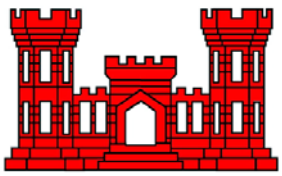
Appendix B
Part 1

Economics of Alternatives



U.S. Army Corps of Engineers
Memphis District

Appendix B
ECONOMICS OF ALTERNATIVES

INTRODUCTION

The purpose of this section is to present information pertaining to the annual benefits, costs, and economic justification of the alternatives that have been developed to address the flooding problems faced by the East Prairie, Missouri area. Alternatives presented in this section include a no action plan, the alternative recommended in the March 1997 St. Johns Bayou and New Madrid Floodway Missouri First Phase Limited Reevaluation Report (LRR), and four more environmentally sensitive versions of this plan.

GENERAL

For the purpose of this section, construction is assumed to begin in fiscal year 2012 and to be completed in fiscal year 2017. The period of analysis is from the end of 2018 through the end of 2067. For discounting purposes, costs are assumed to take place at the end of the year during which they are expended and benefits related to the physical construction from such costs are assumed to accrue one year after construction is completed. All benefits and costs accruing prior to the end of 2017 were compounded forward, and those occurring after the end of 2017 were discounted backward to determine the present value of project benefits and costs as of the end of 2017. The sum of the present values for each category was amortized over the period of analysis (50 years) to obtain average annual uniform equivalent values. The First Phase feature of Alternative 2 was chosen to illustrate the methodology used to calculate annual economic benefits and costs in this appendix. These features are chosen for illustration purposes only and may or may not be recommended for construction.

The price levels and the land use used in this section are based on 2012 conditions. Estimates of land use are based on information obtained from area farmers, the University of Missouri Office of Social and Economic Data Analysis, and the USDA Census of Agriculture. The area is predominately rural and dependent on agriculture for its livelihood. Little urban development occurs in the area.

Two interest rates are used for plan formulation purposes in this section. The Mississippi River Levees feature consisting of a 1,500 foot levee closure and gravity structure at the south end of the New Madrid Floodway was formulated using a previously authorized interest rate of 2.5%. This interest rate was used because the levee closure was authorized for construction as part of the Flood Control Act of 1954. The levee closure is an integral part of the ongoing MRT project which has been ongoing since the great flood of 1927. The remaining features were formulated using the current interest rate for Federal water resource projects of 4%. However, for sensitivity purposes, all features of the project are presented using an array of interest rates; 2.5%, 4.0%, and 7.0%.

ALTERNATIVES

A total of six alternatives are presented in this section. A brief description of each alternative is presented in the following paragraphs. A more detailed description of the alternatives can be found in the main body of this report.

Alternative 1. Alternative 1 is the "No Action" alternative. This is the same as existing conditions and forms the basis by which the other alternatives are measured.

Alternative 2. Alternative 2 is part of the total project authorized by the Water Resources Development Act of 1986. Alternative 2 is presented in three sub-sections, Alternatives 2.1, 2.2, and 2.3. Alternative 2.1 is the St Johns Basin only alternative. Alternative 2.2 is the New Madrid Floodway portion including the MRL feature. Alternative 2.3 is both basins combined. The MRL feature consists of a 1,500 -foot levee closure and gravity structure at the south end of the New Madrid Floodway, which will prevent backwater flooding from the Mississippi River. The remainder of Alternative 2 consists of two pumping stations, a 1,500 cfs station in the New Madrid Floodway basin and a 1,000 cfs station in the St Johns Bayou basin. Also included is channel enlargement on St Johns Bayou, Birds Point Levee Ditch, and St James Ditch. The channel work is designed to provide an outlet for the city of East Prairie, Missouri. All of the channel work occurs within the St Johns Bayou basin. No channel improvement occurs within the New Madrid Floodway basin.

Alternative 3.1. Alternative 3.1 is a refinement to allow seasonal flooding during the winter and early spring for migratory waterfowl and to allow fish access through the gates into the New Madrid Floodway. This will be accomplished by modifying the start-stop pump/gate closure elevations. Other environmental features include establishing a riparian corridor along the improved channels.

Alternative 3.2. Alternative 3.2 is very similar to 3.1 but uses a lower start-stop pump/gate closure elevation. This alternative will provide more flood protection but will also require additional mitigation as compared to Alternative 3.1.

Alternative 4.1. Alternative 4.1 is a further refinement which allows river connectivity to the New Madrid Floodway up to an elevation of 290 feet. It is intended to allow more seasonal flooding which will reduce anticipated benefits while saving additional costs for mitigation features.

Alternative 4.2. Alternative 4.2 is very similar to 4.1 but uses a land reforestation on all agricultural areas below 2.90. This alternative should provide significant flood protection by taking cropland and putting it in a non-damaging use (forests). It should also require significantly less mitigation lands but will come with a significantly higher implementation price.

METHODOLOGY USED TO ESTIMATE ANNUAL DAMAGES AND BENEFITS

The benefits consist of agricultural benefits and streets and roads. The agricultural benefits are composed of inundation reduction (flood damage reduction) and intensification.

AGRICULTURAL BENEFITS.

The agricultural benefits are classified into two categories: inundation reduction (flood damage reduction) and intensification. Inundation reduction benefits consist of damage reduction to development under present and projected future changes under without project conditions. Intensification benefits result from additional income that would be obtained as a result of changes in development caused by the project.

a. Land Use. The area is characterized primarily by agricultural operations. Woodlands are virtually nonexistent. The only areas of woods are scattered and very small. The remaining trees are on spoil banks or channel side slopes of drainage channels or in other low-lying areas. The soils are generally poorly drained and fertile. Because of their favorable properties for agricultural use, these soils have significantly influenced development in the area. There is little urban development occurring in the first phase's project area. The town of East Prairie, Missouri is located in the benefited area. There is also scattered rural development in the form of farm residences and associated buildings, etc. throughout the area. The closest large population center is Sikeston, Missouri, which lies immediately north of the project area.

Future without- and with-project land use is expected to remain essentially the same as current conditions. There are no large tracts of woodlands remaining in the area that are expected be cleared. In fact there is a trend toward reforestation being driven by the Wetland Reserve Program which pays farmers to plant frequently flooded croplands to trees. Whether or not this trend continues will be dependent on the relative profitability of farming. Current conditions show that farming is very profitable which should slow or halt this trend. However, due to the past tree plantings, a small continuation of this trend was forecast for this analysis.

b. Crop Data. The crop prices used in this section are the FY 2012 Current Normalized Prices developed by the Economic Research Service (ERS). The ERS is one of four agencies in the Research, Education, and Economics Mission Area of the U.S. Department of Agriculture (USDA). The ERS provides economic analysis on efficiency, efficacy, and equity issues related to agriculture, food, the environment, and rural development to improve public and private decision making. Normalized Prices have been used by Federal agencies in water and related land resources planning, since implementation of the Water Resources Planning Act of 1965 which required their use. The 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 price 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. The ERS estimates these prices based on 5-year moving averages of actual market prices.

Flooding plays an important role in a farmer's decision making process. As the risk of flooding increases, a farmer is less likely to plant higher value crops and use high management production techniques. The project area can be divided into flood zones where these significant changes in cropping practices occur. Dividing the agricultural sector into flood zones helps to better evaluate impacts on the agricultural sector. The crop yields used in this analysis are also affected by flood risk and reflected by the differences between the flood zones. The yields in the lower zone are considered flood risk constrained while those in the upper zone are considered non-flood risk constrained crop management practices. Flood risk constrained management is a condition where flood risk/uncertainty causes inefficient crop management practices. However, with non-flood risk constrained management, there are no inefficiencies. This section used the 5 year flood zone as the point where significant changes in farming practices occur in both the St Johns Bayou and the New Madrid Floodway Basins. The area above the 5 year frequency is where more intensive and profitable crops are grown while slightly lower value crops are grown below the 5 year flood zone.

(1). MRL Feature Data. The primary crops grown in the New Madrid Floodway, absent the MRL Feature, are soybeans, corn, grain sorghum, and wheat. Soybeans is the primary cash crop in the lower portion that is subject to frequent backwater flooding. Table B-1 presents 2012 land use and crop data used to assess the effects of the MRL feature of Alternatives 2, 3, and 4. Land use for future (2067) conditions was also estimated. The calculation of future crop budgets was accomplished by projecting both crop yields per acre and levels of crop production inputs per acre. The price levels for both crops and production costs were held constant at 2012 price levels. The methodology used to project crop yields and levels of production inputs is consistent with that used for other Memphis District flood control studies. A first degree polynomial function was fit to crop budget input and output indices published by the Economic Research Service of the U.S. Department of Agriculture. The resulting regression equations were $y=0.0167348X-32.4349327$ for crop yields and $y=0.0051037X-9.1882495$ for production inputs. The correlation coefficients were 0.94873 and 0.37086 respectively. The output equation was a very good fit as reflected by the correlation coefficient and tested statistically significant at the 1 percent level of significance. The input equation was not as good a fit and only tested significant at the 2 percent level. Projected crop data is presented in Table B-2.

(2). Remaining Features Data. Current (2012) crop data for the remaining features of Alternatives 2 and 3 is presented in Table B-3. This data reflects current cropping practices within the St Johns Bayou basin, which is already protected from backwater flooding from the Mississippi River. However, it reflects a significant shift in cropping patterns for the New Madrid Floodway basin. The shift is primarily away from soybeans to more profitable and higher value crops such as corn and double cropping soybeans and wheat. It also reflects a shift to increased use of irrigation in the New Madrid Floodway as farmers increased investments are protected from the frequent backwater flooding.

Table B-1
New Madrid Floodway Agricultural Land Use
Existing Conditions (2011)
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Item	Corn		Rice	Dryland Cotton			Irrigated Cotton			Soybeans		Wheat	Double Crop Soybeans		Grain Sorghum		Total
	Dryland	Irrigated		Lint	Seed	Total	Lint	Seed	Total	Dryland	Irrigated		Dryland	Irrigated	Dryland	Irrigated	
	(bu)	(bu)	(cwt)	(lb)	(ton)		(lb)	(ton)		(bu)	(bu)	(bu)	(bu)	(bu)	(cwt)	(cwt)	
0-5 Year Floodplain																	
Price	3.38									8.29	8.29	4.22	8.29	8.29	5.64		
Yield	120.0									34.0	42.5	55.0	29.8	38.3	42.50		
Gross Value	405.60									281.86	352.33	232.10	246.63	317.09	239.70		
Production Cost	368.97									227.23	273.60	214.31	213.37	261.54	223.07		
Net Return	36.63									54.63	78.74	17.79	33.26	55.55	16.63		
Distribution	0.053									0.399	0.416	0.130	0.063	0.067	0.002		1.130
Wt Net Return	1.94									21.80	32.75	2.31	2.10	3.72	0.03		64.66
5 Year-SPF Floodplain																	
Price	3.38	3.38	10.81	0.530	161.60		0.530	161.60		8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	140.0	180.0	72.00	935	0.823		1,100	0.968		40.0	50.0	70.0	35.0	45.0	50.00	62.00	
Gross Value	473.20	608.40	778.32	495.55	132.96	628.51	583.00	156.43	739.43	331.60	414.50	295.40	290.15	373.05	282.00	312.48	
Production Cost	375.37	384.97	503.05			595.40			606.34	228.42	274.87	216.01	214.22	262.56	225.50	250.50	
Net Return	97.83	223.43	275.27			33.11			133.09	103.18	139.63	79.39	75.93	110.49	56.50	61.98	
Distribution	0.096	0.100	0.037			0.050			0.048	0.250	0.260	0.147	0.072	0.075	0.006	0.006	1.147
Wt Net Return	9.39	22.34	10.18			1.66			6.39	25.80	36.30	11.67	5.47	8.29	0.34	0.37	138.20

Table B-2
New Madrid Floodway Basin Agricultural Land Use
Future Without Project Conditions (2067)
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Item	Corn		Rice	Dryland Cotton			Irrigated Cotton			Soybeans		Wheat	Double Crop Soybeans		Grain Sorghum		Total
	Dryland	Irrigated		Seed	Lint	Total	Seed	Lint	Total	Dryland	Irrigated		Dryland	Irrigated	Dryland	Irrigated	
	(bu)	(bu)	(cwt)	(lb)	(ton)		(lb)	(ton)		(bu)	(bu)	(bu)	(bu)	(bu)	(cwt)	(cwt)	
0-5 Year Floodplain																	
Price	3.38									8.29	8.29	4.22	8.29	8.29	5.64		
Yield	195.0									50.0	62.0	84.0	43.0	56.0	66.0		
Gross Value	659.10									414.50	513.98	354.48	356.47	464.24	372.24		
Production Cost	430.55									265.15	319.26	250.08	248.98	305.19	260.30		
Net Return	228.55									149.35	194.72	104.40	107.49	159.05	111.94		
Distribution	0.053									0.399	0.416	0.130	0.063	0.067	0.002		1.130
Wt Net Return	12.11									59.59	81.01	13.57	6.77	10.66	0.22		183.93
5 Year-SPF Floodplain																	
Price	3.38	3.38	10.81	0.53	161.60		0.53	161.60	0.00	8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	227.0	292.0	107.0	1364.0	1.200		1605.0	1.412		58.0	73.0	107.0	51.0	66.0	78.0	97.0	
Gross Value	767.26	986.96	1156.67	722.92	193.97	916.89	850.65	228.24	1078.89	480.82	605.17	451.54	422.79	547.14	439.92	488.88	
Production Cost	438.02	449.22	587.01			694.77			707.53	266.54	320.74	252.06	249.97	306.38	263.13	292.31	
Net Return	329.24	537.74	569.66			222.12			371.36	214.28	284.43	199.48	172.82	240.76	176.79	196.57	
Distribution	0.096	0.100	0.037			0.050			0.048	0.250	0.260	0.147	0.072	0.075	0.006	0.006	1.147
Wt Net Return	31.61	53.77	21.08			11.11			17.83	53.57	73.95	29.32	12.44	18.06	1.06	1.18	324.97

Table B-3
St Johns Bayou and New Madrid Floodway Basins Agricultural Land Use
With the MRL Features
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Item	Corn		Rice	Dryland Cotton			Irrigated Cotton			Soybeans		Wheat	Double Crop Soybeans		Grain Sorghum		Total
	Dryland	Irrigated		Lint	Seed	Total	Lint	Seed	Total	Dryland	Irrigated		Dryland	Irrigated	Dryland	Irrigated	
	(bu)	(bu)	(cwt)	(lb)	(ton)		(lb)	(ton)		(bu)	(bu)	(bu)	(bu)	(bu)	(cwt)	(cwt)	
0-5 Year Floodplain																	
Price	3.38	3.38	10.81	0.53	161.60		0.53	161.60		8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	140.0	180.0	72.0	935.0	0.823		1100.0	0.968		40.0	50.0	70.0	35.0	45.0	50.0	62.0	
Gross Value	473.20	608.40	778.32	495.55	132.96	628.51	583.00	156.43	739.43	331.60	414.50	295.40	290.15	373.05	282.00	312.48	
Production Cost	375.37	384.97	503.05			595.40			606.34	228.42	274.87	216.01	214.22	262.56	225.50	250.50	
Net Return	97.83	223.43	275.27			33.11			133.09	103.18	139.63	79.39	75.93	110.49	56.50	61.98	
Percent Distribution	0.096	0.100	0.037			0.050			0.048	0.250	0.260	0.147	0.072	0.075	0.006	0.006	1.147
Weighted Net Return	9.39	22.34	10.18			1.66			6.39	25.80	36.30	11.67	5.47	8.29	0.34	0.37	138.20
5 Year-SPF Floodplain																	
Price	3.38	3.38	10.81	0.53	161.60		0.53	161.60		8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	155.0	200.0	80.0	1040.0	0.915		1225.0	1.078		45.0	55.0	78.0	39.0	50.0	55.0	69.0	
Gross Value	523.90	676.00	864.80	551.20	147.90	699.10	649.25	174.20	823.45	373.05	455.95	329.16	323.31	414.50	310.20	347.76	
Production Cost	380.17	391.37	506.81			595.40			606.34	229.27	275.72	217.37	214.90	263.41	226.35	251.69	
Net Return	143.73	284.63	357.99			103.70			217.11	143.78	180.23	111.79	108.41	151.09	83.85	96.07	
Percent Distribution	0.171	0.114	0.021			0.066			0.046	0.182	0.118	0.124	0.073	0.051	0.084	0.054	
Weighted Net Return	24.58	32.45	7.52			6.84			9.99	26.17	21.27	13.86	7.91	7.71	7.04	5.19	170.52

Projected (2067) land use is presented in Table B-4. The procedure to project this data is the same as for the MRL feature in the previous paragraph.

c. Agricultural Flood Damage Prevented. Flood damage reduction benefits to crops are based on the difference between average annual equivalent flood damages for without- and with-project conditions. Flood damages are calculated by applying crop damage rates per flooded acre to expected annual acre estimates. This procedure for Alternative 3.1 is described in the following paragraphs.

(1). Expected Annual Acres. The number of expected annual cleared acres flooded was calculated by the use of partial duration frequency curves and stage-area information. Results indicate that there are approximately 21,632 expected annual cleared acres flooded by headwater in the project area under existing conditions. The project lowers this figure to 1,271 acres for a reduction of 20,361 or a 94% reduction (Table B-5). Backwater floods in the New Madrid Floodway inundate approximately 69,700 cleared acres under existing conditions. With the MRL closure in place this figure is reduced 82% to 15,657 acres. Of the remaining 15,657 acres in the New Madrid Floodway, the pumping station will reduce an additional 6,131 acres. In the St Johns Basin Headwater flooding is reduced 46% by the pump station from 26,669 acres to 14,409 acres.

Headwater and backwater flooding can and do occur concurrently. To avoid duplication of benefits, the overlapping effect had to be eliminated. From historical hydrologic data, it was determined that when headwater and backwater floods occurred concurrently, the backwater influence was dominant. Therefore, only adjustment of headwater damages was necessary to avoid duplication in the estimation of total damage. Also, from this historical hydrologic data, an estimate was made of the proportion of time that headwater and backwater flooding occurred concurrently. Using this data, factors were developed to reduce the headwater benefits. These factors are presented in Table B-6. These factors represent the percent of the time that backwater flooding would not overlap the effects of the proposed channel work. For instance, for St Johns Bayou, Reach 1, the channel improvements would provide headwater benefits approximately 66.3 percent of the time. The remaining 33.7 percent, backwater would be the dominant factor with backwater filling the channels and inundating adjacent cropland.

(2). Crop Damage Rates. Agricultural crop damage rates were calculated using a computer program entitled Crop Flood Damage Analysis or CFDA. It was developed by Mississippi State University for the Lower Mississippi Valley Division, Corps of Engineers. This program calculates crop flood damages by analysis of daily flood events. The program also has the capability to calculate damage from multiple flooding events in the same area during the same year. In addition, the program allows for specific crop replanting and/or crop substitution. The program is structured to compute flood damages based on the time of the flood event in relation to the sequence of agricultural operations that have occurred in the production process. Duration factors, expressed as the number of days required to cause damage, are developed for four stages of plant development. Normal, late planting, and last day of planting dates are also developed by crop. These dates are extremely important as they, in conjunction

Table B-4
St Johns Bayou and New Madrid Floodway Basins Agricultural Land Use Projected to 2067
With the MRL Features
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Item	Corn		Rice	Dryland Cotton			Irrigated Cotton			Soybeans		Wheat	Double Crop Soybeans		Grain Sorghum		Total
	Dryland	Irrigated		Lint	Seed	Total	Seed	Lint	Total	Dryland	Irrigated		Dryland	Irrigated	Dryland	Irrigated	
	(bu)	(bu)	(cwt)	(lb)	(ton)		(lb)	(ton)		(bu)	(bu)	(bu)	(bu)	(bu)	(cwt)	(cwt)	
0-5 Year Floodplain																	
Price	3.38	3.38	10.81	0.53	161.60		0.53	161.60		8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	227.0	292.0	107.0	1364.0	1.200		1605.0	1.412		58.0	73.0	107.0	51.0	66.0	78.0	97.0	
Gross Value	767.26	986.96	1156.67	722.92	193.97	916.89	850.65	228.24	1078.89	480.82	605.17	451.54	422.79	547.14	439.92	488.88	
Production Cost	438.02	449.22	587.01			694.77			707.53	266.54	320.74	252.06	249.97	306.38	263.13	292.31	
Net Return	329.24	537.74	569.66			222.12			371.36	214.28	284.43	199.48	172.82	240.76	176.79	196.57	
Percent Distribution	0.096	0.100	0.037			0.050	0.000	0.000	0.048	0.250	0.260	0.147	0.072	0.075	0.006	0.006	1.147
Weighted Net Return	31.61	53.77	21.08			11.11			17.83	53.57	73.95	29.32	12.44	18.06	1.06	1.18	324.97
5 Year-SPF Floodplain																	
Price	3.38	3.38	10.81	0.53	161.60		0.53	161.60		8.29	8.29	4.22	8.29	8.29	5.64	5.04	
Yield	251.0	324.0	119.0	1518.0	1.336		1788.0	1.573		66.0	80.0	120.0	57.0	73.0	86.0	108.0	
Gross Value	848.38	1095.12	1286.39	804.54	215.87	1020.41	947.64	254.27	1201.91	547.14	663.20	506.40	472.53	605.17	485.04	544.32	
Production Cost	443.62	456.69	591.39			694.77			707.53	267.53	321.74	253.65	250.77	307.37	264.13	293.70	
Net Return	404.76	638.43	695.00			325.64			494.37	279.61	341.46	252.75	221.76	297.80	220.91	250.62	
Percent Distribution	0.171	0.114	0.021			0.066			0.046	0.182	0.118	0.124	0.073	0.051	0.084	0.054	1.104
Weighted Net Return	69.21	72.78	14.59			21.49			22.74	50.89	40.29	31.34	16.19	15.19	18.56	13.53	386.81

Table B-5
Expected Annual Acres
Alternative 3.1, First Phase Features
St Johns Bayou and New Madrid Floodway, EIS

Item	Without-Project		Alternative 3.1		Reduction	
	0-5 Year	5 Yr-SPF	0-5 Year	5 Yr-SPF	0-5 Year	5 Yr-SPF
Headwater						
St Johns Bayou	5,418	52	818	0	4,600	52
St James Ditch	7,538	168	246	0	7,292	168
Birds Point Levee Ditch	8,392	64	207	0	8,185	64
Backwater						
St Johns Basin						
Present	12,504	1,714	7,417	264	5,087	1,450
Future 1/	10,792	1,659	6,472	256	4,320	1,403
New Madrid Floodway Basin						
MRL Closure						
Present	68,382	1,318	15,657	0	52,725	1,318
Future 1/	66,612	1,318	14,408	0	52,204	1,318
Pump						
Present	14,291	1,366	9,510	16	4,781	1,350
Future 1/	13,052	1,356	8,404	16	4,648	1,340

1/ Future reflects conversion of cropland to WRP.

Table B-6
Backwater-Headwater Overlap Factors
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS

Item	Backwater-Headwater Overlap Factors
St Johns Bayou, Reach 1	0.663
St James Ditch	0.973
BPLD Reach 1	0.854

with the duration factors, are the base dates from which flood damages, crop replanting, crop substitution, and crop yield reductions are developed. Three cost vectors were developed for the crop budgets used in the program to assess flood damages. These include: (a) production costs and fixed harvesting equipment costs; (b) expected net returns to lands, management, and general farm overhead; and (c) operation revenues consisting of realized gross value of the harvested crop. Major data requirements include crop distribution, net and gross returns by crop, crop substitution data, daily flood duration data, and cleared acres flooded on a daily basis. Current crop mixes, production costs, crop yields, and crop prices were incorporated into the CFDA runs to yield the current crop damage rates per acre presented in Table B-7.

(3). Annual Benefit. The expected annual acres calculated in (1) are multiplied by the average damage per cleared acre flooded from (2) above to obtain crop damage estimates for with- and without-project conditions. These damage estimates are then adjusted by the appropriate backwater-headwater overlap factors presented in Table B-6. The results are presented in Table B-8 for various years. These damages and benefits are put on an annual basis using standard discounting procedures as outlined in the introduction. Total annual benefits for Alternative 3.1 (less the MRL feature) are estimated at $3,336,000 at the current (4.0 percent) discount rate. Including the MRL feature adds an additional $2,598,000 to the project's benefits for a total of $5,934,000.

(4) Risk Analysis. This section provides an estimate of the risk inherent with the economic and hydrologic data used to evaluate the flood damage prevented benefits. It addresses the areas where risk and uncertainty are known to exist so that the economic performance of the project can be expressed in terms of probability distributions. Risk-based analyses incorporate risk and uncertainty into the calculation of agricultural damages by using a simulation technique in which multiple iterations select from the full range of possible values for selected key variables utilized in the computation of proposed project benefits. The resulting mean (average) value and probability distributions provide the decision maker with a more complete analogy of possible results.

This analysis was performed using an Excel spreadsheet in conjunction with an add-on simulation model entitled @Risk. The @Risk program uses Monte Carlo simulation to derive the possible occurrences. Monte Carlo simulation utilizes randomly generated numbers to simulate the occurrences of selected variables from established ranges and distributions. It incorporates the range (maximum and minimum) of possible values for an input variable in the flood damage calculation, and specifies the statistical distribution of likely outcomes over the chosen range. In the case where a normal distribution is assumed, 68 percent of the occurrences of a particular outcome would fall within (plus or minus) one standard deviation, on either side of the mean, and 95 percent within two standard deviations on either side of the mean. With each sample or iteration, a value is selected and utilized through the computational process to derive the proposed project benefits. The sum of all sampled values divided by the number of samples (iterations) yields the expected mean value. This routine is accomplished simultaneously for each of the variables evaluated for its inherent uncertainty.

Table B-7
Crop Damage Rates
Alternative 3.1, First Phase Features
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Item	Without-Project		Alternative 3.1	
	0-5 Year	5 Yr-SPF	0-5 Year	5 Yr-SPF
Headwater				
Present Conditions	64.34	25.45	64.34	25.45
Future Conditions	112.65	53.37	112.65	53.37
Backwater				
St Johns Basin				
Present Conditions	64.34	25.45	37.86	20.71
Future Conditions	112.65	53.37	65.98	40.60
New Madrid Floodway Basin				
MRL Closure				
Present Conditions	38.49	9.25	45.29	0.00
Future Conditions	69.57	18.04	80.88	0.00
Pump				
Present Conditions	72.40	28.90	14.68	28.90
Future Conditions	125.14	61.50	23.68	61.50

Table B-8
Agricultural Crop Damages and Benefits
Alternative 3.1, First Phase Features
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Year	MRL Closure			First Phase Features		
	Without-Project	Alternative 3.1	Benefit	Without-Project	Alternative 3.1	Benefit
2017	2,860,000	2,860,000	0	3,532,000	3,532,000	0
2018	2,896,000	766,000	2,130,000	3,570,000	542,000	3,028,000
2027	3,220,000	839,000	2,381,000	3,914,000	586,000	3,328,000
2037	3,579,000	921,000	2,658,000	4,296,000	635,000	3,661,000
2047	3,939,000	1,002,000	2,937,000	4,677,000	683,000	3,994,000
2057	4,298,000	1,084,000	3,214,000	5,059,000	732,000	4,327,000
2067	4,658,000	1,165,000	3,493,000	5,441,000	781,000	4,660,000
Average Annual Equivalent						
Includes Backwater-Headwater Overlap	3,501,000	903,000	2,598,000	4,212,000	625,000	3,587,000
Excludes Overlap						3,336,000

The initial step in constructing an @Risk simulation is to identify the sources of uncertainty. Some sources of risk and uncertainty arise from measurement errors, small sample sizes, estimation and forecasting errors, and modeling errors. The variables chosen and the amounts they are allowed to vary during the simulation are presented in Table B-9. All distribution functions are assumed to be normal distributions. The variables chosen were Stage Frequency (1.5 foot standard deviation), Stage Area (10%), Projection Factors (25%), Crop Yields (10%), Crop Prices (15%), Production Costs (5%), and Interest Rate (0.25%).

The @Risk simulation was performed utilizing 3,000 iterations, or different combinations, of the chosen variables. The 68 and 95 percent confidence bands around the mean results are plus/minus one and two standard deviations, respectively. An additional step was taken to identify which variable(s) contributed the most to uncertainty. The simulation was run again for all variables, varying each individually while holding the remaining variables constant. The most important variable was the 1.5-foot variation in stage frequency followed by the 10 percent variation in the stage area relationship. The results of the individual simulations for Alternative 3.1 and their ranking are presented in Table B-9. One standard deviation yields a range from a low of $4,688,000 in agricultural flood protection benefits to a high of $7,204,000.

AGRICULTURAL NONCROP BENEFITS.

Flood damages 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 Mississippi State University Department of Agricultural Economics at the Mississippi Agricultural and Forestry Experiment Station. These values in this study were updated to 2012 price levels to reflect current production and equipment costs.

The MSU report estimated flood damages for three types of flood events in 11 counties (limited, moderate, and severe) in the lower Yazoo and Mississippi River delta areas in the Vicksburg District. The limited category was used in this analysis because it was felt to be a conservative estimate. Many farming practices in the study are directly comparable to practices in lower Yazoo River delta area. But due to the geographical distance between the areas it was felt prudent to err to the conservative side. Updated noncrop damage rates ranged upward to a high of $57.65 per acre with an average of $24.69 for 2012 conditions. Future projections were made using the crop input factor described previously yielding a 2067 per acre rate of $28.80. These rates were applied to the expected annual acres flooded presented previously in Table B-5 for without- and with-project conditions. They were discounted using the current discount rate of 4.0%. The results of this analysis for Alternative 3.1 is presented in Table B-10 for individual project features. The MRL Closure provides $1,422,000 in benefits while the remainder of Alternative 3.1 provides $785,000 in benefits for a total of $2,207,000.

Table B-9
Agricultural Flood Damage Prevented
Results of Risk Analysis, Variables Ranked by Importance
Alternative 2, First Phase Features
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Item	Variation	Agricultural Flood Damage Prevented		Rank
		Mean Value	Standard Deviation	
All Variables		5,946,000	1,258,000	
Stage Frequency	1.5 Feet	5,948,000	1,202,000	1
Stage Area	10 Percent	5,921,000	298,000	2
Projection Factors	25 Percent	5,921,000	184,000	3
Crop Yields	10 Percent	5,921,000	152,000	4
Crop Prices	15 Percent	5,922,000	142,000	5
Production Costs	5 Percent	5,921,000	83,000	6
Interest Rate	3.75% to 4.25%	5,922,000	2,000	7

Table B-10
Agricultural Non-Crop Damages and Benefits
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Year	MRL Closure			First Phase Features		
	Without-Project	Alternative 3.1	Benefit	Without-Project	Alternative 3.1	Benefit
2017	1,746,000	1,746,000	0	1,586,000	1,586,000	0
2018	1,750,000	390,000	1,360,000	1,589,000	458,000	1,131,000
2027	1,788,000	395,000	1,393,000	1,612,000	461,000	1,151,000
2037	1,830,000	400,000	1,430,000	1,638,000	464,000	1,174,000
2047	1,872,000	405,000	1,467,000	1,665,000	467,000	1,198,000
2057	1,914,000	410,000	1,504,000	1,691,000	470,000	1,221,000
2067	1,956,000	415,000	1,541,000	1,717,000	473,000	1,244,000
Average Annual Equivalent						
Includes Backwater-Headwater Overlap	1,821,000	399,000	1,422,000	1,326,000	463,000	863,000
Excludes Overlap						785,000

AGRICULTURAL INTENSIFICATION BENEFITS.

Flood protection, full or partial, reduces the financial risks involved in farming operations. Such a reduction allows an intensification of farmlands, which results in higher yields and, subsequently greater net returns to land. Intensification benefits result from an intensification of land that is presently being farmed as no conversion from non-farmed lands is expected to take place. These benefits result from a change to a more profitable crop distribution combination and from more intensive farm inputs that provide greater yields on the individual crops. Flood control improvements would permit better use of land protected from frequent flooding.

a. Increased Net Returns per Acre. The intensification benefits are based on the increase in net returns between with- and without-project conditions and are adjusted to account for the increased residual damage to the intensified practices caused by any remaining flooding. The increase in net productive value per cleared acre after installation of the plan was derived from the data presented in Tables B-3 and B-4. These practices are based on those used by the area farmers under without-project conditions in the above 5-year flood zone less the below 5-year zone.

b. Acres Intensified. These values were applied to the number of acres to be intensified yielding the basic benefit values. The acres intensified are the cleared acres flooded by the 5-year without-project flood less the cleared acres flooded by the 5-year with-project flood (Table B-11).

c. Annual Benefit. The basic benefit values are adjusted downward to account for any increased damage caused by planting higher value crops on those acres flooded after project installation (Table B-12) and the backwater-headwater overlap factors presented in Table B-6 and discussed previously. The results are presented in Table B-13 for various years. These benefits are put on an annual basis using standard discounting procedures as outlined in the introduction. Total annual benefits are estimated at $2,697,000 for the MRL Closure and $917,000 for the remaining features at the current (4.0 percent) discount rate.

Risk Analysis. This section provides an estimate of the risk inherent with the economic and hydrologic data used to evaluate the agricultural intensification benefits. It addresses the areas where risk and uncertainty are known to exist so that the economic performance of the project can be expressed in terms of probability distributions. This analysis was performed very similar to the method used in the Agricultural Benefit section. It uses an Excel spreadsheet in conjunction with a simulation model entitled @Risk. It incorporates the range (maximum and minimum) of possible values for an input variable and specifies the statistical distribution of likely outcomes over the chosen range. In the case where a normal distribution is assumed, 68 percent of the occurrences of a particular outcome would fall within (plus or minus) one standard deviation, on either side of the mean, and 95 percent within two standard deviations on either side of the mean. The variables chosen and the amounts they were allowed to vary are presented in Table B-14. All distribution functions are assumed to be normal. The variables chosen were Stage Frequency (1.5 foot standard deviation), Crop Prices (15%), Crop

Table B-11
Area Subject to Intensification
Five-Year Flood Zone
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS

Item	Without-Project	Alternative 3.1	Area Intensified
Headwater			
St Johns Bayou	3,248	1,074	2,174
St James Ditch	7,284	330	6,954
Birds Point Levee Ditch	5,932	0	5,932
Backwater			
St Johns Basin			
Present	14,527	11,286	3,241
Future 1/	12,912	9,895	3,017
New Madrid Floodway Basin			
MRL Closure			
Present	61,518	18,034	43,484
Future 1/	60,664	17,370	43,294
Pump			
Present	18,034	10,219	7,815
Future 1/	17,370	9,590	7,780

1/ Future reflects conversion of cropland to WRP.

Table B-12
Increased Residual Damage due to Intensified Practices
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
October 2012 Price Levels

Stream/Reach	2012 Increased Residual Damage	2067 Increased Residual Damage
Headwater		
St Johns Bayou	6,793	12,897
St James Ditch	2,914	5,533
Birds Point Levee Ditch	2,581	4,900
Backwater		
St Johns Basin	20,531	36,286
New Madrid Basin		
MRL Closure	729,726	1,450,501
Pump	3,648	6,865

Table B-13
Agricultural Intensification Benefits
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Year	MRL Closure	First Phase Features
2017	0	0
2018	2,134,000	773,000
2027	2,435,000	850,000
2037	2,770,000	935,000
2047	3,105,000	1,021,000
2057	3,440,000	1,106,000
2067	3,775,000	1,191,000
Average Annual Equivalent	2,697,000	917,000

Table B-14
Agricultural Intensification Benefits
Results of Risk Analysis, Variables Ranked by Importance
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Item	Variation	Agricultural Flood Damage Prevented		Rank
		Mean Value	Standard Deviation	
All Variables		3,455,000	618,000	
Stage Frequency	1.5 Feet	3,457,000	416,000	1
Crop Prices	15 Percent	3,560,000	380,000	2
Crop Yields	10 Percent	3,560,000	191,000	3
Stage Area	10 Percent	3,560,000	178,000	4
Projection Factors	25 Percent	3,560,000	169,000	5
Production Costs	5 Percent	3,560,000	77,000	6
Interest Rate	3.75% to 4.25%	3,560,000	60,000	7

Yields (10%), Stage Area (10%), Projection Factors (25%), Production Costs (5%), and Interest Rate (0.25%).

The @Risk simulation was performed utilizing 3,000 iterations, or different combinations, of the chosen variables. The 68 and 95 percent confidence bands around the mean results are plus/minus one and two standard deviations, respectively. The simulation was run again, varying each variable individually while holding the remaining variables constant. The most important variable was the 1.5-foot variation in stage frequency followed by the 15 percent variation in crop prices. The results of the individual simulations and their ranking are presented in Table B-14. One standard deviation yields a range from a low of $2,837,000 in agricultural flood protection benefits to a high of $4,073,000.

STREET AND ROAD BENEFITS.

On several occasions in recent years the Missouri Highway Department has had to sandbag a section of Interstate 55 to prevent overtopping of the highway by floodwaters that back up St Johns Ditch. Representatives of the Department have considered raising this section of the Interstate in the past. They have not done so yet because of the potential of construction of this project. Construction of the pumping station on St Johns Bayou will relieve this flooding problem and save the State of Missouri considerable highway funds. The reduced cost of reconstructing Interstate 55 is estimated at $83,101,000 (Table B-15). This estimate was prepared by the Cost Section of the Memphis District COE. When annualized at the current discount rate and a 50 year period of analysis, an annual benefit of $3,439,000 directly attributable to the St Johns pumping station is estimated.

Other less significant benefits from area roads are also presented in Table B-15. The reduction of headwater flooding in the St Johns Basin is estimated at $102,000 annually while backwater benefits accrue to the New Madrid Floodway pump station ($36,000). The MRL Closure provides $169,000 in annual benefits at 4.0%.

METHODOLOGY USED TO ESTIMATE PROJECT ANNUAL COSTS

The project costs, like the annual benefits, are based on current price levels (October 2012), estimated over a 50-year period of analysis plus the installation period, and discounted to the end of the project installation period using the current Federal discount rate (4.0%). Economic costs associated with the project are initial investment charges, operation and maintenance charges, and replacement charges.

Table B-15
Annual Street and Road Benefit
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Item	$
St Johns Pump Station	
Cost of Raising I55	83,101,000
Present Value Factor	0.88900
Present Value	73,877,000
Amortization Factor	0.04655
Annual Benefit	3,439,000
Benefit to Other Public Roads from Prior Reports	
Headwater	102,000
Backwater	
New Madrid Basin	
MRL Closure	169,000
Pump	36,000
Total	3,746,000

PROJECT FIRST COSTS.

Project financial costs total $164,779,000 for Alternative 3.1 which includes the MRL Features. These costs are based on October 2012 price levels. Included in these costs is the cost of mitigation reforestation. Mitigation reforestation totals $40,358,000. However, a portion of this cost is viewed as a financial cost and not an economic cost. The mitigation reforestation is converting lands from cropland to woodlands. The total cost of the cropland is included in the financial costs because the sponsor will have to expend this amount to acquire the lands. However, the woodlands will still have significant remaining value. Therefore, only the difference between the cropland and woodland costs is viewed as an economic cost to be included in the project's benefit-to-cost ratio. The project economic costs are only $16,915,000 which is a $23,443,000 difference. Project economic costs total $141,337,000 and are assumed to be end of year expenditures for discounting purposes.

ANNUAL INTEREST AND SINKING FUND COSTS.

The annual interest and sinking fund costs are summarized in Table B-16. They are based on a reference point at the beginning of year 2018 (end of year 2017), the current discount rate of 4.0 percent, and a 50 year period of analysis. Annual interest charges are $5,994,000 and annual sinking fund charges are $980,000. Total annual interest and sinking fund costs are $6,974,000.

ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT COSTS.

a. Channel Items. The estimated costs of channel maintenance and replacements for the First Phase feature of Alternative 3.1are presented in Table B-17. These expenditures reflect previous experience with similar projects from this region. Brush-kill is required at 4 year intervals. Channel maintenance is required at 20 year intervals. Bridge replacements are required every 30 to 50 years as dictated by the life of the new bridges. Total maintenance and replacement cost is approximately $37,000.

b. Pumping Stations. Operation, maintenance, and replacement costs associated with the pumping stations are estimated at $109,000 annually for the New Madrid Pump and $129,000 for the St Johns Pump (Table B-18). They include electricity and labor costs replacement of pump impellers every 40 years, gear reducers every 30 years, electric motor stators and motor control centers every 35 years, and roof replacement at 20 year intervals.

Table B-16
Annual Investment Cost
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

	St Johns Basin			New Madrid Floodway Basin				Present	St Johns Basin			New Madrid Floodway Basin			
Year	Channels	Pump	Subtotal	MRL Closure	NNF Pump	Subtotal	Total	Value Factor	Channels	Pump	Subtotal	MRL Closure	NNF Pump	Subtotal	Total
2012	549,000	313,000	862,000				862,000	1.21665	667,941	380,811	1,048,752	0	0	0	1,048,752
2013	3,219,000	1,835,000	5,054,000		317,000	317,000	5,371,000	1.16986	3,765,779	2,146,693	5,912,472	0	370,846	370,846	6,283,318
2014	3,258,000	1,858,000	5,116,000		2,096,000	2,096,000	7,212,000	1.12486	3,664,794	2,089,990	5,754,784	0	2,357,707	2,357,707	8,112,491
2015	12,970,000	7,395,000	20,365,000	19,476,000	13,057,000	32,533,000	52,898,000	1.08160	14,028,352	7,998,432	22,026,784	21,065,242	14,122,451	35,187,693	57,214,477
2016	12,970,000	7,395,000	20,365,000	24,459,000	9,860,000	34,319,000	54,684,000	1.04000	13,488,800	7,690,800	21,179,600	25,437,360	10,254,400	35,691,760	56,871,360
2017	1,731,000	987,000	2,718,000	14,852,000	2,740,000	17,592,000	20,310,000	1.00000	1,731,000	987,000	2,718,000	14,852,000	2,740,000	17,592,000	20,310,000
Total	34,697,000	19,783,000	54,480,000	58,787,000	28,070,000	86,857,000	141,337,000		37,346,666	21,293,726	58,640,392	61,354,602	29,845,404	91,200,006	149,840,398
Annual Interest								0.04000	1,494,000	852,000	2,346,000	2,454,000	1,194,000	3,648,000	5,994,000
Annual Sinking Fund								0.00655	244,000	139,000	383,000	402,000	195,000	597,000	980,000
Total Interest and Sinking Fund								0.04655	1,738,000	991,000	2,729,000	2,856,000	1,389,000	4,245,000	6,974,000

Table B-17
Annual Operation, Maintenance, and Replacement Costs for Channel Items
Alternative3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Item	Cost				Annual Cost			
	Brushkill	Cleanout	Replacements		Brushkill	Cleanout	Replacements	Total
St John's Bayou								
Miles	4.50	4.50						
$			371,000	460,000	1,207	861	10,555	13,000
Frequency	4 Years	20 Years	30 Years	50 Years				
St James Ditch								
Miles	10.80	10.80						
$			816,000	210,000	2,609	1,911	14,151	19,000
Frequency	4 Years	20 Years	30 Years	50 Years				
Birds Point Levee Ditch								
Miles	12.40	12.40						
$					3,197	2,282		5,000
Frequency	4 Years	20 Years						

Table B-18
Annual Operation, Maintenance, and Replacement Costs for Pump Stations
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels, 4.0%)

Item	New Madrid Station			St Johns Station		
	Interval	Replacement Cost	Annual Cost	Interval	Replacement Cost	Annual Cost
Replacement Cost and Interval						
Pump Impellers	40	325,000	3,277	40	277,000	2,686
Gear Reducer	30	210,000	2,576	30	119,000	1,708
Electric Motor Stators	35	136,000	2,030	35	121,000	1,427
Motor Control Center	35	381,000	4,674	35	277,000	3,268
Roof	20	47,000	1,512	20	37,000	1,145
Maintenance Cost						
Roof	7	36,000	4,709	7	26,000	3,270
Estimated Maintenance	1	21,000	21,000	1	21,000	21,000
Operating Cost						
Labor			26,000			26,000
Energy Charges			38,000			63,000
Facility Charge			5,000			5,000
Total Annual Costs			109,000			129,000

SUMMARY OF PLANS

ALTERNATIVE 2.1.

Alternative 2.1 is the St Johns Bayou portion of the total project. It includes the St Johns Bayou pumping station and the channel work on St Johns Bayou, St James Ditch, and Birds Point Levee Ditch which is designed to provide an outlet to the city of East Prairie, Missouri.

a. Annual Benefit. Total annual benefits for Alternative 2.1 are presented in Table B-19. Agricultural benefits account for 49 percent of the feature's benefits. Inundation reduction benefits comprise 91 percent of the benefits followed by intensification at 9 percent.

b. Annual Cost. Annual costs Alternative 2.1 are also presented in Table B-19. Annual interest and sinking fund costs reflecting the financing costs of the project account for 94 percent of the alternative's cost. The remaining 6 percent is operation and maintenance that is primarily operation and maintenance of the pumping station and associated facilities.

c. Summary. Alternative 2.1 has a healthy benefit-to-cost ratio of 2.4 to 1. All increments of the alternative are economically justified.

ALTERNATIVE 2.2.

Alternative 2.2 is the New Madrid Floodway portion of the total project. It includes the 1,500 foot levee closure and structure at the south end of the New Madrid Floodway which will prevent backwater flooding from the Mississippi River and the New Madrid pumping station. Benefits and costs for the closure (MRL feature) are presented for both 4.0% and 2.5% discount rates.

a. Annual Benefit. Total annual benefits for Alternative 2.2 are presented in Table B-19. Agricultural benefits account for 97 percent of the feature's benefits. Inundation reduction benefits comprise 64 percent of the benefits with intensification accounting for 36 percent.

b. Annual Cost. Annual costs Alternative 2.2 are also presented in Table 19. Annual interest and sinking fund costs reflecting the financing costs of the project account for 98 percent of the alternative's cost. The remaining 2 percent is operation and maintenance that is primarily operation and maintenance of the pumping station and associated facilities.

c. Summary. Alternative 2.2 also has a healthy benefit-to-cost ratio of 1.5 to 1. All increments of this alternative are also economically justified.

Table B-19
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 2
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	Alternative 2.1 St Johns Basin			Alternative 2.2 New Madrid Basin				Alternative 2.3 Both Basins
	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,038,000	2,779,000	2,858,000	3,817,000	5,972,000
AG NonCrop	461,000	163,000	624,000	232,000	1,502,000	1,512,000	1,734,000	2,358,000
AG Intensification	486,000	105,000	591,000	512,000	2,825,000	2,919,000	3,337,000	3,928,000
Streets and Roads	102,000	3,439,000	3,541,000	106,000	211,000	214,000	317,000	3,858,000
Total	2,513,000	4,398,000	6,911,000	1,888,000	7,317,000	7,503,000	9,205,000	16,116,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,383,000	3,758,000	2,312,000	5,141,000	7,487,000
Sinking Fund	244,000	139,000	383,000	227,000	615,000	948,000	842,000	1,225,000
O&M	37,000	129,000	166,000	137,000	0	0	137,000	303,000
Total	1,775,000	1,120,000	2,895,000	1,747,000	4,373,000	3,260,000	6,120,000	9,015,000
Excess Benefits	738,000	3,278,000	4,016,000	141,000	2,944,000	4,243,000	3,085,000	7,101,000
BCR	1.4	3.9	2.4	1.08	1.7	2.3	1.5	1.8

ALTERNATIVE 2.3.

Alternative 2.3 is the combined or total. It includes all features of both basins including the 1,500 foot levee closure and structure at the south end of the New Madrid Floodway. Total annual benefits for this alternative are $16,116,000. Total annual costs are $9,015,000. This alternative has a benefit-to-cost ratio of 1.8 to 1. A summary of Alternative 2.3 is also presented in Table B-19.

ALTERNATIVE 3.1.

Alternative 3.1 is a refinement of Alternative 2 above, which incorporates measures designed to avoid some of the detrimental environmental effects associated with Alternative 2. Included is a different start-stop pump/gate closure scenario which will allow for additional winter waterfowl flooding and spring fish passage. Annual benefits and annual costs for the Alternative 3.1 are presented in Table B-20. Like Alternative 2, the majority of benefits are agricultural and inundation reduction. The annual costs reflect a decrease in mitigation costs due to higher start-stop pump/gate closure elevations. All increments are economically feasible as shown in Table B-20. This alternative has also been designated as the NED plan.

ALTERNATIVE 3.2.

Alternative 3.2 is a further refinement of Alternative 3.1, which incorporates a slightly start-stop pump/gate closure scenario which will allow for less winter waterfowl flooding and spring fish passage. However, it still allows for less impact than Alternative 2 and therefore has lower mitigation costs. Annual benefits and annual costs for the Alternative 3.2 are presented in Table B-21. The majority of benefits are also agricultural and inundation reduction. The annual costs while reflecting a decrease in mitigation costs are higher than Alternative 3.1. All increments are economically feasible as shown in Table B-21.

ALTERNATIVE 4.1.

Alternative 4.1 is a further refinement that allows Mississippi River connectivity in the New Madrid Floodway until an elevation of 290 is reached. At this time the MRL gates are closed. This alternative for even more winter waterfowl flooding and spring fish passage. However, because of the increased flooding it provides for less flood protection but has less environmental impacts and therefore lower mitigation costs. Annual benefits and annual costs for the Alternative 4.1 are presented in Table B-22. The majority of benefits are also agricultural and inundation reduction. All increments are economically feasible as shown in Table B-22.

Table B-20
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	St Johns Basin			New Madrid Basin				Both Basins
	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,181,000	2,598,000	2,672,000	3,779,000	5,934,000
AG NonCrop	461,000	163,000	624,000	161,000	1,422,000	1,432,000	1,583,000	2,207,000
AG Intensification	486,000	105,000	591,000	326,000	2,697,000	2,787,000	3,023,000	3,614,000
Streets and Roads	102,000	3,439,000	3,541,000	36,000	169,000	171,000	205,000	3,746,000
Total	2,513,000	4,398,000	6,911,000	1,704,000	6,886,000	7,062,000	8,590,000	15,501,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,194,000	2,454,000	1,510,000	3,648,000	5,994,000
Sinking Fund	244,000	139,000	383,000	195,000	402,000	619,000	597,000	980,000
O&M	37,000	129,000	166,000	109,000	0	0	109,000	275,000
Total	1,775,000	1,120,000	2,895,000	1,498,000	2,856,000	2,129,000	4,354,000	7,249,000
Excess Benefits	738,000	3,278,000	4,016,000	206,000	4,030,000	4,933,000	4,236,000	8,252,000
BCR	1.4	3.9	2.4	1.1	2.4	3.3	2.0	2.1

Table B-21
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 3.2
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	St Johns Basin			New Madrid Basin				Both Basins
	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,233,000	2,622,000	2,697,000	3,855,000	6,010,000
AG NonCrop	461,000	163,000	624,000	191,000	1,433,000	1,443,000	1,624,000	2,248,000
AG Intensification	486,000	105,000	591,000	378,000	2,697,000	2,787,000	3,075,000	3,666,000
Streets and Roads	102,000	3,439,000	3,541,000	49,000	174,000	176,000	223,000	3,764,000
Total	2,513,000	4,398,000	6,911,000	1,851,000	6,926,000	7,103,000	8,777,000	15,688,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,246,000	2,666,000	1,640,000	3,912,000	6,258,000
Sinking Fund	244,000	139,000	383,000	204,000	437,000	673,000	641,000	1,024,000
O&M	37,000	129,000	166,000	115,000	0	0	115,000	281,000
Total	1,775,000	1,120,000	2,895,000	1,565,000	3,103,000	2,313,000	4,668,000	7,563,000
Excess Benefits	738,000	3,278,000	4,016,000	286,000	3,823,000	4,790,000	4,109,000	8,125,000
BCR	1.4	3.9	2.4	1.2	2.2	3.1	1.9	2.1

Table B-22
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 4.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	St Johns Basin			New Madrid Basin				Both Basins
	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,357,000	2,501,000	2,572,000	3,858,000	6,013,000
AG NonCrop	461,000	163,000	624,000	70,000	1,380,000	1,389,000	1,450,000	2,074,000
AG Intensification	486,000	105,000	591,000	157,000	2,564,000	2,649,000	2,721,000	3,312,000
Streets and Roads	102,000	3,439,000	3,541,000	7,000	153,000	156,000	160,000	3,701,000
Total	2,513,000	4,398,000	6,911,000	1,591,000	6,598,000	6,766,000	8,189,000	15,100,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,142,000	2,203,000	1,355,000	3,345,000	5,691,000
Sinking Fund	244,000	139,000	383,000	188,000	360,000	556,000	548,000	931,000
O&M	37,000	129,000	166,000	84,000	0	0	84,000	250,000
Total	1,775,000	1,120,000	2,895,000	1,414,000	2,563,000	1,911,000	3,977,000	6,872,000
Excess Benefits	738,000	3,278,000	4,016,000	177,000	4,035,000	4,855,000	4,212,000	8,228,000
BCR	1.4	3.9	2.4	1.1	2.6	3.5	2.1	2.2

ALTERNATIVE 4.2.

Alternative 4.2 is similar in nature to Alternative 4.1. In addition to the features of 4.1 it includes the reforestation of all croplands below 290. This will prevent the flood damages on these lands by converting them to a non-damaging land use. Annual benefits and annual costs for Alternative 4.2 are presented in Table B-23. The majority of benefits are also agricultural and inundation reduction. The annual costs while reflecting a decrease in mitigation costs are higher than Alternative 3.1. All increments are economically feasible except for the New Madrid Floodway Pumping Station. In addition to the traditional benefits presented in this analysis, Alternative 4.2 has the potential for providing significant nutrient capture and carbon sequestration benefits due to reforesting the croplands below 290. While these benefits cannot be included in the NED analysis, they could potentially be significant. These potential benefits will be addressed later in the Sensitivity Analysis section.

NED PLAN.

A true NED plan was not identified in that all components of the plans were not optimized or sized. For example, no additional pumping station sizes were analyzed. Instead the authorized components were analyzed with differing mitigation scenarios with the focus on lowering environmental impacts while not having significant impacts on the project's outputs. The resulting plan that maximized excess benefits was chosen as the NED plan. This plan is Alternative 3.1 with benefits over costs of $8,252,000. Alternative 4.1 is next with excess benefits of $8,228,000 followed by Alternative 3.2 with $8,125,000, and Alternative 2 with of $7,101,000.

SENSITIVITY ANALYSIS

DISCOUNT RATES.

The Independent Expert Peer Review identified the need to present a sensitivity analysis that included multiple interest rates. This need was primarily due to the project having two different interest rates for the two authorizations. The closure levee used an authorized interest rate of 2.5 percent while the remainder of the project uses the current rate which is not 4.0 percent. So to address this concern it was decided to present three interest rates that bracket the current rate. The rates chosen were 2.5 percent, 4.0 percent, and 7 percent. Table B-24 compares Alternative 3.1 at these three discount rates. As expected all increments of the project are feasible at 2.5 percent. It is also interesting to note that all increments except the New Madrid Floodway Pumping Station and the St Johns Basin Channels are viable at 7 percent.

NUTRIENT CAPTURE AND CARBON SEQUESTRATION BENEFITS. Alternative 4.2 targets all of the cropland below elevation 290 for purchase and reforestation. This is approximately 16,417 acres under existing conditions or 15,768 under future without-project conditions. The 649 acre

Table B-23
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 4.2
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	St Johns Basin			New Madrid Basin				Both Basins
	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	217,000	3,321,000	3,412,000	3,538,000	5,693,000
AG NonCrop	461,000	163,000	624,000	57,000	1,742,000	1,753,000	1,799,000	2,423,000
AG Intensification	486,000	105,000	591,000	157,000	2,564,000	2,649,000	2,721,000	3,312,000
Streets and Roads	102,000	3,439,000	3,541,000	106,000	211,000	214,000	317,000	3,858,000
Total	2,513,000	4,398,000	6,911,000	537,000	7,838,000	8,028,000	8,375,000	15,286,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,370,000	3,735,000	2,297,000	5,105,000	7,451,000
Sinking Fund	244,000	139,000	383,000	224,000	611,000	943,000	835,000	1,218,000
O&M	37,000	129,000	166,000	84,000	0	0	84,000	250,000
Total	1,775,000	1,120,000	2,895,000	1,678,000	4,346,000	3,240,000	6,024,000	8,919,000
Excess Benefits	738,000	3,278,000	4,016,000	-1,141,000	3,492,000	4,788,000	2,351,000	6,367,000
BCR	1.4	3.9	2.4	0.32	1.8	2.5	1.4	1.7

Table B-24
Annual Benefits, Costs, Excess Benefits, and Benefit-to-Cost Ratios
Alternative 3.1
St Johns Bayou and New Madrid Floodway, EIS
(October 2012 Price Levels)

Item	St Johns Basin			New Madrid Basin			Both Basins
	Headwater	Backwater	Total	Pump	Closure	Total	
Discount Rate	**2.5%**	**2.5%**	**2.5%**	**2.5%**	**2.5%**	**2.5%**	**2.5%**
Benefits	2,633,000	3,698,000	6,331,000	1,744,000	7,062,000	8,806,000	15,137,000
Costs	1,323,000	861,000	2,184,000	1,141,000	2,129,000	3,270,000	5,454,000
Excess Benefits	1,310,000	2,837,000	4,147,000	603,000	4,933,000	5,536,000	9,683,000
BCR	2.0	4.3	2.9	1.5	3.3	2.7	2.8
Discount Rate	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**
Benefits	2,513,000	4,398,000	6,911,000	1,704,000	6,886,000	8,590,000	15,501,000
Costs	1,775,000	1,120,000	2,895,000	1,498,000	2,856,000	4,354,000	7,249,000
Excess Benefits	738,000	3,278,000	4,016,000	206,000	4,030,000	4,236,000	8,252,000
BCR	1.4	3.9	2.4	1.1	2.4	2.0	2.1
Discount Rate	**7.0%**	**7.0%**	**7.0%**	**7.0%**	**7.0%**	**7.0%**	**7.0%**
Benefits	2,326,000	5,683,000	8,009,000	1,640,000	6,603,000	8,243,000	16,252,000
Costs	2,886,000	1,738,000	4,624,000	2,386,000	4,588,000	6,974,000	11,598,000
Excess Benefits	-560,000	3,945,000	3,385,000	-746,000	2,015,000	1,269,000	4,654,000
BCR	0.8	3.3	1.7	0.7	1.4	1.2	1.4

difference is due to lands that are expected to convert to woodlands in the future under the Wetland Reserve Program. Elevation 290 is inundated approximately 1.5 times per year from Mississippi River backwater. The elevations below 290 are inundated more frequently. Because of this frequent flooding along with reforestation these lands have great potential to receive significant benefits from carbon sequestration.

A report prepared in 2000 by Leonard Shabman and Laura Zepp of the Department of Agricultural and Applied Economics at Virginia Tech presents information on the potential value of similar woodlands in the Yazoo River basin in Mississippi. The report was prepared in cooperation with the US Environmental Protection Agency. It is titled, "An Approach for Evaluating Nonstructural Actins with Application to the Yazoo River (Mississippi) Backwater Area. Table E-2 on page 127 of the report gives ranges from $4.71 per acre to $12.19 per acre depending on the species of tree established and the elevation of flooding. Table B-25 reproduces some of this data.

If the 16,417 acre area could be valued at even the low end of the figures in Table B-25, the area would still accrue a substantial benefit. The low end of these benefits would be approximately $77,000 (16,417 acres times $4.71) annually while the upper end would be $200,000 (16,417 times $12.19).

Table B-25
Annual Equivalent Value of per acre Carbon Returns on Alligator (hydric) Soils - Reach One

	Elevation				
	One	Two	Three	Four	Five thru Eight
Sycamore	$6.18	$9.62	$9.99	$9.99	$9.99
Green Ash	$6.54	$10.44	$10.86	$10.86	$10.87
Sweet Gum	$6.18	$9.62	$9.99	$9.99	$9.99
Nuttal Oak	$5.54	$9.35	$10.85	$10.86	$10.86
Seeded Nuttal Oak	$4.71	$7.94	$9.22	$9.23	$9.23
Cottonwood	$9.09	$9.33	$9.33	$9.33	$9.33
Cottonwood-Nuttal Oak Inerplanted	$8.63	$11.05	$11.94	$12.19	$12.19
Cherrybark Oak	-	-	-	-	-
Bald Cypress	$6.67	$10.67	$11.10	$11.10	$11.10

Source: "An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area, by Leonard Shabman and Laura Zepp, Department of Agricultural and Applied Economics, Virginia Tech, February 7, 2000.