YAZOO BACKWATER AREA, MISSISSIPPI
(REFORMULATION STUDY)

APPENDIX 7
ECONOMIC ANALYSIS

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YAZOO BACKWATER AREA, MISSISSIPPI
(REFORMULATION STUDY)

APPENDIX 7
ECONOMIC ANALYSIS

SECTION 1 - INTRODUCTION

GENERAL

1. This appendix presents the economic analyses pertaining to the reformulation of water resources improvements for the Yazoo Backwater Area in the west-central portion of the State of Mississippi. These analyses identify flood damage impacts, address the economic feasibility of water resources improvements, and aid in selecting a recommended alternative from the entire array of alternatives in an effort to reduce flood damages in the area in combination with developing an environmentally balanced plan that will restore and enhance the quality of the environment in this region.

HISTORY OF THE YAZOO BACKWATER REFORMULATION OF ALTERNATIVES

2. In 1982, a reevaluation report was completed by the U.S. Army Corps of Engineers, Vicksburg District, for the Yazoo Area pump project, Yazoo Backwater Area, Mississippi. That report identified the National Economic Development (NED) plan as Alternative C, a 17,500-cubic-foot-per-second (cfs) pump located near the existing Steele Bayou structure, an inlet channel from Steele Bayou and an outlet channel to the Yazoo River. Pumping would be initiated when interior water in the sump reached an elevation of 80 feet, National Geodetic Vertical Datum (NGVD), except during December 1 to March 1 when pumping would be initiated at elevation 85 feet, NGVD. Proposed mitigation for the pump station consisted of acquiring 6,000 acres of woodlands in fee title or land use easements, 6,500 acres of woodlands, or a combination of both. The benefit-cost ratio of this alternative was 3.3 to 1 at the then current project interest rate of 2-1/2 percent and 1.3 to 1 at the Federal interest rate of 7-5/8 percent.

YAZOO BACKWATER AREA, REFORMULATION REPORT, SEPTEMBER 2000, INITIAL ARRAY OF ALTERNATIVES

3. The draft reformulation report of September 2000 began its final array analysis evaluating five pump station sizes (ranging in size from 10,500 to 24,500 cfs) and a levee alternative proposed along the Big Sunflower River. Evaluations of the initial array of alternatives were based on a 50-year growth period (economic development), an expected project economic useful

life of 50 years, a Federal discount rate of 7-5/8 percent, 1997 price levels, and an estimated project completion date of 2005 for the pump station alternatives and 2006 for the Big Sunflower River levee alternative. (Data for the recommended alternative utilized 1998 agricultural price levels, 1999 price levels for all other categories, 1988 land use, a Federal discount rate of 7-5/8 percent, and a base year of 2006.) Results from the initial array analysis are presented in Table 7-1. Alternative 2 was identified as the NED plan with a benefit-cost ratio of 1.5 to 1 and excess benefits over cost of $6,651,000. Alternative 2 consisted of a 14,000-cfs pump station which would be operated on a year-round basis at elevation 80 feet, NGVD.

TABLE 7-1
INITIAL ARRAY OF ALTERNATIVES—SEPTEMBER 2000 REPORT
SUMMARY OF ECONOMIC ANALYSIS a/
FIRST COSTS, ANNUAL COSTS, ANNUAL BENEFITS,
EXCESS BENEFITS AND BENEFIT-COST RATIOS
YAZOO BACKWATER AREA, MISSISSIPPI
($000)

Item	Pump Station Alternatives b/					Levee Alternative c/
	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
First Costs	109,501	131,178	156,068	179,407	199,677	118,362
Annual Costs	11,633	14,057	16,866	19,281	21,377	11,580
Annual Benefits	17,720	20,708	22,742	23,951	24,740	16,083
Excess Benefits	6,087	6,651	5,876	4,670	3,363	4,503
Benefit-Cost Ratio	1.5	1.5	1.3	1.2	1.2	1.4

SOURCE: Yazoo Backwater Area, Mississippi, Reformulation Report, September 2000, U.S. Army Corps of Engineers, Vicksburg District: Table 7-64, page 7-131.

a/ Benefits and costs annualized using a 50-year economic project life, the current Federal interest rate of 7-5/8 percent, 1988 land use, and 1997 prices. Alternative 2 identified as the NED plan, 14,000-cfs pump.

b/ Alternatives 1 through 5 are pump station facilities including 3,500-cfs increments from 10,500- to 24,000-cfs pumping capacities.

c/ Alternative 6 includes a levee on the west side of the Little and Big Sunflower Rivers and the east side of Big Sunflower River.

SECOND ARRAY OF ALTERNATIVES--
SEPTEMBER 2000 REPORT

4. After the initial array of alternatives was analyzed, the Vicksburg District held a series of three facilitated workshops in 1997 to receive input from all interested groups in the Yazoo Backwater Reformulation effort. Many interest groups attended the meetings including nongovernmental environmental organizations, farmers, local interests, regional interest groups, and state and Federal agencies. Preliminary results from the September 2000 report initial array

of alternative plans outlined previously were presented. As a result of these workshops, several additional conceptual alternatives were identified that contained either totally nonstructural solutions or plans with a combination of structural/nonstructural solutions. This led to the second array of alternatives which included 9 nonstructural alternatives, 13 combination (structural/nonstructural) alternatives, and 6 structural alternatives.

5. Table 7-2 displays the features of all 28 alternatives developed from the facilitated workshops. The combination alternatives in the Second Array of Alternatives utilized only the 14,000-cfs pump station. The nonstructural and combination structural/nonstructural alternatives were composed of several nonstructural features used in different combinations. These features included (a) conservation easements for reestablishment of forest lands, (b) conservation easements for cropland retained in its current use, (c) flowage easements that allow for ponding of water for use by waterfowl and other aquatics, and (d) preservation easements to ensure that existing woodlands remain in woods; i.e., they are not cleared for agricultural or other purposes.

THIRD ARRAY OF ALTERNATIVES-- SEPTEMBER 2000 REPORT

6. Following the consensus workshops, the Board of Mississippi Levee Commissioners (also referred to as the Mississippi Levee Board) requested the Corps delay the study to allow for additional feedback from various groups. From March 1999 to March 2000, the Mississippi Levee Board hosted a number of facilitated workshops. As a result, the conceptual alternatives were modified slightly to further allow consideration of alternatives with a broader range of potential environmental impacts. These alternatives consisted of three basic nonstructural features—reforestation, conservation easements (land use retained for cleared lands and preservation of existing woodlands), and water management, in combination with either a 14,000- or 17,500-cfs pump, as well as the levee alternative. A total of 24 combination alternatives were evaluated (12 for each of 2 pump sizes). Each of these combination alternatives contains conservation easements for preserving existing woodlands below specific elevations. Alternatives 3 through 14 include a 14,000-cfs pump station as the structural component of the alternative, and Alternatives 15 through 26 include a 17,500-cfs pump station. Several of the alternatives contain flowage easements for lands below elevation 80 or 85 feet, NGVD, and several options for reforestation of open agricultural lands below 85 or 90 feet, NGVD, were included. Pump operation levels of 80, 85, and 90 feet, NGVD, were also evaluated. Alternative 27 is the traditional 14,000-cfs pump station alternative; Alternative 28, the traditional 17,500-cfs pump station alternative; Alternative 29, the traditional levee alternative; and Alternative 30, the traditional 14,000-cfs pump station alternative with conservation easement for all existing woodlands below elevation 100.3 feet, NGVD (approximately 159,000 acres—1988 land use).

TABLE 7-2
SECOND ARRAY OF ALTERNATIVES--SEPTEMBER 2000 REPORT
SUMMARY OF PROJECT FEATURES AND TOTAL FIRST COSTS
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Easements			Total First Costs (1997 Prices)					Pump	Acres of Mitigation
	Conservation Easements on Woodlands	Reforestation/Open Lands	Flowage/Water Management a/	Easements	Reforestation	Mitigation	Pump	Total		
				($ Million)						
NONSTRUCTURAL										
1	Preserved below 100.3 feet	Use Retained below 100.3 feet	N/A	217.0			N/A	217.0	N/A	
2	Preserved below 100.3 feet	Use Retained below 100.3 feet	Below 80.0 feet	235.3	0		N/A	235.3	N/A	
3	Preserved below 100.3 feet	Use Retained below 100.3 feet	Below 85.0 feet	253.2	0		N/A	253.2	N/A	
4	Preserved below 100.3 feet	Reforested below 85.0 feet	N/A	232.1	8.1		N/A	240.2	N/A	
5	Preserved below 100.3 feet	Reforested below 85.0 feet	Below 80.0 feet	255.0	8.1		N/A	263.1	N/A	
6	Preserved below 100.3 feet	Reforested below 85.0 feet	Below 85.0 feet	257.0	8.1		N/A	265.1	N/A	
7	Preserved below 100.3 feet	Reforested below 90.0 feet	N/A	246.5	15.7		N/A	262.2	N/A	
8	Preserved below 100.3 feet	Reforested below 90.0 feet	Below 80.0 feet	269.3	15.7		N/A	285.0	N/A	
9	Preserved below 100.3 feet	Reforested below 90.0 feet	Below 85.0 feet	280.1	15.7		N/A	295.8	N/A	
COMBINATION NONSTRUCTURAL-STRUCTURAL										
10	Preserved below 85.0 feet	Use Retained below 85.0 feet	N/A	48.9	0		102	150.9	14,000 cfs b/	
11	Preserved below 85.0 feet	Use Retained below 85.0 feet	Below 80.0 feet	59.2	0		102	161.2	14,000 cfs b/	
12	Preserved below 85.0 feet	Use Retained below 85.0 feet	Below 85.0 feet	75.1	0		102	177.1	14,000 cfs b/	
13	Preserved below 85.0 feet	Reforested below 85.0 feet	N/A	59.7	8.1		102	169.8	14,000 cfs b/	
14	Preserved below 85.0 feet	Reforested below 85.0 feet	Below 80.0 feet	68.9	8.1		102	179.0	14,000 cfs b/	
15	Preserved below 85.0 feet	Reforested below 85.0 feet	Below 85.0 feet	78.9	8.1		102	189.0	14,000 cfs b/	
16	Preserved below 90.0 feet	Use Retained below90.0 feet	N/A	82.5	0		102	184.5	14,000 cfs b/	
17	Preserved below 90.0 feet	Use Retained below90.0 feet	Below 80.0 feet	87.7	0		102	189.7	14,000 cfs b/	
18	Preserved below 90.0 feet	Use Retained below90.0 feet	Below 85.0 feet	103.6	0		102	205.6	14,000 cfs b/	
19	Preserved below 90.0 feet	Reforested below 90.0 feet	N/A	104.6	15.7		102	222.3	14,000 cfs b/	
20	Preserved below 90.0 feet	Reforested below 90.0 feet	Below 80.0 feet	111.8	15.7		102	229.5	14,000 cfs b/	
21	Preserved below 90.0 feet	Reforested below 90.0 feet	Below 85.0 feet	121.6	15.7		102	239.3	14,000 cfs b/	
22	Preserved below 100.3 feet	N/A	N/A	69.1		22.6	102	193.7	14,000 cfs b/	18,500
STRUCTURAL										
23	N/A	N/A	N/A			18.7	85	103.7	10,500 cfs c/	15,000
24	N/A	N/A	N/A			22.6	102	124.6	14,000 cfs c/	18,500
25	N/A	N/A	N/A			23.1	124	147.1	17,500 cfs c/	19,000
26	N/A	N/A	N/A			26.7	145	171.7	21,000 cfs c/	22,000
27	N/A	N/A	N/A			30.6	158	188.6	24,500 cfs c/	25,000
28	N/A	N/A	N/A			12.6	177	189.6	N/A	10,000

SOURCE: Yazoo Backwater Area, Mississippi, Reformulation Report, September 2000, U.S. Army Corps of Engineers, Vicksburg District, Table 7-70, page 7-142.
a/ 1 December to 1 March.
b/ A 14,000-cfs pump would be operated to reduce flood damages above easement elevations.
c/ Initiate pumping at 85 feet, NGVD, during 1 December to 1 March; initiate pumping at 80 feet, NGVD, during cropping season.

Notes:
Alternatives 1 through 9 are Nonstructural.
Alternatives 10 through 22 are Combination.
Alternatives 23 through 27 are standard Alternatives, including a pump while Alternative 28 is a structural levee Alternative along the Sunflower River.
N/A = Not applicable.

7. Based on then-current criteria for alternative selection, the traditional 14,000-cfs pump (Alternative 27) remained the alternative with the greatest excess benefits over costs. However, several of the combination alternatives had positive excess benefits, and these alternatives provide significantly more environmental benefits than Alternative 27.

8. The final results of the analyses of the third array of alternatives are presented in Table 7-3. The evaluation of these proposed alternatives utilized data developed earlier in this study and the methodology used was consistent among alternatives. Results of the analyses indicated that the 14,000-cfs pump station alone, or in combination with nonstructural features, were the alternatives that provided the greatest excess benefits over costs. As in earlier evaluations, the 14,000-cfs pump station with associated mitigation is the plan, overall, with the greatest excess benefits over costs (Plan 27). Specific details about each alternative in the third array of alternatives is shown on Plate 4-6 of Appendix 4.

FOURTH ARRAY OF ALTERNATIVES—2000 DRAFT REPORT

9. The results of the fourth (and final) array of alternatives evaluated and outlined in the September 2000 report are presented in Tables 7-4 and 7-5. Table 7-4 shows a breakdown of the benefits and costs for Alternatives 2 through 7 between the structural and nonstructural components. Results of the standard economic analysis revealed positive benefit-cost ratios for Alternatives 3-6. Alternative 3 was identified as the NED plan with the most excess benefits over costs, but Alternative 5 was identified as offering additional environmental benefits than Alternative 3. Thus, after a comprehensive evaluation weighing environmental versus economic benefits and detriments, Alternative 5 was chosen as the recommended alternative for the Draft Report and the Environmental Impact Statement. Maximizing the sum of net NED and Environmental Quality (EQ) benefits, Alternative 5 offered a better balance of Federal objectives.

10. Table 7-5 provides an update of the results of the standard economic analysis for the recommended alternative—Alternative 5. An update of various parameters was deemed necessary prior to finalization of the draft reformulation report in September 2000. These updates included agricultural benefits upgraded with 1999 crop budgets and 1999 current normalized agricultural prices, and updates to the residential/nonresidential structure database from 1990 to June 2000. The final results of the September 2000 analysis are displayed in Table 7-5 for the recommended alternative. Benefits and costs were annualized using a 50-year economic project life, the current Federal interest rate of 6-5/8 percent, 1988 land use, and 2000 price levels.

RESULTS OF FINAL ARRAY ANALYSES—CURRENT ANALYSES

11. Based on comments received during a meeting with the Atlanta Regional Offices of the U.S. Fish and Wildlife Service (FWS) and the Environmental Protection Agency (EPA), modifications were made to most of the proposed combination alternatives. A final array of alternatives was developed that included the evaluation of four nonstructural alternatives, one

TABLE 7-3
THIRD ARRAY OF ALTERNATIVES—SEPTEMBER 2000 REPORT
SUMMARY OF ECONOMIC ANALYSIS a/
YAZOO BACKWATER AREA, MISSISSIPPI
($000)

Alternative	Total First Costs	Pump Costs	Easement Costs	Mitigation Costs	Annual Costs	Annual Benefits	Excess Benefits
1	261,364	--	261,364	--	19,238	--	(19,238)
2	329,655	--	329,655	--	24,265	(4,452)	(28,717)
3	193,661	120,195	42,113	31,353	16,365	16,242	(123)
4	210,391	120,635	63,519	26,237	17,548	16,242	(1,306)
5	228,606	120,635	81,734	26,327	18,890	16,242	(2,648)
6	187,193	120,195	66,998	--	15,574	16,900	1,326
7	201,819	120,634	81,185	--	16,654	16,900	246
8	213,346	120,635	92,711	--	17,503	16,900	(603)
9	24,551	120,195	85,229	19,127	18,522	13,387	(5,135)
10	228,478	120,635	102,022	5,821	18,675	13,387	(5,288)
11	243,518	120,635	117,063	5,820	19,783	13,387	(6,396)
12	276,598	120,195	156,403	--	22,155	13,883	(8,272)
13	280,781	120,635	160,146	--	22,466	13,883	(8,583)
14	282,795	120,635	162,160	--	22,615	13,883	(8,732)
15	219,727	143,411	42,113	34,203	18,562	18,052	(510)
16	236,594	143,858	63,519	29,217	19,756	18,052	(1,704)
17	254,809	143,858	81,734	29,217	21,097	18,052	(3,045)
18	210,409	143,411	66,998	--	17,532	18,159	627
19	225,043	143,858	81,185	--	18,612	18,159	(453)
20	236,569	143,858	92,711	--	19,461	18,159	(1,302)
21	251,464	143,411	85,229	22,824	20,783	14,794	(5,989)
22	253,252	143,858	102,022	7,372	20,763	14,794	(5,969)
23	268,094	143,858	117,063	7,173	21,855	14,794	(7,061)
24	299,815	143,411	156,404	--	24,113	14,917	(9,196)
25	304,006	143,858	160,148	--	24,424	14,917	(9,507)
26	306,020	143,858	162,162	--	24,573	14,917	(9,656)
27	160,725	120,195	--	40,530	13,990	17,539	3,549
28	191,640	143,411	--	48,229	16,636	19,664	3,028
29	234,237	215,072 b/	--	19,165	19,552	15,102	(4,450)
30	232,905	120,195	73,257	39,453	19,348	17,539	(1,809)

SOURCE: Yazoo Backwater Area, Mississippi, Reformulation Report, September 2000, U.S. Army Corps of Engineers, Vicksburg District: Table 7-71, page 7-144.

a/ Benefits and costs annualized using a 50-year economic project life, the current Federal interest rate of 7-1/8 percent, 1988 land use, and 1997 prices.

b/ Represents cost of levee construction.

TABLE 7-4
FOURTH (FINAL) ARRAY OF ALTERNATIVES--SEPTEMBER 2000 REPORT
SUMMARY OF ECONOMIC ANALYSIS – ALL ALTERNATIVES a/
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Alternative Alternatives b/																	
	Alternative 2			Alternative 3			Alternative 4			Alternative 5			Alternative 6			Alternative 7		
	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/
ANNUAL BENEFITS ($000) a/																		
BENEFITS BY CATEGORY																		
Agricultural Crop	--	380	380	12,934	--	12,934	10,085	1,027	11,112	9,763	1,162	10,925	8,708	854	9,562	6,274	380	6,654
Agricultural Noncrop	--	--	--	2,705	--	2,705	2,579	--	2,579	2,241	--	2,241	2,159	--	2,159	1,770	--	1,770
Structures c/	--	--	--	1,967	--	1,967	1,935	--	1,935	1,871	--	1,871	1,788	--	1,788	1,639	--	1,639
Road and Bridge	--	--	--	883	--	883	863	--	863	828	--	828	802	--	802	766	--	766
Urban Streets	--	--	--	90	--	90	89	--	89	83	--	83	80	--	80	66	--	66
Emergency Costs	--	--	--	170	--	170	168	--	168	158	--	158	152	--	152	126	--	126
FIA	--	--	--	31	--	31	31	--	31	30	--	30	29	--	29	25	--	25
Catfish	--	--	--	383	--	383	377	--	377	365	--	365	352	--	352	319	--	319
Timber/Hunting Leases	--	2,488	2,488	--	--	--	--	608	608	--	936	936	--	1,158	1,158	--	2,488	2,488
Total Benefits	--	2,868	2,868	19,163	--	19,163	16,127	1,635	17,762	15,339	2,098	17,437	14,070	2,012	16,082	10,985	2,868	13,853
EMPLOYMENT BENEFITS	--	841	841	438	--	438	417	43	460	376	130	506	351	188	539	395	384	683
TOTAL ANNUAL BENEFITS	--	3,709	3,709	19,601	--	19,601	16,544	1,678	18,222	15,715	2,228	17,943	14,421	2,200	16,621	11,380	3,252	14,536
Total Annual Benefits – Excluding Employment Benefits	--	1,569	1,569	19,163	--	19,163	16,127	1,635	17,762	15,339	2,098	17,437	14,070	2,012	16,082	10,985	2,868	13,853
ANNUAL COSTS ($000) a/																		
FIRST COST d/	--	291,001	291,001	115,233	38,477 e/	153,710	140,391	14,341	154,732	134,978	46,617	181,595	127,913	68,461	196,274	120,383	154,271	274,654
INTEREST DURING CONSTRUCTION	--	27,731	27,731	14,648	--	14,648	13,374	1,366	14,740	12,863	4,442	17,305	12,180	6,524	18,704	11,472	14,701	26,173
GROSS INVESTMENT	--	318,732	318,732	129,881	38,477 e/	168,358	153,765	15,707	169,472	147,841	51,059	198,900	140,093	74,985	214,981	131,855	168,972	300,827
ANNUAL COSTS d/																		
Amortization	--	22,005	22,005	8,967	2,656	11,623	10,616	1,085	11,701	10,207	3,525	13,732	9,665	5,177	14,842	9,103	11,666	20,769
O&M Project	--	--	--	812	--	812	812	--	812	812	--	812	812	--	812	812	--	812
O&M Entergy	--	--	--	379	--	379	253	--	253	183	--	183	142	--	142	76	--	76
O&M Mitigation	--	--	--	0	334	334	--	--	--	--	--	--	--	--	--	--	--	--
Pump Replacement	--	--	--	154	--	154	154	--	154	154	--	154	154	--	154	154	--	154
TOTAL ANNUAL COSTS	--	22,005	22,005	10,312	2,990	13,302	11,835	1,085	12,920	11,356	3,525	14,881	10,773	5,177	15,950	10,145	11,666	21,811

TABLE 7-4 (Cont)

Item	Alternative Alternatives b/																	
	Alternative 2			**Alternative 3**			Alternative 4			Alternative 5			Alternative 6			Alternative 7		
	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/	Structural c/	Nonstructural c/	Total c/
RESULTS OF THE STANDARD ECONOMIC ANALYSIS																		
EXCESS BENEFITS ($000)	(19,595)			6,299			5,302			3,063			670			(7,181)		
Excluding Employment Benefits	(20,436)			5,861			4,842			2,557			131			(7,960)		
BENEFIT-COST RATIO	0.11			1.47			1.41			1.23			1.07			0.67		
Excluding Employment Benefits	0.07			1.44			1.37			1.19			1.03			0.64		

SOURCE: Yazoo Backwater Area, Mississippi, Reformulation Report, September 2000, U.S. Army Corps of Engineers, Vicksburg District: Table 10, pages 74 through 75.
a/ Benefits and costs annualized using the current Federal interest rate of 6-5/8 percent, a 50-year economic project life, 1988 land use, and 2000 price levels.
b/ Alternative 2 is the nonstructural alternative; Alternative 3, the structural alternative; Alternatives 4-7 are combination structural/nonstructural alternatives.
c/ Structural = structural components of alternative; Nonstructural = Nonstructural components of alternative; total structural and nonstructural components of alternative.
d/ Includes costs for mitigation for Alternative 3; Alternatives 2 and 4-7 include conservation easement and reforestation costs.
e/ Includes mitigation costs. Interest during construction not applicable to mitigation costs.

TABLE 7-5
FOURTH (FINAL) ARRAY OF ALTERNATIVES--SEPTEMBER 2000 REPORT
SUMMARY OF ECONOMIC ANALYSIS a/
RECOMMENDED ALTERNATIVE – ALTERNATIVE 5
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Alternative 5	
	Excluding Employment Benefits	Including Employment Benefits
ANNUAL BENEFITS ($000)		
STRUCTURAL COMPONENTS		
Agricultural Crop b/	11,639	11,639
Agricultural Noncrop	2,241	2,241
Structures c/	2,256	2,256
Road and Bridge	828	828
Urban Streets	83	83
Emergency Costs	158	158
FIA	30	30
Catfish	365	365
Total Structural Benefits	17,600	17,600
NONSTRUCTURAL COMPONENTS		
Agricultural Crop d/	2,960	2,960
Timber/Hunting Leases	936	936
Total Nonstructural Benefits	3,896	3,896
EMPLOYMENT	--	506
TOTAL ANNUAL BENEFITS	21,496	22,002
ANNUAL COSTS ($000)		
FIRST COST	181,595	181,595
INTEREST DURING CONSTRUCTION	17,305	17,305
GROSS INVESTMENT	198,900	198,900
ANNUAL COSTS		
Amortization	13,732	13,732
O&M Project	812	812
O&M Entergy	183	183
Pump Replacement	154	154
TOTAL ANNUAL COSTS	14,881	14,881
STANDARD ECONOMIC ANALYSIS		
EXCESS BENEFITS ($000)	6,615	7,121
BENEFIT-COST RATIO	1.44	1.48

SOURCE: Yazoo Backwater Area, Mississippi, Reformulation Report, September 2000, U.S. Army Corps of Engineers, Vicksburg District: Table 15, page 88.

a/ Benefits and costs annualized using the current Federal interest rate of 6-5/8 percent, a 50-year economic project life, 1988 land use, and 2000 price levels.
b/ Agricultural crop benefits include FY 99 Current Normalized Guidance II Commodity Prices and 1999 agricultural crop budgets published by MSU MAFES.
c/ Residential and nonresidential structure data based on updated property surveys conducted in the spring of 2000 (current year 2000 values).
d/ Benefits consist of insurable losses.

structural alternative, and four combination alternatives. The nonstructural alternatives (Alternatives 2, 2A, 2B, and 2C) were labeled as "nonstructural" because they did not include a 14,000-cfs pump in these alternatives. These alternatives include relocating buildings, floodproofing buildings, ring levees, conservation easements for land use, and reforestation of agricultural lands. Alternative 3 is the only structural alternative because it includes a 14,000-cfs pump, and no additional reforestation above what is necessary to obtain a no-net loss in habitat units (HU). The combination alternatives (Alternatives 3 through 7) were labeled as "combination" because they include a 14,000-cfs pump as part of the construction features. Table 7-6 provides a summary of the features associated with each alternative evaluated in the final array. The summary of economic analysis for the final array of alternatives evaluated in the current analysis is presented and discussed in "SECTION 7 – SELECTION OF THE RECOMMENDED ALTERNATIVE," pages 7-116 and 7-117 of this document.

NONSTRUCTURAL ALTERNATIVES 1,
2, 2A, 2B, AND 2C

12. The alternatives carried into the final array are described below, and all elevations are based on the elevation at the Steele Bayou structure. The operation of the Little Sunflower structure will not change with any of the alternatives.

[NOTE: Blocking Out. The reforestation/conservation features easement acquisition limits for the Yazoo Backwater Reformulation Study were established based upon flood frequency stage elevations. However, based upon sound real estate practices and guidance as found in USACE real estate regulations, blocking out will be utilized to address such items as access, the extent of severance damages, and avoidance of an uneconomic remainder. The blocking out will result in the acquisition of some lands outside a given flood event or elevation. The Vicksburg District Real Estate Division has vast experience in the acquisition of lands based upon elevation and typically uses a blocking factor of 30 percent. This figure was utilized for calculating the acreage to be acquired for the reforestation/conservation features easement in connection with the Yazoo Backwater Reformulation Study. The symbol "(b)" indicates a blocked acreage in the alternative descriptions listed below. Acreages are rounded to the nearest 100 acres and are based on 2005 land use.

Slope. Throughout the descriptions of the alternatives, the elevation at the Steele Bayou structure will be referenced regarding the acquisition of perpetual/flowage easements. These references do not imply an absolute elevation, but imply an elevation that rises as you move upstream from the structure. The rate of the rise or the slope of the surface can be found in Appendix 6 (Engineering), and it is based upon a hydrologic event, such as the 1-year frequency flood. The use of the elevation at the Steele Bayou structure establishes a standard point of reference for comparison of the alternatives.]

TABLE 7-6
FINAL ARRAY OF ALTERNATIVES—CURRENT ANALYSES
SUMMARY OF PROJECT FEATURES
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Structural Feature	Pump Operation Elevation (feet, NGVD)		Steele Bayou Operational Changes (feet, NGVD)	Reforestation (acres)	Flowage Easements/ Income Assurance (acres)	Floodproofing Buildings (No. Structures)	Purchase Buildings and Remove (No. Structures)
		1 March-31 October	1 November-28 February					
1	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	None	N/A	N/A	70 to 73	124,400	191,600	No	No
2A	None	N/A	N/A	N/A	81,400	234,600	1,363 e/	No
2B	Ring Levees	N/A	N/A	N/A	48,880 b/	No	No	179 d/
2C	None	N/A	N/A	N/A	114,400	201,600	No	1,576
3	Pump	80	85	70 to 73	53,363 c/	No	No	No
4	Pump	85	85	70 to 73	37,200	No	No	No
5	Pump	87	87	70 to 73	55,600	No	No	No
6	Pump	88.5	88.5	70 to 73	81,400	No	No	No
7	Pump	91	91	70 to 73 a/	124,400	No	No	No

a/ Additional operation features to this alternative would be to reintroduce flows from the Mississippi River up to a maximum elevation of 87 feet, NGVD.
b/ 26,400 acres are associated with the nonstructural feature and 22,480 acres are compensatory mitigation.
c/ Mitigation acres required for this alternative.
d/ Buildings outside ring levee system would be purchased and removed from 100-year flood plain.
e/ Floodproofing cost was computed for all structures where first-floor elevations were within 1 foot of the 100-year flood elevation. The depth-damage curve utilized to compute flood damages begins computing damages at 2 feet below the first-floor elevation. Therefore, the number of structures damaged by a 100-year event (1,576) differs for the number of structures floodproofed (1,363).

a. No Action.

Alternative 1. This is the no-action alternative. This action would not eliminate potential flood damages. Residential and nonresidential structures would continue to be affected by flooding, which economically impacts the area. Local, state, and Federal governments would continue to pay for flood-fighting efforts and repair of urban and rural roads, bridges, and other infrastructure. There will be no project impacts with the no-action alternative.

b. Nonstructural alternatives. The flowage easements and income assurance features of the nonstructural alternatives would require additional authorization from Congress to implement.

(1) Alternative 2. This alternative contains nonstructural and operational features which influence land-use patterns and activities. There is a no-pump station feature in Alternative 2. To be consistent with alternatives that include a pump station (i.e., some level of benefit across the study area), the nonstructural easements would provide flood damage reduction through reforestation or some degree of compensation across the entire study area. Reforestation of the 2-year flood plain (elevation 91.0 feet, NGVD, at the Steele Bayou structure) would provide flood damage reduction and remove impacts of agricultural practices on these lands. Compensation would be provided above elevation 91.0 feet, NGVD, at the Steele Bayou structure. Features include:

(a) Nonstructural.

1. Acquisition and reforestation/conservation features on up to 124,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 95,700 acres of cleared land are potentially available below elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure), and the remaining acreage needed to reach up to the 124,400 acres would be acquired above elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to, (a) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (b) food plots; (c) permanent openings maintained in early successional stages; (d) access trails, roads, and firebreaks; or (e) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches. The Vicksburg District will have the right to enforce the terms of the recorded conservation easements.

2. Acquisition of up to 197,600 acres of agricultural lands between elevations 91.0 and 100.3 feet, NGVD, at the Steele Bayou structure, through flowage easements. No agricultural intensification or other development would be allowed under the easement. Easements would be perpetual and from willing sellers only.

(b) Operational. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

(2) Alternative 2A. This alternative contains nonstructural features which influence land-use patterns and activities. There is a no-pump station feature in this alternative. Features include:

(a) Nonstructural.

1. Acquisition and reforestation/conservation features on up to 81,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 62,600 acres of cleared land are potentially available below elevation 88.5 feet, NGVD, at the Steele Bayou structure, and the remaining acreage needed to reach up to the 81,400 acres would be acquired between elevations 88.5 and 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to, (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches. The Vicksburg District will have the right to enforce the terms of the recorded conservation easements.

2. Flood proofing 1,363 structures in the 100-year flood plain.

3. Implementing an income assurance program that would be established for 235,000 acres of cropland above elevation 88.5 feet, NGVD.

(3) Alternative 2B. This alternative is a nonstructural alternative with a structural component. There is a no-pump station with this alternative. Features include:

(a) Nonstructural.

1. Acquisition and reforestation/conservation features on up to 26,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. As a result of design and alignment of the 14 ring levees (see below), approximately 20,300 acres of cleared land are potentially available below elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure), and outside the ring-leveed areas. Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to, (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

2. Relocate the remaining 194 structures not protected by the ring levees.

(b) Structural. Fourteen ring levees would be required with this alternative to provide 100-year protection to 88 percent of the structures in the Yazoo Backwater study area. Ring levees would require an accompanying infrastructure to evacuate precipitation from inside the ringed area and provide for operation of septic systems in saturated grounds. This would require water control structures, interior channels, road crossings, wastewater facilities, pumps, etc., in addition to the levees.

(4) Alternative 2C. This alternative is a nonstructural alternative that influences land-use patterns and activities. This alternative is based on the Shabman Report. There is a no-pump station feature in this alternative. Features include:

Nonstructural.

1. Acquisition and reforestation/conservation features on up to 114,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 95,700 acres of cleared land are potentially available below elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure), and the remaining acreage needed to reach up to the 114,400 acres would be acquired above elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not

necessarily limited to, (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

2. Implementing an income assurance program on 201,900 acres of cropland, which is all remaining cropland in the 100-year flood plain.

3. Relocation of all 1,576 structures damaged by a 100-year flood event.

c. Structural alternative. As part of the structural feature, pump-on elevations were selected to meet project purpose.

(1) Alternative 3. Features include:

(a) Structural. A 14,000-cubic-foot-per-second (cfs) pump station with a pumping elevation of 80.0 feet, NGVD, between 1 March and 31 October. Pumping elevation of 85.0 feet, NGVD, between 1 November and 28 February. This would allow retention of more water during the winter waterfowl season.

(b) Operational. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

d. Combined structural and nonstructural alternatives. As part of the structural feature, pump-on elevations were selected to meet project purpose.

(1) Alternative 4. Features include:

(a) Nonstructural. Acquisition and reforestation/conservation features on up to 37,200 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 28,600 acres of cleared land are potentially available below elevation 85.0 feet, NGVD, at the Steele Bayou structure, and the remaining acreage needed to reach up to the 37,200 acres would be acquired between elevations 85.0 and 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

(b) Structural. A 14,000-cfs pump station with a year-round pumping elevation of 85.0 feet, NGVD.

(c) Operational. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

(2) Alternative 5. Features include:

(a) Nonstructural. Acquisition and reforestation/conservation features on up to 55,600 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 42,800 acres of cleared land are potentially available below elevation 87.0 feet, NGVD (1-year flood plain at the Steele Bayou structure), and the remaining acreage needed to reach up to the 55,600 acres would be acquired between elevations 87.0 and 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

(b) Structural. A 14,000-cfs pump station with a year-round pumping elevation of 87.0 feet, NGVD.

(c) Operational. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

(3) Alternative 6. Features include:

(a) Nonstructural. Acquisition and reforestation/conservation features on up to 81,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 62,600 acres of cleared land are potentially available below elevation 88.5 feet, NGVD, at the Steele Bayou structure, and the remaining acreage needed to reach up to the 81,400 acres would be acquired between elevations 88.5 and 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

(b) Structural. A 14,000-cfs pump station with a year-round pumping elevation of 88.5 feet, NGVD.

(c) Operational.

1. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

2. Reintroduce flows from the Mississippi River up to a maximum elevation of 87.0 feet, NGVD (1-year frequency annual flood event), by leaving the Steele Bayou structure open.

(4) Alternative 7. Features include:

(a) Nonstructural.

1. Acquisition and reforestation/conservation features on up to 124,400 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 95,700 acres of cleared land are potentially available below elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure), and the remaining acreage needed to reach up to the

124,400 acres would be acquired above elevation 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to, (a) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (b) food plots; (c) permanent openings maintained in early successional stages; (d) access trails, roads, and firebreaks; or (e) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

2. Conservation easements on 81,800 acres of forested lands below elevation 91.0 feet, NGVD. Easements would be perpetual and from willing sellers only.

(b) Structural. A 14,000-cfs pump station with a year-round pumping elevation of 91.0 feet, NGVD.

(c) Operational.

1. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

2. Reintroduce flows from the Mississippi River up to a maximum elevation of 87.0 feet, NGVD (1-year frequency annual flood event), by leaving the Steele Bayou structure open.

13. Detailed descriptions of alternatives considered for this reformulation study are presented in the Main Report.

SECTION 2 – OVERVIEW OF THE CURRENT ANALYSIS

14. Damage and benefit evaluations are based on current hydrologic analyses, land use and survey data, detailed cost data, extensive engineering and economic technical data, and other current factual data including risk-based analyses incorporated into various structure and agricultural analyses. Factual data and computations describe the evaluation methodology utilized in determining annual benefits/costs for the improvements proposed. Evaluations are based on a 50-year growth period (economic development), an expected project economic useful life of 50 years, a Federal discount rate of 5-1/8 percent, 2005 price levels, 2005 land use, a base year of 2012, and an estimated project completion date of 2011.

15. Background data consist of a description of the flood plain, discussion of properties affected by flooding, and discussion of benefits/impacts associated with the various alternatives considered and evaluated, including appropriate risk-based analyses for specific parameters.

16. Economic evaluations and analyses compared the without- (base hydrologic conditions) to with-project conditions in order to determine the best alternative in terms of economic development and environmental enhancement; i.e., a balance between NED and EQ. Thus, all information presented herein will address the economic analysis that was conducted to identify the NED/EQ plan for the final array of alternatives. The NED plan is the optimum plan economically, the plan that produces the greatest excess benefits over costs or net benefits. The EQ plan is the environmental quality plan--the plan that protects the quality of the environment. In accordance with Engineer Regulation (ER) 1165-2-28 (30 April 1980), the EQ plan “must enhance, preserve, or restore the environment of the study area.” The “without-project” condition reflects conditions expected to prevail in the area in the absence of any additional water resources improvements and is equivalent to the "no-action" alternative. The “with-project” condition reflects conditions expected to prevail in the area with additional water resources improvements in place.

17. Due to the massive number of calculations and data required in the computation of damages, benefits, and costs for the Yazoo Backwater economic analysis, the recommended alternative (Alternative 5) will be presented as the “with-project” condition in many of the tables. By providing a more detailed step-by-step process for one alternative in the calculation of agricultural, urban, and other average annual damages, benefits, and cost computations, the general procedures of the process can be more easily followed and understood. However, all of the necessary information for alternative comparison will be provided for all alternatives in the final array in the appropriate tables. Thus, with-project conditions in the current analyses of the final array of alternatives denote conditions with the installation of the recommended alternative (Alternative 5--14,000-cfs pump station) in place for illustrative purposes throughout this narrative unless otherwise noted.

18. The term "project area" is defined as the area affected by the construction of water resources improvement alternatives. For this study, the greater Yazoo Backwater Project Area covers approximately 926,000 acres extending from the Yazoo River a few miles north of Vicksburg northerly about 65 miles to the vicinity a few miles south of Greenville. The primary area affected by the proposed project and subject of this analysis is only a portion of the total project area. Hereafter referred to as the "study area," this is the area subject to flooding by the 100-year frequency flood event and is delineated to be about 630,000 acres. The term "economic base study area" will be utilized in this report to denote Sharkey and Issaquena Counties, Mississippi, the area that appropriately reflects the socioeconomic problems, needs, conditions, and opportunities indicative of the entire Yazoo Backwater Area. Less than 13 percent of the study area is located outside the economic base area (Sharkey and Issaquena Counties).

19. "Urban" areas, defined by the Bureau of Census as communities with populations of 2,500 persons or more, do not exist in the Yazoo Backwater economic base area. Therefore, population "cluster" areas in the study area will be referred to as urban development or developed areas. With a population of 2,237 in 2006, Rolling Fork is the largest town in the economic base area. Other developed areas in the economic base area (i.e., Issaquena and Sharkey Counties) include the communities of Anguilla, Cary, Eagle Lake, Mayersville, Midnight, Onward, Silver City, and Valley Park, Mississippi.

THE YAZOO BACKWATER AREA

LOCATION

20. The Yazoo Backwater study area is located almost entirely within Sharkey and Issaquena Counties and partially within five additional counties in west-central Mississippi and east-central Louisiana in the Yazoo River Basin (Humphreys, Warren, Washington, and Yazoo Counties, Mississippi, and Madison Parish, Louisiana). The area affected by implementation of the project (project area) covers a drainage area of approximately 1,447 square miles and is displayed on Plate 4-1 of Appendix 4. This area is bounded on the west by the east bank Mississippi River levee, on the north by State Highway 12, and on the east and south by the west levee of the Will M. Whittington channel and the Yazoo River. The topography of the area is typified by

flat, nearly level land, characteristic of the Mississippi River alluvial valley. The Yazoo Backwater Area was once heavily forested with extensive bottom-land hardwoods, wetlands, swamps, and lakes. Big Sunflower and Little Sunflower Rivers, Deer Creek, Steele Bayou, and Eagle Lake provide drainage to the entire project area. The total drainage area flowing through the Steele Bayou structure covers approximately 4,093 square miles, including runoff from as far north as Clarksdale (Plate 4-2, Appendix 4).

DESCRIPTION OF THE STUDY AREA

21. For purposes of this reformulation study, the Yazoo Backwater study area is the primary area which would be impacted by implementation/operation of the proposed water resources improvement project inclusive of the area encompassed by the 100-year frequency flood elevation delineation from existing (base) or without-project conditions. The study area presented on Plate 4-4 also shows the boundaries of the two hydrologic reaches established for evaluation of the proposed water resources improvements in the Yazoo Backwater Area. Reach 1 comprises the lower Yazoo Backwater ponding area consisting of 256,262 acres affected by operation of the Steele Bayou structure; and Reach 2 comprises the upper ponding area consisting of 373,725 acres affected by operation of the Little Sunflower structure. (In the previous studies, there were four reaches analyzed—Reach 1 comprised the lower area and Reaches 2, 3, and 4 comprised the upper area in the eastern portion of the study area. However, for this analysis, since Reaches 2, 3, and 4 are evaluated against the same hydrologic water profiles, these three reaches were combined into one reach.)

22. Mississippi counties located within the Yazoo Backwater impacted area boundary include Issaquena and Sharkey Counties. In addition, portions of Humphreys, Warren, Washington, and Yazoo Counties, Mississippi, and a portion of Madison Parish, Louisiana, are located within the impacted study area.

23. Prior to past water control improvements, the Yazoo Backwater study area was subject to flooding from Mississippi River backwater which entered the area through a void between the end of the mainline Mississippi River levee and the adjacent hills. Construction of the Will M. Whittington Auxiliary Channel divided the area west of the Yazoo River into two areas. The larger, more westerly of these areas is known as the Yazoo Area. The Yazoo Backwater study area currently is protected from Mississippi River backwater flooding up to a design overtopping elevation of 107.0 feet, NGVD, from the Mississippi River and Tributaries Project Design Flood by the Yazoo Backwater levee that extends for approximately 28 miles between the lower limits of the Mississippi River east bank levee and the west bank of the auxiliary channel.

24. The evaluation of flood damages and benefits contained in this reformulation report is presented for the "study area" only, with two hydrologic-based reaches developed and utilized to address the flood problems in the Yazoo Backwater Area. Two water resources improvement projects within the project area (Yazoo Area and Satartia Area Backwater levee projects) have been completed and will not impact the analyses of this report.

TOPOGRAPHY

25. The Yazoo alluvium, or Delta area, is in the alluvial valley of the Mississippi River. These lands are gently sloping lowlands bordering the Mississippi River mainline levee. The topography is characterized by low, relatively flat, poorly drained flatlands with slopes of 0.3 to 0.9 foot per mile and belts of aligned hills and valleys. Elevations range from approximately 70 feet, NGVD, in southern low-lying areas to approximately 100 feet, NGVD, in the northern portion of the study area.

CLIMATE

26. The climate of the study area is primarily humid, subtropical with abundant precipitation generally influenced by the Gulf of Mexico to the south and the continental landmass to the north. Summers are long, hot, and humid--the area is almost totally dominated by the westward extension of the Bermuda high, a subtropical, semipermanent anticyclone. Generous supplies of moisture and thermal instability, associated with the prevailing flow, combine to produce frequent afternoon and evening thunderstorms. Temperatures of 90 degrees F or greater are expected an average of 66 days annually with a normal annual temperature of 64 degrees F and an average of 33 days when the temperature is expected to be colder than 32 degrees F. Observed temperature extremes range from -16 to 115 degrees F. The normal annual precipitation is 51 inches, with rainfall amounts heaviest during the months of December to April, with minimum rainfall occurring generally during the months of September and October. Precipitation maximizes in March with an average of approximately 5.7 inches and minimizes in October when the average is approximately 2.5 inches. Severe rainfall, producing locally intense runoff and flooding, can occur at any time of the year. The average length of the frost-free growing season is approximately 270 days--over 9 months. An annual snowfall event occurs in the study area on the average, with average accumulations of approximately 2 inches.

NATURAL RESOURCES

27. Highly productive agricultural lands, wildlife, forested areas, lakes, streams, wetland areas, and minerals are the area's most valuable natural resources. Agricultural lands, which support the majority of the area's economy, accounted for nearly 65 percent of the total land use in the project area in 2005 while forested land comprised over 30 percent. Water bodies and other resources made up the remainder of the project area's 926,000 acres. Streams, lakes, and wetland areas provide habitat for wildlife and are used by area residents in outdoor sports activities. Bottom-land hardwood areas provide high quality habitat for terrestrial species. In addition to the tributary systems, numerous lakes provide fishing opportunities for area residents. Abundant mineral resources include clay, sand, gravel, stone, and lignite.

Area Soils

28. The alluvial soils of the Yazoo Backwater Area are very fertile, produce excellent agricultural crops, and support vigorous growths of hardwood forests comprised of numerous species adaptable to varying and complex soil and moisture conditions. This agriculturally oriented area is a part of the extremely rich deltaic region whose cultivated soils constitute one of the more productive areas in the United States. Major agricultural crops produced in the area are cotton, soybeans, rice, corn, grain sorghum, and wheat. Catfish farming operations also contribute significantly to the total value of farm products sold within the study area.

Area Rivers and Streams

29. Principal streams include the Little Sunflower and Big Sunflower Rivers, Steele Bayou, and Deer Creek. Two connecting channels are also constructed within the study area. One of these channels connects the Big Sunflower and Little Sunflower Rivers; the other parallels the Yazoo backwater levee from the structure on the Little Sunflower River to the structure on Steele Bayou.

30. In addition to the streams and rivers, the Yazoo Backwater Area contains large numbers of oxbow lakes and wetland and backwater areas. One of the larger oxbow lakes in the study area is Eagle Lake. The old river channel occupied by the lake continues to be the boundary between the States of Mississippi and Louisiana. Other large lakes in the study area are Cypress Lake,

Five-Mile Lake, Lake Washington, and Lake George. The size of the oxbow lakes range from a few acres to more than 3,000 acres each. Historically, these lakes and wetland areas have provided excellent fishing, waterfowl hunting, and other recreational opportunities.

Forests

31. The forests of the Yazoo Backwater Area are primarily bottom-land hardwoods and vary considerably in composition and density. Conditions of the forested areas depend primarily on ownership, past and present silvicultural practices, and local site quality.

32. Future land use in the study area is expected to parallel present conditions of development and will depend to a large degree on future market demands for agricultural production and incentives for reforestation.

Fish and Wildlife Resources

33. In agricultural areas, the current farming practices of straight-row cropping, cultivation to the edges of streams and lakes, large-field monoculture, and other practices allow limited habitat for wildlife. However, forested areas, which cover approximately 275,000 acres in the project area, provide essential and highly productive habitat for white-tailed deer, wild turkey, squirrels, raccoons, opossums, mink, otter, cottontail and swamp rabbits, nesting and migratory waterfowl, herons, egrets, hawks, owls, and many species of nesting and wintering songbirds.

34. The abundance of water also supports many species of fish and related creatures. Various species of turtles, snakes, and amphibians and the American alligator are native to the area. Frequent winter and early spring flooding of woodlands and low-lying farmlands provides habitat for wintering waterfowl. With implementation of the recommended alternative, the amount of waterfowl habitat is expected to increase with the reforestation of agricultural lands within the study area.

35. Fifty-seven species of fish were identified as being residents of the Yazoo Backwater Area, including flathead catfish, freshwater drum, gizzard shad, common carp, bigmouth buffalo, white crappie, gar, bowfin and bull heads, and sunfishes.

36. Also, two endangered species were identified by FWS as potentially occurring in the study area. These include the pondberry plant (*Lindera melissifolia*) and the Louisiana black bear (*Ursus americanus luteolus*).

RECREATIONAL RESOURCES

37. Major recreational activities in the study area are hunting and fishing with associated use of lakes and streams. Limited public use facilities exist for camping and boating.

38. Currently, there are over 118,000 acres of publicly owned lands available for recreational and other uses in the 926,000-acre project area. The Delta National Forest as well as several state Wildlife Management Areas (WMA) and National Wildlife Refuges (NWR) are located in the project area and provide public use areas for hunting, fishing, and wildlife-oriented recreation. The Delta National Forest, the only bottom-land hardwood ecosystem in the National Forest System, contains over 60,000 acres of bottom-land hardwoods and forested wetlands. The Forest is managed to promote healthy tree stands for the timber industry; enhanced practices to support healthy waterfowl, wildlife, and other habitat; and year-round recreational opportunities (hiking, ATV trails, camping, fishing, hunting, swimming), in addition to heritage resources and natural history. The same type of recreational opportunities and environmental practices are available at the Yazoo NWR (12,941 acres), Lake George WMA (8,383 acres), Mahannah WMA (12,675 acres), Twin Oaks WMA (5,675 acres), as well as portions of other NWRs and WMAs. Current recreation needs in the study area include improved public access to available areas and development of additional recreational areas with facilities for parking, access, and other amenities.

ECONOMIC RESOURCES

39. Economic and demographic data for the Yazoo Backwater Area are presented in the Socioeconomic Profile (Appendix 8) of this report to provide a description of the economic conditions of the study area. The economic base area includes the political boundary of Sharkey and Issaquena Counties, Mississippi. Since these counties are located almost entirely within or primarily within the Yazoo Backwater hydrological boundary and comprise 87 percent of the area, they are considered representative of the study area. Small portions of other counties, which are within the limits of the hydrological boundary, were not included as part of the economic base area. The Yazoo Backwater study area is presented on Plate 4-4.

40. Economic and demographic data presented in this report, in part, are used to furnish an analysis of the area's past, present, and projected future economic development. Projections are based on extensions of past relationships-- establishing order or pattern that can be recognized and translated into the future. Projections should be used as an indicator of the direction and relative magnitude of economic activity that may be expected to prevail in the economic base area.

Population

41. Based on Bureau of Census data, the population of the Yazoo Backwater economic base area (Sharkey and Issaquena Counties) was an estimated 8,854 persons in 2000. When the estimated population for the portions of the other Mississippi counties that are located within the Yazoo Backwater Project Area are included (i.e., Humphreys, Warren, Washington, and Yazoo Counties), total population estimates approximately 20,000 people. Since the 1930s, the economic base area has exhibited a declining population. However, the population has become more urbanized and, in recent years, the economic base area has experienced some commercial and industrial growth. Principal population centers in or adjacent to the economic base area are Anguilla, Belzoni, Cary, Delta City, Eagle Lake, Fitler, Glen Allan, Hollandale, Holly Bluff, Louise, Mayersville, Midnight, Onward, Rolling Fork, Silver City, and Valley Park, Mississippi. The remaining population is sparse and is centered around older farming areas and communities.

Economy

42. The majority of the economy in the area is based on agricultural enterprises. This includes the production and sale of cotton, soybeans, rice, wheat, cattle, catfish, and forestry products as well as associated agribusiness enterprises, insurance, trade, and other industries. The market value of agricultural products sold in the economic base area was estimated to be $64.2 million in 2002, with commodity crops accounting for 85 percent of this value. The total value of forestry resources in the economic base area was estimated to be approximately $63 million based on data from the 1992 Census of Agriculture. Data for 1997 and 2002 were not reported due to disclosure of confidential information. These timber resources provide commercial products for wood yards, pulpmills, and sawmills and represent a significant input to the area's economy, as well as adjacent areas. Thus, farming is still the most important sector of the total economy as much of the commercial and industrial development is agriculture-related. (All Census values are presented in 1996 dollars.)

Land Use

43. Existing land use for the Yazoo Backwater Area was based on computerized satellite surveys utilized by the U.S. Army Corps of Engineers (USACE) Geographic Information System (GIS) in 2005. Based on the acreage delineations from these surveys, the total Yazoo Backwater Project Area covers over 926,000 acres, or approximately 1,447 square miles, in the Yazoo River Basin. Agricultural lands comprise the majority of the total land use with approximately 593,350 acres. The remaining rural areas, including forest lands, water bodies, wetlands, and other lands, represent 36 percent of the rural areas and over 332,650 acres of the total land area.

44. While the project area covers over 926,000 acres, the primary area affected by the proposed project is only a portion of the total area. The primary area subject to flooding by the 100-year frequency flood event, or the study area, is estimated to be approximately 630,000 acres. Of this, approximately 50 percent consists of cleared land (316,000 acres) and 20 percent is forested (124,000 acres). The remaining 190,000 acres (30 percent) includes water bodies, urban properties, and public lands. Land use for the 100-year frequency delineation is depicted on Plate 4-12 of Appendix 4.

45. Landownership in the economic base area varies in tract size. Large corporate holdings and moderate to large farm units and timber tracts predominate. However, there are some small landowners in the area. In 2002, there were 113 farms less than 1,000 acres in size—as compared to 79 larger farms of 1,000 acres or greater. The average size of the larger farms was 6,317 acres versus 290 acres for the smaller farms in the study area. In addition to these lands, there are large tracts of publicly owned lands located in 16th Section school lands, the Delta National Forest, Panther Swamp NWR, the Yazoo NWR, and the Lake George, Twin Oaks, and Mahannah WMAs.

Most Probable Future Land Use

46. Future land use in the Yazoo Backwater Area flood plain without or with implementation of water resources improvements is expected to parallel that of its current use. A trend toward some increased reliance on manufacturing and other nonfarm sources of income has developed within the study area in recent years with some reduction in its dependence on agriculture. There will likely be only an insignificant amount of expansion of nonfarm land use resulting in conversion of agricultural lands to residential, commercial, public, and industrial uses. Agriculture is expected to continue to play the dominant role in the area's economy.

47. Currently, the Natural Resources Conservation Service (NRCS) has observed that only 1,105 acres have been cleared in the entire Delta, which converted woodlands to cropland since 1985. Based on this information, future conversion of land from woodland to cropland was expected to be minor when compared to the total lands in crop production in the study area. This 1,105 acres relates to a conversion rate of less than 4 acres per year for the 13 counties that make up the Mississippi Delta area. While some reforestation has taken place under the U.S. Department of Agriculture (USDA) conservation program, this effort has probably been maximized due to the fact that both Issaquena and Sharkey Counties have essentially reached their cap under the Wetlands Reserve Program (WRP) and the Conservation Reserve Program (CRP). Unless Congress increases the percent cap for these two counties, no additional lands will be enrolled in WRP and CRP for those counties in the near future.

48. Future land use associated with recreation, roads, railroads, and other infrastructure are expected to remain essentially unchanged. However, there are future alternatives to four-lane U.S. Highway 61 north through the study area from Vicksburg through Rolling Fork and onward through Leland northerly to Memphis.

49. Land use patterns similar to those that currently exist in the Yazoo Backwater study area are anticipated to continue in the future. Agricultural production is expected to continue as a key factor in the local economy, although some diversification will occur in associated agricultural industries and agribusinesses. Urbanized development areas could expand slightly. Any level of flood protection would reduce the financial risks involved in rural and/or urbanized area development. Only minor changes are expected in future rural land use within the study area. There has been some reforestation of cropland over the past few years. Current agricultural use is expected to continue relatively unchanged. Reduction in the risk of flooding will create opportunities for farmers to maximize production potential by implementing the latest technology in areas where the threat of flooding prohibits utilizing these advancements.

SECTION 3 - PROBLEMS AND NEEDS

50. Flooding is the principal problem in the Yazoo Backwater Project Area. When the Little Sunflower River and Steele Bayou structures are closed due to high stages on the Mississippi River, flooding from ponding of interior drainage is the principal problem especially in the southern part of the study area. Major problems resulting from frequent flooding include flood damages or losses to agricultural crops; agricultural noncrop items; residential and nonresidential structures; automobiles; public roads and streets; emergency operations; flood insurance administration; and a restriction on the part of farm operators to apply improved production inputs and techniques.

FLOOD HISTORY

51. The alluvial lands of the study area have always been subject to flooding by the Mississippi River. From 1897 through 1937, massive floods inundated the region regularly. Then, for a 35-year period, less severe (moderate) flooding occurred, causing many to dismiss massive floods as things of the past. However, in 1973, a severe flood devastated the area again. Other severely destructive floods followed in rapid succession in 1974, 1975, and 1979. Hundreds of persons were forced from their homes, crops and buildings were damaged or lost, and wildlife was destroyed. Smaller floods occurred in 1970, 1971, 1972, 1976, 1977, 1978, 1983, and 1991. The most severe flood of the 1970 decade (1973) created a body of water 60 miles long, with financial losses in excess of $65 million (in current year 1973 dollars) and with personal trauma immeasurable in dollars. The flooding lasted almost 9 months.

EXISTING PROBLEMS AND NEEDS

52. For existing conditions, interior ponding inundates low-lying lands in the Yazoo Backwater Area damaging manmade resources and agricultural crops. Farm improvements; public roads and streets; urban structures (residences, nonresidential buildings); automobiles; and other properties are also subject to flooding in the study area. There is a need to provide flood protection to these sources and thereby reduce the financial and social risks involved for the residents of this region.

53. In consideration of the environment, the continuing decline of fish and wildlife habitat constitutes a problem of local, state, and national significance. Over most of the 20th century, the number of acres of productive bottom-land forests were reduced on the flood plain of the

lower Mississippi River. These bottom-land forests provide forest products and quality habitat for a variety of wildlife. There is also a need to maintain quality habitat to support fish and wildlife resources.

54. The following plates illustrate flood conditions in the Yazoo Backwater study area for base (without-project) and with-project conditions. The 100-year frequency flood is depicted on Plate 4-10, the 10-year frequency flood on Plate 4-9, the 2-year frequency flood on Plate 4-8, and the 1-year frequency flood on Plate 4-7.

Flood Seasons, Duration, and Frequency of Occurrence

55. Three important factors that affect flood losses to agricultural lands are time of year, duration, and frequency of flooding. Frequent or intermittent flooding can occur any time of year. However, flood records indicate that the majority of the floods occur during land preparation, spring planting months, and summer growing months (January through June). The historical flood record utilized in this report covered a 55-year period (1943-1997).

SECTION 4 - FLOOD DAMAGES

AGRICULTURAL FLOOD DAMAGE ANALYSES

GENERAL

56. Field surveys, field investigations, data developed by Mississippi State University (MSU) in 2005, and data from previous studies of the Yazoo Backwater study area were used to obtain the information regarding the various types of development impacted by flooding in the study area and the extent and character of flooding and flood damages.

57. This reformulation of the authorized Yazoo Backwater study area and analyses of other alternatives were conducted for with- and without-project conditions. Without-project conditions for the final array of alternatives reflect base existing conditions in the study area as of 2005. Results from the evaluation of this alternative are used for illustrative purposes throughout this report. This evaluation of flood damages was conducted for the 2012-2061 period of economic analysis--the period of expected project economic life. In this evaluation, the term "current values" refers to activities/development affected by flooding in the year the analysis was conducted (2005).

LAND USE

58. Stage-area curves are based on land-use information derived from 2005 satellite imagery and extensive ground truthing. The land-use data reflected in this stage area information reflect the latest information on the amounts of cropland, catfish ponds, CRP and WRP lands, WMA and NWR lands, urban areas, wooded lands, and other land uses in the study area. The stage-area information presented in Table 7-7 reflects the total number of existing acres corresponding to each given elevation by reach. The data are then correlated with the hydrologic flood stage-frequency data in determining the number of acres flooded by elevation. Hydrologic stage-frequency curves reflect the relationship of stage/elevation of flooding and the frequency of occurrence.

TABLE 7-7
STAGE-AREA CURVE
INCLUDING ACRES BY REACH AND ELEVATION a/
YAZOO BACKWATER AREA, MISSISSIPPI

Elevation (feet, NGVD)	Acres (No.)							
	Reach 1				Reach 2			
	Cropland	Wooded	Other	Total	Cropland	Wooded	Other	Total
73.0	1,806	4,188	10,664	16,658	988	1,242	10,128	12,358
78.0	2,802	7,214	23,518	33,534	2,154	2,837	28,091	33,082
83.0	6,037	14,022	34,759	54,818	7,701	6,685	56,967	71,353
88.0	20,674	33,884	28,106	82,664	28,554	18,133	97,015	143,702
93.0	44,362	51,009	41,298	136,669	84,942	40,244	107,831	233,017
98.0	72,147	61,187	83,871	217,205	170,407	52,238	100,900	323,545
100.3	103,733	67,748	84,781	256,262	212,266	56,152	105,307	373,725

Note: "Other" includes catfish ponds; CRP, WRP, and public lands; urban areas, roads, and improvements; and other water bodies. All acreages based on 2005 land use.
a/ Acreage reflects total acres, not flooded acres, by elevation.

FLOOD DAMAGE REACHES

59. Hydrologic analyses delineate the study area--the area impacted by implementation of the Yazoo Backwater study area recommended alternative (Alternative 5). The impacted area was divided into two hydrologic reaches to appropriately and more precisely reflect flooding problems. Reach 1 is the area covered by the lower sump area in previous studies and encompasses approximately 256,262 total acres. Reach 2 is the area that was designated as the upper sump in original studies and encompasses approximately 373,725 total acres. In the previous reevaluation report, the current Reach 2 was broken down into three reaches--Reach 2, the area between the proposed Big Sunflower River levees location/placement and Deer Creek; Reach 3, the area bordered on the west by the proposed Big Sunflower River levees; and Reach 4, which contains the remainder of the current designated upper sump area (the area of the eastern portion of the study area).

STRATIFICATION

60. To more precisely address/evaluate flood damages to agricultural crops, each designated hydrologic reach was "stratified" (arranged or split) into an upper area or stratum and a lower stratum. This stratification establishes a "breakpoint," or elevation, which reflects that in the lower stratum, which is more flood-prone, farming operations differ from those of the upper stratum. Field survey data, acreages flooded for various frequencies of flooding, and other information were utilized in the stratification process. A 2-year frequency flood elevation was determined to be appropriate for stratification purposes in the Yazoo Backwater study area

reformulation analysis. A copy of the farm surveys conducted in November-December 2005 is attached (Attachment 7A). This information was used to determine planting dates for the more flood-prone areas in the study area versus the upper strata area.

AVERAGE OR EXPECTED
ANNUAL ACRES FLOODED

61. Hydraulic engineers prepared a variety of flood analysis curves that were utilized to determine flood damages. The area-frequency curve (data) is used to calculate average (expected) annual acres flooded for each hydrologic reach. Area-frequency data consist of the integration of stage-area data (elevation of flooding associated with area flooded) and stage-frequency data (elevation of flooding associated with frequencies of flooding/percent chance of flood occurrence). Stage-frequency data for existing conditions and all the structural alternatives are presented in Tables 7-8 and 7-9. Consequently, frequencies of flooding associated with applicable flooding elevations and acres flooded are assimilated. The above data are integrated to create area-frequency relationships. These types of flood analyses data not only consider the frequencies of past flood events, but also take into account the probability of other potential flood frequencies. Average annual cleared acres flooded are applied to damage-per-acre factors and other data to determine annual flood damages for agricultural crops and noncrop items. The calculations of average annual cropland acres flooded are presented in Tables 7-10 through 7-18 for without- and with-project (Alternative 5) conditions. The average annual cropland acres for Alternative 5 are presented without and with the removal of the 55,600 acres of reforested cropland. Table 7-19 presents the average annual cropland acres flooded for without-project conditions and for all structural alternatives without and with the removal of reforested cropland.

COMPUTATION OF
AVERAGE ANNUAL ACRES

62. It is important in the water resource evaluation process that all flood damages, benefits, and costs be placed on a common basis or period of time. For Corps projects, this is accomplished by utilization of the frequency method of annualization which is the process of converting values to a yearly, or annual, basis. In water resources planning, frequency and probability distributions are utilized to convert losses at various flood magnitudes to an average annual basis.

Step 1: The Stage-Area Curve

63. To accomplish the annualization of acres, a stage-area curve must be developed for the various types of land use in the study area. For the Yazoo Backwater study area, the stage-area curve was developed using satellite imagery from numerous flood scenes, which is based on existing 2005 land use and is displayed in Table 7-7 by reach. To assess impacted acreage for with-project conditions, the stage-area curve is expanded to include all possible stages between the 4-month and 100-year frequency flood events. Interpolations between the given stage/elevations and acreage data are calculated to derive the complete stage-area curve from which the appropriate data can be extracted for the evaluation of each alternative. Development of the stage-area curve is the first step in the computation of average annual acres.

Step 2: The Stage-Frequency Curve

64. The next step in the annualization process is the integration of the stage-area data with the flood frequency data in the development of a stage-frequency curve. The flood frequency information, developed through hydraulic and hydrologic applications and methodology, is expected in more detail in the Engineering Appendix (Appendix 6). Stage-frequency curves reflect the relationship of the stage/elevation of flooding and the frequency (expected probability) of occurrence. The results of this process are displayed in Tables 7-8 and 7-9 by reach for existing conditions and the structural alternatives. Stage-frequency curves are utilized to determine the number of acres impacted by flood frequency for each alternative of improvement.

65. It should be noted that frequency of flooding is quantified based on a probability of occurrence, which is directly related to the elevation of the land, rainfall records, and hydraulic/ hydrologic conditions that affect the drainage of the land. When expected probability (or frequency of occurrence) is mentioned in this document, it refers to the expected probability that land will flood in any given year on an annual basis. For example, land that is determined to be in the 1-year flood elevation (based on elevation and hydrology) has a 100 percent chance of flooding one time in any given year. Conversely, land in the 100-year flood plain has a 1.0 percent chance of flooding in any given year. Therefore, land at the 100-year flood elevation has a mathematical probability of flooding one time in every 100-year period. The 100-year flood is the flood that is equaled or exceeded once in 100 years on the average, but the term should not be taken literally as there is no guarantee that the 100-year will occur at all within the 100-year period or that it will not recur several times. A 100-year flood event can and has

TABLE 7-8
FLOOD-FREQUENCY RELATIONSHIPS, REACH 1
YAZOO BACKWATER AREA, MISSISSIPPI

Recurrence (or Return) Interval	Expected Probability	Flood Elevations (feet, NGVD)					
		Existing	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
100	0.01	100.3	95.4	95.4	95.7	96.0	96.0
50	0.02	99.2	94.0	94.0	94.4	94.6	94.6
25	0.04	98.0	92.5	92.6	93.0	93.5	93.7
10	0.10	96.3	90.3	91.0	91.2	91.8	92.5
5	0.20	94.6	88.4	89.1	89.6	90.5	91.8
2	0.50	91.0	84.7	86.0	87.8	89.5	91.2
1	1.00	87.0	81.5	85.0	87.0	87.0	87.0
0.5	2.00	78.0	78.0	78.0	78.0	78.0	78.0
0.33	3.00	73.0	73.0	73.0	73.0	73.0	73.0

TABLE 7-9
FLOOD-FREQUENCY RELATIONSHIPS, REACH 2
YAZOO BACKWATER AREA, MISSISSIPPI

Recurrence (or Return) Interval	Expected Probability	Flood Elevations (feet, NGVD)					
		Existing	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
100	0.01	100.3	95.6	96.0	96.4	96.5	96.7
50	0.02	99.5	94.3	94.8	95.1	95.3	95.5
25	0.04	98.5	93.3	93.5	93.8	94.4	94.8
10	0.10	96.8	91.5	91.8	92.0	92.9	93.8
5	0.20	95.0	89.9	90.2	90.7	91.5	92.7
2	0.50	91.6	86.8	87.3	88.9	90.0	91.8
1	1.00	87.8	83.2	85.9	87.8	87.8	87.8
0.5	2.00	78.8	78.8	78.8	78.8	78.8	78.8
0.33	3.00	73.0	73.0	73.0	73.0	73.0	73.0

occurred more than one time in a 100-year period, but from a mathematical probability standpoint, it is expected to occur one time in every 100 years. The numeric probability for a flood event is determined by dividing 1 by the frequency of the flood event (e.g., 1 ÷ 100 [the 100-year flood] = .01 or 1 percent). This application was computed for all flood frequency events that were evaluated in this analysis (i.e., the 4-month, 6-month, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year frequency flood events).

Step 3: The Stage-Frequency Relationship

66. The last step in the annualization process is to compute the annual value of each frequency's respective cleared acres to a yearly basis. A computer program developed by the Vicksburg District (CURARA) was used to compute the frequency method of annualization to these acres.

67. As an example, the cleared cropland acres for Reach 1 existing conditions will be utilized to illustrate this process. According to Table 7-7, there are 103,733 cleared acres impacted by the 100-year frequency flood event and its corresponding elevation of 100.3 feet, NGVD. The mathematical value of these 103,733 acres is computed to be 1,037.3 (i.e., 103,733 multiplied by the probability of a 100-year event [.01]). For the other frequencies (previously listed in paragraph 64), the methodology is similar, but because the acres are cumulative, adjustments are made to the computation to avoid double-counting of acres.

68. To further demonstrate this process, data for the 4-month flood frequency event for Reach 1 will be illustrated. As shown in Table 7-7, there are 1,806 cleared acres affected at the elevation of 73.0 feet, NGVD, which correspond to the flood frequency data for the 4-month event (displayed in Tables 7-8 and 7-9). These data are correlated to compute the expected annual acres for each flood frequency. For example, the 1,806 cleared acres for Reach 1 at the 4-month flood frequency event result in the expected annual acres of 2,311 (i.e., the value of the cleared acres at this frequency on an average annual basis). These results are utilized in the computations of total expected annual cleared acres by reach, which are displayed in Tables 7-10 through 7-18. The question could be asked, why the value is greater than the acres at this elevation, and the reason is that these acres have the mathematical probability of flooding up to three times in any given year. The formula utilized to compute the average annual value for the acres at the 4-month flood event is as follows:

0.5 x 1,806 (cleared acres at the 4-month) + 2,802 (cleared acres at the 6-month) x
3.003 (the frequency value of the 4-month) – 2 (the frequency value of 6-month)

TABLE 7-10
EXPECTED ANNUAL CLEARED ACRES FLOODED
EXISTING CONDITIONS-NO STRATIFICATION
YAZOO BACKWATER AREA, MISSISSIPPI

Reach 1				Reach 2				Total YBW Area	
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Cleared Acres	Expected Annual Acres
--	0.00	103,733	--	--	0.00	212,266	--	315,999	--
100	0.01	103,733	1,037	100	0.01	212,266	2,123	315,999	3,160
50	0.02	97,078	1,004	50	0.02	198,928	2,056	296,006	3,060
25	0.04	72,147	1,692	25	0.04	178,681	3,776	250,828	5,468
10	0.10	65,032	4,115	10	0.10	150,550	9,877	215,582	13,992
5	0.20	52,150	5,859	5	0.20	119,038	13,479	171,188	19,339
2	0.50	34,626	13,016	2	0.50	61,075	27,017	95,701	40,033
1	1.00	16,023	12,662	1	1.00	26,747	21,956	42,770	34,618
0.5	2.00	2,802	9,413	0.5	2.00	2,340	14,544	5,142	23,956
0.333	3.00	1,806	2,311	0.333	3.00	988	1,669	2,794	3,980
Expected Annual Cleared Acres			51,110	--	--	--	96,496	--	147,606

TABLE 7-11
EXPECTED ANNUAL CLEARED ACRES FLOODED
EXISTING CONDITIONS-BELOW 2-YEAR FLOOD STRATA
YAZOO BACKWATER AREA, MISSISSIPPI

Reach 1				Reach 2				Total YBW Area	
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Cleared Acres	Expected Annual Acres
--	0.00	34,626	--	--	0.00	61,075	--	95,701	--
100	0.01	34,626	346	100	0.01	61,075	611	95,701	957
50	0.02	34,626	346	50	0.02	61,075	611	95,701	957
25	0.04	34,626	693	25	0.04	61,075	1,222	95,701	1,914
10	0.10	34,626	2,078	10	0.10	61,075	3,665	95,701	5,742
5	0.20	34,626	3,463	5	0.20	61,075	6,108	95,701	9,570
2	0.50	34,626	10,388	2	0.50	61,075	18,323	95,701	28,710
1	1.00	16,023	12,662	1	1.00	26,747	21,956	42,770	34,618
0.5	2.00	2,802	9,413	0.5	2.00	2,340	14,544	5,142	23,956
0.333	3.00	1,806	2,311	0.333	3.00	988	1,669	2,794	3,980
Expected Annual Cleared Acres			41,699	--	--	--	68,705	--	110,404

TABLE 7-12
EXPECTED ANNUAL CLEARED ACRES FLOODED
EXISTING CONDITIONS-ABOVE 2-YEAR FLOOD STRATA
YAZOO BACKWATER AREA, MISSISSIPPI

Reach 1				Reach 2				Total YBW Area	
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence Acres	Expected Annual Acres
--	0.00	69,107	--	--	0.00	151,191	--	220,298	--
100	0.01	69,107	691	100	0.01	151,191	1,512	220,298	2,203
50	0.02	62,452	658	50	0.02	137,853	1,445	200,305	2,103
25	0.04	37,521	1,000	25	0.04	117,606	2,555	155,127	3,554
10	0.10	30,406	2,038	10	0.10	89,475	6,212	119,881	8,250
5	0.20	17,524	2,397	5	0.20	57,963	7,372	75,487	9,768
2	0.50	0	2,629	2	0.50	0	8,694	0	11,323
1	1.00	0	0	1	1.00	0	0	0	0
0.5	2.00	0	0	0.5	2.00	0	0	0	0
0.333	3.00	0	0	0.333	3.00	0	0	0	0
Expected Annual Cleared Acres			9,412	--	--	--	27,791	--	37,202

TABLE 7-13
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 1-NO STRATIFICATION
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (20,127 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	60,485	--	--	0.00	40,358	--
100	0.01	60,485	605	100	0.01	40,358	404
50	0.02	51,177	558	50	0.02	31,050	357
25	0.04	44,362	955	25	0.04	24,235	553
10	0.10	35,600	2,399	10	0.10	15,473	1,191
9.73	0.103	34,626	99	9.73	0.103	14,499	42
5	0.20	28,115	3,049	5	0.20	7,988	1,093
2	0.50	19,744	7,179	2	0.50	0	1,198
1	1.00	16,023	8,942	1	1.00	0	0
0.5	2.00	2,802	9,413	0.5	2.00	0	0
0.333	3.00	1,806	2,311	0.333	3.00	0	0
Expected Annual Cleared Acres			35,509	--	--	--	4,838

TABLE 7-14
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 1-BELOW 2-YEAR FLOOD
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (20,127 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	34,626	--	--	0.00	14,499	--
100	0.01	34,626	346	100	0.01	14,499	145
50	0.02	34,626	346	50	0.02	14,499	145
25	0.04	34,626	693	25	0.04	14,499	290
10	0.10	34,626	2,078	10	0.10	14,499	870
9.73	0.103	34,626	97	9.73	0.103	14,499	41
5	0.20	28,115	3,049	5	0.20	7,988	1,093
2	0.50	19,744	7,179	2	0.50	0	1,198
1	1.00	16,023	8,942	1	1.00	0	0
0.5	2.00	2,802	9,413	0.5	2.00	0	0
0.333	3.00	1,806	2,311	0.33	3.03	0	0
Expected Annual Cleared Acres			34,453	--	--	--	3,782

TABLE 7-15
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 1-ABOVE 2-YEAR FLOOD STRATA
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (20,127 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	25,839	--	--	0.00	25,839	--
100	0.01	25,839	258	100	0.01	25,859	258
50	0.02	16,551	212	50	0.02	16,551	212
25	0.04	9,736	263	25	0.04	9,736	263
10	0.10	974	321	10	0.10	974	321
9.73	0.103	0	1	9.73	0.103	0	1
5	0.20	0	0	5	0.20	0	0
2	0.50	0	0	2	0.50	0	0
1	1.00	0	0	1	1.00	0	0
0.5	2.00	0	0	0.5	2.00	0	0
0.333	3.00	0	0	0.33	3.03	0	0
Expected Annual Cleared Acres			1,056	--	--	--	1,056

TABLE 7-16
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 2-NO STRATIFICATION
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (35,473 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	143,548	--	--	0.00	108,075	--
100	0.01	143,548	1,435	100	0.01	108,075	1,081
50	0.02	120,789	1,322	50	0.02	85,316	967
25	0.04	98,580	2,194	25	0.04	63,107	1,484
10	0.10	67,894	4,994	10	0.10	32,421	2,866
9.5	0.105	61,075	341	9.5	0.105	25,602	153
5	0.20	52,944	5,400	5	0.20	17,471	2,040
2	0.50	36,684	13,444	2	0.50	1,211	2,802
1	1.00	26,347	15,758	1	1.00	0	303
0.5	2.00	2,340	14,344	0.5	2.00	0	0
0.333	3.00	988	1,669	0.333	3.00	0	0
Expected Annual Cleared Acres			60,900	--	--	--	11,696

TABLE 7-17
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 2-BELOW 2-YEAR FLOOD
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (35,473 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	61,075	--	--	0.00	25,602	--
100	0.01	61,075	611	100	0.01	25,602	256
50	0.02	61,075	611	50	0.02	25,602	256
25	0.04	61,075	1,222	25	0.04	25,602	512
10	0.10	61,075	3,665	10	0.10	25,602	1,536
9.5	0.105	61,075	323	9.5	0.105	25,602	135
5	0.20	52,944	5,400	5	0.20	17,471	2,040
2	0.50	36,684	13,444	2	0.50	1,211	2,802
1	1.00	26,347	15,758	1	1.00	0	303
0.5	2.00	2,340	14,344	0.5	2.00	0	0
0.333	3.00	988	1,669	0.333	3.00	0	0
Expected Annual Cleared Acres			57,044	--	--	--	7,840

TABLE 7-18
EXPECTED ANNUAL CLEARED ACRES FLOODED
ALTERNATIVE 5 - REACH 2-ABOVE 2-YEAR FLOOD STRATA
YAZOO BACKWATER AREA, MISSISSIPPI

No Reforestation				Reforestation (35,473 acres)			
Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres	Recurrence (or Return) Interval	Frequency	Cleared Acres	Expected Annual Acres
--	0.00	82,473	--	--	0.00	82,473	--
100	0.01	82,473	825	100	0.01	82,473	825
50	0.02	59,714	711	50	0.02	59,714	711
25	0.04	37,505	972	25	0.04	37,505	972
10	0.10	6,819	1,330	10	0.10	6,819	1,330
9.5	0.105	0	18	9.5	0.105	0	18
5	0.20	0	0	5	0.20	0	0
2	0.50	0	0	2	0.50	0	0
1	1.00	0	0	1	1.00	0	0
0.5	2.00	0	0	0.5	2.00	0	0
0.333	3.00	0	0	0.333	3.00	0	0
Expected Annual Cleared Acres			3,856	--	--	--	3,856

It should be noted that none of the alternatives evaluated will impact the hydrology of lands at or below the 1-year frequency elevation and thus, the existing and with-project conditions are the same on these lands. This process was continued for each of the frequencies analyzed, and their values were summed to derive average annual acres.

69. The cumulative results of this process are also displayed in Table 7-19. As shown, the existing average annual cleared acres flooded for Reach 1 were 51,111. This same process was utilized for all conditions evaluated for both reaches in the study area.

AGRICULTURAL CROP BENEFITS

70. The guidelines under which the U.S. Army Corps of Engineers, Vicksburg District, analyzes agricultural flood control projects allow for two separate categories of benefits to agricultural crops--inundation reduction and intensification. Inundation reduction benefits are on cropland where there is no change in cropping patterns, and intensification benefits are on cropland where there is a project-induced change in cropping patterns resulting from the reduced threat of flooding. There are no intensification benefits to any of the alternatives evaluated in the final array of alternatives for the Yazoo Backwater Reformulation Study. All crop benefits result from a reduction of loss of production costs and increased expected net returns resulting from adoption of irrigation and earlier planting dates for the existing cropping pattern. This is possible because the alternatives analyzed reduce the extent, frequency, and duration of flooding, encouraging farmers to plant earlier and allowing them to make investments so they might irrigate later during periods during the growing season when water might be needed.

TABLE 7-19
AVERAGE ANNUAL CROPLAND ACRES FLOODED BY REACH AND STRATA FOR
EXISTING CONDITIONS AND ALL STRUCTURAL ALTERNATIVES
YAZOO BACKWATER AREA, MISSISSIPPI

Area/Item	Existing	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Without Reforestation Acres						
Reach 1						
Lower Strata	41,699	19,876	27,747	34,453	38,456	41,699
Upper Strata	9,412	677	884	1,056	1,310	2,574
Total Reach 1	51,111	20,553	28,631	35,509	39,766	44,273
Reach 2						
Lower Strata	68,705	36,382	46,032	57,044	62,749	68,705
Upper Strata	27,791	2,282	3,358	3,856	4,956	11,250
Total Reach 2	96,496	38,664	49,390	60,900	67,705	79,955
TOTAL AREA	147,607	59,217	78,021	96,409	107,471	124,228
With Reforestation Acres						
Reach 1						
Lower Strata	N/A	2,693	5,663	3,782	1,354	0
Upper Strata	N/A	677	884	1,056	1,310	482
Total Reach 1	N/A	3,370	6,547	4,838	2,664	482
Reach 2						
Lower Strata	N/A	6,144	10,987	7,840	3,026	0
Upper Strata	N/A	2,282	3,358	3,856	4,956	4,848
Total Reach 2	N/A	8,426	14,345	11,696	7,982	4,848
TOTAL AREA	N/A	11,796	20,892	16,534	10,646	5,330

NOTE: Alternative 3, reforestation of 53,363 acres of cleared lands.
Alternative 4, reforestation of 40,500 acres of cleared lands.
Alternative 5, reforestation of 55,600 acres of cleared lands.
Alternative 6, reforestation of 88,900 acres of cleared lands.
Alternative 7, reforestation of 124,400 acres of cleared lands.

71. A series of detailed tables will be used in this section to show each step in the process of calculating agricultural benefits. For this evaluation, the recommended alternative (Alternative 5) will be depicted to represent with-project conditions in most of the computational tables displayed in this report in the explanation of flood damage/benefit evaluations. (Totals from table to table may not add exactly due to rounding.)

RISK CONSIDERATIONS

72. Flood risk is a major problem which often severely limits agricultural activities. Frequent flooding precludes/limits various crop production activities necessary to maximize net returns. This detrimental impact from flooding also extends to less frequently flooded areas. Failure to evacuate water from the more flood-prone areas prevents the effective use of higher elevation areas, increasing cropping delays in these areas.

73. Due to the soil wetness problems created or magnified by flooding, farmers are prevented from planning for and selecting the highest yielding crop varieties and planting on optimum dates. By planting recommended varieties at the appropriate time, improved performance can be achieved from periods of more favorable plant growth, less insect pressure, favorable harvest conditions, and an increased number of days suitable for various crop production operations. Research performed by the Division of Agriculture, Forestry, and Veterinary Medicine of MSU and presented in a report, "Agricultural Data for the Yazoo Backwater study area of Mississippi," (see Attachment 7B) indicates that delayed planting, especially of soybeans, can cause significant reductions in expected yields.

74. Due to the risk and uncertainty associated with areas of frequent flooding, farmers are unable to properly plan their farming operation. Farmers generally make plans prior to the spring planting season and translate these plans into commitments with suppliers to purchase seeds, fertilizer, and chemicals, as well as tractors, trucks, and other associated agricultural equipment. Financial needs are arranged through lending institutions based on anticipated crop types and activities, considering flood risk and other elements.

75. Expected agricultural flood damages for existing conditions and with proposed flood control measures installed were estimated utilizing the risk and uncertainty guidance in EC 1105-2-100, "Planning Guidance Notebook" (22 April 2000); ER 1105-2-101, "Planning - Risk Analysis for Flood Damage Reduction Studies" (3 January 2006); and EC 1105-2-205, "Risk Analysis Framework for Evaluation of Hydrology/Hydraulics and Economics in Flood Damage Reduction Studies" (25 February 1994). The specific purpose of this portion of the analysis was to quantify, to the extent possible, any uncertainties inherent in the flood damage evaluation which would aid in making a decision to invest in a flood protection project for the Yazoo Backwater study area (see Attachment 7C, Agricultural Risk and Uncertainty Analyses).

IMPROVED PRODUCTION LEVELS

76. Benefits from improved production levels, because of irrigation and early planting on study area cleared lands, are reflected in the increase in net productive values per acre harvested resulting from improved farming operations due to flood reductions provided by the project.

IMPACTS TO FARMED WETLANDS

77. According to NRCS, currently, there are approximately 45,000 acres of farmed wetlands within the Yazoo Backwater study area. Since flood reduction benefits to farmed wetlands cannot be used to evaluate these potential projects, they have been removed from the cleared acres analyzed in the report. Approximately 32,750 acres or 73 percent of these lands are enrolled in the WRP and no longer farmed. Of the remaining farmed wetlands, 15, 7.5, and

4.5 percent, respectively, are located within the 1-year, 2-year, and above 2-year existing flood plain. None of the final array alternatives evaluated impacted the existing 1-year frequency flood plain and thus, these lands will not be impacted by the construction and operation of these structural alternatives. All of the alternatives incorporated reforestation of currently cleared agricultural lands at the existing 1-year frequency and above for some alternatives. The recommended alternative (Alternative 5) includes reforestation of up to 55,600 acres of currently cleared lands targeting the lowest flood plain (1-year and below). Currently, there are 42,770 acres of cleared lands within the 1-year flood plain and an additional 52,931 acres within the 2-year flood plain under existing conditions. A blocking factor of 30 percent was used to address items such as access, the extent of severance damages, and avoidance of an uneconomic remainder. Because of this blocking factor, it was assumed that an additional 30 percent of acreage would be acquired using conservation easements in order to reforest all lands within the existing 1-year flood plain. Therefore, the estimated reforestation for Alternative 5 was 55,600 acres (42,770 x 1.30). This same blocking factor was applied to all plans that incorporated reforestation as a nonstructural feature. For a more detailed description of the blocking factor, see the Real Estate Appendix. Reforestation was assumed to occur on the lowest lands until the target goal of each alternative was realized. With implementation of Alternative 5, this meant that approximately 58 percent of the cropland at or below the 2-year flood plain would be reforested, thus it is highly probable that all of the remaining farmed wetlands will be reforested with implementation of the recommended Alternative 5. Therefore, there are no structural benefits associated with farmed wetlands.

THE AGRICULTURAL FLOOD DAMAGE/BENEFIT EVALUATION--CROP, NONCROP, AND OTHER

GENERAL

78. The agricultural flood damage analysis of the Yazoo Backwater study area involved the identification and evaluation of several separate categories of flood losses associated with farm operations. For this analysis, structural damages and benefits are defined as the benefits that accrue to the project as the result of the construction and operation of construction features; i.e., 14,000-cfs pump. Nonstructural damages and benefits are those benefits that accrue to the project as a result of the reforestation/conservation measures on cleared agricultural lands or the removal of property from the flood plain. Thus, agricultural flood damages discussed herein are evaluated for existing (without-project) and with-project conditions for the following categories: crop damages and benefits for structural alternatives; noncrop damages and benefits for structural alternatives; crop damages and benefits for nonstructural alternatives; and noncrop damages and benefits for nonstructural alternatives.

CROP ANALYSIS—STRUCTURAL ALTERNATIVES AND COMBINATION ALTERNATIVES

79. For base (without-project) hydrologic conditions, approximately 630,000 total acres would be flooded in the area from a 100-year frequency flood event. This area includes 50 percent cropland acres, 20 percent woodlands, and 30 percent cleared land in catfish ponds, CRP, WRP, wildlife management areas, urban areas, roads and improvements, and other water bodies. Flooding in the study area is usually confined to the winter and spring months. Flooding may result from a single storm of a few days or a series of storms extending over several months.

80. Flood damages to agricultural crops are impacted by the time of year, duration, and frequency of flooding. Although frequent or intermittent floods occur any time of the year, flood records indicate the majority of flooding occurs during the cropland preparation and spring planting months (January-June). Other flood events occur in the area during harvest (October-December). The average number of days flooded (duration of flooding) ranges from approximately 8 to 89 days. The longest duration occurred during the 1973 flood. Stage-frequency relationships for existing conditions and all five structural alternatives were presented in a previous section of this discussion.

Current Normalized Prices for Agricultural Crops

81. The gross returns for the analysis of the final array of alternatives were calculated using "Fiscal Year (FY) 2005 Current Normalized Prices" outlined in Economic Guidance Memorandum (EGM) 06-06, 17 October 2005. Use of current normalized prices is required by existing regulations and guidelines in evaluation of all water-related development projects. The Economic Research Service (ERS) annually calculates normalized prices for evaluating alternative development and management plans for water and related land resources. Normalized prices smooth out the effects of short-term fluctuations so that plans can be evaluated on a more realistic basis rather than using current prices, which may be lower or higher than normal because of short-lived phenomena. Since 1993, ERS has estimated these prices based on 5-year moving averages of actual market prices (1999-2003 for 2005 current normalized prices). State-level prices for 2005 were calculated by multiplying the national-level normalized prices by the average ratios of the state prices to the national prices for 2001-2003. Table 7-20 presents the FY 05 current normalized prices for this analysis for several of the major agricultural crops in the area.

TABLE 7-20
2005 CURRENT NORMALIZED PRICES FOR SELECTED CROPS
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Unit	Price ($) a/
Corn	Bushel (bu)	2.06
Cotton	Pound of Lint (lb)	0.52
Rice	Hundredweight (cwt)	5.69
Soybeans	bu	5.17

Note: Cotton price includes a normalized price for Mississippi of $0.451 per pound of lint, $83.24 per ton of cottonseed, and 1.72 pounds of seed for each pound of lint.
a/ Values in 2005 dollars.

82. Crop distributions for existing (without-project) conditions for the study area were based on 2005 satellite imagery and sample field site surveys to confirm the signatures used to identify the various crops being grown in the study area. Irrigation distributions were based on well locations from permits issued by the Yazoo Joint Water Management District. These well locations were overlaid over the land use and crop files, and acres of irrigated land by crop were identified for existing conditions for the study area. Data regarding existing agricultural crop yields, varieties, planting dates, and crop budgets were obtained from research performed by MSU (see Appendix 7B) as a part of this reevaluation study. In the previous referenced study, MSU identified Washington County as a proxy county that would closely mirror the conditions in the study area with complete flood protection. Land use for Washington County was developed in the same manner as for the study area. Interviews with persons farming the lower lands in the study area indicate they would not plant soybeans at the optimum date (prior to April 16) under current conditions because of the flood threat. Therefore, under existing conditions, soybeans in the area below the 2-year flood were assumed to be planted from May 1 through May 15, and soybeans in the area above the 2-year flood were assumed to be planted before April 16. Crop distributions for Reaches 1 and 2 in the study area for existing (without-project) conditions and for Washington County are presented in Table 7-21.

TABLE 7-21
CROP DISTRIBUTIONS FOR STUDY AREA AND WASHINGTON COUNTY
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Reach 1		Reach 2		Washington County (%)
	Below 2-Year Flood (%)	Above 2-Year Flood (%)	Below 2-Year Flood (%)	Above 2-Year Flood (%)	
Dry Land					
Corn	5.0	8.0	3.1	5.6	0.2
Cotton	8.2	22.4	14.5	25.2	12.8
Rice	0.0	0.0	0.0	0.0	0.0
Soybeans	55.2	47.1	48.2	36.1	24.2
Wheat	0.0	0.0	0.0	0.0	0.3
Irrigated					
Corn	1.4	2.1	0.9	1.7	0.2
Cotton	0.9	3.5	3.8	8.9	16.6
Rice	11.4	5.1	7.6	6.6	5.8
Soybeans	17.9	11.8	21.9	15.9	39.5
Wheat	0.0	0.0	0.0	0.0	0.4
TOTAL	100.0	100.0	100.0	100.0	100.0

83. Washington County was used as the proxy county for establishing with-project conditions. The percent of soybean acreage irrigated in Washington County was carried forward into the portion of the study area that moved from below the 2-year flood under existing conditions to above the 2-year flood under with-project conditions and the area that was above the 2-year flood both under existing conditions and with-project conditions. For the area moving from below the 2-year flood under existing conditions to above the 2-year flood under with-project conditions, the planting date for soybeans was moved from May 1 through May 15 to before April 16 resulting in increase yield levels. The acres moving from below the 2-year flood under existing conditions into the above the 2-year flood with the various alternatives were assumed to have the same crop distributions as the area above the 2-year flood under existing conditions except for the fact that irrigated and dry land soybeans were assumed to be the same percentages as found in Washington County. The calculation procedure for the soybean distribution for the area above the 2-year flood under with-project conditions is presented in Table 7-22. The net productive value per acre harvested is calculated for each crop based on the differences in yield levels and crop distribution by reach for without- (existing) and with-project (Alternative 5) conditions as presented in Tables 7-23 through 7-26.

TABLE 7-22
CALCULATION OF CROP DISTRIBUTIONS FOR ALTERNATIVE 5
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Reach 1 (No./%)	Reach 2 (No./%)	Washington County (%)
Acres below 2-year without project	34,626	61,075	--
Acres below 2-year with Alternative 5	19,744	36,684	--
Acres moving above the 2-year frequency with Alternative 5 a/	14,882	24,391	--
Acres above 2-year without project	69,107	151,191	--
Acres above 2-year with Alternative 5	83,989	175,582	--
Percent soybeans above 2-year without project	58.9%	52.0%	--
Percent soybeans dry land in Washington County	--	--	37.9%
Percent soybeans irrigated in Washington County	--	--	62.1%
Percent soybeans dry land above 2-year with Alternative 5 (58.9% x 37.9%) and (52.0% x 37.9%)	22.3%	19.7%	--
Percent soybeans irrigated above 2-year with Alternative 5 (58.9% x 62.1%) and (52.0% x 62.1%)	36.6%	32.3%	--

a/ Due to hydraulic changes with operation of pump.

84. Based on crop yield, distributions, and net returns discussed above and using 2005 production cost data developed by MSU (Attachment 7B), input data were developed for use in an agricultural crop damage program to evaluate flood damages to crops. The crop damage program used in this study was the “Computerized Agricultural Crop Flood Damage Assessment System.”

Computerized Agricultural
Crop Flood Damage Assessment
System (CACFDAS)

85. The CACFDAS, presented in Attachment 7D, was developed by cooperative actions of the Department of Agricultural Economics of MSU, which is one of the major research components of MAFES, and the Vicksburg District. The CACFDAS program was developed in the early 1980s and has been utilized in assessing the agricultural flood damages for all water resource projects in the Mississippi Valley Division since its development. Others involved in development of CACFDAS included specialists from USDA; Delta Branch Experiment Station, Stoneville, Mississippi; and the Mississippi Cooperative Extension Service, MSU. Participating scientists included agricultural agronomists, plant geneticists, plant pathologists, plant physiologists, soil and weed scientists, agricultural engineers, and agricultural economists.

TABLE 7-23
CROP YIELDS, DISTRIBUTIONS, AND NET RETURNS a/
REACH 1, EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Below the 2-Year Flood				Above the 2-Year Flood			
	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)
Dry Land								
Corn	150 bu	5.0	36.54	1.83	150 bu	8	36.54	2.92
Cotton	964 lb	8.0	-101.41	-8.11	964 lb	22	-101.41	-22.31
Rice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Soybeans (April 16)	41 bu	0.0	60.53	0.00	41 bu	47	60.53	28.45
Soybeans (May 1-16)	28 bu	55.0	-6.68	-3.67	28 bu	0.0	-6.68	0.00
Irrigated								
Corn	200 bu	2.0	19.85	0.40	200 bu	2.0	19.85	0.40
Cotton	1,065 lb	1.0	-143.71	-1.44	1,065 lb	4.0	-143.71	-5.75
Rice	68.4 cwt	11.0	-119.02	-13.09	68.4 cwt	5.0	-119.02	-5.95
Soybeans (April 16)	62 bu	0.0	95.82	0.00	62 bu	12.0	95.82	11.50
Soybeans (May 1-16)	54 bu	18.0	49.94	8.99	54 bu	0.0	49.94	0.00
Total	--	100.0	--	-15.10	--	100.0	--	9.26

a/ Values in 2005 dollars.

TABLE 7-24
CROP YIELDS, DISTRIBUTIONS, AND NET RETURNS a/
REACH 2, EXISTING (WITHOUT PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Below the 2-Year Flood				Above the 2-Year Flood			
	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)
Dry Land								
Corn	150 bu	3.0	36.54	1.10	150 bu	6.0	36.54	2.19
Cotton	964 lb	15.0	-101.41	-15.21	964 lb	25.0	-101.41	-25.35
Rice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Soybeans (April 16)	41 bu	0.0	60.53	0.00	41 bu	36.0	60.53	21.79
Soybeans (May 1-16)	28 bu	48.0	-6.68	-3.21	28 bu	0.0	-6.68	0.00
Irrigated								
Corn	200 bu	1.0	19.85	0.40	200 bu	2.0	19.85	0.40
Cotton	1,065 lb	4.0	-143.71	-5.75	1,065 lb	9.0	-143.71	-12.93
Rice	68.4 cwt	7.0	-119.02	-8.33	68.4 cwt	6.0	-119.02	-7.14
Soybeans (April 16)	62 bu	0.0	95.82	0.00	62 bu	16.0	95.82	15.33
Soybeans (May 1-16)	54 bu	22.0	49.94	10.99	54 bu	0.0	49.94	0.00
Total	--	100.0	--	-20.21	--	100.0	--	-5.72

a/ Values in 2005 dollars.

TABLE 7-25
CROP YIELDS, DISTRIBUTIONS, AND NET RETURNS a/
REACH 1, WITH-PROJECT CONDITIONS (ALTERNATIVE 5)
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Below the 2-Year Flood				Above the 2-Year Flood			
	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)
Dry Land								
Corn	150 bu	5.0	36.54	1.83	150 bu	8.0	36.54	2.92
Cotton	964 lb	8.0	-101.41	-8.11	964 lb	22.0	-101.41	-22.31
Rice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Soybeans (April 16)	41 bu	0.0	60.53	0.00	41 bu	22.0	60.53	13.32
Soybeans (May 1-16)	28 bu	55.0	-6.68	-3.67	28 bu	0.0	-6.68	0.00
Irrigated								
Corn	200 bu	2.0	19.85	0.40	200 bu	2.0	19.85	0.40
Cotton	1,065 lb	1.0	-143.71	-1.44	1,065 lb	4.0	-143.71	-5.75
Rice	68.4 cwt	11.0	95.82	-13.09	68.4 cwt	5.0	-119.02	-5.95
Soybeans (April 16)	62 bu	0.0	95.82	0.00	62 bu	37.0	95.82	35.45
Soybeans (May 1-16)	54 bu	18.0	49.94	8.99	54 bu	0.0	49.94	0.0
Total	--	100.0	--	-15.10	--	100.0	--	18.08

a/ Values in 2005 dollars.

TABLE 7-26
CROP YIELDS, DISTRIBUTIONS, AND NET RETURNS a/
REACH 2, WITH-PROJECT CONDITIONS (ALTERNATIVE 5)
YAZOO BACKWATER AREA, MISSISSIPPI

Crop	Below the 2-Year Flood				Above the 2-Year Flood			
	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)	Yield/ Acre	Distribution (%)	Net Return ($)	Weighted Net Return ($)
Dry Land								
Corn	150 bu	3.0	36.54	1.10	150 bu	5.0	36.54	1.83
Cotton	964 lb	15.0	-101.41	-15.21	964 lb	25.0	-101.41	-25.35
Rice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Soybeans (April 16)	41 bu	0.0	60.53	0.00	41 bu	20.0	60.53	12.11
Soybeans (May 1-16)	28 bu	48.0	-6.68	-3.21	28 bu	0.0	-6.68	0.00
Irrigated								
Corn	200 bu	1.0	19.85	0.20	200 bu	2.0	19.85	0.40
Cotton	1,065 lb	4.0	-143.71	-5.75	1,065 lb	9.0	-143.71	-12.93
Rice	68.4 cwt	7.0	-119.02	-8.33	68.4 cwt	6.0	-119.02	-7.14
Soybeans (April 16)	62 bu	0.0	95.82	0.00	62 bu	33.0	95.82	31.62
Soybeans (May 1-16)	54 bu	22.0	49.94	10.99	54 bu	0.0	49.94	0.00
Total	--	100.0	--	-20.21	--	100.0	--	0.52

a/ Values in 2005 dollars.

86. The CACFDAS calculates flood damages for each crop by analyzing daily flood-stage recorded data which reflect varying flood events (when cleared cropland is being flooded) or multiple flood events (analysis of multiple flood events of cleared cropland in the same year on the same area). The program allows for specific crop replanting and/or crop substitution. The CACFDAS was developed to include various levels of management; planting dates; and yields for the principal crops of rice, cotton, soybeans, and corn.

87. Calculation of agricultural crop flood damage is a complex process. The analytical program (CACFDAS) is structured to compute flood damages based on the time of the flood event as related to sequence of agricultural operations that have occurred in the crop production process. Duration factors, expressed as the number of days required to create damages, are developed for four stages of plant development from planting through harvest. These factors range from 1 to 10 days, depending on the crop and stage of plant development. Dates of normal, late, and last planting are also developed by crop. These dates are important since they, in conjunction with the duration factors, are the base dates allowing flood damage, crop replanting, crop substitution, and crop yield reduction data to be derived. The historical flood period of record covered a 55-year period (1943-1997).

88. Three components of information developed within the crop budgets are essential in assessing flood damages. These include production costs and harvesting equipment fixed costs; expected net returns to lands, management, and general farm overhead; and operation revenues consisting of realized gross value of the harvested crop. These crop budget data (referred to as "Flood Damage Tables") were developed by MSU, the land grant college for Mississippi. These crop budgets are the primary inputs to the flood-damage assessment program. Other important input items include crop distribution data; net and gross returns by crop, crop substitution data, etc.; and hydrologic data containing "Daily Flood Duration Data," including date, elevation, and the number of cleared acres flooded for each daily stage.

89. A major input to the agricultural crop damage program is the hydrologic daily stage information for the Yazoo Backwater study area. The daily stage hydrologic data, including date, associated stage or elevation of flooding, and number of cleared acres associated with each elevation of flooding, were prepared for base (without-project) and with-project conditions for each reach and each alternative. The hydrologic data for each reach were then "split," applying the without-project conditions 2-year frequency flood elevation to form daily stage records for the lower and upper strata of each reach.

Crop Damages and
Benefits—Structural Alternatives

90. Results from the agricultural crop damage program indicate that for existing (without-project) conditions, the estimated crop damages per acre for the lower stratum, ranged from $45.55 per acre in Reach 1 to $50.11 per acre in Reach 2. In the upper stratum, agricultural crop damages for existing (without-project) conditions ranged from $86.32 per acre in Reach 1 to $53.84 per acre in Reach 2. Table 7-27 presents a summary of per-acre agricultural crop damages for existing (without-) and with-project conditions for all structural alternatives of improvement (Alternatives 3-7).

TABLE 7-27
PER ACRE CROP DAMAGES FROM CACFDAS a/
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT CONDITIONS
FOR THE STRUCTURAL ALTERNATIVES
YAZOO BACKWATER AREA, MISSISSIPPI

Condition	Reach 1		Reach 2	
	Lower Strata	Upper Strata	Lower Strata	Upper Strata
Existing Conditions	$45.55	$86.32	$50.11	$53.84
Alternative 3	$38.95	$159.75	$40.93	$123.37
Alternative 4	$41.89	$147.52	$45.03	$120.37
Alternative 5	$42.28	$125.81	$45.90	$75.60
Alternative 6	$42.61	$118.56	$45.95	$62.85
Alternative 7	$44.96	$88.09	$48.03	$49.15

a/ Values in 2005 dollars.

91. Agricultural crop benefits were calculated as the difference between net returns under without- (existing) and with-project conditions. These net returns were calculated based on net productive values for each condition, flood damages remaining, and degree of protection which is the percent reduction in average or expected annual acres flooded. The computation of agricultural crop damages for without- and with-project (Alternative 5) conditions is presented in Table 7-28 along with the agricultural crop benefits with the implementation of Alternative 5.

TABLE 7-28
CALCULATION OF AGRICULTURAL CROP DAMAGES AND BENEFITS a/
EXISTING (WITHOUT-PROJECT) AND
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Reach 1	Reach 2
Lower Strata		
Existing Conditions		
Net Returns:		
Acres in Strata	34,626	61,075
Weighted Net Return Per Acre b/	-$15.10	-$20.21
Unadjusted Net Returns for Strata	-$522,853	-$1,234,326
Flood Damages:		
Average Annual Acres	41,699	68,705
CACFDAS Damage Per Acre	$45.55	$50.11
Crop Damages	$1,899,389	$3,442,808
Adjusted Net Value	-$2,422,242	-$4,677,134
With Alternative 5		
Net Returns:		
Acres in Strata	19,744	36,684
Weighted Net Return Per Acre c/	-$15.10	-$20.21
Degree of Protection	0.17	0.17
Unadjusted Net Returns for Strata	-$298,134	-$741,484
Flood Damages:		
Average Annual Acres	34,453	57,044
CACFDAS Damage Per Acre	$42.28	$45.90
Crop Damages	$1,456,667	$2,618,320
Adjusted Net Value	-$1,754,801	-$3,359,704
Crop Benefits for Lower Strata	$667,441	$1,317,430
Upper Strata		
Existing Conditions		
Net Returns:		
Acres in Strata	69,107	151,191
Weighted Net Return Per Acre b/	$9.26	-$5.72
Unadjusted Net Returns for Strata	$639,931	-$864,813
Flood Damages:		
Average Annual Acres	9,412	27,791
CACFDAS Damage Per Acre	$86.32	$53.84
Crop Damages	$812,444	$1,496,267
Adjusted Net Value	-$172,513	-$2,361,080
With Alternative 5		
Net Returns:		
Acres in Strata	83,989	175,582
Weighted Net Return Per Acre c/	$18.08	$0.52
Degree of Protection d/	0.89	0.86
Adjusted Net Return Per Acre e/	17.11	-0.35
Unadjusted Net Returns for Strata	$1,437,052	-$61,454
Flood Damages:		
Average Annual Acres	1,056	3,856
CACFDAS Damage Per Acre	$125.81	$75.60
Crop Damages	$132,855	$291,514
Adjusted Net Value	$1,304,197	-$352,968
Crop Benefits for Upper Strata	$1,476,710	$2,008,112
Crop Benefits for Both Stratum	$2,144,151	$3,325,542
TOTAL CROP BENEFITS FOR BOTH REACHES	$5,469,693	

a/ Values in 2005 dollars.
b/ Obtained from Tables 7-23 and 7-24.
c/ Obtained from Tables 7-25 and 7-26.
d/ Degree of protection is defined as the level of protection afforded an area resulting from the implementation of a flood reduction alternative. This is usually expressed as a percentage of flood damage reduction (i.e., if 1,000 acres flood under existing conditions and only 200 acres flood with the implementation of a water resource alternative, the level of protection would be 80 percent [or 800 ÷1,000]).
e/ Weighted net returns were derived by applying the degree of protection to the net increase in productive value for each reach and strata. (No increase in production was estimated for the lower strata.)

Agricultural Projections

92.   Potential exists in the study area's agricultural sector for continued improvements in crop yields and/or overall increases in farm production levels. These increases in yields/production levels result from new and improved seed varieties, improved crop tillage methodologies, better management techniques, and/or various other new technologies which could emerge in the future. One example of this is the significant soybean yields that are now being realized with new early maturing varieties that can be planted in early to mid-April. Because of the threat of flooding, many farmers in the lower lands of the study area do not plant in April and realize significantly reduced yields. The construction of this project would do much to relieve this situation. However, these technological benefits will be limited without implementation of the proposed water resources improvement project, which will reduce the threat of flooding. In order to reflect the impact of these crop yields/production levels, projection factors were employed to estimate crop damage for future time periods.

93.   Projection factors for estimating future crop damage were based on results of a linear regression computer program. Without-project data for this evaluation included the values per harvested acre for selected years of reported agricultural crop sales data for the two primary counties in the economic base area. The U.S. Census of Agriculture data for agricultural crop sales and applicable number of harvested cropland acres are reported at 5-year intervals. These crop sales values were converted to a constant dollar basis for projection purposes. These values of farm product sales per harvested acre are reliable indicators of the historical increases in productivity for a specific area, and the extension of these trends into the future provides reasonable estimates of expected increases. Historical and projected values of all farm products sold per harvested acre for selected years are presented in Table 7-29. These factors were used to project the increases in all agricultural crop and noncrop damages.

TABLE 7-29
VALUE OF FARM PRODUCTS SOLD PER HARVESTED ACRE a/
AND PROJECTION FACTORS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Value of Farm Products Sold Per Harvested Acre (1996 $)	Ratio of Increase From Previous Period	
		%	Factor
Historical			
1969	304	--	--
1982	352	15.8	1.1579
1987	374	6.3	1.0625
1992	393	5.1	1.0508
Projected			
2005	443	12.7	1.1273
2012	470	6.1	1.0610
2021	505	7.5	1.0745
2031	544	7.7	1.0772
2041	583	7.2	1.0717
2051	621	6.5	1.0652
2061	660	6.3	1.0628

a/ Per harvested acres values (Census statistics presented in 1996 dollars) projected based on results of linear regression analysis.

Future and Average Annual
Structural Crop Benefits

94. The ratios of increase presented in Table 7-29 were used to project 2005 damages to agricultural crops to future time periods by 10-year increments (Table 7-30). Crop damages were projected and presented for without- (existing) and with-project (Alternative 5) conditions. For this analysis, the estimated project completion date for all alternatives of improvement is 2011. The first full year of project benefits (base year) is 2012. The 50-year period established as the expected economic life of the project is from 2012 to 2061. The structural crop average annual value of benefits associated with Alternative 5 is $6,534,000.

TABLE 7-30
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
STRUCTURAL CROP BENEFITS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Growth Factor a/	Benefits ($000) e/
2005 b/	--	5,470
2012 c/	1.0609	5,802
2021	1.0745	6,234
2031	1.0772	6,716
2041	1.0717	7,197
2051	1.0652	7,666
2061	1.0628	8,148
Expected Annual d/	--	6,534

a/ Based on projections (Table 7-29).
b/ Current year.
c/ Base year of project or first full year of project operation in which project benefits will occur.
d/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.
e/ Values in 2005 dollars.

NONCROP ANALYSIS—
STRUCTURAL ALTERNATIVES

95. Flood damages in the Yazoo Backwater study area also occur to noncrop items (i.e., farm property other than crops). These include damages to farm supplies; farm roads; drainage ditches, including V and W types; fences; irrigation systems; and landforming and leveling. Agricultural noncrop damages are based on a study, "Agricultural Non-Crop Flood Damage: Mississippi Delta, Mississippi" (September 1994), conducted by the MSU Department of Agricultural Economics at the Mississippi Agricultural and Forestry Experiment Station. This study, updated to 2005 price levels to reflect current production and equipment costs, was also revised to account for additional land leveling due to increased irrigation. This report is presented in Attachment 7E. Counties in the study area impacted by agricultural noncrop damages are Issaquena, Humphreys, Sharkey, and Washington.

96. The noncrop report prepared by MSU computed flood damages for three types of flood events--limited, moderate, and severe--as presented in Table 22 of Attachment 7E. The moderate category was used in this analysis because it was thought to reflect the average flood event incurred in the study area. By definition, a moderate flood was an event that had duration

of a few days. Damages to noncrop items ranged from a high of $48.90 per acre in Sharkey County to a low of $22.38 per acre for Humphreys County. The moderate damage per acre for Issaquena, Humphreys, Sharkey, and Washington Counties were averaged to compute the damage per acre amount of $38.06.

Noncrop Damages and Benefits—Structural Alternatives

97. Table 7-31 shows the existing (without-project) current year noncrop damages by reach and for the total study area. The average annual acres are multiplied by the damage per acre to derive the damage for each frequency condition. The existing (without-project) annual noncrop damage was estimated to be $5,618,000. Using the same process, the annualized noncrop damages with Alternative 5 were estimated to be $3,669,000. Table 7-32 displays the with-project (Alternative 5) noncrop damages. Subtracting the existing damages from the with-project damages derives benefits for the current year of $1,949,000 ($5,618,000 less $3,669,000) (Table 7-33).

Future and Average Annual Structural Noncrop Benefits

98. The current year values shown in Table 7-32 are applied to the growth indexes presented previously in Table 7-29 to develop the benefit stream shown in Table 7-34. The structural noncrop average annual value benefits associated with Alternative 5 are $2,328,000.

CROP ANALYSIS— NONSTRUCTURAL ALTERNATIVES

99. All of the final array alternatives incorporated reforestation features of presently cleared agricultural lands with the exception of Alternative 3. Table 7-35 displays the reforestation acres by alternative. Reforestation acres varied between alternatives and ranged from a high of 124,400 acres with Alternatives 2 and 6 to a low of 26,400 acres with Alternative 2B.

TABLE 7-31
EXISTING (WITHOUT-PROJECT) CONDITIONS
STRUCTURAL NONCROP DAMAGES
CURRENT YEAR
YAZOO BACKWATER AREA, MISSISSIPPI

Reach	Average Annual Cleared Acres Flooded (No.)	Damage/Acre a/ ($)	Current Year Damages ($000) b/
1	51,111	38.06	1,945
2	96,496	38.06	3,673
Totals	147,607	--	5,618

a/ Based on updated noncrop damage value for four counties within the study area.
b/ Values in 2005 dollars.

TABLE 7-32
WITH-PROJECT (PLAN 5) CONDITIONS
STRUCTURAL NONCROP DAMAGES
CURRENT YEAR
YAZOO BACKWATER AREA, MISSISSIPPI

Reach	Average Annual Cleared Acres Flooded (No.)	Damage/Acre a/ ($)	Current Year Damages ($000) b/
1	35,509	38.06	1,351
2	60,900	38.06	2,318
Totals	96,409	--	3,669

a/ Based on updated noncrop damage value for four counties within the study area.
b/ Values in 2005 dollars.

TABLE 7-33
WITH-PROJECT (PLAN 5) CONDITIONS
STRUCTURAL NONCROP BENEFITS
CURRENT YEAR
YAZOO BACKWATER AREA, MISSISSIPPI

Reach	Current Year Without-Project Damages ($000) a/	Current Year With Plan 5 Damages ($000) a/	Current Year Benefits ($000) a/
1	1,945	1,351	594
2	3,673	2,318	1,355
Totals	5,618	3,669	1,949

a/ Values in 2005 dollars.

TABLE 7-34
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
STRUCTURAL NONCROP BENEFITS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Growth Factor a/	Benefits ($000) e/
2005 b/	--	1,948
2012 c/	1.0609	2,067
2021	1.0745	2,221
2031	1.0772	2,393
2041	1.0717	2,564
2051	1.0652	2,731
2061	1.0628	2,903
Expected Annual d/	--	2,328

a/ Based on projections (Table 7-29).
b/ Current year.
c/ Base year of project or first full year of project operation in which project benefits will occur.
d/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.
e/ Values in 2005 dollars.

TABLE 7-35
ACRES OF REFORESTATION BY ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Acres of Reforestation (No.)
1	N/A
Nonstructural Alternatives	
2	124,400
2A	81,400
2B	48,880 a/
2C	114,400
Structural alternatives	
3	b/
4	37,200
5	55,600
6	81,400
7	124,400

NOTE: Alternative 1 is the no-action alternative.
a/ 26,400 acres are associated with the nonstructural features and 22,480 acres are for compensatory mitigation.
b/ Mitigation requirements of this alternative amounted to 53,363 acres; no additional reforestation above these requirements.

100. In absence of the water resource improvements evaluated, these agricultural lands are expected to remain in agricultural crop production. Reforesting these agricultural lands removes flood damage associated with crop production. All of the structural alternatives, with the exception of Alternative 3, had combination of structural and nonstructural features. Alternative 3 required 53,363 acres of lands for mitigation of habitat losses associated with construction and operation of this alternative. Alternatives 2, 2A, 2B, and 2C were labeled nonstructural alternatives; however, as discussed earlier, Alternative 2B incorporated ring levees into the alternative. For this analysis, planting trees on presently cleared agricultural lands was deemed a "nonstructural" measure.

Crop Damages and Benefits—
Nonstructural Alternatives

101. To determine the existing (without-project) damage associated with these reforested acres, the same general methodology described in the "AGRICULTURAL FLOOD DAMAGE ANALYSIS" section (page 7-26) was utilized to evaluate the agricultural crop damages/benefits to these reforested lands. The existing damage by strata and by reach was applied to the average annual acres flooded associated with the reforested agricultural lands to derive current year crop damages. Table 7-36 displays the without-project average annual acres flooded associated with these reforested lands by reach for all alternatives in the final array.

TABLE 7-36
AVERAGE ANNUAL ACRES FLOODED ASSOCIATED WITH REFORESTED LANDS
BY ALTERNATIVE, BY REACH
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Acres Reforested (No.)			Average Annual Acres Flooded (No.) a/		
	Reach 1	Reach 2	Total	Reach 1	Reach 2	Total
2	45,033	79,367	124,400	43,790	75,108	118,898
2A	29,467	51,933	81,400	37,103	59,724	96,826
2B b/	10,245	16,155	26,400	13,123	16,504	29,626
2C	41,413	79,987	114,400	44,074	72,875	116,949
3 c/	19,317	34,046	53,363	17,183	30,238	47,421
4	13,466	23,734	37,200	22,084	35,045	57,129
5	20,127	35,473	55,600	30,671	49,204	79,875
6	29,467	51,933	81,400	37,103	59,724	96,826
7	45,033	79,367	124,400	43,790	75,108	118,898

a/ The average annual acres flooded is greater than reforested acres with some alternatives because some of the acres are flooded multiple times per year.
b/ An additional 22,480 acres would be purchased outside the study area for compensatory mitigation. No structural or nonstructural benefits were computed for these lands.
c/ Mitigation lands required for this alternative.

102. For Alternative 5, the total reforested acres were 55,600 acres, of which 20,127 and 35,473 acres, respectively, were estimated to be in Reaches 1 and 2. The average annual flooded acres associated with the lands to be reforested was 79,875 acres for both reaches in the study area (30,671 acres in Reach 1 and 49,204 acres in Reach 2). These average annual acre values were applied to the existing damage per acre values (shown in Table 7-37) to derive existing current year crop damages.

TABLE 7-37
EXISTING CROP DAMAGE BY STRATUM a/
YAZOO BACKWATER AREA, MISSISSIPPI

Reach	Lower Strata ($)	Upper Strata ($)
1	45.55	86.32
2	50.11	53.84

SOURCE: CACFDAS program for existing conditions.
NOTE: CACFDAS crop damage values for all alternatives and conditions are found in Table 7-27.
a/ Values in 2005 dollars.

103. Current year crop damages for these reforested acres for Alternative 5 was estimated to be $3.9 million. For Reach 1, the existing crop damage per acre of $45.55 was multiplied by the 30,671 average annual values to derive existing damages for Reach 1 of $1,397,064. Using this same process, Reach 2 yields existing crop damage of $2,465,612 ($50.11 X 49,204 acres). This same process was utilized to determine crop damages and benefits for all alternatives with reforestation/conservation features. Under with-project conditions, these lands that are reforested would achieve 100 percent reduction in crop damages because these lands are removed from agricultural production and would no longer incur crop damages when flooded. Current year nonstructural crop benefits for all alternatives in the final array are displayed in Table 7-38. As shown, nonstructural crop benefits ranged from a high of $7.5 million with Alternative 2B to a low of $2.3 million with Alternative 3.

TABLE 7-38
NONSTRUCTURAL CROP BENEFITS
CURRENT YEAR BY ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Current Year Crop Benefits ($000) a/
2	5,867
2A	4,683
2B	7,486 b/
2C	5,772
3	2,298
4	2,762
5	3,863
6	4,683
7	5,867

a/ Values in 2005 dollars.
b/ Approximately 79 percent of this is from lands protected by ring levees and 21 percent is from reforestation of lands outside levees.

Future and Average Annual
Nonstructural Crop Benefits

104. The current year crop damages/benefits shown in Table 7-38 is projected over the 50-year economic life using the growth indexes shown in Table 7-29. In absence of the project, this growth in agricultural crops would continue and thus, this projection was made for both structural and nonstructural crop benefits. Current year benefits were projected over the 50-year period of analysis and benefits by year for Alternative 5 are shown in Table 7-39.

TABLE 7-39
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
NONSTRUCTURAL CROP BENEFITS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Growth Factor a/	Crop Benefits ($000) e/
2005 b/	--	3,863
2012 c/	1.0609	4,098
2021	1.0745	4,403
2031	1.0772	4,743
2041	1.0717	5,083
2051	1.0652	5,415
2061	1.0628	5,755
Expected Annual d/	--	4,615

a/ Based on projections (Table 7-29).
b/ Current year.
c/ Estimated first full year of project operation.
d/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.
e/ Values in 2005 dollars.

105. The projected nonstructural crop benefits were annualized at the current Federal discount rate of 5-1/8 percent over the 50-year period of analysis. Results from this process are displayed in Table 7-40 for all alternatives in the final array. As shown, nonstructural crop benefits ranged from a high of $8.9 million annually with Alternative 2B to a low of $2.7 million with Alternative 3. Average annual benefits for Alternative 5 were $4.6 million.

TABLE 7-40
NONSTRUCTURAL AVERAGE ANNUAL CROP BENEFITS
BY ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Average Annual Benefits ($000) a/
2	7,010
2A	5,595
2B	8,943 b/
2C	6,896
3	2,745
4	3,300
5	4,615
6	5,595
7	7,010

a/ Values in 2005 dollars. Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.

b/ Approximately 79 percent of these benefits are from croplands protected by ring levees and 21 percent are associated with reforestation of cleared croplands outside the ring levee system.

NONCROP ANALYSIS—
NONSTRUCTURAL ALTERNATIVES

Noncrop Damages and
Benefits—Nonstructural Alternatives

106. As with nonstructural crop benefits, the associated damages to noncrop items would be reduced with the reforestation/conservation measures on these lands. For a detailed description of what types of losses are categorized as “noncrop,” see the “NONCROP ANALYSIS—STRUCTURAL ALTERNATIVES” section of this appendix (page 7-50). The noncrop damage value of $38.06 was applied to the average annual value of the acres reforested (see Table 7-36). For Alternative 5, multiplying the $38.06 damage per acre by the value of the average annual acres of 79,875, yields current year damages/benefits of $3,040,042 (Table 7-41). All alternatives were evaluated utilizing this same methodology. Current year nonstructural damages/benefits to the noncrop category are displayed in Table 7-41 for all alternatives in the final array.

TABLE 7-41
NONSTRUCTURAL NONCROP BENEFITS
CURRENT YEAR BY ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Current Year Noncrop Benefits ($000) a/
2	4,525
2A	3,685
2B	5,553 b/
2C	4,451
3	1,805
4	2,174
5	3,040
6	3,685
7	4,525

a/ Values in 2005 dollars.
b/ Approximately 79 percent of these benefits are from croplands protected by ring levees and 21 percent are associated with reforestation of cleared croplands outside the ring levee system.

Future and Average Annual
Nonstructural Noncrop Benefits

107. The current year noncrop damages/benefits as shown in Table 7-41 were projected over the 50-year period of analysis and are displayed for Alternative 5 in Table 7-42. Annualizing these at the current Federal interest rate of 5-1/8 percent over the 50-year period yields average annual benefits for Alternative 5 of $3,632,000. Average annual values for all alternatives are displayed in Table 7-43. As shown, nonstructural noncrop benefits ranged from a high of $6.6 million annually with Alternative 2B to a low of $2.2 million with Alternative 3. Average annual benefits for Alternative 5 were $3.6 million.

TABLE 7-42
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
NONSTRUCTURAL NONCROP BENEFITS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Growth Factor a/	Noncrop Benefits ($000) e/
2005 b/	--	3,040
2012 c/	1.0609	3,225
2021	1.0745	3,466
2031	1.0772	3,733
2041	1.0717	4,001
2051	1.0652	4,262
2061	1.0628	4,529
Expected Annual d/	--	3,632

a/ Based on projections (Table 7-29).
b/ Current year.
c/ Estimated first full year of project operation.
d/ Annualized at the current Federal interest rate of 5-1/8 percent and 50-year economic life.
e/ Values in 2005 dollars.

TABLE 7-43
NONSTRUCTURAL AVERAGE ANNUAL NONCROP BENEFITS
BY ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Average Annual Benefits ($000) a/
2	5,407
2A	4,403
2B	6,633 b/
2C	5,318
3	2,156
4	2,598
5	3,632
6	4,403
7	5,407

a/ Values in 2005 dollars. Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.
b/ Approximately 79 percent of these benefits are from croplands protected by ring levees and 21 percent are associated with reforestation of cleared croplands outside the ring levee system.

BENEFITS TO HUNTING
LEASES AND TIMBER VALUES

108. Most of the alternatives evaluated in this report contain significant reforestation of cleared land that is currently in crop production. The removal of this land from crop production results in benefits from the prevention of crop and noncrop damages that would have occurred if the land had remained in production. There are also benefits from the sale of hunting leases and production of timber that accrue to these crop lands that have been reforested.

Timber Benefits Attributed
to Reforested Land

109. Timber benefits were assumed to be equal to the cost of the reforestation of the acres that were converted from cropland to forestland. This is because there are limited data and models to predict growth and yield in natural bottom-land hardwood stands. The number of acres to be reforested under each alternative and the average annual acres flooded for these acres are presented for all alternatives in Tables 7-35 and 7-36. Timber benefits for the recommended alternative (Alternative 5) are presented in Table 7-44, including the computation. The total average annual timber benefits attributed to reforested land were calculated to be $435,000.

TABLE 7-44
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
TIMBER BENEFITS TO REFORESTED LAND a/
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Acres Reforested (No.)	Value/Acre ($) b/	Current Value ($)
Reach 1	20,127	140	2,817,780
Reach 2	35,473	140	4,966,220
Totals	55,600	--	7,784,000
Average Annual Value ($)	--	--	435,000
Interest Rate (%)	--	--	0.05125
50-Year Amortization Factor (No.)	--	--	0.055838069

a/ Values in 2005 dollars.
b/ Costs of reforestation per cleared acre were based on cost of previous reforestation efforts in the Vicksburg District.

110. Benefits for timber are based on data from the report, "An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River Backwater Area (Mississippi)," by Dr. Leonard Shabman which indicated that returns for reforestation would be essentially equal to the costs of reforestation of the area (i.e., $140 per cleared acre per previous reforestation efforts by the Vicksburg District). The assumption was made that benefits for timber would be equal to the annualized costs of reforestation (costs for planting trees only).

Benefits from Hunting Leases

111. Data provided by Wildlife Technical Services, a wildlife consulting firm, show that currently, hunting leases in the study area range from a high of $40 per acre to lows of $7 per acre. The range in values is primarily associated with the type hunting that is available and the abundance of game. For lands that possess the ability to flood portions of the property for waterfowl hunting, the lease values are significantly higher than those that have no waterfowl hunting opportunities.

112. The benefits from the sale of hunting leases are based on data collected by the Vicksburg District from land management companies that track the lease of hunting properties through the study area. Hunting leases were valued differently based on whether land had the potential to be irrigated or not. Irrigation provides an additional benefit to waterfowl hunting. Nonirrigated lands benefit deer and similar wildlife, but exclude waterfowl. It was assumed that 48 percent of the reforested land could be irrigated by owners and 52 percent could not. The hunting leases on irrigated land were valued at $7 and $12 per acre per year for the first 2 years and $14 per acre per year thereafter for the 50-year project life. Hunting leases on nonirrigated lands were valued at $5 and $7 per acre per year for the first 2 years and $10 per acre per year thereafter for the 50-year project life. Average annual hunting lease benefits for Alternative 5, which were computed to be $638,000, are displayed in Table 7-45.

TOTAL AVERAGE ANNUAL
AGRICULTURAL BENEFITS

113. The average annual agricultural benefits include structural flood damage reduction benefits to agricultural crops and noncrops and nonstructural benefits to crops and noncrops on the cropland that will be reforested. Benefits to reforestation also include timber and hunting lease benefits. A summary of benefits to cropland and cropland that is to be reforested are presented in Table 7-46.

TABLE 7-45
WITH-PROJECT (PLAN 5) CONDITIONS
HUNTING LEASE BENEFITS a/
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Hunting Lease Values b/						
	Irrigated Potential ($/acre)	Dry acres ($/acre)	Rent Income Irrigated ($)	Rent Income Dryland ($)	Combined Income ($)	Present Value Factors (no.)	Present Value ($)
1	7	5	185,955	145,175	331,130	0.951248514	314,987
2	12	7	318,780	203,245	522,025	0.904873735	472,367
3	14	10	371,910	290,350	662,260	0.860759795	570,047
4	14	10	371,910	290,350	662,260	0.818796476	542,256
5	14	10	371,910	290,350	662,260	0.778878931	515,820
6	14	10	371,910	290,350	662,260	0.740907425	490,673
7	14	10	371,910	290,350	662,260	0.704787087	466,752
8	14	10	371,910	290,350	662,260	0.670427669	443,997
9	14	10	371,910	290,350	662,260	0.637743324	422,352
10	14	10	371,910	290,350	662,260	0.606652389	401,762
11	14	10	371,910	290,350	662,260	0.577077183	382,175
12	14	10	371,910	290,350	662,260	0.548943813	363,544
13	14	10	371,910	290,350	662,260	0.522181986	345,820
14	14	10	371,910	290,350	662,260	0.496724838	328,961
15	14	10	371,910	290,350	662,260	0.472508764	312,924
16	14	10	371,910	290,350	662,260	0.449473259	297,668
17	14	10	371,910	290,350	662,260	0.42756077	283,156
18	14	10	371,910	290,350	662,260	0.406716547	269,352
19	14	10	371,910	290,350	662,260	0.386888511	256,221
20	14	10	371,910	290,350	662,260	0.368027121	243,730
21	14	10	371,910	290,350	662,260	0.350085252	231,847
22	14	10	371,910	290,350	662,260	0.333018075	220,545
23	14	10	371,910	290,350	662,260	0.316782949	209,793
24	14	10	371,910	290,350	662,260	0.301339309	199,565
25	14	10	371,910	290,350	662,260	0.28664857	189,836
26	14	10	371,910	290,350	662,260	0.272674026	180,581
27	14	10	371,910	290,350	662,260	0.259380762	171,778
28	14	10	371,910	290,350	662,260	0.246735565	163,403
29	14	10	371,910	290,350	662,260	0.234706839	155,437
30	14	10	371,910	290,350	662,260	0.223264532	147,859
31	14	10	371,910	290,350	662,260	0.212380054	140,651
32	14	10	371,910	290,350	662,260	0.202026211	133,794
33	14	10	371,910	290,350	662,260	0.192177133	127,271
34	14	10	371,910	290,350	662,260	0.182808212	121,067
35	14	10	371,910	290,350	662,260	0.17389604	115,164
36	14	10	371,910	290,350	662,260	0.165418349	109,550
37	14	10	371,910	290,350	662,260	0.157353959	104,209
38	14	10	371,910	290,350	662,260	0.14968272	99,129
39	14	10	371,910	290,350	662,260	0.142385465	94,296
40	14	10	371,910	290,350	662,260	0.135443962	89,699
41	14	10	371,910	290,350	662,260	0.128840867	85,326
42	14	10	371,910	290,350	662,260	0.122559683	81,166
43	14	10	371,910	290,350	662,260	0.116584717	77,209
44	14	10	371,910	290,350	662,260	0.110901038	73,445
45	14	10	371,910	290,350	662,260	0.105494448	69,865
46	14	10	371,910	290,350	662,260	0.100351437	66,459
47	14	10	371,910	290,350	662,260	0.095459155	63,219
48	14	10	371,910	290,350	662,260	0.090805379	60,137
49	14	10	371,910	290,350	662,260	0.086378482	57,205
50	14	10	371,910	290,350	662,260	0.082167403	54,416
Present Year Value of Hunting Leases ($)							11,418,485
Amortization factor for 50-years							0.055838069

Source of hunting lease values: Wildlife Technical Services.

a/ Values in 2005 dollars. Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.

b/ Based on 55,600 reforested acres, 48 percent of which are irrigated..

TABLE 7-46
SUMMARY OF AVERAGE ANNUAL AGRICULTURAL BENEFITS, ALL ALTERNATIVES a/
YAZOO BACKWATER AREA, MISSISSIPPI
($000)

Item	Alternative 2	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Structural									
Agricultural Crop	0	0	0	0	9,554	7,970	6,534	5,153	3,235
Agricultural Noncrop	0	0	0	0	4,019	3,164	2,328	1,825	1,063
Nonstructural									
Agricultural Crop	7,010	5,595	8,943	6,896	2,745	3,300	4,615	5,595	7,010
Agricultural Noncrop	5,407	4,403	6,633	5,318	2,156	2,598	3,662	4,403	5,407
Timber Values	972	636	206	894	b/	291	435	636	972
Hunting Leases	1,403	918	298	1,290	b/	420	638	918	1,403
Total Agricultural Benefits	14,792	11,552	16,080	14,398	18,474	17,743	18,212	18,530	19,090

a/ Values in 2005 dollars. Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.
b/ No timber value and values for hunting leases computed for these reforested lands because these lands would be in public lands and open to the general public use.

URBAN STRUCTURE FLOOD DAMAGE ANALYSES

GENERAL

114. This section describes the urban structure flood damage evaluation of proposed water resource improvements in the Yazoo Backwater study area. The basic parameters of the economic analysis include 2005 price levels, an interest rate of 5-1/8 percent, a 50-year project life, and a project completion date of 2011. Background data consist of a description of the impacted area, a discussion of the number of properties and various categories of urban damage affected by flooding, a narrative of the methodology used to determine economic flood damages and benefits, and a discussion of the resulting benefits/impacts associated with the various alternatives of improvement.

115. The economic evaluation of urban flood damages in the Yazoo Backwater study area included the comparison of the flood damage setting for "without-project" (base hydrologic conditions) and "with-project" conditions for each set of alternatives in determining project benefits and the NED plan for water resources improvements. The without-project conditions, or existing conditions, for this analysis reflect the conditions expected to prevail in the absence of any alternative plan of improvement. It is the same as the alternative of "no action." The with-project conditions reflect conditions in the area when a selected alternative to alleviate flooding problems is in place.

URBAN BENEFITS

116. The NED Procedures Manual for Urban Flood Damage recognizes four primary categories of benefits for urban flood control plans: inundation reduction, intensification, location, and employment benefits. Inundation reduction is the only category of NED benefits for urban areas considered in this analysis. This category includes damages to residential and nonresidential structures, losses to the contents in those structures, damages to privately owned automobiles, emergency costs, and Federal Insurance Administration (FIA) costs.

RISK CONSIDERATIONS

117. Expected flood damages for existing conditions and with proposed flood control measures in place were considered utilizing the risk and uncertainty guidance in EC 1105-2-100, “Planning Guidance Notebook” (22 April 2000), and ER 1105-2-101, “Planning - Risk Analysis for Flood Damage Reduction Studies” (3 January 2006). The specific purpose of this analysis was to

determine the feasibility of providing flood protection for the area and quantify the uncertainty associated with making the decision to invest in a flood protection project in the Yazoo Backwater study area. This component of the analysis was accomplished utilizing the Hydrologic Engineering Center Next Generation Flood Damage Analysis (HEC-FDA) computer program which is discussed in more detail later in this section.

NED/EQ CONSIDERATIONS

118. Due to the immense number of alternatives that have been evaluated during the entire Yazoo Backwater Reformulation process, the step-by-step process of the economic analysis will only present with-project conditions for the recommended alternative--Alternative 5. This alternative was identified as the most effective alternative overall in regard to both economic development (NED) and environmental considerations (EQ). The NED plan is the optimum plan economically (i.e., the plan that produces the greatest excess benefits over costs or net benefits); and the EQ plan is the environmental quality plan implemented to enhance, preserve, or restore environmental resources such as fish and wildlife habitat, water quality, streamflow, cultural resources, and/or wetlands.

THE IMPACTED AREA

119. For the purposes of this study, the study area is the area subject to flooding by the 100-year frequency flood event in the Yazoo Backwater Area. The study area was divided into two hydrologic reaches which are used as flood damage reaches in this section to identify the existing impacts on the flood damage setting and evaluate various alternative improvements. Reach 1 comprises the lower sump area consisting of the area affected by operation of the Steele Bayou structure, and Reach 2 comprises the upper sump area consisting of the area affected by operation of the Little Sunflower structure.

EXISTING URBAN ENVIRONMENT

GENERAL

120. The urban flood damage analysis of the Yazoo Backwater study area involved the identification and evaluation of several categories of flood losses associated with urban development. Existing (without-project) and with-project urban flood damages and impacts will be presented illustrating the recommended alternative (Alternative 5) as the with-project condition unless otherwise noted. A complete display of the flood damages and benefits for all alternatives in the final array of alternatives will be presented in the "TOTAL ANNUAL BENEFITS" summary at the end of this section (page 7-109).

121. In the absence of flood control measures in the Yazoo Backwater study area, various types of damages and losses are incurred as a result of flooding in and around urbanized development. These include damages to residential and nonresidential structures, losses to the contents in those structures, flood damages to automobiles, the costs associated with flood emergency operations, and the cost for administering the FIA program. Most of these damages and costs are directly related to the number of structures flooded by flood frequency.

STRUCTURE ANALYSIS—WITHOUT
RISK AND UNCERTAINTY

122. In the initiation of urban flood damage analyses, field investigations were conducted and data were collected to identify the extent and character of flooding in the Yazoo Backwater study area. The determination of existing urban flood damages was based on the integration of depth-damage relationships and flood frequency distributions to the structures located in the area. Development of the existing structural database (i.e., residential and nonresidential properties located in the study area) was dependent upon the examination of aerial photographs and hydrologic data and a compilation of field survey data. The use of applicable flood damage analysis curves was used to depict the relationships between the stage and area inundated, stage and frequency of occurrence, stage and damage, and damage and frequency of occurrence.

Structure Inventory

123. The existing urban flood damages for the Yazoo Backwater study area were determined utilizing a structural database developed in 2005. These data were based on onsite structural surveys conducted during April-May 2000, updated by additional inventories in 2005 to identify all new construction and include any structural changes that had occurred since the previous inventories. Information gathered on each structure consisted of value, structure type, first-floor elevation (FFE), type of construction, type of foundation, number of stories, physical condition, size in dimensions, age, and location. The comprehensive survey, as opposed to a sample, and highly detailed data it produced were critical to this evaluation and enhance the accuracy of the study findings.

124. Based on the 2000-2005 surveys, the Yazoo Backwater study area consists of 2,813 structures, including 2,320 residential and 493 nonresidential properties, or 82 and 18 percent of total structures, respectively. The total number of urban structures located in the study area by reach is presented in Table 7-47 for existing (without-project) conditions. It should be noted that although all of the above structures are located in the study area, not all of these structures are subject to flooding by a 100-year flood event.

TABLE 7-47
NUMBER OF STRUCTURES IN THE STUDY AREA BY REACH
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Residential		Nonresidential		Total Structures	
	(No.)	(%)	(No.)	(%)	(No.)	(%)
Structures Located in the Study Area						
Reach 1	1,326	57	164	33	1,490	53
Reach 2	994	43	329	67	1,323	47
Total Area	2,320	100	493	100	2,813	100
Percent of Total Area (%)	-	82	-	18	-	100
Structures Receiving Flood Damage in the Study Area a/						
Reach 1	377	29	108	38	485	31
Reach 2	917	71	174	62	1,091	69
Total Area	1,294	100	282	100	1,576	100
Percent of Total Area (%)	-	82	-	18	-	100

a/ Structures receiving flood damages from a 100-year frequency flood event. Output from URBAN based on structure surveys conducted 2000-2005.

125. Since the HEC-FDA program will not readily identify individual structures flooded or provide a count of the number of structures flooded, the URBAN Computer Flood Damage Program (URBAN) developed by the Vicksburg District was utilized in determining these impacts. This program was created in the late 1970s to calculate the average annual flood damages to urban properties. Modifications through the 1990s have allowed for greater flexibility in analyzing various project parameters. This program, which has been used in the evaluation of numerous studies in the lower Mississippi Valley Division, will compute average annual damages by individual structure as well as groups of structures at specific locations along a stream. Impacts can be measured by reach, flood frequency, total area, and/or individual units.

Variable inputs include structure types, elevations, structure contents ratios, hydrologic flowlines, cross-section alignments, flood frequency data, etc. However, there are no risk and uncertainty options incorporated in URBAN. For the Yazoo Backwater analysis, URBAN was used as a tool to count the number of structures impacted by flooding for each reach by structure type and by frequency of flooding. The HEC-FDA program, inclusive of risk considerations, was used in the calculation of average annual flood damages to urban properties in the Yazoo Backwater study area in accordance with ECs 1105-2-100 and 1105-2-101.

Impacted Structures

126. A number of existing properties within the 100-year flood plain are subject to flooding from the backwater of the Yazoo, Little Sunflower, and Big Sunflower Rivers and their tributaries, especially when there are high stages on the Mississippi River and the gates of the Steele Bayou structure have been closed. Table 7-47 also presents the number of structures flooded in the study area by residential/nonresidential type and reach. Residential structures affected by flooding include houses and mobile homes. Nonresidential development susceptible to flooding includes retail (commercial) and services (professional) buildings, industrial structures, public and semipublic buildings, warehouses, and hunting camps. A total of 1,576 structures were identified to be subject to flooding from a 100-year frequency flood event in the Yazoo Backwater study area. This includes 1,294 residences (82 percent) and 282 nonresidential buildings (18 percent). The majority of the urban development affected by flooding is located in Reach 2 with approximately 69 percent of the total structures flooded.

Structure and Contents Values

127. Structure and contents values are major elements influencing the impact of depth-damage relationships and magnitude of flood damages to urban structures. Real estate appraisers for the Vicksburg District determined the values associated with the majority of the structures in the study area whereby each structure was visually evaluated. Depreciated replacement values were used in estimating the correct measure of structure values for this analysis. For the purposes of estimating urban flood damages, a structure is defined as a building and any attached components, such as built-in appliances, shelves, carpeting, etc. The value of land is excluded in the determination of urban structure values. Structure values of development in the area since 2000 were derived utilizing the Marshall and Swift Valuation Service (M&S) to calculate the depreciated cost for residential and nonresidential structures. M&S, who has been a leading provider of building cost data in the real estate industry since 1932, has been a recommended and approved source of real estate valuation for the Corps for over the past 10 years. For this study, M&S building cost data are used to develop replacement costs, depreciation values, and insurable values of buildings and other improvements impacted by flooding in the Yazoo Backwater study area. Table 7-48 displays the value of residential and nonresidential structures by reach for existing (without-project) conditions.

TABLE 7-48
AVERAGE STRUCTURE VALUE OF STRUCTURES BY REACH a/
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Structure Type	Average Value ($) b/	Structure Count (No.)	Total Value All Structures ($) b/
Reach 1			
Residential	45,000	1,326	59,699,700
Nonresidential	27,900	164	4,575,400
Total Structures	43,100	1,490	64,275,100
Reach 2			
Residential	42,600	994	42,306,200
Nonresidential	49,500	329	16,276,200
Total Structures	44,300	1,323	58,582,400
Total Area			
Residential	44,000	2,320	102,005,900
Nonresidential	42,300	493	20,851,500
Total Structures	43,700	2,813	122,857,400

a/ M&S input and URBAN output based on structure surveys conducted 2000-2005.
b/ Values in 2005 dollars rounded to nearest hundred. Totals may not add due to rounding.

128. In determining flood damages to contents, contents represent the furnishings and equipment of a structure or all items within the structure that are not permanently attached. For this analysis, contents-to-structure value ratios (CSVR) were taken from the Generic Depth-Damage Relationships provided for Corps flood damage and flood control studies as directed by the Flood Damage Data Collection Program (FDDCP) in EGM 04-01, "Generic Depth-Damage Relationships." The primary purpose of FDDCP is to meet the requirement by providing Corps District offices with standardized relationships for estimating flood damages and other costs of flooding based on actual losses from flood events. Under this program, the Generic Depth-Damage Relationships and corresponding CSVRs developed in this analysis are based on data collected nationwide since 1996. The CSVRs were developed for 11 structure categories, 3 residential and 8 nonresidential structure classifications. The CSVRs developed for the each structure category in the Yazoo Backwater study area are shown in Table 7-49.

TABLE 7-49
CONTENTS-TO-STRUCTURE VALUE RATIOS a/
YAZOO BACKWATER AREA, MISSISSIPPI

Structure Type	CSVR (%)
Residential	
Residential	
1-story	100
2-story	100
Mobile Homes	50
Nonresidential	
Hunting Camps	
1-story	100
2-story	100
Retail (Commercial)	125
Services (Professional)	125
Public	24
Semipublic	24
Industrial	113
Warehouse	125

a/ CSVRs from EGM 04-01.

Structure Elevations

129. Structure elevations for the Yazoo Backwater study area were derived from nearly digital elevation models (DEM) which were further refined using 5-foot contour mapping. Later, access to a base station and a rover global positioning system (GPS) with centimeter accuracy was used to collect elevation data in the area. Prior to structure elevations, a network of benchmarks was established. Each benchmark had some overlap in coverage to allow for low signal strength due to terrain features. Each benchmark was occupied with a static session of at least 6 hours providing for a centimeter or less accuracy in all three planes (latitude, longitude, and elevation). Structure elevations were collected by setting up a base station on one of the established benchmarks and mounting the rover on a vehicle. Each data point had a 20 epoch (approximately 20 seconds) static session to ensure centimeter accuracy.

130. Elevations for approximately 500 structures were collected using this method. When these elevations were compared to the elevations originally derived from an early DEM or contour mapping, it was found that the GPS-derived elevations were higher than the original elevations by 1.7 feet. This average amount of difference was added to the other structure elevations that were not collected with GPS.

131. Using computer analyses, first-floor elevations (FFE) of structures are correlated with depth-damage factors and hydrologic data to calculate the expected flood depths to each structure for each set of hydrologic conditions. The resulting damages by each frequency were used to determine the existing average or expected annual urban flood damages for each reach. This process was applied for both without- and with-project conditions in determining the number of structures flooded by frequency. The number of structures impacted by flood frequency for existing (without-project) conditions for each reach is presented in Table 7-50. These data are also displayed noncumulatively in the graph in Figure 7-1.

TABLE 7-50
TOTAL NUMBER OF STRUCTURES IMPACTED BY STRUCTURE TYPE
BY FREQUENCY OF FLOODING a/
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Frequency of Occurrence (Freq/Yr)	Reach 1			Reach 2			Total Area (Both)		
	Res (No.)	Nonres (No.)	Total Structures (No.)	Res (No.)	Nonres (No.)	Total Structures (No.)	Res (No.)	Nonres (No.)	Total Structures (No.)
1	-	-	-	-	-	-	-	-	-
2	3	-	3	88	2	90	91	2	93
5	36	30	66	227	19	246	263	49	312
10	115	56	171	394	51	445	509	107	616
25	243	65	308	611	112	723	854	177	1,031
50	331	84	415	770	160	930	1,101	244	1,345
100	377	108	485	917	174	1,091	1,294	282	1,576

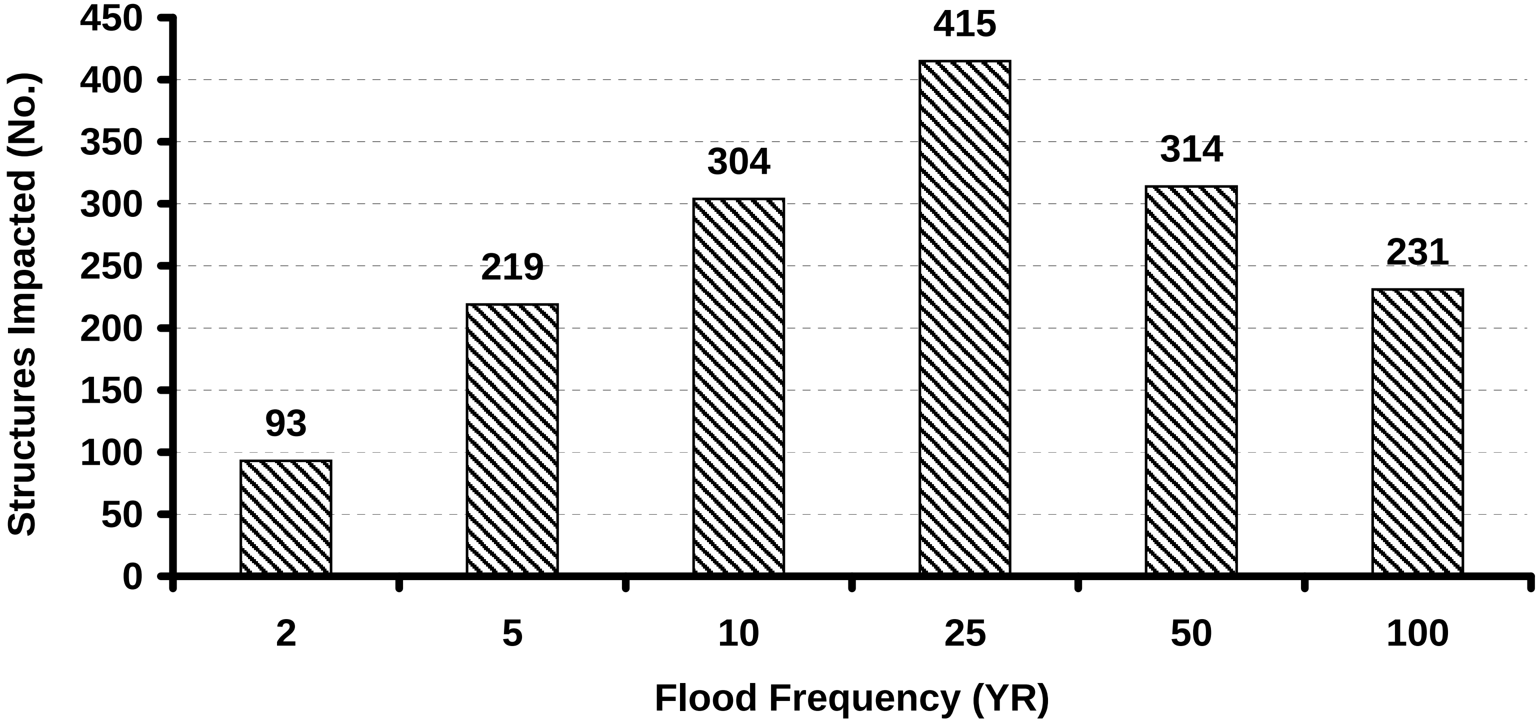
NOTE: Res = Residential structures
Nonres = Nonresidential structures

a/ Output from URBAN based on structure surveys conducted during 2000-2005.

Depth-Damage Relationships

132. Generic Depth-Damage Relationships provided in guidance EGM 04-01 were used to quantify the extent of flooding and urban flood damages in the Yazoo Backwater study area. These curves were used to indicate the percentage of the total structure (and contents) value that would be damaged at various depths of flooding. Damage percentages were determined for each 1-foot increment from 2 feet below the first-floor elevation to 12 feet above the FFE of the structure.

Figure 7-1
Number of Structures (Non-cumulative) Impacted by Frequency Existing Development Yazoo Backwater Area, Mississippi



Flood Damages to Structures
(Without Risk and Uncertainty)

133. In quantifying the extent of existing flood impacts in the Yazoo Backwater study area, the Urban Flood Damage Program (URBAN) was used as a tool to correlate various structure types by their elevation to specific hydrologic conditions. Within the program, specific types of urban structures (along with contents) are evaluated using hydrologic profile data, structure alignments, FFEs, depth-damage relationships, and structure values to compute the damages for each structure for various frequency flood events. The resulting damage-frequency output is integrated with stage-frequency data to develop stage-damage curve relative to each area.

134. Table 7-51 presents the estimated damages and number of structures impacted for selected flood frequencies for existing (without-project) conditions. Results of the URBAN program show that nearly 1,600 structures are susceptible to flooding in the study area with 93 structures beginning to flood at the 2-year frequency flood event. Results of the URBAN program, examples of which are displayed in Tables 7-47 through 7-51, can also be used to obtain the number of structures impacted by frequency storm event for both without- and with-project conditions. In addition, the number of structures impacted by flood frequency can be applied to other types of urban flood damage (i.e., automobiles, emergency costs, and FIA) to quantify their impacts by flood frequency.

TABLE 7-51
TOTAL NUMBER OF STRUCTURES IMPACTED AND ASSOCIATED FLOOD DAMAGES BY REACH AND BY FREQUENCY OF FLOODING a/
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Frequency of Occurrence (Frequency Per Year)	Number of Structures (No.)			Damages b/ ($000)		
	Reach 1	Reach 2	Total	Reach 1	Reach 2	Total
1	0	0	0	--	--	--
2	3	90	93	0	61	61
5	66	246	312	115	1,097	1,213
10	171	445	616	705	2,873	3,578
25	308	723	1,031	1,878	6,022	7,900
50	415	930	1,345	3,171	9,441	12,612
100	485	1,091	1,576	4,833	12,552	17,386

a/ Output from URBAN based on structure surveys conducted during 2000-2005.
b/ Values in 2005 dollars.

135. The comprehensive evaluation of flood damages to structures and other properties in the study area requires additional risk-based analyses to account for any inherent uncertainty associated with the economic and hydrologic input variables of the analysis. Thus, urban flood damages for without- and with-project conditions for all identified flood damage categories are accomplished utilizing the HEC-FDA program discussed in the following section.

RISK-BASED FLOOD DAMAGE ANALYSES

136. Even though every attempt is made to ensure accuracy, a degree of uncertainty is implicit in many areas of planning for water resource projects. The uncertainty arises due to error in the data being measured or errors inherent in the methods used to estimate the values of certain critical variables. The potential for error exists throughout the previous traditional analysis because each of the variables has been assigned a single point value rather than a range of values. In order to compensate for possible error, risk-based analysis can be applied to the planning and design of water resource projects. This approach, which quantifies the extent of systematic risk, provides the decisionmaker with a broader range of information. Thus, a decision can be made that reflects the explicit tradeoff between risks and costs.

THE HEC-FDA PROGRAM

137. The Corps requires the use of risk-based analysis procedures for formulating and evaluating flood damage reduction measures. The HEC-FDA is the interdisciplinary computer program that was utilized to evaluate flood damages in the Yazoo Backwater study area using risk-based analysis. The risk-based approach to urban flood damage analysis incorporates elements of risk and uncertainty more directly into project formulation, evaluation, and design of alternatives in the analysis of flood inundation damages and hydrologic engineering performance for plan evaluations in accordance with Corps policy regulations ERs 1105-2-100 and 1105-2-101. Both economic flood damage and hydrologic engineering analyses are performed using a consistent study configuration (e.g., streams, damage reaches, plans, and analysis years). Two types of evaluation are available in the program—analysis of damage and project performance by analysis years and equivalent annual damage. The type of evaluation used for the Yazoo Backwater study area was the analysis of damage and project performance by analysis years. A copy of the introduction to the HEC-FDA website is presented in Attachment 7F. It provides a brief summary of how the program works. More detailed information can be obtained from the website: http://www.hec.usace.army.mil/sofware/hec-fda/hecfda-hecfda.html.

METHODOLOGY

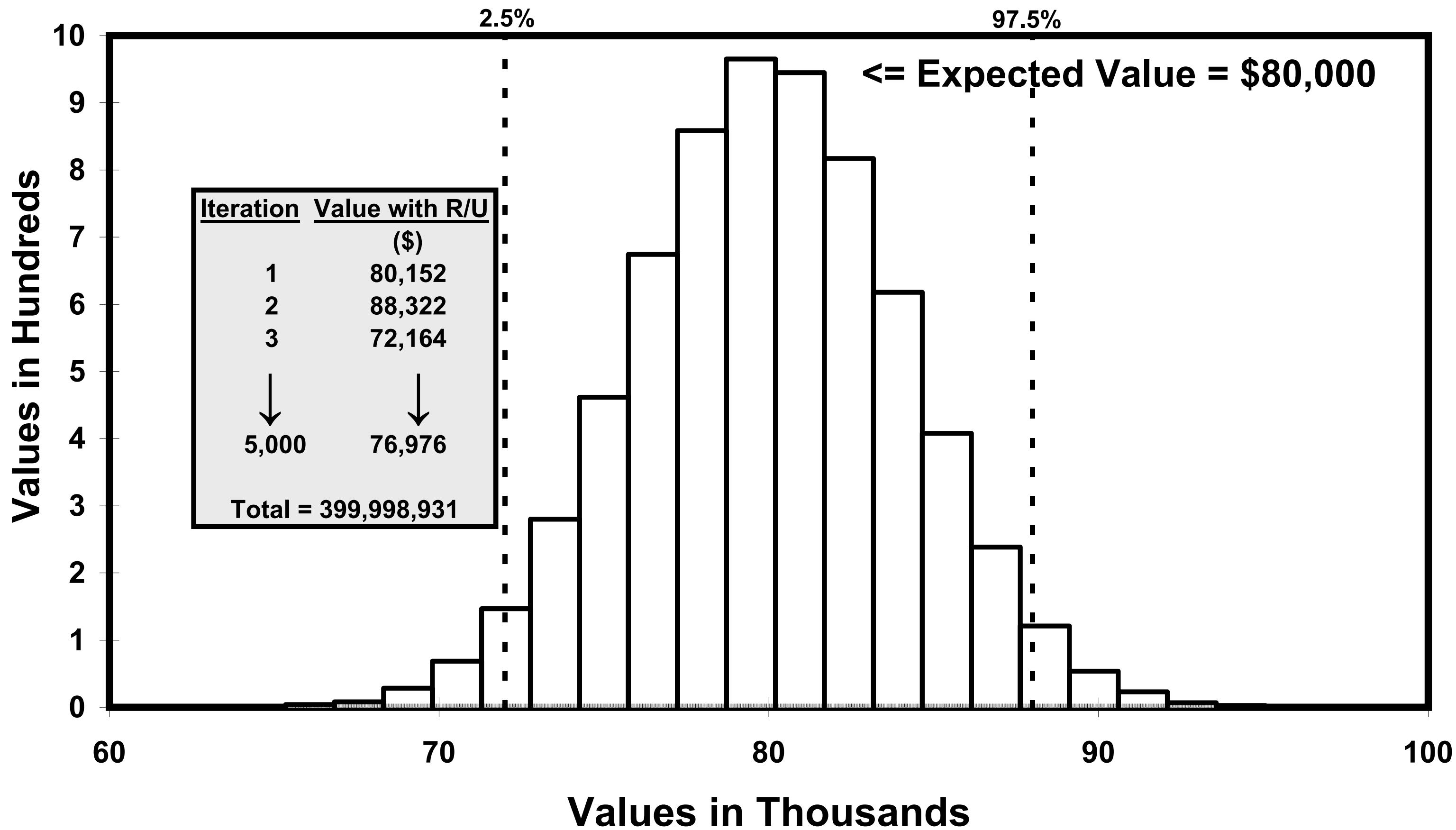
138. Risk-based analysis integrates risk and uncertainty into the computation of flood damages for specified events by using a simulation technique in which multiple iterations selected from a full range of possible values for each variable identified as a source of uncertainty. The analysis is accomplished by considering the range of possible values (maximum and minimum values for each input variable in the flood damage calculation) and distribution of the likely occurrence of outcomes over the specified range.

139. The HEC-FDA uses inventories of flood plain structures to calculate stage-damage-uncertainty information at damage index locations. To compute the uncertainty or error surrounding the elevation- or stage-damage curves, a maximum and a minimum value for each economic variable (FFE, structure and content values, and depth-damage relationships) is input. The program also uses the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-frequency curves. The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, the computerized Latin Hypercube sampling technique was used to sample from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results.

140. The sum of all sampled values divided by the number of samples yielded the expected value, or mean. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes. Expected and/or equivalent annual damage is computed in the evaluation portion of HEC-FDA.

141. Figure 7-2 displays a schematic diagram example of the results of risk and uncertainty modeling from calculating the structure value for an individual residential structure. A normal distribution is depicted with a sample mean value of $80,000, standard deviation of .05102 (.10/1.96), and a range plus or minus 10 percent. Assuming there is a 95 percent confidence level, the true mean is within ±10 percent of the sample mean. This implies a standard deviation for structure values of $80,000 equals 8,000/1.96 or 4,082. The risk model not only evaluates the uncertainty of each variable in this manner, but integrates the uncertainty of all the variables.

Figure 7-2
Example
Structure Value Uncertainty
Yazoo Backwater Area, Mississippi



ECONOMIC PARAMETERS
OF UNCERTAINTY

142. In the Yazoo Backwater study area, risk-based analysis was performed on four key economic variables: structure values, contents-to-structure value ratios, first-floor elevations, and depth-damage relationships. Each of these variables was analyzed for its impact on the elevation-damage curve. The HEC-FDA program calculates economic stage-damage with uncertainty; integrates the stage-damage curve, stage-discharge curve, and the discharge-probability curve; and will evaluate levees, channels, existing and proposed levees including project sizing and project reliability.

HYDROLOGIC/HYDRAULIC
PARAMETERS OF UNCERTAINTY

143. The Vicksburg District Hydraulics and Hydrology (H&H) Branch provided stage-frequency curves for without- and with-project conditions. The stages for seven frequency storms (1-, 2-, 5-, 10-, 25-, 50-, and 100-year events) that were provided represent the entire range of frequency events between the 1- and 100-year frequency flood events. The stage-frequency data and the first-floor elevation of the residential and nonresidential structures were used to determine the number of structures flooded in each reach for without- and with-project conditions. The H&H used an equivalent record length of 55 years to determine the uncertainty associated with the stage-frequency data. Based on this equivalent record length, the program calculated the confidence limits surrounding the stage-frequency function. (Refer to the Hydraulics Appendix for a more complete discussion.)

URBAN FLOOD DAMAGE/BENEFIT EVALUATION—RISK-BASED

STRUCTURE ANALYSIS

Structure Values

144. The two basic structural damage categories considered in the analysis include residential and nonresidential properties. A detailed description of the procedures used to obtain the structure inventory and all its components is presented in the "Structure Inventory" section (page 7-66). Structure values determined by real estate appraisers or M&S rate a fairly high

degree of accuracy. Thus, in calculating any possible error associated with the calculation of urban flood damages to structures, the uncertainty is represented by a TNORMAL probability density function with the appraised value representing the mean, a standard normal deviation, and a minimum value of the mean minus 10 percent and a maximum value of the mean plus 10 percent for residential structures. A TNORMAL probability density function is a normal distribution that is truncated at each end of the distribution by the limits of the range of possible values established. Nonresidential minimum and maximum were based on a 10 percent estimated error.

CSVR

145. Content-to-structure value ratios were obtained from the Generic Depth-Damage Relationships provided in EGM 04-01 as directed by the Institute of Water Resources (IWR) and are deemed to be very reliable. A TNORMAL probability density function was used with each content category and a standard deviation of 10 percent was calculated.

Structural First-Floor Elevation (FFE)

146. Structure elevations for the Yazoo Backwater study area were derived by DEM, 5-foot contour mapping, and survey-grade GPS. The risk assessment for the structure FFEs was based on estimates of error established for the least accurate method of determining elevation, the 5-foot contour map. A TNORMAL probability density function with a standard deviation of 2.5 feet (one-half the contour interval) was used to describe the uncertainty associated with this variable.

Depth-Damage Relationships

147. Generic depth-damage relationships were obtained from the generic depth-damage relationships provided in EGM 04-01 as directed to use by IWR. These curves were used to indicate the percentage of the total structure value that would be damaged from various depths of flooding. Damage percentages were determined for each 1-foot increment from 2 feet below the FFE to 12 feet above the FFE of the structure. A TNORMAL probability density function was used to determine the uncertainty associated with each increment of flooding and a standard deviation of 10 percent was calculated.

Structure Damages with Uncertainty

148. The HEC-FDA results of the structural flood damage analysis, including any potential risk and uncertainty factors, are presented in Table 7-52 for the Yazoo Backwater study area. Total expected annual structure damages were estimated to be over $4.4 million (expressed in 2005 prices) for existing (without-project) conditions. With the implementation of Alternative 5, expected annual damages to structures were estimated to be $2.3 million, or 49 percent in flood damage reduction. Reach 2 comprised 84 percent of the total damage with over $3.7 million in expected annual damages. Based on future population projections, the number of people in the economic base area is expected to remain constant over the next 50 years; thus, damages are not projected to increase over the life of the project.

TABLE 7-52
TOTAL ANNUAL STRUCTURE DAMAGES
WITH UNCERTAINTY BY REACH
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Existing (Without-Project) Structure Damages a/b/ ($)	With-Project (Alternative 5) Structure Damages a/b/ ($)
2005 (Current Year)		
Reach 1	704,000	151,000
Reach 2	3,712,000	2,110,000
Total	4,416,000	2,261,000
2012 (Base Year)		
Reach 1	704,000	151,000
Reach 2	3,712,000	2,110,000
Total	4,416,000	2,261,000
2061		
Reach 1	704,000	151,000
Reach 2	3,712,000	2,110,000
Total	4,416,000	2,261,000

a/ Structural flood damages are held constant over the estimated project economic life (2012-2061) based on future population projections.
b/ Expected annual damages with uncertainty (output from the HEC-FDA program) are presented in 2005 dollars.

AUTOMOBILE ANALYSIS

149. The analysis of automobile damages involved determining the number of units (automobiles) impacted and the application of these data to a damage per unit value. Estimation of the number of automobiles per household by frequency was accomplished utilizing the number of automobiles per household and the number of households assumed to be damaged in each area (from the HEC-FDA program). These values were applied to an average damage per automobile to derive overall damages.

150. Variations in the depth of flooding in these urban areas would result in some automobiles having a higher percentage of damage than others. Therefore, it was determined that the damage per automobile should be based on an average of several flood depths and represent potential average damage values. The average residence in the Yazoo Backwater study area was assumed to have two automobiles per household (based on U.S. Census Statistics). Each of these automobiles was assigned a value of $15,000 based on a composite average value of used automobiles from J.D.Powers' Automobiles.com and local auto auctions (with a dealer markup).

151. In addition, considering the low-velocity flooding typical of the Yazoo Backwater study area, only one-third of the affected automobiles were assumed to receive flood damages. Furthermore, it was assumed that each automobile was parked 0.5 foot below the elevation of slab houses (i.e., the water entry level) and 1.5 feet below the elevation of houses built on piers. No vehicles were assigned to commercial properties since there are no national guidelines showing number, type, or value of vehicles associated with commercial properties.

152. A TNORMAL probability density function was used to determine the uncertainty surrounding the values assigned to the automobiles in the inventory with a mean value of $9,893 (one-third of the average value of two automobiles) and a standard deviation of 10 percent.

Automobile Damages with Uncertainty

153. The HEC-FDA results presented in Table 7-53 calculated the expected annual damages to automobiles in the Yazoo Backwater study area to be approximately $561,000 for existing (without-project) conditions. These damages, expressed in 2005 prices, included the inherent risk and uncertainty associated with automobile flood damage. With the implementation of

Alternative 5, expected annual damages to automobiles were estimated to be $263,000, or 53 percent in flood damage reduction. Since automobile damages are correlated with structures, they are not projected to increase over the life of the project.

TABLE 7-53
TOTAL ANNUAL AUTOMOBILE DAMAGES
WITH UNCERTAINTY BY REACH
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Existing (Without-Project) Automobile Damages a/b/ ($)	With-Project (Alternative 5) Automobile Damages a/b/ ($)
2005 (Current Year)		
Reach 1	119,000	26,000
Reach 2	442,000	237,000
Total	561,000	263,000
2012 (Base Year)		
Reach 1	119,000	26,000
Reach 2	442,000	237,000
Total	561,000	263,000
2061		
Reach 1	119,000	26,000
Reach 2	442,000	237,000
Total	561,000	263,000

a/ Automobile flood damages are held constant over the estimated project economic life (2012-2061) based on future population projections.
b/ Expected annual damages with uncertainty (output from the HEC-FDA program) are presented in 2005 dollars.

EMERGENCY COST ANALYSIS

154. Emergency costs include such items as evacuation and reoccupation costs; flood-fighting expenses; costs for emergency shelter and food for evacuees; state and Federal disaster relief; increased expense of normal operations; increased costs of police, fire, and/or military patrol; and losses due to abnormal depreciation of equipment (e.g., fire trucks, patrol cars, bulldozers, etc.) resulting from catastrophic flooding. Specific flood-fighting activities include sandbagging, road

barricades, pumps and associated equipment, levees, transport of fill dirt, etc., and other requirements resulting from flooding. These are expenses or costs borne by affected residents and property owners, local or state governments or agencies, and other Federal agencies or national organizations.

155. Emergency costs were calculated based on the number of structures flooded by frequency in the HEC-FDA program applied to an emergency cost value per structure of $1,112 for residential structures and $1,827 for nonresidential structures. This was based on a survey conducted by the Vicksburg District after several floods in the 1990s. The number of structures affected was combined with the emergency cost per structure to develop the stage-damage relationship for each area.

156. A TNORMAL probability density function was used to determine the uncertainty surrounding the values assigned to cost of emergency flood-fighting operations, and a standard deviation of 10 percent was calculated.

Emergency Costs with Uncertainty

157. The HEC-FDA results presented in Table 7-54 calculated the expected annual emergency costs in the Yazoo Backwater study area to be approximately $206,000 for existing (without-project) conditions. These costs, expressed in 2005 prices, included the inherent risk and uncertainty associated with the costs of emergency operations. With the implementation of Alternative 5, expected annual damages (or additional costs) to emergency operations were estimated to be $102,000, or 50 percent in flood damage reduction. Since emergency costs are correlated with structures, they are not projected to increase over the life of the project.

TABLE 7-54
TOTAL ANNUAL EMERGENCY COSTS
WITH UNCERTAINTY BY REACH
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Existing (Without-Project) Emergency Costs a/b/ ($)	With-Project (Alternative 5) Emergency Costs a/b/ ($)
2005 (Current Year)		
Reach 1	48,000	12,000
Reach 2	158,000	90,000
Total	206,000	102,000
2012 (Base Year)		
Reach 1	48,000	12,000
Reach 2	158,000	90,000
Total	206,000	102,000
2061		
Reach 1	48,000	12,000
Reach 2	158,000	90,000
Total	206,000	102,000

a/ Costs associated with emergency operations were held constant over the estimated project economic life (2012-2061) based on future population projections.
b/ Expected annual damages with uncertainty (output from the HEC-FDA program) are presented in 2005 dollars.

FEDERAL FLOOD INSURANCE ANALYSIS

158. The net national cost of the flood insurance program includes the costs of claims adjustment, agent commissions, and the cost of servicing the policies. Since fewer property owners will be in the 100-year flood plain and will be required to have flood insurance coverage, potential benefits attributable to the project will arise from a reduction in the administration overhead.

159. In order to determine the expected annual FIA costs, the URBAN computer program was used to determine the number of residential structures within the 100-year flood plain under the without- and with-project conditions. The 100-year flood plain was defined as the number of structures with a first-floor elevation equal to or less than the stage associated with a 100-year frequency storm event. The number of structures was then multiplied by the $192 average administrative cost per property in determining the total costs associated with FIA.

160. Benefits accrued from the reduction in the cost of administering the flood insurance program deals with probable changes in the aerial extent of the 100-year flood plain for the without- versus with- project conditions. The number of structures participating in the program which would no longer be in the 100-year flood plain was used to compute these benefits based on a current operating cost per policy of $192 based on guidance provided by EGM 06-04, "NFIP (National Flood Insurance Program) Operating Costs FY 2006." Results of this analysis are provided in Table 7-55. Risk and uncertainty procedures are not applied to FIA savings since they are based on a fixed cost.

TABLE 7-55
TOTAL ANNUAL COSTS ASSOCIATED WITH
FLOOD INSURANCE ADMINISTRATION (FIA)
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Existing (Without-Project)		With-Project (Alternative 5)	
	Residential Structures at 100-Year (No.)	FIA Costs ($) a/	Residential Structures at 100-Year (No.)	FIA Costs ($) a/
2005 (Current Year)				
Reach 1	377	72,400	78	15,000
Reach 2	917	176,100	451	86,600
Total	1,294	248,400	529	101,600
2012 (Base Year)				
Reach 1	377	72,400	78	15,000
Reach 2	917	176,100	451	86,600
Total	1,294	248,400	529	101,600
2061				
Reach 1	377	72,400	78	15,000
Reach 2	917	176,100	451	86,600
Total	1,294	248,400	529	101,600

a/ Costs (rounded to nearest hundred) derived from individual FIA policy cost of $192 for 2006 and held constant over the estimated project economic life (2012-2061) based on future population projections.

FIA Costs

161. Results of the FIA evaluation presented in Table 7-55 calculated the expected annual FIA costs in the Yazoo Backwater study area to be approximately $248,400 for existing (without-project) conditions. With the implementation of Alternative 5, expected annual FIA costs were estimated

to be $101,60073,500 or 52 percent in flood cost reduction. Since FIA costs are correlated with structures, they are not projected to increase over the life of the project.

SUMMARY OF EXISTING URBAN FLOOD DAMAGES

162. A summary of total expected annual urban flood damages is presented by category and reach in Table 7-56 for existing conditions (i.e., without flood reduction measures in place). Total existing damages in the Yazoo Backwater study area are estimated to be approximately $5.4 million. Of this amount, residential structures comprise 70 percent of the total expected annual damages.

TABLE 7-56
TOTAL EXPECTED ANNUAL URBAN FLOOD DAMAGES
BY CATEGORY AND REACH
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Category	Total Expected Annual Urban Flood Damages by Reach a/b/					
	Reach 1 ($000)	Percent of Total Damages (%)	Reach 2 ($000)	Percent of Total Damages (%)	Total Area ($000)	Percent of Total Damages (%)
Structures	704	75	3,712	83	4,416	81
(Residential)	(582)	(62)	(3,201)	(71)	(3,783)	(70)
(Nonresidential)	(122)	(13)	(511)	(11)	(633)	(12)
Automobiles	119	13	442	10	561	10
Emergency Costs	48	5	158	4	206	4
FIA Costs	72	8	176	4	249	5
Total Damages	943	100	4,488	100	5,432	100

a/ Based on risk and uncertainty analysis using HEC-FDA with the exception of FIA costs.
b/ Values in 2005 dollars.

TOTAL AVERAGE ANNUAL URBAN BENEFITS

163. The HEC-FDA program integrated the results of the economic uncertainty analysis (elevation-damage curve with error) with the results of the hydrologic/hydraulic uncertainty analysis (stage-frequency curve with error) to produce the without- and with-project expected annual damages. With-project expected annual damages are subtracted from without-project

expected annual damages in order to determine the inundation (or cost) reduction benefits for the Yazoo Backwater study area. Table 7-57 shows the total expected annual damages by flood damage category and reach for the without- and with-project (recommended alternative—Alternative 5) conditions and the percent flood damage reduction. Based on Table 7-57, the majority of the existing damages and flood damages prevented is located in Reach 2 (83 percent).

TABLE 7-57
TOTAL EXPECTED ANNUAL URBAN FLOOD DAMAGES
BY CATEGORY AND REACH a/b/c/
EXISTING (WITHOUT-PROJECT) CONDITIONS,
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS AND
FLOOD DAMAGES PREVENTED (WITH PERCENT REDUCTION)
YAZOO BACKWATER AREA, MISSISSIPPI

Category	Total Expected Annual Urban Flood Damages by Reach and Category			
	Existing (Without-Project) Conditions ($000)	With-Project (Alternative 5) Conditions ($000)	Flood Damages Prevented ($000)	Percent Flood Damage Reduction (%)
Reach 1				
Structures	704	151	553	79
Automobiles	119	26	93	78
Emergency Costs	48	12	36	75
FIA Costs	72	15	57	79
Total Damages	943	204	729	78
Reach 2				
Structures	3,712	2,110	1,602	43
Automobiles	442	237	205	46
Emergency Costs	158	90	68	43
FIA Costs	156	87	90	51
Total Damages	4,488	2,524	1,965	44
Total Area				
Structures	4,416	2,261	2,155	49
Automobiles	561	263	298	53
Emergency Costs	206	102	104	50
FIA Costs	249	102	147	59
Total Damages	5,432	2,728	2,704	50

a/ Based on risk and uncertainty analysis using HEC-FDA with the exception of FIA costs.
b/ Values in 2005 dollars.
c/ Totals may not add due to rounding.

164. Table 7-58 shows the total expected annual flood damages and benefits by reach for the without- and with-project (Alternative 5) conditions and the percent flood damage reduction for all alternatives.

OTHER FLOOD DAMAGE ANALYSES

165. Other flood damages were identified in the Yazoo Backwater study area that are not included in the HEC-FDA program. Other damages considered in this evaluation include flood damages to public roads, streets, and catfish operations.

PUBLIC ROAD ANALYSIS

166. Many public roads and streets are susceptible to flooding in both rural and urban sectors of the Yazoo Backwater study area. Road damage estimates are based on available field survey data and applicable hydrologic data for the study area. Since there were no available reports on bridge damage to backwater flooding, flood damages discussed herein include rural roads and urban streets in the study area.

167. Existing miles of roads for the study area were determined by use of satellite imagery in combination with GIS mapping tools. Elevations of roads were determined by overlaying the frequency layers over the miles of roads to develop the miles of road impacted by frequency. Table 7-59 shows the miles of road by flood frequencies and by reach that were evaluated in this study. Under existing (without-project) conditions, it was estimated that 1,164 miles of roads are impacted by the 100-year flood event.

TABLE 7-58
TOTAL EXPECTED ANNUAL URBAN FLOOD DAMAGES AND BENEFITS a/
BY REACH FOR ALL ALTERNATIVES b/
INCLUDING PERCENT FLOOD DAMAGE REDUCTION
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	Existing (Without-Project) Conditions ($)	With-Project Conditions ($)	Urban Flood Benefits ($)	Percent Flood Damage Reduction (%)
Reach 1				
2	944	944	-	0
2A	944	-	944	100
2B	944	-	944	100
2C	944	-	944	100
3	944	145	798	85
4	944	147	797	84
5	944	204	739	78
6	944	272	671	71
7	944	363	580	62
Reach 2				
2	4,487	4,487	-	0
2A	4,487	-	4,487	100
2B	4,487	-	4,487	100
2C	4,487	-	4,487	100
3	4,487	1,851	2,636	59
4	4,487	2,212	2,276	51
5	4,487	2,524	1,963	44
6	4,487	2,676	1,812	40
7	4,487	3,106	1,381	31
Total Area				
2	5,431	5,431	-	0
2A	5,431	-	5,431	100
2B	5,431	-	5,431	100
2C	5,431	-	5,431	100
3	5,431	1,996	3,435	63
4	5,431	2,358	3,073	57
5	5,431	2,728	2,703	50
6	5,431	2,948	2,483	46
7	5,431	3,469	1,962	36

a/ Includes damages or additional costs incurred from flooding to residential and nonresidential structures, automobiles, emergency costs, and FIA costs.
b/ Values in 2005 dollars.

TABLE 7-59
MILES OF ROADS IMPACTED BY FLOOD FREQUENCY BY REACH
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Frequency of Occurrence (Freq/Yr)	Reach 1 (miles)	Reach 2 (miles)	Total Area (miles)
1	80	144	224
2	139	269	408
5	208	436	644
10	259	545	804
25	289	647	936
50	362	721	1,083
100	395	769	1,164

168. Table 7-60 displays the miles of road and the associated damages for each of the flood frequency events evaluated. Damages for each flood event (1 through 100 years) were derived using road damages reported to the Mississippi Emergency Management Agency (MEMA) from counties that incurred road damages from the last major flood event in the Mississippi Delta (1991). Road damages ranged from $1,000 to $3,000 per mile for areas that were identified to have experienced flooding between the 1- and 10-year frequency events. Dividing the total reported road damages in 1991 by the number of miles impacted yielded a road damage amount of $1,635 per mile. Updated to current year dollars yielded a road damage per mile value of $2,400 for 2005. Using the same methodology, the road damage for counties that experienced flooding events between the 25- and 100-year frequency flood events averaged $4,543 in road damages per mile in 1991 dollars, or $6,600 per mile in 2005 dollars. The updated damage per mile figures were applied to the number of miles of road impacted to develop the road damages by flood frequency shown in Table 7-60.

TABLE 7-60
TOTAL ROAD DAMAGE BY FREQUENCY
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Frequency of Occurrence (Freq/Yr)	Total Roads Impacted (miles)	Damage per Mile ($) a/	Total Existing (Without-Project) Road Damages a/b/ ($)
1	224	2,400	537,600
2	408	2,400	979,200
5	644	2,400	1,545,600
10	804	2,400	1,929,600
25	936	6,600	6,177,600
50	1,083	6,600	7,147,800
100	1,164	6,600	7,682,400
Current Year Damages			1,460,100

a/ Values in 2005 dollars.
b/ Totals may not add due to rounding.

Public Road Damages and Benefits

169. As shown in Table 7-60, the current year damages for roads and streets were estimated to be $1.5 million for existing (without-project) conditions. Remaining road damages by frequency under the with-project (Alternative 5) conditions are shown in Table 7-61. Subtracting the existing damage ($1,460,100) from the with-project (Alternative 5) damage ($1,016,900) yields a current year benefit of $443,200 to public roads.

TABLE 7-61
TOTAL ROAD DAMAGE BY FREQUENCY
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Frequency of Occurrence (Freq/Yr)	Total Roads Impacted (miles)	Damage per Mile ($) a/	Total With-Project Road Damages a/b/ ($)
1	224	2,400	537,600
2	307	2,400	737,500
5	420	2,400	1,007,000
10	491	2,400	1,178,900
25	594	6,600	3,920,000
50	670	6,600	4,419,200
100	727	6,600	4,800,300
Current Year Damages			1,016,900

a/ Values in 2005 dollars.
b/ Total may not add due to rounding.

170. Results of the flood damage analysis to public roads are presented in Table 7-62 for the Yazoo Backwater study area. Total expected annual road damages were estimated to be nearly $1.5 million (expressed in 2005 prices) for existing (without-project) conditions. With the implementation of Alternative 5, expected annual damages to roads were estimated to be $1.0 million or 30 percent in flood damage reduction. Reach 2 comprised 67 percent of the total damage with $977,000 in expected annual damages. Based on future population projections, the number of people in the economic base area is expected to remain constant over the next 50 years. Since roads are part of the infrastructure serving the population, they are also expected to basically remain constant. Thus, damages to roads are not projected to increase over the life of the project.

TABLE 7-62
TOTAL ANNUAL ROAD DAMAGES BY REACH
EXISTING (WITHOUT-PROJECT) AND WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Area	Existing (Without-Project) Road Damages a/b/ ($)	With-Project (Alternative 5) Road Damages a/b/ ($)
2005 (Current Year)		
Reach 1	483,200	335,400
Reach 2	976,900	681,600
Total	1,460,100	1,016,900
2012 (Base Year)		
Reach 1	483,200	335,400
Reach 2	976,900	681,600
Total	1,460,100	1,016,900
2061		
Reach 1	483,200	335,400
Reach 2	976,900	681,600
Total	1,460,100	1,016,900

a/ Road flood damages are held constant over the estimated project economic life (2012-2061) based on future population projections.
b/ Expected annual damages are presented in 2005 dollars.

171. The project benefits over the life of the project for flood damages prevented to roads are displayed in Table 7-63. Annualizing these benefits at the current interest rate of 5-1/8 percent and a 50-year economic life yields total average annual benefits of $443,000 for roads and streets.

TABLE 7-63
TOTAL EXPECTED ANNUAL
FLOOD DAMAGE BENEFITS TO ROADS
WITH-PROJECT (ALTERNATIVE 5) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Benefits ($) a/
2005 b/	443,200
2012 c/	443,200
2021	443,200
2031	443,200
2041	443,200
2051	443,200
2061	443,200
Expected Annual Benefits d/	443,200

a/ Values in 2005 dollars.
b/ Current year.
c/ Base year—estimated first full year of project operation.
d/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

172. It is extremely difficult to determine flood damages associated with flooding to roads because many damages to roads do not reveal themselves until months or years after flood events occur. Compounding this problem is a lack of detailed records that document damages/repairs associated with the flooding to roads. Therefore, this analysis took a “conservative” approach to estimating the damages/benefits for this study. Discussions with the Mississippi Department of Transportation (MDOT) indicate that a 3- to 4-inch overlap of asphalt costs between $120,000 and $140,000 per mile (in 2005 dollars). Assuming that only 10 percent of the road is damaged, the damage amount could easily increase to $12,000 to $14,000 per mile of impacted road. Although it is acknowledged that not all roads in the study area are hard-surfaced concrete or asphalt, these figures support the statement that the road damages per mile of $2,400 and $6,600 used in this analysis are conservative.

CATFISH FARMING OPERATIONS ANALYSIS

173. Although catfish farming operations are significant agricultural enterprises in the Yazoo Backwater study area, they are discussed along with the road and street evaluation instead of agricultural flood damages because of the direct influence that road elevations and their overtopping have on catfish damages.

174. There are an estimated 31,200 acres of farm-raised catfish ponds in the Yazoo Backwater study area. Based on a 5-year average price of $0.75 per pound and an output of 4,000 pounds per acre, the annual gross value of production of these ponds is $100 million. Reach 2 within the Yazoo Backwater study area has some flooding problems or damages to catfish farming operations. Flood-related damages to the catfish industry include revenue lost from escaped fish, reduced revenue due to shortened growing season, additional costs for restocking ponds after flooding, draining and refilling ponds, and from damages to pond levees, drainage systems, and water supply systems.

175. In the draft 2000 Reformulation report, it was estimated that flood damage benefits to catfish farming operations would occur. In 1973, significant catfish losses were experienced by farmers in the study area. However, since that event, most of the ponds that experienced flood losses from the 1973 event have either raised the levees above the 100-year elevation or removed the catfish pond from production. Subsequent analyses which involved determining elevations of the access roads and tops of levees of the catfish ponds revealed that most access roads and levees were at or above the 100-year flood elevation of 100.3 feet, NGVD. Therefore, this analysis did not include any benefits to catfish farming operations within the study area.

SECTION 5 - BENEFITS

GENERAL

176. The with-project benefits presented in this section reflect conditions with Alternative 5. Benefits are based on the period of economic analysis; i.e., the period beginning with the estimated first full year of operation (base year) and continuing through the expected project economic life (2012-2061).

BENEFIT CATEGORIES

177. The two major categories of benefits are inundation reduction, and employment benefits. Inundation reduction benefits consist of damage reduction to development expected to exist for present conditions and the reduction of damage to additional development without project installation. Additional inundation benefits result from potential created by the project, particularly in agriculture where opportunities for improvement are enhanced. Employment benefits are benefits derived from construction labor cost expenditures credited to the relief of unemployment and underemployment allocated to counties or parishes eligible for aid pursuant to the Economic Redevelopment Administration, U.S. Department of Commerce, as per current guidelines (EGM 04-04, 22 March 1994).

BENEFITS BY SECTOR

178. Future flood control benefits were determined for nonagricultural and agricultural sectors affected by implementation of a water resources improvement project. Nonagricultural benefits within the study area consist of flood damage reduction to structures, automobiles, roads and streets, and reduction in emergency costs and NFIP operating costs. Agricultural benefits accruing to the project consist of flood damage reduction to agricultural crops, a variety of agricultural noncrop items, and increased net returns to land.

179. All benefits were discounted to determine present worth and were amortized over the expected project economic life to determine average annual values for each category. Benefits derived in the final analysis are described herein. They are based on a 50-year development period, an expected project economic life of 50 years, and a current Federal discount rate of 5-1/8 percent.

INUNDATION REDUCTION BENEFITS

180. Inundation (or cost) reduction benefits reflect the difference between without- and with-project conditions for each benefit category. Total inundation reduction benefits discussed herein were evaluated for urban items (i.e., structures, automobiles, emergency costs, and NFIP operating costs), roads and streets, agricultural crop and noncrop items, timber values, and hunting leases. Total benefits with the implementation of Alternative 5 are displayed by category in Tables 7-64 through 7-70 by structural/nonstructural components.

REDUCTION IN FLOOD DAMAGES TO URBAN ITEMS

181. Inundation reduction benefits were evaluated for four categories of urban flood damage. These include flood damage reduction benefits to structures (residential and nonresidential) and automobiles. Cost reduction benefits include the reduction in the costs associated with emergency operations and FIA. Flood reduction benefits to urban items were estimated to total $2.7 million with the implementation of Alternative 5 (Table 7-64). These benefits are attributed to the structural component of the alternative only.

TABLE 7-64
INUNDATION REDUCTION BENEFITS TO URBAN ITEMS a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	2,703	0	2,703
2012 (Base Year) b/	2,703	0	2,703
2021	2,703	0	2,703
2031	2,703	0	2,703
2041	2,703	0	2,703
2051	2,703	0	2,703
2061	2,703	0	2,703
Average Benefits c/	2,703	0	2,703

a/ Values in 2005 dollars include benefits to structure damage reduction, flood insurance, automobiles, and emergency costs.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

REDUCTION IN FLOOD DAMAGES
TO AGRICULTURAL CROPS

182. Flood damage reduction benefits to agricultural crops are based on an analysis of practices on lands not incurring changes in cropping patterns due to the project. Refer to pages 7-26 through 7-49 for a detailed description of the crop evaluation procedures employed in this study. That detailed process yielded the benefits for 2005 for each reach, strata, etc. Agricultural prices utilized in this portion of the study were Fiscal Year 2005 current normalized prices.

183. Computations indicate that the base year (2012) flood damage reduction benefits to crops would be $9.9 million. Total average annual inundation reduction benefits to crops would be $11.1 million. Discounting of agricultural crop benefits was accomplished utilizing the computer discounting program ECON. Table 7-65 presents the flood damage reduction benefits to crops for Alternative 5. Total flood damage reduction benefits to this category was $11.1 million. Structural and nonstructural features comprised 58.6 and 41.4 percent, respectively, of the benefits.

TABLE 7-65
INUNDATION REDUCTION BENEFITS TO AGRICULTURAL CROPS a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	5,470	3,863	9,333
2012 (Base Year) b/	5,802	4,098	9,900
2021	6,234	4,403	10,637
2031	6,716	4,743	11,459
2041	7,197	5,083	12,280
2051	7,666	5,415	13,081
2061	8,148	5,755	13,903
Annual Benefits c/	6,534	4,615	11,149

a/ Values in 2005 dollars.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

REDUCTION IN FLOOD DAMAGES
TO AGRICULTURAL NONCROP ITEMS

184. Benefits from flood damage reduction to agricultural noncrop items were determined by deriving the difference between projected base (without-project) flood damage values and projected with-project (Alternative 5) damage values and annualizing the projected benefit values. Total average annual benefits to agricultural noncrop items of $6.0 million would accrue to the study area (Table 7-66). Approximately 39 percent of these benefits are attributable to the structural features of Alternative 5 and the remaining 61 percent is nonstructural benefits.

TABLE 7-66
INUNDATION REDUCTION BENEFITS TO AGRICULTURAL NONCROP ITEMS a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER AREA, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	1,948	3,040	4,988
2012 (Base Year) b/	2,067	3,225	5,292
2021	2,221	3,466	5,687
2031	2,393	3,733	6,126
2041	2,564	4,001	6,565
2051	2,731	4,262	6,993
2061	2,903	4,529	7,432
Annual Benefits c/	2,328	3,632	5,960

a/ Values in 2005 dollars.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

REDUCTION IN FLOOD
DAMAGES TO ROADS

185. Benefits from the reduction of flood damages to roads were estimated to be approximately $443,000 with Alternative 5 in place. These benefits are attributed to the structural component of the alternative only. Inundation reduction benefits to roads, which actually include benefit from flood damage reduction to roads and streets, are displayed in Table 7-67.

TABLE 7-67
INUNDATION REDUCTION BENEFITS TO ROADS a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	443	0	443
2012 (Base Year) b/	443	0	443
2021	443	0	443
2031	443	0	443
2041	443	0	443
2051	443	0	443
2061	443	0	443
Average Benefits c/	443	0	443

a/ Values in 2005 dollars.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

INUNDATION REDUCTION BENEFITS
TO TIMBER VALUES

186. Inundation reduction benefits accrue to timber values based on the reforestation of agricultural land that would have normally flooded without the implementation of the project. Timber benefits were assumed to be equal the cost of reforestation of the acres that will be converted from cropland to forest land with the implementation of Alternative 5. Inundation reduction benefits to timber values, presented in Table 7-68, were estimated to be $435,000. They are attributed to the nonstructural component of the alternative only.

TABLE 7-68
INUNDATION REDUCTION BENEFITS TO TIMBER a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	0	435	435
2012 (Base Year) b/	0	435	435
2021	0	435	435
2031	0	435	435
2041	0	435	435
2051	0	435	435
2061	0	435	435
Average Benefits c/	0	435	435

a/ Values in 2005 dollars.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

INUNDATION REDUCTION BENEFITS
TO HUNTING LEASES

187. Inundation reduction benefits were identified to accrue to the reforested lands from the sale of hunting leases based on practices of land management companies in the study area. Benefits from hunting leases were estimated to be approximately $638,000 with the implementation of Alternative 5 (Table 7-69). These benefits are attributed to the nonstructural component of the alternative only.

TABLE 7-69
INUNDATION REDUCTION BENEFITS TO HUNTING LEASES a/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER, MISSISSIPPI

Year	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
2005 (Current Year)	0	638	638
2012 (Base Year) b/	0	638	638
2021	0	638	638
2031	0	638	638
2041	0	638	638
2051	0	638	638
2061	0	638	638
Average Benefits c/	0	638	638

a/ Values in 2005 dollars.
b/ Estimated first full year of project operation. No benefits accrue prior to completion of project construction.
c/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

REDUCTION IN FLOOD DAMAGES TO
CATFISH FARMING OPERATIONS

188. As discussed previously, due to catfish access roads and tops of levees being at or above the 100-year elevation (100.3 feet, NGVD), no benefits were assumed to occur to catfish operations within the study area.

TOTAL AVERAGE ANNUAL
INUNDATION REDUCTION BENEFITS

189. Total average annual inundation reduction benefits are presented in Table 7-70 for all benefit categories with the implementation of Alternative 5. Benefit categories are also separated by the structural/nonstructural component. Total benefits in the Yazoo Backwater study area were calculated to be $21.3 million (before the application of employment benefits

discussed in the next section). In order from highest to lowest proportion, agricultural crops comprise the majority of the total benefits (52 percent) followed by agricultural noncrop (28 percent), urban items (13 percent), hunting leases (3 percent), roads (2.1 percent), and timber values (2 percent).

TABLE 7-70
INUNDATION REDUCTION AVERAGE ANNUAL BENEFITS
ALL CATEGORIES a/b/
WITH-PROJECT (ALTERNATIVE 5)
YAZOO BACKWATER, MISSISSIPPI

Category	Structural Features ($000)	Nonstructural Features ($000)	Total Benefits ($000)
Urban Items	2,703	0	2,703
Roads	443	0	443
Crop	6,534	4,615	11,149
Noncrop	2,328	3,632	5,960
Timber Value	0	435	435
Hunting Leases	0	638	638
Totals	12,008	9,320	21,328

a/ Values in 2005 dollars.
b/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year project life.

EMPLOYMENT BENEFITS

190. Construction of Alternative 5 within the study area will result in the creation of additional NED benefits to the project from employment of previously unemployed/underemployed labor resources in the area, thereby directly reducing unemployment and underemployment in the construction industry in this area. Also, project construction can contribute to an increase in the income of persons in associated industries (manufacturing, retail and wholesale trade, etc.),

which will be increased indirectly due to the interrelationship and interdependence of these industries. Current economic evaluation guidance indicates that both counties are areas eligible for this type of benefit since these counties have been identified as experiencing "substantial and persistent unemployment." The criteria for identification of these areas are contained in NED Benefit Evaluation Procedures, Section XI of the Water Resources Council's Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies. These criteria were formerly used by the Economic Development Administration in designating qualified areas under Subsection 1 of Title IV of the Public Works and Economic Development Act of 1965 (Public Law 89-136, as amended). These criteria state that substantial and persistent unemployment exist in an area when:

a. The current rate of unemployment, as determined by appropriate annual statistics for the most recent 12 consecutive months, is 6 percent or more and has averaged at least 6 percent for the qualifying time periods specified in paragraph b.

b. The annual average rate of unemployment has been at least (1) 50 percent above the national average for 3 of the preceding 4 calendar years, (2) 75 percent above the national average for 2 of the preceding 3 calendar years, or (3) 100 percent above the national average for 1 of the preceding 2 calendar years. The determinations of substantial and persistent unemployment were based on the unemployment rates for the study area during the following time periods provided by the Bureau of Labor Statistics (1994, 16.6 percent; 1995, 18.0 percent; 1996, 18.4 percent; 1997, 15.3 percent; 1998, 13.4 percent; 1999, 16.9 percent; 2000, 10.4 percent; 2001, 10.7 percent; 2002, 11.3 percent; 2003, 10.4 percent; 2004, 11.1 percent; 2005, 13.1 percent; and 2006, 10.0 percent).

191. Tables 7-71 and 7-72 are presented as an example of the procedure for calculation of employment benefits with construction of Alternative 5. Table 7-71 presents the employment benefits associated with the structural features of the recommended Alternative 5. Likewise, Table 7-72 presents employment benefits for the nonstructural features of Alternative 5. This same procedure was used for evaluation of employment benefits for all of the alternatives evaluated. As presented in Table 7-71, Step 1, the first cost of the structural feature for construction of Alternative 5 is $120,337,558. This cost excludes costs for lands, easements, rights-of-way, rehabilitation, and damages, engineering and design costs, and costs of construction management. In Step 1 of the calculation, the costs are allocated by construction year (2008-2011, 4 years). In Step 2, the costs are adjusted to reflect present-worth values which convert costs during the construction period to present values. Costs are presented for the

5-1/8 percent discount rate. Step 3 allocates the amount of the present-worth costs which is estimated to be expended for labor. For this alternative, 40 percent of the construction cost is estimated to be the costs for construction labor. In Step 4, the estimated onsite construction labor cost is allocated by skill level. In Step 5, the onsite labor costs by skill level are adjusted to reflect the amount applicable as a benefit to the unemployed/underemployed area labor resources. In Step 6, these employment benefits are annualized for the 50-year expected economic life, resulting in an estimated employment benefit of $1,007,000 annually for the structural components of Alternative 5. This same process was utilized to determine the employment benefits for the nonstructural features of Alternative 5, $81,000 annually. It must be noted that, although employment benefits are identified as valid NED benefits, they cannot and were not used in this report in the project reformulation, project sizing, or NED plan determination/selection. However, they are included in the presentation of a final benefit-cost analysis, as per current regulations and guidelines. Table 7-73 presents employment benefits for all of the detailed structural alternatives considered for both structural and nonstructural features.

TABLE 7-71
EMPLOYMENT BENEFITS
(STRUCTURAL COMPONENTS ONLY)
WITH ALTERNATIVE 5
YAZOO BACKWATER AREA, MISSISSIPPI
(5-1/8 Percent Discount Rate Analysis)

1. ESTIMATED CONSTRUCTION EXPENDITURES a/: = $120,337,558

Year	Percent	Construction Expenditures ($000)
2008	20	24,068
2009	14	16,847
2010	29	34,898
2011	37	44,525
Total	100	120,338

TABLE 7-71 (Cont)

2. PRESENT WORTH VALUE, CONSTRUCTION COSTS:

Year	Factors	Present Worth Values ($000)
2008	1.191163	28,668
2009	1.133092	19,089
2010	1.077852	37,615
2011	1.025305	45,652
Total	--	131,024

3. ESTIMATED ONSITE CONSTRUCTION LABOR COSTS ($000):

(Use 40 Percent) b/ $52,410

4. ALLOCATION OF ONSITE CONSTRUCTION LABOR COST BY SKILL LEVEL:

Skill Level	Percent c/	Amount ($000)
Skilled	60	31,446
Unskilled	30	15,723
Other	10	5,241
Total	100	52,410

TABLE 7-71 (Cont)

5. ALLOCATION TO UNEMPLOYED/UNDEREMPLOYED RESOURCES:

Skill Level	Percent c/	Amount ($000)
Skilled	30	9,434
Unskilled	47	7,390
Other	23	1,205
Total	100	18,029

6. ANNUAL BENEFIT VALUE ($000): = $1,007 d/

a/ 2005 price levels. Construction costs exclude costs for engineering and design, construction management, and lands and damages

b/ Based on similar work in region. Obtained from Design Branch, Cost Engineering Section.

c/ As prescribed by Section XI, ER 1105-2-100 (28 Dec 90), page 6-127.

d/ Annualized with use of 5-1/8 percent discount rate and an estimated 50-year project economic life.

TABLE 7-72
EMPLOYMENT BENEFITS
(NONSTRUCTURAL FEATURES ONLY)
WITH ALTERNATIVE 5
YAZOO BACKWATER AREA, MISSISSIPPI
(5-1/8 Percent Discount Rate Analysis)

1. ESTIMATED CONSTRUCTION EXPENDITURES a/: = $9,663,280

Year	Percent	Construction Expenditures ($000)
2008	20	1,933
2009	14	1,353
2010	29	2,802
2011	37	3,575
Total	100	9,663

2. PRESENT WORTH VALUE, CONSTRUCTION COSTS:

Year	Factors	Present Worth Values ($000)
2008	1.191163	2,302
2009	1.133092	1,533
2010	1.077852	3,021
2011	1.025305	3,666
Total	--	10,522

3. ESTIMATED ONSITE CONSTRUCTION LABOR COSTS ($000):

(Use 40 Percent) b/ $4,209

TABLE 7-72 (Cont)

4. ALLOCATION OF ONSITE CONSTRUCTION LABOR COST BY SKILL LEVEL:

Skill Level	Percent c/	Amount ($000)
Skilled	60	2,525
Unskilled	30	1,263
Other	10	421
Total	100	4,209

5. ALLOCATION TO UNEMPLOYED/UNDEREMPLOYED RESOURCES:

Skill Level	Percent c/	Amount ($000)
Skilled	30	758
Unskilled	47	593
Other	23	97
Total	100	1,448

6. ANNUAL BENEFIT VALUE ($000): = $81 d/

a/ 2005 price levels. Construction costs exclude costs for engineering and design, construction management, and lands and damages, land acquisition, and mitigation costs.
b/ Based on similar work in region. Obtained from Design Branch, Cost Engineering Section.
c/ As prescribed by Section XI, ER 1105-2-100 (28 Dec 90), page 6-127.
d/ Annualized with use of 5-1/8 percent discount rate and an estimated 50-year project economic life.

TABLE 7-73
SUMMARY
EMPLOYMENT BENEFITS a/
FOR NONSTRUCTURAL, STRUCTURAL, AND COMBINATION ALTERNATIVES
(BY STRUCTURAL AND NONSTRUCTURAL FEATURES)
YAZOO BACKWATER STUDY AREA

Alternative	Employment Benefits ($000) b/		
	Structural Features	Nonstructural Features	Total Benefits
Nonstructural Alternatives			
2	0	181	181
2A	0	118	118
2B	0	1,656	1,656
2C	0	166	166
Structural Alternatives			
3	1,007	188	1,195
Combination Alternatives			
4	1,007	54	1,061
5	1,007	81	1,088
6	1,007	118	1,125
7	1,007	181	1,188

NOTE: Employment benefits for structural features are the same for structural and combination alternatives because the pump features (size) were the same for all alternatives (14,000 cfs).

a/ Values in 2005 dollars. Do not include mitigation costs, land easement costs, or design and engineer costs in the computation of employment benefits; does include all other construction costs.

b/ Annualized at the current Federal interest rate of 5-1/8 percent and a 50-year economic life.

TOTAL ANNUAL BENEFITS

192. Table 7-74 presents the total annual benefits for each of the alternatives evaluated in the final array. Total benefits, excluding employment benefits, ranged from $14.8 million for Alternative 2, to $22.6 million for Alternatives 3 and 2B. Benefits for Alternative 5 totaled $21.3 million for the Yazoo Backwater study area. Alternatives 3 and 5 both consist of a 14,000-cfs pump with various operation, reforestation, and other features, as discussed on page 7-12.

SUMMARY OF TOTAL BENEFITS

193. Total average annual benefits for Alternative 5 were determined to be $21,328,000, excluding employment benefits (see Table 7-75). Total average annual benefits for Alternative 5, including employment benefits are determined to be $22,416,000. The above values are also based on the current Federal interest rate of 5-1/8 percent, a 50-year growth period, and an expected project economic life of 50 years. Table 7-75 present annual benefits for the Yazoo Backwater study area.

TABLE 7-74
ANNUAL BENEFITS FOR THE STRUCTURAL, NONSTRUCTURAL, AND COMBINATION ALTERNATIVES
BY FLOOD DAMAGE CATEGORY
FINAL ARRAY OF ALTERNATIVES
YAZOO BACKWATER REFORMULATION STUDY

Benefits	Nonstructural Alternatives				Structural Alternative	Combination Alternatives			
	Alternative 2	Alternative 2A (Includes Floodproofing)	Alternative 2B (Includes Ring Levees and Relocations)	Alternative 2C (Includes Relocations)	Alternative 3 (With 14,000-cfs Pump)	Alternative 4 (With 14,000-cfs Pump)	Alternative 5 (With 14,000-cfs Pump)	Alternative 6 (With 14,000-cfs Pump)	Alternative 7 (With 14,000-cfs Pump)
STRUCTURAL BENEFITS ($000) a/b/c/									
Structures	0	0	0	0	2,769	2,461	2,154	1,984	1,546
Flood Insurance Costs	0	0	0	0	165	155	147	129	120
Automobiles	0	0	0	0	369	338	298	276	222
Emergency Costs	0	0	0		132	118	104	95	73
Public Roads	0	0 d/	0	0 d/	711	602	443	375	274
Agricultural Crops	0	0	0	0	9,554	7,970	6,534	5,153	3,235
Agricultural Noncrop	0	0	0	0	4,019	3,164	2,328	1,825	1,063
SUBTOTAL	0	0	0	0	17,719	14,808	12,008	9,837	6,533
NONSTRUCTURAL BENEFITS ($000) a/b/c/									
Structures	0	4,416	4,416	4,416	0	0	0	0	0
Flood Insurance Costs	0	248	248	248	0	0	0	0	0
Automobiles	0	561	561	561	0	0	0	0	0
Emergency Costs	0	206	206	206	0	0	0	0	0
Public Roads	0	0 d/	1,102	0 d/	0	0	0	0	0
Agricultural Crops	7,010	5,595	8,943	6,896	2,745	3,300	4,615	5,595	7,010
Agricultural Noncrop	5,407	4,403	6,633	5,318	2,156	2,598	3,632	4,403	5,407
Timber Values	972	636	206	894	0	291	435	636	972
Hunting Leases	1,403	918	298	1,290	0	420	638	918	1,403
SUBTOTAL	14,792	16,983	22,613	19,829	4,901	6,609	9,320	11,552	14,792
TOTAL STRUCTURAL AND NONSTRUCTURAL	14,792	16,983	22,613	19,829	22,620	21,417	21,328	21,389	21,325

a/ 2005 dollar values presented in thousands.
b/ Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.
c/ All structural, nonstructural, and combination structural/nonstructural alternatives include reforestation.
d/ There are no road benefits attributable to the floodproofing and relocations measures provided by Alternatives 2A and 2C.
e/ Projected and annual benefits for the recommended alternative are displayed in Table 7-75.

TABLE 7-75
SUMMARY OF PROJECTED AND ANNUAL BENEFITS a/
WITH ALTERNATIVE 5
YAZOO BACKWATER AREA, MISSISSIPPI
($000)

Year	Benefit Categories											
	Inundation Reduction										Employment Benefits a/	Total
	Structures	Emergency Costs	Flood Insurance Costs	Automobile Damages	Public Roads and Bridges	Agricultural Crops	Agricultural Noncrops	Timber Values	Hunting Leases	Subtotal		
2005 b/	2,154	104	147	298	443	9,332	4,988	435	638	18,540	1,088	19,628
2012 c/	2,154	104	147	298	443	9,900	5,292	435	638	19,411	1,088	20,499
2021	2,154	104	147	298	443	10,637	5,687	435	638	20,543	1,088	21,631
2031	2,154	104	147	298	443	11,459	6,126	435	638	21,804	1,088	22,892
2041	2,154	104	147	298	443	12,280	6,565	435	638	23,064	1,088	24,152
2051	2,154	104	147	298	443	13,081	6,993	435	638	24,293	1,088	25,381
2061	2,154	104	147	298	443	13,903	7,432	435	638	25,554	1,088	26,642
Annual Benefits d/	2,154	104	147	298	443	11,149	5,960	435	638	21,328 e/	1,088	22,416

a/ 2005 dollar values presented in thousands.
b/ Current year. No benefits estimated to accrue to impacted area prior to completion of construction of the NED/EQ plan of improvement.
c/ Base year of project, first full year of project operation—first year in which full benefits to project accrue.
d/ Annualized at the current Federal interest rate of 5-1/8 percent using a 50-year period of analysis.
e/ Recommended alternative benefits by category are displayed in Table 7-74.

SECTION 6 - COSTS

COSTS (ALL DETAILED STRUCTURAL AND NONSTRUCTURAL ALTERNATIVE ALTERNATIVES)

FIRST COSTS

194. Construction first costs; i.e., the costs of building the project, for the final array of alternatives evaluated in detail are presented in Table 7-76 to facilitate the alternative evaluation/selection process. Estimated total first costs for the various alternatives range from $480.1 million for Alternative 2C to $192.8 million for Alternative 4. All first costs are Federal costs with no non-Federal costs required for project construction. First costs are based on October 2005 price levels. Engineering and design and construction management costs are estimated based on costs from the engineering organizations for each technical component necessary for the construction and operation of the construction alternatives. Detailed cost information is contained in Appendix 6.

ANNUAL COSTS

195. Annual costs for all alternatives are summarized in Table 7-77. Estimates of annual costs associated with construction of structural and nonstructural alternatives evaluated in detail were based on an expected project economic life of 50 years and applying the current Federal discount rate of 5-1/8 percent. Interest and sinking fund costs reflect the estimated amortization costs. Costs for interest during construction, which account for the cost of capital incurred during the construction period, are included in total investment costs. The estimated cost of operation and maintenance is based on previous annual cost expenditures for similar work for this region. Annual rehabilitation costs are also included. Pump station replacement costs are estimated to be required every 35 years during the expected economic life of each alternative. Pump rehabilitation costs occur the same year for each alternative. Project-related natural resource fish, wildlife, and wetlands losses are not included in the annual costs, but are included in the assessment of net values (gains and losses) in the associated mitigation analysis (Appendix 1).

TABLE 7-76
FIRST COSTS BY MAJOR FEATURE
FINAL ARRAY OF ALTERNATIVES—CURRENT ANALYSES
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Alternative 1 b/	Alternative 2	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Structural Components ($000) a/										
Lands and Damages	N/A	--	--	--	--	151	151	151	151	151
Relocations	N/A	--	--	--	--	3,538	3,538	3,538	3,538	3,538
Pumping Plant (Diesel)	N/A	--	--	--	--	107,566	107,566	107,566	107,566	107,566
Levee and Floodwalls	N/A	--	--	--	--	1,142	1,142	1,142	1,142	1,142
Channels and Canals	N/A	--	--	--	--	5,004	5,004	5,004	5,004	5,004
Floodway Control and Diversion Structures	N/A	--	--	--	--	0	0	0	0	0
Building, Grounds, and Utilities	N/A	--	--	--	--	1,720	1,720	1,720	1,720	1,720
Permanent Operating Equipment	N/A	--	--	--	--	1,367	1,367	1,367	1,367	1,367
Mitigation c/	N/A	--	--	--	--	86,702	29,268	15,496	5,065	4,994
Planning, Engineering, and Design	N/A	--	--	--	--	19,468	19,468	19,468	19,468	19,468
Construction Management	N/A	--	--	--	--	7,207	7,207	7,207	7,207	7,207
Total Structural Components	N/A	--	--	--	--	233,865	176,431	162,659	152,228	152,157
Nonstructural Components ($000) a/										
Lands and Damages	N/A	406,726	361,467	120,378	458,025	--	7,708	45,574	93,078	207,292
Levees and Floodwalls	N/A	--	--	188,764	--	--	--	--	--	--
Fish and Wildlife Facilities	N/A	21,620	14,147	9,214	19,883	--	6,465	9,663	14,147	21,620
Mitigation	N/A	--	--	33,407	--	--	--	--	--	--
Planning, Engineering, and Design	N/A	1,435	1,435	43,322	1435	--	1,435	1,435	1,435	1,435
Construction Management	N/A	763	763	21,661	763	--	763	763	763	763
Total Nonstructural Components	N/A	430,544	377,812	416,746	480,105	--	16,371	57,435	109,423	231,110
Total First Costs	N/A	430,544	377,812	416,746	480,105	233,865	192,802	220,094	261,651	383,267

NOTE: Totals may not add due to rounding.
a/ Costs reflect October 2005 price levels presented in thousands.
b/ Alternative 1 is the no-action alternative.
c/ Nonstructural cost to obtain a no-net loss in habitat types.

TABLE 7-77
FIRST COSTS AND ANNUAL COSTS a/b/c/
FINAL ARRAY OF ALTERNATIVES—CURRENT ANALYSES
YAZOO BACKWATER AREA, MISSISSIPPI
($000)

Item	Alternative 1 d/	Alternative 2	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
FIRST COST										
Structural Features e/	N/A	0	0	0	0	233,865	176,431	162,659	152,228	152,157
Nonstructural Features e/	N/A	430,544	377,812	416,746	458,025	0	16,371	57,435	109,423	231,110
TOTAL FIRST COSTS	N/A	430,544	377,812	416,746	458,025	233,865	192,802	220,094	261,651	383,267
INTEREST DURING CONSTRUCTION										
Structural Features	N/A	0	0	0	0	12,687	10,687	10,687	10,687	10,687
Nonstructural Features	N/A	1,920	1,256	17,581	1,766	0	574	858	1,256	1,920
COMBINED TOTAL INTEREST DURING CONSTRUCTION	N/A	1,920	1,256	17,581	1,766	12,687	11,261	11,545	11,943	12,607
TOTAL INVESTMENT										
Structural Features	N/A	0	0	0	0	246,552	187,118	173,346	162,915	162,844
Nonstructural Features	N/A	432,464	379,068	434,327	481,871	0	16,945	58,293	110,679	233,030
COMBINED TOTAL INVESTMENT	N/A	432,464	379,068	434,327	481,871	246,552	204,063	231,639	273,594	395,874
ANNUAL COSTS										
INTEREST AND SINKING FUND										
Structural Features	N/A	0	0	0	0	13,767	10,448	9,679	9,097	9,093
Nonstructural Features	N/A	24,148	21,166	22,387	26,907	0	946	3,255	6,180	13,012
COMBINED INTEREST AND SINKING	N/A	24,148	21,166	22,387	26,907	13,767	11,394	12,934	15,277	22,105
OPERATION AND MAINTENANCE (O&M)										
STRUCTURAL FEATURES										
Pump Maintenance	N/A	0	0	0	0	1,056	1,056	1,056	1,056	1,056
Pump Operation (Energy)	N/A	0	0	0	0	1,155	771	557	433	232
Major Rehabilitation, Pumps	N/A	0	0	0	0	393	393	393	393	393
Mitigation Maintenance	N/A	0	0	0	0	1,657	54	21	f/	0
TOTAL STRUCTURAL O&M	N/A	0	0	0	0	4,261	2,274	2,027	1,882	1,681

TABLE 7-77 (Cont)

Item	Alternative 1 d/	Alternative 2	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
NONSTRUCTURAL FEATURES										
Monitoring Reforested Lands	N/A	249	163	53	229	0	20	90	163	249
O&M on Levees	N/A	0	0	3,397	0	0	0	0	0	0
Mitigation on Levees	N/A	0	0	1,865	0	0	0	0	0	0
TOTAL NONSTRUCTURAL O&M	N/A	249	163	5,315	229	0	20	90	163	249
COMBINED O&M COSTS	N/A	249	163	5,315	229	4,261	2,294	2,117	2,045	1,930
TOTAL ANNUAL COSTS	N/A	24,397	21,329	27,702	27,136	18,028	13,688	15,051	17,322	24,035

NOTE: Totals may not add due to rounding.

a/ October 2005 price levels presented in thousands.

b/ Based on an interest rate of 5-1/8 percent, an estimated construction period of 4 years for all alternatives, and a 50-year project life.

c/ Annual fish and wildlife losses are incorporated in the mitigation analyses.

d/ Alternative 1 is the no-action alternative.

e/ Includes mitigation cost, if required.

f/ O&M less than $200 is included with total nonstructural O&M.

SELECTION OF RECOMMENDED ALTERNATIVE

196. Selection of the alternative which maximizes net benefits (alternative with greatest amount of excess benefits over costs) accomplishes the current guidance for addressing the NED plan of improvement. Data at the current Federal discount rate of 5-1/8 percent were used to select the optimum plan, the plan with the greatest net benefits, from the final alternatives were compared.

197. Table 7-78 summarizes the results of the reformulation/evaluation analyses for all structural and nonstructural alternatives evaluated in the final array. It includes a summary of the standard economic analyses—a comparison of costs, benefits, benefit-cost ratios, and excess benefits over costs. Based on this criteria alone, Alternative 4 was identified as the NED plan, with excess benefits over costs of $8,908,000, including all benefit categories. However, Alternatives 4 and 5 were very close in terms of NED. The Vicksburg District conducted an incremental analysis to consider environmental quality factors for Alternatives 4 and 5, as well as other combination alternatives that satisfied NED criteria. Based on this incremental analysis, Alternative 5 produces more environmental benefits than Alternative 4. Thus, Alternative 5 was selected as the combination NED/EQ plan and the recommended alternative. Environmental benefits evaluated for the Yazoo Backwater study area are summarized in "SECTION 8 – ADDITIONAL ECONOMIC ANALYSES" under "RECOMMENDED ALTERNATIVE SELECTION" (pages 7-119 through 7-124). For more details on rationale for selecting Alternative 5 as the recommended alternative, see the Main Report.

The Recommended Alternative—Alternative 5

198. First costs for the recommended alternative--Alternative 5--are estimated at $220.1 million with annual costs of $15.1 million including costs for mitigation and annual benefits of $21.3 million excluding employment benefits ($22.4 million including employment benefits). The excess benefits over costs for Alternative 5 are $7.4 million and the benefit-cost ratio is 1.5 including employment benefits. The excess benefits over costs are $6.3 million excluding employment benefits with a benefit-cost ratio of 1.4 for Alternative 5. Results of the incremental analysis of environmental benefits show Alternative 5 to produce more HUs in aquatics at the least cost per unit, overall, than any of the other alternatives in the final array.

TABLE 7-78
SUMMARY OF THE STANDARD ECONOMIC ANALYSIS
FIRST COSTS, ANNUAL COSTS, ANNUAL BENEFITS,
EXCESS BENEFITS OVER COSTS, AND BENEFIT-COST RATIOS
FINAL ARRAY OF ALTERNATIVES
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Nonstructural Alternatives				Structural Alternative	Combination of Alternatives			
	Alternative 2	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
First Costs ($000) b/	430,544	377,812	416,746	480,105	233,865	192,802	220,094	261,651	383,267
Annual Costs ($000) a/b/	24,183	21,542	27,573	25,026	18,028	13,688	15,051	17,322	24,035
Annual Benefits ($000) b/									
All Benefit Categories b/	14,973	17,101	24,269	19,995	23,815	22,478	22,416	22,514	22,513
Benefits Excluding Employment Benefits	14,792	16,983	22,613	19,829	22,620	21,417	22,328	21,389	21,325
Excess Benefits Over Costs ($000)									
All Benefit Categories b/	-9,424	-4,228	-3,433	-7,141	5,787	8,790	7,365	5,192	-1,522
Benefits Excluding Employment Benefits	-9,605	-4,346	-5,089	-7,307	4,592	7,729	6,277	4,067	-2,710
Benefit-Cost Ratio									
All Benefit Categories	.61	.80	.88	.74	1.3	1.6	1.5	1.3	.94
Benefits Excluding Employment Benefits	.61	.80	.82	.73	1.3	1.6	1.4	1.2	.89

a/ Benefits and costs (in 2005 prices) are annualized at the current Federal interest rate of 5-1/8 percent and a 50-year project economic life.
b/ October 2005 price levels. Mitigation costs are included.

ECONOMIC ANALYSIS

Summary of Benefits

199. Annual benefits for the recommended alternative (summarized from Tables 7-74 through 7-75) are presented in Table 7-79. Annual benefits accruing as a result of implementation of Alternative 5 for all benefit categories total $22,416,000.

TABLE 7-79
SUMMARY OF ANNUAL BENEFITS, ALTERNATIVE 5 a/
YAZOO BACKWATER AREA, MISSISSIPPI
(5-1/8 Percent Interest Rate Analysis)

Benefit Category	Annual Benefits ($000)
Inundation Reduction	
Nonagricultural	
Structures	2,154
Emergency Costs	104
Flood Insurance Program Operating Costs	147
Automobiles	298
Public Roads	443
Subtotal	3,233
Agricultural	
Crops	11,149
Noncrop	5,960
Subtotal	17,109
Other Categories	
Timber Values	435
Hunting Leases	638
Subtotal (Flood Control Benefits)	21,328
Employment	1,088
TOTAL	22,416

a/ Values in 2005 dollars.

SECTION 8 - ADDITIONAL ECONOMIC ANALYSES

RECOMMENDED ALTERNATIVE SELECTION – A BALANCE OF ECONOMIC AND ENVIRONMENTAL BENEFITS

GENERAL

200. In accordance with Federal regulations for water resources planning, evaluations were conducted to develop alternative flood protection plans that would provide a balance between economic development and environmental enhancement for water resources improvements in the Yazoo Backwater study area. Thus, the purpose of this study was to determine the best plan overall in terms of flood damage reduction, NED, and EQ. The NED plan is the optimum plan economically (i.e., the plan that produces the greatest excess benefits over costs or net benefits); and the EQ plan is the environmental quality plan--the plan that protects the quality of the environment in water resources planning – resources such as fish and wildlife habitat, water quality, streamflow, cultural resources, and/or wetlands. In accordance with ER 1165-2-28 (30 April 1980), the EQ plan "must enhance, preserve, or restore the environment of the study area." Other guidance can be found in ER 1105-2-100 and Policy Guidance letter #24 (USACE, 1991).

201. The results of the comprehensive economic evaluation identified Alternative 4 as the NED plan, followed closely by Alternative 5. However, Alternative 5 was recognized as the EQ plan because it provided more aquatics benefits at a lower cost per HU than Alternative 4. Thus, further scrutiny was necessary in identification of the best combined NED/EQ plan. Based on the differential in benefits and percentage of flood damages reduced, Alternative 5 was selected to be the recommended alternative because it was deemed the most effective alternative overall in regard to both economic development and environmental considerations of water resources improvements in the Yazoo Backwater study area. A discussion of this conclusion is presented in the following paragraphs.

ENVIRONMENTAL PLANNING

202. Flood reduction alternatives evaluated in the Yazoo Backwater study area comprised both structural and nonstructural measures--with the nonstructural measures including considerations for reforestation and mitigation. However, there is not a common measurement for comparing the nonmonetary benefits with the monetary costs of environmental plans. Thus, cost effectiveness and incremental cost analyses were used to assist in the decisionmaking process.

203. First, the cost effectiveness analysis was conducted to ensure that the "least cost" solution was identified for each possible level of environmental output. In the Yazoo Backwater evaluation, qualitative assessments of environmental impacts were conducted for four types of environmental resources to generate numeric values for those environmental functions. Other environmental resources were evaluated qualitatively. This appendix utilized the outputs of the qualitative environmental evaluations. These included wetlands measured in functional capacity units (FCU), terrestrial measured by average annual habitat units (AAHU), waterfowl measured by duck-use days (DUD), and aquatics measured in AAHUs. Then, the incremental cost analysis of the "least cost" solution was conducted to reveal changes in costs per HU for increasing levels of environmental output. These procedures are outlined in IWR Report 94-PS-2, "Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps" (October 1994).

THE INCREMENTAL ANALYSIS

204. A modified incremental environmental analysis was conducted to determine the most cost effective alternative from an environmental benefit perspective for the Yazoo Backwater evaluation. This is a "modified" incremental analysis because this analysis was conducted to demonstrate that deviation from the NED plan is warranted and in the best interest of the nation in regard to implementing water resources improvements in the Yazoo Backwater study area.

205. Table 7-80 displays the average annual cost for the nonstructural features for Alternatives 4, 5, and 6. These are the three alternatives in the final array identified to be within the closest proximity to the NED plan and exhibit the "least" total average annual costs. For these alternatives, the average annual costs of nonstructural features ranged from a low of $966,000 with Alternative 4 to a high of $6.3 million with Alternative 6. Nonstructural Alternatives 2 through 2C and structural Alternatives 3 and 7 were excluded from the incremental analysis of environmental benefits. Alternatives 2 through 2C and Alternative 7 were not economically justified in the traditional NED analysis and since Alternative 3 is a "mitigation only" alternative, it has no increase in HUs. Alternative 3 only provides for the status quo on environmental resources because it achieves a no-net loss of environmental resources based on compensatory mitigation.

TABLE 7-80
AVERAGE ANNUAL NONSTRUCTURAL COSTS BY HABITAT TYPE a/b/c
AND BY SELECTED ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Habitat Type	Environmental Benefits by Alternative								
	Alternative 4			Alternative 5			Alternative 6		
	Annual Costs ($000)	Units d/	Cost Per Unit ($)	Annual Costs ($000)	Units d/	Cost Per Unit ($)	Annual Costs ($000)	Units d/	Cost Per Unit ($)
Wetlands (FCU)	966	6,712	9.99	3,345	172,525	19.39	6,343	264,164	24.01
Terrestrial (AAHU)	966	52,355	18.45	3,345	78,188	42.78	6,343	114,534	55.38
Waterfowl (DUD)	966	489,408	1.97	3,345	977,406	3.42	6,343	1,754,222	3.62
Aquatics (AAHU)	966	913	1,058.05	3,345	5,850	571.79	6,343	10,889	582.51

a/ Values presented in 2006 dollars.
b/ Costs of nonstructural features annualized at the current Federal interest rate of 5-1/8 percent over a 50-year economic project life.
c/ Annual costs for the nonstructural component are presented in Table 13 of the Main Report and include the cost of land and reforestation, which applies to all environmental resource categories.
d/ Net project habitat gains from all features.

206. The four habitat types analyzed during this analysis--wetlands, terrestrial, waterfowl, and aquatics--and their corresponding number of units are shown for each alternative in Table 7-80. Since HUs cannot be integrated between habitat types, outputs for each habitat type must be scrutinized individually as well as compared with incremental benefits from the entire array of habitat of outputs. For example, with Alternative 4, the average cost per aquatics (in AAHUs) was determined to be $1,058.05 ($966,000 ÷ 913 AAHUs). This same process was utilized to determine the average cost per unit by habitat type for all three alternatives. As a result, Alternative 5 was identified to produce more units at a lower cost per unit for aquatics AAHUs and is the resource requiring the most reforestation.

207. It is important to note that out of the four habitat types, the aquatics habitat type is the controlling resource in determining reforestation requirements. This single category alone influences the deviation from Alternative 4 to Alternative 5 in the analysis of environmental outputs. As recognized in Table 7-80, the cost of the aquatics AAHUs is noteworthy because the difference in the cost per AAHU was nearly $500 less with Alternative 5. The cost per unit of the aquatics AAHUs for Alternative 4 was estimated to be $1,058.05 as compared to $571.79 per unit for Alternative 5.

208. Table 7-81 provides the results of the incremental cost analysis, which illustrates the cost per HU increase between alternatives, and further substantiates the change from Alternative 4 to Alternative 5. The average annual nonstructural cost for Alternative 5 increased by $2,379,000 over Alternative 4's average annual costs (i.e., $3,345,000 for Alternative 5 less $966,000 for Alternative 4). Likewise, the average annual cost for the nonstructural features of Alternative 6 increased by $2,998,000 (i.e., $6,343,000 for Alternative 6 less $3,345,000 for Alternative 5).

TABLE 7-81
AVERAGE ANNUAL NONSTRUCTURAL INCREMENTAL COSTS a/b/
ABOVE THE NED ALTERNATIVE
BY HABITAT TYPE AND BY SELECTED ALTERNATIVE
YAZOO BACKWATER AREA, MISSISSIPPI

Habitat Type	Environmental Benefits by Alternative								
	Alternative 4 c/			Alternative 5 d/			Alternative 6 e/		
	Annual Costs ($000)	Units	Cost Per Unit ($)	Annual Costs ($000)	Units	Cost Per Unit ($)	Annual Costs ($000)	Units	Cost Per Unit ($)
Wetlands (FCU)	0	0	0	2,379	75,813	31.38	2,998	91,639	32.72
Terrestrial (AAHU)	0	0	0	2,379	25,833	92.13	2,998	36,346	82.49
Waterfowl (DUD)	0	0	0	2,379	487,998	4.88	2,998	776,816	3.86
Aquatics (AAHU)	0	0	0	2,379	4,937	481.87	2,998	5,039	594.96

a/ Values presented in 2005 dollars.
b/ Costs of nonstructural features annualized at the current Federal interest rate of 5-1/8 percent over a 50-year economic project life.
c/ NED alternative.
d/ Alternative 5 is compared to Alternative 4.
e/ Alternative 6 is compared to Alternative 5.

209. In regard to additional costs per unit (Table 7-81), Alternative 5 produces 4,937 more in aquatics AAHUs than Alternative 4 at an incremental cost of $481.87 per unit. Implementation of Alternative 5 reduces the incremental cost of aquatics and thus, was the deciding factor in deviating from Alternative 4 to Alternative 5. In addition, Alternative 6 was removed from the array because the incremental costs per HU for Alternative 6 for aquatics (AAHUs) were higher per unit than the incremental costs per HU for Alternative 5. As previously discussed, aquatic spawning habitat is the limiting resource and therefore, is the controlling cost account.

SUMMARY OF ENVIRONMENTAL BENEFITS

210. Table 7-82 presents a comparison of the results of NED and EQ evaluations for Alternatives 4 and 5. As shown, Alternative 5 has excess benefits over costs of $6.3 million, or $1.5 million less than Alternative 4 with $7.8 million. Average annual costs increase by approximately $1.4 million with Alternative 5 ($15.1 million) versus Alternative 4 ($13.7 million). Results of the benefit-cost analysis yield benefit-cost ratios within very close proximity--1.4 to 1 for Alternative 5 and 1.6 to 1 for Alternative 4. Total average annual benefits

were estimated to be $21.3 million for Alternative 5 as compared to $21.5 million for Alternative 4, a difference of only $61,000 or less than 0.3 percent of the total benefits. Alternative 5 reduces existing flood damages by 75.2 percent overall and by 92 percent for agricultural items with the project implementation. Agricultural flood damages comprise the majority of the damages from backwater flooding. In comparison, Alternative 4 reduces existing flood damages by 75.1 percent overall and by 87 percent for agricultural items.

TABLE 7-82
SUMMARY COMPARISON OF ALTERNATIVE 4 VERSUS ALTERNATIVE 5
BY RESULTS OF NED/EQ ANALYSES
YAZOO BACKWATER AREA, MISSISSIPPI

Item	Comparison of NED/EQ Results a/	
	Alternative 4	Alternative 5
Results of the NED Analysis (Monetary Impacts)		
Average Annual Costs ($000)	13,688	15,051
Difference Between Alternatives ($000)	--	*+1,363*
Average Annual Benefits ($000) b/	21,417	21,328
Difference Between Alternatives ($000)	--	*-89 c/*
Benefits Cost Ratio	1.6	1.4
Difference Between Alternatives	--	*-.2*
Excess Benefits over Costs ($000)	7,729	6,277
Difference Between Alternatives ($000)	--	*-1,452*
Total Flood Damage Reduction (FDR) (%)	75.1	75.2
Agricultural FDR (%)	86.8	91.7
Results of the Incremental Analysis of Environmental Benefits (Nonmonetary Impacts in HUs)		
Wetlands (FCUs)	96,712	172,525
Difference Between Alternatives	--	*+75,813*
Terrestrial (AAHUs)	52,355	78,188
Difference Between Alternatives	--	*+ 25,833*
Waterfowl (DUDs)	489,408	977,406
Difference Between Alternatives	--	*+487,998*
Aquatic (AAHUs)	913	5,850
Difference Between Alternatives	--	*+4,937*

a/ Values presented in 2005 dollars, including all costs associated with the construction and operation of these alternatives, and annualized at the current Federal interest rate of 5-1/8 percent over a 50-year economic project life.

b/ Excludes employment benefits, but includes all other categories.

c/ Less than 0.5 percent difference.

211. Environmentally, Alternative 5 produces significantly more aquatics AAHUs at a lower cost per unit than Alternative 4, as displayed in Table 7-80. In the overall comparison of environmental outputs of Alternative 5 over Alternative 4 (Table 7-82), Alternative 5 produces 86 percent more in wetlands FCUs than Alternative 4; 49 percent more in terrestrial AAHUs; 100 percent more in waterfowl DUDs; and 541 percent more in aquatics HUs. Therefore, since Alternative 5 produces almost the exact same monetary benefits as Alternative 4, but generates more aquatics AAHUs at lower costs, Alternative 5 was identified as the best overall NED/EQ plan for implementation in the Yazoo Backwater study area. As a result, Alternative 5 was selected as the recommended alternative for reducing flood damages while providing environmental enhancement in the study area.

NONSTRUCTURAL FLOODPROOFING CONSIDERATIONS

212. Additional economic analyses in the reformulation study included the examination of implementing nonstructural measures in the Yazoo Backwater study area. The Water Resources Development Act of 1986 requires that any Federal agency planning projects involving flood protection shall give full and equal consideration to nonstructural alternatives to prevent or reduce flood damages. Nonstructural alternatives include utilization of measures such as floodproofing, structure raising, relocation, acquisition/demolition, and/or the construction of small walls to provide flood protection/reduction to residential and other structures from a 100-year frequency flood event.

213. Several nonstructural options were evaluated for protection of the homes, businesses, and other structures located in the study area flood plain to determine the economic feasibility of these measures. Comprehensive nonstructural analyses were conducted in the 2000 reformulation study whereby the implementation cost for each nonstructural category was calculated by structure and compared to the corresponding flood protection benefit. However, none of the nonstructural flood reduction measures were determined to be economically feasible.

214. During the current analysis, approximately 1,576 structures were recognized to incur damages in the 100-year frequency flood plain. Thus, additional nonstructural options relative to protecting these structures were identified and evaluated. Nonstructural measures to protect these structural properties are included in nonstructural Alternatives 2A, 2B, and 2C, which also include environmental reforestation features. Alternative 2A consists of floodproofing residential and nonresidential buildings in the 100-year flood plain; Alternative 2B, the construction of 14 ring levees and the purchase/removal of any buildings outside the protected areas of the ring levees; and Alternative 2C, the purchase/removal of buildings in the flood plain. Table 7-83 displays the results of the nonstructural floodproofing measures evaluated during the reformulation study in terms of costs, benefits, and benefit-cost ratios.

TABLE 7-83
ECONOMIC ANALYSIS SUMMARY
OF NONSTRUCTURAL MEASURES a/b/
EXISTING (WITHOUT-PROJECT) CONDITIONS
YAZOO BACKWATER AREA, MISSISSIPPI

Alternative	No. of Structures	First Cost ($000)	Annual Cost ($000)	Annual Benefit a/ ($000)	Benefit-Cost Ratio
Total Area					
Alternative 2A – Structure Raising	1,363	377,812	21,329	16,983	0.80
Alternative 2B – Ring Levees d/	1,308	416,746	27,702	10,343	0.37
Alternative 2C – Acquisition/ Demolition	1,576	480,105	27,136	19,829	0.73

a/ Values in 2005 dollars.
b/ Nonstructural analyses based on 5-1/8 percent discount rate and existing conditions.
c/ Excludes employment benefits.
d/ 179 structures outside the ring levees will be acquired and demolished.

215. The floodproofing feature of Alternative 2A includes “structure raising” of 1,363 residential and nonresidential buildings in the flood plain. It should be noted that the number of structures floodproofed with this alternative differs from the number of structures incurring damage from a 100-year event. The reason for this difference is that the depth-damage curve begins computing flood damage when water is within 2 feet of the FFE. Floodproofing costs were computed for all structures that had FFEs within 1 foot of the existing 100-year event. This measure raises structures above the floodwaters enough that the structure FFE cannot be damaged by the design flood event. Raising a structure is considered a viable alternative for most structures according to FEMA Report No. 312, “Homeowner’s Guide to Retrofitting: Six Ways to Protect Your House from Flooding” (June 1998). This scenario consists of providing 1 foot of freeboard between the design flood event and the FFE of the structure. The cost of structure raising is estimated based on the construction material of each structure. Costs include extending the foundation and utilities and miscellaneous items such as sidewalks and driveways, but exclude the placement of new fill or concrete slab in a basement. The costs applied were on 1-foot intervals beginning at the 2-foot elevation (including freeboard). Costs for raising structures also includes relocation costs under Public Law 91-64 in which individuals (occupants) are compensated up to $25,000 per structure in benefits for each structure. Among the costs attributed to structure raising are moving, storage, rent differential, temporary housing, and compensation for relocation. Based on estimates from the Vicksburg District Real Estate Division and the FEMA Report, the cost per square foot of raising a structure from 1 to 2 feet above the FFE was estimated to be $21 for a frame with crawlspace/basement; $43 for a brick with crawlspace/basement; and $58 for both frame and brick on slabs. The cost of raising a mobile home up to 4 feet is $3,000. All values are expressed in October 2005 dollars. In addition, real estate estimates include a 25 percent contingency on nonstructural floodproofing costs.

216. Alternative 2B includes the construction of 14 ring levees and the purchase and removal of 194 residential and nonresidential buildings unprotected by the ring levees. According to FEMA Report No. 312, the purchase of property is considered an effective and feasible mitigation option for buildings whose estimated value is less than the costs of other

floodproofing mitigation options or in cases in which other mitigation options are considered infeasible or undesirable. Buyout costs are based on estimated structure value plus an estimated land cost. The average structure value is $43,000 for residential and nonresidential buildings in the Yazoo Backwater study area. These values represent average depreciated replacement values for type of each structure. In addition, a separate cost of $4,300 (in 2005 dollars) is added for each structure to account for demolition, debris removal, and landfill costs (including hazardous waste materials). Costs for buyouts also include relocation costs (benefits) of up to $25,000 per structure under Public Law 91-646 discussed in the previous paragraph. In addition, real estate estimates include a 25 percent contingency on nonstructural floodproofing costs.

217. The relocation feature of Alternative 2C involves the purchase, removal, and relocation of 1,576 residential and nonresidential buildings in the flood plain. The evaluation is the same as with Alternative 2B above. Costs for buyouts also include relocation costs (benefits) of up to $25,000 per structure under Public Law 91-646 discussed in the previous paragraphs. In addition, real estate estimates include a 25 percent contingency on nonstructural floodproofing costs.

SENSITIVITY ANALYSES

SECTION 219 SENSITIVITY ANALYSIS

218. Section 219 of WRDA 99 directs that the Corps calculate benefits for nonstructural flood damage reduction using methods similar to those used in calculating benefits for structural projects, including similar treatment in calculating the benefits from losses avoided. Currently, Army Corps of Engineers Planning Guidance directs the use of only the externalized portion of flood damages prevented in calculating benefits for evacuation projects. For evacuation projects, current guidance explicitly assumes that the internalized portion of flood damages is reflected in reduced market value of the properties used in the calculation of evacuation costs (i.e., the cost of buyout of the flood plain). This internalized portion includes uninsured losses, flood insurance premiums, any deductible, and agents fees. Typically, externalized flood damages are developed by calculating total flood damages using the standard techniques used in structural flood control projects. Then the internalized portion of flood damages are subtracted. The subtraction of the internalized portion of flood damages is intended to remove potential double counting from the benefit-cost calculation.

219. To accommodate the Section 219 analysis in the current study, an update of the Section 219 evaluation from the 2000 draft Yazoo Backwater Reformulation Study was performed using current 2005 land use, commodity prices, crop production budgets, and other inputs. The results of the analysis yielded the same results as the standard economic analysis presented in Section 7 (pages 7-116 through 7-118). Alternative 4 was identified as the NED

plan with excess benefits of $7.7 million followed by Alternative 5 with $6.3 million. These results were previously displayed in the current draft Economic Appendix, but after consideration of comments from the Independent Technical Review (ITR), it was determined that the Section 219 analysis outlined for urban evacuation projects was not necessarily pertinent to the nonstructural features applicable in the prevention of crop damages. Based on the recommendations of the ITR, the Section 219 analysis was excluded in the final report. Thus, the benefits for the nonstructural flood damage reduction features contained in this appendix were not determined using the Section 219 methodology, but through traditional economic analyses.

VALIDATION OF BENEFIT EVALUATION

220. In accordance with Principles and Guidelines (Policy and Planning Guidance for Conducting Civil Works Planning Studies, 28 December 1990, ER 1105-2-100), detailed project reports are encouraged to contain discussions summarizing any critical sensitivity analyses undertaken as part of plan formulation, evaluation, and selection. These analyses are used in examining the effects of varying assumptions and data relative to economic, hydrologic, and other elements which could determine the feasibility and recommendation of a project.

221. Sensitivity analyses, applied in the evaluation of structure (residences, commercial buildings, etc.) damages in the Yazoo Backwater study area, included the application and testing of various hydrologic data at selected flood frequencies in determining the actual hydrologic conditions in the area. Other analyses include a comprehensive real estate assessment of each individual structure in the area which provided highly detailed data for each structure by specific location.

222. The level of agricultural production and agricultural price levels used in this study analyses were developed to eliminate the cyclical fluctuations characteristic of the agricultural industry. Use of the sensitivity analyses would have necessitated consideration of varying production levels plus alternative assumptions on agricultural exports, allotment restrictions, etc. Since the study area is relatively small compared to the overall United States agricultural production areas, any alternative level of agricultural production would not significantly affect total United States agricultural production.

223. The benefit evaluations in this appendix were subject to sensitivity analysis for structure damage assessment, sampling techniques, statistical testing, etc.

224. Structure damages to residential and nonresidential properties were based on surveys of affected areas to determine number, type, and value of structures at selected elevations of flooding. Sampling techniques were applied to collect basic values used to determine damages to agricultural noncrop items and agricultural crops and roads and streets.

VARIATIONS IN PROJECTED GROWTH RATE

225. In consideration of the agricultural projections, variations in the rate of growth will have little effect on the outcome of the projected agricultural benefits. The projection factors, or ratios of increase for estimating future agricultural damages, presented in Table 7-29 (page 7-49) are based on linear regression analysis for the historical year provided years 1969 through 1992. When additional years are input, the growth rate projections actually increase, which increases the overall agricultural and associated damages. Thus, agricultural crop, noncrop, and other damages presented in this report as a result of the 2005 reformulation analysis are considered to actually understate the flood impacts to agriculture in the Yazoo Backwater study area.

226. Conversely, the application of a "no-growth" rate in the evaluation of agricultural and related flood damages in the Yazoo Backwater study area is of little consequence to project evaluation results. The difference in the benefit-cost ratios between Alternatives 4 and 5 stays exactly the same. Preliminary investigations into this consideration deemed Alternative 5 to remain the leading NED/EQ plan in the alleviation of flood damages and the enhancement of the environment in the Yazoo Backwater study area. Table 7-84 displays the results of this no-growth analysis for the recommended Alternative 5. As shown, using no growth reduced average annual benefits by $2.8 million, but the benefit-cost ratio remained above unity at 1.2 to 1.

TABLE 7-84
SUMMARY OF AVERAGE ANNUAL BENEFITS a/
WITH PROJECTION OF GROWTH AND NO GROWTH ABOVE
CURRENT YEAR BENEFITS
($000)

Category of Benefits	Projecting Growth	No Growth	Net Change
Crop			
Structural	6,534	5,470	1,064
Nonstructural	4,615	3,863	752
Noncrop			
Structural	2,328	1,948	380
Nonstructural	3,632	3,040	592
Roads	443	443	0
Urban	2,703	2,703	0
Timber Values	435	435	0
Hunting Values	638	638	0
Total Benefits	21,328	18,540	2,788
Average Annual Costs	15,051	15,051	N/A
Benefit-Cost Ratio	1.4	1.2	.2

Note: Only Crop and noncrop damages/benefits are projected to grow over time and thus, there are the only categories of benefits affected by changing growth projections.

a/ Annual benefits and costs were annualized using the current Federal discount rate of 5-1/8 percent and a 50-year economic life.

CHANGES IN CROP YIELDS
AND DISTRIBUTIONS

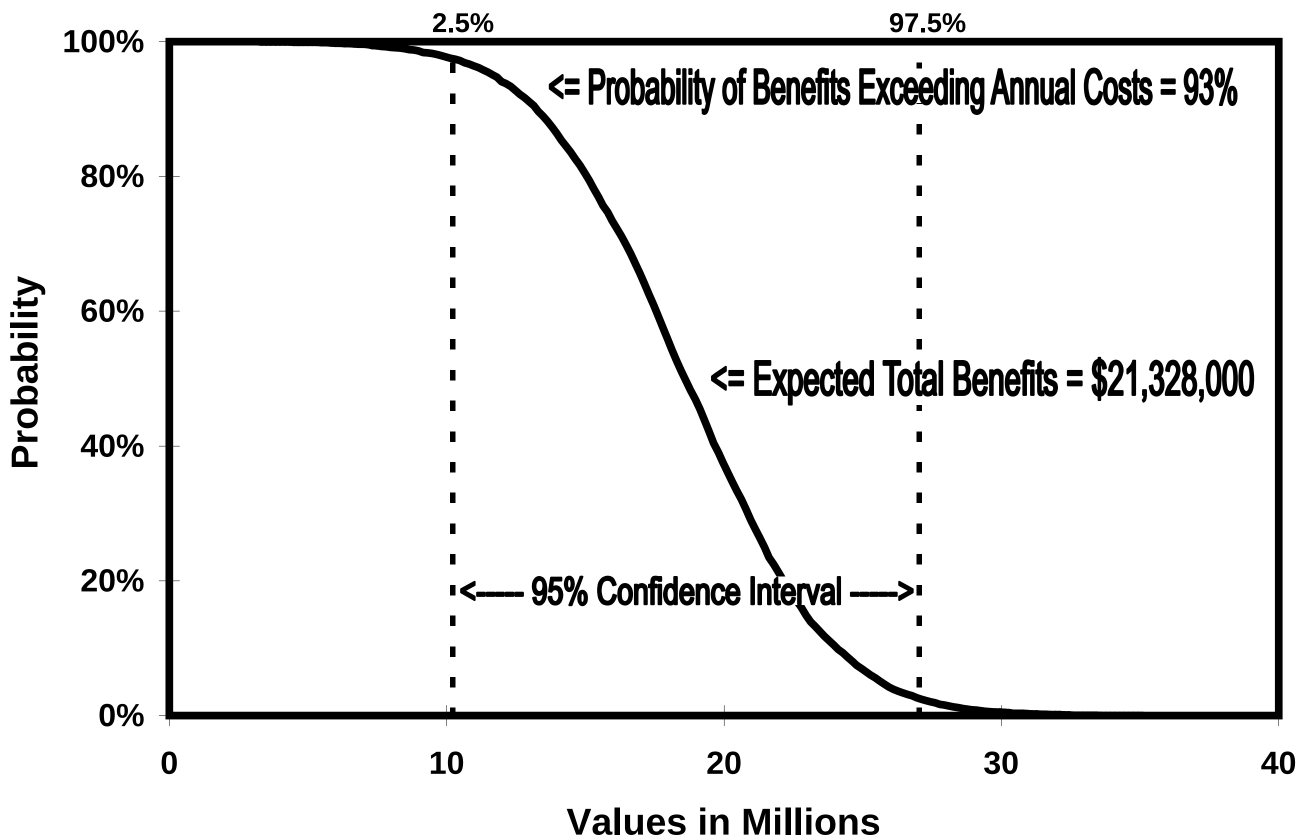
227. Based on information received from agricultural specialists and farmers in the Yazoo Backwater study area and the report completed by MSU (Attachment 7B), crop yields are expected to be higher for with-project conditions than for without-project conditions. No changes in crop distributions from soybeans to corn or cotton were also assumed to occur for with-project conditions. As a sensitivity of project viability to changes in yields and distributions, an analysis was conducted to evaluate the impacts on agricultural benefits to different yield and crop distribution assumptions. To simplify this analysis, changes in net returns were used as a proxy for changes in yields and distributions. The increases in net returns that were assumed for the with-project condition for the recommended alternative (Alternative 5) were used as the baseline against which other assumed levels of yields and distributions were compared. The baseline estimate of average annual agricultural crop benefits for structural and nonstructural features is $11.1 million.

228. If it was assumed that there was no increase in yields in the baseline with-project condition, annual crop benefits would decrease to approximately $9.3 million, a decrease of $1.8 million. A reduction of 100 percent in estimated increased net returns produces an economically viable plan with excess benefits of approximately $4.6 million (excluding employment benefits) assuming that all other benefit categories remained constant.

RELIABILITY OF EXPECTED PROJECT
BENEFITS AND B/C RATIO

229. Reliability of the project benefits is one issue that can be addressed in risk and uncertainty analyses. Project analyses conducted within this framework yield expected mean flood benefits and the corresponding standard deviations which provide the analyst the statistical parameters to make inferences about the data. The expected mean, often called the average, is the most widely used measure of central tendency. The mean is the sum of a set of measurements divided by the number of measurements. The standard deviation is the measure of data variability. The standard deviation can be used for describing the variability of a set of measurements.
Figure 7-3 illustrates the cumulative probability distribution and expected annual benefits of the recommended alternative--Alternative 5. The expected annual benefits of Alternative 5 are $21,328,000.

Figure 7-3
Expected Total Benefits
Excluding Employment
Plan 5 - Recommended Plan
Yazoo Backwater Area, Mississippi



230. Another attribute of evaluating a project with risk and uncertainty is the ability to determine the sensitivity of the project benefit-cost ratio (i.e., the probability that the benefit-ratio is greater than 1). This calculation illustrates how sensitive the project benefit-cost ratio is to the uncertainty inherent in the economic and hydrologic variables used to calculate flood damages. In risk analyses, the output probability distributions give a complete picture of all the possible outcomes. The probability distribution determines a "correct range" because the uncertainty associated with every input variable has been rigorously defined. Also, a probability distribution shows the relative likelihood of occurrence for each possible outcome. As a result, the process is no longer just comparing desirable outcomes with undesirable outcomes. Instead, it is recognized that some outcomes are more likely to occur than others and should be given more weight in the evaluation. This process has an advantage over traditional analyses because a probability distribution graphically displays the probabilities and gives a feel for the risk involved. Given the annual cost of the project, the probability of a given benefit-cost ratio can be determined by evaluating the benefit probabilities.

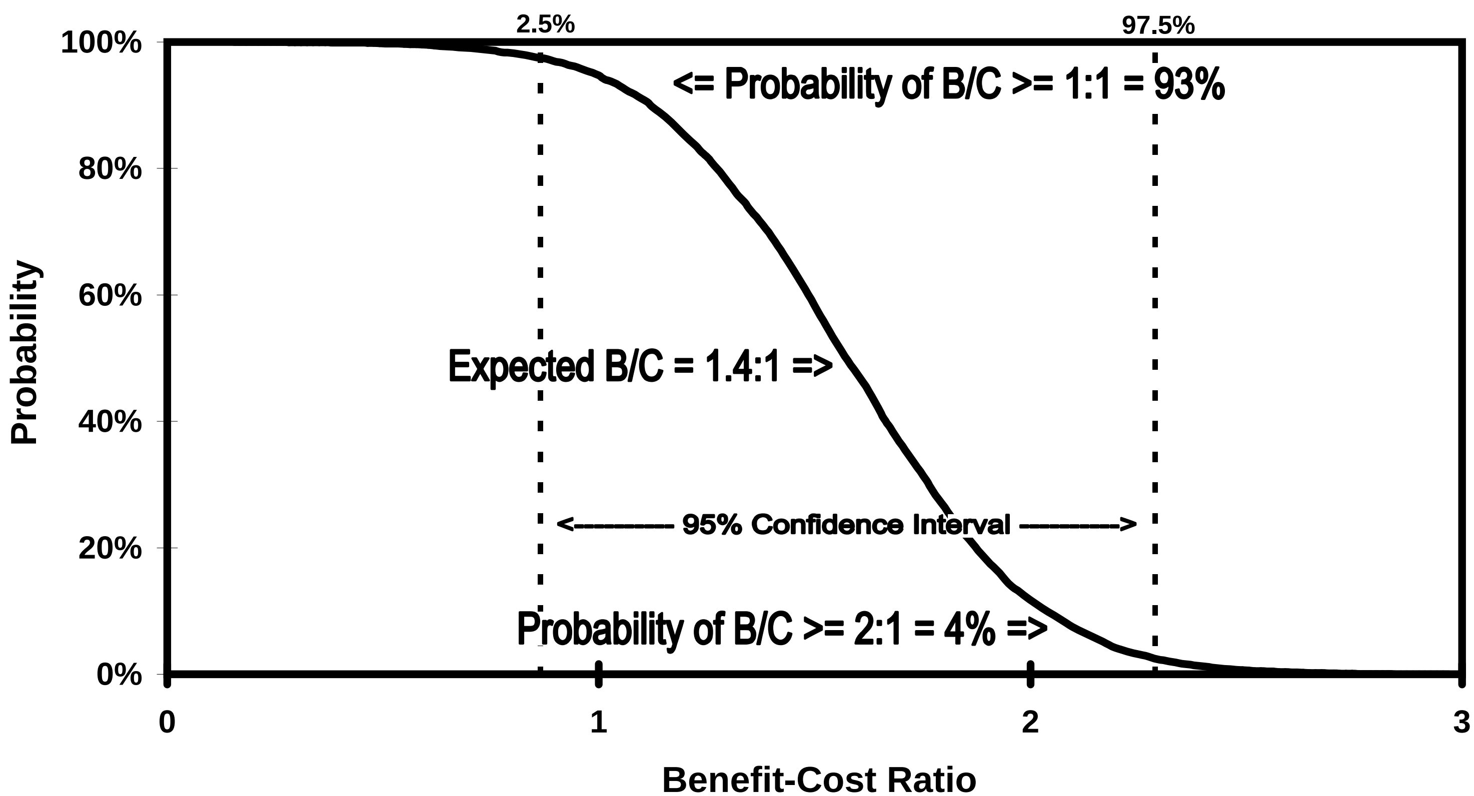
Expected Benefits

231. Figure 7-3 also displays the selected alternative benefits and corresponding probabilities within the risk and uncertainty framework for the Yazoo Backwater evaluation. To determine the total expected benefits, histogram functions for each reach and set of project conditions were developed. Histograms are actually points along a graph calculated in the risk-based program to represent the output probability distributions of the expected benefits. These histogram functions were used to evaluate the uncertainty of the probability distributions for each reach and determine the benefits accrued based on the difference between with- and without-project conditions. Based on this analysis, there is a 95 percent probability that the combination of events for Alternative 5 (the recommended alternative) would result in expected benefits greater than annual costs.

Expected Benefit-Cost Ratio

232. The probabilities of possible benefit-cost ratios were determined by dividing the probable benefits by the annual costs of the recommend alternative. The benefit-probability curve was thus converted to a benefit-cost ratio probability curve. Results of this evaluation indicate Alternative 5 to have a 95 percent probability that the combination of events would be a benefit-cost ratio greater than or equal to 1.0. Figure 7-4 displays the recommended alternative expected benefit-cost ratio probabilities.

Figure 7- 4
Probability of Expected Benefit-Cost Ratio
Excluding Employment
Plan 5 - Recommended Plan
Yazoo Backwater Area, Mississippi



COMPARISON OF SHABMAN REPORT TO CORPS ANALYSIS

233. The main purpose of this section is to discuss the farming practices identified and utilized by the Vicksburg District in the computation of agricultural flood damages as compared to nonstructural recommendations outlined in a report prepared by Dr. Leonard Shabman and Ms. Laura Zepp of Virginia Tech University (VT) in 2000.

234. During the 2000 draft study of the Yazoo Backwater Reformulation Project, several issues arose relative to the viability of the pump alternative as a fully funded Federal expenditure. Further studies were recommended by EPA to address nonstructural agricultural measures applicable to the Yazoo River Backwater Area. A research grant was financed by EPA and contracted with the Department of Agricultural and Applied Economics at VT. Results of these findings are documented in "An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area," 7 February 2000, hereafter referred to as the Shabman Report.

235. A major difference between the Shabman Report and the Vicksburg District analysis is the way in which flooding and the risk of flooding contribute to yields and crop distributions in the computation of agricultural flood damages. The Shabman analysis recognizes that flooding is a problem in the lower Mississippi Delta. Dr. Shabman also recognizes that planting dates can have significant impacts on yields. However, his analysis does not attempt to identify or quantify what these impacts may be. He simply states that although there is significant flooding, farmers simply wait for floods to recede, then they employ best management practices and they are able to achieve the same yields they would have achieved if they were allowed to plant at an earlier date. This is not the case in the Yazoo Backwater study area. In the reanalysis of the project, it was discovered that many of the farmers in the lower areas of the study area actually delay planting, especially during times when the Mississippi River is rising upstream. The information in this appendix documents that there are differentiations and thus differentiate economic outcomes based on this delay in planting.

236. Based on data from Mississippi Agricultural and Forestry Experiment Station (MAFES), early planting can increase yields significantly and reduce production costs. With the new early maturing varieties of soybeans, farmers can expect much higher yields when soybeans are planted prior to April 16 (41 bushels per acre for nonirrigated and 62 bushels per acre for irrigated) in comparison with those planted between May 1 and May 15 (28 bushels for nonirrigated and 54 for irrigated). Early planting allows corn to take advantage of higher rainfall and lower temperatures that occur earlier in the growing season. Corn requires high water intake as it matures in order to fill ears properly, and the lower temperatures reduce stress on plants which lowers the incidence of plant diseases. Research also indicates that a crop rotation that has cotton following corn can result in significantly higher cotton yields.

237. With the flooding and risk of flooding currently experienced in the lower Delta, farmers in this area are not always able to plant crops early enough to achieve these higher yields. Implementation of the proposed project would allow farmers to achieve earlier planting dates and be able to achieve cost reductions that arise from early planting. These cost reductions include less herbicide, insecticide, and potentially lower irrigation and harvesting cost. Based on discussions with farmers in the area and with agricultural specialists at MSU, it was assumed that no changes in the crop distributions would occur because of the project. However, because of the reduction in flood risk, farmers would plant soybeans earlier and more soybean acreage would be irrigated.

238. Another significant difference in the analyses concerned crop prices. The Vicksburg District utilized current normalized crop prices as specified by current Corps policy guidelines. These prices are developed by the USDA for use by agencies involved in water resource development. The Shabman Report utilized prices developed from the Food and Policy Research Institute (FAPRI) model based on the analysts' expectations of lower future prices. This set of prices is significantly lower that the Current Normalized Prices specified by policy for use in water resource project analysis.

239. The Shabman Report indicated that the indices used by the Vicksburg District were inappropriate for estimating future benefits of agricultural flood damage reduction. Dr. Shabman indicates that instead of using a single projection rate, each of the individual elements of agricultural returns (yields, commodity prices, and production costs) should be projected independently. He cites the projections made by FAPRI as an example. These projections are based on a series of assumptions about future domestic and international macroeconomic and policy conditions.

240. The projections made by the Vicksburg District are based on historic data for value of agricultural crop sales per harvested acre for the Yazoo Backwater study area. The implicit assumption is that the current relationship between crop prices and input costs would hold throughout the planning horizon. Utilizing the methodology prescribed by Shabman calls for a myriad of assumptions concerning multiple national and international economic factors.

241. Dr. Shabman states that flood damage reduction benefits from a change in agricultural flood plain land use is not a valid benefit category. He states that including benefits for flood damage reduction would be double counting since the cost of purchasing lands in fee simple title or through easements would be reduced because markets have already recognized the flooding problem and made the appropriate adjustments in land values which reduces project costs. However, current principles and guidelines state that benefits for evacuation projects should be calculated in the same manner as other flood damage reduction measures, and then the internalized portion of flood damages should be subtracted. These internalized damages include

uninsured losses, flood insurance premiums, any deductible fees and agents' fees. The subtraction of the internalized portion of flood damages is intended to remove potential double counting from the benefit-cost calculation. Damages and benefits for the nonstructural flood damage reduction measures proposed as part of the Yazoo Backwater Project were calculated in this manner.

242. These differences in methodology define the primary differences in the two approaches. Although the Shabman Report addressed some of the other benefit categories covered in the Vicksburg District's report (e.g., structures), these categories were not addressed in detail. The Shabman Report also included benefits for carbon sequestration and nutrient load reduction which the Corps does not currently recognize. A significant portion of the net benefits identified in the Shabman Report as justification for Federal expenditures were comprised of these two categories. There are numerous weaknesses in the methodologies used in the Shabman Report in the measurement of these benefits. These are discussed in detail in the Vicksburg District comments on that report (See Appendix 17). Additionally, these same benefits would accrue to the nonstructural flood measures proposed by the Vicksburg District due to the extensive reforestation that would occur with implementation of the recommended alternative.

243. There was a significant difference in prices used in the two analyses. As explained above, the Shabman Report utilized prices derived from the FAPRI model; the Vicksburg District utilized current normalized prices. The Shabman Report described how the Vicksburg District net returns based on 1997 prices and budgets were too high. However, information from MAFES indicated that the Vicksburg District estimates of net returns were similar to actual returns. The mean net return from a survey of 27 soybean producers in the lower Mississippi delta was found to be $85 per acre before costs for land were deducted. The net returns from the surveys ranged from -$77 to $222 per acre before payment for land. Data from the Vicksburg District's report were reported at $106.89 for the upper stratum and Shabman’s returns were $61 per acre. Mean net returns to cotton producers in the lower delta in 1997 as reported by MAFES were $236 per acre before land costs are deducted with a range of -$10 to $606. The Corps estimate in the upper stratum was $297 per acre and Shabman’s returns were reported at $132 per acre. This report is based on 2005 land use, 2005 current normalized prices, and crop budgets developed by MSU in late 2005.

244. The Shabman Report used returns of $61.08 for soybeans and $132 for cotton in an analysis to estimate capitalized land values. Through this analysis Dr. Shabman attempted to demonstrate that the prices and net returns used by the Vicksburg District were too high. However, as can be seen from the data above, the prices used by the Vicksburg District for

analysis of 1997 price levels were similar to net returns reported by area farmers. The net returns used by Shabman are significantly less than returns reported by area producers for 1997. Additional discussions of the problems noted in Shabman's capitalized land value analysis can be found in Appendix 17.

245. Four nonstructural alternatives were evaluated. These alternatives consisted of various combinations of acquisition and reforestation/conservation measures, operational measures which influence land-use patterns and activities, income assurance measures, ring levees to protect some structures, floodproofing of structures within the 100-year flood plain, relocation of structures within the 100-year flood plain, and ring levees to protect some structures. These nonstructural alternatives include Alternatives 2, 2A, 2B, and 2C. Detailed descriptions of these alternatives can be found on pages 7-10 through 7-18 of this appendix.

IMPACT ASSESSMENT – DISPLAY OF SYSTEM OF ACCOUNTS

246. In addition to the standard economic analysis, an impact or effects assessment is conducted to identify and describe the economic, social, and environmental impacts expected from implementation of the recommended alternative. This evaluation forms the basis for assessing overall beneficial and adverse contributions of the project. The difference in each pertinent parameter between the without- and with-project condition is the impact of the alternative. Significance of impacts is determined when specific impact situations are considered crucial to decisionmaking. This evaluation is discussed in more detail in Attachment 7G, along with a display of the impact assessment in the Systems of Accounts format. Four accounts are used to display the information--the NED, EQ, Regional Economic Development, and Other Social Effects. These four accounts encompass all significant effects of a plan as required by the National Environmental Policy Act of 1969, Section 122 of the River and Harbor Act and Flood Control Act of 1970 (Public Law 91-611).