

Based on the preliminary analysis, any component with a pool raise feature has been eliminated from further consideration; therefore, this component will not be evaluated as part of the study.

3.2.3.2.3 Navigation Channel Deepening via a Combination of Dredging and Raising the Pool Level

Under this Component a combination of additional dredging, river training structures such as dikes, and modifying the locks and dams along the MKARNS to hold more water would be employed to deepen the navigation channel on the MKARNS. A combination of these measures would deepen the MKARNS navigation channel between 1 and 3 additional feet. A variety of combinations of dredging and pool raising were considered including:

- 1 Foot Additional Navigation Channel Depth (10 ft navigation channel) – ½ foot dredging and ½ foot pool raise;
- 2 Foot Additional Navigation Channel Depth (11 ft navigation channel) – 1 foot dredging and 1foot pool raise;
- 3 Foot Additional Navigation Channel Depth (12 ft navigation channel) – 2 foot dredging and 1foot pool raise;
- 3 Foot Additional Navigation Channel Depth (12 ft navigation channel) – 1 foot dredging and 2foot pool raise; and
- 3 Foot Additional Navigation Channel Depth (12 ft navigation channel) – 1 ½ foot dredging and 1 ½ foot pool raise.

Like the pool raising component described previously, this would result in additional flooding in surrounding land upstream of each of the dams. Modifying the existing infrastructure and purchasing flowage easements along the river would require a substantial amount of funding and, therefore, would not be practical. In consideration of the economic and environmental costs, the combination of raising the pool levels and dredging to facilitate navigation channel deepening does not generate enough tangible and intangible benefits to merit further evaluation for development.

At this time, a combined pool raising/dredging plan is not justified and the component will not be evaluated as part of this study.

3.2.3.2.4 Widening the Verdigris River

The Verdigris River portion of the MKARNS lies in Oklahoma and includes a portion of Pool 16 and all of Pools 17 and 18 including the Chouteau and Newt Graham Locks and Dams. This portion of the MKARNS is approximately 50 miles long and provides a 150-foot wide navigation channel rather than the 250-foot wide navigation channel existing throughout the rest of the MKARNS. At this width tows cannot pass in the navigation channel without passing zones that allow down river tows and up river tows to pass. This narrower navigation channel causes time of travel delays for the tows.

As part of this study, a preliminary evaluation of the possibility of widening the navigation channel to eliminate these delays was conducted. A preliminary analysis was completed utilizing the following factors:

a. Excavation. One side of the navigation channel would be widened 100 feet and the excavated material placed along the bank for the entire length of the navigation channel. Approximately 30 million cubic yards of material would be moved.

b. Lands. Along the navigation channel additional easement would be required for widening and material disposal totaling 1200 acres.

c. Mitigating. Assuming one-quarter of the total acres needed for construction are prime habitat i.e. trees and a four to one habitat ratio, an additional 1200 acres of farm land would be required for planting trees for habitat replacement. About 240,000 trees would be planted.

d. A contingency of 25% was utilized.

e. Engineering and Design and Supervision and Inspection were estimated at 15% of the construction cost.

The preliminary cost for widening the Verdigris River is $100,000,000 based on the above factors.

The estimated benefit of widening the Verdigris River is based on both current and future delay times. Also, a wider navigation channel offers a reduced risk of accidents on the waterway as a result of tows going in the opposite direction meeting on the navigation channel. From interviews with towboat operators, USACE operations personnel indicate that delays on the Verdigris River due to two-way congestion are fewer than two a week. The tows are in constant communication with one another and safety issues associated with two-way traffic on the waterway has been minimal. A given delay, due to two-way traffic, is never more than 5 hours in length, amounting to less than a half-day a month. The preliminary examination of the current and projected traffic on the waterway indicates that the existing passing lanes can fully accommodate two-way traffic with minimum delays. In consideration of the economic and environmental costs, the widening of the Verdigris River portion of the system does not generate enough tangible and intangible benefits to merit further evaluation for development.

At this time, widening is not justified and the component is not to be evaluated as part of this study.

3.2.3.3 Navigation Channel Deepening Components to be assessed in Detail

Based upon the components review process detailed in the preceding sections, viable components were selected for detailed analysis. The components include the No Action Component as well as a variety of navigation channel dredging components that incorporate multiple navigation channel depths and river segments. These components are described in detail in Section 3.3.3 and evaluated in Chapter 5.

3.3 Components Evaluated in Detail

Based on the components evaluation process described in the preceding section, the most viable components were evaluated in detail for possible implementation. This section describes the components evaluated in detail in this study. The impacts associated with these components are discussed in Chapter 5. Based on the analyses of these impacts a series of alternatives were analyzed in chapters 6 and 7 and these alternatives are described in Section 3.4.

3.3.1 Navigation Channel Depth Maintenance Features and Components

Based upon the components review process detailed in Section 3.2.3, three navigation channel depth maintenance components were selected for detailed analysis. The components include the No Action Component as well as two viable implementation components:

- Component 1: No Action Component;
- Component 2 Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan; and
- Component 3 Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in New Disposal Sites.

Common features of the two implementation 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).

Maintenance dredging occurs throughout the MKARNS on an annual basis. Quantities dredged and disposed of vary annually based on river flows and sediment depositional patterns in the navigation channel. Between 1995 and 2003 the annual maintenance dredging volumes on the MKARNS ranged from approximately 378,800 cubic yards to 1,145,000 cubic yards.

Under these components there would be 2 new river training structures, modifications to 50 existing river training structures, 2 new revetments, and modifications to 4 existing revetments along the MKARNS (Tables 3-2 and 3-3).

Table 3-2. Additional River Training Structures Required for Navigation Channel Depth Maintenance on the MKARNS.

Segment	Number of Existing Structures	Number of New Structures*	Total Length (ft) of New Structures	Number of Modified (Raised) Structures*
1-Mouth To Pine Bluff	278	2	800	18
2-Pine Bluff to Little Rock	201	0	0	0
3-Little Rock to Dardanelle	392	0	0	24
4-Dardanelle to Fort Smith	236	0	0	8
5-Fort Smith to Muskogee	195	0	0	0
6-Muskogee to Catoosa	12	0	0	0

* Structures required to maintain a 9-foot navigation channel.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

Table 3-3. Additional Revetments Required for Navigation Channel Depth Maintenance on the MKARNS.

Segment	Number of Existing Structures	Total Length (mi) of Existing Structures	Number of New Structures*	Total Length (mi) of New Structures*	Number of Modified (Raised) Structures*
1-Mouth To Pine Bluff	57	56.7	0	0.00	0
2-Pine Bluff to Little Rock	49	44.5	1	0.80	0
3-Little Rock to Dardanelle	64	75.3	0	0.00	3
4-Dardanelle to Fort Smith	49	58.3	1	0.83	1
5-Fort Smith to Muskogee	34	58.5	0	0.00	0
6-Muskogee to Catoosa	42	35.6	0	0.00	0

* Structures required to maintain a 9-foot navigation channel.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

3.3.1.1 Navigation Channel Depth Maintenance – No Action Component (NCDM-NA)

Existing dredging and disposal to maintain the navigation channel would continue under this component. Dredged material would continue to be disposed of at existing sites until they reach their holding capacity (less than 10 years). The USACE would utilize existing approved disposal sites, and no new dredged material disposal sites would be developed.

3.3.1.2 Navigation Channel Depth Maintenance – Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Existing dredging and disposal to maintain the navigation channel would continue under this component. After currently utilized disposal sites reach their holding capacity, dredged material would be disposed of at inactive sections within areas approved in the 1974 O&M Plan and EIS, regardless of the quality or type of habitat present. There are 1314 existing river training structures and 295 revetments on the MKARNS (Tables 3-5 and 3-6). River training structures and revetments would be constructed as detailed in Tables 3-7 and 3-8.

- 1-Mouth to Pine Bluff 2 new and 18 modified river training structures;
- 2-Pine Bluff to Little Rock 0 new and 0 modified river training structures;
- 3-Little Rock to Dardanelle 0 new and 24 modified river training structures;
- 4-Dardanelle to Fort Smith 0 new and 8 modified river training structures;
- 5-Ft Smith to Muskogee 0 new and 0 modified river training structures;
- 6-Muskogee to Catoosa 0 new and 0 modified river training structures; and
- **Total NCDM-1** 2 new and 50 modified river training structures.

- 1-Mouth to Pine Bluff 0 new and 0 modified revetments;
- 2-Pine Bluff to Little Rock 1 new and 0 modified revetments;
- 3-Little Rock to Dardanelle 0 new and 3 modified revetment;
- 4-Dardanelle to Fort Smith 1 new and 1 modified revetments;
- 5-Ft Smith to Muskogee 0 new and 0 modified revetments;
- 6-Muskogee to Catoosa 0 new and 0 modified revetments; and
- **Total NCDM-1** 2 new and 4 modified revetments.

3.3.1.3 Navigation Channel Depth Maintenance – Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Existing dredging and disposal to maintain the navigation channel would continue under this component. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term Dredged Material Disposal Plan (DMDP). Under this component, areas with high quality habitat such as forest, wetlands, and grassland would be avoided wherever practical. There are 1314 existing river training structures and 295 revetments on the MKARNS (Tables 3-5 and 3-6). River training structures and revetments would be constructed as detailed in Tables 3-7 and 3-8.

- 1-Mouth to Pine Bluff 2 new and 18 modified river training structures;
- 2-Pine Bluff to Little Rock 0 new and 0 modified river training structures;
- 3-Little Rock to Dardanelle 0 new and 24 modified river training structures;
- 4-Dardanelle to Fort Smith 0 new and 8 modified river training structures;
- 5-Ft Smith to Muskogee 0 new and 0 modified river training structures;
- 6-Muskogee to Catoosa 0 new and 0 modified river training structures; and
- **Total NCDM-2** 2 new and 50 modified river training structures.

- 1-Mouth to Pine Bluff 0 new and 0 modified revetments;
- 2-Pine Bluff to Little Rock 1 new and 0 modified revetments;
- 3-Little Rock to Dardanelle 0 new and 3 modified revetment;
- 4-Dardanelle to Fort Smith 1 new and 1 modified revetments;
- 5-Ft Smith to Muskogee 0 new and 0 modified revetments;
- 6-Muskogee to Catoosa 0 new and 0 modified revetments; and
- **Total NCDM-2** 2 new and 4 modified revetments.

The disposal of dredged material associated with continued channel maintenance would frequently occur at existing approved disposal sites, however, new disposal sites would be required at some locations along the MKARNS (Table 3-6). New maintenance dredging disposal sites within each river segment would be developed as follows:

- 1-Mouth to Pine Bluff 0 new dredged material disposal sites;
- 2-Pine Bluff to Little Rock 0 new dredged material disposal sites;
- 3-Little Rock to Dardanelle 0 new dredged material disposal sites;
- 4-Dardanelle to Fort Smith 0 new dredged material disposal sites;
- 5-Ft Smith to Muskogee 19 new dredged material disposal sites;
- 6-Muskogee to Catoosa 7 new dredged material disposal sites; and

- **Total MKARNS (NCDM-2)** 26 new dredged material disposal sites.

3.3.2 Flow Management Feature and Components

Based upon the components review process detailed in Section 3.2.1 four components were selected for detailed analysis. The components include the No Action Component as well as three viable implementation components:

- Component 1 No Action Component;
- Component 2 175,000 cfs Component (A02 x 12);
- Component 3 200,000 cfs Component (A02 x 11); and
- Component 4 Operations Only Component (A02 x 10).

3.3.2.1 Flow Management - No Action Component (FM-NA)

The No Action Component consists of maintaining the current MKARNS Operation System. No changes in existing river or reservoir operations would be made.

A detailed description of the existing operations plan including general operations as well as a description of taper (gradual reduction in river flow) and bench (range where the flow is held at or below a specified flow) operations is presented in the Feasibility Study Report. Key features of the current operations plan are:

- A taper operation of 40,000 cfs to 20,000 cfs. When the flood storage remaining in the 11 controlling reservoirs reaches from 3% in the spring to 11% in the summer, the target flow at Van Buren is gradually reduced from 40,000 cfs to 20,000 cfs. This allows navigation to continue until dredging operation can remove the sediment deposited in the navigation channel during high flow.
- A 75,000 cfs bench (a range where the flow is held at or below 75,000 cfs). This feature is also adjusted seasonally to maximize benefit to farming and minimize flood impacts during that portion of the year more susceptible to floods.

3.3.2.2 Flow Management - 175,000 cfs Component (FM-175)

The 175,000 cfs Component is described as: Van Buren at 175,000 cfs and Sallisaw at 175,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3% except from June 15 – October 1.

The SUPER Model analysis of this component indicates that there would be a decrease in the number of days above 60,000 cfs by 9 days per year compared to the existing operation plan. The analysis also indicates a decrease in the number of days above 100,000 cfs by 15 days and a decrease by 4 days in flows above 137,000 cfs.

3.3.2.3 Flow Management - 200,000 cfs Component (FM-200)

The 200,000 cfs Component is described as: Van Buren at 200,000 cfs and Sallisaw at 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3% except from June 15 – October 1.

The results of the SUPER Model analysis indicate that there would be a decrease in the number of days above 60,000 cfs by 9 days per year. It also decreases the number of days above 100,000 cfs by 17 days and it decreases by 5 days the flow above 137,000 cfs.

3.3.2.4 Flow Management - Operations Only Component (FM-OPS)

The Operations Only Component entails modifying the current operations plan to better meet the objectives of the proposed action.

The Operations Only Component is defined as the existing 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.

SUPER Model analysis indicates an approximately 14-day reduction in flows above 60,000 cfs at Van Buren. The analysis also produced 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).

3.3.3 Navigation Channel Deepening Feature and Components

Based upon the components review process detailed in Section 3.2.3 the No Action Component as well as a variety of navigation channel dredging components, which incorporate multiple navigation channel depths and river segments, were selected for detailed analysis. Table 3-4 shows the navigation channel deepening components.

Table 3-4. Navigation Channel Deepening Components.							
NAVIGATION DEPTH		**River Segment**					
CHANGE	**NAV DEPTH**	**Mouth to Pine Bluff 1**	**Pine Bluff to Little Rock 2**	**Little Rock to Dardanelle 3**	**Dardanelle to Fort Smith 4**	**Ft Smith to Muskogee 5**	**Muskogee to Catoosa 6**
		N.M. 0.0 To N.M. 75.2	N.M. 75.2 To N.M. 119.5	N.M. 119.5 To N.M. 220.3	N.M. 220.3 To N.M. 308.7	N.M. 308.7 To N.M. 394.0	N.M. 394.0 To N.M. 445.2
		75.2 Miles	44.3 Miles	100.8 Miles	88.4 Miles	85.3 Miles	51.2 Miles
No Action (No Change in Depth)	**9 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
10 Ft Channel(1 Foot change)	**10 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
11 Ft Channel (2 Foot change)	**11 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
12 Ft Channel (3 Foot change)	**12 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate

This component set explores the options of deepening the navigation channel to 10, 11 or 12 feet at up to six separate segments of the MKARNS. To better assess the navigation channel deepening components, the MKARNS was divided into six river segments, from the mouth of the MKARNS near the Mississippi River to the Port of Catoosa in Oklahoma. This makes analysis of the action comprehensive and flexible by providing the decision maker with the option of deepening the navigation channel only up to a certain segment on the system or the entire river, as appropriate.

Deepening the navigation channel to 10, 11, or 12-foot, would be analyzed in addition to the No Action Component (9-foot navigation channel). Different depths are included in the components because barges carrying some types of solid commodities on the MKARNS (coal, gravel, etc.) are not operating at their full capacity at a 9-foot draft and could carry enough to navigate up to a 12-foot draft, while barges carrying liquid commodities are not able to carry loads that require more than a 9-foot draft.

The two elements of the navigation channel deepening component are:

- Navigation channel deepening via dredging and the disposal of dredged materials; and
- Construction of additional river training structures to facilitate the maintenance of the deeper navigation channel.

The three action components for navigation channel deepening (10-Foot, 11-Foot, and 12-Foot) are similar in nature in that all three would include the deepening of the navigation channel. The three components vary only in the amount of material dredged and disposed of as well as the length of any necessary new or modified river training structures.

Based upon USACE calculations (USACE Little Rock, 2004) the following quantities of materials would be dredged from the navigation channel in each of the navigation channel depths and segments (Table 3-5). Required new disposal sites are presented in Table 3-6. A construction period of three years is anticipated for navigation channel deepening and disposal.

Table 3-5. Dredge volumes (cubic yards) by River Segment and Navigation Depth.*

	River Segment					
	Mouth to Pine Bluff 1	**Pine Bluff to Little Rock 2**	**Little Rock to Dardanelle 3**	**Dardanelle to Fort Smith 4**	**Ft Smith to Muskogee 5**	**Muskogee to Catoosa 6**
Navigation Depth	N.M. 0.0 To N.M. 75.2	N.M. 75.2 To N.M. 119.5	N.M. 119.5 To N.M. 220.3	N.M. 220.3 To N.M. 308.7	N.M. 308.7 To N.M. 394.0	N.M. 394.0 To N.M. 445.2
No Action (9 Ft Channel)	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance
10 Ft Channel	790,615	98,929	196,478	378,400	1,319,910	1,241,554
11 Ft Channel	1,299,276	225,517	387,227	643,500	2,255,323	2,026,333
12 Ft Channel	2,066,867	445,995	925,439	1,226,500	3,256,749	3,063,790

* In addition to maintenance dredging volumes

Table 3-6. Additional Dredged Material Disposal Sites Required for Navigation Maintenance and Deepening Components on the MKARNS.

Segment	Number Existing Disposal Sites	Number New Maintenance Disposal Sites	Number of New Joint Use Maintenance and Deepening Disposal Sites (10-12 foot)	Number of New 12 ft Deepening Sites (10-12 foot)
1-Mouth To Pine Bluff	27	0	0	2
2-Pine Bluff to Little Rock	5	0	0	2
3-Little Rock to Dardanelle	40	0	0	2
4-Dardanelle to Fort Smith	22	0	0	0
5-Fort Smith to Muskogee	21	10	9	20
6-Muskogee to Catoosa	27	4	3	15

Source: USACE, 2004.

Based upon USACE calculations, the following new river training structures would be required for each navigation channel segment (Tables 3-7 and 3-8)

Table 3-7. Additional River Training Structures Required for Navigation Deepening Components on the MKARNS.

Segment	Number Existing Structures	Number New Structures*	Total Length (ft) of New Structures for 12' Channel Component**	Number Modified (Raised or Extended) Structures*	Change in Length (ft) of Modified Structures for 12' Channel Component**
1-Mouth To Pine Bluff	278	4	2040	21	3615
2-Pine Bluff to Little Rock	201	30	9700	4	0
3-Little Rock to Dardanelle	392	5	2050	34	4600
4-Dardanelle to Fort Smith	236	6	1850	28	2300
5-Fort Smith to Muskogee	195	44	48,729	0	0
6-Muskogee to Catoosa	12	0	0	0	0

* Structures required for 10-foot, 11-foot, and 12-foot navigation channel components. The number of Structures required for each component is the same.
** Structures required for 11-foot navigation channel component would be approximately 2/3 the length of those required for 12-foot navigation channel component. Structures required for 10-foot navigation channel component would be approximately 1/3 the length of those required for 12-foot navigation channel component.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

Table 3-8. Additional Revetments Required for Channel Deepening Components on the MKARNS.

Segment	Total Number of Existing Structures	Total Length (mi) of Existing Structures	Number New Structures*	Total Length (mi) of New Structures for 12' Channel Component**	Number Modified (Raised or Extended) Structures*	Change in Length (mi) of Modified Structures for 12' Channel Component**
1-Mouth To Pine Bluff	57	56.7	0	0	9	0.06
2-Pine Bluff to Little Rock	49	44.5	1	2.3	0	0
3-Little Rock to Dardanelle	64	75.3	0	1.5	1	0
4-Dardanelle to Fort Smith	49	58.3	0	2.5	6	0.09
5-Fort Smith to Muskogee	34	58.5	0	0	0	0
6-Muskogee to Catoosa	42	35.6	0	0	0	0

* Structures required for 10-foot, 11-foot, and 12-foot navigation channel components. The number of Structures required for each component is the same.
** Length of new and modified revetments would be comparable for the 10-foot, 11-foot, and 12-foot navigation channel components.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

3.3.3.1 Navigation Channel Deepening - No Action Component (NCD-NA)

Under this Component the current 9-foot navigation channel would be maintained along the entire MKARNS. No sections of the navigation system would be deepened through dredging and new river training structures would not be required.

3.3.3.2 Navigation Channel Deepening - 10-foot Channel Component (NCD-10)

Under this Component parts of the MKARNS would be dredged and river training structures would be constructed to achieve a navigable depth of 10 feet for some or all segments of the MKARNS. Additional dredged material disposal sites would be required to accommodate the increase in dredged material.

Under this component, dredging to a depth of 10 feet would require the removal and relocation (removal from the navigation channel and disposal at near shore or on shore locations) of the following approximate volumes of sediment:

- 1-Mouth to Pine Bluff 790,615 Cubic Yards;
- 2-Pine Bluff to Little Rock 98,929 Cubic Yards;
- 3-Little Rock to Dardanelle 196,478 Cubic Yards;
- 4-Dardanelle to Fort Smith 378,400 Cubic Yards;

- 5-Ft Smith to Muskogee 1,319,910 Cubic Yards;
- 6-Muskogee to Catoosa 1,241,554 Cubic Yards; and
- **Total MKARNS (10 Ft)** 4,025,886 Cubic Yards.

The disposal of dredged material associated with deepening the channel would frequently occur at existing approved disposal sites, however, new disposal sites would be required at some locations along the MKARNS (Table 3-6). New disposal sites within each river segment would be developed as follows:

- 1-Mouth to Pine Bluff 2 new dredged material disposal sites;
- 2-Pine Bluff to Little Rock 2 new dredged material disposal sites;
- 3-Little Rock to Dardanelle 2 new dredged material disposal sites;
- 4-Dardanelle to Fort Smith 0 new dredged material disposal sites;
- 5-Ft Smith to Muskogee 20 new dredged material disposal sites;
- 6-Muskogee to Catoosa 15 new dredged material disposal sites; and
- **Total MKARNS (10 Ft)** 41 new dredged material disposal sites.

Under this component, dredging to a depth of 10 feet would require the following approximate number of new and modified river training structures and revetments. (Revetments are bank stabilization structures). There are 1314 existing river training structures and 295 revetments on the MKARNS (Tables 3-5 and 3-6). Under this component there would be an approximate 7% increase in the number of new river training structures and a 0.3% increase in the number of new revetments along the MKARNS.

- 1-Mouth to Pine Bluff 4 new and 21 modified river training structures;
- 2-Pine Bluff to Little Rock 30 new and 4 modified river training structures;
- 3-Little Rock to Dardanelle 5 and 34 modified river training structures;
- 4-Dardanelle to Fort Smith 6 and 28 modified river training structures;
- 5-Ft Smith to Muskogee 44 new and 0 modified river training structures;
- 6-Muskogee to Catoosa 0 new or modified river training structures; and
- **Total MKARNS (10 Ft)** 89 new and 87 modified river training structures.

- 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; and
- **Total MKARNS (10 Ft)** 1 new and 16 modified revetments.

3.3.3.3 Navigation Channel Deepening - 11-foot Channel Component (NCD-11)

Under this Component parts of the MKARNS would be dredged and river training structures would be constructed to achieve a navigable depth of 11 feet for some or all segments of the MKARNS. Additional dredged material disposal sites would be required to accommodate the increase in dredged material.

Under this component, dredging to a depth of 11 feet would require the removal and relocation (removal from the navigation channel and disposal at near shore or on shore locations) of the following approximate volumes of sediment:

- 1-Mouth to Pine Bluff 1,299,276 Cubic Yards;
- 2-Pine Bluff to Little Rock 225,517 Cubic Yards;
- 3-Little Rock to Dardanelle 387,227 Cubic Yards;
- 4-Dardanelle to Fort Smith 643,500 Cubic Yards;
- 5-Ft Smith to Muskogee 2,255,323 Cubic Yards;
- 6-Muskogee to Catoosa 2,026,333 Cubic Yards; and
- **Total MKARNS (11 Ft)** 6,837,176 Cubic Yards.

The disposal of dredged material associated with deepening the channel would frequently occur at existing approved disposal sites, however, new disposal sites would be required at some locations along the MKARNS (Table 3-6). New disposal sites within each river segment would be developed as follows:

- 1-Mouth to Pine Bluff 2 new dredged material disposal sites;
- 2-Pine Bluff to Little Rock 2 new dredged material disposal sites;
- 3-Little Rock to Dardanelle 2 new dredged material disposal sites;
- 4-Dardanelle to Fort Smith 0 new dredged material disposal sites;
- 5-Ft Smith to Muskogee 20 new dredged material disposal sites;
- 6-Muskogee to Catoosa 15 new dredged material disposal sites; and
- **Total MKARNS (10 Ft)** 41 new dredged material disposal sites.

Under this component, dredging to a depth of 11 feet would require the following approximate number of new river training structures and revetments. There are 1314 existing river training structures and 295 revetments on the MKARNS (Tables 3-5 and 3-6). Under this component there would be an approximately 7% increase in the number of river training structures and a 0.3% increase in the number of revetments along the MKARNS.

- 1-Mouth to Pine Bluff 4 new and 21 modified river training structures;
- 2-Pine Bluff to Little Rock 30 new and 4 modified river training structures;
- 3-Little Rock to Dardanelle 5 and 34 modified river training structures;
- 4-Dardanelle to Fort Smith 6 and 28 modified river training structures;
- 5-Ft Smith to Muskogee 44 new and 0 modified river training structures;
- 6-Muskogee to Catoosa 0 new or modified river training structures; and
- **Total MKARNS (10 Ft)** 89 new and 87 modified river training structures.

- 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; and
- **Total MKARNS (11 Ft)** 1 new and 16 modified revetments.

3.3.3.4 Navigation Channel Deepening - 12-foot Channel Component (NCD-12)

Under this Component parts of the MKARNS would be dredged and river training structures would be constructed to achieve a navigable depth of 12 feet for some or all segments of the MKARNS. Additional dredged material disposal sites would be required to accommodate the increase in dredged material.

Under this component, dredging to a depth of 12 feet would require the removal and relocation (removal from the navigation channel and disposal at near shore or on shore locations) of the following approximate volumes of sediment:

- 1-Mouth to Pine Bluff 2,066,867 Cubic Yards;
- 2-Pine Bluff to Little Rock 445,995 Cubic Yards;
- 3-Little Rock to Dardanelle 925,439 Cubic Yards;
- 4-Dardanelle to Fort Smith 1,226,500 Cubic Yards;
- 5-Ft Smith to Muskogee 3,256,749 Cubic Yards;
- 6-Muskogee to Catoosa 3,063,790 Cubic Yards; and
- **Total MKARNS (12 ft)** 10,985,339 Cubic Yards.

The disposal of dredged material associated with deepening the channel would frequently occur at existing approved disposal sites, however, new disposal sites would be required at some locations along the MKARNS (Table 3-6). New disposal sites within each river segment would be developed as follows:

- 1-Mouth to Pine Bluff 2 new dredged material disposal sites;
- 2-Pine Bluff to Little Rock 2 new dredged material disposal sites;
- 3-Little Rock to Dardanelle 2 new dredged material disposal sites;
- 4-Dardanelle to Fort Smith 0 new dredged material disposal sites;
- 5-Ft Smith to Muskogee 20 new dredged material disposal sites;
- 6-Muskogee to Catoosa 15 new dredged material disposal sites; and
- **Total MKARNS (10 Ft)** 41 new dredged material disposal sites.

Under this component, dredging to a depth of 12 feet would require the following approximate number of new river training structures and revetments. There are 1314 existing river training structures and 295 revetments on the MKARNS (Tables 3-5 and 3-6). Under this component there would be an approximately 7% increase in the number of river training structures and a 0.3% increase in the number of revetments along the MKARNS.

- 1-Mouth to Pine Bluff 4 new and 21 modified river training structures;
- 2-Pine Bluff to Little Rock 30 new and 4 modified river training structures;
- 3-Little Rock to Dardanelle 5 new and 34 modified river training structures;
- 4-Dardanelle to Fort Smith 6 new and 28 modified river training structures;
- 5-Ft Smith to Muskogee 44 new and 0 modified river training structures;
- 6-Muskogee to Catoosa 0 new or modified river training structures; and
- **Total MKARNS (12 Ft)** 89 new and 87 modified river training structures.

- 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; and
- **Total MKARNS (12 Ft)** 1 new and 16 modified revetments.

3.4 Alternatives Development

3.4.1 Introduction

A series of decision alternatives were developed to achieve the proposed action to different extents. These alternatives include combinations of the individual features and components previously discussed. These alternatives are described and analyzed in the following pages.

3.4.2 Study Components Retained for Evaluation

Based upon the analysis of features and components described in the previous pages and presented in detail in Chapter 5, some components were retained as viable and were included in the decision alternatives. Components retained within each feature are discussed in the following pages.

3.4.2.1 Navigation Channel Depth Maintenance Features and Components

Two action components were evaluated in detail. Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts, the Maintenance Dredged Material Disposal in New Disposal Sites Component was clearly the most favorable component among the Navigation Channel Depth Maintenance Features. This component achieved the proposed action while presenting fewer adverse environmental impacts compared to the other component evaluated. Financially the two components were similar per the analysis in the Feasibility Study Report. Consequently this is the only component of the Navigation Channel Maintenance Features that was carried forward as a part of the decision alternatives analyses.

3.4.2.2 Flow Management Features and Components

Three action components were evaluated in detail. Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts the Operations Only Component was clearly the most favorable component among the Flow Management Features. This component achieved the proposed action while achieving a positive cost benefit ratio and having minimal adverse environmental impacts. Consequently this is the only component of the Flow Management Features that was carried forward as a part of the decision alternatives analyses.

3.4.2.3 Navigation Channel Deepening Features and Components

The navigation channel deepening features evaluated included increased channel depths (10, 11, and 12 feet) within six river segments comprising the entire McClellan Kerr Arkansas River Navigation System (MKARNS). Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts the following was determined:

- Economic benefits of deepening the navigation channel are achieved primarily via deepening the entire system and not portions of the system. Seventy percent of the economic benefits of deepening the navigation channel are associated with channel deepening from the MKARNS mouth, at the confluence of the Mississippi River, upstream to the Port of Catoosa. Incremental deepening of the navigation channel on only lower portions of the MKARNS is not financially justified.
- Deepening the navigation channel to a depth of 10 feet is not financially justified as the cost benefit ratio for this component is below 1.0.
- Deepening the navigation channel to depths of 11 or 12 feet achieves the proposed action, is financially justified in that a positive cost benefit ratio is achieved, and there are no significant adverse impacts associated with either component. Consequently, these two components of the Navigation Channel Deepening Features are both included in the decision alternatives analyses.

3.4.3 Decision Alternatives Evaluated in the EIS

Decision Alternatives were developed based upon the analyses of features and components evaluated in detail in Chapter 5. As described above, some components were retained as viable and were included in the decision alternatives, other components, which were not environmentally or economically justifiable were discarded as non-viable. Viable features and components were combined into the alternatives evaluated in this EIS. Table 3-9 summarizes the components used in the five alternatives selected for evaluation.

Table 3-9. 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)	**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

3.4.3.1 Alternative A - No Action

The No Action Alternative consists of maintaining the current MKARNS Operation System. No changes in existing river or reservoir operations would be made. The existing flow management plan would remain unchanged, the existing depth of the navigation channel would remain unchanged, and the existing navigation channel maintenance activities would remain unchanged.

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

ALTERNATIVE A – NO ACTION

Navigation Channel Maintenance: Existing dredging and disposal to maintain the 9-foot navigation channel would continue. Dredged material would continue to be disposed of at existing active and inactive sites until they reached their holding capacity. The USACE would utilize only existing approved disposal sites and no new dredged material disposal sites would be developed.

Flow Management: The existing river flow management plan employing a taper operation of 40,000 cfs to 20,000 cfs and a 75,000 cfs flow "bench" at Van Buren would remain unchanged. (See Chapter 3 for details regarding the Taper and Bench operations).

Navigation Channel Depth: The current 9-foot navigation channel would be retained along the entire MKARNS. No sections of the navigation system would be deepened through dredging and new river training structures would not be constructed.

3.4.3.2 Alternative B – Navigation Channel Maintenance Only

Alternative B consists of adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity, which will reach capacity at some locations along the MKARNS in the near future. The existing flow management plan would remain unchanged and the existing depth of the navigation channel would remain unchanged.

The following characterizes what would occur for each study feature/component under Alternative B:

ALTERNATIVE B

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this alternative, areas with high quality habitat such as bottomland forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: No change from the current flow management plan.

Navigation Channel Depth: No change from the current 9-foot navigation channel.

3.4.3.3 Alternative C - Navigation Channel Maintenance and Operations Only Flow Management

Alternative C consists of adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity, which will reach capacity at some locations along the MKARNS 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.

The following characterizes what would occur for each study feature/component under Alternative C:

ALTERNATIVE C

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this alternative, areas with high quality habitat such as bottomland forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Alternative entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Alternative is defined as the existing 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.

Navigation Channel Depth: No change from the current 9-foot navigation channel.

3.4.3.4 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 supplement current disposal site capacity which will reach capacity at some locations along the MKARNS 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.

The following characterizes what would occur for each study feature/component under Alternative D:

ALTERNATIVE D

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this alternative, areas with high quality habitat such as bottomland forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Alternative entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Alternative is defined as the existing 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.

Navigation Channel Depth: The current 9-foot navigation channel would be deepened to an 11-foot navigation channel throughout the entire length of the MKARNS.

Navigation channel deepening to 11-foot would include the construction of:

- 41 new dredged material disposal sites.
- 89 new and 87 modified river training structures, and
- 1 new and 16 modified revetments.

3.4.3.5 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 supplement current disposal site capacity which will reach capacity at some locations along the MKARNS 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.

The following characterizes what would occur for each study feature/component under Alternative E:

ALTERNATIVE E

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this alternative, areas with high quality habitat such as bottomland forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Alternative entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Alternative is defined as the existing 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.

Navigation Channel Depth: The current 9-foot navigation channel would be deepened to a 12-foot navigation channel throughout the entire length of the MKARNS.

- Navigation channel deepening to 11-foot would include the construction of:41 new dredged material disposal sites,
- 89 new and 87 modified river training structures, and
- 1 new and 16 modified revetments.

3.5 Decision to be Made

The analysis of the five alternatives for implementing the proposed action will require a decision to be made as to which alternative will be implemented. The decision regarding which course of action (or no action) to take regarding the various alternatives (and their associated features and components) will result in the final record of decision for this study

The decision to be made is: Which of the five alternatives will be selected for implementation to attain the proposed action.

- Alternative A - No Action;
- Alternative B – Navigation Channel Maintenance Only;
- Alternative C - Navigation Channel Maintenance and Operations Only Flow Management;
- Alternative D - Navigation Channel Maintenance, Operations Only Flow Management, and 11 Foot Navigation Channel; and
- Alternative E - Navigation Channel Maintenance, Operations Only Flow Management, and 12 Foot Navigation Channel.