APPENDIX 1

MITIGATION

YAZOO BACKWATER AREA REFORMULATION

APPENDIX 1
MITIGATION

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MITIGATION SUMMARY

The reformulation goal was to develop a project that provides an appropriate balance between environmental sustainability and flood damage reduction. To achieve this goal, the mitigation process of avoiding, minimizing, and compensating adverse environmental effects was initiated early in the planning process and was integral to the development of a balanced recommended alternative (Alternative 5). Wetland, aquatic, terrestrial, and waterfowl resources were considered significant resources, and effects to these resources were used in this mitigation analysis. This analysis was conducted using assessment methodologies that accounted for both the quantity of habitat (acres) and the quality of habitat (e.g., capacity to export organic carbon). This approach is consistent with the 1990 Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army.

The recommended alternative includes structural (14,000-cubic-foot-per-second pump station) and nonstructural (reforestation/conservation features on up to 55,600 acres) flood damage reduction features. Avoid and minimize measures included in the recommended alternative were a pump-on elevation of 87 feet, National Geodetic Vertical Datum (the 1982 recommended alternative initiated pumping at 80.0 feet, NGVD); holding water 3 feet higher than currently at the Steele Bayou structure during the low-water period; and the use of a nonstructural flood damage reduction feature (reforestation/conservation features on up to 55,600 acres). The combination of the higher pump-on elevation and holding water 3 feet higher for the recommended alternative reduced losses to wetland function by 67.7 percent, aquatic spawning value by 79.7 percent, aquatic rearing value by 67.4 percent, and waterfowl foraging value by 100.0 percent. There was no effect on terrestrial resource value from these features. The nonstructural flood damage reduction feature (reforestation/conservation features on up to 55,600 acres) offsets any remaining adverse effects to wetland function and aquatic spawning and rearing values. Collectively, the structural and nonstructural features produced a net increase of 11.2 percent in terrestrial resource value, 8.0 percent in aquatic rearing value, 30.3 percent in aquatic spawning value, 52.8 percent in waterfowl foraging value, and a 19.5 percent increase in wetland function for the recommended alternative.

Compensatory mitigation to offset the adverse effects of the pump station construction and hydrologic changes associated with the pump station operation is included in the nonstructural feature (reforestation). A minimum threshold of reforested acres using perpetual conservation easements was calculated for the recommended alternative to ensure a no net loss of environmental values is achieved prior to initiation of the pump station operation. Impacts to spawning habitat were used to determine the minimum threshold. A minimum of 10,662 acres of reforestation under the nonstructural feature is required to achieve a no-net-loss of spawning habitat value. This minimum would also produce a net gain of 6,804 wetland acres (minimum required was 3,858 acres). If the nonstructural feature does not achieve this threshold, any

remaining acres would be acquired in fee title and managed by a Federal or state resource agency. The offer to purchase the remaining perpetual conservation easements will remain open for 10 years after completion of the pump station construction.

Unmet compensation requirements from past construction and mitigation actions were also addressed in the analysis. Impacts from the clearing of 215 acres of bottom-land hardwoods at the pump site in 1986, and additional compensation needed to meet mitigation requirements from the construction of the backwater levee were determined. A total of 4,367 acres of reforestation (519 acres for the pump site and 3,848 acres for the backwater levee) are needed to fulfill these remaining obligations.

A minimum of 15,029 acres of reforestation is required prior to initiation of pumping operations. This reflects the minimum threshold (mitigation) required under the recommended alternative (10,662 acres), remaining compensatory mitigation for past pump site construction (519 acres), and backwater levee construction (3,848 acres). Although a minimum of 15,029 acres is required prior to operation of the pump station, the U.S. Army Corps of Engineers, Vicksburg District, is committed to acquiring and reforesting up to 55,600 acres of the nonstructural feature. The acquisition process would begin 2 months after the Record of Decision is signed and continue for 10 years after completion of the structural feature (pumping station requires a 4-year construction period). This provides a minimum of 14 years for acquisition. Concerns about achieving actual replacement of resource value (e.g., wetland functional value) and additional clearing of bottom-land hardwoods as a result of changes in hydrology were also addressed.

The Vicksburg District initiated a wetland function monitoring program for mitigation lands in the Yazoo Basin in 2000. This monitoring is being conducted by the U.S. Army Engineer Research and Development Center using the Hydrogeomorphic methodology used in the impact assessment. Preliminary data indicate that functional replacement is occurring as projected. However, long-term data are required before final conclusions can be made. If data indicate that functional replacement is not occurring as projected, a mitigation reanalysis would be conducted.

This mitigation analysis indicated that the probability of additional clearing of bottom-land hardwoods as a result of changes in hydrology is low. Of particular concern are the 26,263 of the 189,600 acres of wetlands that would potentially not meet the Federal definition of wetlands as a result of changes in hydrology (although they would still provide wetland functional value). Approximately 18,000 of the 26,263 acres were in the forested or reforested class, and approximately 10,900 acres of these were under some form of public protection (National Wildlife Refuge, National Forest, Wetland Reserve Program, etc.). The low probability for additional clearing was determined based on three factors: (a) 10,900 acres would remain under some form of public protection; (b) regulatory provisions of Swampbuster provide disincentives for additional clearing for agricultural practices; and (c) Geographic Information System analysis of the 1970s, 1980s, 1990s, and 1999 land use indicate that the number of forested acres has remained stable since the early 1980s. Of the 251,780 acres of forest in the early 1970s,

approximately 200,000 of the same forested acres remained in the early 1980s (199,776 acres), early 1990s (200,505 acres), and 2001 (198,001 acres). There is a maximum difference of approximately 2,504 acres between these dates (1.2 percent). In addition, of the 200,000 acres of forest in the project area, approximately 73,000 acres are privately owned nonwetland forest. These acres were never converted (since the early 1970s), despite the fact that these lands do not meet the Federal definition of wetlands.

YAZOO BACKWATER AREA REFORMULATION

APPENDIX 1
MITIGATION

1. This appendix addresses environmental effects of the final array of alternatives, the use of avoid-and-minimize mitigation features, and the development and need for features to compensate aquatic, waterfowl, terrestrial, and wetland losses. It also addresses compensatory mitigation for past construction at the pump station site and additional compensation needed to meet mitigation requirements for construction of the Yazoo Area Backwater levees.

2. This analysis used habitat units (HU) for aquatic and terrestrial resources, duck-use-days (DUD) for waterfowl resources, and functional capacity units (FCU) for wetland resources. The use of HUs, DUDs, and FCUs accounted for not only the number of acres of habitat affected, but also the quality of the habitat being provided to the resource (both acres and resource unit impacts are displayed). Combining both aspects provided a better assessment of the true value of the resources. For example, 1 acre of mature bottom-land hardwoods provides greater wetland functional value than 1 acre of a 10-year-old restored stand of bottom-land hardwoods. Therefore, all mitigation analyses used these units rather than acres to summarize environmental effects and assess the need for compensatory mitigation. This approach is consistent with the 7 February 1990 Memorandum of Agreement between the Environmental Protection Agency (EPA) and the Department of the Army concerning the determination of mitigation under the Clean Water Act Section 404(b)(1) guidelines. Section III.B states ". . . such mitigation should provide, at a minimum, one for one functional replacement (i.e., no net loss of values) . . . ." This approach is also consistent with Regulatory Guidance Letter No. 02-2. Sections 2a, 2c, and 2d address a watershed-based approach, mitigation to replace functional losses to aquatic resources (including wetlands), and functional assessment, replacement, and accounting. Detailed evaluations for these resources are provided in their respective appendixes.

3. The U.S. Army Engineer Research and Development Center (ERDC) (formerly the U.S. Army Engineer Waterways Experiment Station) prepared the aquatic and terrestrial appendixes under the guidance of interagency Habitat Evaluation Procedures (HEP) Teams. The ERDC also prepared the revised waterfowl appendix using a U.S. Fish and Wildlife Service (FWS) methodology based on the caloric value of foraging habitat. The revised Wetland Appendix was prepared by the U.S. Army Corps of Engineers, Vicksburg District; EPA, Region 4; and ERDC.

4. A primary reformulation goal was to develop a project that achieves an appropriate balance between environmental sustainability and flood damage reduction.

RESOURCES

5. The study area contains 629,987 acres of land and water of which 168,736 acres are currently managed by state and Federal agencies or under Federal programs (Table 1-1).

TABLE 1-1
LAND USE WITHIN THE YAZOO BACKWATER STUDY AREA

Land Use	Acres
Cropland	273,100
Forest	241,800
Reforest a/	67,300
Ponds	23,400
Water	24,100
Miscellaneous	300
Total	630,000

a/ Includes herbaceous cover.

6. Significant resources are described in the Final Supplemental Environmental Impact Statement (SEIS) (see Main Report). Waterfowl, terrestrial, wetland, and aquatic resources were considered significant, and these evaluations were used to evaluate avoid, minimize, and compensation features.

7. The effects on waterfowl, terrestrial, wetland, and aquatic resources were reanalyzed after the draft report review. The same methodologies were used for the waterfowl, terrestrial, and aquatic resources, but revisions were made based on comments received, additional field sampling, and updated 2005 land use data. Based on comments and concerns about the draft wetland analysis, a new analysis using a state-of-the-art Geographic Information System technique to determine wetland areal extent and a hydrogeomorphic (HGM) methodology developed by ERDC in cooperation with EPA to determine wetland functional value was used. Although outputs from these new analyses were used, both the revised and draft appendixes are included in the final report for reference. The revised appendixes also include an evaluation of the cumulative effects to these resources with the Big Sunflower River Maintenance Project in place. However, this mitigation analysis was based only on the effects from the Yazoo Backwater Area Project because greater adverse effects occurred to the Yazoo Backwater Area project without the Big Sunflower River Maintenance Project. See the Wetlands Appendix (Appendix 10), Aquatics Appendix (Appendix 11), Waterfowl Appendix (Appendix 12), and the Terrestrial Appendix (Appendix 13) for detailed comparisons of functional impacts with and without the Big Sunflower River Maintenance Project in place.

8. In the 2000 draft, "Yazoo Backwater Reformulation Report" and draft supplemental Environmental Impact Statement, 35 plans were evaluated to determine which would best achieve a sustainable economic and environmental balance. The 35 plans are a compilation of the third and fourth arrays of alternatives defined in the Main Report. The 35 plans (Table 1-2) were grouped into three separate categories--nonstructural, structural, and combination, as defined in the Main Report.

TABLE 1-2
PROJECT FEATURES - ENVIRONMENTAL INVESTIGATION ARRAY

Alternative Project Plans				
Plan	Features			
	Structural	Easement		
		Existing Woodlands	Existing Open Lands	Water Management
1	N/A	Preserve below 100.3 ft	Use Retained	N/A
2	N/A	Preserve below 100.3 ft	Reforest below 90 ft	N/A
3	14,000-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	N/A
4	14,000-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	Below 80 ft b/
5	14,000-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	Below 85 ft c/
6	14,000-cfs pump a/	Preserve below 85 ft		N/A
7	14,000-cfs pump a/	Preserve below 85 ft	Reforest below 85 ft	Below 80 ft b/
8	14,000-cfs pump a/	Preserve below 85 ft	Reforest below 85 ft	Below 85 ft c/
9	14,000-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	N/A
10	14,000-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	Below 80 ft b/
11	14,000-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	Below 85 ft c/
12	14,000-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	N/A
13	14,000-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	Below 80 ft b/
14	14,000-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	Below 85 ft c/
15	17,500-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	N/A
16	17,500-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	Below 80 ft b/
17	17,500-cfs pump a/	Preserve below 85 ft	Use retained below 85 ft	Below 85 ft c/
18	17,500-cfs pump a/	Preserve below 85 ft	Reforest below 85 ft	N/A
19	17,500-cfs pump a/	Preserve below 85 ft	Reforest below 85 ft	Below 80 ft b/
20	17,500-cfs pump a/	Preserve below 85 ft	Reforest below 85 ft	Below 85 ft c/
21	17,500-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	N/A

TABLE 1-2 (Cont)

Alternative Project Plans				
Plan	Features			
	Structural	Easement		
		Existing Woodlands	Existing Open Lands	Water Management
22	17,500-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	Below 80 ft b/
23	17,500-cfs pump a/	Preserve below 90 ft	Use retained below 90 ft	Below 85 ft c/
24	17,500-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	N/A
25	17,500-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	Below 80 ft b/
26	17,500-cfs pump a/	Preserve below 90 ft	Reforest below 90 ft	Below 85 ft c/
27	14,000-cfs pump d/	N/A	N/A	N/A
28	17,500-cfs pump d/	N/A	N/A	N/A
29	Levee	N/A	N/A	N/A
30	14,000-cfs pump	Preserve below 100.3	N/A	N/A
31	14,000-cfs pump	N/A	Reforest below 87 ft	Below 75 ft e/
32	14,000-cfs pump	N/A	Reforest below 87 ft	Below 73 ft f/
33	14,000-cfs pump	N/A	Reforest below 91 feet	Below 73 feet f/
34	14,000-cfs pump		Reforest below 91 feet	Below 91 feet
35	14,000-cfs pump		Reforest below 88.5 feet	Below 88.5 feet

a/ Pump station would be operated to provide flood damage reduction for cleared lands above the easement elevation.
b/ 1 December to 1 March.
c/ 80 feet 1 December to 1 January and 15 February to 1 March; 85 feet 1 January to 15 February.
d/ Pump station would be operated to provide flood damage reduction for cleared lands above elevation 80 feet except during 1 December to 1 March when pump station would be operated at 85 feet.
e/ Year-round.
f/ Minimum pool will range from elevation 70 to 73 feet during low-water periods.

a. The nonstructural alternative (Alternative 2) included conservation easements on forested and agricultural lands.

b. The structural alternatives (Alternatives 27 and 28) included only the construction of pump stations at different capacities (14,000 cubic feet per second (cfs) and 17,500 cfs) or a levee (Alternative 29) along the Big Sunflower River.

c. The combination alternatives (Alternatives 3-26 and 30-35) included various combinations of structural and nonstructural features. The structural feature was a pump station near the Steele Bayou water control structure with a capacity of 14,000 cfs or 17,500 cfs. The nonstructural feature included conservation easements on forested and agricultural lands and water level management in the ponding area.

9. Since the release of the draft report, three additional nonstructural alternatives were evaluated and included in the final array-- Alternatives 2A, 2B, and 2C. The final array includes 10 alternatives versus 7 alternatives considered in the draft report. A no-action alternative was included in the final array. Table 1-3 shows the relationship of the 35 alternatives to the final array.

TABLE 1-3
PLAN COMPARISON

Final Array Alternatives	Environmental Investigation Array
Alternative	Plan
1	No-Action
2	2
2A	NA
2B	NA
2C	NA
3	27
4	6
5	32
6	35
7	34

FINAL ARRAY ALTERNATIVES

10. The final array includes four nonstructural alternatives (Alternatives 2, 2A, 2B, and 2C), one structural alternative (Alternative 3), four structural and nonstructural combination alternatives (Alternatives 4, 5, 6, and 7), and a no-action alternative (Alternative 1). These alternatives are discussed in detail in the Main Report.

ENVIRONMENTAL EFFECTS

11. The effects of features included in the final array of alternatives include changes in hydrology caused by the pump station operation, changes in habitat function caused by the pump station construction and ring levee construction, changes in hydrology by holding water levels at

the Steele Bayou structure 3 feet higher, and changes in habitat function caused by reforestation and the construction of waterfowl impoundments. Because up to 10 percent of the lands acquired under the nonstructural feature could be used for conservation purposes other than reforestation, 90 percent of acreage was used to calculate reforestation benefits. It was also assumed that 5 percent of the lands could be used for waterfowl impoundments and therefore, waterfowl foraging benefits were calculated on 5 percent of lands acquired for the nonstructural feature. No benefits were quantified on the remaining 5 percent of lands. Based on the analysis contained in the "RISK AND UNCERTAINTY" section of this appendix, the probability of additional clearing of bottom-land hardwoods is low and therefore, this potential effect is not included in this appendix. Hydrologic effects refer to the effects caused by operating the pump station on Alternatives 3 through 7 and effects caused by the ring levees on Alternative 2B. These are classified as structural effects. Reforestation effects refer to effects caused by the conversion of agricultural land to bottom-land hardwood habitat. These are classified as nonstructural effects. Hydrologic and reforestation effects are addressed in the "Environmental Effects Due to Pump Operation and Reforestation" section of this appendix. Construction effects (pump site and ring levees) are addressed in the "Environmental Effects Due to Construction" section of this appendix.

ENVIRONMENTAL EFFECTS DUE TO PUMP OPERATION AND REFORESTATION

TERRESTRIAL RESOURCES

12. Effects on terrestrial resources were determined with HEP, which was developed by FWS. A HEP team of biologists from the Corps; FWS; and the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) worked cooperatively to establish the methodology (Appendix 13). Habitat was sampled to determine habitat quality based on habitat suitability index (HSI) models developed for selected evaluation species. Species were selected to reflect the wildlife values of the relatively mature forests existing in the basin. Four species (barred owl, gray squirrel, Carolina chickadee, and pileated woodpecker) inhabit upland forests and forested wetlands. Barred owls and pileated woodpeckers prefer mature forests with closed canopies and large trees. Woodpeckers excavate nesting cavities in live trees or snags, and owls use preexisting cavities. Carolina chickadees nest in small cavities and forage in closed forests with abundant tree foliage. Gray squirrels prefer mature forests with dense understory vegetation and abundant mast-bearing trees such as oaks and hickories. The remaining two species, wood duck and mink, also inhabit forested areas, but require the presence of surface water for at least part of the year. Wood ducks build their nests in large cavities in live trees or snags or will use artificial nest boxes, if present. Brood-rearing habitat consists of areas that are flooded continuously during the spring and have abundant cover near the water's surface. Mink inhabit

wooded swamps and upland forests adjacent to lakes and streams. Much of their diet consists of fish and aquatic invertebrates, although they also capture birds, small mammals, reptiles, and amphibians. A contractor, Geo-Marine, Inc., under the guidance of ERDC and the HEP team, collected habitat data.

13. The HEP estimated current habitat value, future habitat value, compared plans, and devised mitigation strategies. HEP calculated HUs which reflected both the quality and quantity of the habitat. HUs were calculated by multiplying the Habitat Suitability Index (HSI) value, that ranges from 0.0 (unsuitable habitat) to 1.0 (optimum habitat), by the number of acres affected for each species. Effects of each alternative were determined by calculating the net change in average annual HUs (AAHU).

14. The wood duck and mink were the only evaluation species affected by hydrologic changes (Table 1-4). The wood duck HSI model was applied only to areas that were potential brood habitat (9,850 acres), defined as forest that is flooded continuously every year during the brood-rearing period (March-May). The mink model for forested wetlands applied to the number of acres of forest that have surface water present for at least 25 percent of the year (cumulative duration) at 2-year frequency (12,960 acres). Alternative 2B is the only alternative with negative hydrologic effects. There was no effect with Alternatives 2, 2A, 2C, and 3. Alternatives 4, 5, 6, and 7 had small, positive effects.

TABLE 1-4
HYDROLOGIC EFFECTS ON TERRESTRIAL RESOURCES a/

Alternative	Baseline AAHU	Acres Affected		With-Project AAHU	Net Effect AAHU	Relative Effect (%)
		Wood Duck	Mink			
1	699,592	0	0	699,592	0	0.0
2	699,592	0	0	699,592	0	0.0
2A	699,592	0	0	699,592	0	0.0
2B	699,592	-5,175	-6,810	695,691	-3,901	-0.6
2C	699,592	0	0	699,592	0	0.0
3	699,592	0	0	699,592	0	0.0
4	699,592	430	0	699,831	239	0.0
5	699,592	430	0	699,831	239	0.0
6	699,592	430	1,030	699,953	361	0.0
7	699,592	430	1,030	699,953	361	0.0

a/ Hydrologic effects result from operation of the pump station.

15. The reforestation of agricultural lands, included as a nonstructural flood damage reduction feature, provided a 4.7 to 25.0 percent gain over baseline to terrestrial resources across Alternatives 2 through 7 (Table 1-5).

TABLE 1-5
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECTS
ON TERRESTRIAL RESOURCES

Alternative	Hydrologic Effect (AAHU)	Reforestation Acres	Reforestation Effect (AAHU) a/	Net Effect (AAHU)	Relative Effect (%)
1	0	0	0	0	0.0
2	0	124,400	174,658	174,658	25.0
2A	0	81,400	114,286	114,286	16.3
2B	-3,901	26,400	37,066	33,165	4.7
2C	0	114,400	160,618	160,618	23.0
3	0	0	0	0	0.0
4	239	37,200	52,229	52,468	7.5
5	239	55,600	78,062	78,301	11.2
6	361	81,400	114,286	114,647	16.4
7	361	124,400	174,658	175,019	25.0

a/ Ninety percent of the reforestation acreage was used to calculate AAHUs because up to 10 percent of the property could be used for other conservation purposes.

WETLAND RESOURCES

16. The HGM method developed by ERDC and EPA estimated current and future wetland functional value, compared alternatives, and devised mitigation strategies. The procedures, models, and scientific basis used to assess potential adverse effects to wetland functions and the recovery of wetland functions are fully described in the 2002 Yazoo Basin Regional Guidebook and the Wetland Appendix (Appendix 10). Wetland functions evaluated were detain floodwater, detain precipitation, cycle nutrients, export organic carbon, physical removal of elements and compounds, biological removal of elements and compounds, maintain plant communities, and provide wildlife habitat. Wetland functional capacity was estimated using FCUs, which reflected both the quantity and quality of wetland functional values. The value of each wetland function was estimated using a functional capacity index (FCI). The FCI ranged from 0.0 (no value) to 1.0 (optimum function). The FCUs were determined by multiplying the FCI value of each function and the acreage affected. The acres potentially affected by change in hydrology were determined by a pre- and postproject flood duration analysis described in detail in the Wetland Appendix.

17. Alternatives 2, 2A, and 2C had no hydrologic effects (Table 1-6). Alternatives 2B, 3, 4, 5, 6, and 7 all had negative effects ranging from 5.8 percent (Alternative 2B) to 0.4 percent (Alternative 7) loss in some of the functional capacity measured. Functional losses occurred in only four of the eight functions evaluated. The functional analysis included five land use types,

including agricultural lands. Because all agricultural lands potentially impacted are included, impacts to farmed wetlands are accounted for in this category. Table 1-7 illustrates losses across functions for the recommended alternative. The distribution of losses was similar for all alternatives.

TABLE 1-6
HYDROLOGIC EFFECTS ON WETLAND RESOURCES a/

Alternative	Baseline FCU	Acres Affected	With-Project FCU	Net Effect (FCU)	Relative Effect (%)
1	885,296	0	885,296	0	0.0
2	885,296	0	885,296	0	0.0
2A	885,296	0	885,296	0	0.0
2B	885,296	92,104	834,427	-50,869	-5.8
2C	885,296	0	885,296	0	0.0
3	885,296	118,486	841,306	-43,990	-5.0
4	885,296	101,629	853,321	-28,132	-3.2
5	885,296	66,945	871,108	-14,188	-1.6
6	885,296	48,066	875,996	-9,300	-1.0
7	885,296	28,408	881,347	-3,949	-0.4

a/ Hydrologic effects result from operation of the pump station.

TABLE 1-7
DISTRIBUTION OF FUNCTIONAL CAPACITY UNIT LOSSES
RECOMMENDED ALTERNATIVE

Function	Mature Forest	Middle Aged Forest	Early Aged Forest	Recently Logged	Agricultural	Total
Detain Floodwater	0	0	0	0	0	0
Detain Precipitation	0	0	0	0	0	0
Cycle Nutrients	0	0	0	0	0	0
Export Organic Carbon	-2,852	-45	-886	-8	-651	-4,442
Physical Removal of E and C	-2,363	-53	-575	-10	-1,628	-4,629
Biological Removal of E and C	-2,852	-45	-886	-8	-651	-4,442
Maintain Plant Communities	0	0	0	0	0	0
Provide Wildlife Habitat	-471	-7	-195	-2	0	-675
TOTAL	-8,539	-150	-2,542	-28	-2,930	-14,188

18. Wetland functional recovery through reforestation accounts for temporal differences in function as the forest develops (see Table 1-30 for specific values). For example, the detain precipitation function provides 0.25 FCU per acre in the first year after reforestation, 0.50 FCU per acre in the 20th year, and 1.00 FCU per acre in the 50th year. Reforestation of agricultural lands, included as a nonstructural flood damage reduction feature, produced a net gain in wetland functional capacity in 8 of 10 alternatives (Table 1-8). Alternatives 2, 2A, and 2C had only positive effects (30.9 to 47.2 percent increase), and Alternative 3 had only a negative effect (5.0 percent decrease). Alternatives 2B, 4, 5, 6, and 7 had both negative (hydrologic) and positive (reforestation) effects, with a positive net effect for all of these alternatives (4.3 to 46.8 percent increase). Alternative 3 is the only alternative with negative net effects.

TABLE 1-8
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECTS
ON WETLAND RESOURCES

Alternative	Hydrologic Effect (FCU)	Reforestation Acres	Reforestation Effect (FCU)a/	Net Effect (FCU)	Relative Effect (%)
1	0	0	0	0	0.0
2	0	124,400	418,291	418,291	47.2
2A	0	81,400	273,704	273,704	30.9
2B	-50,869	26,400	88,769	37,900	4.3
2C	0	114,400	384,666	384,666	43.4
3	-43,990	0	0	-43,990	-5.0
4	-28,132	37,200	125,084	-96,952	11.0
5	-14,188	55,600	186,953	172,765	19.5
6	-9,300	81,400	273,704	264,404	29.9
7	-3,949	124,400	418,291	414,342	46.8

a/ Ninety percent of the reforestation acreage was used to estimate FCUs because up to 10 percent of the property could be used for other conservation purposes.

19. The FWS is concerned about impacts to lands with shorter hydroperiods (<5 percent backwater flood duration). These are lands affected by the 2-year backwater flood event that do not meet hydrology requirement of the Federal definition of wetlands. In other words, they meet the “in most years” criterion (2-year flood plain), but not the 5 percent backwater flood duration. The HGM analysis evaluated lands with a preproject duration band between 2.5 and 5.0 duration (7 to 13 days) that occurred in the 2-year flood plain (these effects are not included in Table 1-6). Function loss in this duration band ranged from 4,632 FCUs on Alternative 3 to 2,496 FCUs on Alternative 7 (Table 1-9). These impacts are not included in the net effects presented in the “Summary of Environmental Effect” because they do not meet the Federal definition of wetlands. However, the impact of these losses on the recommended mitigation acreage is addressed in the “Resource Summary” section.

TABLE 1-9
HYDROLOGIC LOSSES ON ACREAGE BETWEEN
2.5 AND 5.0 PERCENT DURATION

Alternative	Acres Affected	FCU Loss
1	0	0
2	0	0
2A	0	0
2B	26,527	-3,199
2C	0	0
3	31,434	-4,632
4	29,195	-4,416
5	27,396	-4,154
6	23,677	-3,682
7	14,698	-2,496

WATERFOWL RESOURCES

20. The waterfowl analysis was conducted by ERDC using an FWS methodology based on the caloric value of foraging habitat available to waterfowl during the fall and winter (Appendix 12). This methodology estimated current and future foraging values, compared alternatives, and devised mitigation strategies. A DUD represents the amount of forage required to meet the energy requirements of one duck for 1 day. For example, if an acre of habitat had 100 DUDs, then it could meet the energy requirements of 100 ducks for 1 day. Foraging habitats used were soybeans, rice, fallow, and bottom-land hardwoods flooded 18 inches or less during the winter waterfowl season (November 1 to February 28). The acres of available waterfowl foraging habitat were calculated using the period-of-record hydrologic data (1943-1997). This methodology is discussed in the Engineering Appendix (Appendix 6) and the Waterfowl Appendix.

21. Pump station operation during the waterfowl season will be minimal. For the 55 years between 1943 and 1997, the pumps would have pumped a total of 155 days during the duck season months of December and January or less than 3 days per year in these months throughout that period. Most of those days during that 55-year period were for large flood events which began in December, such as the 1973 flood event (the largest flood event on record in the backwater area) and the 1983 flood event. During this time of year, the Mississippi River is normally experiencing low water; therefore, the gates at the Steele Bayou Drainage Structure will be open and the pump station will not be operated.

22. The DUDs were estimated by multiplying the number of acres of habitat (e.g., rice) by the estimated number of DUD per acre for that habitat (e.g., 580 DUD per acre for rice). Only Alternatives 2B and 3 produced a negative hydrologic effects (Table 1-10). Alternatives 2A and 2C produced no effect, and Alternatives 2, 4, 5, 6, and 7 produced positive hydrologic effects (2.3 to 15.2 percent increase). Net gains in foraging acres occurred on Alternative 2 because water is being held, on average, 3 feet higher at the Steele Bayou structure during the low-water period. This low-water period immediately precedes the winter waterfowl season and provides an additional 1,384 acres of foraging habitat.

TABLE 1-10
HYDROLOGIC EFFECTS ON WATERFOWL RESOURCES a/

Alternative	Baseline DUD	Acres Affected	With-Project DUD	Net Effect	Relative Effect (%)
1	1,849,741	0	1,849,741	0	0.0
2	1,849,741	1,384	2,045,217	195,476	10.6
2A	1,849,741	0	1,849,741	0	0.0
2B	1,849,741	-4,766	1,176,106	-673,635	-36.4
2C	1,849,741	0	1,849,741	0	0.0
3	1,849,741	-128	1,832,256	-17,485	-1.0
4	1,849,741	301	1,891,773	42,032	2.3
5	1,849,741	561	1,927,714	77,973	4.2
6	1,849,741	1,861	2,110,867	261,126	14.1
7	1,849,741	2,001	2,131,332	281,591	15.2

a/ Hydrologic effects result from operation of the pump station.

23. Reforestation of agricultural lands produced negative effects to foraging value for all alternatives except Alternative 3 (Table 1-10). This resulted because the DUD per acre for reforestation is less than the DUD per acre of the agricultural lands being reforested. The net loss in waterfowl foraging value ranged from 1.0 to 51.5 percent. The reforestation acres in Table 1-11 represent only that portion of the total number of agricultural acres flooded 18 inches or less during the wintering waterfowl season (November 1 to February 28) with the alternative in place.

TABLE 1-11
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECTS
ON WATERFOWL RESOURCE

Alternative	Hydrologic Effect (DUD)	Reforestation Acres	Reforestation Effect (DUD) a/	Net Effect (DUD)	Relative Effect (%) a/
1	0	0	0	0	0.0
2	195,476	1,940	-526,574	-331,098	-17.9
2A	0	1,753	-471,171	-471,171	-25.5
2B	-673,635	1,106	-279,754	-953,389	-51.5
2C	0	1,753	-471,171	-471,171	-25.5
3	-17,485	0	0	-17,485	-1.0
4	42,032	1,793	-482,318	-440,286	-23.8
5	77,973	1,827	-491,181	-413,208	-22.3
6	261,126	2,001	-543,808	-282,682	-15.3
7	281,591	2,022	-549,128	-267,537	-14.5

a/ Ninety percent of the reforestation acreage was used to estimate DUDs because up to 10 percent of the property could be used for other conservation purposes.

24. Up to 10 percent of the land acquired for nonstructural flood damage reduction can be used for other conservation purposes, including impoundments with water control structures, to provide winter waterfowl habitat (see alternative descriptions in the Main Report for additional discussion on other conservation purposes). The Vicksburg District will pay landowners for water control structures to be used for creation of winter waterfowl foraging areas on up to 5 percent of the land acquired for nonstructural flood damage reduction (see Plate 4-16). These waterfowl foraging areas would be included in the 10 percent allowed for other conservations purposes. Waterfowl impoundments currently are used extensively on properties in the study area and, therefore, for the purposes of the mitigation analysis, it was assumed that 5 percent of the total land acquisition would be used for waterfowl foraging areas. Because the use of waterfowl foraging areas is voluntary, the Vicksburg District will track the actual acreage converted to waterfowl foraging areas to evaluate whether this goal is being achieved.

25. An average DUD value of 501 DUDs per acre was used to estimate the benefit from waterfowl foraging areas. This was derived by subtracting the average of fallow, rice, and soybean DUDs per acre (536) from the DUD value of 1,037 DUDs per acre for moist soil plants (the anticipated condition in the waterfowl foraging areas). The use of waterfowl foraging areas produced net gains in waterfowl foraging value ranging from 26.6 to 154.0 percent (Table 1-12).

TABLE 1-12
FORAGING BENEFITS FROM WATERFOWL FORAGING AREAS

Alternative	Waterfowl Foraging Areas (acres)	Waterfowl Foraging Areas (DUDs)	Hydrologic and Reforestation Effects (DUDs)	Net Effect (DUDs)	Relative Effect (%)
1	0	0	0	0	0
2	6,220	3,116,220	-331,098	2,785,122	150.6
2A	4,070	2,039,070	-471,171	1,567,899	84.8
2B	1,320	661,320	-953,389	-292,069	-15.8
2C	5,720	2,865,720	-471,171	2,394,549	129.4
3	0	0	-17,485	-17,485	-1.0
4	1,860	931,860	-440,286	491,574	26.6
5	2,780	1,392,780	-413,208	979,572	53.0
6	4,070	2,039,070	-282,682	1,756,388	95.0
7	6,220	3,116,220	-267,537	2,848,683	154.0

AQUATIC RESOURCES

26. Effects to aquatic resources were determined with HEP. A HEP team of biologists from the MDWFP, FWS, and the Corps worked cooperatively to establish the methodology. The analysis was conducted by the ERDC (Appendix 10). The analysis addressed effects to spawning and rearing habitat.

27. The 57 species of fish documented in the Yazoo Backwater study area were assigned to a guild based on reproductive strategy and habitat preference. This arrangement resulted in 12 guild cells that represented the broad range of reproductive requirements (pelagic, sand and gravel, vegetation, and crevice) and habitat preferences (lacustrine/generalists, slack water, and swift water) of the fish assemblage in the Yazoo Backwater study area.

28. The interagency HEP Team selected six evaluation species from the guild, and based on more recent fish collections in the Yazoo Delta, three additional species were selected to better represent the overall fish community that would be susceptible to project impacts. Overall, evaluation species represented greater than 80 percent of the taxa documented in the system. All evaluation species were either numerically abundant or are recreationally/commercially exploitable. All evaluation species can be potentially impacted from reduced flood plain inundation and loss of forested areas as a result of construction. Most evaluation species live in main channel environments as adults, but may move laterally onto the flood plain during spring and early summer to spawn or rear as larvae.

29. Habitat was sampled to determine habitat quality based on habitat suitability models for selected evaluation species. The species were the threadfin shad, blacktail shiner, ghost shiner, speckled chub, smallmouth buffalo, channel catfish, flathead catfish, white crappie, and freshwater drum. The HEP estimated current habitat value, future habitat value, compared alternatives, and evaluated mitigation strategies. The HEP calculated HUs, which reflected both the quality and quantity of the habitat. The HUs were calculated by multiplying the HSI value by the number of acres affected. The HSI values ranged from 0.0 (unsuitable) to 1.0 (optimal habitat).

30. Spawning acres are average acres flooded during March-June within the 2-year flood plain. Spawning acres included only the portion of the flood plain where duration of flooding is greater than 8 days and depth of flooding is greater than 1 foot. There are 34,122 spawning acres available under existing conditions. The hydrologic effect was negative on Alternatives 2B, 3, 4, and 5, with a decrease in spawning value of 35.5, 40.3, 20.9, and 8.2 percent, respectively (Table 1-13). There was no effect on Alternatives 2, 2A, 2C, and 6 and a 7.0 percent increase on Alternative 7.

TABLE 1-13
HYDROLOGIC EFFECTS ON AQUATIC SPAWNING RESOURCE a/

Alternative	Baseline AAHU	Acres Affected	With-Project AAHU	Net Effect (AAHU)	Relative Effect (%)
1	19,337	0	19,337	0	0.0
2	19,337	0	19,337	0	0.0
2A	19,337	0	19,337	0	0.0
2B	19,337	-14,347	12,473	-6,864	-35.5
2C	19,337	0	19,337	0	0.0
3	19,337	-16,285	11,546	-7,791	-40.3
4	19,337	-8,463	15,288	-4,049	-20.9
5	19,337	-3,303	17,757	-1,580	-8.2
6	19,337	-2	19,336	-1	0.0
7	19,337	2,828	20,690	1,353	7.0

a/ Hydrologic effects result from operation of the pump station.

31. Rearing acres are average acres flooded during March-June within the 2-year flood plain. Rearing acres include all flooded acres regardless of duration or depth. There are 135,292 rearing acres available under existing conditions. The hydrologic effect was negative on Alternatives 2B, 3, 4, 5, and 6 with a decrease in rearing value of 36.6, 16.4, 9.9, 5.3 and 1.0 percent, respectively (Table 1-14). There was no effect or a slight increase in rearing value on the remaining alternatives.

TABLE 1-14
HYDROLOGIC EFFECTS ON AQUATIC REARING RESOURCE a/

Alternative	Baseline AAHU	Acres Affected	With-Project AAHU	Net Effect (AAHU)	Relative Effect (%)
1	89,414	0	89,414	0	0.0
2	89,414	2,353	90,766	1,352	1.5
2A	89,414	0	89,414	0	0.0
2B	89,414	-57,002	56,672	-32,742	-36.6
2C	89,414	0	89,414	0	0.0
3	89,414	-25,529	74,751	-14,663	-16.4
4	89,414	-15,364	80,589	-8,825	-9.9
5	89,414	-8,321	84,635	-4,779	-5.3
6	89,414	-1,586	88,504	-910	-1.0
7	89,414	2,442	90,817	1,403	1.6

a/ Hydrologic effects result from operation of the pump station.

32. Reforestation of agricultural lands produced a 4.9 to 93.3 percent net gain in spawning value (Table 1-15) for all alternatives except Alternatives 2B and 3. Reforestation produced 8.1 to 31.6 percent gain in rearing value (Table 1-16) for all alternatives except Alternatives 2B, 3, and 4.

TABLE 1-15
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECTS
AQUATIC SPAWNING RESOURCE

Alternative	Hydrologic Effect (AAHU)	Reforestation Acres	Reforestation Effect (AAHU) a/	Net Effect (AAHU)	Relative Effect (%)
1	0	0	0	0	0.0
2	0	40,299	16,684	16,684	86.3
2A	0	26,370	10,917	10,917	56.5
2B	-6,864	8,552	3,541	-3,323	-17.2
2C	0	37,060	15,343	15,343	79.4
3	-7,791	0	0	-7,791	-40.3
4	-4,049	12,051	4,989	940	4.9
5	-1,580	18,012	7,457	5,877	30.4
6	-1	26,370	10,917	10,916	56.5
7	1,353	40,299	16,684	18,037	93.3

a/ Ninety percent of the reforestation acreage was used to estimate AAHUs because up to 10 percent of the property could be used for other conservation purposes.

TABLE 1-16
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECTS
AQUATIC REARING RESOURCES

Alternative	Hydrologic Effect (AAHU)	Reforestation Acres	Reforestation Effect (AAHU) a/	Net Effect (AAHU)	Relative Effect (%)
1	0	0	0	0	0.0
2	1,352	64,902	26,870	28,222	31.6
2A	0	42,468	17,582	17,582	19.7
2B	-32,742	13,773	5,702	-27,040	-30.2
2C	0	59,685	24,710	24,710	27.6
3	-14,663	0	0	-14,663	-16.4
4	-8,825	19,408	8,035	-790	-0.9
5	-4,779	29,008	12,010	7,231	8.1
6	-910	42,468	17,582	16,672	18.6
7	1,403	64,902	26,870	28,273	31.6

a/ Ninety percent of the reforestation acreage was used to estimate AAHUs because up to 10 percent of the property could be used for other conservation purposes.

SUMMARY OF HYDROLOGIC/ REFORESTATION PROJECT EFFECTS

33. Table 1-17 is a summary of the hydrologic effects on resource units for the final array of alternatives. Table 1-18 is a summary of the reforested effects on resource units for the final array, and Table 1-19 is the combined hydrologic and reforestation effects. Pump station operation had the greatest adverse effect on the wetland and aquatic resources. Reforestation generally had a positive effect for all resources. For combined effects, Alternatives 2B, 3, and 4 were the only alternatives with negative effects on waterfowl, wetland, and/or aquatic resources. There was a net gain in all other resource values on all other alternatives.

TABLE 1-17
HYDROLOGIC EFFECT
ALL RESOURCES

Alternative	Terrestrial (AAHU)	Waterfowl (DUD)	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
1	0	0	0	0	0
2	0	195,476	0	0	1,352
2A	0	0	0	0	0
2B	-3,901	-673,635	-50,869	-6,864	-32,742
2C	0	0	0	0	0
3	0	-17,485	-43,990	-7,791	-14,663
4	239	43,032	-28,132	-4,049	-8,825
5	239	77,973	-14,188	-1,580	-4,779
6	361	261,126	-9,300	-1	-910
7	361	281,591	-3,949	1,353	1,403
Baseline	699,592	1,849,741	885,296	19,337	89,414

TABLE 1-18
REFORESTATION (NONSTRUCTURAL) EFFECT
ALL RESOURCES

Alternative	Terrestrial (AAHU)	Waterfowl (DUD) a/	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
1	0	0	0	0	0
2	174,658	2,785,122	418,291	16,684	26,870
2A	114,286	1,567,899	273,704	10,917	17,582
2B	37,066	-292,069	88,769	3,541	5,702
2C	160,618	2,394,549	384,666	15,343	24,710
3	0	-17,485	0	0	0
4	52,229	491,574	125,084	4,989	8,035
5	78,062	979,572	186,953	7,457	12,010
6	114,286	1,756,388	273,704	10,917	17,582
7	174,658	2,848,683	418,291	16,684	26,870
Baseline	699,592	1,849,741	885,296	19,337	89,414

a/ Includes waterfowl foraging area benefits.

TABLE 1-19
HYDROLOGIC AND REFORESTATION (NONSTRUCTURAL) NET EFFECT
ALL RESOURCES

Alternative	Terrestrial (AAHU)	Waterfowl (DUD) a/	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
1	0	0	0	0	0
2	174,658	2,785,122	418,291	16,684	28,222
2A	114,286	1,665,155	273,704	10,917	17,582
2B	33,165	-292,069	37,900	-3,323	-27,040
2C	160,618	2,491,805	384,666	15,343	24,710
3	0	-17,485	-43,990	-7,791	-14,663
4	52,468	491,573	96,952	940	-790
5	78,301	979,572	172,765	5,877	7,231
6	114,647	1,756,388	264,404	10,916	16,672
7	175,019	2,848,683	414,342	18,037	28,273
Baseline	699,592	1,849,741	885,296	19,337	89,414

a/ Includes waterfowl foraging area benefits.

34. Pump operation had the greatest acreage impact on wetland and aquatic acres, and reforestation acres were greatest on terrestrial and wetland resources (Tables 1-20 and 1-21).

TABLE 1-20
ACRES AFFECTED BY CHANGED HYDROLOGY

Alternative	Terrestrial	Waterfowl	Wetlands	Aquatic c/	
				Spawning	Rearing
1	0	0	0	0	0
2	0	1,384	0	0	2,353
2A	0	0	0	0	0
2B	-11,985 a/	-4,766	92,104	-14,347	-57,002
2C	0	0	0	0	0
3	0	-128	118,486	-16,285	-25,529
4	430 b/	301	101,629	-8,463	-15,364
5	430 b/	561	66,945	-3,303	-8,321
6	1,460 a/	1,861	48,066	-2	-1,586
7	1,460 a/	2,001	28,408	2,828	2,442

a/ Combined wood duck and mink acres.
b/ Wood duck acres only.
c/ Average flooded acres.

TABLE 1-21
ACRES AFFECTED BY REFORESTATION AND
WATERFOWL IMPOUNDMENTS

Alternative	Terrestrial	Waterfowl		Wetlands	Aquatic a/	
		Reforestation a/	Impoundments		Spawning	Rearing
1	0	0	0	0	0	0
2	124,400	1,940	6,220	124,400	40,299	64,902
2A	114,000	1,753	4,070	81,400	26,370	43,468
2B	26,400	1,106	1,320	26,400	8,552	13,773
2C	114,400	1,753	5,720	114,400	37,060	59,685
3	0	0	0	0	0	0
4	37,200	1,793	1,860	37,200	12,051	19,408
5	55,600	1,827	2,780	55,600	18,012	29,008
6	81,400	2,001	4,070	81,400	26,370	42,468
7	124,400	2,022	6,220	124,400	40,299	64,902

a/ Average flooded acres.

ENVIRONMENTAL EFFECTS DUE TO CONSTRUCTION

35. The lands at the pump station site are generally the same today as they were in 1987 (after the initial project construction). Construction of the pump station and bridge relocation, however, could require the conversion of up to an additional 38 acres of bottom-land hardwoods and 5.6 acres of open water. This produced additional losses for all resource categories (Table 1-22). In addition to these effects, there are unmitigated effects from previous construction of Yazoo Backwater features. These effects are addressed in the following section.

TABLE 1-22
CONVERSION EFFECTS a/
FINAL ARRAY ALTERNATIVES

Alternative	Terrestrial (AAHU)	Waterfowl (DUD)	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
1	0	0	0	0	0
2	0	0	0	0	0
2A	0	0	0	0	0
2B	-9,892	-290,768	-16,732	-1,904	-2,116
2C	0	0	0	0	0
3	-113	-2,166	-240	-27	-30
4	-113	-2,166	-240	-27	-30
5	-113	-2,166	-240	-27	-30
6	-113	-2,166	-240	-27	-30
7	-113	-2,166	-240	-27	-30

a/ Effects to the 38 acres of bottom-land hardwoods at the pump station site for Alternatives 3-7. Alternative 2B reflects the effects from 3,156 acres of bottom-land hardwoods cleared for levee construction.

PAST ENVIRONMENTAL EFFECTS

Lake George Area

36. In 1990, the Corps acquired 8,807 acres of agricultural lands in Yazoo County, Mississippi. It was acquired in two parts. One tract consisted of an 8,382-acre block, which was reforested, and now reconnects Panther Swamp NWR with Delta National Forest. The other tract of 425 acres borders Panther Swamp NWR and was reforested too. These properties were acquired to compensate terrestrial losses from project-induced land clearing, reduction in flooding, and rights-of-way clearing for the completed reaches of the Yazoo Area Backwater levees.

37. As part of the reformulation process, compensatory mitigation for the completed Yazoo Area Backwater levees was reanalyzed. The levees were completed in 1978, but the mitigation analysis was not completed until 1982, and the authority to acquire mitigation land was not acquired until passage of the Water Resources Development Act (WRDA) of 1986. This led to a 13-year delay in acquisition of the mitigation property (Lake George). In addition, not all of the Lake George property could be reforested (e.g., levees). Therefore, the Corps in consultation with FWS agreed to restudy the compensatory mitigation requirements for the Yazoo Area Backwater levees. The Corps also agreed to provide any additional compensatory mitigation determined from the reanalysis.

38. The Lake George reanalysis was based on the construction of the Yazoo Area Backwater levees that resulted in the loss of 526,950 terrestrial AAHUs. These losses were documented in "Yazoo Area Pump Project and Yazoo Area and Satartia Area Backwater Levee Projects, Fish and Wildlife Mitigation Report," July 1982. The levee system was completed in 1978; however, mitigation was not purchased and reforestation initiated until 1990. The reanalysis objectives were to:

a. Recalculate HUs lost based on the 13-year delay in implementing the mitigation.

b. Account for the phased planting over an 8-year period (1990-1997).

c. Calculate additional HUs lost assuming additional plantings occur in 2007 (a 10-year delay from 1997).

d. Determine additional compensatory mitigation acreage required.

39. Objectives a and b above were calculated with the following assumptions:

a. 526,950 terrestrial AAHUs were lost.

b. The period of analysis was 63 years rather than 50 years to account for the 13-year delay in implementation.

c. FWS estimated a 55.57 AAHUs per acre gain from reforestation and the Corps estimated 62.78 AAHUs per acre gain. An average of 59.27 AAHUs per acre was used to estimate the gain from reforestation.

d. No AAHU value was assigned at the beginning of planting year 1 and full value was assigned in planting year 8.

e. 8,082 acres were planted from 1990 to 1997.

40. The AAHUs lost from 1978 to 2040 was 33,197,850 HUs (526,950 AAHUs per year X 63 years). Approximately 22,274,436 HUs will be gained from the 8,082 acres planted from 1990 to 1997 (1,676,570 HUs from the phased planting and 20,597,866 HUs from 1998 to 2040). Therefore, 10,923,414 HUs remain to be compensated.

41. Additional compensation will be achieved through conservation easements associated with the recommended alternative in 2008. This would result in an additional 10-year delay in completing the compensation. An additional 479,300 HUs (47,930 AAHUs X 10 years) would be lost during this time period. The 47,930 AAHUs is the difference between the annualized loss of 526,950 AAHUs and the annualized gain of 479,020 from reforesting 8,082 acres. Therefore, the total HUs that require compensation is 11,402,714. Mitigation acreage was determined by dividing the AAHUs loss of 228,054 AAHUs (11,402,714 ÷ 50 years) by the reforestation benefit of 59.27 AAHU per acre. This results in the need for an additional 3,848 acres of reforestation. This additional mitigation acreage is included with the recommended alternative.

42. The 3,848 acres of additional mitigation was based on a terrestrial loss of 526,950 AAHUs. The 526,950 AAHUs were based on an older version of HEP. The most notable difference was that resource values ranged from 0 to 100 rather than 0 to 1.0 used in this appendix. Also, different parameters were measured; however, at the time, this method was agreed to by the Corps and FWS.

Yazoo Backwater Pump Station Site

43. In 1986 the site location of the proposed pump station was cleared of 215.2 acres of bottom-land hardwood wetlands. The inlet and outlet channels and cofferdam were completed. Compensatory mitigation for this impact was not accomplished because construction was stopped as a result of language in WRDA 86 which required cost sharing by the local project sponsor. The sponsor could not meet the cost-sharing requirement and construction stopped prior to mitigation implementation. This mitigation would be implemented in 2008 as part of the conservation easements associated with the recommended alternative. The wetland FCI values from Appendix 10 were used to estimate the wetland functional loss as a result of the 1986 clearing for construction. Approximately 1,362 FCUs were lost from the clearing (assumed a total loss although some wetland function still exists at the site). The 1,362 FCUs were multiplied by 71 years. This accounts for the 21 years since clearing and the continued loss over

the 50-year project life. This total (96,688 FCUs) was divided by the 50-year project life to produce 1,934 FCUs that must be replaced annually over the life of the project. Approximately 519 acres of reforestation is required (1,934 FCUs ÷ 3.74 FCU [value gained from each acre of reforestation, reference Wetland Appendix]) to mitigate the loss in wetland functional value.

SUMMARY OF AVOID-AND-MINIMIZE MEASURES

44. The reformulation goal was to develop a project that provides an appropriate balance between environmental sustainability and flood damage reduction. To achieve this goal, the mitigation process of avoiding and minimizing adverse environmental effects was initiated early in the planning process and was integral to the development of a balanced recommended alternative. Avoid-and-minimize measures in the final array of alternatives included:

a. Higher pump-on elevations (the 1982 recommended alternative initiated pumping at 80.0 feet, NGVD, at the Steele Bayou structure. See Main Report). Additional elevations (at the Steele Bayou structure) considered were 85, 87, 88.5, and 91.0 feet, NGVD.

b. Holding water 3 feet higher at the Steele Bayou structure during the low-water period.

c. Nonstructural flood damage reduction (reforestation).

45. The use of a higher pump-on elevation and holding water 3 feet higher at the Steele Bayou structure significantly reduced adverse effects to the wetland function (between 36.0 and 91.0 percent), waterfowl foraging value (100.0 percent), and aquatic spawning and rearing values (between 39.8 and 100.0 percent) (Table 1-23). The nonstructural flood damage reduction feature (reforestation) offsets any remaining adverse effects to wetland function and aquatic spawning and rearing value (Table 1-24).

TABLE 1-23
REDUCTION OF ADVERSE IMPACTS FROM HIGHER PUMP-ON ELEVATION
AND PONDING WATER BETWEEN 70 AND 73 FEET, NGVD,
AT THE STEELE BAYOU STRUCTURE

Alternative	Pump-On Elevation	Adverse Impact Reduction (%) a/				
		Terrestrial	Waterfowl	Wetlands	Aquatic Spawning	Aquatic Rearing
2	N/A	0.0	0.0	0.0	0.0	0.0
2A	N/A	N/A	N/A	N/A	N/A	N/A
2B	N/A	N/A	N/A	N/A	N/A	N/A
2C	N/A	N/A	N/A	N/A	N/A	N/A
3	80.0	N/A	N/A	N/A	N/A	N/A
4	85.0	0.0	100.0	36.0	48.0	39.8
5	87.0	0.0	100.0	67.7	79.7	67.4
6	88.5	0.0	100.0	78.9	100.0	93.8
7	91.0	0.0	100.0	91.0	100.0	100.0

NOTE: N/A - not a feature of the alternative.
0.0 - No adverse impact reduction because feature provided only net gains to the alternative.
Alternative 2 only includes ponding water between 70.0 and 73.0 feet, NGVD.

a/ Relative adverse impact reduction of HUs, DUDs and FCUs compared to Alternative 3. The percentages are based on hydrologic effects presented in Tables 1-4, 1-6, 1-10, 1-13, and 1-14.

TABLE 1-24
MITIGATION OF ADVERSE IMPACTS FROM REFORESTATION
(NONSTRUCTURAL FLOOD DAMAGE REDUCTION)

Alternative	Adverse Impact Offset (%) a/				
	Terrestrial	Waterfowl b/	Wetlands	Aquatic Spawning	Aquatic Rearing
2	0.0	0.0	0.0	0.0	0.0
2A	0.0	0.0	0.0	0.0	0.0
2B	0.0	69.4	100.0	51.6	17.4
2C	0.0	0.0	0.0	0.0	0.0
3	N/A	N/A	N/A	N/A	N/A
4	0.0	0.0	100.0	100.0	100.0
5	0.0	0.0	100.0	100.0	100.0
6	0.0	0.0	100.0	0.0	100.0
7	0.0	0.0	100.0	0.0	0.0

a/ N/A - not a feature of the alternative.
0.0 - no adverse impact reduction because feature provides only net gains to the alternative.
b/ Includes reforestation and waterfowl foraging areas. Although reforestation results in a net loss of foraging value, the inclusion of waterfowl foraging areas in the recommended alternative offsets reforestation losses and produces a net gain in waterfowl foraging value.

46. By selecting a higher pump-on elevation and holding water 3 feet higher at the Steele Bayou structure, the recommended alternative (7 feet higher than the elevation of 80.0 feet, NGVD, included in the 1982 recommended alternative) reduced adverse effects to wetland function by 67.7 percent, aquatic spawning value by 79.7 percent, aquatic rearing value by 67.4 percent, and waterfowl foraging value by 100.0 percent. There was no effect on terrestrial resource value from this feature. The nonstructural flood damage reduction feature (reforestation) offsets any remaining adverse effects to wetland function and aquatic rearing and spawning value.

SUMMARY OF ENVIRONMENTAL EFFECTS

47. Gains and/or losses to the environment included hydrologic (pump station operation and holding the water level 3 feet higher at the Steele Bayou structure), reforestation/conservation features, and construction effects and past losses that have been prorated over time. Table 1-25 is a summary of these resource changes for the final array of alternatives Table 1-26 is a summary of acreage impacts for the final array of alternatives. The net effects of each alternative are presented as structural effects (hydrologic and construction impacts) and nonstructural effects (reforestation or foraging areas). This allowed the calculation of a minimum threshold of reforestation to achieve a no net loss using structural effects only (mitigation). Table 1-27 provides a summary of resource changes for the recommended alternative only. Table 1-28 is a summary of the net effect of each alternative.

TABLE 1-25
ENVIRONMENTAL GAINS AND LOSSES
YAZOO BACKWATER AREA REFORMULATION
FINAL ARRAY OF ALTERNATIVES
(2005 Land Use)

Alternative	Terrestrial (AAHU)			Wetland (FCU)			Waterfowl (DUD)				Aquatic Spawning (AAHU)			Aquatic Rearing (AAHU)		
	Structural Effect		Nonstructural Effect a/	Structural Effect		Nonstructural Effect a/	Structural Effect		Nonstructural Effect		Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation a/	Construction	Hydrologic	Reforestation a/	Construction	Hydrologic	Reforestation a/	Foraging b/	Construction	Hydrologic	Reforestation a/	Construction	Hydrologic	Reforestation a/
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	174,658	0	0	418,291	0	195,476	-526,574	3,116,220	0	0	16,684	0	1,352	26,870
2A	0	0	114,286	0	0	273,704	0	0	-471,171	2,039,070	0	0	10,917	0	0	17,582
2B	-9,892	-3,901	37,066	-16,732	-50,869	88,769	-290,768	-673,635	-279,754	661,320	-1,904	-6,864	3,541	-2,116	-32,742	5,702
2C	0	0	160,618	0	0	384,666	0	0	-471,171	2,865,720	0	0	15,343	0	0	24,710
3	-113	0	0	-240	-43,990	0	-2,166	-17,485	0	0	-27	-7,791	0	-30	-14,663	0
4	-113	239	52,229	-240	-28,132	125,084	-2,166	42,032	-482,318	931,860	-27	-4,049	4,989	-30	-8,825	8,035
5	-113	239	78,062	-240	-14,188	186,953	-2,166	77,973	-491,181	1,392,780	-27	-1,580	7,457	-30	-4,779	12,010
6	-113	361	114,286	-240	-9,300	273,704	-2,166	261,126	-543,808	2,039,070	-27	-1	10,917	-30	-910	17,582
7	-113	361	174,658	-240	-3,949	418,291	-2,166	281,591	-549,128	3,116,220	-27	1,353	16,684	-30	1,403	26,870

NOTE: Construction effects are those that result from the actual construction site; hydrologic effects are those that result from operation of the structural features; reforestation effects are those that result from reforesting agricultural lands; and foraging effects are those that result from installation of water control structures.

+ indicates a gain in environmental resources.
- indicates a loss in environmental resources.

a/ 90 percent of the reforestation acreage was used to estimate habitat value because up to 10 percent of the nonstructural feature could be used for other conservation purposes.
b/ Assumes 5 percent of the easement lands would be used for waterfowl foraging habitat.

TABLE 1-26
ACRES AFFECTED BY PLAN
YAZOO BACKWATER AREA REFORMULATION
FINAL ARRAY OF ALTERNATIVES
(2005 Land Use)

Alternative	Terrestrial			Wetland			Waterfowl				Aquatic Spawning			Aquatic Rearing		
	Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect		Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation	Construction	Hydrologic	Reforestation	Construction	Hydrologic	Reforestation c/	Foraging d/	Construction	Hydrologic e/	Reforestation e/	Construction	Hydrologic e/	Reforestation e/
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	124,400	0	0	124,400	0	1,384	1,940	6,220	0	0	40,299	0	2,353	64,902
2A	0	0	81,400	0	0	81,400	0	0	1,753	4,070	0	0	26,370	0	0	42,468
2B	-3,156	-11,985 a/	26,400	-3,156	92,104	26,400	-3,156	-4,766	1,106	1,320	-3,156	-14,347	8,552	-3,156	-57,002	13,773
2C	0	0	114,400	0	0	114,400	0	0	1,753	5,720	0	0	37,060	0	0	59,685
3	-38	0	0	-38	118,486	0	-38	-128	0	0	-38	-16,285	0	-38	-25,529	0
4	-38	430 b/	37,200	-38	101,629	37,200	-38	301	1,793	1,860	-38	-8,463	12,051	-38	-15,364	19,408
5	-38	430 b/	55,600	-38	66,945	55,600	-38	561	1,827	2,780	-38	-3,303	18,012	-38	-8,321	29,008
6	-38	1,460 a/	81,400	-38	48,066	81,400	-38	1,861	2,001	4,070	-38	-2	26,370	-38	-1,586	42,468
7	-38	1,460 a/	124,400	-38	28,408	124,400	-38	2,001	2,022	6,220	-38	2,828	40,299	-38	2,442	64,902

NOTE: Construction effects are those losses that result from the actual construction site; hydrologic effects are those that result from operation of the structural features; reforestation effects are those that result from reforesting agricultural lands; and foraging effects are those that result from installation of water control structures.

+ indicates a gain in acres.
- indicates a loss in acres.

a/ Combined wood duck and mink acres.
b/ Wood duck acres only.
c/ Represents only that portion of total number of acres reforested that contribute to waterfowl resources.
d/ Waterfowl foraging acres based on 5 percent of the easement lands.
e/ Average flooded acres.

TABLE 1-27
STRUCTURAL AND NONSTRUCTURAL EFFECTS
RECOMMENDED ALTERNATIVE
YAZOO BACKWATER AREA REFORMULATION

Effect	Terrestrial		Waterfowl		Wetlands		Aquatic Spawning		Aquatic Rearing	
	AAHUs	% Change a/	DUDs	% Change a/	FCUs	% Change a/	AAHUs	% Change a/	AAHUs	% Change a/
Baseline	699,529	-	1,849,741	-	885,296	-	19,337	-	89,414	-
Structural										
Construction	-113	0	-2,166	-0.1	-240	0	-27	-0.1	-30	0
Hydrologic	239	0	77,973	4.2	-14,188	-1.6	-1,580	-8.2	-4,779	-54.0
Total Structural	126	0	75,807	4.1	-14,428	-1.6	-1,607	-8.3	-4,809	-5.4
Nonstructural										
Reforestation	78,062	11.2	-491,181	-26.6	186,953	21.1	7,457	38.6	12,010	13.4
Foraging	N/A		1,392,780	75.3	N/A		N/A		N/A	
Total Nonstructural	78,062	11.2	901,599	48.7	186,953	21.1	7,457	38.6	12,010	13.4
TOTAL	78,188	11.2	977,406	52.8	172,525	19.5	5,850	30.3	7,201	8.0

NOTE: + indicates a gain in environmental resources.
- indicates a loss in environmental resources.

a/ % Change where comparing total to baseline.

TABLE 1-28
ENVIRONMENTAL GAINS AND LOSSES

Alternative	Terrestrial (AAHU)	Waterfowl (DUD)	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
1	0	0	0	0	0
2	174,658 (25.0)	2,785,122 (150.6)	418,291 (47.2)	16,684 (86.3)	28,322 (31.6)
2A	114,286 (16.3)	1,567,899 (84.8)	273,704 (30.9)	10,917 (56.5)	17,582 (19.7)
2B	23,273 (3.3)	-582,837 (-31.5)	21,168 (2.4)	-5,227 (-27.0)	-29,156 (-32.6)
2C	160,618 (23.0)	2,394,549 (129.4)	384,666 (43.4)	15,343 (78.8)	24,710 (27.6)
3	-113 (0.0)	-19,651 (-1.1)	-44,230 (-5.0)	-7,818 (-40.3)	-14,693 (-16.4)
4	52,355 (7.5)	489,408 (26.5)	96,712 (10.9)	913 (4.7)	-820 (-1.0)
5	78,188 (11.2)	977,406 (52.8)	172,525 (19.5)	5,850 (30.3)	7,201 (8.0)
6	114,534 (16.4)	1,754,222 (94.8)	264,164 (29.8)	10,889 (56.3)	16,642 (18.6)
7	174,906 (25.0)	2,846,517 (153.9)	414,102 (46.8)	18,010 (93.1)	28,243 (31.6)

48. In conclusion, the avoid-and-minimize and nonstructural flood damage reduction features reduced or offset all adverse effects on all alternatives except Alternatives 2B and 3, which would require compensatory mitigation. The recommended alternative (Alternative 5) would provide a 19.5 percent increase in wetland function, 11.2 percent increase in terrestrial resource value, 52.8 percent increase in waterfowl foraging value, 30.3 percent increase in aquatic spawning value, and a 8.0 percent increase in aquatic rearing value. The total nonstructural reforestation amount was selected without regard to mitigation and was based on providing flood damage reduction to frequently flooded areas. Only the reforestation acres above that required to offset the impacts from the construction and operation of the pump station are providing any net increases in resource functions. Alternatives 4-6 require the calculation of a minimum threshold of reforestation to achieve a no net loss if the estimated acreage for the nonstructural feature is not achieved.

MITIGATION PLANNING

49. The lands in the lower Mississippi Delta are noted for high value fish and wildlife resources. The area serves as an integral part of the economic and social life of local residents and sportsmen from around the Nation. Incorporating avoid-and-minimize features and the nonstructural reforestation/conservation feature eliminated losses to the terrestrial, wetland, waterfowl, and aquatic resources in the basin.

50. The reforestation of up to 55,600 acres of agricultural lands through perpetual conservation easements from willing sellers is the nonstructural feature of the recommended alternative. Should the minimum threshold of reforestation not be achieved prior to pump station completion, then traditional compensatory mitigation efforts will be used, such as fee title acquisition. The difference in acreage between the voluntary conservation easements and the minimum threshold

of reforestation to achieve a no net loss of resource value will be used as a basis for compensatory mitigation through fee title acquisition. The offer to purchase the remaining perpetual conservation easements will remain open for 10 years after the completion of pump station construction.

COMPENSATION ANALYSIS

TERRESTRIAL RESOURCES

51. The recommend alternative would provide an increase of 78,188 terrestrial AAHUs. Construction of the structural feature had a small negative effect on terrestrial value, and the nonstructural feature provided an increase in terrestrial resource value. The habitat benefits of establishing new forest vary with the characteristics of the site and may depend upon the measures that must be provided at the same time. For example, the four generalist species--barred owl, gray squirrel, Carolina chickadee, and pileated woodpecker--would benefit from almost any newly established forest, if tracts are of sufficient size (>10 acres not counting narrow or fringe woods) and enough time is allowed for growth. Wood ducks, however, require surface water within the forest at least during the brood-rearing period, and have the additional requirement of secure nesting cavities. Mink will use forested wetlands that are flooded more than 25 percent of the year, and also will benefit from establishment of forest cover adjacent to streams or lakes, as long as shoreline vegetation is allowed to develop.

52. The HEP software was used to calculate the net gain in terrestrial AAHUs provided by reforestation of 100 acres of cleared land under various management plans. Models of the predicted HSI values for each evaluation species over the initial stages of forest growth were developed by consensus of the HEP team. It was assumed that management plans would be implemented concurrently with construction. The assumed median date of forest establishment was 2008 and the analysis extended to the end of the project life. AAHU benefits were annualized over the 50-year economic life of the project (Appendix 13).

53. In practice, the selection of tree species composition will depend on the existing hydrology and soil characteristics of the site. Although Table 1-29 was developed specifically for bottom-land hardwoods, it is anticipated that actual forest replacement will involve a mixture of bottom-land hardwood species.

TABLE 1-29
TERRESTRIAL BENEFITS OF FOREST REESTABLISHMENT
UNDER VARIOUS MANAGEMENT PLANS

Plan	Increase in Average Annual Habitat Units (AAHU) per 100 Acres						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
Natural Succession							
MP 1	34.35	25.95	46.80	27.00	0.00	0.00	134.10
MP 2	34.35	25.95	46.80	27.00	62.70	44.55	241.35
MP 3	34.35	25.95	46.80	27.00	62.70	55.65	252.45
Reforestation with Hard-Mast Trees							
MP 4	34.35	47.85	46.80	27.00	0.00	0.00	156.00
MP 5	34.35	47.85	46.80	27.00	62.70	44.55	263.25
MP 6	34.35	47.85	46.80	27.00	62.70	44.55	274.35

54. MPs 1, 2, and 3 assume that the area is allowed to revegetate naturally with a mix of typical bottom-land species, whereas MP 4, 5, and 6 involve active reforestation by planting primarily mast-bearing species (i.e., oaks and hickories). Within each category, plans differ according to the assumed flooding regime within the developing forest or its proximity to a semipermanent stream or lake. Although natural succession was evaluated in the Terrestrial Appendix as a means for mitigation, the cost per HU gained through reforestation is less and therefore, only reforestation (planting) will be used for the nonstructural flood damage reduction (see "Incremental Analysis" section).

55. MP 1 (natural succession) and MP 4 (reforestation) assume that the site is flooded cumulatively less than 25 percent of the year (<90 days) and is not located within 328 feet of a stream or lake containing surface water more than 90 days each year. Therefore, reestablishing forest cover on the site will benefit barred owls, gray squirrels, Carolina chickadees, and pileated woodpeckers, but will provide no habitat for either mink or breeding wood ducks. It probably would not be appropriate to rely solely on these management plans for any project that involves significant impacts to the water-dependent species. However, these MPs may be appropriate in some portions of a larger management area or if more than one site is used in mitigation of project impacts.

56. The remaining plans are applicable to management areas adjacent to streams or lakes that contain water for long periods each year. As long as dense shoreline cover is encouraged, these areas will provide added benefits to mink and wood ducks. The plans are not well suited to flood plain situations because the frequent, very long-duration flooding would likely reduce habitat value for the generalist forest species (barred owl, gray squirrel, Carolina chickadee, pileated woodpecker) and may prevent the establishment of a diverse and structurally complex forest.

57. MP 2 (natural succession) and MP 5 (reforestation) assume that the management area is within 328 feet of a stream or lake that contains surface water for exactly 6 months cumulatively each year including continuous inundation during the March-May wood duck brood-rearing period. If the adjacent water body contained water less than 6 months, the site would have somewhat less value to mink, whereas it would have greater value if water was present more than 6 months. The benefit to wood ducks depends upon the presence of abundant over-water brood cover, and adequate numbers of well maintained, predator-proof nesting boxes.

58. MP 3 (natural succession) and MP 6 (reforestation) assume that the reforested area is within 328 feet of a stream or lake, that water is present more than 9 months each year including the March-to-May period, and that wood duck boxes are provided. Well-developed shoreline cover (for mink) and brood cover over the water (for wood ducks) are required.

59. The value of 156 AAHUs/100 acres for MP4 was used to estimate the terrestrial benefit from reforestation. MP4 was used because it would be difficult to acquire large tracts of land that flood cumulatively more than 25 percent of the year and that are within 328 feet of a stream or lake with water more than 90 days each year. MP4 underestimates benefits because small portions of acquired tracts likely would meet these criteria. Seventy-two acres of the minimum threshold is required to mitigate terrestrial losses associated with the pump station construction, and none of the minimum threshold is for losses attributed to pump operation from the recommended alternative.

WETLAND RESOURCES

60. The recommended alternative would provide an increase of 172,525 FCUs. Although the structural features produced a loss in functional value, the nonstructural feature (reforestation) offset these effects and produced an overall net gain in functional value. The wetland functional value of the reforested lands was estimated by projecting the FCU value per acre for each function over the project life (Table 1-30). Every reforested acre provided 3.74 FCUs per year over the project life. This value assumes that flood duration is less than 5 percent, and therefore underestimates benefits because portions of acquired tracts would have flood durations greater than 5 percent. A detailed discussion on the HGM analysis, assumptions, and models is provided in Appendix 10.

61. Sixty-four acres of the reforestation minimum threshold is required to mitigate wetland losses associated with the pump station construction, and 3,794 acres of the reforestation minimum threshold mitigates for wetland losses resulting from the pump station operation; i.e., change in hydrology. Therefore, to achieve a no net loss, 3,858 acres must be reforested under the nonstructural feature.

TABLE 1-30
AVERAGE ANNUAL CHANGE IN FCU PER ACRE FOR REFORESTED AGRICULTURAL LANDS

Function	FCU/Acre Restoration						Average Annual Change in FCU/Acre a/
	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50	
Detain Floodwater	0.00	0.44	0.59	0.80	0.94	0.97	0.62
Detain Precipitation	0.25	0.38	0.50	0.69	0.88	1.00	0.61
Cycle Nutrients	0.19	0.56	0.60	0.95	1.00	1.00	0.72
Export Organic Carbon	0.03	0.16	0.19	0.31	0.33	0.33	0.23
Physical Removal of E/C	0.00	0.04	0.08	0.17	0.25	0.33	0.15
Biological Removal of E/C	0.03	0.16	0.19	0.31	0.33	0.33	0.23
Maintain Plant Communities	0.00	0.53	0.68	0.82	0.91	0.98	0.65
Provide Wildlife Habitat	0.00	0.00	0.59	0.80	0.87	0.90	0.53
Total	0.49	2.27	3.42	4.87	5.51	5.86	3.74

SOURCE: Wetland Appendix.

a/ Average Annual = (Sum of Year 1 through 50) / 6.

WATERFOWL RESOURCES

62. A total of 977,406 DUDs of waterfowl resource would be gained with the recommended alternative. Although the structural feature produced a gain in DUD, the nonstructural feature produced a loss in DUD. This resulted because the foraging value of reforested lands is less than agricultural lands (Table 1-31). A value of 237 DUDs per acre was used to estimate the effect of reforestation on foraging value. Although reforestation resulted in a loss of DUDs, the addition of waterfowl foraging areas on 5 percent of the nonstructural lands produced a net gain in waterfowl foraging value.

TABLE 1-31
COMPENSATION VALUES FOR WATERFOWL MITIGATION

Land Use	DUD per Acre
Moist Soil	1,037
Rice	580
Soybean	253
Bottom-land Hardwoods @ 30% Red Oak	57
Bottom-land Hardwoods @ 50% Red Oak	123
Bottom-land Hardwoods @ 70% Red Oak	237 a/
Bottom-land Hardwoods @ 90% Red Oaks	270

a/ 70 percent red oaks is used in this appendix as an average seedling survival rate. Forty-one DUD was added due to the present of moist soil (fallow field) habitat during the first years after planting. The 237 DUD/acre is used as the carrying capacity of reforested cleared land in the calculation of future with and without project conditions, and to determine mitigation acres.

63. While the project could have an adverse impact on DUDs (if insufficient waterfowl impoundments [foraging areas] are provided as conservation features in easements), the reforestation provides other functions for waterfowl that were not quantified, but qualitatively offset the possible reduction of foraging habitat. Reforestation is the FWS preferred mitigation technique for waterfowl for several reasons:

a. Reforestation constitutes an ecosystem approach to replacing the waterfowl values. Instead of concentrating on implementing a mitigation feature aimed at primarily replacing the lost food values, reforestation would address all wintering waterfowl habitat requirements. A bottom-land hardwood forest ecosystem provides food and other waterfowl habitat needs such as courtship sites, protection from predators and adverse weather, resting and roosting areas, and isolation from human disturbance.

b. Reforestation would provide a stable, low maintenance, high reliability mitigation feature. These mitigation features would last for the 50-year project life with little or no management/maintenance required. Other mitigation techniques, such as moist soil management areas, would require periodic maintenance and/or active operation in order to provide the predicted food supply. With constantly changing funding priorities a "no maintenance-no operation-self sustaining" mitigation feature is more reliable and cost effective.

c. The chance of successful waterfowl habitat value replacement is highest with reforestation. Reforestation would create a system that would mimic the previously existing bottom-land hardwood ecosystem, which historically has a proven record of providing high quality waterfowl habitat.

d. Application of the principles of landscape ecology dictate that reforestation be used as the primary mitigation technique. To establish ecosystem diversity, large blocks of forested habitat should be established.

e. Reforestation would also offset terrestrial, aquatic, and wetland losses.

f. Reforestation of marginal agricultural or other cleared lands is easily accomplished.

g. Contributes to the goals of the North American Waterfowl Management Plan.

64. Reforested mitigation areas should be subject to frequent and sustained winter flooding. Forest stand composition should intentionally favor, but not be exclusively composed of, heavy seed species dominated by red oaks for maximum benefits to wintering waterfowl. Reforestation benefits could be expected immediately due to the presence and availability of native moist soil plants in the newly planted "forest" and would gradually change to those benefits associated with forest dominated by red oaks and the associated invertebrate community. The Vicksburg District agrees with the FWS preferred waterfowl mitigation technique and plans to follow the management principles.

AQUATIC RESOURCES

65. The recommended alternative would provide an increase of 5,850 AAHUs for spawning habitat and an increase of 7,201 AAHU for rearing habitat. Although the structural feature produced a loss for both habitats, the nonstructural feature (reforestation) offset these effects and produced an overall gain in aquatic value. Spawning and rearing values of reforested lands were estimated by projecting an average HSI value for all evaluation species over the project life (Table 1-32). Every reforested acre provided 0.46 AAHU per acre for spawning and rearing resource values.

TABLE 1-32
REFORESTATION HSI VALUES FOR
OVERALL SPAWNING AND REARING HABITAT

Flood Plain Habitat	Rearing HIS	Spawning HSI
Agricultural	0.3	0.2
Fallow Fields	0.4	0.3
Bottom-land Hardwoods	0.8	0.7
Average Annual HSI a/	0.46	0.46

a/ Annualized net between agricultural value and bottom-land hardwood value assuming a 10-year transition period from agricultural to bottom-land hardwoods. (See Appendix 11 for calculations)

66. Fifty-nine acres of the reforestation minimum threshold is required to mitigate aquatic spawning losses with the pump station construction, and 10,603 acres of the reforestation minimum threshold mitigates for aquatic spawning losses resulting from the pump station operation; i.e., change in hydrology.

67. Because spawning habitat was considered the controlling habitat type (Appendix 10), it was used to calculate the threshold for aquatic resources. EnviroFish (computer program, see Engineering Appendix) was developed especially to delineate spawning habitat because this life stage requires specific hydraulic conditions for eggs to survive. Without successful spawning, year-class strength would be reduced even if rearing habitat was optimum. In contrast to spawning, rearing fishes do not have specific hydraulic requirements other than a preference to slack-water or swift-water conditions, depending on the species. Larval fish can exploit a variety of depths, and most species along the shoreline tend to move with fluctuating water levels without stranding or injury. Deeper, persistent water, inclusive of spawning sites, is exploited by larvae fishes for food (plankton, benthos) as is shallow, transient water for rapid growth (i.e., warmer water temperatures elevate larval fish metabolism). For these reasons, we assumed that spawning is the limiting life stage regulating population growth when changes in flood elevation and duration are altered due to flood control features.

68. The threshold was estimated using 0.46 AAHU per acre. Because spawning acres are the average number of acres flooded per day during the 122-day spawning evaluation period, not every acre reforested will be flooded every day during the 122-day period. On average, 32 percent of the average acres below the 2-year frequency will be flooded on any given day during the 122-day period (30,819 average acres with project divided by 95,134 average maximum acres in the 2-year frequency). Therefore, every acre reforested would only receive 32 percent of the 0.46 HU per acre gain from reforestation (i.e., 0.149 HU/acre). The appropriate reforestation acreage to achieve a no net loss of spawning value from changes in hydrology would be 10,603 acres (1,580 HUs divided by 0.149 HU/acre reforested). In addition, 59 acres

of reforestation is necessary to offset losses from the pump station construction. The total reforestation acreage to mitigate the loss of spawning value from the construction and operation of the pump station is 10,662.

RESOURCE SUMMARY

69. The recommended alternative provided a net gain in terrestrial, wetland, waterfowl, and aquatic resource values (Table 1-33). Although there was a net increase in resource value, this assumed the reforestation component provided enough acres to offset the negative effects of the pump construction and operation. The wetland and aquatic resources both had a loss in resource value under the structural feature that must be offset under the nonstructural feature to achieve a no net loss in resource value (Table 1-34). Spawning habitat required a minimum threshold of 10,662 acres of reforestation to achieve a no net loss. If this acreage is achieved, then wetland function value would achieve a net gain (a net gain of 6,804 acres of bottom-land hardwood wetlands). Table 1-35 summarizes the minimum acreages required for compensatory mitigation of past construction and to achieve a no net loss of resource value under the nonstructural feature of the recommended alternative. A total of 15,029 acres is required to achieve a no net loss of resource value. This mitigation acreage would provide a no net loss of aquatic spawning value, a 1.4 percent increase in waterfowl foraging value, a 2.1 percent increase in terrestrial value, and a 2.4 percent increase in wetland value over baseline conditions.

TABLE 1-33
SUMMARY OF RECOMMENDED ALTERNATIVE EFFECTS

Item	Terrestrial (AAHU)	Waterfowl (DUD)	Wetlands (FCU)	Aquatic (AAHU)	
				Spawning	Rearing
Net Effect	78,188	997,406	172,525	5,850	7,201
Relative Change (%)	11.2	52.8	19.5	30.3	8.0

TABLE 34
MITIGATION/MINIMUM THRESHOLD REFORESTATION REQUIREMENTS
RECOMMENDED ALTERNATIVE

Effect	Terrestrial		Waterfowl		Wetlands		Aquatic Spawning		Aquatic Rearing	
	AAHUs	Threshold Acres	DUDs	Threshold Acres a/	FCUs	Threshold Acres	AAHUs	Threshold Acres	AAHUs	Threshold Acres
Baseline	699,529	-	1,849,741	-	885,296	-	19,337	-	89,414	-
Structural										
Construction	-113	72	-2,166	4	-240	64	-27	59	-30	65
Hydrologic	239	0	77,973	0	-14,188	3,794	-1,580	10,603	-4,779	19,979
Total Structural	126	72	75,807	4	-14,428	3,858	-1,607	10,662	-4,809	20,044
Nonstructural										
Reforestation	78,062	0	-491,181	980	186,953	0	7,457	0	12,010	
Foraging	N/A	NA	1,392,780	0	N/A	N/A	N/A	N/A	N/A	N/A
Total Nonstructural	78,062	0	901,599	980	186,953	0	7,457	0	12,010	0
TOTAL	78,188	72	977,406	984	172,525	3,858	5,850	10,662	7,201	20,044

a/ Acres of waterfowl impoundments.

TABLE 1-35
MITIGATION REFORESTATION ACREAGE
RECOMMENDED ALTERNATIVE

Item	Acreage
Nonstructural Reforestation Required – Recommended Alternative	
Pump Structure – Indirect (Changes in hydrology)	10,603
Pump Structure – Direct (38 acres of woodlands at site)	59
Subtotal	10,662
Compensatory Mitigation Required – Past Construction	
Pump Structure (original 215.2 acres of clearing in 1986 prorated for time lag)	519
Lake George Mitigation Area – (Prorated for time lag and unplanted areas)	3,848
Subtotal	4,367
Total Acreage to be Acquired (Needed to Achieve No-net-loss)	15,029

70. The FWS and EPA have raised concerns about the Vicksburg District's estimate of the extent of wetlands and the level of impacts and mitigation associated with the wetland estimate. The FWS is concerned that lands with a shorter hydroperiod were not included in the wetland analysis. Although the Vicksburg District does not agree that these lands should be included in the wetland and mitigation analyses, it has conducted a functional analysis of lands between the 2.5 to 5.0 duration band (i.e., lands with a shorter hydroperiod). Table 1-9 provides the FCUs associated shorter hydroperiod lands under each alternative. The recommended alternative would result in the loss of 4,154 FCUs, which would need 1,111 acres of mitigation if these losses were included in the mitigation analysis. The EPA is concerned that the Vicksburg District wetland extent may be underestimated by 27,000 acres and therefore, the amount of mitigation may be underestimated. The Vicksburg District's baseline estimate is 189,600 acres, and the EPA's baseline estimate is 216,600 acres (see Appendix 10 for a detailed discussion of this issue). To address this issue, the Vicksburg District calculated a 90 percent confidence range on its flood duration elevation and recalculated the acreage impacted and functional capacity on both the lower and upper 90 percent confidence limits. The Vicksburg District's 90 percent confidence range of 150,000 to 229,000 acres of baseline wetlands encompasses EPA's baseline estimate of 216,000 acres. Using the upper confidence limit of acreage potentially falling below the 5 percent duration (44,600 acres versus 26,300 acres under the recommended alternative), the amount of mitigation acres required would be 7,893 (3,858 acres are required under the recommended alternative). Combining the Vicksburg District's analyses of the FWS and EPA concerns produces the need for 9,004 acres of wetland mitigation. The

recommended alternative requires 10,662 acres of mitigation. Although the Vicksburg District does not agree with the FWS and EPA positions, the current mitigation plan contains sufficient mitigation acreage regardless which wetland extent or impact estimates are used.

IDENTIFICATION AND SCREENING OF ALTERNATIVES

71. Incorporation of features to reduce adverse effects to the environment has been an integral component of the planning and design of the reformulation study. These features are a refinement of the project flood damage reduction plan in an effort to reduce, minimize, avoid, or eliminate adverse environmental effects while not compromising the purpose of the project. The following features were considered during the evaluation of the project impacts.

OPERATION OF PUMP STATION

72. Alternatives 3 through 7 in the final array are all based on the same capacity pump station. The difference between the alternatives is primarily the pump on/off elevation. In general, the lower the pump elevation, the greater the potential for adverse effects to the environment. The consensus of the reformulation effort was to protect higher elevations lands while changing the land use on lower elevation lands. See the "Summary of Avoid-and-Minimize Measures" section for details on the effect of changing the pump-on elevation on reducing adverse impacts.

OPERATION OF STEELE BAYOU/ LITTLE SUNFLOWER STRUCTURES

73. The current minimum ponding area elevation during periods of low water ranges from 68.5 to 70 feet. With this operation plan, the structure was closed 3,475 out of 7,300 days (48 percent) from 1978 to 1997. Out of the 3,475 days the structure was closed, 71 percent of the time (2,452 days) was for environmental purposes (closed in the case of environmental purposes means the gates of the Steele Bayou structure were being manipulated to restrict outflows to maintain minimum depths in the river channel). A revision in this operation plan to raise this minimum ponding area to 70.0 to 73.0 feet was considered in the final array of alternatives. With this operation plan under the recommended alternative, the structure would have been closed 5,017 out of 7,300 days (69 percent). Out of the 5,017 days the structure would have been closed, 80 percent of the time (3,994 days) would have been for environmental purposes and 20 percent for flood damage reduction purposes (1,023 days). Out of the 1,023 days the structure would have been closed for flood damage reduction, 64 percent of the time (657 days), the pump station would also have been pumping. Plate 6-51 (Engineering Appendix) illustrates this relationship for the period-of-record hydrology. This operation plan

would provide a net increase of 1,384 acres of waterfowl foraging habitat and 2,353 acres of rearing habitat, without implementation of the structural or nonstructural features. See the "Summary of Avoid-and-Minimize Measures" section for details on the effect of holding water at a higher elevation on reducing adverse impacts.

MITIGATION BY ACQUISITION AND MANAGEMENT OF SEPARABLE LANDS

Fee Title Acquisition and Management of Bottom-land Hardwoods

74. This alternative, considered in previous studies, is based on providing additional habitat quality through management of existing bottom-land hardwoods. Project-induced losses are assumed to be offset through management of existing bottom-land hardwoods by increasing the HU value of the land. Only the incremental increase in habitat value can be used to offset environmental losses; therefore, vast amounts of land are required. In addition, the net gain from management is difficult to measure; therefore, monitoring of this alternative to ensure increases in habitat values are occurring and offsetting impacts is impractical. Based on this information, acquisition and management of privately owned bottom-land hardwoods to offset project losses was eliminated from further consideration.

Perpetual Land Use Easement Acquisition of Bottom-land Hardwoods

75. This alternative is designed to prevent any change in existing land use for bottom-land hardwoods by securing a perpetual land use easement. This alternative preserves bottom-land hardwoods but does not offset project impacts. No project-induced clearing is anticipated as a result of this study; therefore, this alternative was not considered. In addition, sufficient laws exist that make it not economically feasible to convert bottom-land hardwoods.

Easement Acquisition of Cleared Agricultural Lands with Reforestation

76. Farmers/landowners are allowed to retain ownership, but the lands are removed from production and allowed to revegetate naturally or reforested with naturally occurring hardwood species. The Corps would pay for the appropriate easement, reforestation, and other management requirements. This is the key element in the nonstructural feature of the recommended alternative.

Fee Title Acquisition of Cleared Agricultural Land with Reforestation

77. This alternative would reestablish a functional bottom-land hardwood forest on agricultural lands. The Corps acquisition of these lands would increase the property under Federal control. Management of these lands would become necessary to establish and maintain habitat value of the property.

RECOMMENDED MITIGATION ALTERNATIVE

78. Reforestation of 15,029 acres of bottom-land hardwoods, included in the 55,600 acres, will assure no net loss of resource functions and compensate for hydrologic and construction impacts of the project. The reestablishment of up to 55,600 acres of bottom-land hardwoods and waterfowl impoundments as a nonstructural flood damage reduction feature provided a 11.2 percent increase in terrestrial resource value, 8.0 percent increase in aquatic rearing value, 30.3 percent increase in aquatic spawning value, 52.8 percent increase in waterfowl foraging value, and a 19.5 percent increase in wetland function value. The following sections discuss aspects of implementing the nonstructural feature (reforestation/conservation features). The same aspects would apply to acquisition of mitigation lands if enough acres are not acquired under the nonstructural feature.

IMPLEMENTATION OF NONSTRUCTURAL FLOOD CONTROL

79. Easement acquisition of up to 55,600 acres of agricultural land will be from willing sellers. These lands represent the open lands on or about the equivalency of the 1-year frequency flood plain or the pump-on elevation of 87.0 feet, NGVD, at the Steele Bayou structure. All perpetual conservation easements will be acquired using a blocking factor. In order to achieve the goal of acquiring the easements within the 1-year frequency flood plain, the blocking factor will require the acquisition of some land outside the 1-year flood plain. Due to the Yazoo Backwater study area's hydrology, the Vicksburg District believes most of these blocks would be on those lands within the with-project 2-year frequency flood plain. These easement lands will be removed from agricultural production and reforested with hardwood tree species. The Corps would pay for the appropriate conservation easement and reforestation/conservation features.

80. Prior to the purchase and reforestation of lands under conservation easements and eventual reforestation, several criteria must be met. A cultural resource survey will be conducted as described in Appendix 15, and a hazardous, toxic, and radioactive waste survey will also be conducted. Once these criteria are satisfied, Real Estate Division will prepare a Real Estate Design Memorandum which will have estimated values of the easements prior to offers being made to willing sellers.

81. The process of securing conservation easements could begin in 2008 or after the Record of Decision is signed. A minimum of 15,029 acres will be acquired prior to pump operation. Purchasing of the easements would continue up to 10 years after completion of the pump station. The Corps is committed to the acquisition and reforestation/conservation features of up to 55,600 acres of conservation easements.

REVIEW OF PAST BOTTOM-LAND HARDWOOD RESTORATION EFFORTS

82. The Lower Mississippi River Alluvial Valley, comprising the flood plain of the Mississippi River from southern Illinois to Louisiana, historically contained an estimated 25 million acres of bottom-land hardwood forest (NRCS, Wetland Science Institute, 1998). These bottom-land hardwoods provide function such as wildlife habitat and timber production. Because of their positions along rivers and streams, they also provide function to society such as water quality enhancement and flood control. The objectives of most reforestation programs are to establish forest cover for wildlife habitat or restore other functions and values of cleared bottom-land hardwood systems (King and Keeland, 1999). There has been a major effort by Government agencies in restoring these ecosystems by utilizing Federal funds and restoration programs, such as the CRP, WRP, Wildlife Habitat Improvement Program, and the Environmental Quality Incentives Program.

83. Some problems that often occur in restoration efforts are a lack of clear definition of restoration, clear plans and objectives, and no established baseline for restoration, as well as problems with obtaining the seed and seedlings from suppliers and restored or managed hydrology (King and Keeland, 1999). Ecological restoration is generally accepted as the reestablishment of natural ecological processes that produce certain dynamic ecosystem properties of structure, function, and processes. However, restoration is a term that is often used and applied loosely (Stanturf and Schweitzer, 1998). It is difficult to obtain a clear definition of restoration and quantifying the different spatial end ecological entities involved in restoration success. The lack of clear objectives will increase the chances of failure. There must be objectives in order to be successful in the effort of restoration. Monitoring is critical to ensure

that the plans and objectives are being achieved and find out what went wrong when it fails. Without an established baseline for restoration projects, it will be difficult to monitor for restoration success.

84. Many factors may influence failures or success of a given restoration project, including acorn collection and handling, planting techniques, competition, weather, herbivore damage, species selection, or a combination of all these. As part of a survey conducted by the U.S. Geological Survey (USGS) during late 1997 on "Evaluation of Reforestation in the Lower Mississippi River Alluvial Valley," Federal and state agencies were surveyed. The survey obtained questions dealing with the amounts of restoration tract, problems, failures, and success of reforestation. In the survey, respondents indicated certain problems that could lead to failures of any given restoration project; e.g., excessive flooding, drought and herbicidal damage (King and Keeland, 1999). In 1996, the Forest Service conducted a survey on 46 WRP tracts for the purpose of assessing reforestation success on these tracts (Stanturf and Schweitzer, 1998). According to their findings, the first years of the WRP program were not successful.

85. The success of the Federal and state agency reforestation programs and its foundation on principles of landscape ecology were encouraging; however, as noted by USGS, the overall success is still limited by on-the-ground problems (King and Keeland, 1999). King and Keeland stated in their report that state and Federal agencies are having an impact on reforestation of the Lower Mississippi River Alluvial Valley. To have a successful reforestation or restoration program, the first step is to eliminate the factors responsible for ecosystem degradation (King and Keeland, 1999).

REESTABLISHMENT OF BOTTOM-LAND HARDWOODS

86. Acquisition of conservation easements on agricultural lands will be initiated concurrent with project design and construction. Once a tract of land has been identified, evaluated, and an easement secured by the Corps, a reforestation plan will be developed that will evaluate the species of trees most suitable for this tract. The evaluation will include a review of the frequency and duration of flooding, soil types, tree species common to the area, planting dates, and other factors which may affect the mortality of the trees. The spacing and number of trees per acre will be based on the species recommended and current planting practices. A Federal/state interagency team will also be established to provide technical assistance to landowners. After planting, the tract will be monitored to ensure a sufficient survival rate of trees. If sufficient trees do not survive, the tract will be replanted until sufficient survival rates exist to ensure a satisfactory forest stand.

87. Planting species to provide ecological productivity is the primary objective of the reforestation effort. Additional diversification will come from volunteer species expected for a given site. Plantings and natural regeneration of species such as willow, water, Nuttall, and overcup oaks; bitter pecan; green ash; persimmon and other native species and understory plants will provide diversity to recreate a forest environment ideal for supporting a wide range of wildlife populations.

88. Reforestation can be accomplished through natural succession or artificial regeneration. These reforestation methods are discussed below.

a. Natural succession. This method of reforestation should only be considered where available acorn or other seed sources exist at or near the site to be reforested. The increase in AAHUs associated with natural succession presented in Table 1-29 assumes that reliable mast-producing seed sources exist near or within the mitigation site. Available mitigation lands are typically cultivated on a large scale for crops with little or no adjacent trees for mast sources. Natural regeneration on these types of areas would most likely result in undesirable light seeded, wind-distributed species with few hard mast-producing trees such as oaks and pecans. Although this alternative is economical, quality reforestation and desired mitigation results are site dependent.

b. Artificial regeneration. Experience in the reestablishment of bottom-land hardwoods on mitigation tracts indicates that containerized seedlings tend to survive in much greater proportions than bare root seedlings or trees established through direct seeding. These and other considerations will be taken into account prior to choosing a method of reforestation on a tract-by-tract basis. Seedling survival depends to a great extent on the amount of flooding or drought that occurs during the first few growing seasons. All reasonable techniques will be employed to ensure the survival of seedlings through this critical period.

89. Acquisition of easements and reforestation will be accomplished concurrently with project design and construction. The conservation easements acquired initially will be used to mitigate for past construction at the pump station site and Lake George area. A total of 4,367 acres will be required. After this milestone is met, all future lands will be assigned to the recommended alternative.

INCREMENTAL ANALYSIS

90. Natural regeneration would require the purchase of additional acreage due to a reduced habitat value. Table 1-29 provides a breakdown of estimated terrestrial benefits under various management plans. A breakdown of the cost comparison is shown below.

Artificial Regeneration

15,029 acres x 1.88 AAHUs per acre = 28,254 AAHUs

15,029 acres x $2,247.50 (development costs per acre) = $33,777,677.50

$33,777,677.50 ÷ 28,254 AAHUs = $1,195.50 per AAHU

Natural Regeneration

28,254 AAHUs ÷ 1.66 AAHUs per acre = 17,020 acres

17,020 acres x $2,072.50 (development costs per acre, less reforestation) = $35,273,950.

$35,273,950 ÷ 28,254 AAHUs = $1,248.46 per AAHU

This cost comparison shows that artificial regeneration provides the required AAHUs at less cost. Natural regeneration would require the purchase of conservation easements on an additional 1,991 acres of open lands in order to meet minimum mitigation requirements. Values of AAHUs per acre used in the above calculation are based on a weighted average of 70 percent of Management Plan 4 plus 30 percent of Management Plan 5 to reflect existing available wood duck habitat.

IMPLEMENTATION OF REFORESTATION MEASURES

91. The minimum threshold of reforestation compensates for hydrologic and construction impacts of the alternative which will be generated as part of the nonstructural reforestation. Table 1-36 shows the nonstructural reforestation acres and the mitigation/minimum threshold acres required to offset construction and hydrologic impacts.

TABLE 1-36
COMPARISON OF NONSTRUCTURAL REFORESTATION
AND MITIGATION/MINIMUM THRESHOLD REQUIREMENTS

Alternative	Nonstructural Reforestation (acres)	Mitigation/Minimum Threshold (acres) a/
1	None	None
2	124,400	None
2A	81,400	None
2B	26,400	53,019
2C	114,400	None
3	0	53,363
4	37,200	27,230
5	55,600	10,662
6	81,400	66
7	124,400	0

a/ Number of acres to reforest to achieve a no net loss of spawning resource value. Achieving this threshold would produce net gains in the other resource categories.

92. Under the recommended alternative, the Vicksburg District has committed to the purchase of conservation easements on up to 55,600 acres of agricultural lands on or about elevation 87.0 feet, NGVD. As previously stated, the purchase of easements will begin as soon as the Record of Decision is signed, funding becomes available, and the Real Estate documentation can be completed. This process will run concurrently with the design of and construction of the structural feature. A Real Estate Design Memorandum will have to be prepared by the Vicksburg District in which the estimated values of the easements on those lands offered by willing sellers are approved by higher authority. While an HTRW survey will be conducted prior to purchase of any easement, the cultural resource survey may or may not occur prior to purchase. However, the cultural resource surveys will occur prior to reforestation/conservation features. Once all these criteria are satisfied, Real Estate Division will begin negotiations with the landowner as to the price to be paid for the perpetual easements. As a part of these negotiations, a conservation alternative will be developed, whereby the landowner will delineate those areas where he desires conservation features in lieu of reforestation. When the easement is secured, these lands will be evaluated as to the most suitable species of trees that will be planted on that particular site. A team comprised of the landowner, Vicksburg District, and state and Federal agencies will be assembled to evaluate the best restoration features for that particular site based on soil type, flooding regimes, and landowner management objectives. Seeds and/or seedlings will be ordered from nurseries and planted by the Vicksburg District generally in the late fall and winter. In addition, any water control structures will be sized, ordered, and delivered to the landowners for installation. It will be the responsibility of the landowner to secure any permits that may be required. The Vicksburg District will monitor to be assured that any water control structure furnished to the landowner is installed. Tree survival will be monitored visually by the Vicksburg District to ensure success in the early years; however, after successful establishment, monitoring of both the reforestation and water control

structures will primarily be conducted by remote sensing techniques with visual onsite inspections, if warranted. Planting of the perpetual easement lands, as well as the purchase of water control structures, will be accomplished as rapidly as funding, manpower, seedlings, and structures are available, but should be complete within 24 months of acquisition of the perpetual easements.

93. The first 4,367 acres acquired will be credited to compensatory mitigation required for past construction and the Lake George reanalysis. The next 3,858 acres will achieve a no net loss of wetland functional value. The remaining 6,804 acres to achieve the minimum threshold of reforestation to achieve a no net loss in aquatic spawning resource value will be acquired prior to pump operation. Therefore, a minimum of 15,029 acres must be acquired prior to pump operation. Should the District be unsuccessful in securing enough conservation easements to cover the minimum threshold requirements for pump station construction and operation, compensatory mitigation for the previous work on the inlet and outlet channel, losses from the timing of the mitigation for the Yazoo Backwater levee, and unforested areas within Lake George WMA, then the difference between the amount of conservation easements acquired and the minimum threshold will be purchased in fee title from willing sellers. This purchase in fee would first be evaluated in the Yazoo-Mississippi Delta, but if sufficient agricultural lands were not available, then the District would look elsewhere in the Mississippi Alluvial Valley. Fee title acquisition will follow the same selection criteria as easement acquisition; i.e., primarily the 1-year flood plain with some acquisition above the 1-year flood plain due to real estate blocking requirements. These lands would be reforested and turned over to a state or Federal agency to manage. The offer to purchase the remaining perpetual conservation easements within the Yazoo Backwater Study Area will remain open for 10 years after completion of the pump station construction.

94. Tracts of land acquired by the Corps for fee title would be of sufficient size to justify management or would be contiguous to existing public lands. The Corps will authorize funds to provide for the operation and maintenance of mitigation lands to assure they will be developed and managed to their fullest potential. In order to establish baseline costs associated with management of lands, Tables 1-37 and 1-38 are provided for a conceptual 1,000-acre mitigation tract. Table 1-37 shows a detailed breakdown of the first costs that can be expected to occur with fee title acquisition of mitigation lands. Table 1-38 shows a detailed breakdown of the estimated annual costs necessary for the proper operation and maintenance of Federally owned mitigation lands. The information provided on these two tables (although conceptual) is based on prior acquisition and development of mitigation lands by the Corps in the Yazoo Basin. Actual costs associated with acquisition, development, and operation and maintenance will vary due to the location and hydrology of the actual site.

TABLE 1-37
CONCEPTUAL TRACT OF 1,000 ACRES
ESTIMATED FIRST COSTS a/

Item	Total Value ($)
Real Estate Costs	
Cropland (1,000 acres @ $1,000)	1,000,000
Improvements	20,000
Severance Damage	0
Total Lands	870,000
Contingencies (25%)	228,000
Total Lands	1,245,000
Acquisition Costs	
Two ownerships at $20,000	40,000
Public Law 91-646	
Public Law 91-646	
Relocations	8,000
Hired Labor	1,300
Title II Payments (Two ownerships at $25,000)	50,000
Title III Payments (Two ownerships at $600)	1,200
Total Estimated Real Estate Costs	1,188,000
Development Costs	
Reforestation (1,000 acres at $140 per acre)	140,000
Wood Duck Boxes (1,000 acres * 0.5 * 0.1 * $80 each)	4,000
Road Construction (4 miles at $450,000 per mile)	200,000
Boundary Survey (6 miles at $2,500 per mile)	15,000
Contingencies (25%)	90,000
Total Development Costs	449,000
Engineering and Design (25%)	408,000
Construction Management (10%)	45,000
Total Estimated First Costs	2,247,500

a/ Wood duck boxes, road construction, and boundary survey costs do not apply to easement acquisition.

TABLE 1-38
CONCEPTUAL TRACT OF 1,000 ACRES
ESTIMATED ANNUAL COSTS a/

Item	Total Value ($)
Annual Costs	
Interest Rate (0.06125)	128,000
Sinking Fund (0.0033)	6,900
Wood Duck Boxes (50 at $12 each per year)	600
Canals and Channel Maintenance (1,000 acres at $4/acre/year)	4,000
Road Maintenance (4 miles at $1,500/mile/year)	6,000
Boundary Maintenance (6 miles at $250/mile/year)	1,500
Vegetation and Water Management (1,000 acres at $3/acre/year)	3,000
Timber Management (1,000 acres at $4/acre/year)	4,000
Project Administration (lump sum at $12,000 per year)	12,000
Total Annual Costs	166,000

a/ Applies only to fee title acquisition. The operation and maintenance cost for easement acquisition is $2 per acre per year.

AVAILABILITY OF POTENTIAL CONSERVATION LANDS

95. The Vicksburg District has acquired sizable compensatory mitigation areas in fee title during the past 20 years. While these lands have been located throughout the District, many were located in portions of the Yazoo Backwater project area. A breakdown of the total acreage that was available for purchase, the net acres acquired, and the percentage of mitigation lands acquired concurrent with construction for projects in the area are shown in Table 1-39.

TABLE 1-39
BREAKDOWN OF TOTAL ACREAGE

Project	Available Acres	Purchased Acres	Percent of Available Acquired	Percent Concurrent With Construction
Upper Yazoo	17,784.24	10,919.24	61.4	99.0
Upper Steele	14,207.56	5,568.98	39.2	110.0
Yazoo Backwater Levee	8,809.88	8,773.38	99.6	104.4
Mississippi River Levee	7,418.61	2,140.00	28.9	98.0
Big Sunflower Maintenance	970.00	287.00	29.6	1,510.0
TOTAL	49,190.29	27,688.60	56.3	

96. The area to acquire the 55,600 acres is bounded by the with-project 2-year flood event as an upper limit, with emphasis on acquisition of lands within the 1-year flood event (42,800 acres). The Vicksburg District Hydraulics Branch has spatially identified the area within the with-project 2-year flood event and determined there are 56,428 acres of open land that would potentially be available for perpetual conservation easement acquisition. Because lands will be acquired by section, township, and range, easement acquisition will not follow a contour (i.e., lands below or between defined elevations). Most easement tracts will have to be blocked to facilitate acquisition and will include lands above the 1- to 2-year frequency. The Vicksburg District believes landowners will be willing to enroll portions of their lands in the with-project 2-year frequency because the pump station does not remove all crop damages to these lands. Depending on the landside and riverside stages at the Steele Bayou structure, the pump may not operate during a 2-year or greater flood event. There is still potential annual loss for landowners on with-project 2-year frequency lands.

97. Also, the proposed conservation easement for the Yazoo Backwater Area is very similar to the easement being used in the USDA WRP. Recent conversations with the District Conservationist of the Sharkey-Issaquena County Natural Resources Conservation Service (NRCS) Office revealed that the two-county area had reached its cap acreage for the program.

98. According to the Farm Services Administration (FSA) national database, the two Yazoo Backwater study area counties with the greatest WRP participation (Sharkey and Issaquena) are capped for any additional enrollment (Table 1-40). Based on the Corps GIS database, these counties account for 83 percent of WRP participation in the Yazoo Backwater study area. In other words, the area with the greatest demonstrated WRP participation, and presumably the highest potential future WRP participation, is not available for enrollment in the WRP.

TABLE 1-40
WRP AND CRP PARTICIPATION
SHARKEY AND ISSAQUENA COUNTIES, MS

Item	Sharkey	Issaquena
Total cropland acres	145,162	105,022
WRP acres a/	15,584	8,412

SOURCE: Provided by NRCS from the FSA national website as of 27 May 2007.
a/ Both Sharkey and Issaquena Counties are considered capped for WRP.

99. The NRCS indicated that property owner demand for this type program was still high and that the easement opportunity being offered in the Yazoo Backwater Study Area would be very appealing to the local landowners. Additional conversations with local area landowners confirmed that there are many "willing sellers" within the Yazoo Backwater Study Area who would participate in the reforestation easement process.

MITIGATION MONITORING

100. The Vicksburg District initiated a long-term wetland function monitoring program for mitigation lands in the Yazoo Basin in 2000. This monitoring is being conducted by ERDC using the HGM methodology used in the impact assessment. Preliminary data indicate that functional replacement is occurring as projected (Attachment 1). However, long-term data are required before conclusions can be made. If data indicate that functional replacement is not occurring as projected, then a mitigation reanalysis would be conducted.

101. The bottom-land hardwood establishment techniques and site characteristics for the Yazoo Backwater project will be the same as those of previous mitigation acquisition. As easement lands are acquired and reforested, they will be incorporated into the existing long-term wetland monitoring program.

102. The Vicksburg District will monitor the reforestation and waterfowl impoundment construction to ensure successful stand establishment and impoundment installation. Monitoring of these features to ensure they are not converted to other land uses will be conducted annually using remote-sensing techniques. Should this monitoring indicate a violation in the terms of the easement, the Vicksburg District will take necessary action to regain voluntary compliance with the terms of the agreement or use legal actions, if necessary.

RISK AND UNCERTAINTY

103. The mitigation alternative addresses all known impacts of the project. The Vicksburg District also considered the likelihood that there would be additional project impacts from land use conversion, particularly clearing of current bottom-land hardwoods. The probability of additional clearing of bottom-land hardwoods as a result of changes in hydrology is low. There are 26,263 acres of wetlands that would potentially lose jurisdictional protection as a result of changes in hydrology (although they would still provide wetland functional value, see Appendix 10). Approximately 18,000 of the 26,263 acres were in the forested or reforested class, and approximately 10,900 acres of these were under some form of public protection

(National Wildlife Refuge, National Forest, Wetland Reserve Program, etc.) The low probability for additional clearing was determined based on three factors: (a) 10,900 acres would remain under some form of public protection, (b) regulatory provisions of Swampbuster provide disincentives for additional clearing for agricultural practices, and (c) Geographic Information System analysis of the 1970s, 1980's, 1990s and 1999 land use indicate that the number of forested acres has remained stable since the early 1980s. Of the 251,780 acres of forest in the early 1970s, approximately 200,000 of the same forested acres remained in the early 1980s (199,776 acres), early 1990's (200,505 acres), and 2001 (198,001 acres). There is a maximum difference of approximately 2,504 acres between these dates (1.2 percent). In addition, of the 200,000 acres of forest in the project area, approximately 73,000 acres are privately owned nonwetland forest. These acres have never been converted (since the early 1970s), despite lacking jurisdictional protection. A complete discussion is included in the wetland appendix (Appendix 10).

104. The NRCS has indicated that clearing of bottom-land hardwoods in the entire Mississippi Delta area over the last 20 years has totaled only 1,105 acres and that the provisions of Swampbuster are triggered by the removal of woody vegetation and not changes in drainage (Attachment 2). In addition, the total clearing permitted by the Vicksburg District between 1995 and 2000 in Sharkey and Issaquena Counties (the two largest in the study area) was 44.1 acres (Table 1-41). The mitigation provided for this clearing was 801.8 acres.

TABLE 1-41
SUMMARY OF PERMITTING BY
VICKSBURG DISTRICT
1995-2000

County	Acres Permitted		Mitigation	
	General Permit	Individual Permit	General Permit	Individual Permit
Humphreys	51.0	212.6	72.6	359.1
Issaquena	0.0	0.0	0.0	0.0
Sharkey	21.8	22.3	785.5	16.3
Warren	2.7	21.8	95.1	28.2
Washington	43.4	46.3	49.6	88.2
Yazoo	9.5	71.4	290.0	92.1
Subtotal	128.4	374.4	1,292.8	583.9
Total	502.8		1,876.7	

105. There is a high probability of acquiring agricultural lands which will provide the necessary hydrology to meet the requirements of providing 10,662 acres to meet the minimum threshold to achieve a no net loss of spawning value. Of the acres available for reforestation in the 2-year frequency, 23,335 acres of crop and noncrop meet the criteria for spawning habitat (8-day duration and minimum 1-foot depth) (Figure 1-1).

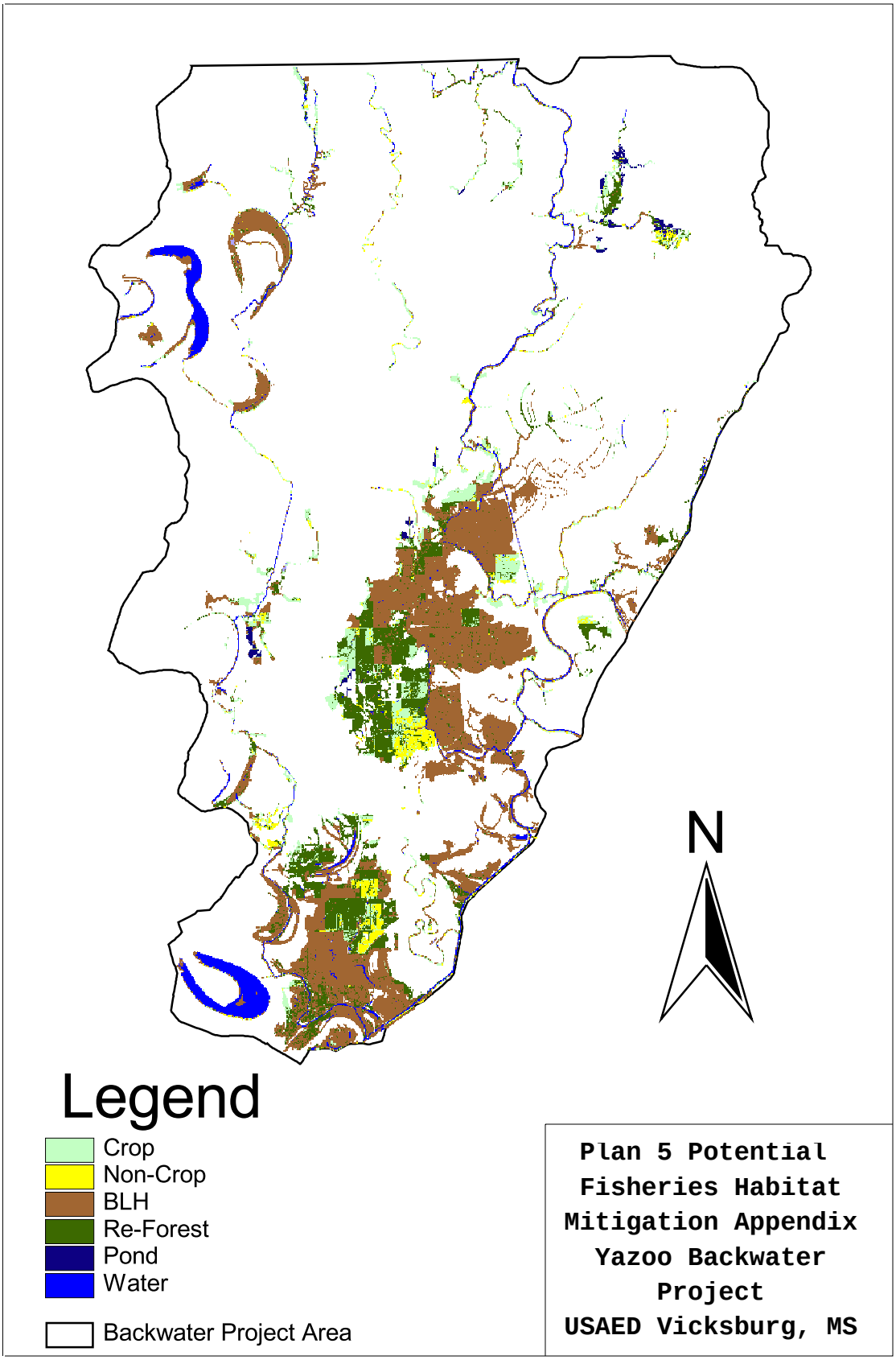
N
Legend
Crop
Non-Crop
BLH
Re-Forest
Pond
Water
Backwater Project Area
Plan 5 Potential Fisheries Habitat Mitigation Appendix Yazoo Backwater Project
USAED Vicksburg, MS

Figure 1-1

STATUS OF VICKSBURG DISTRICT MITIGATION

106. The Vicksburg District is committed to fulfilling all of its authorized mitigation requirements. Lands acquired for mitigation by the Vicksburg District are from willing sellers. The Vicksburg District has been criticized about mitigation timing in relation to flood control projects. The issue is not whether the Vicksburg District has completed mitigation requirements, but rather is mitigation concurrent with project construction. The Vicksburg District has been timely in meeting its mitigation requirements for past projects (Table 1-42). To date, the Vicksburg District has purchased 102,550 acres of mitigation lands, which is 32,165 acres above our required minimum mitigation of 70,385 acres. Since mitigation is ongoing, the data in Table 1-42 are subject to continual change.

TABLE 1-42
VICKSBURG DISTRICT MITIGATION EFFORTS
AUGUST 2006

Project	Acreage Planned for Acquisition	Acreage Acquired a/	Acreage Remaining b/	Total Percent Acquired to Date (%)	Percent Concurrent With Construction
Upper Steele Bayou	5,250	5,569	(319)	103	110
Upper Yazoo Projects	17,000	10,919	6,081	64	99
Yalobusha and Tallahatchie River Channel Maintenance	1,380	1,380	0	100	100
Big Sunflower River Channel Maintenance	1,912	287 c/	1,625	15	1,510
Yazoo Backwater Levee	8,400	8,773	(373)	104	104
Mississippi River Levees	5,200	2,140	3,060	41	98
Aloha-Rigolette Area	964	964	0	100	100
Delta Headwaters Project-Abiaca/Coldwater	1,290	811	479	63	101
Red River Waterway	14,000	7,063	6,937	50 d/	56
Red River Below Denison Dam	189	57	132	30	97
Tensas-Cocodrie Pumping Plant	6,400	6,400	0	100	100
Sicily Island Area Levee	3,000	3,000	0	100	100
Below Red River	3,100	3,100	0	100	100
Bushley Bayou	1,400	1,400	0	100	100
Red River Waterway Below Mile 104	900	900	0	100	100
TOTAL	70,385	52,763	18,314	75	92

a/ To date, the Vicksburg District has purchased 102,550 acres of mitigation lands, which is 32,165 acres above the required minimum.
b/ Surplus acreage in parentheses is not included in the total.
c/ Project is on hold pending completion of new Supplemental EIS. Only one item was constructed with 38 acres of mitigation owed.
d/ Requires congressional action to authorize acquisition of cleared lands. Currently, only purchase of forested lands is authorized.

PROJECT MITIGATION

107. Mitigation for the Upper Steele Bayou Project required the purchase from willing sellers of 5,250 acres of frequently flooded agricultural lands for reforestation. To date, 5,569 acres of mitigation lands have been purchased. Mitigation acquisition is complete. Construction of the Upper Steele Bayou Project is nearing completion.

108. Mitigation for the Upper Steele Bayou Project in the Swan Lake area of the Yazoo NWR consists of a series of five weirs (complete), four lakes (complete), and levees (under construction) for facilitating the waterfowl management practices of FWS. The completion of these facilities will increase the aquatic AAHUs by 12,400 or 105 percent over preproject conditions. The completion of these facilities will also result in an increase in waterfowl resources of 806,938 DUDs over preproject conditions.

109. Mitigation for the Upper Yazoo Projects, Ascalmore Creek-Tippo Bayou, Big Sand Creek Levee Extensions, and the Pelucia Creek Project requires the purchase from willing sellers of 16,250 acres of frequently flooded agricultural lands for reforestation and 750 acres of moist soil management areas. The District has identified and obtained approval to acquire 17,000 acres of potential mitigation lands. To date, 10,919 acres of mitigation lands have been purchased. The Upper Yazoo Projects is under construction and scheduled for completion in 2012. Mitigation acquisition is 99 percent concurrent with construction.

110. Mitigation for the Yalobusha and Tallahatchie River Channel Maintenance required the reforestation of 980 acres, creation of a 400-acre moist soil management area and anchoring instream structures. The District has reforested 980 acres and created a 400-acre moist soil area on Federal lands in the Askew Area. Instream structures did not work as designed and had to be removed. The instream fishery mitigation is being evaluated by ERDC. Preliminary data indicate little fisheries difference between pre- and postproject conditions. However, if this review shows that the fishery resource has not recovered to that of preproject conditions, then the Corps will work with the resource agencies to identify other methods to offset these losses. Construction of the Yalobusha and Tallahatchie River Channel Maintenance Projects is complete.

111. Mitigation for the Big Sunflower River Channel Maintenance requires the purchase from willing sellers of 1,912 acres of frequently flooded agricultural lands for reforestation. The first item of construction for the maintenance project has been completed, and 38 acres of reforestation were required for this item. To date, 287 acres of mitigation lands have been purchased. This project is on hold pending completion of a supplemental environmental impact statement.

112. Reformulation of the Yazoo Backwater Area Project is underway. To date, the District has purchased 8,773 acres for mitigation for the levee measures of the project. These lands were reforested and are currently managed by MDWFP. The District has reanalyzed this mitigation feature as part of the Yazoo Backwater Reformulation Report.

113. Mitigation for the Mississippi River Levees Project requires the acquisition and reforestation of 5,200 acres of frequently flooded agricultural lands. The Vicksburg District has acquired 2,140 acres. Construction is scheduled for completion in 2031. Mitigation acquisition is 98 percent concurrent with project construction.

114. Mitigation for Aloha-Rigolette Area Project requires the reforestation of 542 acres and construction of 422 acres of waterfowl habitat on the Grand Cote NWR near Marksville, Louisiana. Mitigation acquisition is 100 percent current with construction.

115. Environmental design measures incorporated into the Abiaca Creek Watershed levee project, Delta Headwaters Project (formerly Demonstration Erosion Control), Yazoo Basin, Mississippi, resulted in approximately 811 acres mitigation/reforestation acreage for the project. The District purchased a perpetual easement on the acreage that allows for reforestation and certain timber management rights. Mitigation requirements for Sediment and Flood Control Measures, Coldwater River Watershed, and DHP were met by dedicating 313 Abiaca Creek Watershed reforestation acres as compensation. This project is 101 percent concurrent with construction.

116. Red River Waterway, Mississippi River to Shreveport, Louisiana. Mitigation for the Red River Waterway Project, Above River Mile 104, requires the acquisition of approximately 14,000 acres of forested wetlands from willing sellers and the management thereof. Through the original authorizing legislation (WRDA 86) and subsequent modifying legislation, the District has authority to acquire up to 26,000 acres. The District's early authority was to purchase property from Caddo and Bossier Parishes. Approximately 7,063 acres have been acquired to date. Congress passed legislation in calendar year 2000 that now allows the purchase of lands in any of the seven parishes that make up the Red River Waterway District. These include Caddo, Bossier, Red River, Grant, Natchitoches, Rapides, and Avoyelles. This project is 56 percent concurrent with construction because project authority only allows acquisition of current bottom-land hardwood tracts which is a very limited market from willing sellers. Completion of this mitigation requires additional congressional authority to acquire and reforest agricultural lands in the project area.

117. Red River Below Denison Dam, Red River Levees Rehabilitation/Restoration, Arkansas. The final EIS has been filed with EPA and the Record of Decision has been signed. Reforestation of 189 acres of periodically flooded cleared lands within the Red River Basin in Arkansas is recommended to compensate terrestrial wildlife impacts. The mitigation will be accomplished concurrent with construction. Lands will first be solicited from state and Federal agencies within the project area. If sufficient suitable lands from these sources are not found, acquisition of private lands from willing sellers will be pursued. To date, 57 acres have been reforested.

118. The Tensas NWR was established in 1980 (Public Law 96-285) to mitigate the environmental losses caused by six water resource development projects, which includes the lower 104 miles of the Red River Waterway Project. The Corps has purchased approximately 40,000 acres of the 52,780.95 acres in the Tensas NWR as mitigation. Mitigation requirements were for a total of 14,800 acres leaving a credit of 37,980.95 acres.

REFORESTATION

119. A total of approximately 6,044,780 trees have been planted by the Vicksburg District since 1990. Since January 1991, the District has reforested approximately 27,000 acres of lands acquired by easement and by fee title.

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