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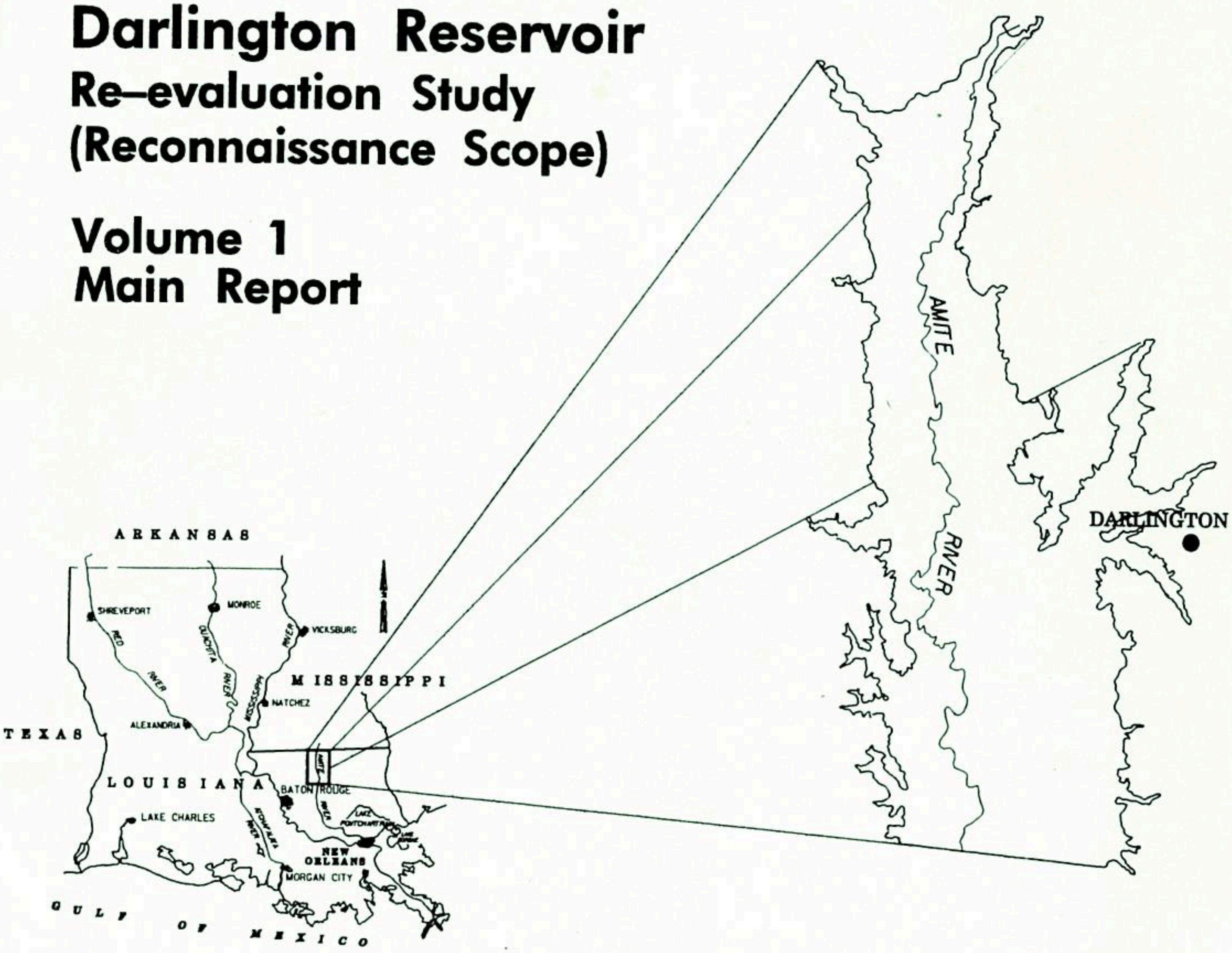
US Army Corps of Engineers
New Orleans District

Louisiana Department of Transportation and Development

Amite River and Tributaries, Louisiana

Darlington Reservoir
Re–evaluation Study (Reconnaissance Scope)

Volume 1
Main Report



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The purpose of the Darlington Reservoir study is to investigate the feasibility of providing flood protection for the residents of the lower Amite River Basin. The proposed Darlington Reservoir project would lower stages on the lower Amite River and tributaries, providing flood protection to the residents of Denham Springs, Port Vincent, and the eastern and southeastern portions of East Baton Rouge Parish. The dam site would be located on the Amite River about 25 miles northeast of Baton Rouge and 6 miles southwest of the town of Darlington in St. Helena Parish. The reservoir would control a 682 square mile drainage area. The dam would be an earthen embankment with a low-level flood control structure outlet and a concrete uncontrolled spillway. Two alternatives were investigated in this re-evaluation: the 25-year dry reservoir and the 25-year reduced wet alternative.

Five major floods have occurred in the Amite River Basin between 1973 and 1990. Flooding within the basin originates from excessive rainfall resulting in headwater and backwater overflow of the Amite River and tributary streams. The maximum flood of record occurred in 1983 and caused approximately $172.0 million in damages.

A feasibility study was completed in September 1992 on the Darlington Reservoir. The most cost-effective dam and reservoir plan was determined to have a benefit-cost ratio of 0.60. The Corps was directed to re-evaluate the work performed for this feasibility study based on conclusions drawn by Harza Engineering Company in their 1995 report entitled "Amite River Basin Flood Control Program". This report documents the results of that re-evaluation. The re-evaluation determined that construction of a dam and reservoir on the upper Amite River is a feasible solution to downstream flood problems. The most cost-effective dam and reservoir plan was determined to have a benefit-cost ratio of 1.35.

DARLINGTON RESERVOIR RE-EVALUATION STUDY

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DARLINGTON RESERVOIR RE-EVALUATION STUDY

STUDY AUTHORITY

The original study was part of the Amite River and Tributaries (ART) Study being conducted in response to a resolution of the committee on Public Works of the United States Senate. The resolution, sponsored by the late Senator Allen J. Ellender and Senator Russell B. Long of Louisiana, was adopted on April 14, 1967, and reads as follows:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the chief of Engineers on Amite River and Tributaries, Louisiana, published as House Document Numbered 419, Eighty-fourth Congress, and other pertinent reports, with a view to determining whether the existing project should be modified in any way at this time with particular reference to additional improvements for flood control and related purposes on Amite River, Bayou Manchac, and Comite River and their tributaries."

The 1996 Senate Appropriation included the following language concerning Amite River and tributaries, LA:

> "The Committee is aware of recent flooding in the Amite River basin which encompasses about 2,000 square miles in southeastern Louisiana and southwestern Mississippi. While the Corps continues to study some possible flood control solutions for this area, the Committee supports the examination of additional measures. Therefore, the Committee has included $200,000 to reevaluate the State of Louisiana's review of the previously suspended feasibility phase studies of Darlington Reservoir."

STUDY PURPOSE AND SCOPE

The purpose of the Darlington Reservoir study is to investigate the feasibility of providing flood protection for the residents of the lower Amite River Basin. The proposed Darlington Reservoir project would lower stages on the lower Amite River and tributaries, providing flood protection to the residents of Denham Springs, Port Vincent, and the eastern and southeastern portions of East Baton Rouge Parish. The dam site would be located on the Amite River about 25 miles northeast of Baton Rouge and 6 miles southwest of the town of Darlington in St. Helena Parish. The reservoir would control a 682 square mile drainage area. The dam would be an earthen embankment with a low-level flood control structure outlet and a concrete uncontrolled spillway. Two alternatives were investigated in this re-evaluation: the 25-year dry reservoir and the 25-year reduced wet alternative. The 25-year dry reservoir alternative consists of a 171.0 feet NGVD flood control pool elevation and a 12,800 acre pool. The top of dam elevation is 201.0 feet NGVD with a spillway crest of 171.0 feet NGVD. The 25-year reduced wet alternative consists of a 172.8 feet NGVD flood control pool elevation and a 13,600 acre pool for flood control. The top of dam elevation is 202.8 feet NGVD with a spillway crest of 172.8 feet NGVD. The reduced wet reservoir also consists of a small normal pool maintained at elevation 150.0 feet NGVD (4,400 acres).

A negative feasibility report on Darlington Reservoir was provided to the local sponsor to document study results in September 1992. The local sponsor, Louisiana Department of Transportation and Development(LDOTD), asked that the study be suspended while they consulted with others on certain Corps' assumptions and design criteria. In 1994, the Amite River Basin Drainage and Water Conservation District contracted with Harza Engineering Company to conduct a comprehensive study of all Corps, state and local flood control studies in the area. Harza's 1995 evaluation report questioned a number of the Corps' assumptions and design criteria and concluded that re-design could sufficiently reduce the cost of the dam to economically justify the project. Congress added money in fiscal years

1996 and 1997 for the New Orleans District to evaluate the Harza report and re-evaluate the earlier Corps work. Generally the analysis is of a reconnaissance level, with the exception of the geotechnical design which is closer to a feasibility level. This re-evaluation report addresses Harza's comments on the 1992 feasibility report, and provides a reconnaissance scope information on the 25-year dry reservoir alternative and the 25-year reduced wet reservoir alternative.

STUDY AREA

The Amite River Basin encompasses about 2,200 square miles in southeastern Louisiana and southwestern Mississippi which is drained by the Amite River and tributaries (Plate 1). It includes portions of East Baton Rouge, Ascension, Livingston, East Feliciana, St. Helena, Iberville, St. James, and St. John the Baptist parishes in Louisiana and Wilkinson, Lincoln, Franklin and Amite counties in Mississippi. The 170-mile-long Amite River and its right bank tributary, the Comite River, rise in southwestern Mississippi and flow generally southward to their confluence east of Baton Rouge in the vicinity of Denham Springs. From that point, the Amite River continues in a southerly direction to a juncture with Bayou Manchac at about mile 36 and then southeasterly and easterly to Lake Maurepas. Bayou Manchac, a right bank tributary of the Amite River and a former distributary of the Mississippi River at Mile 215 above the Head of Passes (AHP), extends about 17 miles eastward between the Mississippi River and Amite River at Mile 36. Major urban centers in the basin include Baton Rouge, Baker, Zachary, Gonzales, Sorrento, and Denham Springs, Louisiana.

PRIOR STUDIES AND REPORTS

The purpose of the ART study was to investigate the feasibility of providing flood protection for the residents in the Amite River Basin. This study was conducted in two phases: a reconnaissance phase and a feasibility phase. The reconnaissance phase was initiated in September 1983 and completed in February 1985 with the signing of a feasibility cost-sharing agreement (FCSA). The cost-sharing partner was the Louisiana Department of Transportation and Development, Office of Public Works (DOTD). The feasibility phase was initiated in April 1985.

The Department of Transportation and Development contracted with Brown and Butler Inc., to investigate the feasibility of a reservoir near Darlington, Louisiana. The proposed reservoir would have a maximum water surface area of about 19,500 acres and a normal water surface area or recreation pool of about 15,000 acres. The study, completed in March 1984, determined that the reservoir was economically feasible and recommended that the Amite River Basin Drainage and Conservation Commission investigate methods to fund the project.

The Department of Transportation and Development contracted with Brown and Butler, Inc. in May 1985 to investigate the hydraulic and hydrologic parameters in more detail than was in the previous study completed in March 1984. In the study, topographic surveys were taken of the Amite River valley from Interstate Highway 12, to the Louisiana-Mississippi state line, a detailed hydrologic and hydraulic model was developed, and several reservoir designs were analyzed. The study was completed in August 1986. It concluded that the hydrologic and hydraulic analyses conducted as part of this study confirms the related findings of the previous study completed in March.

The Department of Transportation and Development applied to the U.S. Corps of Engineers for a Section 404 permit in April 1985 to construct the Darlington Reservoir. DOTD contracted with Espey Huston and Associates, Inc., in December 1987 to develop the necessary engineering and environmental information for the Corps of Engineers to prepare an environmental impact statement. The study was completed in January 1990. In early 1990, however, the State officially withdrew this permit application and requested Federal participation in this project which in turn initiated the Darlington Reservoir feasibility study.

In February 1990 the ART feasibility cost sharing agreement was modified to include the investigation of the

Darlington Dam and Reservoir.

Due to the complex nature of the flood problem, feasibility phase studies were divided along hydrological and political boundaries to advance the study process. The feasibility study of the Comite River Basin was completed in January 1991. The feasibility study for East Baton Rouge Parish was completed in April 1996. Preconstruction Engineering Design (PED) was initiated May, 1996 and is scheduled for completion in December, 1998. The Livingston Parish feasibility study was completed in April 1997. No implementable plan was found. Ascension Parish made the decision to implement flood control measures without federal assistance, therefore, no feasibility study was pursued.

SUMMARY OF 1992 DARLINGTON FEASIBILITY STUDY

The Corps of Engineers, New Orleans District completed a draft feasibility study in September 1992 on the Darlington Reservoir. The draft feasibility study is contained in Appendix A. Numerous structural and nonstructural measures were considered to reduce flood damages along the mainstem of the Amite River and lower tributary streams. In this 1992 evaluation it was determined that construction of a dam and reservoir on the upper Amite River was not a feasible solution to downstream flooding problems. The most cost-effective dam and reservoir plan was determined to have a benefit cost ratio of 0.60.

INITIAL PLAN FORMULATION AND SCREENING

Plan formulation was initially performed in the 1984 Amite River and Tributaries Initial Evaluation Report on Flood Control (Federal Reconnaissance Report). This study identified two structural alternatives, a single reservoir and channel modifications, as potentially feasible structural plans. The latter alternative entails clearing and snagging, and widening of the Amite River. This plan was determined to be more costly than a single reservoir and to have significant environmental and implementation problems. "Channelization" of the Amite River would significantly impact the environmental quality of this waterbody. Also, the disposal of massive quantities of excavated material was also determined to be quite problematic with this alternative. Significant public opposition to this plan was expressed making its implementation questionable. This study also determined that non-structural alternatives are feasible but will not solve all basin-wide flooding problems. Use of non-structural measures in combination with a structural alternative was determined to be desirable.

An extensive plan formulation, evaluation and screening analysis was performed by Espey Huston & Associates, Inc. in their 1989 Amite River Flood Control Study. This analysis entailed initial, secondary and final screening of 33 potential alternatives plus a No Action plan. Alternatives evaluated were single reservoirs of various storage capacities, both wet and dry (with and without recreational lakes of various sizes), multiple reservoirs, channelization of the Amite River, non-structural measures, river bank levees, and several combinations of the above with and without the influence of the proposed Comite River Diversion Canal project. This screening analysis resulted in the recommendation of four alternatives for final detailed evaluation. They are:

- a single reservoir with maximum flood control storage capacity with a permanent full size recreation lake (full size wet reservoir)

- a single reservoir with maximum flood storage capacity without a permanent recreation lake (full size dry reservoir)

- a single reservoir with reduced flood storage capacity without a permanent recreation lake (reduced sized dry reservoir) in combination with selected non-structural measures

- no action plan

The Espey, Huston & Associates plan formulation and screening analysis was reviewed and determined to be sound and comprehensive. It was therefore determined that this work should not be repeated in the Darlington Reservoir feasibility study.

Additional plan formulation was conducted based on the results of the above report. Initial evaluation of reservoir costs and related flood reduction and recreation benefits indicated that a broader range of final alternatives should be evaluated.

It was determined that significant flood control benefits exist with a 25-year level flood control project design, thus confirming the potential feasibility of a small reservoir. This factor resulted in the formulation of various reservoir alternatives with flood storage capacities ranging from a 25-year to a 100 year storm event.

It was also determined that significant recreation benefits exist with incorporating a permanent lake as part of the reservoir scheme. Both large and small recreation lake plans were integrated with the above listed range of flood control options. They were respectively designated as "Wet" and "Reduced Wet" alternatives.

Since "Wet" reservoirs can operate with or without a service spillway, this option was also incorporated into the final plans.

Summarizing the above, three types of reservoirs were selected for final detailed evaluation. They are:

- Wet (reservoir with a full size 12,800 acre recreation lake)

- Reduced Wet (reservoir with a small 4,400 acre recreation lake)

- Dry (reservoir with no recreation lake)

Incorporating three levels of flood control protection 25, 50, and 100 year, and considering each wet reservoir both with and without a service spillway yielded a final array of fifteen final alternatives.

EVALUATION OF FINAL ALTERNATIVES

As detailed below, evaluations of the final alternatives were performed with analyses of the following:

- Hydrologic and Hydraulic Design
- Geology and Dam Location
- Geotechnical and Structural Design
- Roadway and Utility Relocations
- Environmental Impact and Mitigation
- Real Estate
- Recreation Resources
- National Economic Development Benefits

Analyses were done to the extent necessary to adequately determine the feasibility of each alternative. In some cases, only a range of several plans was specifically evaluated. In some categories it was only necessary to analyze two plans to obtain adequate data needed to determine the feasibility of all alternatives.

EVALUATION SUMMARY

Early in the evaluation of the 15 final alternatives it was determined that service spillways were too costly. Six alternatives, 25, 50, and 100 year Wet and Reduced Wet with Service Spillway, were eliminated.

In order to evaluate the overall feasibility of the remaining nine final alternatives, annual costs and benefits were calculated in detail for the Full Size Wet and Dry Reservoirs providing 50-year level flood protection. An interest rate of 8.5% over a 50-year project life was used to annualize initial project costs. A five year construction period was used to calculate gross investment amounts. Table 1 lists each cost component, annualized costs and benefits for both alternatives. As shown, both the 50-year Full Size Wet and Dry Reservoir alternatives were determined to be infeasible with benefit cost ratios of 0.44 and 0.57, respectively. While costs for relocations, real estate, and environmental mitigation are significant, the high cost of the dam structure itself appears to be the most critical factor affecting overall project feasibility.

From the results of these cost estimates it was concluded that all alternatives with larger dam structures were also infeasible. Also, it was determined that the benefits produced by including recreational improvements in both the wet and dry alternatives exceed the costs directly attributed to these improvements. However, the cost of raising the dam structure height to achieve design flood protection with both a full and reduced size recreational lake offset the net recreation benefits of the Wet and Reduced Wet alternatives. This is demonstrated in Figure 1 of the 1992 feasibility report where it can be seen that the increase in dam height for the Wet and Reduced Wet Reservoirs significantly increases the dam structure cost at various levels of design flood protection.

The cost effectiveness of the smallest structure (Dry Reservoir with 25-year design protection) was analyzed. Again, with reference to Figure 1 of the 1992 feasibility report it can be seen that the cost curve for the dam structure "flattens" at these lower design elevations. While benefits stay relatively high in this range, costs do not reduce significantly enough to bring the benefit cost ratio up substantially. The estimated costs and benefits for a 25-year Dry Reservoir were estimated as follows:

Total Initial Cost:	$236,000,000
Total Gross Investment:	$291,321,000
Gross Investment Equivalent Annual Cost	$25,187,000
Annual Operation and Maintenance Cost	$800,000
Total Equivalent Annual Cost	$25,987,000
Total Annual Flood Control and Recreation Benefits	$15,638,000
Benefit/Cost Ratio	0.60

Other studies have concluded that secondary net benefits from potential water supply and hydro-electric power sources are not significant due to the fact that adequate future water and power needs currently exist. Inclusion of these factors has little impact on the cost-effectiveness of these plans.

From the results, it was concluded that all reservoir alternatives are infeasible.

Table 1
1992 FEASIBILITY STUDY
ESTIMATED RESERVOIR COSTS AND BENEFITS

ITEM	FULL SIZED WET RESERVOIR (50-YEAR DESIGN)	DRY RESERVOIR (50-YEAR DESIGN)
DAM STRUCTURE	$282,000,000	$193,000,000
RELOCATIONS	$32,100,000	$9,209,000
REAL ESTATE	$30,861,000	$21,420,000
ENVIRONMENTAL MITIGATION	$27,449,000	$5,726,000
RECREATION	$41,425,000	$31,375,000
TOTAL INITIAL COST	$413,835,000	$260,730,000
TOTAL GROSS INVESTMENT	$510,843,000	$321,849,000
GROSS INVESTMENT EQUIVALENT ANNUAL COST	$44,168,000	$27,826,000
ANNUAL OPERATION AND MAINTENANCE		
-DAM AND RESERVOIR	$175,000	$85,000
-RECREATION FACILITIES	$900,000	$680,000
-ENV. MITIGATION AREAS	$269,000	$79,000
TOTAL ANNUAL O&M	$1,344,000	$844,000
TOTAL EQUIVALENT ANNUAL COST AND O&M	$45,512,000	$28,670,000
ANNUAL FLOOD CONTROL BENEFITS	$10,911,000	$10,971,000
ANNUAL RECREATION BENEFITS	$8,900,000	$5,404,000
TOTAL ANNUAL BENEFITS	$19,811,000	$16,375,000
BENEFIT/COST RATIO	0.44	0.57

SUMMARY OF 1995 HARZA ENGINEERING REPORT

In their 1995 report, Harza Engineering Company reviewed assumptions and design criteria for the major cost elements of the proposed Darlington Reservoir. These elements were also subjected to a cost and value update with the intention of reassessing the economic feasibility of the project. Special emphasis was given to the dam and appurtenant works, mitigation costs, real estate costs, relocations, and recreation costs. It was Harza's conclusion that major cost reductions could be realized for the reservoir concept as proposed by the Corps such that the economic justification could be realized. Harza Engineering Company indicated that the cost of the Darlington Reservoir and appurtenant structures have been overstated in the Corps 1992 feasibility study. Based upon their technical analysis, Harza Engineering indicated that the cost of the reservoir could be reduced by 30 to 50 percent. The following is a summary of the items addressed by the April 1995 Harza Engineering Report, which is included in its entirety in Appendix B.

Harza Engineering listed several reasons indicating why they were optimistic that the Darlington Reservoir is a viable federal project:

1. Their preliminary analysis indicated that a 25-year reduced wet reservoir alternative is economically justified.

2. There are more cost savings to be realized for the project, specifically in the spillway, the mitigation costs, and the recreation costs.

3. There will be more damages in the unprotected portions of the basin as a result of the construction of the only-localized projects with the intention of transferring water to another area in the same watershed.

4. There are additional benefits that have not been considered in the Corps study, including reduction in damage to floodplain structures built since 1987, land-use intensification and location benefits, reduced business

losses during the flood and clean-up period, and employment of unemployed people during construction and operation.

GEOLOGY AND DAM LOCATION

Harza's review of the geotechnical conditions was based on two drilling programs. The first drilling program was conducted by LDOTD in 1983 and the second was conducted by the US Army Corps of Engineers in 1991. During the first program (1983), three 100-foot-deep borings were taken along the dam axis. During the second program (1991), seven more borings were taken along the dam axis. Both programs provided a consistent rendering of the foundation conditions under the dam axis.

Based upon the geotechnical conditions from the 1983 and 1991 borings, Harza recommended modifying the dam section to provide steeper slopes while still providing the requisite safety. It was Harza's opinion that a dam with an upstream slope of 3 horizontal to 1 vertical and a downstream slope of 2.5 horizontal to 1 vertical would be stable under long-term conditions and provide an acceptable margin of safety required during construction and rapid drawdown (see Plate 2). Harza's recommendation modified the base width of the dam in the Amite channel section from 1,400 feet to 500 feet, thereby providing a 40 percent reduction in embankment material required (depending upon the height of the dam).

The outlet works, as presented by the Corps, is 1,120 feet long excluding the stilling basin. With the changed embankment section above, Harza stated that the length of the outlet conduit could be reduced by half to about 560 feet.

Harza stated that the crest length of the spillway was constrained by the need to prevent downstream flow conditions worse than might occur under PMF (probable maximum flood) flows without a dam. As an exercise, a spillway with a surcharge eight feet greater than proposed by the Corps was evaluated by Harza. The exercise resulted in a net cost reduction after accounting for the shorter spillway crest and higher dam. Based on the revised embankment section, the cost of raising the dam to provide surcharge storage is much less and, therefore, the optimum length of the spillway crest would be less, resulting in a net reduction in cost.

COST

Harza reviewed the unit prices reported in the Corps' 1992 report and estimated unit prices representative of a 1995 price level. Harza concluded that the original prices for all materials except semi-compacted random and fully-compacted clay were generally acceptable and were updated to reflect 1995 price level. For excavation and concrete, the prices were generally appropriate. For the random and clay materials, it was Harza's opinion, based on bids, active projects and other sources, that these unit prices could be reduced by about 40 percent. Harza re-estimated the dam structure costs using updated unit prices, revised embankment quantities, and Corps quantity estimates for the remainder of the items. The Corps' contingency, which for most items was 30 percent, was maintained. The engineering cost for design and construction management was reduced from 12 percent to 10 percent.

To provide an indication of the expected cost reduction for the dam structure, the following tabulation presents a comparison of costs for a dam with a crest elevation of 201 ft NGVD:

Corps 1992 estimate:	$173 million
Harza revised estimate:	$121 million

HYDROLOGIC AND HYDRAULIC DESIGN

Harza indicated that three items contributing to the selection of the height of the dam are overly conservative, resulting in increased dam height. The total effect would be to reduce the height of the dam by 10 feet. However, these adjustments were not included in Harza's final cost analysis because the validity and impact of the revised assumptions could not be established in the scope of the study.

The first of the three items outlined by Harza was the antecedent conditions for routing of the probable maximum flood (PMF). Harza indicated that the conditions were more severe than their understanding of the Corps' requirements. The Corps started its PMF routing with the reservoir at the top of the flood control pool. Harza, however, stated that regulations allow starting at the top of the flood control pool or at the elevation occurring five days after the end of the antecedent precipitation equal to about half of the main storm. Since the Corps' PMF routing shows the reservoir drops back to its starting elevation four days after the end of the probable maximum precipitation (PMP), the reservoir would drop back to the starting level within five days after the end of half the PMP. In other words, even with an antecedent flood of half the PMF, the reservoir would not be surcharged at the start of the PMF. Thus, Harza concluded that the PMF routing can be started at maximum normal pool, the top of the conservation pool, which is 13-18 feet lower for the large wet reservoir schemes.

Second, Harza stated that the PMF may be 25 percent too high. The Corps' PMF peak of 556,000 cfs for the 692 square mile basin is equivalent to a Creager C of 168, which is typical of the Caribbean with its hurricane rainfall and mountainous slopes. Espey, Huston (1989) calculated a PMF peak of 492,000 cfs. According to the Nuclear Regulatory Commission (1977), nine other PMFs estimated for sites in the region have Creager C's of 52-111, with a median of 79. In addition, the envelope flood peak for the location of the Amite River is about 215,000 cfs. Harza stated that the peak at Darlington should be untypically high because the Amite and two main tributaries with roughly equal drainage areas enter the reservoir together. Thus, Harza recommended a Creager C of 130, about 2/3 above the median, giving a peak of 430,000 cfs. Routing this flood would result in a reduction of the maximum flood pool elevation by three to four feet.

Harza indicated that the wind speed used for calculating freeboard might be reduced slightly. The Corps' wind speed concurrent with the maximum PMF pool appears to be a ten-year wind speed. According to Harza, a two-year wind speed should be acceptable. Reducing the wind speed to this recommended level would reduce the wave run-up and freeboard requirement by about 1 foot.

REAL ESTATE

An attempt was made by Harza to confirm or update the real estate costs based on the collection of recent sales information in the appropriate parishes. Land sales in East Feliciana and St. Helena Parishes were collected and categorized by land classification. Harza concluded that the average values estimated using the information collected were considered to be unrepresentative for several reasons: 1) in most cases, the sample size is too small, 2) for residential and woodland, the per acre cost range was too large, varying from $240 to $6,000 for residential and $554 to $1,669 for woodland; and 3) a local land assessor suggested that the Corps estimates were high for lands in the reservoir area. Since the real estate values were not updated by Harza, they used the Corps' numbers inflated at a rate of three percent for two years in their assessment.

The land sales information gathered by Harza is included in Table 2 below:

Table 2
HARZA REAL ESTATE COMPARISON

Land Classification	1992 Corps Estimate	Land Sales Information No. Parcels	Avg Value	Used
Pasture/agricultural	$1,100	2	$2,650	$1,170
Woodland	$ 900	10	$1,117	$ 960
Residential	$1,800	5	$2,739	$1,910
Sand & gravel pits	$2,000	1	$1,096	$2,120
Ag lands to be used for --wetlands mitigation	$ 910	0	$ 500	$ 700

ROADWAY AND UTILITY RELOCATIONS

In Harza's analysis of the relocation costs, they generally agreed with the Corps' costs for relocating the roads (based upon an evaluation of the 50-year full reservoir). However, for pipelines, electrical transmissions and distribution lines, and phone lines Harza indicated that relocation costs can be reduced by about 33 percent.

Harza's costs were estimated based upon discussions with Entergy and DEMCO for transmission line relocations, a material supplier and contractor for the pipeline weighting, and recent estimates for highways LA 557 and LA 505 performed by Brown and Butler. Harza developed a revised estimate of the 50-year full reservoir relocations cost. In addition to changes in direct costs, the allowance for engineering and administration was reduced from 22 percent to 15 percent. The relocations costs comparisons from the 1992 feasibility study and the 1995 Harza Report are shown in Table 3.

Table 3
RELOCATION COST COMPARISONS
FOR 50-YEAR FULL ALTERNATIVE

ITEM	CORPS (1992)	HARZA (1995)
LA 960	$1,254,000	$800,000
LA 10	$4,148,000	$4,086,000
Parish Rd 42	$593,000	$593,000
Colonial Pipeline	$3,050,000	$3,606,000
Transcontinental Gas Pipeline	$6,469,000	$2,850,000
Shell Pipeline	$0	$882,000
EXXON Pipeline	$0	$70,000
Gulf States Utilities	$15,719,000	$4,980,000
DEMCO	$1,728,000	$3,616,000
Other power and phone	$435,000	$435,000
TOTAL	$33,396,000	$21,920,000

Harza's primary conclusion from this analysis was that there is substantial disagreement in the pricing of these measures and room for substantial reductions in the cost of relocations.

ENVIRONMENTAL IMPACT AND MITIGATION

Harza's analysis indicates that mitigation costs for the full-size wet reservoir could be reduced by approximately 50 percent. This reduction would result from a reduction in required lands due to recent logging and establishment of new wetlands and hardwoods from the wet reservoir, reducing the cost of replacement of wetlands, and eliminating fencing.

The Espey, Huston & Associates environmental report (1989) indicates that the full wet reservoir (20,150 acres including flood surcharge area) will inundate about 8,230 acres of bottomland hardwood and that the dry reservoir will inundate about 500 acres. A timber inventory and appraisal of the proposed reservoir area (17,000 acres) is stated to have a fair market value of $5,320,000 in 1988. Harza stated that the Corps did not take the fact that these timber resources can be harvested prior to inundation into account in their cost analysis. In addition, analysis of 1993 aerial photographs indicates that approximately 450 acres of bottomland hardwood forest within the full wet reservoir area have been logged or converted to sand and gravel mining since the environmental report was produced by Espey, Huston in 1989. Harza claims that this logging will reduce the total area of woodland impacted by the full reservoir from 8,230 acres to about 7,780 acres.

Harza also indicated that the development of new areas of bottomland hardwood and other wetland and woodland types along the shoreline of the wet reservoir would mitigate some of the losses of bottomland hardwood and wetland vegetation types flooded by the reservoir. The establishment of about 1,500 acres of wetland and woodland vegetation types would further reduce the area of impacted woodland to about 6,280 acres. In addition, Harza indicated that areas of wetlands will naturally develop along the shoreline of the full wet reservoir.

Harza indicated that the potential impact and mitigation concerns of the proposed reservoir, expressed in the 1992 Corps report, overlook benefits of the reservoir. The benefits refer to the reservoir's impact on existing factors adversely affecting the ecological productivity of the Amite River. The present land use and physical characteristics of the river are the major factors adversely affecting the aquatic ecology and productivity. The full wet reservoir will create wetlands and cause deposition of organic sediments which will enrich the soil. Downstream of the wet reservoir, scouring due to peak flows will be reduced. Bank erosion and channel movement will also be reduced, allowing development of biologically productive bank vegetation. Also, proposed project mitigation actions (acquiring streambank lands below the proposed damsite and the reduction of erosive flood flows by the regulated release of the dam) may allow the Alabama heelsplitter mussel, P. inflatus to re-establish itself in the upper reaches of the Amite River. Over the past 20 to 30 years, land use, sand and gravel mining, head-cutting, and flood flows have removed mussel habitat from the upper reaches of the Amite River.

Based on the above analysis, mitigation costs were developed for the full wet reservoir following the same procedure used in the 1992 feasibility study. A habitat suitability index (HSI) of 0.65 was still used to be conservative, although Harza indicated that the HSI of woodland is likely less because of high grading. Grading is where the most commercially-valued trees, primarily oak, have been removed. Exhibits 8 and 9 in the Harza Report, included in Appendix B, reflect cost adjustments in impacts and needed mitigation.

Harza also indicated that acquisition and fencing of 38 miles of river bank for mitigation of the full wet reservoir is impractical. The high cost of maintenance of the fence and local use pressures (sand and gravel mining and public access) will make it difficult to improve the riverine habitat for the entire reach. Harza suggests that a more logical approach may be to concentrate mitigation in the downstream areas of remaining critical habitat and where sand and gravel mining has not had a significant effect.

RECREATION RESOURCES

Harza indicated that recreation costs appear to be very high. But, no benchmark data were available other than estimates for individual recreation facilities. The aggregation of these individual items with estimates for infrastructure led Harza to reduce the Corps recreation costs by 25% for their analysis.

Harza indicated that the average depth of water for the reduced wet reservoir condition is too low for recreation. Harza suggested that the average depth for the reduced wet reservoir be increased from 5 to 10 feet.

HYDROPOWER

Harza admits that the region is currently in an energy surplus which would result in low benefits for additional power development. As a result, Harza concluded that development of a hydropower installation with the intention of selling the power and energy to a local utility would not result in significant revenue that could be used to repay project bonds. However, Harza felt that a major power user, such as a city or large industrial complex, could develop hydropower to offset some or all of their electricity costs. Benefits could accrue to the owner of the project from the purchase, by the user, of the power right. These benefits were not included in Harza's analysis.

WATER SUPPLY

The Darlington Reservoir could provide a major quantity of potable water. In addition, Harza indicated that the Mississippi River is becoming a less acceptable raw water source for potable supplies and indicated that a new source will be required. While Harza realized this potential, they did not include water supply benefits in their analysis.

ECONOMICS

Benefits from reduced structural damages in the 1992 Darlington Reservoir feasibility report are based on an April 1987 survey of structures by Gulf States Research Institute of Baton Rouge. Two adjustments were made to these benefits by Harza for their economic analysis:

- The price level of benefits for Darlington was indexed from 1989 to the end of December 1994 by a factor of 1.207 based on the change in the Consumer Price Index (CPI) during that period.

- Minor changes in benefits for subbasins in the west Denham Springs area, were based on corrected estimates of structural damages provided by the Corps in 1995.

Harza used a December 1994 price level for economic analysis. The period selected for analysis was 50 years after completion of construction. The interest rate used in the analysis was 7.75%, the rate used in 1994 for the analysis of federal projects.

The following items were mentioned in the Harza report as areas where further investigation is warranted. However, Harza did not take these items into account in their 1995 economic analysis.

- Harza suggested updating cost benefits to include price level increases.

- Harza requested that the Corps respond to the fact that the Darlington Reservoir and the Comite River Diversion projects include the same benefitted areas, thereby reducing economic benefits to one depending upon sequence of construction.

- Harza has asked for a more rigorous review of the slab elevation surveying problem in Denham Springs.

- Harza suggested updating benefits based upon the increase in the number of structures on the floodplain since 1987. The Ascension Parish levees take away about 12 square miles of floodplain-area storage, so the flood crest and damages to other areas may be somewhat higher as a result of these new levees.

- Harza indicated that there will be location/intensification benefits from land use changes from primarily rural or agricultural to recreation related residential use. Harza indicated that these benefits were not included in the 1992 Corps' study because they are more difficult to quantify. Nevertheless, Harza stated that some attempt should be made to estimate their magnitude.

- Harza stated that there are more benefits from avoiding losses of business profits and employment during the period of economic disruption caused by the flood and clean-up. There are also benefits from employment of unemployed or underemployed people during construction and operation of project facilities and in the private businesses stimulated as a result of project recreation development.

The results of Harza's 1995 economic analysis are shown in Table 4. The analysis indicates that Darlington Reservoir may be economically justified from the national perspective with the revised costs and flood control benefits derived from the 1992 Corps analysis. Harza also indicated that with the inclusion of the above suggestions, the economic viability of the project increases. These items mentioned above are estimated in Table 4, bringing the feasibility of all alternatives reanalyzed to at least 1.0.

Table 4
HARZA'S 1995 REPORT
COMPARISON OF COSTS AND BENEFITS OF ALTERNATIVE PLANS
($000, December 1994 price level)

	25-year Reduced Wet	50-year Reduced Wet	25-year Full Wet	50-year Full Wet
Crest Elevation, ft msl	207	210	212.5	214.8
Cost Item				
-Dam Structure	$131,500	$137,000	$142,000	$147,400
-Relocations	$9,000	$12,000	$18,000	$21,000
-Real Estate	$25,000	$28,000	$31,000	$32,500
-Mitigation	$9,500	$11,500	$13,000	$14,000
-Recreation	$25,000	$27,500	$29,500	$31,100
Subtotal	$200,000	$216,000	$233,500	$246,000
-Interest During Constr	$30,000	$32,400	$35,120	$37,010
Total Investment	$230,000	$248,400	$268,620	$283,010
Annual Investment	$18,262	$19,723	$21,329	$22,471
Annual Operation, Maintenance and Replacement				
-Dam and Reservoir	$144	$158	$175	$175
-Recreation Facilities	$790	$869	$900	$900
-Mitigation Areas	$91	$100	$141	$141
Total OM&R	$1,025	$1,128	$1,216	$1,216
Total Annual Cost	$19,287	$20,851	$22,545	$23,687
Annual Benefits				
-Flood Control	$11,745	$12,106	$11,652	$12,030
-Recreation	$7,595	$7,595	$9,452	$9,452
Total	$19,340	$19,701	$21,104	$21,482
Benefit/Cost Ratio	**1.00**	**0.94**	**0.94**	**0.91**
Est Additional Flood Control Benefits	$1,500	$2,500	$1,500	$2,500
Total Benefits	$20,840	$22,201	$22,604	$23,982
Benefit/Cost Ratio	1.08	1.06	1.00	1.01

CONCLUSION OF 1995 HARZA REPORT

Harza's preliminary analysis as part of the 1995 report indicated that a 25-year reduced wet alternative is economically justified. With Harza's revisions in place, the benefit/cost ratio for the 25-year reduced wet alternative is 1.00. It is Harza Engineering's opinion that the opportunity exists to formulate a justified federally-funded reservoir project that will be effective in controlling flooding in the basin.

DARLINGTON RESERVOIR RE-EVALUATION

As part of this re-evaluation report, the design criteria and assumptions made in the 1992 feasibility study were revisited. Two alternatives were investigated in this re-evaluation: the 25-year dry reservoir and the 25-year reduced wet alternative (see Plate 3). These 25-year reduced wet alternative was analyzed because Harza stated that their preliminary analysis indicated that a 25-year reduced wet reservoir was economically justified. The 25-year dry alternative was also analyzed because it was the alternative with the highest B/C ratio in the 1992 feasibility study, and therefore the most likely to be justified as a result of the re-evaluation. The following areas were reanalyzed as part of the re-evaluation.

Hydrologic and Hydraulic Design
Geotechnical Design
Roadway and Utility Relocations
Environmental Impact and Mitigation
Real Estate
Recreation Resources
Economics
Cost
Hydropower and Water Supply
Cultural and Natural Resources

Each area contains a summary of the criteria and assumptions which went into the 1992 feasibility report, a discussion of Harza's comments, and any re-assessment as a result of the Harza comments.

HYDROLOGIC AND HYDRAULIC DESIGN

1992 FEASIBILITY SUMMARY

Comprehensive flood hydrographs were required for estimating peak flows for specified return, accomplished by use of the rainfall/runoff model HEC-1. A HEC-1 model was developed for the Amite River Basin. Hypothetical precipitation values for the 1, 2, 5, 10, 25, 50, 100, 200, and 500 year return storms were determined. The storms were centered over the entire watershed and had a 7 day duration. Precipitation values were also developed for the Standard Project Storm (SPS) and the Probable Maximum Storm (PMS). Discharge frequency curves were developed at each gage location with recorded discharges. The HEC-1 model was calibrated to the hypothetical storms and the calibration checked against the 1979, 1979, and 1983 historical events.

For the 1992 feasibility study, the original Corps model, revised by Espey, Huston & Associates was used. Espey, Huston & Associates revised the Corps' existing conditions HEC-1 model for the Comite River Basin feasibility study for their use in Amite River Basin. The model was reviewed and calibrated.

HEC-2 was used to simulate the hydraulic response of the watershed. As with the HEC-1 model, the New Orleans District developed the HEC-2 model for the Comite River Basin feasibility study. The model was calibrated to three historical events; the 1977, 1979, and 1983 flood events. Espey, Huston & Associates refined the Corps model to better define the upper Amite River Basin. This refined model was used in the 1992 Darlington feasibility study.

For the 1992 feasibility study 15 alternatives were initially investigated. During the alternative analyses and evaluations, all alternatives which included service spillways were eliminated due to the excessive cost of the service spillway. This resulted in 9 alternatives. The array considered is included in Table 5.

Stage lowerings for the 15 alternatives were determined for various points along the Amite and Comite Rivers as well as their primary tributaries. These stages were determined by routing the reservoir outflow hydrographs downstream through the Amite River, using HEC-1 and HEC-2 models.

The HEC-1 models were used to determine the Flood Control Pool elevation for each reservoir. The design storm for each dam was routed on top of the conservation pool for the large and reduced wet alternatives. The invert elevation of the Amite River established initial conditions for the dry alternative. For the wet reservoirs, the dam was assumed to pass a maximum of 10,000 cfs between conservation pool and flood control pool through the low level outlets and the service spillway. The dry reservoir was designed to pass the maximum 10,000 cfs through the uncontrolled low level outlets. This maximum release of 10,000 cfs is the bank full capacity below the reservoir. Flood control pool elevation established the crest elevation of the spillway.

ER 1110-8-2 (FR) **Inflow Design Floods for Dams and Reservoirs** was used to determine criteria for calculating the height of each dam alternative. The height of each dam was computed as the maximum surcharge pool elevation plus freeboard.

The Maximum Surcharge Pool Elevation was calculated by routing the runoff from the Probable Maximum Precipitation (PMP) on top of the flood control pool elevation. The PMP rainfall was determined using the HMR52 Probable Maximum Storm computer program. The number of subareas upstream of the reservoir were reduced from 8 to 3 to account for the impact of the reservoir pool on the inflow hydrograph at the reservoir structure. An induced surcharge pool of 3 feet above the Flood Control Pool Elevation was used for the service spillway design.

Freeboard requirements for wave run-up and wind setup were calculated using ETL 1110-2-305 **Determining Sheltered Water Characteristics** and EC 1110-2-27 **Policies &**

Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams which referenced ETL 1110-2-8 **Computation of Freeboard Allowances for Waves in Reservoirs.** Wind speeds were estimated from ETL 1110-2-221 and Civil Works Investigations Project CW-178 "Freeboard Criteria for Dams and Levees," Tech Bulletin No. 1. Half a foot was added to this freeboard calculation for the estimated increase in stages due to sedimentation over the project life. A sedimentation analysis would have been completed if the original feasibility study had continued. This would have allowed a more detailed estimate of freeboard needs due to sedimentation.

The low level outlets for all reservoir alternatives were designed to pass a maximum of 10,000 cfs at the flood control pool elevation. These sizes were checked for drawdown requirements as specified in ER 1110-2-50 (Low Level Discharge Facilities for Drawdown of Impoundments). The low level outlets were assumed to be closed above the Flood Control Pool Elevation due to high velocities through these culverts.

Due to the large number of alternatives, only the 50-year reservoir alternatives were initially evaluated to determine project costs for economic feasibility. The designs of the spillways and low-level outlets were done using EM 1110-2-1603 **Hydraulic Design of Spillways.** EM 1110-2-1602 **Hydraulic Design of Reservoir Outlet Works** was used to design the low level outlet works. Several of the CORPS computer programs were used for the design of the spillway crest and nappe profiles. Flows from a PMP were used in this design.

Once the hydraulic design data for each of the reservoir alternatives had been developed and costs of the proposed project were estimated, the designs were revisited to determine if refinements could reduce the total costs of the project. At this time, most of the refinements were applied to the dry reservoir design because it appeared that the wet reservoir would be far too costly to be economically justified. The refinements included redesign of the spillway, optimization of the low-level outlets, and methods for reducing the height of the dam and thereby reducing the total cross-sectional needs of the dam.

The initial design of the spillway involved an ogee type concrete spillway similar to the type provided by Espey, Huston & Associates. This structure proved to be extremely expensive. The design was refined to provide a concrete chute spillway.

A 1000 foot long spillway was provided for each of the initial 15 reservoir designs. In an effort to reduce the height of the dam, the length of the spillway was varied to determine if the reduced cost of the dam embankment would offset the increased cost of the spillway. However, this refinement was limited by PMP discharge over the spillway. To prevent induced stages downstream of the dam, longer spillways which resulted in increased PMP discharges from existing conditions were eliminated from further consideration. A shorter spillway was also investigated to determine if the cost savings in a shorter spillway would offset the higher cost of the resulting higher dam and embankment. None of the refinements produced cost savings.

An attempt was made to lower the top of the dam by increasing the amount of low-level discharges from the reservoir. As possible refinements, low-level discharges of 20,000 and 30,000 cfs were used for some of the dry reservoirs. This resulted in lowering the top of the dam from 4 to 10 feet, depending on the level of protection of the reservoir. However, these refinements required additional concrete box culverts to provide the larger low-level discharge thereby reducing the potential cost savings. The potential impacts downstream of the reservoir from the increased low-level discharges were not determined in this analysis.

Table 5
1992 FEASIBILITY STUDY
HYDROLOGIC AND HYDRAULIC ANALYSES OF FINAL ALTERNATIVES

	Dry			Wet			Reduced Wet		
	25-yr Design	50-yr Design	100-yr Design	25-yr Design	50-yr Design	100-yr Design	25-yr Design	50-yr Design	100-yr Design
Conservation Pool Elev	N/A	N/A	N/A	171.0	171.0	171.0	150.0	150.0	150.0
-Storage (acre-ft)	0	0	0	213,000	213,000	213,000	39,000	39,000	39,000
-Surface Area (ac)	0	0	0	12,800	12,800	12,800	4,400	4,400	4,400
Flood Control Pool Elev	171.0	175.3	178.7	184.0	186.9	189.4	172.8	176.9	180.2
-Storage (acre-ft)	213,000	270,000	320,000	198,000	255,000	304,000	198,000	254,000	303,000
-Surface Area (ac)	12,800	14,600	16,200	18,900	20,500	22,100	13,600	15,300	17,000
Surcharge Pool Elev	193.5	197.0	200.5	205.0	207.3	209.9	195.3	198.5	201.7
(PMF max stage)									
-Storage (acre-ft)	399,000	433,000	469,000	525,000	541,000	572,000	421,000	449,000	490,000
-Surface Area (ac)	25,000	27,300	29,500	32,500	34,300	36,000	26,100	28,000	30,300
Total Peak Storage (acre-ft)	612,000	703,000	789,000	936,000	1,008,000	1,089,000	658,000	742,000	832,000
Dam Height									
Earth Embank, w/riprap									
Dam Side Slope	1V:5H	1V:5H	1V:5H	1V:5H	1V:5H	1V:5H	1V:5H	1V:5H	1V:5H
Freeboard, ft	7.5'	7.5'	7.5'	7.5'	7.5'	7.5'	7.5'	7.5'	7.5'
Top Elev of Dam	201.0	204.5	208.0	212.5	214.8	217.4	202.8	206.0	209.2
Spillway									
Crest Elev	171.0	175.3	178.7	184.0	186.9	189.4	172.8	176.9	180.2
Length of Spillway	1000'	1000'	1000'	1000'	1000'	1000'	1000'	1000'	1000'
Low Level Outlet									
Concrete Box Culverts									
(Invert Elev=120.0)									
No. of Culverts	3	3	3	3	3	3	3	3	3
Size of Culverts	10'X10'	10'X10'	9'X10'	10'X10'	10'X10'	10'X10'	10'X10'	10'X10'	10'X10'
Outflow Spillway	425,000	410,000	396,000	392,000	386,000	375,000	432,000	423,000	408,000
Outflow Low Level Outlet	12,000	12,000	11,000	0	0	0	0	0	0
Max Total Outflow (cfs)	437,000	422,000	407,000	392,000	386,000	375,000	432,000	423,000	408,000

NOTE: All elevations are in feet, NGVD
Storage Pool quantities are incremental

DISCUSSION OF HARZA COMMENTS

Harza indicated in their 1995 report that three items under Hydraulics and Hydrology could be revised. The three items are:

- The PMF (probable maximum flood) was routed through the reservoir starting at the top of the flood-protection pool, e.g. peak 50-year-flood elevation. Harza indicated that this starting elevation is overly conservative and not required by Corps regulations. Harza suggests that routing should be started at maximum normal pool.

- The PMF peak flows may be 25 percent too high.

- The wind speed used for calculating freeboard might be reduced slightly.

Harza also stated that the crest length of the spillway was constrained by the need to prevent downstream flow conditions worse than might occur under PMF (probable maximum flood) flows without a dam. As an exercise, a spillway with a surcharge eight feet greater than proposed by the Corps was evaluated by Harza. The exercise resulted in a net cost reduction after accounting for the shorter spillway crest and higher dam. Based on the revised embankment section, the cost of raising the dam to provide surcharge storage is much less and; therefore, the optimum length of the spillway crest would be less, resulting in a net reduction in cost.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

The maximum surcharge pool elevation was calculated by routing the runoff from the Probable Maximum Precipitation (PMP) on top of the Flood Control Pool Elevation. **ER-1110-8-2(FR) Inflow Design Floods for Dams and Reservoirs** was used to determine criteria for calculating the height of the dam. If the study continues to the feasibility phase we will assess the appropriateness of routing the Spillway Design Storm on top of the conservation pool.

The PMP rainfall was determined using the **HMR52 Probable Maximum Storm Computer Program** which optimized the storm orientation and size. It was determined to use the PMP developed for the basin upstream of the reservoir site rather than for the entire basin, for sizing the reservoir. The rainfall values were redistributed using Figure 7 of the **HMR52 Users Manual** to get the maximum runoff and maximum reservoir stage. Total rainfall over the reservoir basin only was 41.9 inches in 72 hours. The number of subareas upstream of the reservoir were reduced from eight to three to account for the impact of the reservoir pool on the inflow hydrographs at the reservoir structure. Inflow hydrographs were computed from Clark Unit Hydrograph parameters that were calibrated and verified to historical events. Accordingly, those parameters which affect the PMF peak; rainfall, rainfall distribution, and unit hydrograph appear reasonable. If the study continues to the feasibility phase we will revisit unit and runoff hydrographs and reassess the appropriateness of the spillway design flood hydrograph.

Freeboard requirements for wave runup and wind setup were calculated using **ETL-1110-2-305 (Determining Sheltered Wave Water Characteristics)** and **EC 110-2-27 (Policies & Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances For Dams)** which referenced **ETL 1110-2-8 (Computation of Freeboard Allowances for Waves in Reservoirs)**. Wind Speeds were estimated from **ETL 1110-2-221** and Civil Works Investigations Project CW-178 "Freeboard Criteria For Dams and Levees, Technical Bulletin No. 1." One half a foot was added to this freeboard calculation for estimated increase in stages due to sedimentation over the project life as predicted by Brown & Butler Engineering in their report. We disagree that a 2-yr wind speed should be used in determining the required freeboard for the project.

In summary, no changes were made to the Hydraulics and Hydrologic analysis during this re-evaluation. But, the Corps will revisit the PMF routing and PMF calculations if the study continues to the feasibility phase.

GEOTECHNICAL DESIGN

1992 FEASIBILITY SUMMARY

The proposed reservoir area for the 1992 feasibility study was located in East Feliciana and St. Helena Parishes, Louisiana. Soil borings were taken east-west along the reservoir basin along the centerline of the proposed dam site. From these borings a characterization of the soils at the dam site was determined.

The dam is to cross a deep entrenchment of the Amite River between the approximate elevation 200 contours. Locations both upstream and downstream of the selected site were evaluated and it was determined that there was no geologic advantage to moving the dam from its current site.

Surveys of the dam centerline were performed resulting in a centerline profile and centerline traverse. Seven soil borings were taken along the centerline for the 1992 study and three soil borings were taken in previous investigations along the east side of the Amite River. Index type testing was performed on the representative samples from the soil borings to aid in the classification of the soils. No detailed shear testing was performed. General soil shear strength properties were assumed based upon experience with the soil type. The alignment included in Appendix A was based upon the seven soil borings taken for the 1992 feasibility study by the Corps of Engineers and the three previous soil borings taken by LDOTD.

Two types of dam structures were considered appropriate for this application-roller compacted concrete and earthen section. Analysis revealed that while the roller compacted concrete is smaller in material section than an earthen structure, its heavier unit weight required a pile supported foundation given the existing soil conditions. The cost associated with the required pile foundation makes the roller compacted concrete dam's overall cost far excessive relative to an earthen structure of equal height. The earthen section dam structure was therefore selected for further study.

Detailed design analysis based upon assumed foundation and embankment strengths were performed to determine dimensions for the full size wet reservoir (crest elevation of 211.5 feet NGVD).

Shear stability analyses were performed using the method of planes, based upon best estimates of the stratification and shear strength as determined from the soil borings. Construction case analyses were performed and a cross-section necessary to obtain a 1.30 safety factor was developed. These cross-sections were developed for a crown elevation of 211.5 and a 28 foot crown width. Sudden draw-down and steady seepage analyses were also performed. The design safety factor was 1.0 for the sudden draw-down analyses. A long term steady state seepage condition was also analyzed. In all cases, the construction case (short term) governed the cross-sections of the dams.

Since the predominant soil type in the area available for borrow is silt, a core of impervious clay was considered to reduce through seepage of the dam. In addition, a collector drain of gravel was required to reduce the hydraulic gradient through the dam. The collector drain was separated from the adjacent soils by a geotextile. To reduce under seepage a slurry trench cut-off wall was proposed to extend 5 feet into the stiff to hard clay for the full length of the dam.

The spillway was originally planned on the east bank of the river. The CASE computer program "CSLIDE" was used to analyze the sliding stability of the spillway. In order to provide a safety factor against sliding of 1.30 in the S-case (long term), the spillway was relocated nearer to the eastern abutment. Although this location required a longer entrance and exit to be excavated, the base elevation could be raised, thereby reducing the overall spillway cost. The spillway has a 30 foot deep cut-off wall of steel sheetpile at both the entrance side and the exit side to prevent local undermining. An underdrain system of collection pipes placed in an inverted filter 2 feet thick was also planned to relieve uplift problems. The filter was placed on a geotextile separator. The collector pipes will drain into manholes and then exit into the tail bay. The spillway is to be constructed of roller compacted concrete and lined with reinforced concrete.

In summary, the wet, reduced wet, and dry reservoirs will essentially differ only in height and overall section width. All dams will have a 1,000 foot long spillway and three-10 foot by 10 foot concrete box culverts low flow outlet.

DISCUSSION OF HARZA COMMENTS

It is Harza's opinion that a dam with an upstream slope of 3 horizontal to 1 vertical and a downstream slope of 2.5 horizontal to 1 vertical would be stable under long-term conditions and provide an acceptable margin of safety required during construction and rapid drawdown. Harza's recommendation modifies the base width of the dam in the Amite channel section from 1,400 feet to 500 feet.

The outlet works, as presented by the Corps, is 1,120 feet long excluding the stilling basin. With the changed embankment section above, Harza states that the length of the outlet conduit could be reduced by half to about 560 feet.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

Introduction.

The full description of the Geotechnical re-evaluation is included in Appendix C.

Harza's 1995 Report mainly addressed the size of the earth section under Geotechnical items. Authorization for the re-evaluation study provided an opportunity to look beyond the main point of contention in Harza's 1995 Report and investigate other areas where significant cost savings in the geotechnical design are possible. Three major areas were investigated for cost savings: the size of the dam sections, substitution of a zoned embankment for the gravel chimney drain, and a thinner layer of concrete for the spillway section together with drainage relief to accommodate uplift pressures.

Four additional borings were taken and samples were tested for shear strength. The higher shear strengths obtained for this re-evaluation, compared to the assumed strengths in the 1992 feasibility study, resulted in smaller reservoir cross sections. The 1997 sections provide adequate margins of safety for stability and seepage requirements. Three major changes were made based on the geotechnical data obtained for this re-evaluation and data from the 1992 feasibility study. These changes have reduced the cost of the reservoir significantly. The changes are:

- smaller reservoir sections
- elimination of the horizontal and inclined gravel drain
- a much thinner concrete layer for the spillway

A part of the 1997 investigation consisted of evaluating and comparing the size of the proposed reservoir to other reservoirs in the region, or to reservoirs that have similar foundation soils. This effort shows that the 1997 revised sections are similar or smaller than other reservoirs that were designed and constructed at other sites by the Corps.

Presented are the geotechnical analyses for the reduced wet reservoir which has a crest elevation of 202.8. Since the other reservoir has a crest elevation of 201, whatever works for the higher reservoir will also work for the lower one.

Geotechnical Design Differences. Harza engineers indicated that a dam with slopes of 1 vertical on 3 horizontal on the pool side, and 1 vertical on 2.5 horizontal on the outflow side can be constructed safely at the site. The basis of this design is the shear strength values used.

Geotechnical Data Obtained for the Re-evaluation. Soil borings were taken to determine if soft clay existed in the foundation and to test for shear strength. Four undisturbed borings were taken for the re-evaluation, one on the west bank of the Amite River and three on the east bank. A bulldozer was used to excavate two trenches to find the types of soil that are available for embankment construction close to the ground surface. It was determined that soils from the trenches can be used for zone embankment construction as well as core construction.

Shear Strength Data. Shear strength data was not available when the sections in the original 1992 feasibility report were analyzed for stability, design strengths were based upon judgement. Reliable strengths must be used to insure that the foundation clays are not stressed to the point where excess pore pressure buildup results in embankment slides on the clay layers during construction. If the embankment can be constructed to design height, then the chance of stability failure during operation is relatively small, since most embankment and foundation materials will gain strength with time due to consolidation and pore pressure dissipation. The strength of the clay governed the design and determined the size of the reservoir sections. For this reason, the primary focus was on the clay layers in the foundation. Granular materials appear to have sufficient strength. In general, sand deposits yielded lower than average friction angle values, due to the amount of clay mixed in the specimen.

Specimens from the borings were sent to the Waterways Experiment Station (WES) for special tests to obtain design values. Visual classifications, water content, Atterburg limits, unconfined compression tests, sieve, and other routine tests were performed during soil processing at the New Orleans District. Compaction tests were performed on lean clay samples from the trenches excavated to determine the optimum moisture content. Shear tests of compacted specimens on the wet, near optimum, and dry side of optimum were conducted to obtain shear values for the core. Unconsolidated undrained (Q), consolidated undrained (R), direct shear (S), consolidation, and various other minor tests were performed on select specimens from the boring logs. Test results are included in Appendix C.

Shear Strength of Clay Core. Compaction tests of lean clay samples from a trench show that the optimum water content is 15.8% at a maximum dry density of 110.4 pcf. Unconsolidated undrained tests at water contents on the dry, near optimum, and wet side yielded very large shear strengths that increase with increasing confining pressure. The behavior is more representative of a consolidated undrained test. It is very unlikely that the clay will retain such high strengths once water reaches the core, or that the clay can be compacted at such low moisture with the amount of rain that occurs in the region. There are two main reasons not to compact the clay to maximum compaction. The first is to prevent brittle failures at low strains. The second is to prevent failures that result from softening when the clay is exposed to water and absorbs water in excess of that at which it was compacted. Based on these concerns, the full strengths of the test results were not used, but the clay design strength was increased from 600 psf to 1,000 psf.

Strength of Embankment Soils. Information from the soil boring and trench excavation reveal that the most abundant soil types close to the ground surface that are available to construct the embankment are sands, gravels, and silts. The deposits are not clean, but instead consist of blends of various types of soils with one type being the predominant material. Clay is mixed in varying quantities throughout the various deposits in the foundation. Some lower than average friction angles measured by the direct shear tests for foundation sands are believed to be due to clay content in the sample. Embankment materials from these deposits will contain the same amount of clay and will result in approximately the same friction angle values. A friction angle of 28 degrees was used to account for some of the lower values measured in the foundation sands.

Strengths of Foundation Clays. The shear strength of foundation clays was determined by unconsolidated undrained (Q) and consolidated undrained (R) tests. In general, Q tests reached peak strength within 2% axial strain and decreased in strength thereafter. Strength reductions of more than 50% were measured when tests were carried out to 20% strain. Peak undrained shear strengths for the top of the clay layer for two of the borings ranged from 1,750 to

1,850 psf, while the residual strengths ranged from 1,300 to 1,400 psf. At the bottom of the layer, peak strengths ranged from 800 to 1,200 psf. The peak value was reduced to 800 when the test was carried to 20% strain. All of the Q specimens exhibited strain softening. Friction angles, for the R tests in the same layer, ranged from 10 to 15 degrees with cohesion intercepts ranging from 800 to 1,000 psf.

Strength of Granular Soils in the Foundation. Direct shear tests and R tests were used to measure the shear strength of sands and lean clay specimens. Some R tests could not be performed on the lean clays because the specimens could not be trimmed due to the amount of gravel in the specimen. The friction angles were lower than expected for many specimens. Some S tests have broken back strength envelopes, a friction angle decrease with increasing normal stress. A friction angle value of 32 degrees was used for sand that contained gravel specimens, and 35 degrees for specimens consisting mainly of gravel.

Stability Analyses. The length along the alignment of the reservoir was divided into reaches to account for different geologic condition and ground surface elevations. Stability analyses are presented for the construction case in the 1992 feasibility report, Plate 20. This plate represents the low ground conditions on both sides of the river. Ground water is below the ground surface, except for one of the cases that are presented. Shear strengths are considered to be on the average to high side. The analyses that are presented are routine and do not fulfill most of the requirements of the Earth and Rock-Fill design manual. Earthquake and other more rigorous cases involving mixed strength envelopes were not evaluated at this time. All of the more complex and routine analyses will be performed during continuation of the feasibility phase. However, the analysis that were performed are considered adequate for cost estimates.

Design Manuals for Dams. During the investigation, the manual entitled "Engineering and Design Stability of Earth and Rock-Fill Dams", EM 1110-2-1902, dated 1 April 1970 was used for guidance about the various methods of analyses.

The recommended methods for slope stability analyses are the Wedge Method, or the optional use of the Modified Swedish Method. A minimum factor of safety of 1.4 is required for dams over 50 ft high on relatively weak foundations. The designer has the option to ignore the forces on the vertical sides of slices. The factors of safety recommended are for the Wedge and Modified Swedish methods. It is questionable whether the factors of safety are compatible with those obtained by the Spencer Method, which uses side forces between slices. Sensitivity analyses clearly show that some stability methods yield much higher safety factors than others for the same embankment configuration and loading conditions.

Method of Slope Stability Computation. The Corps program Utexas3 was used to analyze slope stability. The Corps of Engineers' Modified Swedish Procedure with zero inclination for the side forces between slices will provide accurate stability values in the clay layers. An automatic search with noncircular shear surfaces was used to locate the critical shear surface. No tension crack was allowed in the embankment or core, resulting in less conservative factors of safety.

Design Section. Various iterations were performed to find a section with common slopes that would work for the various ground surface elevations. The design section consists of a reservoir with a 24 ft wide crown at elevation 202.8, side slopes of 1 vertical on 3 horizontal from the crown to elevation 172.8, the elevation of the flood control pool. On the flood side, from the flood control elevation to the conservation pool elevation, the slope is 1 vertical on 6 horizontal. The flatter slope is to reduce the chances of sudden drawdown failures that tend to occur in this zone. Below the conservation pool elevation, the slope is 1 vertical on 4 horizontal. On the protected side, from the flood control pool elevation to the conservation pool, the slope is 1 vertical on 5 horizontal. The flatter slope in this area will increase stability and will resist seepage forces that may concentrate in the lower portion of the dam. Below the conservation pool, the slope is 1 vertical on 3 horizontal (See Plate 4).

Various shear strength conditions and one high water condition are presented in Appendix C.

Conclusions about Stability Analyses. The proposed design sections are significantly smaller than those in the 1992 feasibility report. The various cases show that a reservoir with the proposed slopes can be constructed at the site. Flatter slopes in the mid portion of the reservoir reduce the chances of sudden drawdown failures in the headwater side, and help control any seepage uplift forces that develop on the tailwater side. A broader base, relative to Harza's 1995 section, provides additional relief from under seepage by increasing the seepage length.

Conclusions about Seepage Analysis. Although a thorough seepage analysis is well beyond the scope and cost of this re-evaluation, two major changes results from the re-evaluation of all the data and seepage control methods. The first change eliminates the inclined and horizontal gravel chimney drains. Elimination of the roller compacted concrete beneath the conventional spillway wearing surface constitutes the second major change. These changes result in significant cost savings without reducing the safety or effectiveness of the reservoir. Future studies should determine the effectiveness of the slurry trench and whether seepage control blankets are required in the abutment areas.

Foundation Settlement. Settlement is another area that is beyond the scope and money restraints of this re-evaluation. The consolidation tests that were performed were to determine the stiffness of the deposit and aid in shear strength reliability evaluation. Consolidation tests reveal a stiff clay deposit with high preload values. Excessive foundation settlement is not expected, even in the areas where the clay layers are thicker and closer to the ground surface. The fill volume was increased by one percent to account for settlement.

Comparison of Proposed Reservoir to Other Reservoirs. A part of the investigation consisted of evaluating and comparing the size of the proposed reservoir to other reservoirs in the region, or to reservoirs that have similar foundation soils (Plate 5). This effort will show if the proposed design is overly conservative, unrealistic, or costly.

Two dams in the state of Mississippi, the Ross Barnett and the Arkabutla, are of similar height. A comparison reveals that the re-evaluation assumptions and design are not conservative, but on the liberal side.

The Milford Dam in Kansas is built on what appears to be a similar foundation to the Darlington Reservoir. There is not much difference between the overall slope in the Milford Dam and the proposed section. The Milford Dam has additional safety features to combat seepage, and a 500 foot long impervious blanket on the upstream side.

The design sections that are proposed are realistic in comparison with other reservoirs that were designed and constructed at other sites by the Corps. Based on these comparisons, it was concluded that the proposed section is a good starting point for this level of investigation.

Conclusions. Every effort was made to provide a realistic design for a safe, efficient and low maintenance reservoir. The 1997 sections provide adequate margins of safety for stability and seepage requirements, for this level of investigation. Any further reduction in size will be at the expense of safety. Possible cost savings may be achieved during future analyses of the slurry trench, but the savings could be offset by additional requirements in some portions of the foundation.

Future geotechnical studies should focus on the slurry trench beneath the reservoir. Additional soil borings are required, especially in the higher terraces to evaluate stability, seepage, and the effectiveness of the slurry trench. The final design may require impervious seepage control blankets, on the upstream side in the vicinity of the abutments, together with other seepage measures to insure that no seepage develops in these areas.

ROADWAY AND UTILITY RELOCATIONS

1992 FEASIBILITY SUMMARY

The estimated total roadway and utility relocation costs for the 50-year design project alternatives are as follows:

Alternative	Total Estimated Relocation Cost
50-yr Wet	$33,396,000
50-yr Reduced Wet	$16,752,000
50-yr Dry	$9,209,000

These costs include 12 percent for the owner's engineering, 10 percent for the owner's construction administration, plus 25 percent for contingencies. Some roadway relocations were considered optional and are not included in the relocation costs above.

All existing highways and roads that traverse the proposed reservoir will either be re-rerouted or raised to accommodate a 50-year flood event in accordance with LDOTD standards. Roads that only provide access to areas inside the reservoir limits will be abandoned.

The proposed design elevation of the top surface of the replacement roads and the bottom of the stringer beams of replacement bridges were the 50-year design flood elevation plus an additional two feet of freeboard.

Pipelines located under proposed permanent water will require weighting to offset negative buoyancy. Installation of pre-cast set-on concrete river weights were the most feasible method of in-situ pipe weighting. Natural gas carriers require weighting up to a reasonable flood event elevation. The 100 year flood elevation plus two feet of freeboard was chosen. Liquid carriers that are not normally buoyant required weighting in frequently flooded areas only. Five feet above the proposed permanent water level was chosen. Pipeline reaches under existing river and creek beds that were already weighted were discounted.

Vertical clearance for power and communication limes must be in accordance with ER 1110-2-4401. This regulation states that minimum vertical clearances are to be set above the total design capacity level of the reservoir excluding surcharge. The 50-year flood event pool elevation was used in the 1992 study. It was assumed that sailboating was expected in pool areas south of LA Highway 10 for the wet and reduced wet alternatives.

Tables 6, 7, and 8 show the roads and bridges and utility relocations computed for the 1992 feasibility study. It should be noted that an assumption was made that traffic could be re-routed onto existing roadways at no cost. Therefore, a portion of the cost to raise LA Highway 10, including construction of five replacement bridges, was not included in the 1992 relocations costs. In addition, the cost to permanently re-route LA Highway 448 was also not included in the 1992 relocations costs.

Table 6
1992 FEASIBILITY STUDY
ROADWAY AND UTILITY ESTIMATED RELOCATION COSTS
50-YEAR WET RESERVOIR ALTERNATIVE

A. ROADS AND BRIDGES

1. LA 960 @ West End of Dam; Relocate 1.0 mile around dam. Cost includes 14.5 acres new right-of-way.

Estimated Cost: $1,254,000

2. LA Hwy. 10 Darling Creek Reach; Raise 4,700 feet (by embankment) and construct 350 ft replacement bridge.

Estimated Cost: $4,148,000

3. E. Feliciana Parish Road 42 Collins Creek Bridge; Construct new 60 ft. bridge and raise 1,100 feet of approach roadway.

Estimated Cost: $593,000

Subtotal Roadways: $5,995,000

B. UTILITIES

1. Colonial pipeline Co.; Install set-on concrete river weights on two, 36-inch petroleum product pipeline. Each requires weights for a distance of 6,000 feet across the Amite River Basin.

Estimated Cost: $3,050,000

2. Transcontinental Gas Pipeline Co.; Install set -on concrete river weights on two, 36-in. and one 30-in. gas pipelines. Each require weights for a distance of 9,500 feet across the Amite River Basin.

Estimated Cost: $6,469,000

3. Remove 23 miles of local distribution aerial power and phone lines including poles.

Estimated Cost: $107,000

4. Along new LA 960 reach; relocate 1 mile of local distribution aerial power and phone lines.

Estimated Cost: $137,000

5. Gulf States Utilities (GSU); Relocate 10 miles of 500 / 230 kv transmission power line.

Estimated Cost: $15,719,000

6. Dixie Electric Membership Co. (DEMCO); Relocate 11 miles of 69 kv transmission power line.

Estimated Cost: $1,728,000

7. Along LA 10 reach; Raise 3.5 miles of local distribution aerial power and phone lines; lines to share the above new DEMCO poles.

Estimated Cost: $142,000

8. Along LA 432 reach; Raise 1 mile of local distribution aerial power and phone lines; use existing poles and extend 5 ft vertical.

Estimated Cost: $49,000

Subtotal Utilities: $27,401,000

Total Relocations 50-year wet alternative: $33,396,000

Table 7
1992 FEASIBILITY STUDY
ROADWAY AND UTILITY ESTIMATED RELOCATION COSTS
50-YEAR REDUCED WET ALTERNATIVE

A. ROADS AND BRIDGES

1. LA 960 @ West End of Dam; Relocate 1.0 mile around dam Cost includes 14.5 acres new right-of-way.

Estimated Cost: $1,254,000

Subtotal Roadways: $1,254,000

B. UTILITIES

1. Transcontinental Gas Pipeline Co.; Install set-on concrete river weights on two, 36-in. and one, 30-in. gas pipelines. Each require weights for a distance of 9,000 feet across the Amite River Basin.

Estimated Cost: $6,129,000

2. Remove 22 miles of local distribution aerial power and phone lines including poles.

Estimated Cost: $101,000

3. Along new LA 960 reach; relocate 1 mile of local distribution aerial power and phone lines.

Estimated Cost: $137,000

4. Gulf States Utilities (GSU); Relocate 5 miles of 500/230 kv transmission power line.

Estimated Cost: $7,421,000

5. Dixie Electric Membership Co. (DEMCO); Relocate 10.5 miles of 69 kv transmission power line.

Estimated Cost: $1,609,000

6. Along LA 10 reach; raise 2.5 miles of local distribution aerial power and phone lines; lines to share the above new DEMCO poles.

Estimated Cost: $101,000

Utilities Subtotal: $15,498,000

Total Relocations 50-year reduced wet alternative: $16,752,000

Table 8
1992 FEASIBILITY STUDY
ROADWAY AND UTILITY ESTIMATED RELOCATION COSTS
DRY ALTERNATIVE

A. ROADS AND BRIDGES

1. LA 960 @ West End of Dam; Relocate 1.0 mile around dam. Cost includes 14.5 acres new right-of-way.

Estimated Cost: $1,254,000

Subtotal Roadways:$1,254,000

B. UTILITIES

1. Transcontinental Gas Pipeline Co.; Install set-on concrete river weights on two, 36-in. and one, 30-in. gas pipeline. Each requires weights for a distance of 9,000 feet across the Amite River Basin.

Estimated Cost: $6,129,000

2. Remove 22 miles of local distribution aerial power and phone lines

including poles.

Estimated Cost: <u>$101,000</u>

3. Along LA 960 reach; relocate 1 mile of local distribution aerial power and phone lines along new LA 960 reach.

Estimated Cost: <u>$137,000</u>

4. Relocate 9.5 miles 69 kv Dixie Electric Membership Co. (DEMCO) transmission power line.

Estimated Cost: <u>$1,487,000</u>

5. Along LA 10 reach; raise 2.5 miles of local distribution aerial power and phone lines; lines to share the above new DEMCO poles.

Estimated Cost: <u>$101,000</u>

Subtotal Utilities: <u>$7,955,000</u>

Total Relocations 50-year dry alternative: $9,209,000

DISCUSSION OF HARZA COMMENTS

Harza generally agreed with the Corps' 1992 costs for relocating the roads. However, they indicated that for pipelines, electrical transmissions and distribution lines, and phone lines the cost could be reduced. The relocations cost comparisons from the 1992 feasibility report and the 1995 Harza report are included in Table 2.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

Re-evaluation of relocation costs for utilities has realized a reduction of approximately 26 percent for the 25-year dry reservoir. The 1992 utility relocation cost for the 25-year dry alternative was $7,955,000 and the 1997 utility relocation cost for the same alternative in the 1997 re-evaluation is $5,910,000.

However, all improvements listed in 1992 feasibility study as optional are <u>required</u> and cannot be omitted. The 1992 feasibility study assumed that traffic could be re-routed onto existing roadways at no cost. This assumption was invalid since the same class roadway would be required. Relocations costs to satisfy raising or re-routing roadways were included to either upgrade existing roadways which cross the reservoir, and/or upgrade existing roadways which would serve as replacement for roadways which could not be upgraded in place. However, some reductions to the 1992 costs to upgrade and/or re-route roadways were taken. Costs for LA 960 rerouting were not revised. Costs for rerouting LA 448 and raising LA 10 were reduced. The construction cost for replacing 5 bridges on LA 10 was not reduced. Due to the addition of the items formerly labeled "optional", the overall relocations cost increased from $8,518,000 in 1992 to $25,830,000 in the 1997 re-evaluation (25-year dry reservoir alternative).

Existing information developed from previous study efforts was utilized to identify potentially affected facilities. This information was verified by researching data on locations of roads, railroads, and utilities in the "1990 Louisiana Parish Pipeline & Industrial Atlas", oil and gas maps, USGS quadrangles, and aerial photographs. Revised relocation plans and cost estimates were developed in-house, without owner's review. After approval of this Re-evaluation report, and for relocations input to the Feasibility Report, we will obtain facility owner's criteria, and further develop and update the preliminary relocation plans and cost estimates for the recommended and approved project plans.

The estimated total roadway and utility relocation costs for each 25-year design project alternative are:

Reduced Wet Reservoir	$32,530,000
Dry Reservoir	$25,830,000

These costs include owner's engineering, owner's construction administration, and 25% for contingencies.

In the revised project, the local sponsor (State of Louisiana) would fund and effect relocations and alterations of buildings, utilities, highways, bridges (except railroads), sewers, and related special facilities required for construction of a selected plan.

Estimated Relocation Costs for 25-Year Reduced Wet Alternative.

a. ROADS AND BRIDGES.

(1) LA 960 at West End of Dam; Relocate 1.0 mile around dam.
Estimated Cost $1,200,000

(2) LA 448; Permanently re-route traffic to existing parish road 3 miles to the east; upgrade 8.5 miles of parish road from class RL-1 to RC-2.
Estimated Cost $9,120,000

(3) LA 10 Amite River Basin Reach; Raise 11,500 feet (by embankment) and construct five replacement bridges.
Estimated Cost $9,600,000

Subtotal Roads and Bridges $19,920,000

b. UTILITIES.

(1) Transcontinental Gas Pipeline Co.; Install set-on concrete river weights on two 36-inch, and one 30-inch gas pipelines. Each require weights for a distance of 9,000 feet across the Amite River Basin.
Estimated Cost $4,200,000

(2) Remove 22 miles of local distribution aerial power and phone lines including poles.
Estimated Cost $90,000

(3) Along new LA 960 reach; relocate 1 mile of local distribution aerial power and phone lines.
Estimated Cost $130,000

(4) Gulf States Utilities (GSU); Relocate 5 miles of 500/230 kv transmission powerline; Included:
- clearing cost for all 5 miles with 200 feet wide right-of-way
- new towers spaced at 1,000 feet with minimum line vertical clearance of 36 feet
- cost to remove lines and dismantle towers on 4 miles of existing line

Estimated Cost $6,600,000

(5) Dixie Electric Membership Co. (DEMCO); Relocate 10.5 miles of 69 kv transmission powerline; Included:

- 5 miles to share the above new (GSU) towers - 2 miles to be on new single poles with minimum line vertical clearance of 36 feet across Amite River Basin
- 3.5 miles to be on new single poles with minimum line vertical clearance of 24 feet across Darling Creek Basin and outside of reservoir
- cost of to remove 7 miles of existing line and poles.

Estimated Cost $1,500,000

(6) Along LA 10 reach; raise 2.5 miles of local distribution aerial power and phone lines; lines to share the above new DEMCO poles.

Estimated Cost $90,000

Subtotal Utilities $12,610,000

TOTAL REDUCED WET ALTERNATIVE RELOCATIONS $32,530,000

Estimated Relocation Costs for 25-Year Dry Alternative.

a. ROADS AND BRIDGES.

(1) LA 960 at West End of Dam; Relocate 1.0 mile around dam.

Estimated Cost $1,200,000

(2) LA 448; Permanently re-route traffic to existing parish road 3 miles to the east; Upgrade 8.5 miles of parish road from class RL-1 to RC-2.

Estimated Cost $9,120,000

(3) LA 10 Amite River Basin Reach; Raise 11,500 feet (by embankment) and construct five replacement bridges.

Estimated Cost $9,600,000

Subtotal Roads and Bridges $19,920,000

b. UTILITIES.

(1) Transcontinental Gas Pipeline Co.; Install set-on concrete river weights on two 36-inch, and one 30-inch gas pipelines. Each requires weights for a distance of 9,000 feet across the Amite River Basin.

Estimated Cost $4,200,000

(2) Remove 22 miles of local distribution aerial power and phone lines including poles.

Estimated Cost $90,000

(3) Along LA 960 reach; relocate 1 mile of local distribution aerial power and phone lines along new LA 960 reach.

Estimated Cost $130,000

(4) Relocate 9.5 miles 69 kv Dixie Electric Membership Co. (DEMCO) transmission powerline; Included:

- 4 miles to be installed on existing GSU towers
- 2 miles to be on new single poles with minimum line vertical clearance of 34 feet across Amite River Basin
- 3.5 miles to be on new single poles with minimum vertical clearance of 24 feet across Darling Creek and outside of reservoir
- cost to remove 7 miles of existing line and poles.

Estimated Cost $1,400,000

(5) Along LA 10 reach; raise 2.5 miles of local distribution aerial power and phone lines; lines to share the above new DEMCO poles.

Estimated Cost $90,000

Subtotal Utilities	$5,910,000
TOTAL DRY ALTERNATIVE RELOCATIONS	$25,830,000

ENVIRONMENTAL IMPACT AND MITIGATION

1992 FEASIBILITY SUMMARY

The 1992 feasibility report quantified all woodlands, particularly bottomland hardwoods. This was done because the Water Resources Development Act (WRDA) of 1986 states that "impacts to bottomland hardwoods shall be mitigated in-kind to the extent possible" when impacted by Federal actions. Free-flowing river habitats get their productivity from sources away from the river itself. The rise and fall of these rivers in response to the influx of storm waters results in a constant recharge of organic material. Channelization, dams and reservoirs have resulted in significant adverse impacts to this particular habitat.

Evaluation procedures were utilized to quantify the losses of these two significant resources impacted by the Darlington Reservoir project. There are two evaluation systems acceptable to evaluating the effects of actions on terrestrial resources (wildlife habitat). The Habitat Evaluation Procedures (HEP), developed by the US Fish and Wildlife Service (USFWS) is accepted for use nationally. The Habitat Evaluation System (HES), developed by the US Army Corps of Engineers is accepted for use in the Lower Mississippi Valley. There is no commonly utilized standardized system for evaluating impacts of flood control projects on aquatic habitat. An evaluation system was developed jointly by the biologists of the USFWS and the Corps.

Woodland Analysis. The method used in the 1992 feasibility study was a combination of the HEP and HES. The evaluation utilized HEP habitat sampling done by Espey, Huston & Associates, USFWS, and the Louisiana Department of Wildlife and Fisheries (LDWF). For the purposes of this analysis, average annual habitat units (AAHU) were used.

Terrestrial losses were made up of losses of woodland habitat caused by three categories of project actions. These categories were: 1) direct construction, 2) relocations, and 3) permanent pool inundation. The woodland habitat covered by periodic inundation was not considered a lost resource.

The losses were determined for three reservoir types, the 50-year full wet reservoir, the 50-year reduced wet reservoir, and the 50-year dry reservoir. Losses of all woodland habitat for the three reservoir types were 8,228; 3,012; and 500 acres, respectively. A projected project economic life of 50 years was utilized for the period of analysis. Habitat losses of 7,148; 2,739; and 450 AAHU's were determined to be attributable to construction of the three respective reservoirs. It was assumed in the assessment of losses that the current Habitat Suitability Index (HSI) value, i.e, 0.65, would be maintained in the future without project (no action) for the duration of the analysis period. No reductions in acreage of the woodland habitat in the no action condition was assumed.

Woodland Mitigation Alternatives. Mitigation of project impacts is required by the National Environmental Policy Act (NEPA), the Fish and Wildlife Coordination Act (FWCA), and WRDA of 1986. The goal of the compensation analysis in the 1992 study was to determine the amount of area upon which habitat value equal to that lost due to the action could be produced. Two scenarios were developed for the 1992 Darlington study in order to explain the basis for recommending a certain mitigation plan. Scenario (a) utilized existing open lands and scenario (b) utilized existing wooded lands.

(Open Land Scenario) The scenario that utilized existing open land was based on the premise that the open tract analyzed would remain in an open condition under the no action plan (no mitigation implemented) for the entirety of the analysis period. With the mitigation plan in place, the area would be planted with seedlings of trees that would produce habitat value fairly rapidly and would be managed in such a way that a much higher HSE would be reached over the analysis period than that of woodlands for which actual habitat sampling was completed. For example, approximately 4,019 acres of open land would be required for planting and protection to produce the AAHU's necessary (2,753) to mitigate the habitat losses incurred by the implementation of the 50-year reduced wet reservoir.

(Wooded Land Scenario) If the scenario utilizing a tract of wooded land was implemented, it can be seen that a considerable larger tract of land would be required. The idea of this feature would be to create an amount of habitat value on the mitigation tract above and beyond the no action value in the amount equal to those losses caused by implementation of the flood control plan, i.e., the AAHUs of losses for the analysis period. Under the no action plan (future without condition), it was assumed that the HSE values would remain the same as they were when sampled and the acreage would not change. Under the mitigation action plan, habitat improvement measures (development) would be implemented to result in eventual higher quality habitat. Approximately

16,130 acres of existing wooded land would be required to replace the 2,739 AAHUs lost. Stewardship or protection of the area would be required to assure that the habitat quality projected actually does occur.

Cost estimates were made for costs associated with the implementation of each mitigation measure. The 1992 feasibility study costs include real estate, habitat development, and required annual operation and maintenance. The costs displayed are based upon the original AAHUs lost and compensation acreages required and not upon the corrected and revised AAHUS lost and compensation acreages required. A site located in the West Atchafalaya Floodway in St. Landry Parish was chosen for the purpose of this analysis (See Plate 37 of Appendix A).

Free-flowing River Mitigation. Replacement of the lost productivity due to leaf litter, twigs, and small branches in the Amite River caused by the construction of any dam alternative is the goal of mitigation for the Darlington study. Mitigation for impacted aquatic resources has not been developed to the same extent of mitigation for terrestrial resources. The frequent rise and fall of the river in its natural condition with its out-of-bank flooding, in most cases, cannot be reproduced.

The loss that would be mitigated is the 38 miles of free-flowing river both upstream and downstream of the proposed dam structure. Approximately 97 percent of the materials (leaf litter, twigs, etc.) contributing to biological productivity supplied to warm water flowing streams by frequent flooding out-of-bank areas is derived from the first 300 feet from the streambank. Therefore, an area on either side and within 300 feet of the stream is the significant area, and for the purposes of the study, should be protected.

Related costs for this measure include the assumption that the 300-foot strip would be bought and that a large portion of this area would be in sand and gravel mining areas and a smaller portion would be in wooded lands. The amount of $2,300 per acre was used for sand and gravel mining areas, and 1.32 was used as a multiple to convert actual land costs to obtain a general total cost estimate which includes acquisition costs. However, it was noted in the 1992 feasibility study that the estimate was not obtained from Real Estate Division. Mitigation for the reduced wet reservoir were calculated to be 70 percent of the amount for the full wet reservoir. The dry reservoir was said to be 50 percent of the full wet reservoir.

An additional cost associated with the aquatic mitigation feature was fencing. The increase in productivity of the 300-foot area on each side of the river can be assured only if there is a guarantee of no development or grazing on the strip. A fence was indicated to be required to restrict free-ranging cattle and unauthorized individuals. Fencing was included at a construction cost and was based upon a cost of $3.50 per foot for fence construction through wooded lands.

Combined Terrestrial and Aquatic Mitigation Costs. Tables in the 1992 feasibility report display all costs of the overall combined mitigation plan. Table 9 below indicates the total first costs for the 50-year full wet reservoir, 50-year reduced wet reservoir, and 50-year dry reservoir. The cleared land option was utilized rather than existing wooded land. In the dry reservoir alternative, cleared areas are available within the flood control pool. Fencing would require replacement at intervals of approximately every 17 years. Stewardship would also be required to see that the area is protected from vandalism and unauthorized activities.

Table 9
1992 FEASIBILITY STUDY
ENVIRONMENTAL COST ESTIMATES
Total first costs (Real Estate and Construction)

	50-year full wet	50-year reduced wet	50-year dry
Cleared Option	$27,449,000	$14,998,000	$5,726,000
Wooded Option	$57,412,000	$28,236,000	$5,726,000

DISCUSSION OF HARZA COMMENTS

Harza's analysis indicates that mitigation costs for the full-size wet reservoir could be reduced by approximately 50 percent. This reduction would be realized resulting from a reduction in required lands due to recent logging and establishment of new wetlands and hardwoods from the wet reservoir, reducing the cost of replacement of wetlands, and eliminating fencing.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

Discussions with local forestry officials do not indicate that habitat quality has declined because of recent forestry practices or that bottomland hardwoods would colonize the fringes of the reservoir. To their knowledge, high grading has not been a prevalent practice in the area. Most of the area at the extent of the normal pool is pine forest primarily because of soil type, not just because of moisture. We agree that aquatic vegetation could develop in the upper one or two feet of the reservoir pool at its north end if water levels are held constant. However, because of soil conditions, most of the area around the pool will be pine unless planted with hardwoods. The 500 acres of project land around the wet reservoir that could be planted with hardwoods would offset some of the project impacts. The 500 acres does not seem to be accounted for in the 1992 COE or 1995 Harza analysis. This could reduce land acquisition costs for mitigation. A new habitat analyses would be needed to verify possible changes since the last one was done nearly 10 years ago to establish impacts.

Harza calculated that the total woodland acreage that would be impacted should be reduced from 8,230 to 7,780 acres. We recalculated the area of woodland impacted by the wet reservoir based on 1995 infrared photographs and digitizing the storage pools to be 8,740 acres, which is slightly greater than the acreage originally estimated. We checked the calculations for Average Annual Habitat Units (AAHU) lost and found an error in a spreadsheet formula. The error overestimated impacts. With our new acreage and corrected spreadsheet, for the full wet reservoir, 5,387 AAHU would be lost, rather than the 7,148 AAHU shown in the original estimate. This is a 25 percent reduction in impacts.

The 25 percent figure may not be correct as Harza calculated mitigation real estate costs to be $8,852,500 and construction costs to be $2,207,200 for a total of $11,059,700 for the full wet reservoir. Harza did not present costs for the reduced wet or dry reservoirs. Simply applying the 25 percent reduction in needed mitigation for the full wet reservoir to the original numbers in the 1992 COE report of $27,449,000 would give an estimate of $20,586,000. Our updated estimate for the full wet reservoir mitigation costs is $22,146,000 using the cleared land option (see Table 10).

The original idea behind the fences was to exclude cattle from the mitigation area and clearly mark the boundaries against inappropriate uses such as vehicles in the area. While we can agree with Harza that the fences would not guarantee damage prevention by cattle or vehicles and that maintenance of the fences would be an ongoing cost, we know of no other management that could replace the physical and legal protection offered by fences and Harza offers no specific ideas that can be evaluated. Perhaps if we knew more specifics about the downstream areas of critical habitat that they reference, we could evaluate them. However, it should be noted that we get little mitigation credit for preserving areas that already contain high quality habitat unless those habitats are threatened.

We do not disagree that sand and gravel areas would not be restored easily and additional funds would be needed to restore them quickly. However, we can gain a large amount of mitigation credit from them because we start with something of no habitat value. Lower areas of the river offer little with regards to cleared acreage that could be restored to bottomland hardwoods.

Data show that the number of cattle in East Feliciana Parish and St. Helena Parish has declined by about 25 percent since 1988, but that they are still common. Conversely, off road vehicle activities have increased dramatically in the last 10 years. Cattle and vehicles would certainly enter a mitigation site with no fences. Cattle damage could be devastating to a mitigation area in a short period of time, especially along a water course as this one would be. Therefore, we can not at this time recommend removal of the fencing component of mitigation in the middle and upper reaches of the river. We did find an error in the 1992 calculations that significantly reduced, by a factor of 10, the overall cost of fencing on mitigation lands. Plate 6 shows the extent of environmental mitigation downstream of the dam.

With respect to threatened and endangered species, personnel with the Fish and Wildlife Service in Lafayette, after discussions with Paul Hartfield in their Jackson, MS office do not agree with the assertion in the Harza report that the Alabama heelsplitter will not be impacted by the proposed reservoir. At this time, we would say that we do not have enough information to definitively say one way or the other what effects the reservoir would have. Further study, including a three-dimensional sediment analysis will be needed to determine impacts to the Alabama heelsplitter.

The revised cost estimates were derived using a combination of assumptions from the original 1992 COE report, the 1995 Harza Report (reforestation costs), new calculations on acreage of mitigation land needed, and revised land costs. The refined Comite Diversion projections were used to estimate land costs along the Amite River mitigation area. The acreage of land needed was based on processing the revised spreadsheets to determine the mitigation acreage needed to offset the habitat value lost (AAHU) from flooding the remeasured acreage of woodlands within the reservoir storage pools. Most of the land costs were not formal determinations by COE real estate personnel.

Table 10. 1997 RE-EVALUATION Environmental Mitigation Cost Estimates.

REAL ESTATE	Full Wet Reservoir	Reduced Wet Reservoir	Reduced or Full Dry Reservoir
I. Terrestrial			
Woodland losses (acres)	8740	3217	500
Acres of Cleared lands for Mitigation	7905	2975	474
Costs	\$7,566,000	\$2,854,000	\$0[1]
Acres of Wooded Lands for Mitigation	31725	11950	1902
Costs [2]	\$44,811,000	\$16,897,000	\$0[1]
II. Aquatic			
Size[3]	38 miles of 600 foot buffer (2,764ac)	26.6 miles of 600 foot buffer (1,935ac)	19 miles of 600 foot buffer (1,382ac)[4]
Costs	\$8,277,000	\$5,794,000	\$4,138,000
III. Total Real Estate			
Cleared Option	**\$15,843,000**	**\$8,648,000**	**\$4,138,000**
Wooded Option	**\$53,088,000**	**\$22,691,000**	**\$4,138,000**

CONSTRUCTION	Full Wet Reservoir	Reduced Wet Reservoir	Reduced or Full Dry Reservoir
I. Terrestrial			
Fencing@5.50[5] + 25% contingencies			
Cleared Lands	\$510,000	\$313,000	\$0*
Wooded Lands	\$1,022,000	\$627,000	\$0*
Reforestation @200/acre + 25% contingencies			
Cleared Lands	\$1,976,000	\$747,000	\$120,000
Wooded Lands	N/A	N/A	N/A
II. Aquatic			
Fencing @5.50 + 25% contingencies	\$2,767,000	\$1,940,000	\$1,390,000[4]
Cleared E&D and S&A (20%)	\$1,050,000	\$600,000	\$300,000
Wooded E&D and S&A (20%)	\$758,000	\$520,000	\$280,000
III. Total Construction			
Cleared Option	**\$6,303,000**	**\$3,600,000**	**\$1,810,000**
Wooded Option	**\$4,547,000**	**\$3,087,000**	**\$1,670,000**

[1]Mitigation lands exist within the acquisition limits of the reservoir.

[2] Estimated at \$1,000/acre + 25% contingencies + 13% acquisitions, etc. (From Comite Diversion refinements)

[3]Estimated with 56% sand and gravel at \$3,000/ac and forested at \$1,000/acre + 25% contingencies + 13% acquisitions, etc.

[4]Could probably be reduced considerably by increasing the low flow outlet to 20-30,000 cfs to allow up to a 5-year flood rather than 10,000 cfs.

[5]Fencing would need to be replaced every 17 years.

*\$35,000/year would be needed for the salary of a manager and \$15,000/year would be needed for management expenses.

REAL ESTATE

1992 FEASIBILITY SUMMARY

The 1992 estimated total real estate costs required for the proposed dam structure and flood control storage area for each (50-year design) project alternatives were:

Alternative	Total Acres Required for Dam and Reservoir	Cost
50-year Wet	20,150	$30,861,000
50-year Dry	13,750	$21,420,000

The above includes land, improvements, 25 percent added contingencies, Federal and non-Federal administrative costs for tract acquisitions, and added funds for residential relocations. Itemized cost breakdowns for each 50-year design alternative are shown in Tables 50 and 51 of Appendix A.

Estimated real estate costs for the purchase of areas for environmental mitigation and new rights-of-way for roadway and utility relocations are not included in the above real estate estimate. These costs are included in the mitigation and relocations estimates.

Acreages and land losses for each project alternative were obtained from the Draft Environmental Impact Statement (EIS) for the Darlington Reservoir prepared by Espey, Huston & Associates for the State in 1989. It was assumed that all agricultural land would be purchased after crop harvest. No value was therefore given to these crops in this estimate. An estimated contributing value for timber was included in the final per acre values.

Specific cost data on sand and gravel operations were not available during the 1992 feasibility study. Values for the sand and gravel pits include only raw land costs. No costs were included for a required cemetery relocation. The 1992 report indicated that further analysis should include appropriate revisions to account for commercial use losses for the sand and gravel pits. The 1992 report also indicated that revisions should be made to account for the cost of the required cemetery relocation.

Based upon the Espey, Huston & Associates Draft EIS, the 50-year full wet alternative would affect 20,150 acres that would require in fee purchase of 629 tracts of land. Most of this area (15,000 acres) is woodland with about 4,300 acres in pasture/agricultural lands. The remaining acres are shared among residential, sand and gravel pits, roads and waterbodies. Acquisition would be required for 101 identified improvements.

The 50-year dry reservoir alternative was also based upon data compiled in the Espey, Huston & Associates Draft EIS. This alternative would affect 13,750 acres that would require in fee purchase of 386 tracts of land. Most of this area (10,000 acres) is woodland with about 3,000 acres in pasture/agricultural lands. The remaining acres are shared among residential, sand and gravel pits, roads and waterbodies. Acquisition would be required for 77 identified improvements.

DISCUSSION OF HARZA COMMENTS

The 1995 Harza report stated that data collected concerning real estate unit costs were insufficient to revise the Corps estimates, but indicated that the Corps estimates were high for lands in the reservoir area.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

The Harza report does not contain any documentation to support the conclusion that the government estimates were high for land in the reservoir area. Harza's conclusion is based on a local land assessor who suggested that the Corps' estimates were high. Investigation into unit values for fee purchase in 1997 uncovered a vibrant market with a large number of sales. Due to this the following changes in unit values were made:

	1992 Feasibility	1997 Re-evaluation
Pasture/Agricultural	$1,100	$1,400
Woodland	$900	$1,300
Residential	$1,800	$2,500
Sand & Gravel Pits	$2,000	$2,000

In addition, Real Estate costs in the 1992 report reflect only land up to the elevation of the flood control pool due to an error in acreage. The 1992 feasibility study suggests that Real

Estate acreages included lands up to the PMF, but the acreages used only included lands up to the flood control pool. Additional lands above the flood control pool are required in fee and easement. ER 405-1-12, Chapter 12 (Local Cooperation) is the current guidance for multipurpose reservoir projects. The referenced ER states that the following lands for reservoir construction and operation must be purchased in fee: "(b) Lands below the maximum flowage line of the reservoir including lands below a selected freeboard where necessary to safeguard against the effects of saturation, wave action, and bank erosion and to permit induced surcharge operation". Given the above requirement, the 1997 report reflects fee purchase of all real estate within the flood control pool plus a 5 foot freeboard. In addition, easement up to the probable maximum flood (PMF) is required due to the possibility of claims against the government.

Real Estate cost estimates updated for the 1997 re-evaluation follow in Tables 11, 12, and 13. The estimates include 25-year reduced wet alternative, 25-year dry alternative, as well as mitigation real estate cost in St. Landry Parish, and relocation real estate costs.

IDENTIFICATION
NUMBER 70701

Table 11
LER'S COST ESTIMATE
DARLINGTON DAM AND RESERVOIR
AMITE RIVER
ST. HELENA AND EAST FELICIANA PARISHES, LOUISIANA

Reduced Wet Reservoir

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Fee			
	Pasture/Agricultural	3,858	$1,400	$ 5,401,200
	Woodland	13,371	$1,300	$17,382,300
	Residential	36	$2,500	$ 90,000
	Sand & Gravel Pits	496	$2,000	$ 992,000
	Roads & Waterbodies	132	N/A	
	Improvements*			$ 1,846,000
	Severance Damage			0
	Total (R)			$25,712,000
(b)	Contingencies 25% (R)			$ 6,428,000
(c)	Total Lands, Easements, and Rights-of-Way			$32,140,000

*The number of improvements includes two churches.

IDENTIFICATION
NUMBER 70701

Dry Reservoir

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Fee			
	Pasture/Agricultural	3,819	$1,400	$ 5,346,600
	Woodland	13,236	$1,300	$17,206,800
	Residential	35	$2,500	$ 87,500
	Sand & Gravel Pits	491	$2,000	$ 982,000
	Roads & Waterbodies	131	N/A	
	Improvements*			$ 1,758,000
	Severance Damage			0
	Total (R)			$25,381,000
(b)	Contingencies 25% (R)			$ 6,345,000
(c)	Total Lands, Easements and Rights-of-Way			$31,726,000

*The number of improvements includes 2 churches.

IDENTIFICATION
NUMBER 70701

Probable Maximum Flood (PMF)

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Fee			
	Pasture/Agriculture	4,238	$1,400	$ 5,933,200
	Woodland	14,688	$1,300	$19,094,400
	Residential	39	$2,500	$ 97,500
	Sand & Gravel Pits	544	$2,000	$ 1,088,000
	Roads & Waterbodies	146	N/A	
	Improvements*			$ 2,030,600
	Severance Damage			$ 0
	Total (R)			$28,244,000
(b)	Contingencies 25%			$ 7,061,000
(c)	Total Lands, Easements and Rights-of-Way			$35,305,000

*The number of improvements includes 2 churches.

Jim Smith
Appraiser
2 July 1997

Joseph G. Kopec
Chief, Appraisal Branch
2 July 1997

IDENTIFICATION NUMBER 70626

Table 12

LER'S COST ESTIMATE
DARLINGTON DAM AND RESERVOIR
AMITE RIVER
MITIGATION SITE
ST. LANDRY PARISH, LOUISIANA

Wet Alternative

Estimate of Costs (Date of Value - June 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Fee Pasture/Agricultural	7,905	$750	$5,928,750
	Improvements			0
	Severance Damage			0
	Total (R)			$5,929,000
(b)	Contingencies 25% (R)			$1,482,000
(c)	Total Lands, Easements, and Rights-of-Way			$7,411,000

This land is located within the West Atchafalaya Floodway. The floodwday was acquired in the 1930's, and it has never been used. As a result, the market does not recognize the flowage easement encumbering the land. For this reason, full fee value has been estimated for this area.

IDENTIFICATION
NUMBER 70626

Reduced Wet Alternative

Estimate of Costs (Date of Value - June 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Fee Pasture/Agricultural	2,975	$750	$2,231,250
	Improvements			0
	Severance Damage			0
	Total (R)			$2,231,000
(b)	Contingencies 25%			$ 558,000
(c)	Total Lands, Easements, and Rights-of-Way			$2,789,000

This land is located within the West Atchafalaya Floodway. The floodway was acquired in the 1930's, and it has never been used. As a result, the market does not recognize the flowage easement encumbering the land. For this reason, full fee value has been estimated for this area.

Jim Smith
Appraiser
26 June 1997

Joseph G. Kopec
Chief, Appraisal Branch
26 June 1997

IDENTIFICATION
NUMBER 70702

Table 13
LER'S COST ESTIMATE
DARLINGTON DAM AND RESERVOIR
AMITE RIVER
RELOCATIONS
ST. HELENA AND EAST FELICIANA PARISHES, LOUISIANA

Louisiana Highway 960

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Road Easement Woodland	14.5	$1,300	$18,850
	Improvements			0
	Severance Damage			0
	Total (R)			$19,000
(b)	Contingencies 25% (R)			$ 5,000
(c)	Total Lands, Easements, and Rights-of-Way			$24,000

IDENTIFICATION
NUMBER 70702

GSU and DEMCO New Powerlines

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Utility Easement Woodland	121	$1,300	$157,300
	Improvements			0
	Severance Damage			0
	Total (R)			$157,000
(b)	Contingencies 25% (R)			$ 39,000
(c)	Total Lands, Easements and Rights-of-Way			$196,000

Note: No improvements will be affected; engineering is willing to work around improvements.

IDENTIFICATION
NUMBER 70702

Louisiana Highway 448

Estimate of Costs (Date of Value - July 1997)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Road Easement			
	Pasture/Agriculture	5	$1,400	$ 7,000
	Woodland	20	$1,300	$ 26,000
	Residential	16	$2,500	$ 40,000
	Improvements			$251,000
	Severance Damage			$ 0
	Total (R)			$324,000
(b)	Contingencies 25%			$ 81,000
(c)	Total Lands, Easements and Rights-of-Way			$405,000

Jim Smith
Appraiser
2 July 1997

Joseph G. Kopec
Chief, Appraisal Branch
2 July 1997

RECREATION RESOURCES

1992 FEASIBILITY SUMMARY

There are no major outdoor recreational facility developments in the study area. Public access to the Amite River is limited to a few major bridges and roadway crossings. Major recreational activities occurring the study area are sport hunting, bank and some boat fishing, and canoeing and tubing.

Proposed Recreational Development for 50-year Wet Reservoir. The development of a full sized wet reservoir would provide approximately 12,000 surface acres of lake for water-based recreational purposes and for recreational shoreline development. A conceptual plan developed for the reservoir calls for the development of ten sites. The plan included five major campgrounds with picnic areas and boat launches; four access areas with a boat launch; primitive camping and picnicking; and a high intensity day use area with tail water fishing, hiking and nature trails. Annual use for the wet reservoir recreation plan was projected at approximately 1,800,000 visitors yielding approximately $9,000,000 in average annual benefits based upon an intermediate general recreation unit day value of $5.00/day over a 50 year project life. The $5.00/day unit day value was determined from planning guidance and procedures listed in ER 1105-2-100 from 1990. The average annual costs projected are approximately $5,000,000 yielding a benefit-cost ratio of 1.9 to 1. A breakdown of cost and benefits for this conceptual recreation plan is shown in Table 56 of Appendix A.

Proposed Recreational Development for 50-year Dry Reservoir. The development of a dry reservoir would provide approximately 14,240 acres for land and water-based recreation. A conceptual plan developed for the reservoir calls for the development of six sites. It includes a major park with camping and picnic areas, hiking and backpacking trails, a boat launch, and areas for canoeing, fishing, and swimming; a boat access area with picnicking, hiking, canoeing, and fishing; a designated area developed for off-road vehicle use; a fishing impoundment with beach; lakes; and a high intensity day use area with canoeing, hiking, and nature trails. Annual use for the dry reservoir recreation plan is projected at approximately 1,100,000 visitors yielding approximately $5,500,000 in average annual benefits, again based upon an intermediate general recreation unit day value of $5.00/day over a 50 year project life. The average annual costs are projected at approximately $3,600,000 yielding a benefit-cost ratio of 1.5 to 1. A breakdown of benefits and costs for this conceptual recreation plan is shown in Table 57 of Appendix A.

DISCUSSION OF HARZA COMMENTS

The 1995 Harza Report indicated that costs to provide recreation facilities could be reduced by 25 percent, based upon estimates from similar individual recreation facilities. The report also indicated that the average depth of water for the reduced wet reservoir condition is too low for recreation. Harza suggested that the average depth for the reduced wet reservoir be increased from 5 to 10 feet.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

Based on the comments presented by Harza Consulting Engineers and Scientists in their review of the 1992 Darlington Reservoir Feasibility study, portions of the report pertaining to recreation were revisited.

Although Harza suggested that recreation costs appeared high, those costs presented in the report were detailed existing estimates that were indexed to meet that current year's price levels. The current cost estimates have been revised to reflect actual recreation construction costs that were incurred by the government as recently as 1995 and indexed to 1997 price levels. Harza used the 1992 Corps' recreation benefits in their analysis indexed up to December 1994. The benefits have been re-analyzed to meet 1997 price levels using FY 97 approved Unit Day Values. The current benefit/cost analyses accurately portray today's values.

Harza additionally suggested that the reduced wet reservoir condition would result in an average depth of 5 feet of water that is too low for recreation. In reviewing the different pool elevations for the different reservoirs, the conservation pool elevation for the reduced wet is 150' NGVD. This appears to be a minimum of 10 feet above the ground surface elevation; and the recreation pool will lie somewhere between the conservation pool and the flood control pool eliminating the suggested depth problem. The recreation pool elevation can be discretely adjusted in the future for recreational development and use.

Table 14
ESTIMATED BENEFITS AND COSTS FOR THE
25-YEAR REDUCED WET RESERVOIR CONCEPTUAL RECREATION PLAN

SUMMARY:

TOTAL CONSTRUCTION COST	$47,676,000
GROSS INVESTMENT	$49,871,900
ANNUAL INTEREST AND AMORTIZATION	$3,786,000
ANNUAL O&M COSTS	$954,000
TOTAL ANNUAL COSTS	$4,740,000
TOTAL ANNUAL BENEFITS	$9,567,442
BENEFIT TO COST RATIO	2.02 : 1

CONSTRUCTION COST ITEMS:

SITE #	CONSTRUCTION COST
1.	$4,992,000
2.	$7,236,000
3.	$1,668,000
4.	$5,148,000
5.	$1,548,000
6.	$6,360,000
7.	$1,668,000
8.	$9,060,000
9.	$2,556,000
10.	$7,440,000
TOTALS	$47,676,000

CALCULATED BENEFITS:

SITE#	ANNUAL VISITATION	UNIT DAY VALUE	ANNUAL VALUE
1.	198,732	$5.35	$1,063,216
2.	274,235	$5.35	$1,467,157
3.	40,395	$5.35	$216,113
4.	183,293	$5.35	$980,618
5.	50,547	$5.35	$270,426
6.	211,492	$5.35	$1,131,482

7.	44,695	$5.35	$239,118
8.	403,950	$5.35	$2,161,133
9.	30,596	$5.35	$163,689
10.	350,372	$5.35	$1,874,490
TOTALS	1,788,307		$9,567,442

Table 15
ESTIMATED BENEFITS AND COSTS FOR THE
25-YEAR DRY RESERVOIR CONCEPTUAL PLAN

SUMMARY:	
TOTAL CONSTRUCTION COST	$38,436,000
GROSS INVESTMENT	$40,206,500
ANNUAL INTEREST AND AMORTIZATION	$3,052,200
ANNUAL O&M COSTS	$769,000
TOTAL ANNUAL COSTS	$3,821,200
TOTAL ANNUAL BENEFITS	$5,779,726
BENEFIT TO COST RATIO	1.51 : 1

CONSTRUCTION COST ITEMS:

SITE#	CONSTRUCTION COST
1.	$5,436,000
2.	$9,336,000
3.	$4,380,000
4.	$4,248,000
5.	$6,156,000
6.	$8,880,000
TOTAL	$38,436,000

CALCULATED BENEFITS:

SITE#	ANNUAL VISITATION	UNIT DAY VALUE	ANNUAL VALUE
1.	214,524	$5.35	$1,147,703
2.	441,314	$5.35	$2,361,030
3.	93,903	$5.35	$502,381
4.	16,919	$5.35	$90,517
5.	233,135	$5.35	$1,247,272
6.	70,215	$5.35	$375,650
Hunting	7,119	$7.75	$55,172
Totals	1,077,129		$5,779,726

ECONOMICS

1992 FEASIBILITY SUMMARY

Appendix A of ER 1105-2-100 identifies three primary categories of benefits for urban flood control plans: inundation reduction, intensification, and location benefits. For the 1992 feasibility study, inundation reduction is the only primary category of National Economic Development (NED) benefits considered since no significant differences in land or structure value in the study area could be readily observed strictly on the basis of flood risk.

Inundation reduction was considered only on existing structures. No consideration was given to inundation on agricultural lands in the floodplain. Other benefits (automobiles, fill reduction, emergency cost reduction, Federal Insurance Administration costs saved benefits) were estimated to be 20 percent of the inundation reduction benefits, and were not directly calculated.

Gulf South Research Corporation was contracted in 1987 to produce an inventory of structures within the 500-year flood plain of the Amite River Basin. Values for residential structures were determined using current real estate transfers, or current prices, or homes for sale minus lot prices. Ground elevations were determined using aerial photographs containing 2 foot contour lines. First floor elevations were determined by adding 1.0 to 4.0 feet in ground elevations based upon visual observations.

Nonresidential structures were surveyed in small subareas, and were classified and placed in one of fifteen categories. Each structure was assigned a value per square foot based on data obtained through the Marshall and Swift Valuation Service. First floor elevations were determined based on visual observations for each individual nonresidential structure.

The Amite River contains 60 sub-basins. Plans studies in this analysis provide reduced damages in 23 of these sub-basins. Each sub-basin was further divided into reaches and mini-reaches, each representing approximately 1 foot change in the elevation of the 100-year flood level at the center of the mini-reach. Table

58 in Appendix A provides total structure value by reach within each sub-basin.

Depth-damage curves developed for the Lake Pontchartrain Hurricane Protection Project (developed in 1979-1980) were used in the 1992 Darlington feasibility study for residential damages. The curves show the relationship among contents values, structure values, and damages that would be sustained in both categories with various depths of flooding. Nonresidential depth-damage relationships were based on contractor engineering expertise and field interviews which were carried out during the Lake Pontchartrain Hurricane Protection Project. Relationships for nonresidential contents as a percent of structure values were also developed.

Stage-frequency curves, which express the annual probability of various levels of flooding under each plan analyzed, were developed for each reach.

Damages were calculated using the Hydrologic Engineering Center's (HEC) Flood Damage Analysis Package, flood plain structure inventories, and the depth-damage relationships described above, together with stage-frequency curves for each hydraulically consistent reach. Stage-frequency curves were adjusted for slope within each reach by one foot incremental changes in the 100-year reference flood water surface elevations. These reference flood elevations were assigned to structure cards according to minibands, each representing one foot increment in the reference flood elevation at its center, and designed to cut a path perpendicular to the flows of various rivers and tributaries while taking into account hydraulic obstructions and geographic inconsistencies.

The Structure Inventory for Damage Analysis (SID) computer program was used to calculate elevation-damage curves, with appropriate adjustments. The Expected Annual Flood Damage Computation (END) computer program was used to access the HECDSS file and weight the damage corresponding to each magnitude of flooding by the percent chance of exceedance, and then sum the weighted damage to determine the expected annual damage.

Average annual damages to existing development and damages prevented for each hydrologic condition for the wet and dry reservoir are displayed in Table 65 of Appendix A. Based on comparable data in the Comite River Diversion Report, an additional 20 percent of benefits was added to these inundation reduction benefits to account for other benefit categories, such as vehicle inundation reduction, reduction in emergency cost, Federal insurance administration costs saved, and fill reduction benefits.

DISCUSSION OF HARZA COMMENTS

The 1995 Harza Report suggests that the following areas be revisited in the Economic analysis:

a) Update cost benefits to include price level increases.

b) Respond to the fact that the Darlington Reservoir and the Comite River Diversion projects include the same benefits, thereby reducing economic benefits to one depending upon sequence of construction.

c) Provide a more rigorous review of slab elevation surveying problem in Denham Springs.

d) Update benefits based upon Ascension Parish levee and increase the number of structures on the floodplain.

e) Take into account location/intensification benefits from land use changes from primarily rural or agricultural to recreation related residential use.

f) Include benefits from avoiding losses of business profits and employment during the period of economic disruption caused by the flood and clean-up as well as employment benefits from construction and operation of project facilities.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

In addition to revisiting items suggested by the 1995 Harza Report, the following economic items were revised for the 1997 re-evaluation. The 1992 report uses an interest rate of 8.5% while the re-evaluation used an interest rate of 7⅜%. More current depth-damage relationships and contents-to-structure value ratios developed by an independent panel of local experts for the ongoing Morganza to the Gulf feasibility study and the Lower Atchafalaya re-evaluation study were used. Three-day duration freshwater curves were used in this update, consistent with the nature of expected flooding in the Darlington study area. Updated annual inundation reduction benefits amount to $16,749,000 for the 25-year dry reservoir, increased from $8,864,660 for the 25-year dry reservoir in the 1992 feasibility report. This represents a nearly 90% increase over 1992 estimates for inundation benefits.

For the 1992 report, other categories (automobiles, fill reduction, emergency cost reduction, Federal Insurance Administration costs saved benefits) were estimated at 20% of the inundation reduction benefits. This percentage was based upon percentages found in other studies. For the 1997 re-evaluation, other benefit categories were directly calculated. This resulted in an increase in other benefits from $1,772,930 in 1992 to $6,424,000 in 1997 for the 25-year dry reservoir. Direct calculation of the other benefits results in benefits at 38% of the inundation reduction benefits, far above the assumption of 20% from the 1992 feasibility study.

Specific answers to Harza's concerns are listed:

a) Benefits were updated to October 1996 price levels. Updating of structure values from 1987 to 1996 reflects an increase in benefits due to price level changes of 24.3%.

b) Since the Comite River Diversion Project is authorized for construction, it was assumed in place for the re-evaluation. There is a small overlap in benefitted areas between the Comite River Diversion Project and the Darlington Reservoir Project, but the area is not large enough to significantly impact the B/C ratio.

c) The review has been conducted and the appropriate adjustments were made.

d) If the feasibility phase were to continue, the structure inventory would be updated to include the additional structures in the floodplain. The impact of the Ascension Parish levees would also be evaluated.

e) Intensification benefits for a project are generated as economic development is induced within existing land use patterns in a given study area. In contrast, location benefits are those associated with a project-induced change in land use patterns within the study area. Land converted to an alternate use under with-project conditions has a higher economic value. Therefore, the incremental change in land value is a project benefit. In addition, net returns associated with the economic activity generated by a change in land use are also benefits attributable to the project.

To the extent that either of these categories applies to the proposed Darlington Reservoir, it is more likely that location benefits would be observed, in the form of land use changes from primarily rural or agricultural uses to recreation related residential use. Without detailed analysis, the best estimate of NED benefits associated with this change would be some function of the willingness to pay for recreational opportunities accounted for in the recreation benefits category appropriate to the size and type of reservoir being proposed. Ideally, the estimate of recreational benefits should take explicit consideration of land-based activities likely to generate other location benefits. It should differentiate between day-uses and other uses, and should account for other market area opportunities for location benefit-generating activities, particularly where shortages are believed to exist. Use of the recreation benefits to estimate this category was the study plan on which resource estimates were based.

f) The 1992 feasibility study included reductions in clean-up costs for local governments and for home-owners under the emergency cost reduction benefit category. Business losses are difficult to measure, as referenced in Section IV of the Principles and Guidelines (P&G) paragraphs 6-44a and 6-179c. It should be noted that only those business losses that cannot be recovered by a firm at another location, or by the same firm at a later time can be claimed as a benefit. Any impacts to the employment resources in the area should be discussed in the report but may not be used as a National Economic Development (NED) benefit.

The complete 1997 economic re-analysis follows.

PROJECT BENEFITS

General. Average annual benefits shown in the 1992 Darlington Reservoir feasibility study for the 25-year dry reservoir and the 25-year reduced wet reservoir alternatives are $10,637,590 and $10,039,140, respectively. The inundation reduction benefits category accounts for $8,864,660 of the total benefits for the dry reservoir alternative and $8,365,950 of the total for the reduced wet reservoir alternative. The remainder of total benefits was determined by increasing inundation reduction benefits by 20 percent to represent the other benefit categories. These other categories include fill reduction, emergency cost reduction, and Federal Insurance Administration costs saved benefits. The report indicated that the increase in benefits by 20 percent was based upon percentages found in other studies. For this reanalysis, other benefit categories will be directly computed.

Flood Control. Inundation damage reduction for structures and contents is the largest category of benefits, representing 73 percent of all project benefits. Both residential and commercial structures are located in the flood plain, accounting for 80 percent and 20 percent, respectively, of inundation damage reduction benefits. Benefits in this category were first revised by utilizing more current depth-damage relationships and contents-to-structure value ratios developed by an independent panel of local experts for the ongoing Morganza to the Gulf Feasibility study and the Lower Atchafalaya Reevaluation Study. Three-day duration freshwater curves were used in this update, consistent with the nature of expected flooding in the Darlington study area. Application of these more current relationships to this study resulted in a 63.3 percent increase in benefits for physical damages to structures.

Benefits were further revised by updating structure values to October 1996 price levels using construction cost data (Marshall and Swift Construction Costs, October 1996 Monthly Supplement). Updating of structure values from 1987 to 1996 reflects an increase in benefits due to price level changes of 24.3 percent. No adjustments were made to the effective age of the structure inventory which was compiled in 1987 and which, if updated, would reduce structure values due to depreciation. In accordance with

ER 1105-2-100, field surveys, as well as various conversations with parish officials were used to note any changes that have taken place in the residential and commercial development in the area. These officials have indicated that there has been no significant removal of structures and that some new construction has occurred since the inventory was taken. However, East Baton Parish regulations require slab elevations to be at least 2 feet above the 100-year flood elevation and Livingston Parish regulations require slab elevations to be above the 100-year flood elevation; therefore, benefits that would accrue to this new development would be minimal.

Updated annual inundation reduction benefits amount to $16,749,000 for the dry reservoir and $15,986,000 for the reduced wet reservoir. This represents approximately a 90 percent increase over the 1992 estimates.

BENEFITS TO AUTOMOBILES

General. Damages to automobiles are also incurred as a result of flooding in the study area but were not calculated in the 1992 analysis. Automobile damages involve determining the number of automobiles impacted per household and the application of these data to a damage per automobile value. The elevation of each automobile is determined by its corresponding structure elevation. Automobile damages are then calculated by correlating depth of flooding, depth-damage per automobile, and damage per automobile.

Automobile Benefit Analysis. The 1990 census indicated that there were 2.0 vehicles per household in the Darlington area. For automobile flood damage calculations, it was assumed that each residence had one automobile which was susceptible to damage. For slab homes, automobiles were placed at 0.5 foot below the first floor level, assuming garages and carports are lower than first-floor elevations of homes. For pier homes, automobiles were placed at ground elevation. The assumption of only one vehicle per structure recognizes that a number of vehicles may not be parked at home during the time of a flood due to other uses or that they may be evacuated. Therefore, they are not subject to flooding. The current average damage per automobile in the Darlington area was estimated to be $8,200, based on the replacement value of a depreciated used automobile as reported by the National Automobile Dealers' Association. The results of the automobile damage analysis for existing and with-project conditions show $3,232,000 in benefits annually for the dry reservoir and $2,962,000 annually for the reduced wet reservoir.

FILL REDUCTION BENEFITS

General. As new areas are developed in the study area, much of the land will require the use of fill material in order to bring slab elevations up to the level of the 100-year flood event. This is necessary to comply with flood plain regulations. Benefits will accrue to future homeowners to the extent that a flood control project lowers the elevation of the 100-year flood event, since for every 1 foot decrease in the 100-year event, the homeowner may use 1 foot less of fill material under the slab of the house.

In computing the fill reduction benefits of the project, consideration was given to the number of acres expected to be developed, the timing of the development, the reduction in the 100-year flood event, and the estimated cost of filling land in the parish. The number of acres expected to be developed and the timing of the development were obtained from a 1988 land use study prepared by the Louisiana State Planning Office. The elevation lowerings of the 100-year flood event brought about by the projects under consideration were obtained from HEC II outputs supplied by the H&H Branch. Finally, the estimated cost per acre to fill land in the parish was supplied by the Cost Engineering and Specification Branch.

Expected Land Use. The land use study provides projections for land use in each of the sub-basins under consideration, presented in 10-year increments from 1990 to 2040. Since the base year used in this analysis is 1995, an adjustment to the data for the years 1990-2000 was necessary. Between the years 2040 and 2045, it was assumed that growth would continue at the rate shown in the land use study for the time period between 2030 and 2040. Using the rates of growth indicated by the land use study, the number of acres expected to be developed during each 10-year period between 1995 and 2045 were derived.

Benefit Calculations. Benefit estimates were computed by first dividing the increased number of acres developed in each 10-year period by 10 to obtain the average number of acres expected to be developed per year in each sub-basin. It was assumed that 20 percent of this area will be used for road construction when the area is developed and will, therefore, not require any fill material. It was further assumed that only a portion of residential lots will be filled by homeowners. While homeowners with small lots typically fill their entire lots, homeowners with lots which are relatively large compared to the size of their homes may fill less than half of their land. To avoid overstating project benefits, it was assumed that on average only 50 percent of the newly developed land will be filled by homeowners.

Further adjustments were made to the number of acres expected to be developed in the basin. First, not all future development will occur within the existing 100-year flood plain. It was assumed that the percentage of development which will occur inside of the 100-year flood plain of each sub-basin will remain consistent with the pattern exhibited in the past. Since no benefits will accrue to homeowners who develop land outside of the 100-year flood plain, the number of acres of land on which benefits were computed were reduced by the percentage of development expected to occur outside of the 100-year flood plain of the various sub-basins.

Second, while future development located within the with-project 100-year flood plain will achieve a uniform elevation lowering, future development located within the area that is removed from the 100-year flood plain will achieve reduced lowerings of various amounts. [The degree of lowering can vary from zero feet to the maximum lowering that is achieved in the area retained within the 100-year flood plain. Assuming that elevations between these two points follow a linear pattern and assuming that future development is uniformly distributed, we can conclude that lowerings, within each basin, will average half of that measured for the area retained within the 100-year floodplain.]

Therefore, the acreage expected to be developed in the future was divided between the area retained in the 100-year flood plain and the area removed from the 100-year flood plain according to the proportion of existing development within the two areas.

Using the flood elevation lowerings in each sub-basin, the average number of acres developed per year, the percentage of land to be filled, the percentage of new development expected to occur within the 100-year flood plain of each sub-basin, and the price of fill, the benefits in each year were computed through the following formula:

$$\text{Benefit per Year} = \begin{array}{c}\text{Number of}\\ \text{Acres Developed}\end{array} \times \begin{array}{c}\text{Percent of Land}\\ \text{Developed in}\\ \text{Flood Plain}\end{array} \times$$

$$\begin{array}{c}\text{Percent of Land}\\ \text{Expected to be}\\ \text{Filled}\end{array} \times \begin{array}{c}\text{Reduction in}\\ \text{100-year Flood}\\ \text{(in feet)}\end{array} \times \begin{array}{c}\text{Price of Fill}\\ \text{Per Acre-Foot}\end{array}$$

The product of the first four factors in the above equation is the volume of fill material which will not be needed in the newly developed areas if a project is put in place. Multiplying that figure by the price of the fill gives us the benefit per year, or the cost of filling land which will not be incurred with a project in place. The present value of the benefits generated each year was amortized over the 50-year life of the project to give average annual benefits. Fill reduction benefits for the dry reservoir amount to $1,346,000 and $1,220,000 for the reduced wet reservoir.

EMERGENCY COST REDUCTION BENEFITS

General. Emergency costs are those costs incurred by a community during and immediately following a major storm. These costs can be divided into three categories. The first includes local government or parish emergency costs, such as sandbagging and police overtime, damages to public property, such as roads and bridges, and the subsequent clean-up of private and public properties. The second category includes the costs of evacuating and providing subsistence for those residents forced from their homes. The final category consists of the reoccupation costs incurred by homeowners in order for them to move back into their homes. Some of these damages and costs will be reduced due to the flood protection alternatives provided by the project. The reduction of these costs is considered a benefit attributable to the project and is expressed as average annual values.

Reduction in Parish Emergency Costs and Damage to Public Property. Benefits attributed to this category are defined as the elimination or lowering of parish emergency costs. These costs include flood fighting efforts, disaster relief, and increased costs of police and military patrols, as well as damage to roads, bridges, and other public property.

Based on data compiled from Federal Emergency Management Agency (FEMA) damage report surveys and newspaper articles from previous flood events, the average emergency cost per structure flooded was determined to be $1,600 in 1994 dollars. This amounts to $1,762 per structure, after being adjusted to the current 1996 price level through the use of the Engineering News Record Construction Cost Price Index.

In order to determine average annual emergency costs, the costs associated with storms of different frequencies of occurrence were determined. The number of structures flooded above first floor elevation for the 10, 50, 100, and 500-year storm events were provided by Structural Inventory Damage (SID) program outputs for the existing and with-project conditions. These numbers were then multiplied by the $1,762 average emergency cost per structure in order to establish frequency-damage relationships. Finally, these relationships were entered into the Expected Annual Damage (END) program to determine the average annual damages for the existing and with-project conditions. These average annual damages are shown in Table 16.

The portion of the average annual without-project damage that will be reduced by the project is considered the emergency costs saved. The reduction in parish emergency costs for each project alternative is shown in Table 17.

Reduction in Evacuation and Subsistence Costs. Evacuation and subsistence costs include costs incurred by the various relief organizations and groups that aid residents who are forced from their homes during flood events. These organizations include the American Red Cross and the Salvation Army. Relief efforts are also sponsored by local schools, religious organizations and businesses for flood victims. The costs incurred by these groups include meals, clothing, medical supplies, and shelter assistance for evacuees.

Based on discussions with Red Cross and other emergency relief officials, the average assistance provided to each household flooded was determined to be $300 at current 1996 prices.

In order to determine average annual subsistence and evacuation costs, the subsistence and evacuation costs for storms of different frequencies of occurrence were determined. The number of residential structures flooded above first floor elevation for the 10, 50, 100, and 500-year storm events were provided by SID program outputs for the base and with project conditions. These numbers were then multiplied by the $300 total subsistence and evacuation cost per structure in order to establish frequency-damage relationships. Finally, these relationships were entered into the END program to determine the average annual costs for each project alternative. These average annual subsistence and evacuation costs are shown in Table 16.

The portion of the average annual without-project damages that will be reduced by the project is considered the emergency costs saved. The reduction in subsistence and evacuation emergency costs for each project alternative is shown in Table 17.

Reduction in Reoccupation Costs. Benefits attributed to this category are defined as the elimination or lowering of reoccupation costs. These costs result from the flooding of residential structures at or above first floor elevation, and include the many hours that homeowners spend to contract, supervise, and inspect repairs, to clean and disinfect their homes, and to fill-out casualty loss forms for flood insurance and other disaster assistance.

According to a survey of former flood victims in the Amite River area of the New Orleans District, the average time spent in flood clean-up per household totaled 170 hours. Because the homeowners were forced to forego other activities, including work time, during the flood aftermath, an opportunity cost per hour was assigned. This was determined to be $12.73 per hour, or the average hourly wage in East Baton Rouge Parish for employees covered under the Louisiana Employment Securities Law for the fourth quarter 1995 as reported by the Louisiana Department of

Labor. Thus, the total reoccupation costs for each household is $12.73 times 170 hours, or $2,164.

In order to determine average annual reoccupation costs, the reoccupation costs for storms of different frequencies of occurrence must be known. The $2,164 cost per household was multiplied by the number of residential structures flooded above first floor elevation for events of four different frequencies of occurrence in our study area to develop a frequency-damage relationship. The number of structures flooded above first floor elevation for the 10, 50, 100, and 500-year events was available from SID program outputs for existing and with-project conditions. The frequency-damage relationship was entered into the END program to determine average annual reoccupation costs. The reduction in average annual reoccupation costs for each project alternative is shown in Table 16.

The portion of the average annual without-project damages that will be reduced by the project is considered the reoccupation costs saved. This reduction in reoccupation costs for each project alternative is shown in Table 17.

<u>Federal Insurance Administration Costs Saved</u>. The net national cost of the flood insurance program includes the costs of claims adjustment, agent commissions, and the cost of servicing the policies. The current administrative cost per policy is $122 as reported in Economic Guidance Memorandum 96-3 dated 13 Feb 96. Potential benefits from a project will arise as fewer properties are subject to flooding due to a lowering in the 100-year stage. The reduction in the administration overhead associated with these properties is a benefit associated with the project.

In order to determine the magnitude of this benefit, only residential properties in the 100-year flood plain of study area were considered. The structures were grouped into the following flood zones based on their first floor elevations: 0 to 25 years, 25 to 50 years, and 50 to 100 years. According to discussions with Federal Insurance Administration (FIA) officials, the percentage of properties covered by flood insurance in each zone was 100, 80, and 60 percent, respectively. This number was then multiplied by the estimated proportion of structures with flood insurance coverage and by the annual administrative cost per policy for the different frequency storm events in order to assign an average annual monetary value.

Under existing conditions, currently a total of 12,593 policies were written for residential structures in the study area. Under each of the with-project conditions, the corresponding number of policies eliminated and the gross monetary average annual benefit are shown in Table 18. However, according to discussions with FIA officials, between 30 to 50 percent of property owners will continue to maintain flood insurance coverage, despite being removed from the 100-year flood plain. Thus, the gross average annual monetary benefits were reduced by 40 percent, and are shown as net average annual benefits in Table 18.

Table 16

1997 DARLINGTON RESERVOIR RE-EVALUATION
EXPECTED ANNUAL EMERGENCY COSTS

COST CATEGORY	EXISTING CONDITIONS	25-YEAR DRY RESERVOIR	25-YEAR REDUCED WET RESERVOIR
Parish Emergency Costs	$1,595,070	$ 839,020	$ 864,930
Evacuation & Subsistence	271,580	142,850	191,210
Reoccupation Costs	1,959,080	1,030,490	1,062,310
Total	$3,825,730	2,012,360	$2,118,450

Table 17

1997 DARLINGTON RESERVOIR RE-EVALUATION
EXPECTED ANNUAL EMERGENCY BENEFITS

COST CATEGORY	25-YEAR DRY RESERVOIR	25-YEAR REDUCED WET RESERVOIR
Parish Emergency Costs	$756,050	$730,140
Evacuation & Subsistence	128,730	80,370
Reoccupation Costs	928,590	896,770
Total	$1,813,370	$1,707,280

Table 18

1997 DARLINGTON RESERVOIR RE-EVALUATION
FEDERAL INSURANCE ADMINISTRATION
AVERAGE ANNUAL COSTS SAVED

PROJECT ALTERNATIVE	NO. OF POLICIES ELIMINATED	GROSS MONETARY BENEFITS	NET MONETARY BENEFITS
25-YEAR DRY RESERVOIR	5,613	$52,650	$31,590
25-YEAR REDUCED WET RESERVOIR	4,950	$50,370	$30,220

Summary of Updated Project Benefits. The updated benefit categories for the 25-year dry and 25-year reduced wet alternatives are shown in Table 19.

Table 19
1997 DARLINGTON RESERVOIR RE-EVALUATION
AVERAGE ANNUAL BENEFITS

BENEFIT CATEGORY	25-YEAR DRY RESERVOIR	25-YEAR REDUCED WET RESERVOIR
FLOOD CONTROL	$16,749,000	$15,986,000
AUTOMOBILES	$3,232,000	$2,962,000
FIA COSTS SAVED	32,000	30,000
REDUCED EMERGENCY COSTS	1,814,000	1,707,000
FILL REDUCTION	1,346,000	1,220,000
TOTAL AVERAGE ANNUAL BENEFITS	$23,173,000	$21,905,000

Intensification and Location Benefits. Intensification benefits for a project are generated as economic development is induced within existing land use patterns in a given study area. In contrast, location benefits are those associated with a project-induced change in land use patterns within the study area. Land converted to an alternate use under with-project conditions has a higher economic value. Therefore, the incremental change in land value is a project benefit. In addition, net returns associated with the economic activity generated by a change in land use is also a benefit attributable to the project.

To the extent that either of these categories applies to the proposed Darlington Reservoir, it is more likely that location benefits would be observed, in the form of land use changes from primarily rural or agricultural uses to recreation related residential use. Without detailed analysis, the best estimate of NED benefits associated with this change would be some function of the willingness to pay for recreational opportunities accounted for in the recreation benefits category appropriate to the size and type of reservoir being proposed. Ideally, the estimate of recreational benefits should take explicit consideration of land-based activities likely to generate other location benefits. It should differentiate between day-uses and other uses, and should account for other market area opportunities for location benefit-generating activities, particularly where shortages are believed to exist. Use of the recreation benefits to estimate this category was the study plan on which PD-E resource estimates were based.

COST

1992 FEASIBILITY SUMMARY

Itemized costs for the earthen dam structure for dam heights of 211.5, 201.0, and 191.5 are shown respectively in Tables 35-37 of Appendix A (1992 report). Cost breakdowns for the 1,000 foot long spillway and the (3) 10 foot by 10 foot concrete box culvert low flow outlet, are shown in Tables 38 and 39 of Appendix A, respectively.

Cost estimates were prepared based upon an evaluation of historical data (including previous M-CACES projects) or abbreviated (non-detailed)estimating procedures.

From the above set of three dam structure costs, a cost curve was developed as shown in Figure 1 of Appendix A. Alternative dam designs are illustrated on this curve. It can be seen that the dam structure cost rises geometrically relative to design height. This is not surprising since the material volume of the dam structure also increases geometrically relative to height.

DISCUSSION OF HARZA COMMENTS

Harza developed a preliminary estimate of unit prices for the major cost items in the dam structure, at a 1995 price level. Harza concluded that the original prices for all materials except semi-compacted random and fully-compacted clay were generally acceptable and were updated to reflect 1995 price level. However, for the random and clay materials, it was Harza's opinion, based on bids, active projects and other sources, that these unit prices could be reduced by about 40 percent.

1997 RE-ASSESSMENT OF 1992 FEASIBILITY REPORT

The cost estimates for the Darlington Dam Project were prepared utilizing the M-CACES computer system. However, all data for equipment, labor, and materials were manually entered in lieu of referencing the unit price book and data base. Thus, the cost estimate reflects current and applicable pricing and addresses specific construction procedures for the various line items in the estimate.

The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. In addition, these costs were based upon actual in-house knowledge and experience by NOD cost engineers who have estimated similar projects in the past.

All construction work (e.g., excavation, embankment, rock work, reinforced concrete) with the exception of the roller compacted concrete, is common to NOD. For example, the earthen fill for the structure can be hauled from Government-furnished borrow pits by off-highway trucks or scrapers. While new to NOD, the roller compacted work is not new to the construction industry with several roller compacted projects successfully completed in the Southeast and Texas.

In obtaining contingencies, the cost estimate was subjected to a risk analysis to determine the degree of uncertainty associated with each line item. The Range Estimating computer program, which incorporates risk analysis by varying both quantities and costs, was performed on the cost estimate yielding the contingency values in the cost estimate.

In addition, the Corps re-evaluated the construction costs and concluded the following:

a. that the unit cost for the semi-compacted earthen dam and fully- compacted select clay remains reasonable and will not be revised;

b. that the contingency for the semi-compacted earthen backfill reflect a 20% contingency (revised from a 25% contingency in 1992 report);

c. that the utility relocation costs have been updated and some cost reductions have occurred; and the E&D and S&A have been revised to a 6% figure for each (from 10% and 12%, respectively, in the 1992 report) which results in a 10% across the board reduction.

HYDROPOWER AND WATER SUPPLY

Harza indicated in their 1995 report that consideration should be given to both hydropower and water supply. These items were not addressed in the 1997 re-evaluation, primarily because of the lack of a potential user for electricity and water.

CULTURAL AND NATURAL RESOURCES

The proposed project area has a high potential for the presence of significant cultural resource sites. However, land-use practices, which include sand and gravel mining, timber cutting and farming have taken their toll on cultural resource sites. During the 1980's, Espey Huston & Associates Inc. and Coastal Environments Inc. conducted limited field investigations within the proposed project limits. As a result, thirty cultural resource sites were recorded. These sites range in time from the Archaic period (6000 B.C.-2000 B.C.) through the Historic period (A.D. 1540 - 1940's). Six of the previously recorded sites are potentially eligible for nomination to the National Register of Historic Places. One site, 16SH21 (the Hornsby site) was placed on the National Register in 1981. This site represents two multi-component mounds with artifacts ranging in time from the Archaic to early Historic time periods. The site is located below the proposed dam axis and may not be directly impacted by the proposed dam. Additionally, two historic cemeteries are located within the project area. One is located a short distance south of the dam, and the other is located within the flood pool along Darling Creek.

All three project alternatives, the 25-year dry reservoir, the 25-year wet reservoir, and the 50-year wet reservoir will impact a significant number of cultural resource sites. The 50-year wet reservoir will impact the highest number of cultural resource sites. Based upon the analysis of previously recorded cultural resource sites and a small cultural resource sample survey, Espey Huston & Associates Inc. (1989) developed a predictive model of cultural resource site occurrence. They estimated that 250 prehistoric and 115 historic cultural resource sites could be expected within the proposed 50-year flood control pool. District archeologists have reviewed their findings and concur with the predictive model. Acres purchased above the flood pool elevation (not included in Espey Huston & Associate's Inc. model), have potential for the presence of cultural resource sites. Thus, 50 to 100 additional sites can be expected on fee acres purchased above the flood pool elevation. Site numbers may be between 10 and 20 percent less for the 25-year wet and 25-year dry reservoirs.

Once complete, the selected project will have adverse impacts upon cultural resources. Aside from direct disturbance associated with construction activity, cultural resource site inundation will create a variety of adverse impacts. Sites within the conservation and flood pools will be scoured and destroyed by hydraulic forces resulting from large volume discharges. Cultural resources at the upper portions of the reservoir will be buried in silt. Along the edge of the reservoir between the conservation and flood pool elevations, cultural resource sites will be severely eroded by wave action, shifting water levels, and recreational activities. Periodic inundation negatively impacts the organic artifacts contained within archeological sites. Organic materials such as bone, wood, plant remains etc. decompose at an accelerated rate when subject to changing wet and dry conditions. Thus, a significant portion of the information contained within these sites is destroyed. Due to the negative impacts noted above, the entire project area will have to be surveyed and tested prior to construction. Once National Register eligibility is determined, mitigation plans will be developed and implemented prior to project construction.

To develop realistic cost estimates and assess project impacts, a five percent sample survey and testing of project lands will be needed during the restart of the feasibility study phase. Additionally, land-use patterns associated with sand and gravel mining and timber cutting have destroyed numerous cultural resource sites; thus, previously recorded cultural resource sites need to be relocated and their integrity assessed.

EVALUATION SUMMARY

The results of the benefit-cost analysis for the two alternatives are shown in Table 20. Included in the analysis are benefits and costs associated with the construction of recreation facilities. Project costs include first costs, interest during construction and operation and maintenance costs. The analysis shows that the 25-year dry reservoir has average annual net benefits of $7,421,100. The 25-year reduced wet reservoir shows $7,540,700 in average annual net benefits.

Table 20
DARLINGTON RESERVOIR RE-EVALUATION
BENEFIT-COST ANALYSIS

	25-Year Dry Reservoir	25-Year Reduced Wet Reservoir
Project Benefits		
Average Annual Flood Control Benefits	$23,173.0	$21,905.0
Average Annual Recreation Benefits	$5,780.0	$9,567.0
Total Average Annual Benefits	$28,953.0	$31,473.0
Project Costs		
Reservoir Costs		
First Costs	$193,960.0	$208,620.0
Interest During Construction	$36,297.5	$39,627.2
Gross Investment	$230,257.5	$248,247.2
Average Annual First Cost	$17,479.7	$18,845.3
Annual Operation and Maintenance	$231.0	$346.0
Average Annual Costs	$17,710.7	$19,191.3
Recreation Facilities Costs		
First Costs	$38,436.0	$47,676.0
Interest During Construction	$1,770.5	$2,195.9
Gross Investment	$40,206.5	$49,871.9
Average Annual First Cost	$3,052.2	$3,786.0
Annual Operation and Maintenance	$769.0	$954.0
Average Annual Costs	$3,821.2	$4,740.0
Total Project Costs		
First Costs	$232,396.0	$256,296.0
Interest During Construction	$38,068.0	$41,823.1
Gross Investment	$270,464.0	$298,119.1
Average Annual First Cost	$20,531.9	$22,631.3
Annual Operation and Maintenance	$1,000.0	$1,300.0
Average Annual Costs	$21,531.9	$23,931.3
Project Net NED Benefits	$7,421.1	$7,540.7
Benefit-to-Cost Ratio	1.35	1.32

As part of evaluating Harza's concerns about the Corps assumptions and design criteria, the 25-year dry reservoir and the 25-year reduced reservoir were evaluated at reconnaissance level scope. The results of this analysis are broken down by cost as follows. Also, the 1992 feasibility cost for the 25-year dry reservoir is included for comparison purposes. Cost-benefit ratios which exclude recreation cost are included also.

Table 21
COST-BENEFIT COMPARISON

	1992 Feas 25-yr Dry	**1997 Reeval 25-yr Dry**	**1997 Reeval 25-yr red wet**
Cost Breakdown:			
Dam Structure	$173,275,000	**$125,190,000**	**$126,960,000**
Relocations	$8,518,000	**$25,830,000**	**$32,530,000**
Real Estate	$19,814,000	**$41,130,000**	**$45,530,000**
Envir Mitigation	$5,297,000	**$1,810,000**	**$3,600,000**
Recreation	$29,022,000	**$38,436,000**	**$47,676,000**
Total Initial Cost	$236,000,000	**$232,396,000**	**$256,296,000**
Total Equivalent Annual Cost	$25,987,000	**$21,531,900**	**$23,931,300**
Total Annual Flood Control Benefits	$10,637,590	**$23,173,000**	**$21,905,000**
Total Annual Recreation Benefits	$5,000,410	**$5,780,000**	**$9,567,000**
Total Benefits	$15,638,000	**$28,953,000**	**$31,472,000**
Benefit/Cost Ratio	0.60	**1.35**	**1.32**
Benefit/Cost Ratio (flood control only)		1.31	1.14

87-96 PL

-24% pl chng instruct

- new dd curves - updated fr 1980

- Other ben 38% from 20% (1993)

Actual

about 90% increase

The 1995 Harza Engineering Report contained valid comments on the Corps' 1992 Darlington Reservoir feasibility study. Based on these comments, the New Orleans District made revisions to the original assumptions. There were some cost reductions made as a result of the 1997 re-evaluation of the feasibility of the Darlington Reservoir mainly in the areas of the dam structure and environmental mitigation. There were also increases in costs due to invalid assumptions or errors made during the 1992 feasibility study. Revisions to the economic assumptions were also made, resulting in an increase in benefits. The major reasons for the increase in benefits realized in the 1997 re-evaluation was price level increase, interest rate, the use of new depth-damage curves, and direct calculation of other benefits categories.

autos
fill reduction
emerg costs saved
FIA costs

- 1 day curves vs
- 3 day curves -

Int Rate
8.5 - 7 3/8 %
1992 now

As indicated in the beginning of the report, the 1992 feasibility study was suspended by the local sponsor pending consultation with others. Therefore, the original feasibility phase was never formally completed. With the submittal of this re-evaluation report, the New Orleans District recommends continuing with the feasibility study on Darlington Reservoir. The local sponsor, Louisiana Department of Transportation and Development (LDOTD), has indicated a desire to continue the study.

RECOMMENDATION

As the District Engineer, I have found that this report contains a thorough re-evaluation regarding the construction of a dam and reservoir on the upper Amite River. From the findings of this report, I have concluded the plan of action warrants further feasibility level investigations. I recommend continuation of the feasibility study.

The recommendations contained herein reflects the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

William L. Conner

William L. Conner
Colonel, Corps of Engineers
District Engineer

ARTICLE VIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or other elected official, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom.

ARTICLE IX - COVENANT AGAINST CONTINGENT FEES

The Study Sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Study Sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this agreement without liability or in its discretion to add to the agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY Eugene S. Witherspoon

Colonel Corps of Engineers
District Engineer
Contracting Officer

WITNESSES:

STATE OF LOUISIANA

BY

Secretary
Department of Transportation
and Development

CERTIFICATE OF AUTHORITY

I, Norman L. Sisson do hereby certify that I am the General Counsel of the Department of Transportation and Development, State of Louisiana, that the State of Louisiana is a legally constituted public body with full authority and legal capability to perform the terms of the agreement between the United States of America and the State of Louisiana in connection with the Amite River and Tributaries Study, and with full authority and legal capability to pay judgments for damages through the Legislature of the State of Louisiana, if necessary, in the event of the failure to perform, and that the persons who have executed the agreement on behalf of the State of Louisiana have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certificate this 5th day of February, A.D., 19 85.

Norman L. Sisson
General Counsel
DOTD, State of Louisiana

FIRST SUPPLEMENT TO THE

AGREEMENT BETWEEN

THE UNITED STATES OF AMERICA

AND

THE STATE OF LOUISIANA

FOR THE AMITE RIVER AND TRIBUTARIES STUDY

THIS SUPPLEMENTAL AGREEMENT is entered into this_____ day of _________ 1990, by and between the United States of America (hereinafter called the "Government") represented by the Contracting Officer executing this Supplemental Agreement and the State of Louisiana through the Louisiana Department of Transportation and Development (hereinafter called the "Study Sponsor"), represented by its Secretary,

WITNESSETH THAT:

WHEREAS, on 5th day of February 1985, the Government and the Study Sponsor entered into a Cost-Sharing Agreement for the Amite River and Tributaries Study (hereinafter called the "Original Agreement"); and

WHEREAS, the Study Sponsor has requested that the Original Agreement be modified to include the Darlington Reservoir; and

WHEREAS, the Study Sponsor is currently cost-sharing the Amite River and Tributaries Study on a 50-50 basis; and

WHEREAS, the Study Sponsor is willing to cost-share on a 50-50 basis the increased cost of this modification to include the Darlington Reservoir in the Amite River and Tributaries Study.

NOW THEREFORE, the parties agree as follows:

The Original Agreement for the Amite River and Tributaries Study is hereby modified to include the Darlington Reservoir.

The Secretary of the Army has determined that cost-sharing is necessary, therefore the Study Sponsor shall pay, as is specified in this Supplemental Agreement, 50% of the total costs of the Feasibility Phase Study for the Darlington Reservoir Study.

All the Articles of the Original Agreement, not specifically changed or modified herein, shall remain in full force and effect, and apply to this Supplemental Agreement as if they were incorporated herein and made a part hereof.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

UNITED STATES OF AMERICA

BY ______________________

Colonel, Corps of Engineers
District Engineer
Contracting Officer

WITNESS:

____

____

STATE OF LOUISIANA

BY ______________________

Secretary
Louisiana Department of
Transportation and Development

ANNEX A

Feasibility Cost Sharing Agreement

AGREEMENT BETWEEN

THE UNITED STATES OF AMERICA

AND

THE STATE OF LOUISIANA

FOR THE AMITE RIVER AND TRIBUTARIES STUDY

THIS AGREEMENT, entered into this 5th day, of February 1985, by and between the United States of America (hereinafter called the "Government") represented by the Contracting Officer executing this Agreement and the State of Louisiana (Hereinafter called the "Study Sponsor"),

WITNESSETH, that

WHEREAS, the Public Works Committee of the United States Senate adopted a resolution on 14 April 1967 that authorized the Corps of Engineers to conduct a study to determine the feasibility of providing improvements for flood control and other water related land resource needs including water supply, water quality control, hydropower, recreation, and fish and wildlife; and

WHEREAS, the Corps of Engineers has conducted a reconnaissance phase study of flood problems and other water related land resource problems and potential solutions pursuant to this authority, and has determined that further study in the nature of a "Feasibility Phase Study" is required to fulfill the intent of the study authority and to determine the extent of the Federal interest in solution to flood problems and other water related land resources problems; and

WHEREAS, the Study Sponsor considers it in its best interest to have the "Feasibility Phase Study" promptly completed, and is willing to cost-share up to 50% of the total costs of the "Feasibility Phase Study" as indicated in Article I.

WHEREAS, the Secretary of the Army may determine that it is necessary for cost-sharing by non-Federal interests on the authorized "Feasibility Phase Study."

NOW THEREFORE, the parties agree as follows:

ARTICLE I - CONSIDERATION AND PAYMENT

a. Should the Secretary of the Army determine that cost-sharing is necessary, the Study Sponsor shall pay, as further specified in this agreement, 50% of the total costs of the Feasibility Phase Study for any or all of the following items:

Basinwide Protection

Comite River Diversion

East Baton Rouge Parish

Monte Sano Bayou
Jones Creek
Bayou Fountain
Clay Cut Bayou
Hurricane Creek
Nonstructural measures

Livingston Parish

Grays Creek and Tributaries
Effects of roads and bridges on
Restricting Flood Flows
Nonstructural measures

Ascension Parish

New River, Black Bayou, Bayou Narcisse,
and Bayou Francois
Sorrento
Nonstructural measures

The term "total costs of the feasibility phase study" means:

(1) For any Feasibility Phase Study that is in progress at the time the Secretary of the Army decides to proceed with cost-sharing as provided in this agreement, all actual costs of the Feasibility Phase Study that are incurred by the Government or the Study Sponsor pursuant to the terms of this agreement commencing 60 days after the date the decision to proceed with cost-sharing is made, including supervisory and administrative costs.

(2) For any Feasibility Phase Study that is not in progress at the time the Secretary of the Army decides to proceed with cost-sharing as provided in this agreement, all actual costs of the Feasibility Phase Study incurred by the Government or the Study Sponsor pursuant to the terms of this agreement, including supervisory and administrative costs.

b. A Feasibility Phase Study shall be deemed to be complete for cost-sharing purposes with concurrence of the Study Sponsor when the Division Commander issues his notice of completion of the Feasibility Report.

c. The Government, using funds contributed by the Study Sponsor and appropriated by the Congress, shall expeditiously make and complete the Feasibility Phase Study, applying those procedures usually followed or applied pursuant to Federal laws, regulations and policies. The Government will consult with the Study Sponsor in determining the advisability and scope of work to be performed by contract. All bid proposals will be reviewed by the Study Sponsor at their option and comments will be provided to the Government for use in selection of contractors. Award of any contracts with appropriated funds or Study Sponsor contributed funds shall be exclusively within the control of the Government. Concurrent review of work performed by a contractor by the Government and Study Sponsor will be performed in accordance with the contract provisions.

d. The Study Sponsor makes such contributions with the clear understanding that it does not obligate the Government to either recommend authorization of or undertake the construction of a Federal project upon completion of the Feasibility Phase Study. The Study Sponsor shall not have any recourse for payment or reimbursement of any nature whatsoever from the Government for contributions tendered pursuant to the terms of this agreement (except with respect to excess cash contributions as set forth in Article II.e.).

ARTICLE II - METHOD OF PAYMENT

a. To provide for consistent and effective communication between the Study Sponsor and the Government during the term of study, the Study Sponsor and the Government will appoint representatives to coordinate on scheduling, planning, and other matters relating to the Feasibility Phase Study.

b. The Government will notify the Study Sponsor of the decision to proceed with cost-sharing as provided in this agreement within seven working days of the date the decision to proceed with cost-sharing is made.

(1) In the event the Feasibility Phase Study is in progress at the time this decision is made, the Government will, in addition to notifying the Study Sponsor of that decision, also provide the Study Sponsor with an estimate of the Study Sponsor share of Feasibility Phase Study Costs for the remainder of the Government Fiscal Year. The Study Sponsor will then satisfy its obligation to provide 50% of the total "Feasibility Phase Study" costs for the remainder of the Government Fiscal Year by providing within 60 working days of notice by the Government cash contributions, and/or in-kind services during the course of the remainder of the Government Fiscal Year, equal in amount to the Study Sponsor share of Feasibility Phase Study costs for the remainder of the Government Fiscal Year.

(2) In the event the Feasibility Phase Study is not in progress at the time the decision to proceed with cost-sharing is made, the Government will, at the time it provides notice of the decision to proceed with cost-sharing, also provide the Study Sponsor with a date on which the Government expects to initiate the Feasibility Phase Study and an estimate of the Study Sponsor share of the Feasibility Phase Study costs for the Government Fiscal Year in which the Feasibility Phase Study is to be initiated. The Government will obtain the Study Sponsor Share of the total costs of the Feasibility Phase Study from the Study Sponsor for the Government Fiscal Year in which the study is to be initiated, prior to initiating the Feasibility Phase Study. The estimated Study Sponsor's share of the Feasibility Phase Study costs for the Government Fiscal Year will be limited to 50 percent of the estimated costs for the Feasibility Phase Study for the Government Fiscal Year.

c. For subsequent Government Fiscal Years; the Government will provide the Study Sponsor with a statement of the Study Sponsor's share of the total costs of the Feasibility Phase Study for that Government Fiscal

Year six months before the start of the Government Fiscal Year. The Study Sponsor will provide its share of the total costs of the Feasibility Phase Study for that Government Fiscal Year by providing at the start of the Government Fiscal Year cash contributions, and/or in-kind services during the course of the Government Fiscal Year, equal to the Study Sponsor share. For each subsequent Government Fiscal Year, the estimate of the Study Sponsor's share for the pending Fiscal Year will be limited to 50 percent of the estimated costs of the Study in the pending Government Fiscal Year.

d. The Study Sponsor shall make any cash contributions required under this agreement available to the Government by either cash payments to the Government or by deposits of cash into an escrow account acceptable to the Government. The Government will draw on such contributions as it deems necessary to cover contractual and in-house obligations as they occur.

e. Upon completion of the Feasibility Phase Study and resolution of any contract claims and appeals, the Government will compute the total costs of the Feasibiltiy Phase Study and tender to the Study Sponsor a final accounting of its share of the study costs. In the event the Study Sponsor has paid less than its share of the total Feasibility Phase Study costs at the time of the accounting, the Study Sponsor agrees to pay the Government within 90 calendar days after receipt of written notice, whatever sum is required to meet the Study Sponsor share of study costs, provided the Study Sponsor received prior written notice that additional funds would be necessary to complete the Study and the Study Sponsor concurred. In the event the Study Sponsor paid more than its share of total Feasibility Phase Study costs at the time of the final accounting, the Government will return to the Study Sponsor within 90 calendar days the excess cash contribution.

f. HOWEVER, where the Study Sponsor is the State itself, this agreement does not obligate future legislative appropriations or other funds for such performance and payment when obligating future appropriations or other funds would be inconsistent with State constitutional limitations.

ARTICLE III - CREDIT FOR IN-KIND SERVICES

When approved by the Government, the Study Sponsor may receive a credit for in-kind services provided in connection with accomplishment of the Feasibility Phase Study. The credit shall be applied against the requirement established in Article Ia to pay 50% of the cost of the Feasibility Phase Study, but shall not exceed 50% of the total Study Sponsor requirement for Feasibility Phase Study costs. The procedures and methods for computing the value of in-kind services shall be agreed to by the Government and the Study Sponsor prior to the provision of any such services.

ARTICLE IV - TERMINATION

This agreement may be terminated by either party within thirty days by providing written notice to that effect. There shall be a final accounting and settlement upon termination, with all costs including costs incurred as a result of the termination to be cost shared on a 50-50 basis as is otherwise provided under the terms of this agreement.

ARTICLE V - DISPUTES

Any dispute arising under this agreement which is not disposed of by mutual consent shall be decided by the Contracting Officer who shall reduce his decision to writing and mail or otherwise furnish a copy to the

Study Sponsor. The decision of the Contracting Officer shall be final and conclusive unless, within 30 days from the receipt of such copy, the Study Sponsor mails or otherwise furnishes to the Contracting Officer a written appeal addressed to the Corps of Engineers Board of Contract Appeals. The decision of the Board shall be final and conclusive. Pending final decision of a dispute hereunder, the Study Sponsor shall proceed diligently with the performance of the agreement in accordance with the Contracting Officer's decision.

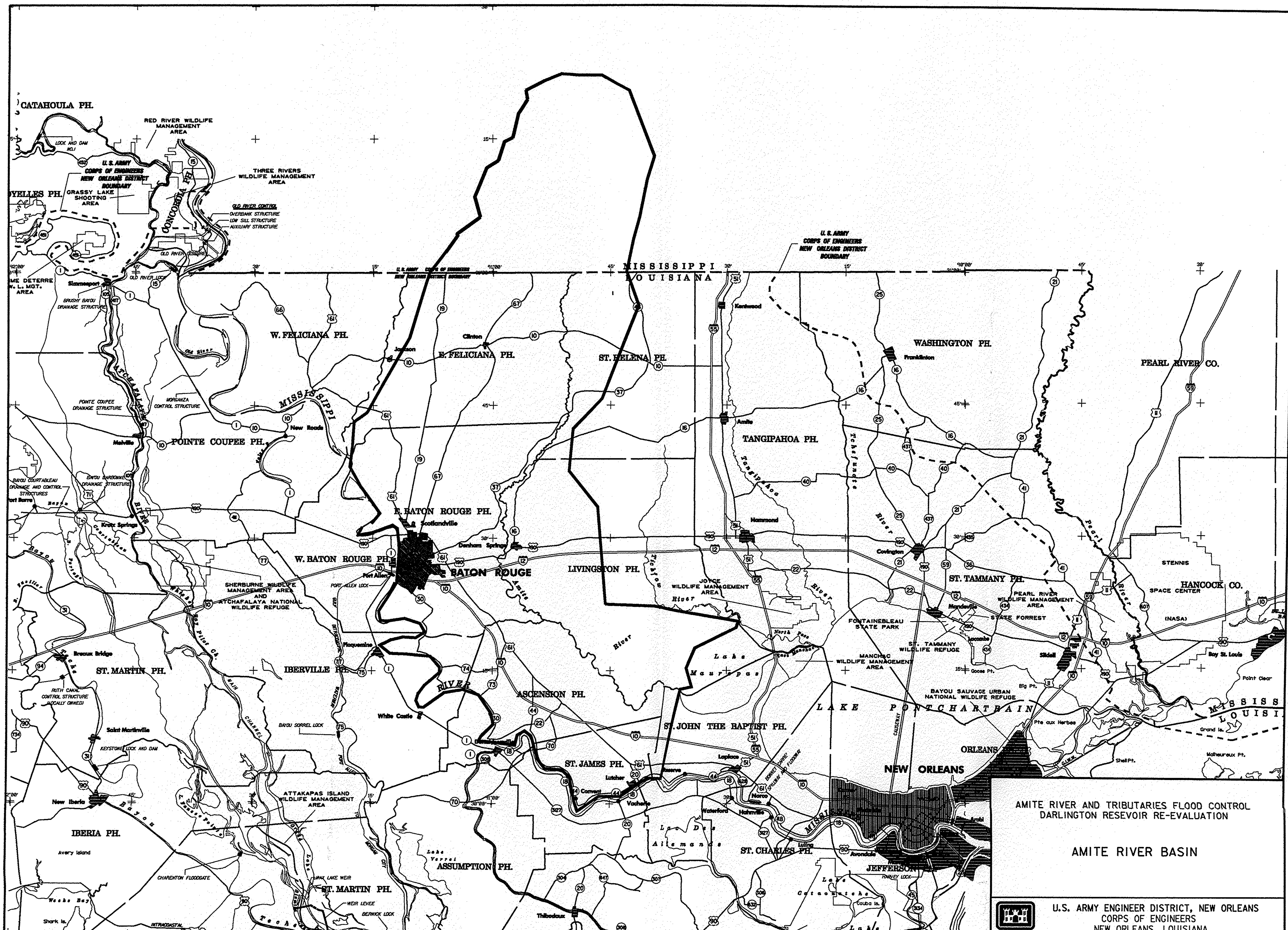
ARTICLE VI - MAINTENANCE OF RECORDS

The Government and the Study Sponsor shall keep books, records, documents and other evidence pertaining to costs and expenses incurred pursuant to this agreement to the extent and in such detail as will properly reflect total Feasibility Phase Costs. The Government and the Study Sponsor shall maintain such books, records, documents and other evidence for inspection and audit by authorized representatives of the parties to this agreement.

ARTICLE VII - RELATIONSHIP OF PARTIES

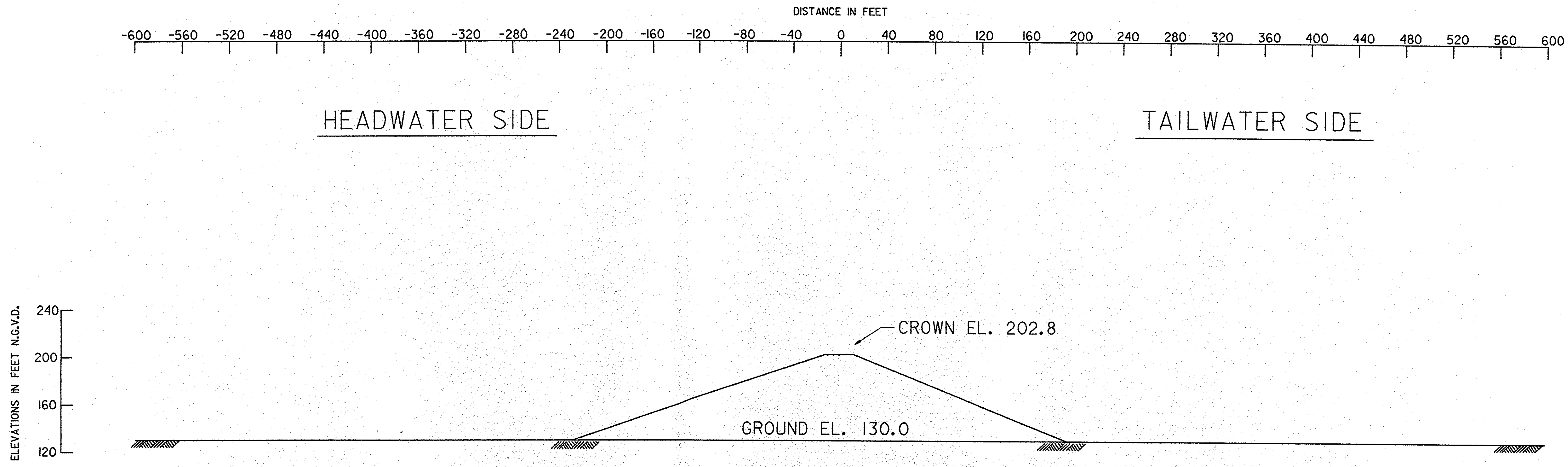
The parties to this agreement act in an independent capacity in the performance of their respective functions under this agreement, and neither party is to be considered the officer, agent, or employee of the other.

PLATES



AMITE RIVER AND TRIBUTARIES FLOOD CONTROL
DARLINGTON RESEVOIR RE-EVALUATION
AMITE RIVER BASIN
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
CATAHOULA PH.
RED RIVER WILDLIFE MANAGEMENT AREA
U. S. ARMY CORPS OF ENGINEERS NEW ORLEANS DISTRICT BOUNDARY
THREE RIVERS WILDLIFE MANAGEMENT AREA
GRASSY LAKE SHOOTING AREA
CONCORDIA PH.
OLD RIVER CONTROL
OVERBANK STRUCTURE
LOW SILL STRUCTURE
AUXILIARY STRUCTURE
Simmesport
BRUSHY BAYOU DRAINAGE STRUCTURE
MISSISSIPPI
LOUISIANA
W. FELICIANA PH.
E. FELICIANA PH.
Clinton
Jackson
ST. HELENA PH.
WASHINGTON PH.
Franklinton
PEARL RIVER CO.
Kentwood
Amite
TANGIPAHOA PH.
POINTE COUPEE PH.
POINTE COUPEE DRAINAGE STRUCTURE
MORGANZA CONTROL STRUCTURE
New Roads
Melville
ATCHAFALAYA RIVER
Krotz Springs
E. BATON ROUGE PH.
Scotlandville
BATON ROUGE
W. BATON ROUGE PH.
Port Allen
PORT ALLEN LOCK
Denham Springs
LIVINGSTON PH.
Hammond
Covington
ST. TAMMANY PH.
STENNIS SPACE CENTER (NASA)
HANCOCK CO.
SHERBURNE WILDLIFE MANAGEMENT AREA AND ATCHAFALAYA NATIONAL WILDLIFE REFUGE
JOYCE WILDLIFE MANAGEMENT AREA
PEARL RIVER WILDLIFE MANAGEMENT AREA
Mandeville
STATE FORREST
FONTAINEBLEAU STATE PARK
ST. TAMMANY WILDLIFE REFUGE
MANCHAC WILDLIFE MANAGEMENT AREA
Slidell
Bay St. Louis
Breaux Bridge
ST. MARTIN PH.
IBERVILLE PH.
Plaquemine
Lake Maurepas
ASCENSION PH.
BAYOU SAUVAGE URBAN NATIONAL WILDLIFE REFUGE
LAKE PONTCHARTRAIN
RUTH CANAL CONTROL STRUCTURE (LOCALLY OWNED)
White Castle
BAYOU SORREL LOCK
Saint Martinville
KEYSTONE LOCK AND DAM
ST. JOHN THE BAPTIST PH.
ST. JAMES PH.
Lutcher
Convent
Vacherie
Laplace
Reserve
Norco
ORLEANS PH.
NEW ORLEANS
New Iberia
ATTAKAPAS ISLAND WILDLIFE MANAGEMENT AREA
IBERIA PH.
Avery Island
Lac Des Allemands
ST. CHARLES PH.
Hahnville
Luling
Avondale
Arabi
JEFFERSON PH.
HARVEY LOCK
ASSUMPTION PH.
Lake Verret
CHARENTON FLOODGATE
ST. MARTIN PH.
WEIR LEVEE
BERWICK LOCK
Thibodaux
Lake Cataouatche
Point Clear
Grand Is.
Shell Pt.
Malheureux Pt.
Pte aux Herbes

PLATE I



AMITE RIVER AND TRIBUTARIES FLOOD CONTROL
DARLINGTON RESERVOIR REEVALUATION STUDY

HARZA's 1995 DAM SECTION

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

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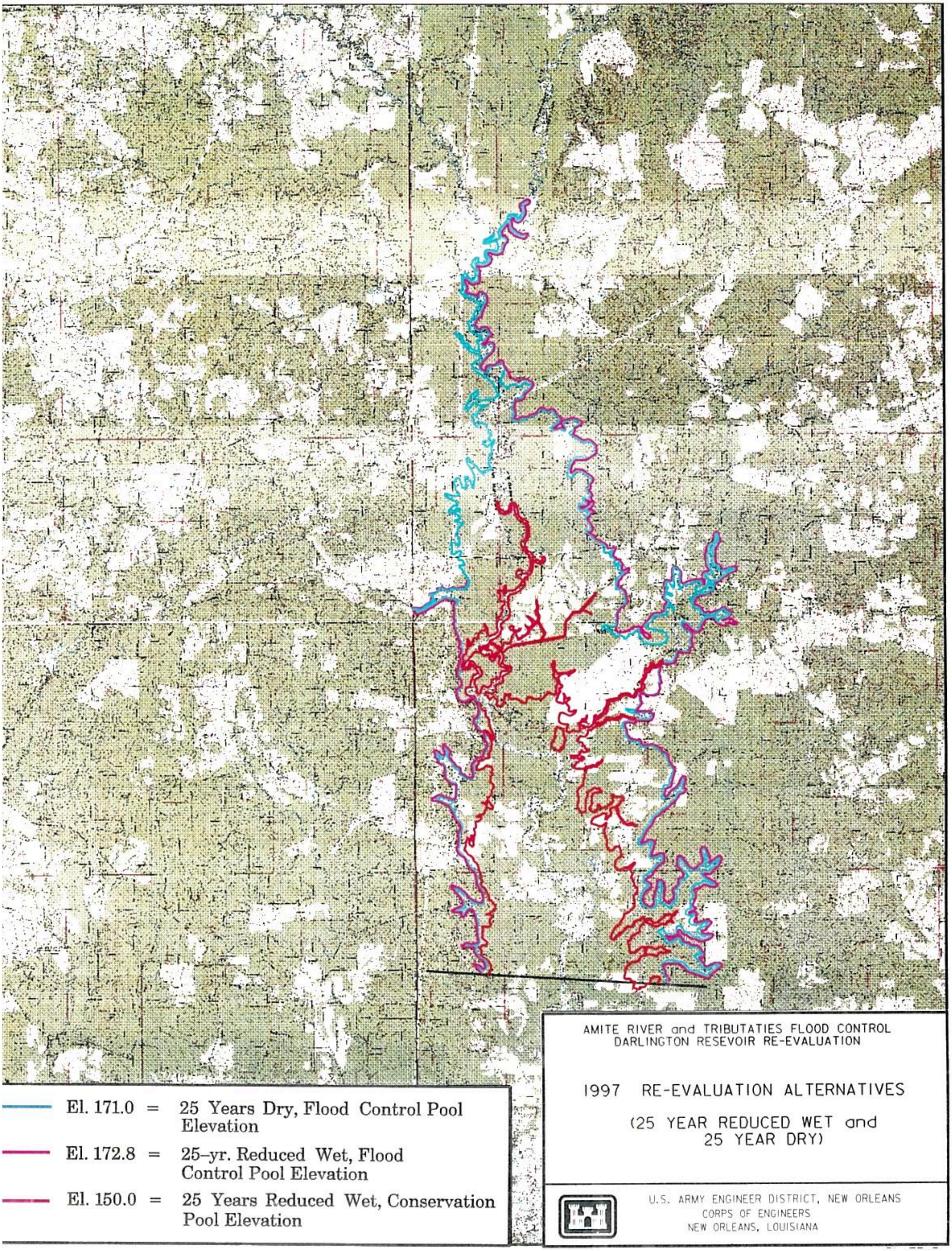
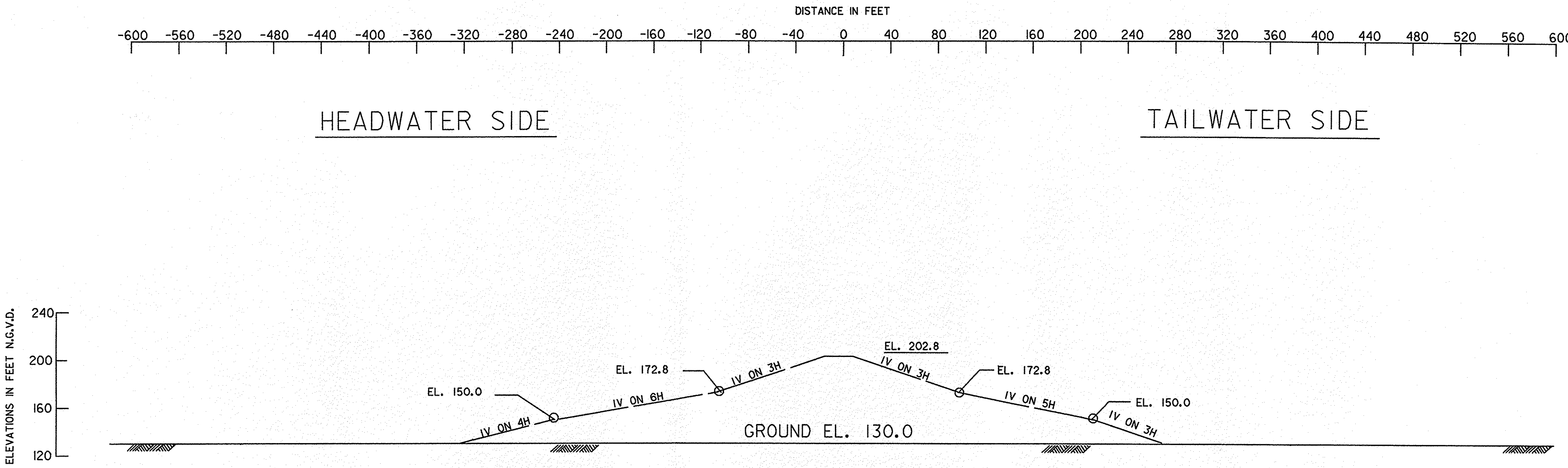


AMITE RIVER and TRIBUTATIES FLOOD CONTROL
DARLINGTON RESEVOIR RE-EVALUATION

1997 RE-EVALUATION ALTERNATIVES

(25 YEAR REDUCED WET and 25 YEAR DRY)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA



AMITE RIVER AND TRIBUTARIES FLOOD CONTROL
DARLINGTON RESERVOIR REEVALUATION STUDY

1997 CORPS REVISED DAM SECTION

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

DESIGNED BY: DRAWN BY: CHECKED BY:	PLOT SCALE:	PLOT DATE: JUNE 1997	CADD FILE: COMPARE.DGN FILE NO.
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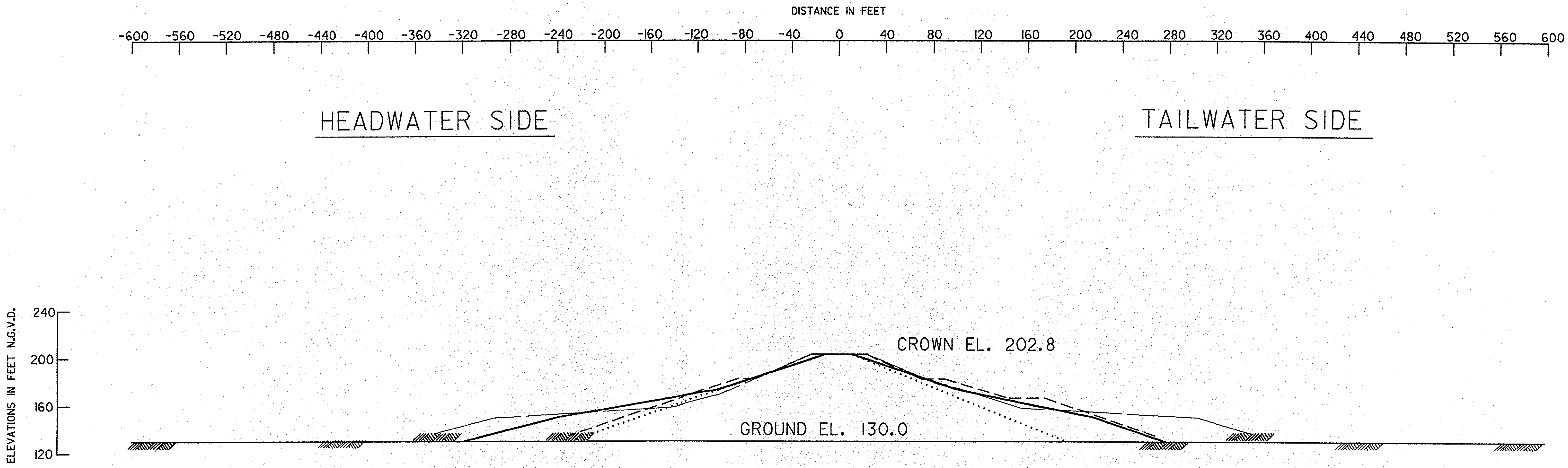


LEGEND

- REVISED USACE DESIGN (1997)
- ARKABUTLA DAM (MISSISSIPPI)
- HARZA's DESIGN
- ROSS BARNETT DAM

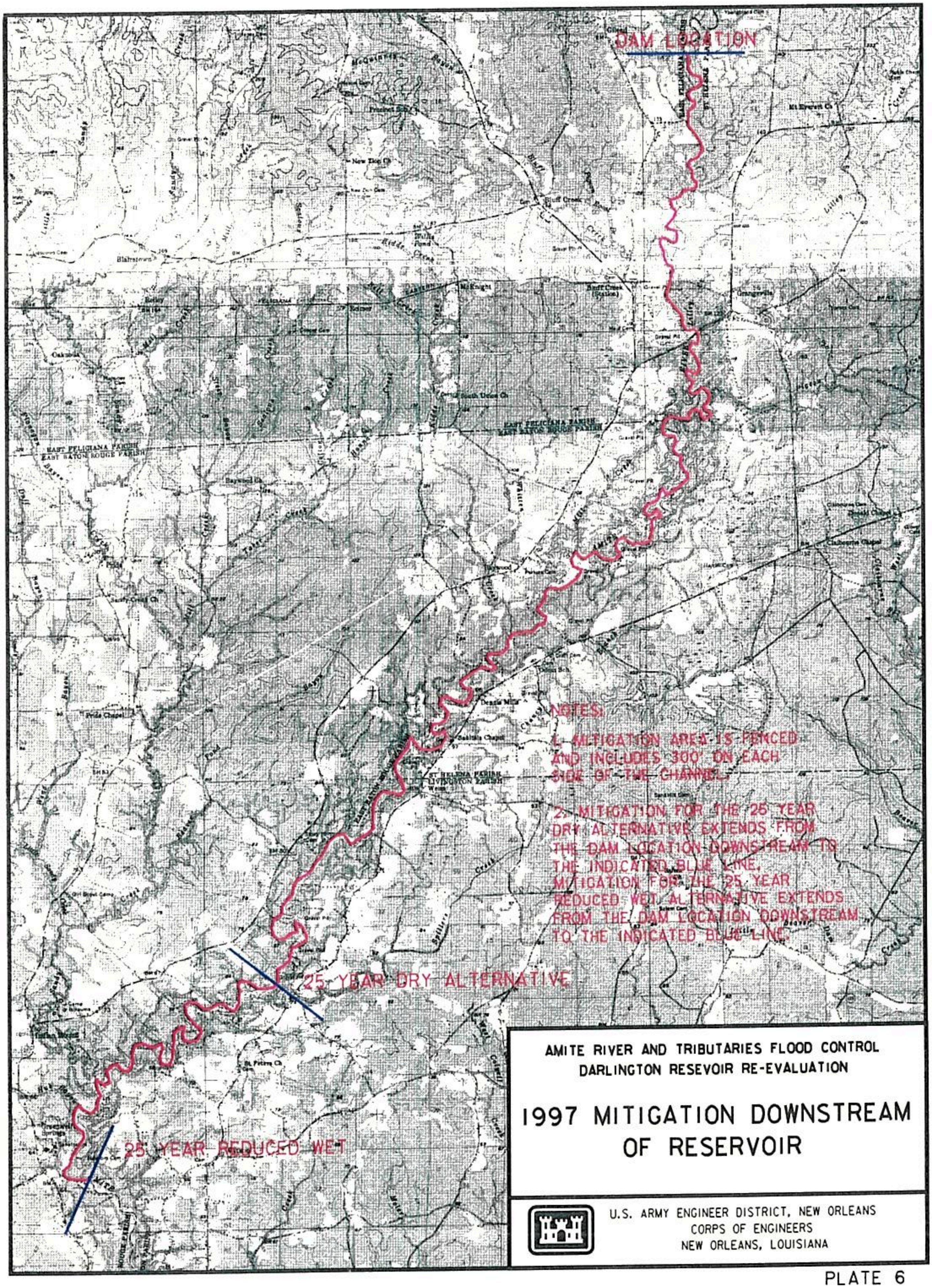
AMITE RIVER AND TRIBUTARIES FLOOD CONTROL
DARLINGTON RESERVOIR REEVALUATION STUDY

COMPARISON OF DAM SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

DESIGNED BY: DRAWN BY: CHECKED BY:	PLOT SCALE:	PLOT DATE: JUNE 1997	CADD FILE: COMPARE2.DGN FILE NO.
	DATE:		

PLATE 5



AMITE RIVER AND TRIBUTARIES FLOOD CONTROL
DARLINGTON RESEVOIR RE-EVALUATION

1997 MITIGATION DOWNSTREAM OF RESERVOIR

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA