105th Congress, 2d Session - - - - - - - - - - - - - House Document 105–173

LOWER SAVANNAH RIVER, GEORGIA AND SOUTH CAROLINA ENVIRONMENTAL RESTORATION PROJECT

COMMUNICATION

FROM

THE ACTING ASSISTANT SECRETARY (CIVIL WORKS), THE DEPARTMENT OF THE ARMY

TRANSMITTING

A REPORT ON THE AUTHORIZATION OF AN ENVIRONMENTAL RESTORATION PROJECT FOR THE LOWER SAVANNAH RIVER, GEORGIA AND SOUTH CAROLINA, PURSUANT TO PUB. L. 104–303, SEC. 101(a)(11)

JANUARY 27, 1998.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

105th Congress, 2d Session - - - - - - - - - - - - - House Document 105–173

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U.S. GOVERNMENT PRINTING OFFICE
46–054 WASHINGTON : 1998

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

REPLY TO
ATTENTION OF

09 DEC 1997

Honorable Newt Gingrich
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

Section 101(a)(11) of the Water Resources Development Act of 1996, authorized an environmental restoration project for the Lower Savannah River, Georgia and South Carolina. The Secretary of the Army supports the authorization and plans to implement the project through the normal budget process.

The authorized project is described in the report of the Chief of Engineers dated July 30, 1996, which includes other pertinent reports and comments. These reports are in partial response to a resolution adopted by the House Committee on Public Works and Transportation on August 1, 1990.

The views of the States of South Carolina and Georgia, the Departments of the Interior, Agriculture, and Transportation, and the Environmental Protection Agency are set forth in the enclosed report.

The authorized project consists of diverting a portion of the flow from the Lower Savannah River, at a point about 20 river miles above the city of Savannah, Georgia, into the Bear Creek and Mill Creek watersheds. The project will improve the quality of wetland and bottomland hardwood habitats in those watersheds, which are located in the State of Georgia. The authorized improvements include modifying and improving the Savannah River approach channel to the entrance of Bear Creek, constructing a small diversion structure at the modified entrance to Bear Creek, constructing a closure plug in the old oxbow of the Savannah River at Bear Creek (Bend #3), and reopening and realigning the entrance to Mill Creek at the Savannah River. None of the improvements will have adverse environmental impacts, or adversely impact navigation on the Savannah River.

The project will increase the quality of wetland and bottomland hardwood habitats by restoring flows and increasing the frequency of overbank flooding. These types of benefits are not amenable to measurement using monetary values. However, to assure that efficient plans were developed, cost effectiveness and incremental analysis techniques were employed to evaluate the net habitat increases of the alternative restoration plans. The authorized project will result in the restoration of about 1,070 average annual fish habitat units, and about 1,960 average annual bottomland hardwood habitat units over a total of about 3,000 acres located in the Bear Creek and Mill Creek watersheds. In addition, the plan will increase by 100 percent the flow into the Bear Creek and Mill Creek watersheds during low-flow periods. These non-monetary benefits justify the cost of the project.

Based on November 1995 price levels, the total first cost of the authorized project is estimated at $3,371,000. The total project cost, including a 5-year, $60,000 monitoring program needed to assess the functioning of the project is estimated at $3,431,000. Total Federal costs are estimated at $2,573,000, while total non-Federal costs are about $858,000.

The Office of Management and Budget advises that there is no objection to the submission of the report to the Congress. A copy of its letter is enclosed in the report.

Sincerely,

John H. Zirschky
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

COMMENTS OF THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

JUN 2 [illegible]

The Honorable H. Martin Lancaster
Assistant Secretary of the
Army for Civil Works
Pentagon - Room 2E570
Washington, D.C. 20310-0108

Dear Mr. Lancaster:

We have completed our review of the following projects, as required by Executive Order 12322:

- Boston Harbor, Massachusetts, by letter of September 20, 1996;
- Blue River Basin, Dodson Industrial Area, Kansas City, Missouri, by letter of October 14, 1996;
- Charleston Harbor, South Carolina, by letter of July 19, 1996;
- Clifton, Arkansas, by letter of June 12, 1996;
- Columbia River Treaty Fishing Access Sites -- Phase II, by letter of July 23, 1996;
- Long Beach Island, New York, by letter of April 30, 1996;
- Lower Savannah River, South Carolina, by letter of September 17. 1996.

Our review concluded that your recommendations for these projects are consistent with the policies and program of the President. The Office of Management and Budget does not object to your submitting these reports to Congress.

We note that these projects have been at OMB for review beyond our normal review time. We regret any difficulties that this extended review time might have created. We are taking steps to improve the timeliness of these reviews to help the Corps and the local sponsors.

Sincerely,

T.J. Glauthier
Associate Director
Natural Resources,
Energy and Science

COMMENTS OF THE STATE OF SOUTH CAROLINA

State of South Carolina

Office of the Governor

DAVID M. BEASLEY
GOVERNOR

OFFICE OF EXECUTIVE
POLICY AND PROGRAMS

ACKNOWLEDGEMENT

April 18, 1996

Mr. Raleigh H. Leef
Acting Chief, Policy Review and
Analysis Division Directorate of Civil Works
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Project Name: Lower Savannah River Basin Environmental Restoration Study Final Interim Feasibility Report, Lower Savannah River Basin, Georgia and South Carolina

Project Number: EIS-9604013-013

Suspense Date: 5/15/96

Dear Mr. Leef,

Receipt of the above referenced project is acknowledged. The Governor's Office, Grant Services Unit, has initiated an intergovernmental review of this project. You will be notified of the results of this review by the suspense date indicated above. South Carolina state agencies are reminded that if additional budget authorization is needed for this project, three copies of the completed GCR-1 form and two copies of the project proposal must be submitted to this office. This action should be initiated immediately, if required. You should use the State Application Identifier number in your correspondence with our office regarding this project. Contact me at (803) 734-0485 if you have any questions.

Sincerely,

Rodney P. Grizzle
Grants Services Supervisor

COMMENTS OF THE STATE OF GEORGIA

OFFICE OF PLANNING AND BUDGET

ZELL MILLER
GOVERNOR

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TIM BURGESS
DIRECTOR

TO: Policy Review Branch/Rev. Div.
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

FROM: TR Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

DATE: 7/2/96

SUBJECT: Executive Order 12372 Review

PROJECT: ERS: Lower Savannah River Basin

STATE ID: GA960522002

CFDA#:

The State level review of the above referenced document has been completed. As a result of the environmental review process, the activity this document was prepared for has been found to be consistent with state social, economic, physical goals, policies, plans, and programs with which the State is concerned.

Additional Comments:

The Corps of Engineers may expect to review comments from other divisions of the Georgia Department of Natural Resources.

TR/ac

ENCL: EPD/Director's Office, June 4, 1996
Chatham Savannah Metro Planning Commission, June 11, 1996

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Policy Review Branch/Rev. Div.
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

FROM: Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

DATE: 5/22/96

SUBJECT: Executive Order 12372 Review

APPLICANT: USCOE

PROJECT: ERS: Lower Savannah River Basin

CFDA #:

STATE ID: GA960522002

FEDERAL ID:

Correspondence related to the above project was received by the Georgia State Clearinghouse on 5/22/96. The review has been initiated and every effort is being made to ensure prompt action. The proposal will be reviewed for its consistency with goals, policies, plans, objectives, programs, environmental impact, criteria for Developments of Regional Impact (DRI) or inconsistencies with federal executive orders, acts and/or rules and regulations, and if applicable, with budgetary restraints. The initial review process should be complete by 6/29/96.

If the Clearinghouse has not contacted you by that date, your proposal may be considered consistent. In that event, forward this receipt to the funding agency to show compliance with Executive Order 12372 or make it part of the federal record for this project.

In future correspondence regarding this project, please include the State Application Identifier number shown above. If you have any questions regarding this project, please contact us at (404) 656-3855.

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

FROM: MR. BRUCE OSBORN
DNR/EPD/DIRECTOR'S OFFICE

SUBJECT: Executive Order 12372 Review

PROJECT: ERS: Lower Savannah River Basin

STATE ID: GA960522002

DATE: June 4, 1996

☒ This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

This notice is not consistent with:

☐ The goals, plans, policies, or fiscal resources with which this organization is concerned. (Line through inappropriate word or words and prepare a statement that explains the rationale for the inconsistency. Additional pages may be used for outlining the inconsistencies).

☐ The criteria for developments of regional impact, federal executive orders, acts and/or rules and regulations administered by your agency. Negative environmental impacts or provision for protection of the environment should be pointed out. (Additional pages may be used for outlining the inconsistencies).

☐ This notice does not impact upon the activities of the organization.

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

FROM: MR. H. BELLINGER
CHATHAM-SAV METRO PLNG COMM.

SUBJECT: Executive Order 12372 Review

PROJECT: ERS: Lower Savannah River Basin

STATE ID: GA960522002

DATE: June 11, 1996

☑ This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

This notice is not consistent with:

☐ The goals, plans, policies, or fiscal resources with which this organization is concerned. (Line through inappropriate word or words and prepare a statement that explains the rationale for the inconsistency. Additional pages may be used for outlining the inconsistencies).

☐ The criteria for developments of regional impact, federal executive orders, acts and/or rules and regulations administered by your agency. Negative environmental impacts or provision for protection of the environment should be pointed out. (Additional pages may be used for outlining the inconsistencies).

☐ This notice does not impact upon the activities of the organization.

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

United States
Department of
Agriculture

Soil
Conservation
Service

Federal Building, Box 13
355 East Hancock Avenue
Athens, Georgia 30601
Telephone: [706] 546-2073

To: Jack Frost
Water Assessment and Special
Studies Coordinator

Date: June 26, 1996

Subject: Corps of Engineers Report -
Lower Savannah River Basin -
Georgia and South Carolina

This memorandum is to acknowledge receipt of your correspondence soliciting Georgia NRCS assistance for comments relating to the above reference project. We appreciate this opportunity to review, and comment on, this report.

We would like to offer the following issues for consideration in the Corps of Engineers final project alignment and design:

1. Develop, install, and maintain an erosion and sediment control plan throughout the project's construction period,

2. Minimize damage to existing vegetation,

3. Minimize damage to natural drainage systems [beyond the scope of this project]. Quickly correct any damage that occurs, and

4. Comply with the 1981 Farmland Protection Policy Act.

If you have any questions regarding this information, please contact me at this office.

Respectfully,

Jimmy Bramblett

JIMMY BRAMBLETT
Resource Conservationist

cc:
Earl Cosby, State Conservationist
Mac Hayes, Assistant State Conservationist

COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

1993

Policy Review Branch
Policy Review and Analysis Division
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 223161

Subject: Lower Savannah River Basin, Georgia and South Carolina

Dear Sir:

Pursuant to Section 309 of the Clean Air Act, EPA, Region 4 has reviewed the final interim Feasibility Report on the proposed environmental restoration of a portion of the Lower Savannah River Basin. This action is being done to mitigate the on-going effects, viz., heavy siltation/flow reductions within the original bends, that constructing navigation cutoffs has had on this portion of the Savannah River ecosystem.

The study area encompasses Cutoff Bends #3 and #4 together with Bear, Raccoon, and Mill Creek Watersheds. While the selected alternative (#22) will not meet the maximum restoration goals, it has the support of the state and federal wildlife agencies. Cost constraints were operative in making this selection in lieu of the more comprehensive solution provided by option #36. Nonetheless, the partial diversion structure and flow improvements of the slackwater channel will allow improved flooding into adjacent bottomland hardwood habitats and enhancement/protection of these important community types. On the basis of the long-term benefits anticipated with this proposal we look forward to its expeditious implementation.

If we can be further assistance, feel free to call on me.

Sincerely yours,

Heinz J. Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

ER 96/271 JUL 10 1996

Mr,. David B. Sanford, Jr.
Chief, Policy Review and Analysis Division
Policy Review Branch
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Mr. Sanford:

The Department of the Interior has completed its review of the proposed Chief of Engineers report and related documents concerning the Lower Savannah River Basin Environmental Restoration Study, Effingham County, Georgia, and Jasper County, South Carolina.

The U.S. Fish and Wildlife Service (FWS) has worked closely with the Corps of Engineers in developing and evaluating alternatives for the Lower Savannah River Environmental Restoration Study. We concur with the Chief of Engineers report and support the recommended alternative. We request that the Savannah District, Corps of Engineers continue close coordination with the FWS's Charleston Field Office throughout development of detailed engineering plans, contracting, and construction of the project.

If you have any questions, please contact Roger Banks of our Charleston Field Office at 404-679-7123.

Sincerely,

Willie R. Taylor

Willie R. Taylor
Director, Office of Environmental
Policy and Compliance

COMMENTS OF THE DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation

United States Coast Guard

Commandant
U.S. Coast Guard

2100 Second St. S.W.
Washington, DC 20593-0001
Staff Symbol: G-MRO-1
Phone: (202) 267-0500

16451

APR 22 1996

Mr. Raleigh H. Leef
Acting Chief,
Policy Review and Analysis Division
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 2315-3861

Dear Mr. Leef:

This in response to your letter of April 15, 1996, in which you forwarded the proposed report of the Chief of Engineers, and the report of the district engineer on Lower Savannah River Basin, Georgia and South Carolina. We have reviewed the reports and have no comments to offer.

Thank you for providing the Coast Guard the opportunity to review the above reports.

Sincerely,

J. C. Jackson

for T. A. Tansey
Commander, U.S. Coast Guard
Chief, Port & Environmental
Management Branch
By direction of the Commandant

LOWER SAVANNAH RIVER BASIN, GEORGIA AND SOUTH CAROLINA

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PE (10-1-7a) 30 Jul 96

SUBJECT: Lower Savannah River Basin, Georgia and South Carolina

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report which recommends an environmental restoration project on the Savannah River, Georgia, and South Carolina. It is accompanied by the report of the Savannah District and the South Atlantic Division Engineers, which includes an environmental assessment and a finding of no significant impact. This report is an interim response to the August 1, 1990, resolution by the Committee on Public Works and Transportation of the U.S. House of Representatives. In the resolution, the committee requested review of the report of the Chief of Engineers on the Savannah River, Georgia, published as House Document 657, 78th Congress, second session, and other pertinent reports to determine the advisability of modifying the recommendations contained therein, with particular reference to determining if any modifications should be made to cutoffs or other structures considered as part of the Savannah River Below Augusta Navigational Project. The committee further requested that alternatives for modifying existing structures or cutoffs should be determined in consideration of recreation, navigation, loss of fish and wildlife resources, water quality and supply, wetlands, other current and foreseeable environmental problems, and loss of environmental amenities along the project. Preconstruction engineering and design activities for this project will be continued under this authority.

2. The reporting officers recommend restoration of a portion of flow from the Savannah River, approximately 20 river miles above the city of Savannah, Georgia into Bear and Mill Creek watersheds, to improve the quality of wetland's habitat and bottomland hardwoods. Both watersheds are located entirely within the State of Georgia. The recommended improvements include modifying and improving the approach channel to the entrance of Bear Creek at the Savannah River, construction of a small diversion structure at the modified entrance to Bear Creek, a closure plug in the Savannah River old oxbow (bend #3) at Bear Creek, and reopening and realigning the entrance to Mill Creek at

the Savannah River. None of the recommended improvements adversely impact the navigability of the Savannah River.

3. Based on November 1995 prices, the estimated first cost of the plan is $3,371,000. The estimated total project cost, including a 5-year, $60,000 monitoring program to assess functioning of the project, is $3,431,000, of which $2,573,000 would be Federal and $858,000 would be non-Federal. Average annual cost based on a discount rate of 7.625 percent and 50-year period of analysis is $267,000. The environmental benefits, increase in quality of wetland habitat and bottomland hardwoods, have been determined to justify expenditure of Federal funds.

4. Washington level review indicates that the proposed plan is technically sound, economical, and environmentally acceptable. The proposed project complies with applicable U.S. Army Corps of Engineers planning procedures and regulations. Also, the views of interested parties, including Federal, State, and local agencies have been considered.

5. I recommend that the environmental restoration plan for the Lower Savannah River basin be authorized for construction in accordance with the reporting officers recommended plan, with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing, and other applicable requirements of Public Law 99-662, and in accordance with the following requirements which the non-Federal sponsor must agree to prior to project implementation.

a. Provide 25 percent of total project costs assigned to environmental restoration, as further specified below:

(1) Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project.

(2) Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the project. Such improvements may include, but are not necessarily limited to, retaining dikes,

waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

(3) Provide any additional amounts as are necessary to make its total contribution equal to 25 percent of total project costs assigned to environmental restoration.

b. For so long as the project remains authorized, operate, repair, replace, rehabilitate and maintain the completed project and hydraulic integrity of the distributary streams, along with any required long-term dredged or excavated material disposal areas, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors.

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments in 32 CFR Section 33.20.

f. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

g. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

h. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

i. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

j. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

k. Provide 25 percent of that portion of total historic preservation, mitigation, and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration.

6. The recommendations contained herein reflect the information available at this time and current departmental policies governing the 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 level reviews within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as a proposal for authorization and/or implementation funding. However, prior to transmittal to Congress, the States; the sponsor, the city of Savannah, Georgia; interested Federal agencies; and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

PAT M. STEVENS IV
Major General, USA
Acting Chief of Engineers

LOWER SAVANNAH RIVER BASIN,
GEORGIA AND SOUTH CAROLINA

ENVIRONMENTAL RESTORATION STUDY

EXECUTIVE SUMMARY

ES.1. INTRODUCTION

The U.S. Army Corps of Engineers, Savannah District, was authorized by Congressional resolution to investigate the feasibility of environmental restoration in the Lower Savannah River Basin to restore environmental resources which have degraded due to construction of navigation cuts on the Savannah River. This Final Interim Feasibility Report was prepared in partial response to the Congressional resolution.

The District conducted a reconnaissance level study and identified 12 sites on the Savannah River which appeared to warrant some degree of environmental restoration. Three sites were selected for detailed investigations. The study area, as shown on Figure ES-1, includes the following cutoff bends and creeks which originate at the bends:

- navigation cut and cutoff bend #3
- navigation cut and cutoff bend #4
- Bear Creek and watershed
- Raccoon Creek and watershed
- Mill Creek and watershed

The study area includes 4,708 acres in the three creek watersheds which are above the zone of tidal influence from the Savannah River. The area is rich in forested wetlands and aquatic habitat.

Photographs of the study area are included at the end of this Executive Summary.

ES.2. PROBLEMS AND NEEDS

Since construction of the navigation cuts in 1962, the bends have experienced heavy siltation and are expected to lose all flow during low flow conditions in the river in less than 15 years. Aquatic habitat in the bends has become practically nonexistent due to the reduction in flows. The creeks which originate at the bends and flow through bottomland hardwood areas have lost most or all of their flows during low flow conditions. This has also resulted in the reduction of periodic overbank flooding which is essential for the forested wetlands in the watersheds.

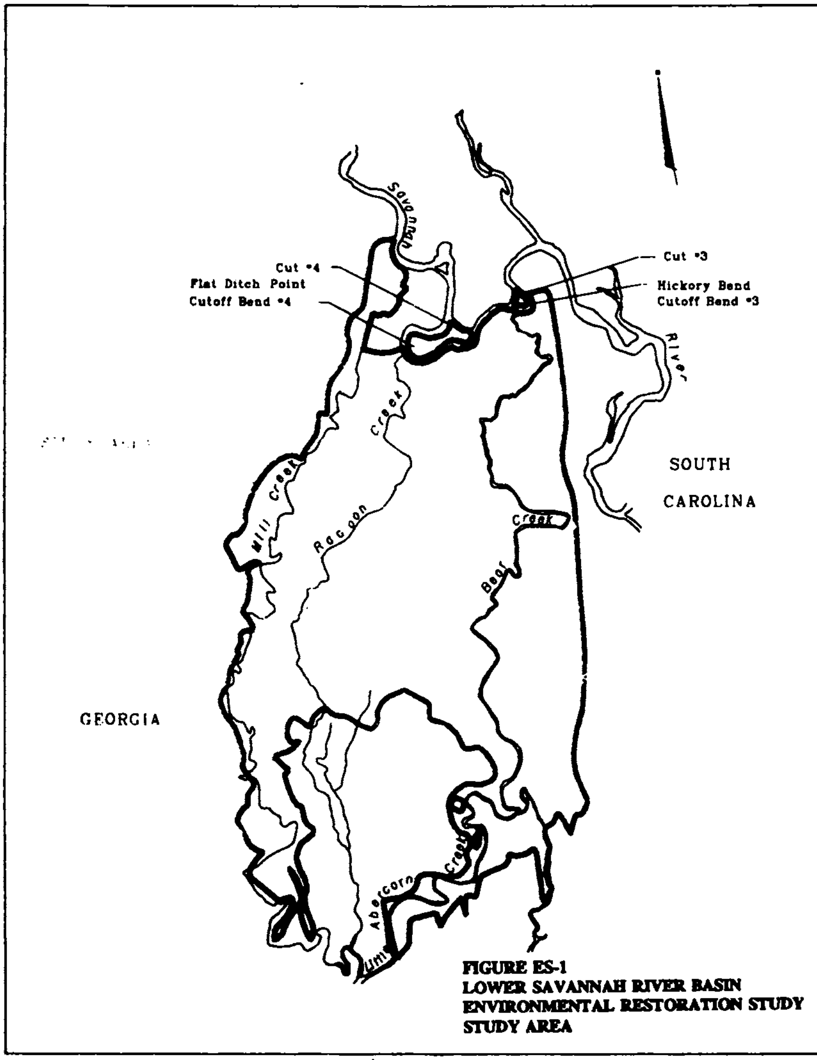


FIGURE ES-1
LOWER SAVANNAH RIVER BASIN
ENVIRONMENTAL RESTORATION STUDY
STUDY AREA

Without a restoration project, siltation of the bends will eventually eliminate flows into the creeks during low flows. Loss and degradation of forested wetlands in the study area will continue. Succession of many of the remaining forested wetland communities to drier habitat types will occur. This, in turn, will reduce the richness and diversity of the river swamp and will degrade or eliminate the values and functions of wetland habitats that are important for fish and wildlife resources. When the hydrologic regime has been altered, landowners will continue to convert land, which was once wetland, to agriculture and pine plantations that are less productive for wildlife.

Hydrologic conditions in the forested wetlands will continue to be adversely affected by the existence of the navigation cuts. Without environmental restoration, there will not be opportunities to restore this valuable wetland area and wildlife habitat to those conditions which existed before construction of the navigation cuts, or to restore degraded water quality and quantity within the study area.

A significant factor in the study was that almost half of the study area is within the Savannah National Wildlife Refuge. The remainder of the study area is within lands proposed for acquisition and addition to the refuge. The U.S. Fish and Wildlife Service manages the refuge and was an active study participant and participated in development of the restoration benefit data.

The local sponsor, the city of Savannah, is concerned about water quality at their raw water intake on Abercorn Creek. Most restoration alternatives in the study area would improve flows into creeks which flow to the city intake, which the city believes would improve water quality at the intake. Water quality improvements at the intake were considered incidental benefits to any potential restoration project.

ES.3. ENVIRONMENTAL RESTORATION ALTERNATIVES

All restoration alternatives were formulated to restore flows and frequency of overbank flooding into the bends, creeks, and watersheds in the study area. All technically feasible environmental restoration alternatives were considered.

From an initial array of over 300 possible restoration actions, 36 preliminary alternatives were selected for evaluation. These provided for combinations of environmental restoration measures at bends #3 and #4 plus Mill Creek. They consisted of various combinations of full or partial closure of the navigation cuts and several different new channels dredged through the bends. These channels maximized either navigation requirements or restoration objectives.

ES.4. EVALUATION AND SCREENING OF ALTERNATIVES

Environmental benefits which would accrue from a restoration plan consist of fish habitat, measured in average annual habitat units, and bottomland hardwood functional values. Each of these are measures of the improvements which would occur under various restoration alternatives. The U.S. Fish and Wildlife Service agreed that, due to the very high significance of the bottomland hardwoods, benefits to bottomland hardwood should be a high priority for restoration. The study benefit analysis included an evaluation of both restoration benefits.

Restoration benefits and preliminary cost estimates were developed for the 36 preliminary alternatives. Using an incremental analysis, these were reduced to 22, then eight, and finally five intermediate restoration alternatives which represented the most cost-effective of all preliminary restoration alternatives.

The five intermediate restoration alternatives were presented to the local sponsor and the U.S. Fish and Wildlife Service.

Two of the five intermediate restoration alternatives could be supported by the Savannah District.

Alternative #22 includes a large partial diversion structure at cut #3, improved flows into Bear Creek, and restoration of Mill Creek. It does not include any restoration at cut and bend #4, which would continue to experience environmental degradation. It provides over 55 percent of maximum attainable environmental benefits at approximately 28 percent of the cost of a maximum restoration alternative. It also maximizes restoration of flows into Bear Creek and Mill Creek. Alternative #22 has an estimated total project cost of $3,419,000.

Alternative #36 includes the same large partial diversion structure at cut #3 and improved flows into Bear Creek as Alternative #22, slackwater channel in bend #3, full closure of cut #4 with a navigation channel in bend #4, and restoration of Mill Creek. It maximizes restoration of all three study area restoration sites. It provides close to the maximum attainable environmental benefits, although it is much more costly than Alternative #22 due to dredging in bend #4 and construction of a disposal area. Alternative #36 has an estimated total project cost of $12,676,000.

The local sponsor, the city of Savannah, is willing to cost-share in Alternative #22. It also recognizes the additional environmental benefits which would accrue with Alternative #36, but this alternative would not appreciably increase flows into the creeks over Alternative #22. Therefore, the city does not support the significant increase in costs which would be required with Alternative #36.

During the draft feasibility report public review period, both alternatives were presented in the draft Environmental Assessment to determine if there might be an additional local sponsor to assist in cost-sharing of Alternative #36. None was subsequently identified, and the Savannah District eliminated Alternative #36 from further consideration due to the lack of local sponsorship.

The U.S. Fish and Wildlife Service prefers the maximum restoration which would be obtained with Alternative #36, but recognizes the funding constraints of the city and is willing to support Alternative #22.

ES.5. RECOMMENDED ENVIRONMENTAL RESTORATION PLAN

Alternative #22 was selected as the Recommended Environmental Restoration Plan. As shown on Figure ES-2, it provides for significant restored flows into Bear Creek at bend #3 and into Mill Creek, plus restored overbank flooding into adjacent wetlands in the watersheds. These restored flows will provide substantial environmental restoration in the study area, including enhancement and protection of the habitat units and bottomland hardwoods. The total project cost of Plan #22 is $3,419,000, with an equivalent average annual cost of $267,000.

The Recommended Environmental Restoration Plan #22 would be cost-shared $2,564,000 Federal and $855,000 non-Federal.

ES.6. RECOMMENDATIONS

The Savannah District Engineer selected Alternative #22, as described in this report, as the Recommended Environmental Restoration Plan for the Lower Savannah River Basin Environmental Restoration Study.

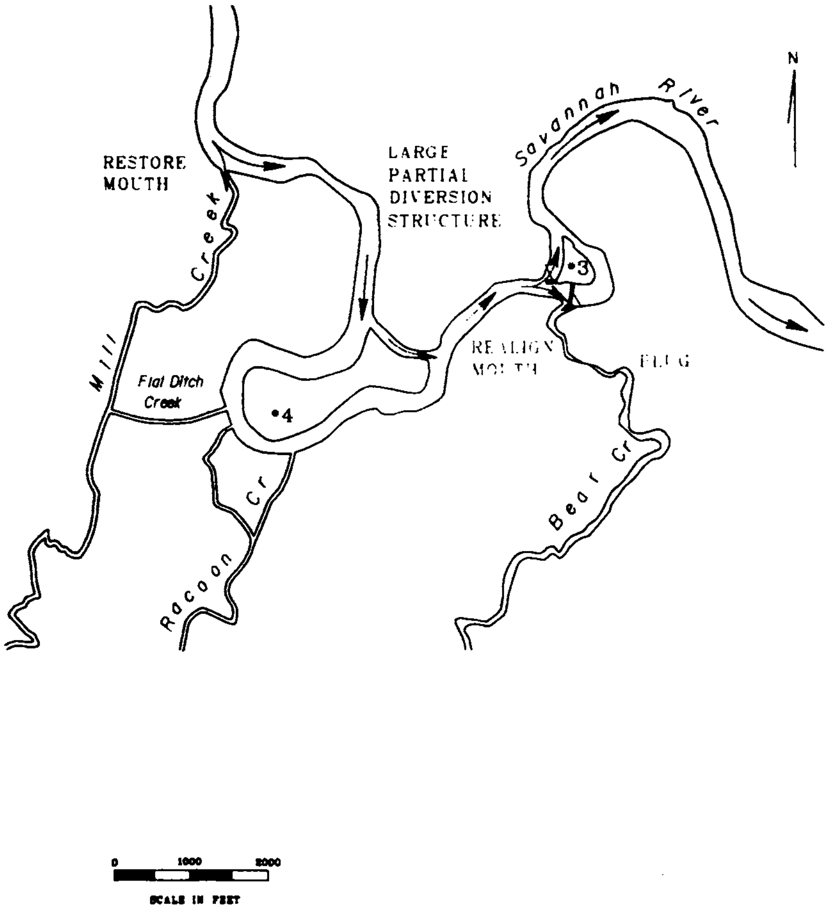
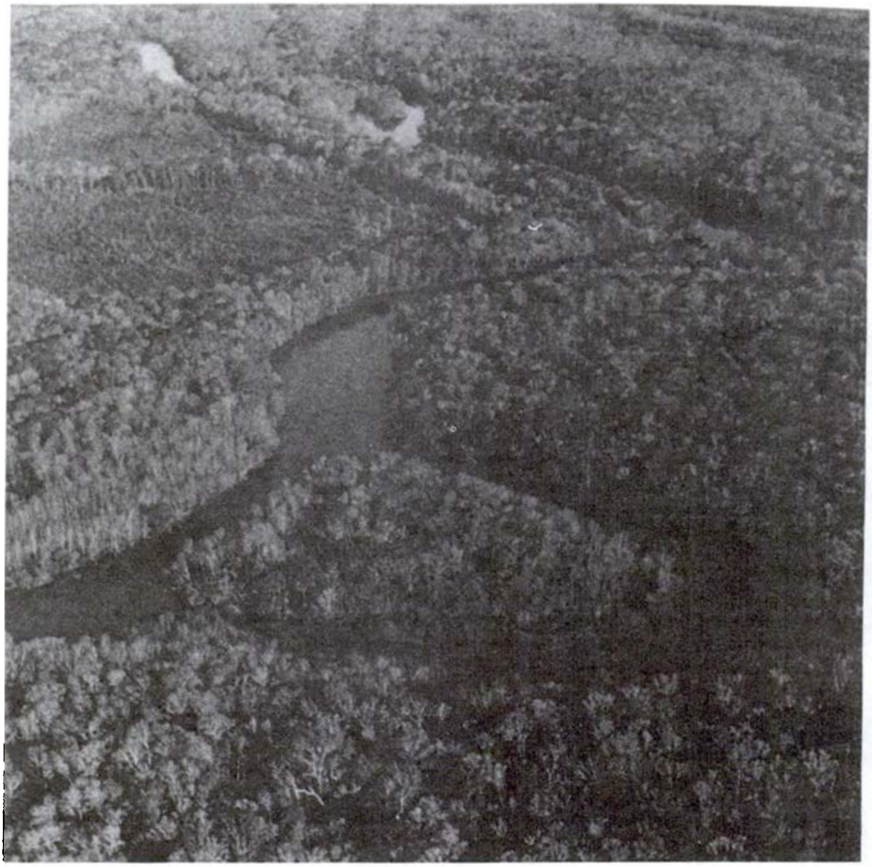


FIGURE ES-2
RECOMMENDED ENVIRONMENTAL RESTORATION PLAN
ALTERNATIVE #22

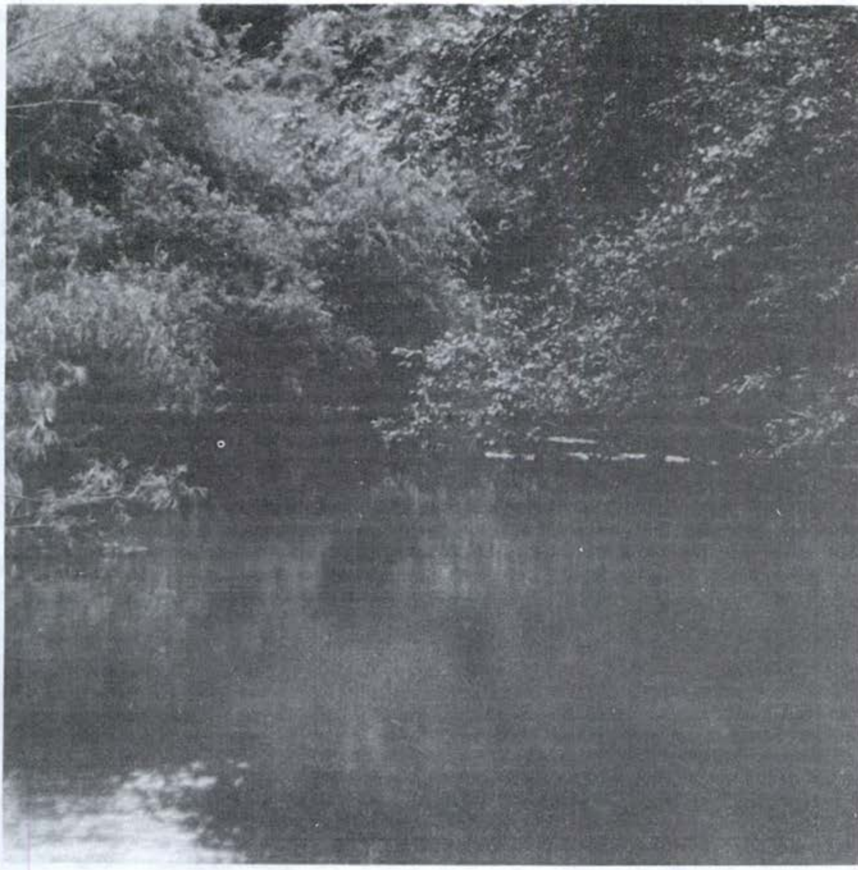
46-054 98 - 2



PHOTOGRAPH ES-1
CUT AND BEND #3
LOOKING EAST
RIVER FLOW FROM LEFT TO RIGHT

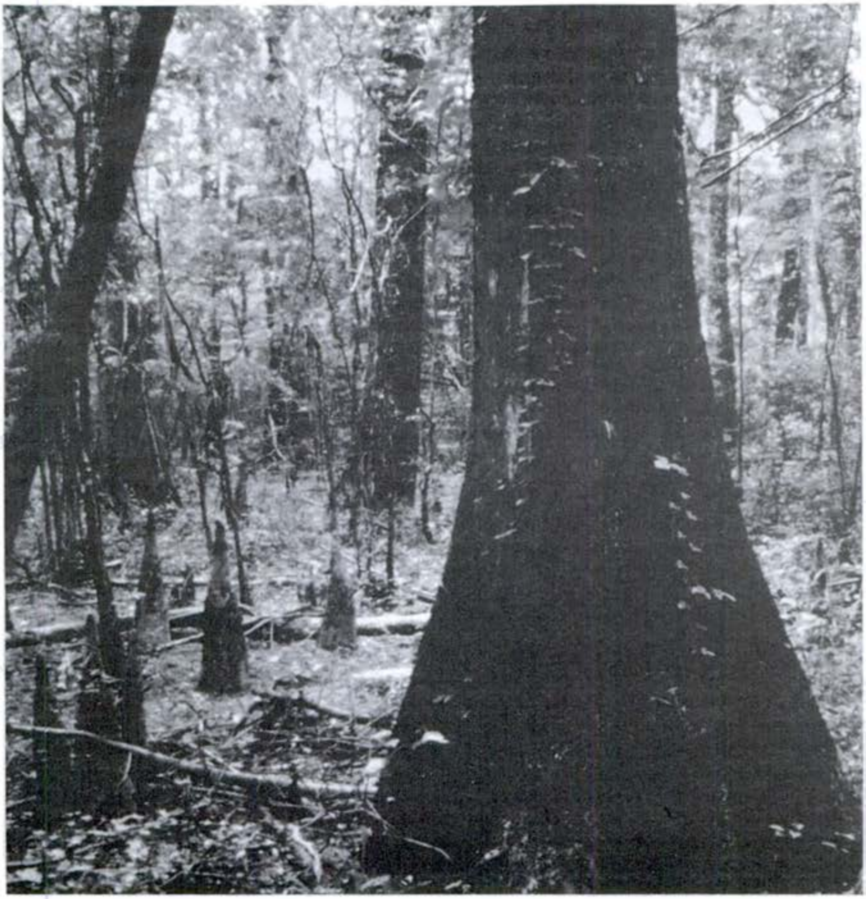
PHOTOGRAPH ES-2
CUT AND BEND #4
LOOKING WEST
RIVER FLOW FROM RIGHT TO LEFT

PHOTOGRAPH ES-3
BEND #3 LOOKING DOWNSTREAM
CONSTRICTED BEND ENTRANCE



PHOTOGRAPH ES-4
BEND #3 LOOKING DOWNSTREAM
LOWER PORTION OF BEND
NOT NAVIGABLE TO SMALL BOATS AT LOW FLOW

PHOTOGRAPH ES-5
ENTRANCE TO BEND #4
ALLIGATOR WEED EMERGING FROM SANDBARS
AT UPSTREAM BEND ENTRANCE
LITTLE FLOW ABLE TO ENTER BEND AT LOW FLOW



PHOTOGRAPH ES-6
EAST SIDE OF BEND #3
TYPICAL BOTTOMLAND HARDWOODS

PHOTOGRAPH ES-7
MILL CREEK

LOWER SAVANNAH RIVER BASIN

ENVIRONMENTAL RESTORATION

SECTION 1

INTRODUCTION

1.1. STUDY PURPOSE AND SCOPE

1.1.1. Study Objectives

A Federal navigation project exists on the Savannah River from Augusta, Georgia, to Savannah. Under that project, numerous navigation cuts were constructed during the period 1959 through 1976 to shorten and straighten the navigation channel. Depletion of natural river flows through the cutoff bends resulted in rapid siltation within the bends. This, in turn, resulted in the reduction of flows to creeks originating at the bends which were the source of vital water to adjacent forested wetlands. At many of the navigation cuts and cutoff bends, the wetlands are experiencing continuing deterioration due to the reduction in flows and periodic flooding. Without environmental restoration, many of the bends will become completely silted in and there will be no flows through the bends and into the creeks during low river flow conditions. Low river flow is defined as 6,300 cfs which is exceeded 87 percent of the time.

The Lower Savannah River Basin Reconnaissance Report, completed by the Savannah District in 1992, investigated 40 navigation cuts along the Savannah River and concluded there are feasible environmental restoration solutions with a Federal interest at 26 sites. Three sites were selected for detailed investigations in this feasibility study. The study area includes cut and bend #3 and cut and bend #4 located about 20 river miles above the city of Savannah plus Mill Creek.

This feasibility study was conducted to examine in detail the needs and potential measures required to restore the bends, creeks, and wetlands which have deteriorated due to construction of the navigation cuts. The purposes of this study were to:

- Examine and evaluate the problems and opportunities related to restoration of fish and wildlife habitat in and adjacent to river bends #3 and #4 and Mill Creek in the Lower Savannah River Basin which have been adversely impacted by construction of navigation cuts for the Savannah River Below Augusta Navigation Project.

- Formulate and evaluate cost-effective plans to address those problems and opportunities, including:

  - Restoration of flow through bends #3 and #4 to restore and protect environmental habitat.

  - Restoration of flows and overbank flooding in creeks originating in bends #3 and #4 plus Mill Creek to restore and protect downstream forested wetlands and aquatic habitat.

This report documents the plan formulation, engineering and design, cost and benefit analysis, and the environmental assessment of environmental restoration alternatives.

1.1.2. Scope of Study

There are 40 navigation cuts on the Savannah River below Augusta, Georgia. Two of these, navigation cuts #3 and #4, were selected for this initial environmental restoration study. It is anticipated that additional Savannah River navigation cuts will be the subject of further restoration studies by the Savannah District, subject to Federal funding and local cost-sharing agreements. Mill Creek was added to the study area because it is hydraulically linked to the major creeks originating from the two bends and it receives flow from bend #4 via Flat Ditch Creek.

The primary scope of the study was environmental restoration. Other water resources factors and uses, such as navigation, water quality, water quantity, and water supply, were considered only to the extent that they impacted on the restoration analysis.

1.2. STUDY AUTHORITY

This environmental restoration study was authorized by a resolution passed on August 1, 1990, by the U.S. House of Representatives Committee on Public Works and Transportation. The text of the authorizing resolution is as follows:

> *"Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Board of Engineers for Rivers and Harbors, is requested to review the report of the Chief of Engineers on the Savannah River, Georgia, published as House Document 657, Seventy-eighth Congress, Second Session, and other pertinent reports, to determine the advisability of modifying the recommendations contained therein, with particular reference to determining if any modifications should be made to cutoffs or other structures considered as part of the Savannah River Below Augusta Navigational Project. Alternatives for modifying existing structures or cutoffs shall be determined in consideration of recreation, navigation, loss of fish and wildlife resources, water quality and supply, wetlands, other current and foreseeable environmental problems, and loss of environmental amenities along the project."*

This Final Interim Feasibility Report was prepared in partial response to the Congressional resolution.

1.3. STUDY AREA

The Savannah River is formed by the confluence of the Seneca and Tugaloo Rivers in the Piedmont Province of Georgia and South Carolina. From this junction, the river flows south-southeast through the Piedmont Plateau. It crosses the fall line at Augusta, Georgia, and flows onward through the Coastal Plain for approximately 300 miles to empty into the Atlantic Ocean near Savannah, Georgia. The entire drainage basin totals 10,577 square miles. The drainage area below Augusta is 3,577 square miles. The Savannah River forms the boundary between the States of Georgia and South Carolina, as shown on Figure 1-1.

There are 40 cutoff bends located along the Lower Savannah River. During the reconnaissance phase of the Lower Savannah River Basin Study, an evaluation was made of potential cutoff bends which would benefit from habitat restoration. Staff from the Savannah District, U.S. Fish & Wildlife Service, Georgia Department of Natural Resources, and South Carolina Department of Natural Resources went on several boat trips down the Lower Savannah River at different times of the year. Each cutoff bend was examined for its environmental importance, and the staff estimated how much, if any, restoration was needed for each particular area. Many areas were functioning well; therefore, no restoration work is necessary. Several others needed some restoration work, but ranked low on the priority list.

As a result of this initial screening, a dozen cutoff bends were identified as priority areas for some degree of environmental restoration. The Lower Savannah River Basin Reconnaissance Report recommended eventual restoration of all twelve of these cutoff bends. However, there were only two cutoff bends in Georgia for which a local sponsor could be identified at this time. There was a third site in South Carolina which the state wanted to sponsor, but the state was unable to do so at that time due to financial constraints. Therefore, for this initial restoration study, the study area was defined to include cutoff bends #3 and #4, Mill Creek, plus the creeks which originate in the two bends and their watersheds. Mill Creek was added to the study area because it merges with other creeks from the two cutoff bends and directly affects creek flows in the study area.

It is anticipated that some of the other cutoff bends needing restoration may be studied for environmental restoration in the future when a willing local sponsor has been identified.

The geographical limits of this environmental restoration study included cut and bend #3, cut and bend #4, Mill Creek, and the watersheds of the creeks which originate at the two bends plus the Mill Creek watershed. The creek watersheds are a vital portion of the study area because this area is where the majority of the restoration benefits accrue. All of the watersheds are either within the Savannah National Wildlife Refuge or are proposed for acquisition and addition to the refuge. Figure 1-2 shows the approximate limits of the study area.

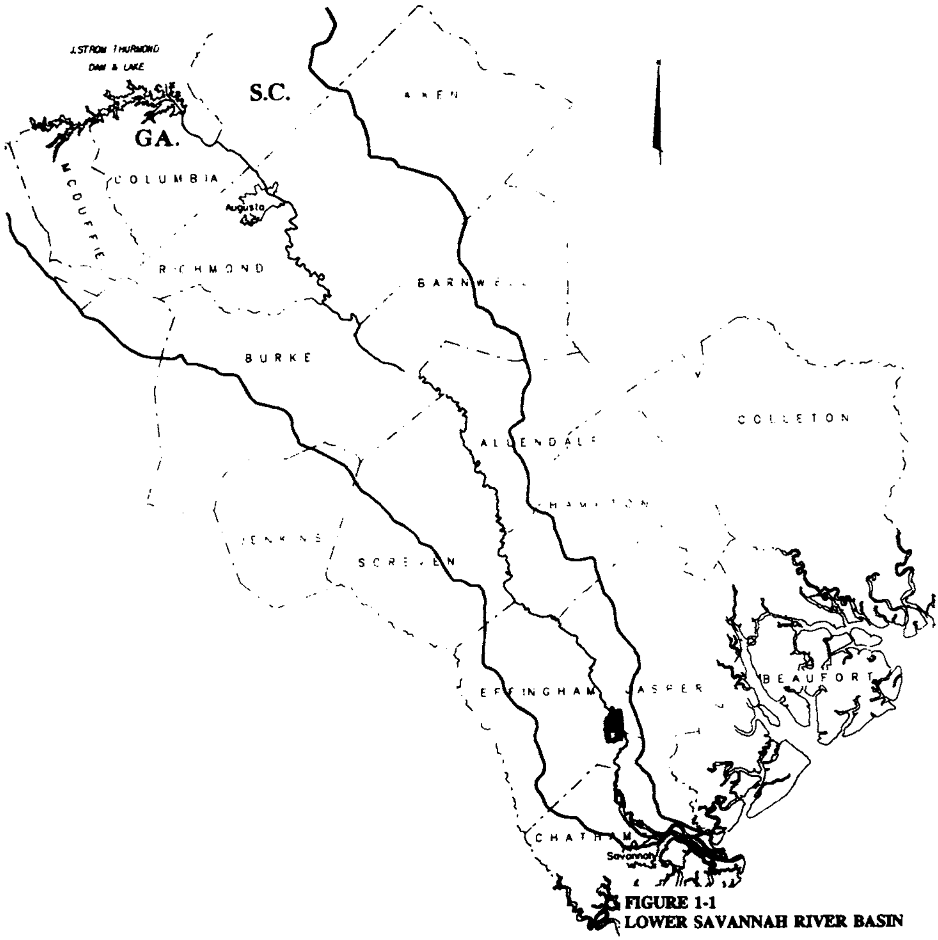


FIGURE 1-1
LOWER SAVANNAH RIVER BASIN

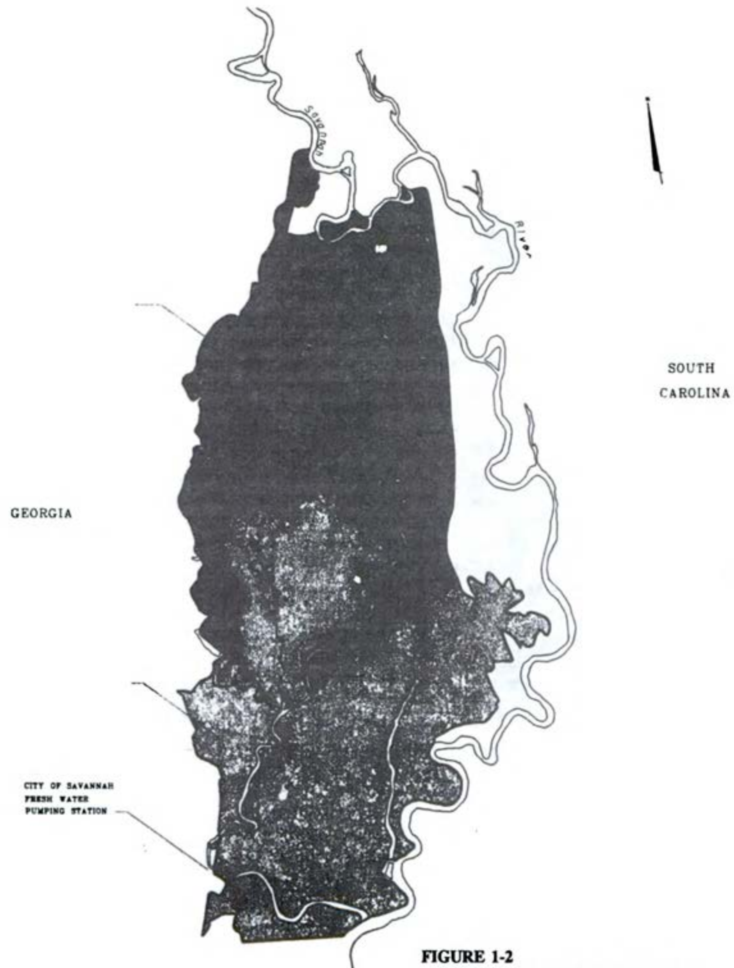


FIGURE 1-2
LOWER SAVANNAH RIVER BASIN
ENVIRONMENTAL RESTORATION STUDY
STUDY AREA

Cut and bend #3, also known as Hickory Bend, is located on the Savannah River at river mile (RM) 40.9, approximately 20 river miles above the city of Savannah. Cut and bend #4, also known as Flat Ditch Point, is located at RM 41.3 about 1/2 mile upstream from cut and bend #3, and Mill Creek originates at the Savannah River at RM 42.0 about 2/3 mile upstream from cut and bend #4. The study area itself is within Effingham County, Georgia, and Jasper County, South Carolina. The original bends #3 and #4 were, and still are, the boundaries between the states of Georgia and South Carolina.

Several creeks originate at the two bends. Bear Creek begins at bend #3, and two unnamed creeks from bend #4 form the beginning of Raccoon Creek. These creeks, plus Mill Creek, flow generally southward. Bear Creek becomes Abercorn Creek, and Raccoon Creek merges with Mill Creek above its confluence with Abercorn Creek. The city of Savannah raw water intake is on Abercorn Creek about 8,000 feet downstream of Mill Creek. It is unusual for creeks to originate at a river; creeks and tributaries normally flow to rivers.

The lower boundary of the study area as shown on Figure 1-2 was defined by the limits of tidal influence from the Savannah River. During high tides, the tidal influence from the Savannah River restricts natural flow down the creeks below the study area. The study area includes the non-tidal portion of the three creek watersheds. The study area is predominately palustrine broad-leaved deciduous forests that are seasonally flooded (Appendix D, *U.S. Fish and Wildlife Coordination Report*). Most of the land west of Mill Creek is upland, with bluffs up to 50 feet high on the west bank. The eastern boundary of the study area is the approximate ridgeline between Bear Creek and the Savannah River.

The study area includes 4,708 acres within three major creeks as shown in Table 1-1. The total drainage area of the three creeks, including the tidal influence area outside the study area, is 11,176 acres. All of the environmental restoration benefits for average annual habitat units and bottomland hardwoods accrue within the non-tidal area.

TABLE 1-1
WATERSHEDS IN STUDY AREA

WATERSHED	AREA (acres)
Bear Creek	2,367
Raccoon Creek	1,633
Mill Creek	708
Total	4,708

1.4. FEDERAL NAVIGATION PROJECT

The Savannah River from Savannah to Augusta is included in the authorized Federal navigation project known as the Savannah River Below Augusta. Figure 1-3 shows the project map. The first involvement of the U.S. Army Corps of Engineers in river navigation dates back to the River and Harbor Act of 1890, which authorized a 5-foot channel from Savannah to Augusta. The River and Harbor Act of 1950 provided for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (RM 21.3) to the head of navigation at Augusta just above the 13th Street Bridge (RM 202.2), a distance of 180.9 river miles.

Modification of the authorized navigation project to provide a 9-foot depth, including construction of navigation cuts, bank protection, dredging, and clearing and snagging, was begun in 1958 and completed in 1976. The project also included a lock and dam at New Savannah Bluff, approximately 15 miles downstream from Augusta. Channel modifications included deepening, widening, bank protection, snagging, construction of navigation cuts, construction of pile dikes, and other work to provide the authorized 9-foot depth. The existing navigation cuts were constructed during the periods 1959, 1960-61, 1962, and 1976 to improve navigation on the river.

By 1980, shipping on the river had declined considerably. The last dredging was performed in October 1979, and the decision to curtail dredging was made in May 1981. The last snagging was December 1980, and the decision to curtail snagging was made in August 1981. Although the volume of shipping has decreased to date, the future river traffic is expected to continue and probably increase.

The minimum flow in the river is regulated by releases from upstream multipurpose reservoirs. The project authorization provided for a 9-foot channel 90 feet wide based upon flows of 5,800 cubic feet per second (cfs) at the New Savannah Bluff Lock and Dam in Augusta, River Mile 203, and 6,300 cfs at the gage in Clyo, Georgia, River Mile 61.

1.5. STUDY PROCESS

The Water Resources Development Act of 1986 (Public Law 99-662) directed the U.S. Army Corps of Engineers to conduct water resources studies in two phases: reconnaissance phase and feasibility phase. Reconnaissance studies are conducted at full Federal expense and are usually completed in 12 months. The purposes of a reconnaissance study are to use preliminary data to evaluate water resource related problems and opportunities, formulate cost-effective alternatives, determine if a Federal interest exists in the implementation of a solution, estimate the time and effort required to conduct a feasibility study, and identify a non-Federal public agency willing to share in the cost of a feasibility study.

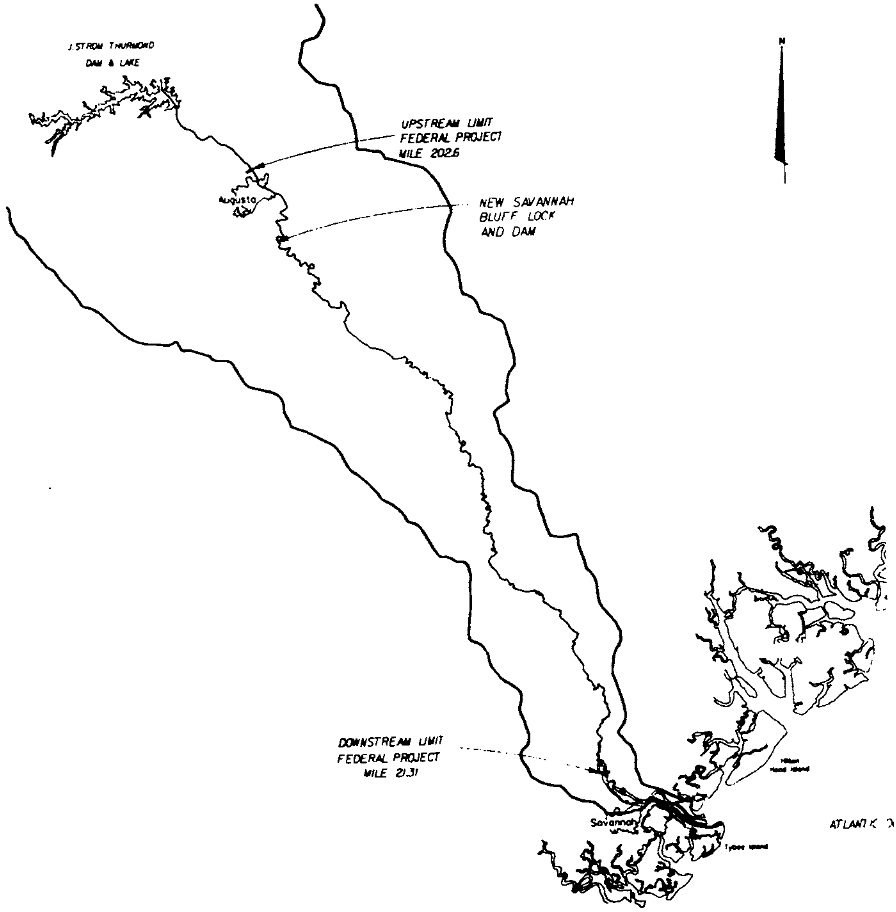


FIGURE 1-3
SAVANNAH RIVER BELOW AUGUSTA
FEDERAL NAVIGATION PROJECT

Feasibility studies are undertaken to develop detailed, site-specific solutions to the identified problems and opportunities. Most necessary engineering investigations required to design and develop a detailed cost estimate of final alternatives or a recommended plan are completed during the feasibility study.

The Lower Savannah River Basin study followed this two-phase planning procedure.

1.5.1. Lower Savannah River Basin Reconnaissance Report

In April 1992, the Savannah District completed a reconnaissance report on *Lower Savannah River Environmental Restoration*. This report identified problems and opportunities in the basin with a primary focus on fish and wildlife habitat restoration and water quality improvement. Potential restoration measures were identified which would restore environmental conditions which had been adversely impacted by previous activities in the basin, particularly construction of the navigation cuts. It was also determined that a Federal and a non-Federal interest existed in further developing restoration alternatives through a cost shared feasibility study. The District Engineer recommended that a feasibility study for environmental restoration be conducted under the study authority.

The reconnaissance report examined 40 navigation cuts in the Lower Savannah River Basin, as shown on Table 1-2. Twelve of these cuts were selected for further study. Of those 12, three navigation cuts and bends were selected for detailed evaluation based on potential cost-sharing sponsors. However, the potential sponsor for Little Hell Landing, the State of South Carolina, withdrew from the study due to budget constraints.

TABLE 1-2
NAVIGATION CUTS ON THE SAVANNAH RIVER

CUT #	CUT AND BEND NAME	RIVER MILE	YEAR CONSTRUCTED
--	Fritz Cut	183.5	Private-1889
--	Bailey's Cut	181.9	Private-1921
24	Beckum's Cut	181.5	1959
23	Lower Silver Bluff Landing	173.3	1959
22	Gray's Landing	169.5	1959
21A	Eagle Point	168.0	1976
21	Cox Point	153.2	1959
20	Cunningham Point	137.5	1959
19C	Sweetwater Creek Cut	136.5	1976
19B	Catfish Hole Point	136.0	1959
19A	Devil's Elbow	135.5	1959
19	Swift Cut	135.3	1959
--	Little Hell Landing	134.5	Natural Cutoff
18B	Little Randall Point	128.5	1960-61
18A	Fat Meat Point	120.8	1960-61
18	Green Log Point	112.4	1960-61
17	Dick's Lookout Point	107.0	1960-61
16	Cook's Field Point	102.8	1960-61
15A	Wildcat Point	102.2	1960-61
15	Seven-day Baptist Point	101.1	1960-61
--	Miller's Old Lake	100.2	Natural Cutoff
14	Whirligig Point	99.9	1960-61
13	Pfeiffers Landing	93.8	1960-61
12	Thompsons Cow Fold Point	92.8	1960-61
11	Mosquito Camp Point	88.8	1960-61
10	Poor Robin Upper Cut	87.1	1960-61
9A	Poor Robin Lower Cut	85.4	1960-61
9	Ware Creek Cut	85.2	1960-61
8C	Blanket Point	81.0	1976
8B	Wildcat Cut	78.6	1976
--	Duck Cut	65.0	Natural?
8	Hog Nose Point	62.3	1960-61
7A	McKenzie's Camp	59.7	1960-61
7	Bowl Maker Point	51.4	1962
6	Big Keiffer Point	43.2	1962
5	Bay Bush Point	41.6	1962
4	Flat Ditch Point	41.3	1962
3	Hickory Bend	40.9	1962
2	Pine Tree Camp Point	37.2	1962
1	Moody Cut	31.4	1962

In Table 1-2, river mile is measured at the midpoint of the navigation cut. The dates for cut construction were obtained from the *U.S. Army Corps of Engineers, Annual Engineer Reports*, 1959-1976, and *Design Memorandum from Project Authorization*, 1957. Names of the bends were usually based upon topographic or historical features.

1.5.2. Feasibility Study Cost Sharing Agreement

When the Savannah District received funding to conduct the Lower Savannah River Basin feasibility study, a feasibility cost-sharing agreement was negotiated with the local sponsor, the city of Savannah, and signed on May 28, 1993.

1.6. PRIOR STUDIES AND REPORTS

1.6.1. U.S. Army Corps of Engineers

1.6.1.1. Design Memorandum Savannah River Below Augusta, General Design. The Savannah District completed this report in August 1957. The report documented a plan for development of a 9-foot deep and 90-foot wide navigation project on the Savannah River from the upper end of Savannah Harbor to the head of navigation 3 miles above Fifth Street Bridge at Augusta, Georgia.

1.6.1.2. Environmental Resource Inventory of the Savannah River Basin. This report was completed by the Savannah District in April 1974. The purpose of the study was to provide an environmental inventory of the Savannah River Basin. The inventory identified and located resources and amenities which comprise man's physical, biological, and cultural environments which should be preserved, protected, or approached with careful deliberation in the planning, development, and management of water and related land resources. The basis of the inventory was an extensive survey of the pertinent literature and review of information obtained from appropriate state and Federal agencies.

1.6.1.3. Final Environmental Statement, Operation and Maintenance of Navigation Project, Savannah River Below Augusta, Including the New Savannah Bluff Lock and Dam. This report was completed by the Savannah District in September 1976. The document addressed the environmental impacts of the continued operation and maintenance of the navigation channel between Savannah and Augusta, Georgia, including the New Savannah Bluff Lock and Dam.

1.6.1.4. Savannah River Below Augusta, Georgia, Evaluation of Authorized Project. The Savannah District completed this report in April 1976, which was revised in February 1977. The scope of the study was confined to an analysis of the existing channel conditions and actions required to reestablish and maintain the authorized depth and width in the channel.

1.6.1.5. Lower Savannah River Environmental Reconnaissance Report. As previously discussed, a reconnaissance level report was completed by the Savannah District in April 1992. The report documented the primary focus of the study, the alternatives studied, findings and conclusions, and the recommendations. This report led to funding for the feasibility study of environmental restoration in the Lower Savannah River Basin.

1.6.2. Other Pertinent Studies

1.6.2.1. Biological Surveys on the Savannah River in the Vicinity of the Savannah River Plant (1951-1976). In 1951, the Academy of Natural Sciences of Philadelphia was contracted by the Savannah River Site to initiate a long-term monitoring program in the Savannah River. The U.S. Department of Energy's primary mission at Savannah River Site from the 1950's until the recent end of the Cold War was the production and processing of nuclear materials to support defense programs. These activities resulted in the generation of five types of waste: liquid high-level radioactive, low-level radioactive, hazardous, mixed (radioactive and hazardous combined), and transuranic wastes.

These wastes continue to be generated by ongoing operations, environmental restoration, and decontamination and decommissioning of surplus facilities. The data from this monitoring program had been computerized by the Savannah River Laboratory. In April 1982, the report containing this data was released by E. I. du Pont de Nemours & Co., Savannah River Laboratory.

1.6.2.2. U.S. Fish and Wildlife Service Planning Aid Report. The U.S. Fish & Wildlife Service (FWS) prepared a reconnaissance level Planning Aid Report in August 1985 which provided fish and wildlife resource information in the Savannah River Basin and identified problems, opportunities, and planning objectives relative to these resources. In December 1989, the FWS provided another reconnaissance level Planning Aid Report addressing water allocation and new water supply requests in the Savannah River Basin.

1.7. STUDY PARTICIPANTS AND COORDINATION

This feasibility study was conducted by a multidisciplinary study team, as shown in Table 1-3.

The Georgia Department of Natural Resources assisted in data collection and sediment testing for the study. The U.S. Fish and Wildlife Service evaluated environmental benefits from the various restoration alternatives.

The Savannah District recognized that public involvement was an important aspect of the Lower Savannah River Basin Study. The District contacted several local barging and towing companies and provided them with preliminary design drawings of the preliminary navigation channels for the bends. During the study, the study manager gave numerous presentations to various groups in the basin.

TABLE 1-3
STUDY TEAM

U.S. ARMY CORPS OF ENGINEERS, SAVANNAH DISTRICT	
Monica Simon Dodd	Study/Project Manager
Daniel Parrott	Senior Project Manager
Larry Lyons	Civil Engineer
Tom Manganini	Engineering Management
Ana Vergara	Biologist
Terry Stratton	Economist
Lynn Harrison	Realty Specialist
Julie Morgan	Archaeologist
Stan Simpson	Hydraulics Engineer
Eric Halpin	Geotechnical Engineer
Jeff Dick	Cost Engineer
Carol Abercrombie	Coastal & Waterways/Civil Engineer
Roger LaFond	Navigation/Civil Engineer
Mark Padgett	Regulatory/Biologist
Warren Swartz	Office of Counsel
CITY OF SAVANNAH	
Harry Jue	Sewer and Water Bureau Chief
John Sawyer	Plant Engineer
GEORGIA DEPARTMENT OF NATURAL RESOURCES	
Nolton Johnson	Chief, Water Resources Management
Carl Hall	Regional Fisheries Supervisor
Dennis Schmitt	Wildlife Biologist
U.S. FISH AND WILDLIFE SERVICE	
Sam Drake	Savannah National Wildlife Refuge
Edwin EuDaly	Fish and Wildlife Biologist
John Robinette	Biologist, Savannah Coastal Refuges

1.8. REPORT CONTENTS

Table 1-4 presents a summary of the contents of this report, illustrating the planning process leading from identified problems and needs to a Recommended Environmental Restoration Plan.

TABLE 1-4
REPORT CONTENTS

SECTION	TITLE	CONTENTS
1	INTRODUCTION	Study purpose, objectives, authority, area, participants.
2	BASELINE CONDITIONS	Background information on study area.
3	PROBLEM IDENTIFICATION	Problems, needs, study goals to find solutions.
4	FORMULATION OF ENVIRONMENTAL RESTORATION MEASURES	Formulation of environmental restoration components at study sites. Design criteria and engineering considerations.
5	FORMULATION OF PRELIMINARY ALTERNATIVES	Combinations of restoration components to develop 36 preliminary environmental restoration alternatives. Benefits and costs of preliminary alternatives.
6	SELECTION OF INTERMEDIATE ALTERNATIVES	Evaluation and screening of 36 preliminary restoration alternatives down to five intermediate alternatives.
7	EVALUATION OF INTERMEDIATE ALTERNATIVES	Evaluation and screening of five intermediate alternatives to select Recommended Restoration Plan.
8	RECOMMENDED ENVIRONMENTAL RESTORATION PLAN	Description of the Recommended Environmental Restoration Plan including benefits, costs, and implementation requirements
9	CONCLUSIONS	Summary of study objectives, needs, and solutions
10	RECOMMENDATIONS	Recommendations of the Savannah District Engineer

SECTION 2

BASELINE CONDITIONS

2.1. BASIN DESCRIPTION

The Lower Savannah River Basin drainage basin (from Augusta, Georgia, to near Clyo, Georgia, river mile 61, approximately 140 miles) is characterized by very little development or human habitation. The river is bounded by extensive cypress-tupelo and bottomland hardwood swamps and pine trees; the majority of the land adjacent to the river is in private and corporate ownership. From Clyo south, there is scattered agriculture and other development, although the river continues to be buffered by swamps. The habitat then changes to fresh water marshes, then to brackish marshes, and finally to salt marsh below the city of Savannah. There are 14 vehicle and/or railroad bridges crossing the river along the course of the navigation project from Augusta to Savannah.

2.2. LAND USE

2.2.1. Historical Land Use

Timberlands along the Lower Savannah River Basin have been selectively harvested since the 1800's. Few virgin stands of timber remain in the basin. Much of the land was privately owned and in large tracts. Large cotton plantations were found along the upper sections of the basin, moving south these gave way to rice plantations.

2.2.2. Historical River Traffic

The Savannah River has been a navigation artery since prehistoric times. American Indians navigated the river in dugout canoes for thousands of years prior to its discovery by Europeans. During the eighteenth century, the river was navigated using human powered watercraft, including poleboats, canoes, flats, and rafts. In 1816, steamboats first appeared on the river and soon transported the bulk of commodities moved between Augusta and Savannah.

The river steamers were used extensively between Augusta and the port of Savannah, where goods were loaded onto ocean-going vessels beginning in the 1830s for export. The inception of the railroad era gave Augusta merchants the option of shipping goods overland to Charleston and bypassing the port of Savannah, an option which became more desirable during times of low water. By the time of the Civil War, steamboats on the river were in decline. After the Civil War, there was a brief resurgence in steam navigation due to the destruction of miles of railroad track and the presence of thousands of bales of cotton stockpiled on the Augusta wharves which could not be moved due to the Union's blockade of southern ports.

Availability of railroad transportation reduced commerce on the Savannah River primarily to bulky, heavy, non-perishable materials, particularly cotton for foreign export. By the mid-1900s, commerce was mainly sparse and sporadic. Barges were light-loaded due to the unpredictable navigation channel, which included shoals, shifting channels, sharp turns, and random debris.

Table 2-1 presents a summary of the waterborne commerce on the Savannah River from Savannah to Augusta. The reduced tonnage during the period 1940-1947 reflects a diversion of gasoline shipments from commercial distribution to wartime uses. Beginning in 1990, tonnage was reported in 1,000 tons, so total tonnage less than 500 tons was reported as zero. Data from 1992 through 1995 was provided by Chem-Nuclear Systems, Inc., which transports large spent nuclear components. Figure 2-1 graphically presents the waterborne commerce since 1986.

TABLE 2-1
WATERBORNE COMMERCE ON SAVANNAH RIVER
SAVANNAH TO AUGUSTA

CALENDAR YEAR	ANNUAL TONNAGE	PRINCIPAL COMMODITIES
1920-1930	average 85,933	N/A
1930-1940	average 62,168	N/A
1940-1947	average 32,728	N/A
1965	59,983	Logs, clay
1970	135,574	Logs, chemicals, minerals, clay
1975	71,070	Oil, minerals, metals, machinery
1985	324	Fish, shellfish
1986	1,140	Fish, shellfish
1987	145	Fish, shellfish
1988	105	Fish, shellfish
1989	313	Fish, shellfish
1990	< 1,000	N/A
1991	< 1,000	N/A
1992	800	Nuclear components & industrial machinery
1993	400	Nuclear components & industrial machinery
1994	400	Nuclear components & industrial machinery
1995	400	Nuclear components & industrial machinery

Source: 1920-1947 *The Case for the Further Improvement of the Savannah River between Augusta and Savannah Georgia*, Thomas and Hutton, Engineers, 1948.
1965-1991 *Waterborne Commerce of the United States*, U.S. Army Corps of Engineers.
1992-1995 Chem-Nuclear Systems, Inc.

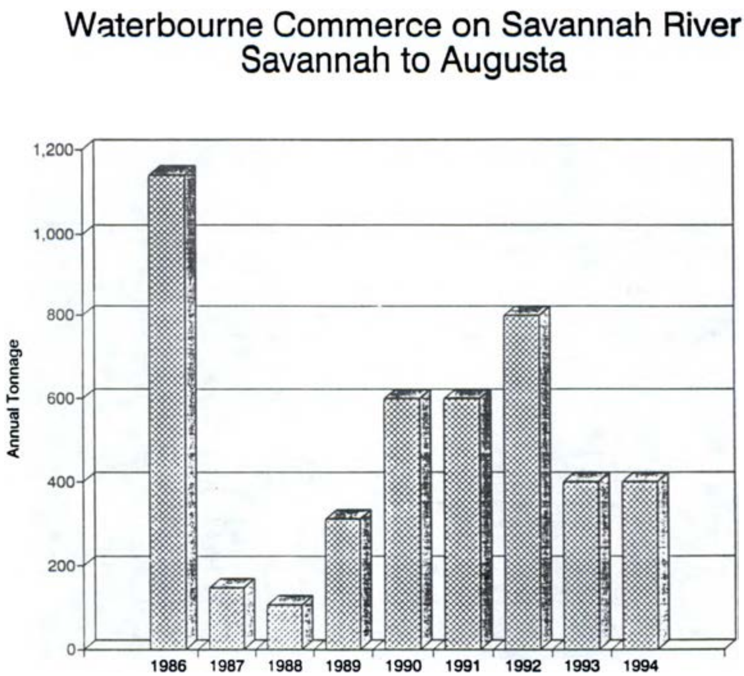


FIGURE 2-1
WATERBORNE COMMERCE

Chem-Nuclear Systems, Inc., is one of the companies which currently uses the Savannah River for barge traffic. They have a private disposal area on the Savannah River below Augusta for low grade spent nuclear components. They indicated their recent traffic consisted of 800 tons in 1992 and 400 tons in each following year. They used 40-foot by 250-foot barge/tow units to transport nuclear components to river mile 158.9 near Augusta to the only low-level radioactive disposal site on the east coast. Other current river users include Kimberly Clark Corporation, Fort Howard Corporation, and Georgia Power Company which ship large machinery which may not be transportable by other means.

The Savannah District conducted a survey to estimate the interest in future navigation on the Savannah River. Results of that survey are described later in this section.

2.2.3. Current Land Use

A summary of current land use patterns is shown in Table 2-2.

TABLE 2-2
LOWER SAVANNAH RIVER BASIN
CURRENT LAND USE

LAND USE CATEGORY	GEORGIA (percent)	SOUTH CAROLINA (percent)
Urban/Industrial	22	5
Agricultural	21	28
Timberlands	45	67*
Forested Wetlands	12	unknown

* Includes forested wetlands

Source: 1991 Georgia County Guide and the 1991 South Carolina Statistical Abstract. Percentages based on total acres in each of the counties in the study area.

The cities of Augusta and Savannah are the only two metropolitan centers along the Lower Savannah River corridor. There are two nuclear facilities along the Lower Savannah River Basin. The Savannah River Site, formerly the Savannah River Plant, is located in South Carolina between river miles 141 and 156. This facility produced plutonium and tritium for the Nation's defense programs and uses the Savannah River for its cooling water supply. Plant Vogtle nuclear powerplant is located in Georgia at river mile 151 about 50 miles downstream of Augusta and is operated by the Georgia Power Company. There are also a number of state and federally owned properties within the basin, which are listed in Table 2-3.

TABLE 2-3
LOWER SAVANNAH RIVER BASIN
LAND OWNERSHIP

OWNERSHIP	ACREAGE
Federal Government:	
Department of Agriculture	
Sumter National Forest	
Department of Energy	
Savannah River Site	
Department of the Interior	
Savannah National Wildlife Refuge	
Subtotal	26,000
State of South Carolina:	
Tillman Sand Ridge WMA	
Webb Wildlife Center	
Subtotal	6,935
State of Georgia	
Yucchi Wildlife Management Area	
Tuckahoe Wildlife Management Area	
Subtotal	17,949
Total	51,000

Lands surrounding the study area are predominately privately owned by timber companies, recreation interests, electric utilities, and the U.S. Fish and Wildlife Service. The area is sparsely populated with only one major industry along the northern edge of the study area. There are no home sites in or near the study area. Land use is primarily timber growth, wildlife preservation, and recreation.

2.2.4. Population

Navigation cuts #3 and #4 are located in or adjacent to Effingham County, Georgia; Hampton County, South Carolina; and Jasper County, South Carolina. Current population and OBERS population projections are shown in Table 2-4.

TABLE 2-4
CURRENT AND PROJECTED POPULATION

COUNTY	1994	2000	2010
Effingham Co, GA	30,499	35,887	41,056
Hampton Co, SC	26,180	30,855	35,343
Jasper Co, SC	21,280	25,080	28,728

2.3. GEOLOGY AND SOILS

2.3.1. Geology

The study area is underlain with unconsolidated and partly consolidated Atlantic Coastal Plain sediments. These sediments generally consist of unconsolidated to semiconsolidated layers of sand and clay and semiconsolidated to very dense limestone and dolomite which can reach a depth of about 5,500 feet. A discussion of the post-Cretaceous Atlantic Coastal Plain sediments is included in Appendix A, *Engineering Analysis*.

2.3.2. Soils

Foundation conditions in the study area are satisfactory for the support of both direct bearing structures, such as closure dikes, and structures requiring driven pile foundations. A large portion of the foundations of the structures are located in scour zones, typical of the outside bends of the main channel. Therefore, foundation soils are predominantly in situ soils and not recent river deposits.

Subsurface conditions, channel and bank soils, in the vicinity of the bends do not indicate any materials or conditions which would present difficulties for any proposed dredging work. Soil types vary considerably both horizontally and vertically in a gradational nature typical of flood plain deposits. Standard penetration test results indicate that the soils are unconsolidated, typical for soils in the Coastal Plain. Classifications ranged from sandy silts (ML and MH) and clays (CL and CH) to clean fine sands (SP). The average percent fines, material smaller than a #200 sieve, within the navigation channel is 52.

No stratum of rock or hard, cemented soils were encountered within the project limits. Based on field observations, no hazardous or toxic materials were encountered at the project site. In view of the history of land-use at the site, no hazardous or toxic materials are anticipated. However, soil samples from the study area were obtained and tested for pollutants which might be disturbed during any construction activities.

2.4. PHYSIOGRAPHY

The physiography of the study area is characteristic of an undeveloped riverine system in the swampy regions of the Coastal Plain. Old meander channels, sand bars, and oxbow lakes are relatively common in the vicinity. Bend #4 contains a complex four-curve alignment, whereas bend #3 is a single curve.

The study area lies within a rural portion of Effingham County, Georgia, adjacent to Jasper County, South Carolina, just downstream of Ebenezers Landing boat ramp. Major land and water uses include fishing, hunting, boating, and tree farming. Access to the site is virtually limited to traffic in the Savannah River. There are no established roads of the type required to mobilize a major construction effort to the site. The roads in the vicinity that do exist are primarily abandoned, overgrown logging roads.

Access via the river can be achieved at a number of private and public points upstream and downstream of the study area. Although an authorized navigation project, the river has not been maintained since 1979. Relatively recent hydrographic surveys indicate that the authorized depth of 9 feet at a flow of 6,300 cfs continues to exist within most of the river channel. However, there are numerous snags and shoal areas within the main river channel and the bends which reduce the channel depth to less than the authorized depth.

The majority of the study area is heavily wooded with mature deciduous and coniferous trees and heavy underbrush. The river banks, particularly in the bends, contain heavy growths of trees which overhang the water. Heavy aquatic plant growth is prevalent in the bends.

The topography is relatively flat and low, which is typical for this area. Typical ground elevations above the river average +5 feet LMVD, although there are long, narrow berms on both sides of the navigation cuts which reach as high as +15 feet LMVD. The berms appear to be excavated material from construction of the navigation cuts. The bottom of the main river contains scour channels as deep as elevation -25 feet LMVD, primarily along the outside of the natural river bends, and the average depth across the river is approximately -15 feet LMVD. The bends vary in depth considerably with location; however, the average depth is only about -5 feet LMVD. There are locations within each bend that have filled with sediment, from both natural processes and past disposal of maintenance dredging, to the point where even shallow draft boats cannot pass. In other areas, sand bars extend across almost the full width of the bend channel.

2.5. CLIMATE

The Coastal Plain Province of Georgia and South Carolina is considered subtropical, with warm summers and mild winters. Summer temperatures average between 80 and 82 degrees Fahrenheit (F), with coastal temperatures reaching above 90 degrees F approximately 50 days per year. Winter temperatures are more variable, but average 56 degrees F, with only 10 days of temperatures below freezing per year. Relative humidity is moderately high throughout the region.

Rainfall increases from the Fall Line to the coast. Near Augusta, as little as 40 inches of rainfall per year is measured, while the coast averages approximately 53 inches per year as shown in Table 2-5. However, rainfall varies greatly from year to year in any given area. From October through April, precipitation is generally of low intensity, covering wide areas and lasting several days. During May through September, precipitation is generally in the form of intense localized thunderstorms. Snowfall is insignificant throughout the study area.

TABLE 2-5
AVERAGE PRECIPITATION AT SAVANNAH AIRPORT

MONTH	PRECIPITATION 1962-1992 (inches)
January	3.09
February	3.17
March	3.83
April	3.16
May	4.62
June	5.69
July	7.37
August	6.65
September	5.19
October	2.28
November	1.89
December	2.77
Year Total	49.71

2.6. BASIN HYDROLOGY

Hydrology of the Savannah River is dominated by three multipurpose dam and reservoir projects above Augusta operated by the U.S. Army Corps of Engineers. They are J. Strom Thurmond (river mile 237.7), Richard B. Russell (river mile 275.2), and Hartwell (river mile 305). Reregulation of the releases from Thurmond Reservoir is provided by Stevens Creek Dam and the New Savannah Bluff Lock and Dam.

Streamflow varies considerably in the lower Savannah River, both seasonally and annually, as shown in Table 2-6. Streamflows are typically high in winter and early spring and low in summer and fall. However, regulation by the reservoirs, together with reregulation by Stevens Creek Dam and New Savannah Bluff Lock and Dam, have stabilized natural flow. Salt water extends up the river from the Savannah Harbor approximately 22 miles, depending on river flow. Tidal influence extends upstream about 20 miles above Savannah to river mile 44.7, about 3 miles upstream of Mill Creek.

The authorized Savannah River navigation project from Augusta to Savannah provides for a 9-foot depth at a river flow of 6,300 cfs, which is considered typical low flow conditions. River flows exceed 6,300 cfs about 87 percent of the time.

TABLE 2-6
AVERAGE STREAMFLOWS,
SAVANNAH RIVER AT CLYO, GEORGIA

MONTH	AVERAGE STREAMFLOW (cfs)		
	1930-1952	1953-1961	1962-1995
January	10,421	7,888	10,038
February	8,816	8,184	9,576
March	11,757	8,793	11,440
April	16,394	9,264	14,013
May	16,476	12,833	15,319
June	18,989	14,784	17,831
July	17,272	15,985	17,845
August	10,476	11,884	12,615
September	8,020	8,214	11,070
October	8,302	7,734	9,512
November	9,197	7,486	9,553
December	6,936	7,772	9,043

Gauge 02198500, river mile 60.9

Plots of average, maximum, minimum streamflows, and streamflow frequency analysis are shown in Appendix A, *Engineering Analysis*.

Prior to 1954, there were no projects designed for flood control on the Savannah River. Construction of Thurmond Dam in 1954 resulted in lower peak discharges in the Savannah River due to flood control storage within the Thurmond reservoir. With the construction of the Hartwell Dam in 1963 and Russell Dam in 1984, additional flood control storage was added to the river. The 100,000+ cfs downstream river flows which were observed prior to 1954 are much less likely to occur.

During low flow periods, the ability of the reservoirs to provide a prolonged dependable minimum flow also becomes important. With implementation of the Savannah River Drought Contingency Plan in 1988, the Savannah River average streamflows are targeted to remain above a minimum 3,600 cfs.

The Savannah River in the vicinity of the study area overflows its banks when the streamflow exceeds approximately 13,300 cfs. Streamflow velocities in the main river typically range from 4 to 6 feet per second. Even though no maintenance dredging has been done for the authorized navigation project since 1981, these velocities have been sufficient to maintain adequate depths for the occasional commercial navigation.

2.7. WATER SUPPLY AND QUALITY

2.7.1. Water Supply

The city of Savannah's surface industrial raw water supply intake and pumping station is located on Abercorn Creek. Bear Creek from bend #3, Raccoon Creek from bend #4, Flat Ditch Creek from bend #4 and Mill Creek merge below the study area and are the major sources of flow into Abercorn Creek.

The city's primary source of domestic water supply is a major aquifer. This aquifer is threatened by heavy usage which has resulted in the beginning of saltwater encroachment. The city may have to place increased reliance on surface water, mainly the Savannah River and tributaries, for a reliable future water supply source. Therefore, protection of existing and potential surface water supply sources is critical for future water supply in the city and Chatham County.

2.7.2. Water Quality

Water quality standards, water intake structures, and effluent discharge permits are jointly regulated by the Georgia Department of Natural Resources, Environmental Protection Division and the South Carolina Department of Health and Environmental Control. More detailed information on water quality standards is included in Appendix B, *Environmental Assessment*. Chemical data from seven sampling sites in the vicinity of cut and bend #3 and #4 were collected between April and June of 1994 by the Georgia Environmental Protection Division. Suspended solids at the sampling sites were found to be normal for this area.

The city of Savannah has been experiencing water quality problems at the water supply intake. Dry periods within the watershed above the intake followed by minor flooding periodically flushes tannic acid and other decomposed inorganic material from the wetlands and swamps into the creeks and to the intake. This is further complicated by the tidal effects in Abercorn Creek, as the contaminants can be moved up and down past the intake for sustained periods. This results in additional capital and operating costs to remove the contaminants.

According to the city of Savannah, the quality of raw water at their intake on Abercorn Creek has deteriorated over the past 15 to 20 years. As a result of this decrease, the direct increase in treatment cost is about $112,000 a year. This is expected to double when amendments to the Safe Drinking Water Act are implemented. Some industrial customers of the system have incurred additional costs for further treatment when industrial processes require higher levels of water quality. In 1993, the city dredged Abercorn Creek and constructed a small diversion structure to divert more flows into Abercorn Creek from Collis Creek. The city considered this a short-term solution that did not address the main problem of decreasing flows from bend #3, bend #4, and Mill Creek.

2.8. RECREATION

Recreational use of the Lower Savannah River area consists primarily of fishing, boating, and hunting. Access points close to the project area are Woods, Becks Ferry, and Ebenezer Creek landings at RM 33.9, 39.0, and 44.7, respectively. Additional access is provided at the city of Savannah's Abercorn Creek water intake. Important game fish found in these waters are largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, red ear sunfish, and warmouth. Additional species taken are channel catfish, white catfish, and brown bullhead. Anadromous species occur in the river, but in low numbers in the project area (GADNR, 1994). Hunters use boat ramps and local roads for access to the area. The principal game species hunted are deer, feral hog, and squirrel. Bird watching is a growing activity, particularly within the Savannah National Wildlife Refuge.

2.9. CULTURAL RESOURCES

In June 1994, a cultural resources survey for the study area was conducted by the Savannah District. The report of the contractor who performed the investigations is included in Appendix C, *Cultural Resources Survey*. The survey area included the waterlogged area at the confluence of Mill Creek and the Savannah River, the south bank of the Savannah River from opposite the middle of Bay Bush Point around Flat Ditch Point up to Hickory Bend, Flat Ditch Point, bend #3 island, and the north bank of the Savannah River from navigation cut #3 to cut #4.

Despite intensive shovel testing along the river banks and on the man-made islands, and visual inspection of the river banks in the project area, no artifacts, cultural strata, or archaeological sites were located in the survey area. Remains of historic watercraft were not observed within the study area. Archaeologists in the Savannah District indicated there are no historic steamboat wrecks recorded for the area.

The District concluded that no further cultural resource investigations are required for the study area regarding potential historic watercraft. The Georgia State Historic Preservation Officer (SHPO) concurred in that determination. If artifacts or anthropic deposits, such as features or middens, should be encountered during construction or in the staging area, work would be halted immediately, and an archaeologist contacted to make an assessment of the situation.

2.10. SAVANNAH NATIONAL WILDLIFE REFUGE

2.10.1. Description

The Savannah National Wildlife Refuge is located in the uppermost reaches of Savannah Harbor, as shown on Figure 2-2. The refuge encompasses both impounded and unimpounded wetlands and marshes. The refuge consists of 26,500 acres of palustrine forested wetland, palustrine and estuarine emergent wetland, palustrine scrub-shrub wetland, riverine wetland, managed waterfowl impoundments, and upland.

2.10.2. Refuge Boundary

As shown on Figure 2-3, the present refuge boundary includes Bear Creek watershed but does not include the two navigation cuts and bends or Mill Creek watershed. However, the area noted for proposed acquisition is a high priority, and the U.S. Fish and Wildlife Service, which manages the refuge, anticipates this land will be acquired before any environmental restoration construction. Environmental restoration benefits which accrue within the refuge have an intrinsic higher value than similar benefits which might occur on remote unmanaged private lands.

2.10.3. Ecosystem within Study Area

In general terms, the ecosystem within the total study area subject to environmental restoration can be broken down into three broad categories:

- Aquatic habitat within the bends and creeks.
- Bottomland hardwood adjacent to bends and in creek watersheds.
- Aquatic and wildlife habitat in the creeks and watersheds.

The aquatic habitat within the bends requires sufficient flow to provide flowing water or slackwater fish habitat. Areas which dry up or become isolated pockets during low flow conditions will not sustain habitat. The bottomland hardwood adjacent to the bends is wetland forest, which requires periodic inundation for optimum conditions. The vegetative and animal habitat within the creek watersheds needs periodic high flows to cause overbank flooding of lands adjacent to the creek beds, and a minimum amount of creek flow is needed during low river flow conditions to sustain fish habitat in the creeks.

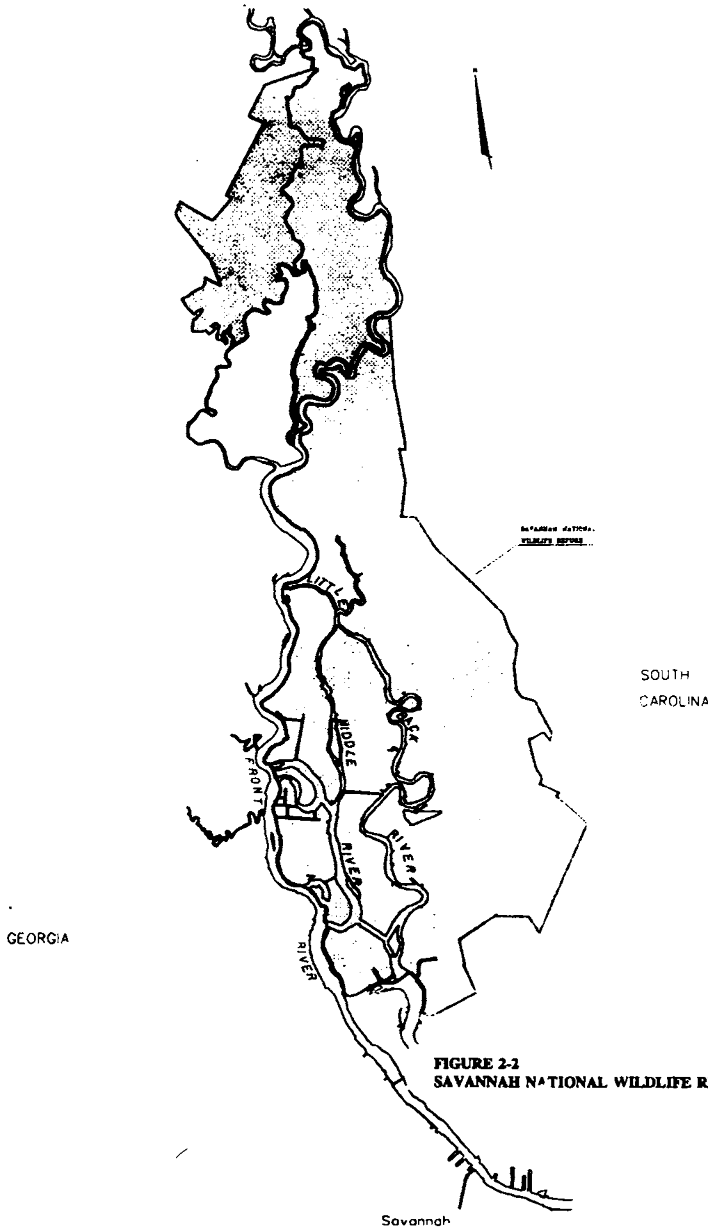


FIGURE 2-2
SAVANNAH NATIONAL WILDLIFE REFUGE

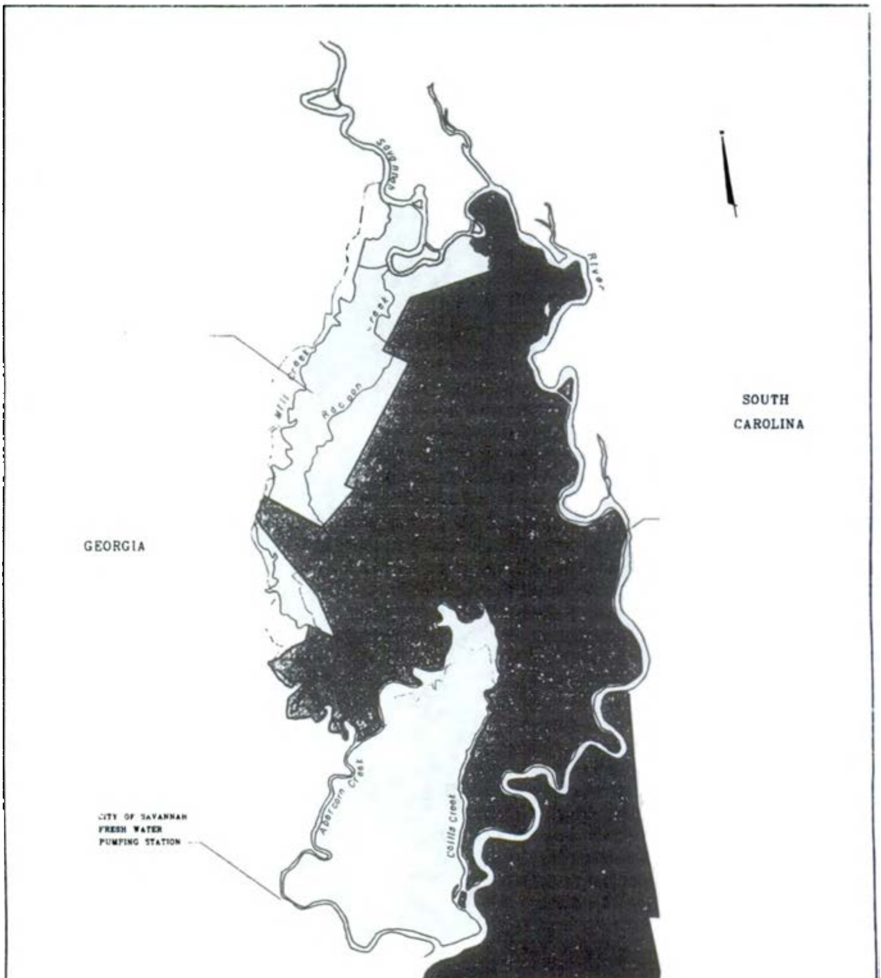


FIGURE 2-3
SAVANNAH NATIONAL WILDLIFE REFUGE
WITHIN STUDY AREA

2.10.4. Priorities for Environmental Restoration

The U.S. Fish and Wildlife Service (FWS) is strongly supportive of environmental restoration which improves wildlife habitat within the Savannah National Wildlife Refuge. They have listed the following areas for restoration in roughly their order of priority:

- Restored flows into the creeks and downstream watersheds for improved bottomland hardwoods and aquatic habitat.

- Restored amount and frequency of overbank flooding of the creeks to maintain wetland vegetation and habitat.

- Restored overbank flooding in the bends to restore amount and frequency of flooding of bottomland hardwoods.

- Restored aquatic habitat within bends.

2.11. FUTURE NAVIGATION ON THE SAVANNAH RIVER

Commercial river navigation from Savannah to Augusta appeared to peak around 1970, with 136,000 total annual tonnage. In 1970, commerce consisted of logs, chemicals, minerals, and clay. Even with modifications to the navigation project from 1958 to 1976 to provide the authorized 9-foot depth, commerce continued to decline. After 1986, the annual tonnage fell below 1,000 tons every year to the present.

However, tonnage figures alone may be misleading in evaluating the importance of the Federal navigation project to commercial interests. Although dredging and snagging of the authorized project was discontinued in 1981, the river remains navigable about 60 percent of the time. Most industries time shipments to coincide with higher river flows. Several industries which still use the river for transportation essentially do not have readily feasible alternate modes of transportation. Some large, oversized shipments cannot be moved by any alternate method. Other industries are seriously considering future barge traffic on the river. The Savannah Electric and Power Company is investigating importing coal and barging it to two power plants on the river downstream of Augusta.

In conjunction with the Lower Savannah River Basin study, the Savannah District sent letters to various agencies to ascertain future use and interest in the river for navigation. These agencies included the states of Georgia and South Carolina, counties adjacent to the river, towing companies, and industries which currently use, or were known to be considering use of, the river for barge shipments. Chem-Nuclear press by ships spent nuclear components to a disposal site on the Savannah River near Augusta. Due to the size and weight of the nuclear components, transport by barge was the only means of transportation feasible.

Chem Nuclear has indicated that if large nuclear components from waste generators could not be transported by barge to the disposal site, they would have to be placed in long-term storage at the generator sites or bear the economic costs and personnel radiation exposure to disassemble and decontaminate these components to a size which could be transported by rail or highway. Georgia Power Company, Fort Howard Corporation, and Kimberly Clark Corporation also currently ship large, heavy mechanical equipment by river.

Even with the presently degraded condition of the navigation project, it is feasible to maintain navigation on the river. There are indications that commerce may increase as the costs of other transportation modes becomes excessive, particularly for bulk goods. Industries have reduced the size of barges and pusher tugs to accommodate shoals and reduced channel depths. Since there are 38 other navigation cuts on the river, it would not be realistic to provide less than a minimum level of navigation through either the cuts or bends in the study area.

It was not within the scope, or intent, of the Lower Savannah River Basin study to conduct a detailed investigation of present and future navigation on the Savannah River from Savannah to Augusta. This would be a costly and time consuming study on its own, plus it was not within the study scope of work which the local sponsor agreed to cost share. The Savannah District believes any recommended environmental restoration alternative must continue to provide a minimum level of navigation in order to maintain a contiguous navigable channel within the authorized navigation project. It is not necessary, or desirable at this time, to further investigate the issue of continued navigation on the river.

Responses to the survey are included in Appendix J, *Future Navigation Survey*. Table 2-7 summarizes the responses.

TABLE 2-7
RESPONSES TO NAVIGATION SURVEY

RESPONDENT	COMMENTS
Savannah Electric & Power Company	Constructing offloading dock for coal at plant at river mile 20 within Savannah Harbor. Plan to barge coal up river to plant at river mile 43 above study area. Expect to move up to 200,000 tons annually.
Savannah Marine Services	Average 3-5 trips per year. Give many quotes to bring cargo to and from Augusta. Strenuously object to closing cuts (eliminate navigation) or less maintenance.
City of North Augusta, Georgia	Supports maintaining navigation. Marinas and other river-oriented facilities planned. Need navigation access to coastal waters. Augusta only inland port city on river. Working with industrial prospect who would need river to transport raw materials.
Central Savannah River Resource Conservation & Development	Navigable river needed for recreational boating. Sponsor annual Great Savannah River Trip with boat regatta from Augusta to Savannah. Recreational boating is major potential economic impact to rural counties.
Chem-Nuclear Systems, Inc.	Supports maintaining commercial navigation. Transports nuclear components every year by barge to disposal site. Too large and heavy for other transportation means. Anticipates increased need for navigation as older nuclear plants are decommissioned.
Kimberly-Clark Corporation	Uses river to transport large machinery to plant on river. May not be transportation alternatives due to weight and clearance. Could prevent machinery upgrade and lose competitive status.
Fort Howard Corporation	River should remain navigable. Have used it to transport large equipment that could not be shipped by land. Anticipate similar shipments in the future. May want to ship fuel in the future.
Georgia Department of Natural Resources	GA DNR has no plans itself for navigation use of the river. Southern Company (Savannah Electric and Power Company) has mentioned interest in possible bulk material shipments. Concerned about increasing cost of alternatives. Need reasonable costs to assure local support for project. Navigation complicating environmental restoration solutions and contributing to costs. No GADNR funding for future maintenance for navigation or environmental restoration. Project disposal site may not support future navigation maintenance.

TABLE 2-7
RESPONSES TO NAVIGATION SURVEY
(cont'd)

RESPONDENT	COMMENTS
Lockwood Brothers, Inc.	Transport oversized equipment for many customers. Some customers have indicated possible future movements. Normally use 200'x40'x10' barges with two tugboats. Past and future work cannot be done by other transportation means. Customers cannot operate without the large equipment moved by river.
Metro Augusta Chamber of Commerce	Support continued river navigation. Do not want to lose option of barge traffic up to Augusta. Prospective industries may want sites accessible by barge.
Georgia Ports Authority	Requests restoration project not increase sediment transport. Georgia Department of Transportation considering replacement of Houlihan Bridge. Low level replacement bridge would essentially eliminate navigation.
Conbulk Marine Terminals Group	Savannah Electric and Power Company constructing dock for coal shipments on river. Estimated annual savings barge versus truck is $262,500. Fort Howard Paper Company considering shipping raw material and products by river. Federal Paper Company may move 100,000-300,000 tons of product by river. Estimated savings barge versus truck is $4.00 per ton. Would need 7-8 foot draft to accommodate all of these shipments.
City of Augusta, Georgia	Invested $180-200 million for economic development. Restricting navigation might eliminate potential growth along river.
Richmond County Board of Commissioners	Supports closing cutoffs and restoring bends. Opposed to deauthorization of navigation. Some ongoing development efforts would be impacted or destroyed by deauthorization.
Georgia Power Company	River only transportation means for replacing some nuclear plant components. As example, steam generators are 70' long by 15' diameter and 400 tons. Georgia Power Company must have option for shipping heavy loads on river.
Department of Energy	Loss of navigation could affect future use of Savannah River Site for major projects. Many components would be too large to ship by any means except barge.

SECTION 3

PROBLEM IDENTIFICATION

3.1. FUTURE CONDITIONS WITHOUT ENVIRONMENTAL RESTORATION

Since construction of the navigation cuts, the cutoff bends have experienced heavy siltation and loss of flow volume. Dense aquatic plant growth is prevalent in the bends, both in the water and on sandbars. Without a restoration project, siltation and sedimentation in the bends will continue, and the mouths of creeks originating at the bends will experience increased siltation and further blockage of flows into the creeks. Based upon a 1993 hydrographic analysis by the Savannah District, only 5 percent of the original channel capacity remained in bend #3 and 11 percent of the original channel remained in bend #4. By the year 2000, only 3 and 6 percent of the original channel capacity, respectfully, would remain.

Without a restoration project, the bends and the creeks will eventually become completely isolated from river flows, particularly during low river flow conditions. The U.S. Fish and Wildlife Service has predicted that future conditions in the study area, without restoration, will include complete filling of bend #3 in less than 10 years and filling of bend #4 in less than 15 years (Appendix D, *U.S. Fish and Wildlife Service Coordination Report*). At that time, the creeks will receive no water during low flow periods and will be completely isolated from the main river. During low flow conditions in the river, there will be no flow within the bends and aquatic habitat will become nonexistent in the bends. Table 3-1 summarizes the past and projected level of sedimentation within the bends.

TABLE 3-1
LOSS OF BEND FLOW CAPACITY

YEAR	REMAINING BEND FLOW CAPACITY (percent of pre-cut conditions)	
	BEND #3	BEND #4
1962	100 %	100 %
1993	5 %	11 %
2000	3 %	6 %
<2005	0	
<2010		0

As shown in Figure 3-1, the existing low flow into Bear Creek and its watershed will be eliminated as bend #3 becomes completely silted in. Flows from bend #4 into Raccoon Creek are already zero at low flow conditions, and will continue to be reduced during higher flows. The only current minimal low flow into Mill Creek comes from bend #4 via Flat Ditch Creek, and this low flow will soon be eliminated due to continued blockage of the mouth at the bend. The blockage of the mouth of Mill Creek will continue to prohibit low flows from the river entering the creek and watershed. Overall, the present low flows of 45.0 cfs in Bear Creek and 0.8 cfs in Flat Ditch Creek, the only sources of water to the watersheds during low flow conditions, will be completely eliminated without restoration.

Without a restoration project, the study area watersheds will continue to be negatively impacted by the continued reduction in water flow and frequency of overbank flooding. Aquatic habitat will diminish and be eliminated in some creeks. Forested wetlands which require periodic inundation will be irreversibly degraded. In lands adjacent to the bends and within the creek watersheds, degradation and loss of forested wetlands will continue, eventually resulting in a change from forested wetlands to a drier type of vegetation and habitat.

As low flows into the bends and creeks continue to be reduced, they will experience further degradation of water quality and fish habitat from elevated temperatures and a decrease in dissolved oxygen. Degradation will directly affect the available fish and wildlife habitat and will reduce the diversity of the wetlands along the river. The index for average annual habitat units will fall from the current 0.67 to 0.44. Likewise, the bottomland hardwood ratings will fall from the current 0.5 to 0.3 in 10 years and 0.2 in 20 years. In addition, the quality and quantity of water at the city of Savannah intake on Abercorn Creek will continue to degrade.

3.2. PROBLEMS, NEEDS, AND OPPORTUNITIES

3.2.1. Navigation Cuts

In order to improve navigation on the Savannah River between Augusta and Savannah, the Federal navigation project included construction of numerous navigation cuts along the river from 1959 to 1976 to straighten and shorten the navigation channel. These cuts directed flow away from some of the original bends, causing the bends to degrade environmentally.

3.2.2. Bends

After the navigation cuts were constructed, bends #3 and #4 began filling with sediment due to insufficient velocities to keep the sediment load moving through the bends. The bends slowly filled in until most of their original channel capacity was lost. Streamflow velocities in the main river and within the navigation cuts typically range from 4 feet per second to 6 feet per second, which have been sufficient to prevent the need for maintenance dredging, thus providing adequate depths for commercial navigation.

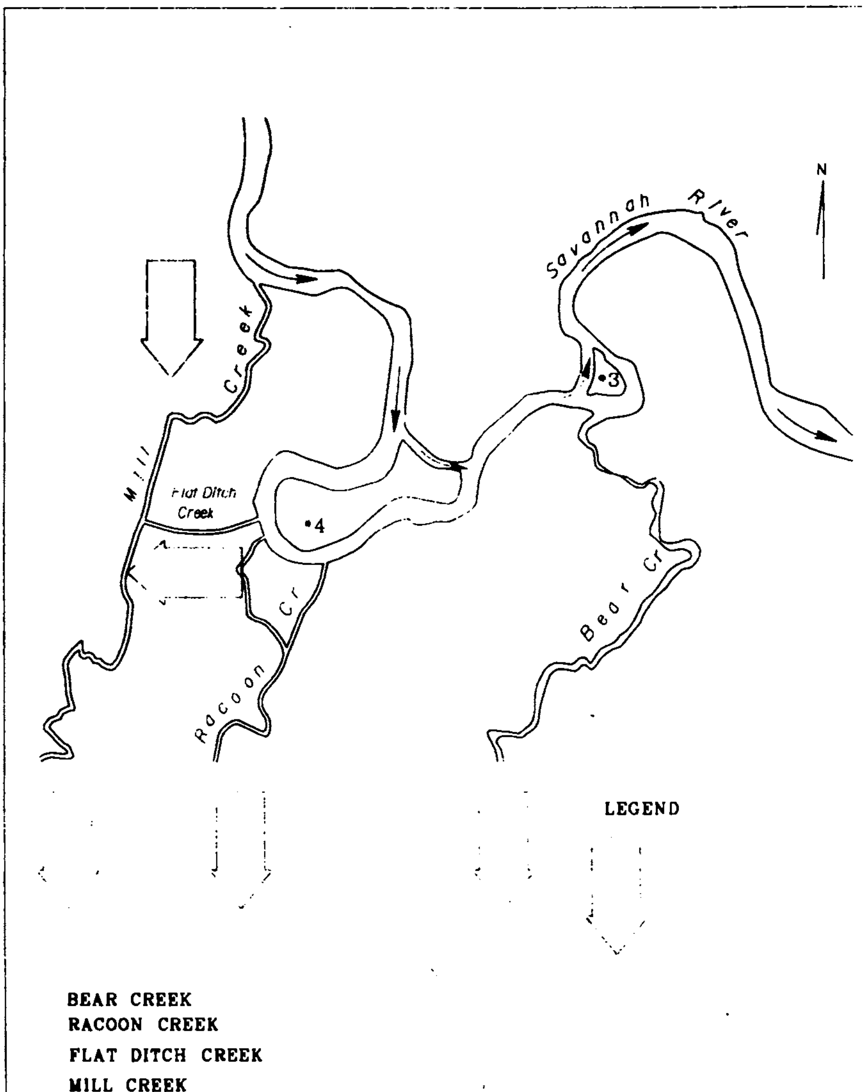


FIGURE 3-1
WITHOUT PROJECT CONDITIONS

As the sediment dropped out in the bends, sandbars formed and they became vegetated. The available bend channel capacity decreased with this process. Available fish habitat has also been reduced during low flow conditions. Fish habitat is adversely affected under these conditions and fish recruitment may be reduced.

In addition, the creeks which originate at the bends have also lost much of their original flows. If no restoration action is taken, siltation will eventually completely fill the bends. The mouths of the creeks will eventually close off completely with no water flow to the downstream creek watersheds during low flow. This is a natural process which has been greatly accelerated due to construction of the navigation cuts.

3.2.3. Wetlands

The extensive forested wetlands of the Lower Savannah River Basin are important habitat to many significant fish and wildlife species, as well as to endangered and threatened plants and animals. These wetlands are also important for flood water storage, water purification, soil enrichment, erosion control, and food chain for fish and wildlife.

The character and existence of southeastern forested wetlands is determined by many factors including:

- Depth, duration, and frequency of river and creek overbank flooding
- Intensity of stream flow
- Quantity, nature, and deposition rates of sediment carried by the stream
- Chemical composition of the water

Severe adverse modifications to the hydraulic regime results in the succession of many of the remaining forested wetland communities to drier habitat types. This also reduces the richness and diversity of the river swamp and eliminates or degrades wetland habitats and associated values and functions that are important for fish and wildlife. In addition, the decrease in duration and depth of flooding in wetland creeks has reduced flushing of detritus and nutrients from the wetlands.

3.2.4. Riverine Fish Populations

Degradation due to construction of the navigation cuts has modified natural mechanisms that enhance the riverine fish populations. Fish populations in some portions of the river, flood plain, and creek watersheds have probably been reduced. Riverine fish communities benefit from natural winter and spring floods. Overbank river flooding allows for inundation of extensive flood plain spawning habitat, including natural oxbow lakes. Floodwater slowly recedes allowing the larval and juvenile fish to contribute to the river population. Temporary connection of the natural oxbow lakes also allows for the movement of adult fish into the frequently isolated oxbows. The carbon cycle of rivers is also closely tied to overbank flooding and productivity suffers with the loss of flood episodes.

3.2.5. Savannah National Wildlife Refuge

All lands in the study area, particularly the creek watersheds, are within the Savannah National Wildlife Refuge or in lands scheduled for acquisition for addition to the refuge. The importance of the forested wetlands, vegetation, and habitat in the study area is underscored by its inclusion in a National wildlife refuge. All of the study area has experienced deterioration of the varied ecosystem. Loss of the channel capacity in the bends has resulted in reduced overbank flooding of adjacent bottomland hardwoods and drastically reduced flows into the creeks originating at the two bends plus Mill Creek. The creek watersheds have also deteriorated due to reduced high flows and the reduced or loss of flows during low flow conditions in the river. This has resulted in the reduction of amount and frequency of creek overbank flooding which is essential for productive forested wetlands.

3.2.6. Significance and Scarcity of Resources

In the 200 years since settlement, Georgia has lost over 1.5 million acres of wetland values. In the mid-1800s, the Federal government encouraged and sponsored wetland drainage. Under these legislative incentives, farmers, developers, and engineers drained and converted over 100 million acres of wetlands (Simkins, Coder, and Lewis, 1991). In the mid-1970s, Georgia had 5.3 million acres of wetlands.

Most of the forested wetlands in the southern United States lie in the Coastal Plain. Sixty-eight percent are found along narrow stream margins and small drainageways, 8 percent are found in deepwater swamps, and 11 percent are found in floodplain forests along major rivers (Walbridge, 1993). A recent statistical report from the Georgia Department of Natural Resources describes the land cover classification for the State of Georgia by county (GADNR, 1995). The total acreage of all forested wetland for the state is 3.1 million acres, or 8.47 percent of the total state area.

Restoration of the study area would directly impact 4,708 acres of forested wetlands in the study area plus indirectly impact 6,468 of tidally influenced wetlands below the study area, for a total of 11,176 acres, or about 0.3 percent of the total forested wetlands in the state.

Healthy and functioning wetlands contribute to our well-being and lives in many ways. They exhibit a diverse range of functions and values, from controlling flooding to protecting and improving surface and groundwater quality, maintaining fishery resources, and providing valuable habitat for plants and animals. They also provide aesthetic features and recreation, such as boating, fishing, hiking, camping, and bird watching. They possess important recreational and historical values and act as buffers between the urban development and our water resources. Wetlands often provide valuable seasonal habitat for fish and other aquatic life, amphibians, and migratory bird reproduction and migration.

Recently, programs have been developed to restore and protect wetland resources at the local, state, and Federal levels of government. At the Federal level, the President of the United States established the goal of "*no net loss of wetlands*" adapted from the National Wetlands Policy Forum recommendations (The Conservation Foundation 1988). Applying water quality standards to wetlands is part of an overall effort to protect the Nation's wetland resources.

A portion of the ecosystem which would benefit from an environmental restoration project in the study area, roughly the Bear Creek watershed, is within the Federal Savannah National Wildlife Refuge. Private land in the Raccoon Creek and Mill Creek watersheds is scheduled for acquisition by the U.S. Fish and Wildlife Service (FWS) for addition to the National Wildlife Refuge. This is a high priority for FWS, and upon completion of acquisition, the FWS would own and manage virtually the entire study area.

Analysis of the "*Landcover of Georgia 1988-1990*," published by the Georgia Department of Natural Resources, indicates that the study area appears to be one of the largest blocks of palustrine forested wetlands in the State of Georgia and is comparable in size to the highly significant swamps of the lower Altamaha River near Darien, Georgia.

The quality of forest in the study area is very high. The floodplain flats on Bear Island in the northern part of the study area has been described as a rare, nearly virgin, sweetgum-diamondleaf oak-green ash forest. The remainder of the study area consists of mature forest with high species diversity and good interspersion of floodplain flats and sloughs vegetated with cypress and gum. Production of wildlife food is high due to the abundance of diamondleaf oaks and overcup oaks. The east facing bluff along the western edge of the floodplain and Mill Creek is covered with a diverse upland hardwood forest. This area and other floodplain edge habitats are important nesting areas for the rare swallowtail kite and Mississippi kite. The study area provides excellent habitat for both game and non-game species. Wild turkey and white-tailed deer are abundant in the area. The extensive forested wetlands provide significant habitat for neotropical migratory birds.

Hydrologic restoration is an important element fo. environmental restoration. It would begin with the reinstatement of the natural distribution of water in space and time. A limited flow has been available to wetland tributaries arising on bends #3 and #4. In the study area, because of reduced wetland flooding, regeneration of a less desirable forest type would be expected. The ecological goal of the restoration study is to recreate and maintain a healthy ecosystem large enough and diverse enough to survive the natural cycles of droughts, floods, and severe weather, and to support large and sustainable communities of native vegetation and wildlife.

Without a restoration project, the study area will continue to be negatively impacted by reduced water flow and overbank flooding. Bends #3 and #4 are almost completely silted in and, without restoration, will become completed closed at low flows. Flow into the creeks is already greatly reduced and will become nonexistent at low river flows without a restoration project. Water quality in the study area will also continue to decline, and available fish habitat will be drastically reduced.

Hydrological restoration would recreate those conditions, or close to those conditions, which existed in the study area before construction of the navigation cuts. The timing, quality, and distribution of water would be restored to more natural conditions.

As development continues throughout the South, its effects on forested wetlands will increase, through both direct wetland losses and changes in land use in surrounding watersheds. The Lower Savannah River Basin environmental restoration study of bends #3 and #4 plus Mill Creek represents an effort towards the "*no net loss*" goal and an opportunity to restore and protect this valuable resource from further degradation and loss.

Table 3-2 shows the significance of the restored resources from a technical, institutional, and public perspective, as described in ER 1105-2-100, Chapter 7, Section IV.

3.3. NON-FEDERAL CONCERNS

The city of Savannah has experienced declining and variable water quality, primarily ph, at its surface water supply intake facility on Abercorn Creek below the study area. City officials believe that this problem is caused or aggravated by reduced flow and wetland flushing in the watersheds above the intake. The creeks that flow into Abercorn Creek include Bear Creek, Raccoon Creek, and Mill Creek.

Reduced flows and frequency of overbank flooding in the watersheds above the water intake have resulted in degradation of water quality at the city water intake. After long dry periods, minor flooding in the watersheds flushes contaminants, particularly tannic acid which lowers the ph, into the creeks and to the water intake. The city believes that increased flows and flooding in the watersheds above the intake would improve water quality at the intake. Increased flows would reduce the magnitude of contaminants by increasing the frequency of minor flooding and the additional flows would dilute the contaminants.

Before construction of the navigation cuts, the watershed above the intake received a significant amount of water from the Savannah River through the creeks and from overbank flooding in the bends. Water quality in the Savannah River is high, with the exception of sediment load. Now when low flow conditions occur in the river, flows from the river to the watershed significantly decrease or cease. Historically, when flows from the watershed have been slightly increased or improved through minor clearing and snagging or removal of small amounts of creek sediments, city water treatment personnel have noted improved water quality at the water intake.

Any improvements to water quantity or quality at the city of Savannah water intake would be incidental to an environmental restoration project. No portion of a restoration plan would be constructed or modified solely for improvements at the water intake.

TABLE 3-2
SIGNIFICANCE OF RESOURCES

RESOURCES	EQ ATTRIBUTE	INDICATORS	SIGNIFICANT			SIGNIFICANT EFFECT (yes/no)
			INSTITUTIONAL RECOGNITION	PUBLIC RECOGNITION	TECHNICAL RECOGNITION	
Creeks	Ecological	Water Quality Fish Habitat (HU)	Clean Water Act, Public Law 92-500, 33 U S C 1251, et seq. Fish and Wildlife Coordination Act of 1958, as amended, Public Law 85-624; 16 U.S.C. 661, et.seq	City of Savannah is currently experiencing water quality problems at the water intake and recognizes this problem should be addressed	State and Federal biologists recognize the water quality problems in the creeks due to interrupted flow and its effect on fishery resources.	Yes
Wetlands	Ecological	Bottomland Hardwoods (acres) Wildlife Habitat	Executive Order 11990; Protection of Wetlands National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. 668, Public Law 89-669 Clean Water Act, Section 404 Fish and Wildlife Coordination Act of 1958, as amended. Public Law 85-624; 16 U.S.C. 661, et.seq.		State and Federal biologists recognize the value of the bottomland hardwood forest and wildlife resources in the study area. They agree on conserving listed species	Yes
		Migratory Birds	Migratory Bird Conservation Act of 1928		State and Federal biologists recognize the benefits of the restoration project to the migratory birds.	Yes
		Endangered Species	Endangered Species Act of 1973, as amended, Public Law 93-205; 16 U.S.C. 1451, et.seq.		State and Federal biologists recognize the benefits of the restoration project to the endangered species present in the study area.	Yes
	Aesthetic					No

3.4. GOALS AND OBJECTIVES

3.4.1. Federal Planning Objectives

The Federal objective in water resources planning, as stated in the Principles and Guidelines, is to contribute to National Economic Development (NED) in order to alleviate problems and/or realize opportunities related to water and related land resources, consistent with protecting the Nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct economic benefits that accrue in the planning area and the rest of the Nation.

Because benefits from wildlife habitat restoration and creation are not amenable to traditional NED benefit analyses, criteria contained in Draft EC 1105-2-206, "*Environmental Restoration Planning Guidance*," dated March 7, 1994, was used to define the Federal objective. These criteria are:

(a) Project outputs will be primarily for the benefit of fish and wildlife habitat.

(b) Environmental degradation of the watershed must be related to previous activities of the U.S. Army Corps of Engineers or restoration would be best accomplished through modification of a Corps of Engineers project.

(c) Project outputs must address significant resources, based on public, scientific and institutional considerations. Incremental analysis techniques should be used to optimize return on investment.

(d) Habitat outputs will be documented with qualitative and quantitative procedures such as the Habitat Evaluation Procedure (HEP).

The primary Federal objective for the restoration study was to provide for maximum cost-effective restoration of the area directly impacted by construction of the two navigation cuts.

3.4.2. Study Objectives

Construction of navigation cuts along the lower Savannah River has caused environmental degradation in the bends and adjacent wetlands. The purpose of this study was to develop a plan for environmental restoration of those lands which have been adversely impacted by the navigation cuts. For this first restoration study in the Lower Savannah River Basin, cut and bends #3 and #4 plus Mill Creek were selected for evaluation and possible restoration.

The primary objective was to restore flows in the bends and creeks and frequency of overbank flooding to conditions approaching those which existed prior to construction of the navigation cuts. This would allow the wetlands and habitat which have been adversely impacted to gradually recover and be protected from further degradation.

Restoration would be accomplished by diverting part or all of the river flow from the navigation cuts into the bends with possible channel dredging in the bends. The creeks which originate in the bends, plus Mill Creek, provide essential water for the forested wetlands. Higher flows through the bends would restore desirable bend and creek overbank flooding to enhance bottomland wetlands adjacent to the bends plus forested wetlands in the creek watersheds. Low flows would be created or increased in the creeks to restore or enhance fish, wildlife, and vegetation habitat in the watersheds. The mouths of the creeks would require some modification to restore natural low flows from the river into the creeks.

3.5. PUBLIC CONCERNS

The initial Lower Savannah River Basin reconnaissance study was initiated by former Georgia Congressman Lindsay Thomas. Congressman Thomas, along with many of his constituents, have expressed concern with the environmental conditio·· of the Lower Savannah River and surrounding wetlands.

Throughout the reconnaissance phase, the Savannah District, Georgia Department of Natural Resources, U.S. Fish and Wildlife Service, and South Carolina Department of Natural Resources met several times and took several boat trips along the entire length of the Lower Savannah River Basin. The purpose of these meetings and field visits was: (1) to determine which bends were deteriorating environmentally, and (2) to determine the concerns of each state.

During the reconnaissance and feasibility phases, the study manager made presentations to various civic and special interest groups, including fishermen, mayors, Congressmen, city councilmen, and other concerned citizens. There is a growing awareness of the need to protect the environmental resources of the river basin, particularly the Savannah National Wildlife Refuge. Water flows in the study area watershed also impact the water quality at the city of Savannah water intake on Abercorn Creek.

Barging interests who use the Savannah River for commercial navigation have also expressed concern that the river be maintained for navigation. Although the amount of barge traffic has gradually declined over the years, the remaining traffic considers the navigation channel to be critical for their present and future operations.

SECTION 4

FORMULATION OF ENVIRONMENTAL RESTORATION MEASURES

4.1. STUDY OBJECTIVES

"No restoration can ever be perfect; it is impossible to replicate the biogeochemical and climatological sequence of events over a geological time that led to the creation and placement of even one particle of soil, much less to exactly reproduce an entire ecosystem. Therefore, all restorations are exercises in approximation and in the reconstruction of naturalistic rather than natural assemblages of plants and animals with their physical environments" (Berger, 1990).

4.1.1. Delineation of Study Area

The study area includes cut and bend #3, cut and bend #4, Mill Creek, plus the creeks and their watersheds that originate at bends #3 and #4. The study area includes 4,708 acres of three major creek watersheds (Bear Creek, Raccoon Creek, Mill Creek) above the zone of tidal influence from the Savannah River.

4.1.2. Environmental Restoration

The Federal objective of the study was to restore significant fish and terrestrial habitat in the Lower Savannah River Basin study area where deterioration has resulted from a previous Federal civil works project, particularly construction of navigation cuts for the Federal navigation project.

Construction of 40 navigation cuts on the Savannah River between 1959 and 1976 to straighten and shorten the navigation channel removed approximately 13 percent of the natural river bends from main river flows. In most of these bends, environmental quality has deteriorated. Adjacent forested wetlands have also deteriorated due to decreases in bend overbank flooding and flows into creeks from the bends.

In the study area, there are several creeks which originate in bends #3 and #4, and flows into these creeks have been severely reduced or eliminated during low flow conditions. These creeks and Mill Creek flow into the Savannah National Wildlife Refuge or adjacent private lands and provide vital flows for forested wetlands and aquatic habitat. The study objective was to restore the fish habitat and forested wetlands in the two bends, adjacent wetlands, and the creek watersheds. This would be accomplished primarily by restoring flows into the bends and creeks. Field flow measurements of Bear Creek and Flat Ditch Creek indicated sufficient hydraulic gradient exists in the upper portions of the creeks to allow flows from the bends into the mouths of the creeks to flow downstream through the remainder of the watersheds.

Therefore, restoration measures at bends #3 and #4 which restore flows into the creek mouths will result in improved flows downstream in the creek watersheds and increased overbank flooding.

4.1.3. Environmental Restoration Benefits

The U.S. Fish and Wildlife Service manages the Savannah National Wildlife Refuge where many of the restoration benefits would accrue. In coordination with the Savannah District and the Georgia Department of Natural Resources, they developed the habitat evaluation methodology and data used in the study to estimate restoration benefits. Restoration benefits are composed of two distinct categories: fish habitat and bottomland hardwoods. Although fish habitat sometimes comprises the primary environmental benefit from a restoration effort, in this study area the unique features and scarcity of the bottomland hardwoods were the dominant measures for environmental restoration alternatives, although benefits to average annual habitat units were also fully developed. The District used the benefit data to conduct an incremental analysis of benefits and cost of the preliminary restoration alternatives.

4.2. FORMULATION ISSUES

4.2.1. Separable Study Sites

The restoration study was more complex than initially expected due to the three individual sites included in the study area, although the three sites (cut and bend #3, cut and bend #4, Mill Creek) are geographically in close proximity. Navigation cut #4 is about 2,000 feet upstream of navigation cut #3 and about 3,700 feet downstream of the mouth of Mill Creek. Most restoration measures at any of the three separate sites are independent of actions at the other sites. However, the environmental benefits within the study area resulting from restoration actions at the three combined sites may be greater than the sum of benefits from restoration at each of the three sites.

The separate restoration components at each of the three sites were combined to form a restoration alternative for the total study area, although some components included no action. The first array of all potential restoration actions at the three sites included a total of 360 alternatives. These were narrowed to 36 preliminary alternatives for evaluation of benefits and costs.

4.2.2. Maximum Environmental Restoration

A simplistic approach for environmental restoration would be to restore the bends to pre-navigation cut conditions by plugging the entrance to the navigation cuts and allowing the total river flow to return to the bend. Dredging would be required to remove sediment deposits accumulated in the bends and provide a channel capable of accommodating total river flows. However, the watersheds of the creeks which originate at the bends contain valuable habitat and forested wetlands, and these have been adversely affected by reduced flows into the creeks from the bends and lower frequency overbank flooding due to construction of the navigation cuts.

The majority of environmental benefits which would result from a total restoration project would accrue in the watershed; instead of the bends. Therefore, an optimum restoration solution might place more emphasis on the 4,708 acres of forested wetlands in the study area instead of the bends themselves.

4.2.3. Preliminary Restoration Measures

One obvious restoration alternative was full closure of the two navigation cuts and restoring total river flows to the bends. Providing a full navigation channel in the bends would not necessarily provide optimum environmental restoration of the bends or watersheds. Therefore, options were considered with total cut closure and a smaller restoration channel with minimal navigation through the bends. Another option would be to construct a partial diversion structure at the entrance to a navigation cut to allow navigation to continue through the cut and provide a small channel with moderate increases in flows through the bend.

Restoring flows into Bear Creek is a high priority restoration measure for the U.S. Fish and Wildlife Service and the city of Savannah. Dredging bend #3 and restoring the creek mouth would increase flows into the creek, but a major increase in flow could be obtained by constructing a partial diversion structure at the entrance to the navigation cut and creating a channel from the river to the mouth of the creek. The flows into Bear Creek could be further increased by plugging bend #3 immediately below the mouth of Bear Creek so all flows entering the bend would go into Bear Creek. Still another approach would be to construct a new creek channel from the river or bend #4 which would join the existing Bear Creek below the mouth.

Other restoration measures were considered, but they are mainly modifications to these basic restoration components. No restoration measures were eliminated unless shown to be not cost effective or there was a similar restoration measure which was more desirable. Additional information is included in Appendix H, *Formulation and Screening of Restoration Alternatives*.

4.2.4. Navigation

All environmental restoration components and alternatives provided for some level of navigation through either the navigation cut or bend at cut and bends #3 and #4. A full navigation channel was defined as providing 9-foot depth at a flow of 6,300 cfs. In addition, in order for a full navigation channel through the bends to meet design standards and design vessel requirements of the Waterways Experiment Station, the channel would have minimum widths and radius throughout the bend.

Some alternatives included a "restoration" channel through the bends. This channel approached pre-cut conditions in the bends and provided a minimal level of navigation. Widths and curves do not meet WES navigation design standards, but barge traffic should still be able to navigate the bends under higher flow conditions. Due to higher velocities and narrow widths, safety and maneuverability would be a concern.

4.2.5. Environmental Restoration Benefits

The Savannah District, Georgia Department of Natural Resources, and U.S. Fish and Wildlife Service jointly developed benefits for each of the environmental restoration alternatives. For fish habitat restoration in the bends and creek, the average annual habitat units created by the restoration measures were computed using standard Habitat Evaluation Procedure models. In addition, the restoration of bottomland hardwoods in the forested wetlands was quantified in bottomland hardwood functional values, which is a measure of hardwood improvement. Since these are not comparable, both types of benefits were listed for each restoration measure. For without project conditions, those habitats which will continue to experience further degradation into the future were evaluated and quantified. Total restoration benefits were computed against without project conditions versus current conditions.

4.2.6. Net Environmental Benefits

Some of the environmental restoration measures evaluated resulted in minor destruction or degradation of existing bottomland hardwood due to construction activities, primarily dredging of bends or dredging a new channel for Bear Creek. The net environmental benefits for each restoration measure were computed as the positive restoration benefits less any construction losses of bottomland hardwood.

4.3. CONSTRAINTS

During formulation of initial alternatives, it was necessary to provide a minimal level of navigation through the bends for the alternatives with full closure of a navigation cut. This required a slight compromise with restoration objectives, although a restoration channel did come close to pre-cut conditions in the bend. A restoration channel would raise safety concerns for barges trying to navigate the bend at low or high flows.

The study team concluded that construction techniques for each restoration alternative should be selected to minimize environmental destruction or adverse impacts. Therefore, all construction was assumed to be marine-based to avoid the adverse impacts of land based construction. This likely resulted in a slight increase in the cost of some components of an alternative, but the major construction item is bend dredging which would be totally marine-based except for the pipeline to an upland disposal area. Small construction equipment such as backhoes would be transported by barge for clearing and restoration of the mouths of the creeks.

Any debris removed from the mouths and upper portion of any of the creek mouths would be moved by small equipment and placed in the flood plain and not burned on-site. However, willows and other growth which has occurred on the sand bars within the two bends would be removed before any bend dredging and burned on a bar in the bend. Debris from clearing the snagging the mouths of the creeks would also be removed and burned on sand bars. Major burning within the study area, particularly the Savannah National Wildlife Refuge, would be avoided.

With no flow in Mill Creek under low flow conditions, it was not possible to obtain flow measurements for hydraulic modelling. Therefore, modelling results from other creeks in the study area were interpolated to obtain future flow estimates for Mill Creek.

4.4. COMPONENTS OF ENVIRONMENTAL RESTORATION ALTERNATIVES

Figure 4-1 shows the study area, including bends #3 and #4 plus Mill Creek. The following is a description of the individual feasible environmental restoration components which were considered. These were later combined to form restoration alternatives for the total study area. The restoration components for the navigation cuts and bends stem from two basic measures:

- Full closure structure at a navigation cut with new channel in the bend

- Partial closure structure at a navigation cut with new channel in the bend

Additional measures were considered to restore flows to the mouth of Bear Creek, which provides the largest flow volume to the study area. Options included: (1) plugging bend #3 and realigning the mouth of the creek, and (2) relocating the mouth of the creek. Other measures were also considered to restore flows into the mouth of Bear Creek, such as a narrow approach channel from the bend to the mouth of Bear Creek.

More detailed information on restoration alternatives is included in Appendix A, *Engineering Analysis*, and Appendix H, *Formulation and Screening of Restoration Alternatives*.

The following Sections 4.5. through 4.10. summarize the individual restoration components which were considered for each of the three sites in the study area. These components were later combined in various ways to become restoration alternatives for the total study area. Additional information on engineering and hydraulic investigations of the restoration options considered is included in Appendix A, *Engineering Analysis*.

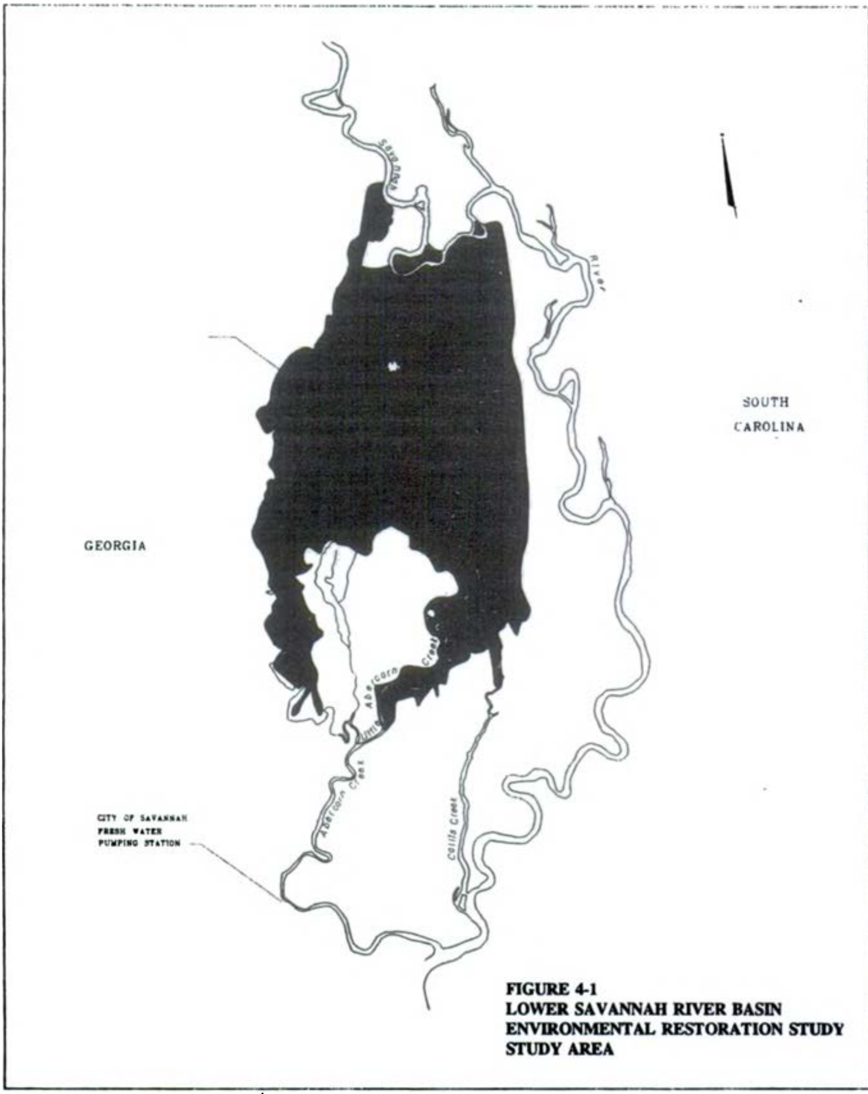


FIGURE 4-1
LOWER SAVANNAH RIVER BASIN
ENVIRONMENTAL RESTORATION STUDY
STUDY AREA

The description of restoration components is listed in the following order:

- NO ACTION
- CUT AND BEND #4
  - Full closure of cut #4
    Navigation channel in bend #4
- MILL CREEK
- CUT AND BEND #3
  - Restoration of cutoff bend
  - Full closure of cut #3
  - Channel options in bend #3
    - Navigation channel
    - Full closure restoration channel
  - Partial closure of cut #3
  - Channel options in bend #3
    - Partial closure restoration channel
    - Plug bend #3 with slackwater channel in bend
  - Modifications to Bear Creek
    - Increase flow to existing mouth
    - Realign or relocate mouth of creek

4.5. NO ACTION

4.5.1. Conditions Prior to Navigation Cuts

Prior to construction of the navigation cuts, bends #3 and #4 carried the full river flow. In order for the flow through the bends to have been relatively stable during low flow conditions, the pre-cut channel through the bends must have had a flow area of at least 1,800 square feet. The original bend width from bank to bank varied from 200 to 250 feet in bend #3, and 200 to 350 feet in bend #4. The velocity of the river flows essentially precluded any significant deposition of sediments within the main bend channel, particularly in curves along the outside bank with highest velocities. Natural deposition did occur on the inside banks where lower velocities resulted in siltation.

4.5.2. Current Conditions

The bends have experienced severe sedimentation and shoaling due to insufficient velocities to keep sediment load moving through the bends. As the sediment was deposited in the bends, sandbars were formed which became vegetated. The available flow in the bends was subsequently restricted, including bend overbank flow and flow into the creeks originating in the bends. If this process is allowed to continue, the bends will completely close off from the river and there will be no flow into the creeks at any time. The existing depth in the bends varies considerably, although the average depth is about -5 feet LMVD.

4.5.3. Future Conditions

No Action in the study area is potentially devastating to bends #3 and #4 and adjacent wetlands. Over the past 30 years, these bends have lost over 90 percent of their original flow capacity. With no action, the remaining bend channels will continue to fill in and lose all flow during low flow conditions, thus eliminating all fish habitat within the bends.

Flow into Mill Creek and creeks originating from the bends will continue to be reduced and will eventually become nonexistent except during high river flows. This loss of flow will result in reduction of habitat quantity and quality in Bear Creek, Raccoon Creek, and Bear Creek. Currently, the only existing major flow to Mill Creek is from bend #4 through Flat Ditch Creek, whose mouth is heavily blocked by debris and sediment. Further loss of this flow from Flat Ditch Creek would cause a severe reduction of available habitat in Mill Creek, up to zero flow.

Water quality in the creeks is also expected to decline as the high quality flow from the river is eliminated. Without a restoration project, there will likely be no opportunities to restore this valuable wetland area and unique wildlife resource to original conditions.

4.6. CUT AND BEND #4 RESTORATION

Several different channels were evaluated for bend #3 and bend #4. It was concluded early in the analysis that the only feasible option for bend #4 was full closure of the navigation cut with a navigation channel through bend #4. Partial closure of cut #4 would result in undesirable shoaling in the bend due to the length and resultant lower velocities in the bend. A channel in bend #4 smaller than a navigation channel would not provide safe navigation.

4.7. MILL CREEK RESTORATION

The only restoration option for Mill Creek is to realign the mouth with river flow and restore the mouth.

4.8. CUT AND BEND #3 RESTORATION

4.8.1. Restoration of Bend #3

Figure 4-2 shows the various feasible channel configurations which were developed for bends #3 and #4. Any channel dredging in the bends would remove sediments and open much of the creek mouths which originate at the bends. Heavy shoaling has occurred at the mouths of the creeks due to lower velocities. A new channel would provide for restored flows from the river to the creek mouths, restore bend overbank flooding into adjacent forested wetlands, plus restore some level of aquatic habitat within the bends themselves.

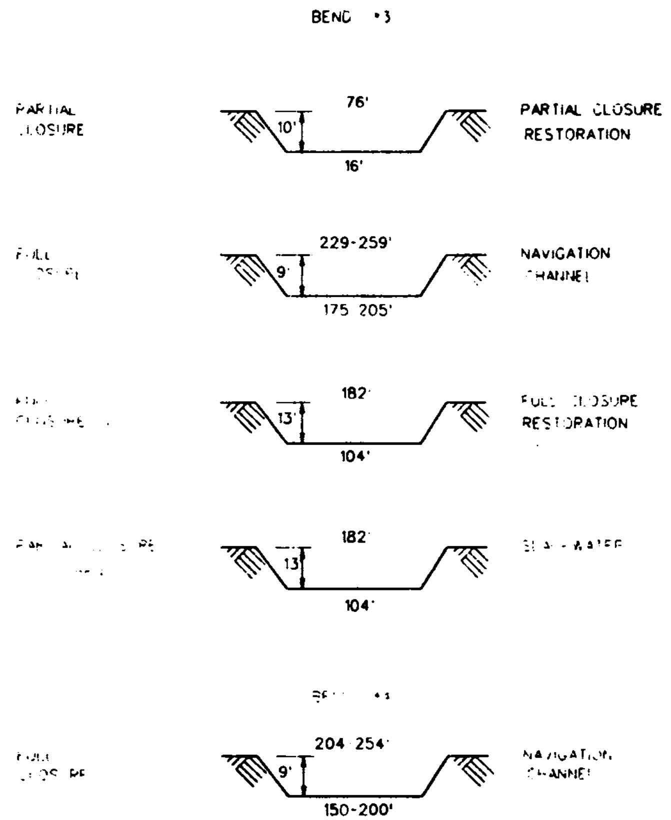


FIGURE 4-2
BEND CHANNEL CONFIGURATIONS

4.8.2. Full Closure of Navigation Cut #3

The Savannah River Below Augusta is an authorized navigation project. Some initial modelling was performed with full closure of the navigation cuts and diverting total river flows into the existing bend channel to analyze the impacts of total diversion on existing bend configurations. The resulting velocities were unstable. The water surface also rose well above the banks. To ensure a stable channel, the cross-sectional flow area through the bend would need to be approximately equal to the cross-sectional flow area in the main channel. This could not be achieved in bend #3 without significantly widening or deepening the existing bend.

For full closure, a diversion structure would be constructed across the main Savannah River at the entrance to the navigation cut. The structure would extend from the point of the island across the river to the opposite bank, creating a smooth transition from the river into the bend. The crest of the diversion structure would match adjacent bank elevations. The full closure option should ultimately provide velocities in the bend similar to that now encountered in the main river. These velocities appear to be sufficient to prevent the requirement of maintenance dredging in the bend.

4.8.2.1. Full Closure Cut #3, Navigation Channel in Bend #3. To ensure that navigation interests and navigation capability are not impacted, the Waterways Experiment Station designed a minimum navigation channel configuration which would provide a 9-foot depth at 6,300 cfs. The navigation channel design provided approximately a 1,800 square foot flow area. For bend #4, the resulting design yields a channel similar to the shape of the bends that existed when the navigation cut was constructed. A navigation channel in bend #3 could not be contained within the banks because the bend has a very sharp curve. A full closure structure would be constructed across the upstream end of the navigation cut, creating a smooth flow transition from the main river channel into the bend. The crest of the closure structure would match adjacent bank elevations. The navigation channel should result in velocities through the bend similar to that now encountered in the main river. These velocities have been sufficient in the past to prevent the need for maintenance dredging.

4.8.2.2. Full Closure Cut #3, Restoration Channel in Bend #3. With full closure of navigation cut #3, a restoration channel would be constructed in bend #3. The channel would have a flow area equivalent to a navigation channel at low flow. A navigation channel design has about 1,800 square feet of flow area. The invert elevation of the bend channel would transition from the invert elevation of the upstream main river channel to the invert elevation of the downstream main channel. The flow are through the bend should not vary considerably.

4.8.3. Partial Closure of Navigation Cut #3

In order to increase flows into bend #3, a partial diversion structure could be constructed in the main river channel to divert a portion of the river flow into the bend. The width of a partial diversion structure was selected to be about one third the width of the main river channel. A wider structure would impede navigation through the navigation cut, and a smaller structure would not provide adequate flows into the bend. The structure would provide a smooth transition from the main stream into the bend. The crest of the diversion structure would match adjacent bank elevations. Typical flow patterns are shown in Appendix A, *Engineering Analysis*.

4.8.3.1. Partial Closure of Cut #3, Restoration Channel in Bend #3. With a partial closure structure at navigation cut #3, a partial closure restoration channel would be dredged in bend #3. It would be much smaller than a navigation channel in order to maximize environmental restoration. Since most river flows would continue throug.. the navigation cut, flows and resultant velocities through the restoration channel would be stable.

4.8.3.2. Partial Closure of Cut #3, Slackwater Channel in Bend #3. As discussed later under modifications to Bear Creek, a feasible option would be to construct a narrow approach channel to the mouth of Bear Creek and plug the bend below the creek mouth to divert all flows entering the bend into Bear Creek. Since bend #3 is heavily shoaled, a slackwater channel could be dredged in the remainder of the bend from the plug to the downstream end of the bend. This would restore aquatic habitat within this portion of the bend. Shoaling would be very gradual since no flows would enter the bend.

4.8.4. Bend #3, Modifications to Bear Creek

4.8.4.1. Increase Flow to Existing Mouth of Bear Creek. A primary environmental restoration objective was to increase and restore flow in Bear Creek and its downstream watershed. Bear Creek currently provides essentially all flow to the study area under low flow conditions. The existing mouth of Bear Creek is oriented in the downstream direction of bend #3, which does not optimize the capture of flows in the bend. Maximum restoration of Bear Creek could increase flows by 72 percent over current conditions. One restoration option would be to restore flows to the existing creek mouth without relocation of the mouth. A small or partial diversion structure would be constructed on the point of the bend #3 island and a channel dredged from the river to the mouth of Bear Creek.

In order to maximize flows into the creek, the bend would be plugged immediately downstream of Bear Creek, forcing all flows entering the bend to enter Bear Creek. In order to keep velocities in the channel sufficiently high to prevent siltation within the approach channel, the channel would be relatively narrow, approximately the same width as Bear Creek. The channel banks would be sheet pile or stabilized to prevent bank sloughing and scouring. The creek mouth would be realigned to improve flows from the bend into the creek.

The size of the diversion structure in the main river greatly affects the water surface elevation in the bend and approach channel to the mouth of Bear Creek. The width of the approach channel did not significantly affect the water surface elevations in the approach channel. However, the velocities in the approach channel increase from near zero to about 1.0 fps when the width of the approach channel is narrowed to the width of Bear Creek, about 40 feet. The maximum velocities encountered in the approach channel should approximate those found in Bear Creek.

With no partial closure structure, there would be essentially no additional low flows into Bear Creek. When a small partial closure structure, about 1/6 the width of the river, is added at the bend entrance, an additional 3 cfs is added to the flows into Bear Creek. With a large partial diversion structure, about 1/3 the river width, there is a significant increase in water surface and a 32 cfs increase in flows over existing conditions. Figure 4-3 shows the configuration for increased flows to the existing mouth of Bear Creek.

4.8.4.2. Relocate Mouth of Bear Creek. If navigation cut #4 were closed, which is one of the restoration options, the entire river flow would be diverted into bend #4. It would be technically feasible to relocate the mouth of Bear Creek, as shown on Figure 4-4, to the outside bank of bend #4 so its alignment would allow significant flow to continue from the bend into the mouth of the creek. A new creek bed would have to be dredged within the bottomland hardwoods from the new mouth location to tie into the existing Bear Creek channel below its present mouth on bend #3. Another option would be to create a new mouth on the river between the two cuts and bends, but this would not provide as much flow into the creek as a new mouth at bend #4.

4.9. POTENTIAL RESTORATION COMPONENTS ELIMINATED

The projected performance of the various potential restoration components were compared to identify favorable options and rule out any options which would not function effectively. This could result from low velocities with extensive shoaling or high velocities with unstable conditions which could cut through a cutoff island. The design and effectiveness of diverting flow from the main river is partially based on the geometry of the entrance to a bend. Several restoration options would provide no significant improvements over either existing conditions or other less costly options and were therefore eliminated from further consideration.

No significant increase in flow into the bends would occur from creation of a small channel through the bends without the addition of a flow diversion structure at the main river channel. This is due to the length and gradient of the bends. Flow diversion structures were added to cause a constriction in the river channel, forcing the water surface to increase. After modelling several restoration options with diversion structures, the study team realized that the main influence would occur local to the diversion structure.

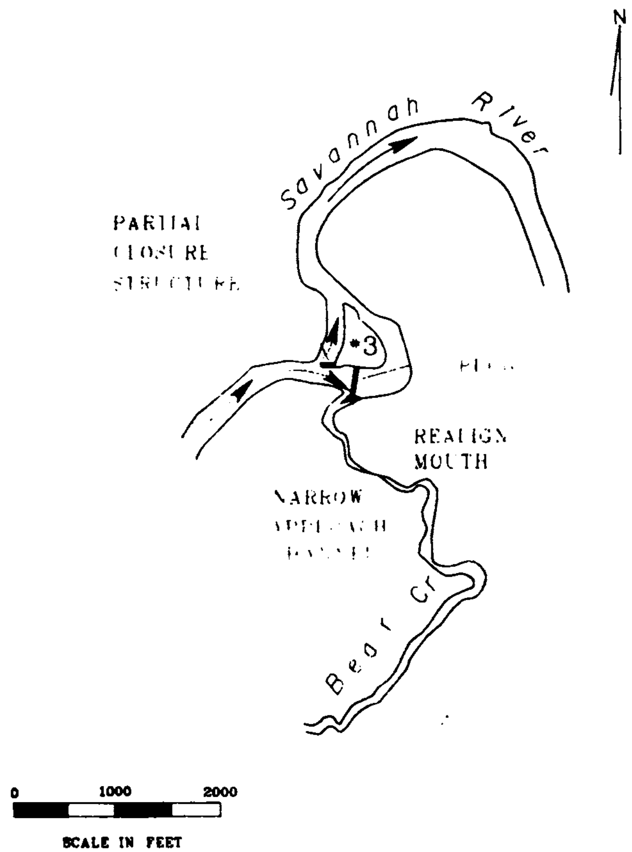


FIGURE 4-3
INCREASED FLOW TO MOUTH OF BEAR CREEK

FIGURE 4-4
RELOCATE MOUTH OF BEAR CREEK

The study team also determined that diversion structures placed within the bends and immediately downstream of mouths of the creeks did not significantly increase the local water surface, especially at low flows. Therefore, flow diverters at these locations would not be effective. This is due to the low velocities in the vicinity of the creek diversions structures.

A partial diversion structure has a strong influence on the water surface elevations. This was most evident in the restoration options which included plugging bend #3 below the mouth of Bear Creek when the low flow into Bear Creek varied from 45.0 cfs with no diversion structure, to 51 cfs with a 1/6 width structure, to 77.4 cfs with a full 1/3 width partial diversion structure. A bend plug by itself with no diversion structure actually caused a decrease of flow into Bear Creek when compared to a partial diversion structure due to a reduction in water level at the entrance to the bend.

Table 4-1 summarizes the environmental restoration components which were considered and eliminated from further consideration. Additional discussion of these components is included in Appendix A, *Engineering Analysis*, and Appendix H, *Formulation and Screening of Restoration Alternatives*.

TABLE 4-1
POTENTIAL RESTORATION COMPONENTS ELIMINATED

DESCRIPTION	REMARKS
Inflatable dam	Not practical for use and location.
Less than pilot channel Minimum conveyance channel	No significant flow improvements, low velocities, shoaling.
Creek diverters	Flow diverter in bend at a creek mouth provides little benefit without a conveyance channel.
Partial closure structure Without minimum conveyance channel	Little benefit and localized unstable hydraulic conditions.
Partial closure structure With minimum conveyance channel	Low velocities and shoaling, particularly in bend #4 due to length.
Full closure structure Without minimum conveyance channel	High velocities with unstable water surface.
Full closure structure With minimum conveyance channel	Flow area similar to river channel needed to maintain stable velocities.
Relocate mouth of Bear Creek to river	Would result in adverse destruction of bottomland hardwoods.
Creek clearing and snagging	Not required for restoration project to function.

The creeks which originate at bends #3 and #4 are a primary source of flows to wetland areas within

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the Savannah National Wildlife Refuge south of the two bends. Bear Creek flows southward from bend #3, Flat Ditch Creek flows westerly from bend #4 to Mill Creek, and two unnamed creeks flow south from bend #4 to Raccoon Creek. All of the flows merge downstream in Abercorn Creek. Gradual scouring of the creek banks has undermined some trees, which have subsequently fallen in or across the creeks. These fallen trees, plus debris which has accumulated behind them, have created minor blockages to creek flow.

Clearing and snagging the three major creeks was considered as a restoration option which could be included with any major restoration project. However, after field surveys and discussions with the U.S. Fish and Wildlife Service, the study team concluded that the existing debris in the creeks is not impeding flow from the bends into the creeks. There is sufficient hydraulic gradient within the creeks to convey restored flows from the bends. Restored flows in the creeks resulting from any restoration project would not be impeded by minor existing debris in the creeks. The U.S. Fish and Wildlife Service and city of Savannah have indicated they would monitor the restoration project after completion and if any clearing and snagging would improve flows within the creek watersheds, it would be done selectively. Therefore, the objective of any environmental restoration project would be to restore the mouths and approximately the first 100 feet of the three creeks. This would assure that the restoration project accomplishes the goal of restoring flows into the creeks.

4.10. SUMMARY OF VIABLE RESTORATION COMPONENTS

Table 4-2 summarizes the restoration components for each site which were selected for more detailed analysis.

TABLE 4-2
ENVIRONMENTAL RESTORATION COMPONENTS

RESTORATION COMPONENT	DESCRIPTION
BEND #3	
No Action	No Action
Partial Closure w/P/C Restoration Channel	Construct partial cut closure structure, increase flow through bend, dredge partial closure restoration channel in bend 76' top width x 10' deep, 1:3 side slopes
Full Closure w/Navigation Channel	Construct full cut closure structure, restore bend to accommodate navigation, dredge navigation channel in bend 229-259' top width x 9' deep @ 6,300 cfs, 1:3 side slopes
Full Closure w/F/C Restoration Channel	Construct full cut closure structure, dredge full closure restoration channel in bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Small Diversion	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth
Bear Creek/Large Diversion	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth
Relocate Mouth of Bear Creek	Relocate mouth of Bear Creek to bend #4, new channel from mouth to existing channel
Bear Creek/Small Diversion/ Slackwater	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Large Diversion/ Slackwater	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes, clear and snag Bear Creek
BEND #4	
No Action	No Action
Full Closure w/Navigation Channel	Construct full cut closure, dredge navigation channel in bend 204-254' top width x 9' deep @ 6,300 cfs, 1:3 side slopes
MILL CREEK	
No Action	No Action
Restore	Reorient mouth alignment, deepen entrance channel

P/C = partial closure F/C = full closure

4.11. DESIGN CRITERIA AND ENGINEERING

Each of the environmental restoration components would have some, but not all, of the following construction actions, costs, and environmental impacts:

- Dredging channel in bends
- Construction of confined upland dredged material disposal site
- Construction of partial or full closure structure at navigation cuts
- Construction of plug in bend
- Construction of narrow approach channel to Bear Creek
- Possible future O&M costs depending on the amount of shoaling
- Monitoring costs
- Net positive environmental impacts within the bends or adjacent areas subject to overbank flooding and creation of AAHUs in the creeks
- Possible adverse environmental impacts, including impacts to bottomland hardwoods due to dredging a channel in a bend or relocating mouth and upper channel of Bear Creek through hardwoods

4.11.1. Dredged Material

4.11.1.1. Dredged Material from Bends. The material which would be dredged from the bends consists of sediments which have been naturally deposited in the bends since the navigation cuts were constructed. In addition, in some locations the navigation channel dimensions fall outside of the original channel banks. In these areas, the material has not been previously excavated or tested. For the purpose of disposal area design, these materials were assumed to be 50 percent fine-grained. Additional information on dredged materials is included in Appendix A, *Engineering Analysis*.

4.11.1.2. Dredged Material from Bear Creek Relocation. Soil samples were not taken for the site of a potential relocation of the Bear Creek channel. This information was not needed for the evaluation and screening of potential restoration alternatives. If this option were carried into the final array of alternatives, sampling would be conducted to determine its suitability for disposal.

4.11.2. Dredging and Disposal Methods

Three methods were considered for dredging and disposal of the dredged material: (1) in-water placement of material, (2) jet-spray dredging, and (3) hydraulic pipeline dredging with placement of the material in a confined upland disposal area. Dredged material would result from dredging bends #3 or #4 or dredging a new channel from bend #4 to Bear Creek.

4.11.2.1. In-Water Placement. Total in-water placement of dredged material from project construction was considered undesirable due to the adverse environmental effects. However, for full closure of navigation cut #4, dredged material from bend #3 or dredging a new channel for Bear Creek could be placed in cut #4, completely filling the cut if necessary. Any localized placement of dredged material would result in a reduction in the amount of material to be pumped to an off-site disposal area and significant cost savings.

4.11.2.2. Jet-Spray Dredging. Jet-spray dredging is a method of hydraulic dredging with discharge of the dredged material in a slurry that is sprayed on either side of the dredge. The city of Savannah has successfully used this method for sediment removal in Abercorn Creek. The material is generally discharged in an area within 150 feet of the existing banks. The average depth of material deposited in this manner should not exceed 3 or 4 inches to prevent filling of wetlands and damage to vegetation. Due to this constraint, it was determined that a maximum of 100,000 cubic yards of material could be disposed of in this manner. Since this would not be adequate for major dredging in the bends, it was concluded that jet-spray dredging would not be used for initial project construction. It was assumed that jet-spray dredging would be used for any future maintenance, if required, of any channel construction in the bends.

4.11.2.3. Hydraulic Pipeline Dredging. The conventional method of dredging includes the use of a hydraulic pipeline dredge, with dredged material pumped via a pipeline to a nearby disposal area. This method was selected for dredging and disposal of dredged material for a restoration project. This also takes advantages of economies of scale for larger dredging operations.

4.11.3. Disposal of Dredged Material

4.11.3.1. Confined Upland Disposal Area. Confined upland disposal of the dredged material was determined to be the most feasible method for disposal during initial project construction. All design calculations were made using EM 1110-2-5027, *Confined Disposal of Dredged Material*. The disposal area design was based on use of an 18-inch hydraulic pipeline dredge with approximately 50 percent fine-grained material.

The size of the disposal area and dike height would depend upon the volume of material dredged and pumped to the disposal site. Dredging volume could vary from zero for alternatives with no dredging to a maximum with channel dredging in both bends. Material to construct the dikes would be obtained from within the disposal area.

Based on the use of an 18-inch dredge, the required weir length would be 20 feet. Either a 20-foot box shaped weir or a series of three 8-foot steel D-shaped weirs discharging into a single discharge pipe could be used for this purpose. The discharge pipe would allow flow through the dike and would discharge into Mill Creek. Some stone scour protection would be required at the location that the pipeline enters the ditch.

A site located near the dredging location was determined to be suitable for construction of the confined disposal area, as shown on Figure 4-5. A different site was originally selected based on an aerial photograph of the project area. After a site visit, the study team determined that it contained cultural resource areas and possible wetland sites. Based on the approximate location of known wetland areas and cultural resource sites identified by Fort Howard Corporation during a prior environmental assessment for plant construction, a second site was identified which is more suitable for project requirements. A wetlands delineation will be required prior to project construction. The property consists primarily of planted pines.

The average pumping distance to the site would be approximately 12,000 feet from bend #3 and 6,300 feet from bend #4. Pipeline access to the site would be along an abandoned logging road.

4.11.3.2. Disposal Area in Navigation Cut #4. If navigation cut #4 were fully closed, some or all of material dredged from bend #3 could be placed within cut #4 as a measure to reduce disposal costs, as shown in Figure 4-6. The navigation cuts have relatively low environmental value for aquatic habitat.

The average pumping distance to the cut would be approximately 5,000 feet, with a maximum pumping distance of 6,300 feet. Any dredged material from bend #3 which exceeded the capacity of cut #4 would be pumped to the confined upland disposal site.

4.11.4. Full Closure Structure

The criteria for the design of the structure required to facilitate full closure included the following:

- The structure must not be a hazard to navigation.
- The majority of construction should be performed from water-borne equipment due to the need to limit land-based construction, and therefore environmental degradation, to a minimum.
- The structure must be permanent and structurally stable during a variety of conditions, including overtopping events.
- The closure dike must resist undermining by scour since the existing channel shows evidence of severe scour.
- The alignment of the structure must produce a smooth transition from the main channel to the bends in order to maximize the increase in hydraulic head at the mouths of the feeder creeks. The structure would have a minimal differential head on it, therefore seepage considerations were not applicable.
- The structure should be aesthetically acceptable and maximize environmental enhancements, where practical.
- The design must be cost effective.

As discussed in Appendix A, *Engineering Analysis*, two full closure design schemes were developed, dredged material-filled geotextile containers or homogeneous dumped rock. The geotextile containers is a relatively new technology. Both schemes use a closure dike across the navigation cut and slope protection. The dumped rock riprap method was selected for construction of a closure structure, as shown on Figure 4-7.

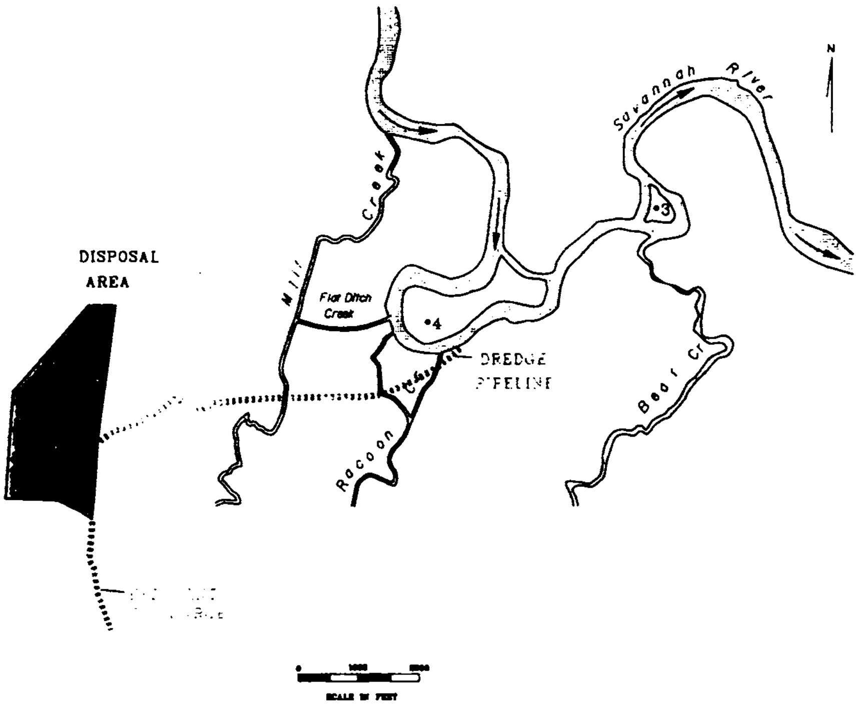


FIGURE 4-5
POTENTIAL UPLAND CONFINED DISPOSAL SITE

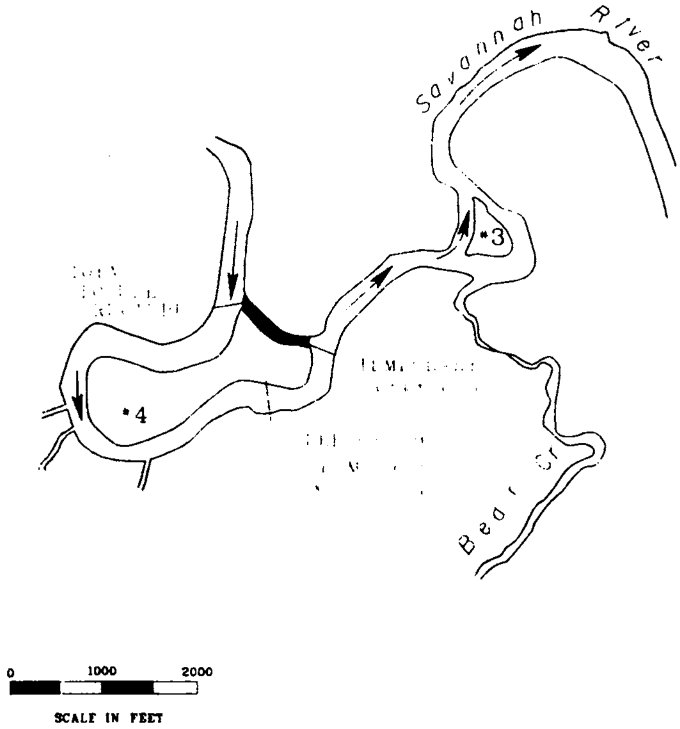


FIGURE 4-6
DISPOSAL AREA IN NAVIGATION CUT #4

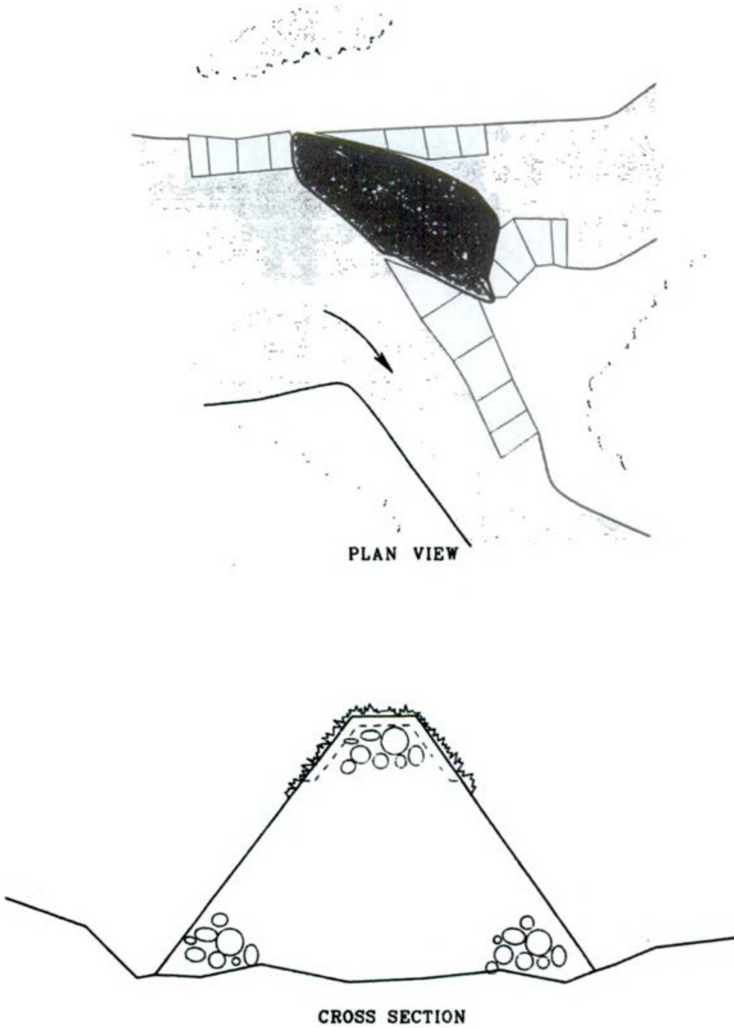


FIGURE 4-7
FULL CLOSURE STRUCTURE

4.11.5. Partial Closure Structure

The general concept of partial closure of a navigation structure is to maintain navigation in the main channel and divert only a portion of the flow into a bend. Partial diversion would not degrade navigation below existing capabilities. Diversion is accomplished by constructing a partial closure structure at the upstream point bar of the cutoff island which splits the flow, as shown on Figure 4-8.

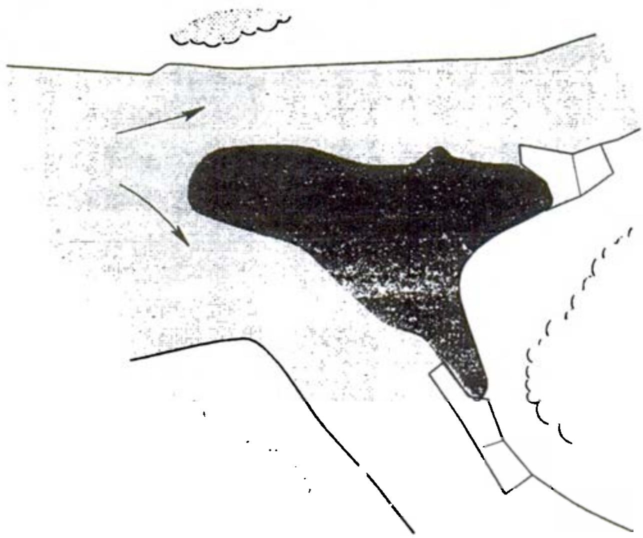
The criteria for the design of the partial closure structure included the following:

- The structure must not be a hazard to navigation within the main channel.
- The majority of construction should be performed from water-based equipment, due to the need to limit land-based construction, and therefore environmental degradation, to a minimum.
- The structure must be permanent, structurally stable during a variety of conditions, including overtopping events.
- The partial closure dike must resist undermining by scour on both sides since the existing channel shows evidence of severe scour.
- The alignment of the structure must produce a smooth transition from the main channel to the bends in order to maximize the increase in hydraulic head at the mouth of the feeder creek.
- The structure should be aesthetically acceptable and maximize environmental enhancements, where practical.
- The design must be cost effective.

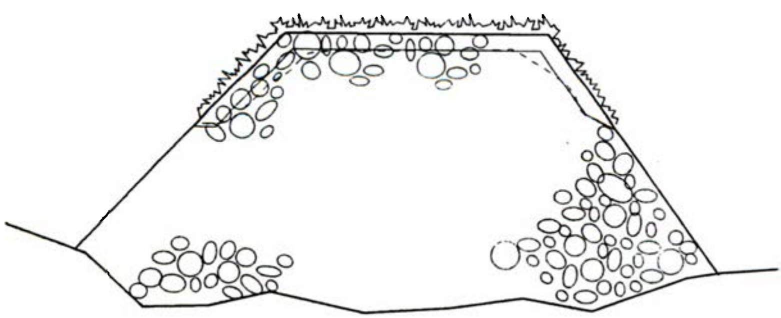
As discussed in Appendix A, *Engineering Analysis*, the design scheme and engineering considerations for partial closure are very similar to those features for full closure. Use of dredged material-filled geotextile containers and homogeneous dumped rock were also considered for partial closure.

4.11.6. Design and Evaluation Flows

The 9-foot authorized navigation channel depths is based upon a flow of 6,300 cfs at the Clyo, Georgia, river gage. This flow was also assumed to represent low flow conditions in the study area bends and creeks. However, for hydraulic modelling of flow into the creeks as described in Appendix A, *Engineering Analysis*, a flow of 6,600 cfs was used based on 5,920 cfs at the Clyo gage. It was also assumed the bends are at bank full when the main river has flows of 13,300 cfs. Flows are less than 6,600 cfs about 13 percent of the time and less than 13,300 cfs 71 percent of the time.



PLAN VIEW



CROSS SECTION

FIGURE 4-8
PARTIAL CLOSURE STRUCTURE

4.11.7. TABS-2 Hydraulic Model

The Savannah District performed a hydrodynamic study to evaluate flow conditions in the river and the two bends. A two dimensional depth-averaged finite element numerical model (TABS-2 created by the Waterways Experiment Station (WES)) was used, applying data obtained from a field survey conducted by the U.S. Geologic Survey (USGS) and the Savannah District. The grid for this model was developed by WES in conjunction with the Savannah District Hydraulics and Hydrology office. The District survey included bathymetric data at 70 strategic cross sections of the study area.

The USGS survey included velocity, water depth, and channel width at seven strategic cross-sections of the area for low and high discharge events. Ultimately, the model was used in the design of structure placement to divert more flow to each bend and, thereby, decrease ongoing deposition.

Due to the close proximity of navigation cuts #3 nd #4, District hydraulic engineers determined that only one finite element grid was needed. The elements controlling the TABS-2 model were upstream head and flow and downstream head. Head and flow into the creeks were also controlling factors. Velocities were calibrated with the existing condition grids for high and low flow.

The survey data and the flow ratings were provided to the Waterways Experiment Station for the initial layout of a two dimensional grid of topography/bathymetry for TABS-2 hydraulic model.

The Waterways Experiment Station performed the following:

(1) Defined channel geometry
(2) Defined material types
(3) Defined initial roughness coefficients.
(4) Calibrated TABS-2 grid to match high and low water surfaces

The complete WES report is included in Appendix A, *Engineering Analysis*.

Savannah District continued with the modelling effort by modifying the WES TABS-2 existing condition grid to include pilot channels through the bends. Diversion structures were modeled at various locations to determine how much the water surface elevation could be affected. WES was then tasked with the design of navigation channels through the bends. They were also required to generate a new grid with the navigation channel geometry. Additional TABS-2 runs were performed to derive new water surface elevations for all alternatives considered.

4.11.8. Navigation Channel in Bends

Bend #3 consists of a single curve, while bend #4 has a complex four-curve alignment. Dredging a navigation channel in either bend should, if possible, avoid or minimize adverse impacts to bottomland hardwoods adjacent to the outside bank of the bends. Bend #3 has a sharp curve and a navigation channel meeting WES standards would extend beyond the banks of the bends. The curves in bend #4 are more gradual and a navigation channel would mostly stay within the banks.

4.11.8.1. Design Criteria. The design criteria for a navigation channel in the bends included the following:

- A channel alignment and width which would permit navigation for the design barge-tow configuration (40-foot wide by 190-foot long barge with a draft of 7 feet and a 60-foot long pusher tug).
- Minimize environmental and real estate impacts.
- Provide protection from natural cutoff of bend #4 at the "necking" portion of the channel.
- Maximize on-site usage of dredged materials in order to minimize disposal area requirements.

4.11.8.2. Waterways Experiment Station Navigation Study. In response to a request from the Savannah District under the Dredging Operations Technical Support (DOTS) Program, the Waterways Experiment Station initially developed a design for a 54-foot wide by 330-foot long barge/pusher combination with an 80-foot long pusher and a draft of 7 feet. This design was provided to the Savannah District by letter dated August 4, 1994. Subsequent to discussions with South Atlantic Division during the Technical Review Conference on July 29, 1994 and discussion with individuals within the District involved with environmental and navigation studies, the study team determined that the initially proposed project dimensions would have too great of an impact on the environment.

Based on discussions with project users, U.S. Fish and Wildlife Service, and Savannah District personnel, a new DOTS request was made to develop a design for a 40 foot wide by 250 foot long barge/pusher combination. The WES report dated August 12, 1994 responded to that request and includes two designs.

The first of the two designs generally followed the old natural channel, as shown on Figure 4-9. The designer expressed some concern that two of the curves represented a complex reach without a crossing channel between the curves. WES stated that this design may be satisfactory, but it is their opinion additional physical model testing would be required prior to finalizing the design. The second plan was a more conservative design with a greater crossing distance between the two curves. WES believed this second design could provide satisfactory navigation for the design tow without additional testing. However, the second design was eliminated due the amount of excavation in wetlands in bend #3 and the total construction cost.

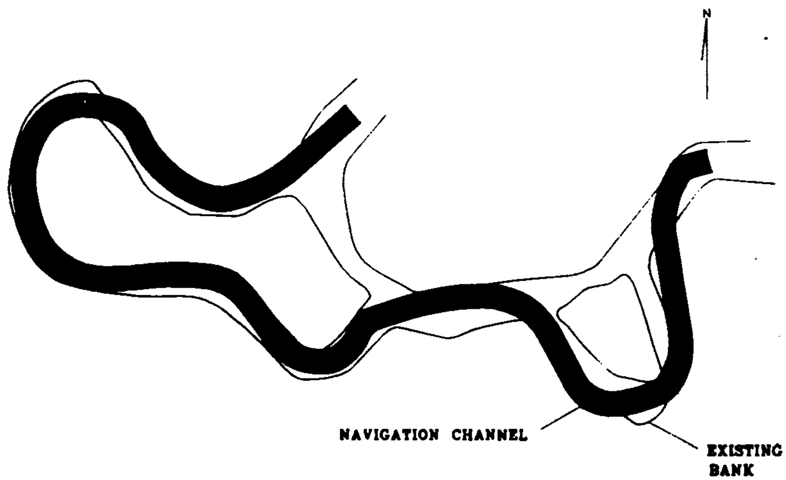


FIGURE 4-9
NAVIGATION CHANNEL THROUGH BENDS

If additional navigation studies were necessary for the Recommended Restoration Plan, they would be performed during preconstruction engineering and design. Additional studies would only be required if the Recommended Plan includes a navigation channel through either of the bends.

4.11.9. Modifications to Mill Creek

The purpose of potential modifications to the mouth of Mill Creek at the Savannah River would be to restore flows to the creek and downstream wetlands. The present shoaled condition of the creek entrance prohibits flow in the creek except at overbank river stages. In addition, the orientation and curvature of the mouth of the creek further restricts flow. Mill Creek restoration would include relocation and realignment of the mouth to face river flows and sediment removal at the mouth to capture more river flows. Figure 4-10 shows the channel modifications and Table 4-3 presents the construction items. Detailed information is included in Appendix A, *Engineering Analysis*.

TABLE 4-3
MODIFICATIONS TO MILL CREEK ENTRANCE

ITEM	SPECIFICATIONS	ESTIMATED QUANTITY	UNIT
Clearing and Grubbing	All woody vegetation within construction limits would be cleared and grubbed.	0.5	acre
Excavation	Excavation of the new entrance of Mill Creek onto the Savannah River .	420	cubic yards
Closure Plug in Old Mill Creek Entrance	The plug would be constructed of excavated materials. Material would be semi-compacted with hauling and spreading equipment.	420	square yards
Grassing	The surface of the excavated channel and the closure plug would be grassed with vegetation common to the area for slope protection.	0.5	acre

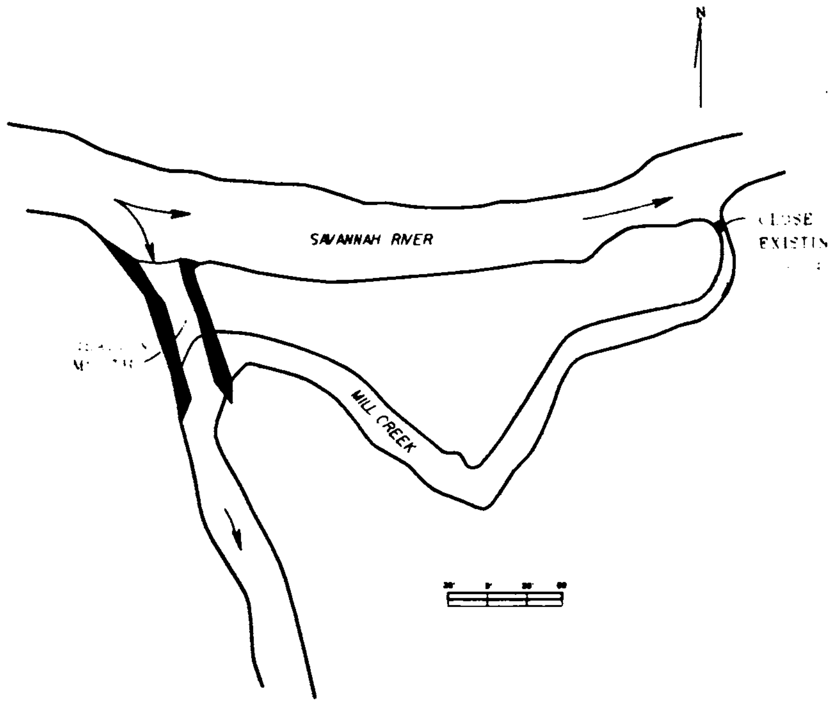


FIGURE 4-10
MILL CREEK RESTORATION

4.11.10. Project Maintenance

Due to the heavy sediment load within the Savannah River, restoration alternatives which resulted in low velocities in the bends or at the mouths of the creeks could produce siltation which would require periodic maintenance. This is the current condition in bends where heavy siltation has occurred due to low velocities after construction of the navigation cuts. After discussions with personnel from the Waterways Experiment Station, the Savannah District concluded that the costs of a detailed sedimentation study were prohibitive. Therefore, a simplified shoaling analysis was conducted to estimate shoaling which might occur in the bends after project completion.

Bedload calculations were made based on the velocity output generated by the TABS-2 model, a numerical hydrodynamic model created by the Waterways Experiment Station, and sediment samples taken in the bends. No specific analysis addressed how these rates would change over time or where the shoaling would occur. It was assumed that the shoaling rate would remain relatively constant between maintenance dredging events. With partial closure of the two navigation cuts, velocities would remain low in the channels constructed in the bends and substantial shoaling would occur over time. Estimated shoaling would be approximately 5,000 cubic yards per year at bend #3 and 20,000 cubic yards per year at bend #4. Since low velocities were predicted near the mouths of the creeks, maintenance should be anticipated in these areas. With full closure, the velocities would be much higher in the bends. Due to these high velocities, it was assumed that no shoaling would occur in the bends in this case. Some scouring could occur due to the high velocities; however, it was assumed that the bends would eventually reach a steady state configuration as they did before construction of the navigation cuts.

The creeks in the study area experience isolated and random debris accumulation due to the natural process of logs and debris clogging stream flow. This may be accompanied by deposition of fine sediments. Any restoration project would not aggravate or accelerate this process, and any required debris removal is not considered project maintenance.

Any structures included in a restoration project, such as diversion structures, sheet piling, or revetments, would be designed to not require maintenance for the life of the project. Design criteria include such structures must be permanent, and structurally sound, over a variety of conditions.

SECTION 5

FORMULATION OF PRELIMINARY ALTERNATIVES

5.1. DEFINITION OF TERMS

The following is a summary of the key terms used to describe the various restoration alternatives and other pertinent features.

- **Study Area** - Cut and Bend #3, Cut and Bend #4, mouth of Mill Creek, and 4,708 acres in the watersheds of Bear Creek, Raccoon Creek, and Mill Creek.

- **Preliminary Restoration Alternatives** - 36 restoration alternatives initially formulated and selected for evaluation.

- **Intermediate Restoration Alternatives** - Five of the preliminary restoration alternatives selected as being most cost effective and optimizing restoration objectives.

- **Final Restoration Plans** - Two environmental restoration alternatives selected for final detailed evaluation.

- **Recommended Environmental Restoration Plan** - Final restoration alternative selected as being the most desirable plan for environmental restoration in the study area.

- **Partial Closure** - Flow diversion structure at the entrance to a navigation cut. A large partial closure structure extends approximately 1/3 distance across width of cut.

- **Full Closure** - Flow diversion structure at the entrance to a navigation cut. Completely blocks flow into cut and routes total flow into the bend.

- **Partial Closure Restoration Channel** - A channel dredged in bend #3 with partial closure of the cut. The channel is 76 feet wide at the top and 10 feet deep, with 1:3 side slopes. It is much narrower than a navigation channel.

- **Full Closure Restoration Channel** - A channel dredged in bend #3 with full closure of the cut. The channel is 182 feet wide at the top and 13 feet deep with 1:3 side slopes. It is about double the width of the partial closure restoration channel but narrower than a navigation channel.

- **Slackwater Channel** - A channel dredged in bend #3 with the bend plugged below the mouth of Bear Creek. The channel is 182 feet wide at the top and 13 feet deep, with 1:3 side slopes. The channel creates non-flowing aquatic habitat in the lower portion of the bend.

- **Bend #3 Navigation Channel** - A channel dredged in bend #3 with full closure of the cut. The channel is 229 to 259 feet wide at the top and 9 feet deep, with 1:3 side slopes.

- **Bend #4 Navigation Channel** - A channel dredged in bend #4 with full closure of the cut. The channel is 204 to 254 feet wide at the top and 9 feet deep, with 1:3 side slopes.

- **Narrow Approach Channel** - A narrow channel 30 to 60 feet wide dredged from the river through part of bend #3 to the mouth of Bear Creek to maintain high velocities to avoid shoaling in the channel. Confined by sheet piling with backfill on island side and backfill with rock armoring on opposite side.

- **Plug Bend** - Narrow blockage across entire width of bend #3. Accomplished by extending sheet piling used to construct narrow approach channel across the width of the bend below the mouth of Bear Creek. Sheet piling is backfilled and armored.

- **Bear Creek Small Diversion Structure** - Minimum structure to divert a small portion of river flows into the bend and the mouth of Bear Creek. Accomplished by extending sheet piling used to construct narrow approach channel around the point of the island.

- **Bear Creek Large Diversion Structure** - Large riprap flow diversion structure at entrance to cut #3 to divert large amount of river flow into bend #3 and mouth of Bear Creek.

- **Average Annual Habitat Unit (AAHU)** - A unit of measure for fish habitat derived by use of standard Habitat Evaluation Procedure models.

- **Bottomland Hardwood (BLHW) Functional Value** - A unit of measure for wetland value. It is obtained by multiplying acres of bottomland hardwood by a functional index, which reflects the amount of base flow and floodwater provided to the wetland system.

- **Current Barge Tow Configuration** - Design barge and pusher 40 feet x 250 feet.

5.2. COMPONENTS OF RESTORATION ALTERNATIVES

The viable environmental restoration components, including No Action, for the three primary study sites include nine options at bend #3, two at bend #4, and two at Mill Creek, as shown in Table 5-1. Figure 5-1 shows the cross-sections of the various bend channels.

5.2.1. Cut and Bend #3

For cut and bend #3, the restoration components include partial and full closure of the navigation cut. Partial closure would include restoring the bend channel to pre-cut conditions. The full closure component has two options: (1) construct a navigation channel in the bend, or (2) restore the bend channel to pre-cut conditions. For Bear Creek, two major options are to restore flow to the existing mouth or relocate the mouth with a new creek channel off bend #4. To restore flows without moving the mouth, a large diversion structure could be constructed to deflect partial river flows into Bear Creek. The bend would be plugged to divert total bend flows into the creek. With either option, the bend might be restored to pre-cut conditions with a slackwater channel from the plug downstream to the river.

5.2.2. Cut and Bend #4

For cut and bend #4, the only feasible restoration component is full closure of the navigation cut and provide a navigation channel through the bend. Partial closure of cut #4 would result in low velocities and shoaling within the bend.

5.2.3. Mill Creek

The only restoration component for Mill Creek is to reorient the mouth alignment and restore the entrance channel.

5.3. PRELIMINARY RESTORATION ALTERNATIVES

An environmental restoration alternative for the entire study area, including bends #3 and #4 plus Mill Creek could be a combination of any of the restoration components shown in Table 5-1. This results in a total of 36 possible combinations, as shown in Table 5-2.

TABLE 5-1
ENVIRONMENTAL RESTORATION COMPONENTS

RESTORATION COMPONENT	DESCRIPTION
BEND #3	
No Action	No Action
Partial Closure w/P/C Restoration Channel	Construct partial cut closure structure, increase flow through bend, dredge partial closure restoration channel in bend 76' top width x 10' deep, 1:3 side slopes
Full Closure w/Navigation Channel	Construct full cut closure structure, restore bend to accommodate navigation, dredge navigation channel in bend 229-259' top width x 9' deep @ 6,300 cfs, 1:3 side slopes
Full Closure w/F/C Restoration Channel	Construct full cut closure structure, dredge full closure restoration channel in bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Small Diversion	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth
Bear Creek/Large Diversion	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth
Relocate Mouth of Bear Creek	Relocate mouth of Bear Creek to bend #4, new channel from mouth to existing channel
Bear Creek/Small Diversion/ Slackwater	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Large Diversion/ Slackwater	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, realign mouth, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes
BEND #4	
No Action	No Action
Full Closure w/Navigation Channel	Construct full cut closure, dredge navigation channel in bend 204-254' top width x 9' deep, 1:3 side slopes
MILL CREEK	
No Action	No Action
Restore	Reorient mouth alignment, deepen entrance channel

F/C = full closure P/C = partial closure

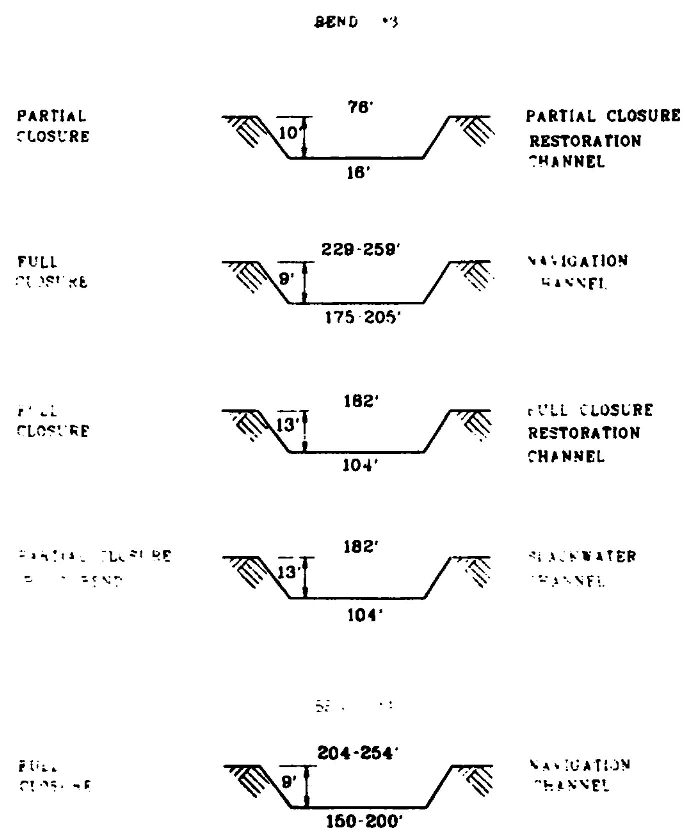


FIGURE 5-1
PRELIMINARY RESTORATION ALTERNATIVES
CHANNEL CROSS-SECTIONS

TABLE 5-2
PRELIMINARY RESTORATION ALTERNATIVES

ALT	CUT AND BEND #3	CUT AND BEND #4	MILL CREEK
1	No Action	No Action	No Action
2	No Action	No Action	Restore
3	No Action	Full Closure w/Navigation Channel	No Action
4	No Action	Full Closure w/Navigation Channel	Restore
5	Partial Closure w/P/C Restoration Channel	No Action	No Action
6	Partial Closure w/P/C Restoration Channel	No Action	Restore
7	Partial Closure w/P/C Restoration Channel	Full Closure w/Navigation Channel	No Action
8	Partial Closure w/P/C Restoration Channel	Full Closure w/Navigation Channel	Restore
9	Full Closure w/Navigation	No Action	No Action
10	Full Closure w/Navigation	No Action	Restore
11	Full Closure w/Navigation	Full Closure w/Navigation Channel	No Action
12	Full Closure w/Navigation	Full Closure w/Navigation Channel	Restore
13	Full Closure w/F/C Restoration Channel	No Action	No Action
14	Full Closure w/F/C Restoration Channel	No Action	Restore
15	Full Closure w/F/C Restoration Channel	Full Closure w/Navigation Channel	No Action
16	Full Closure w/F/C Restoration Channel	Full Closure w/Navigation Channel	Restore
17	Bear Creek/Small Diversion	No Action	No Action
18	Bear Creek/Small Diversion	No Action	Restore
19	Bear Creek/Small Diversion	Full Closure w/Navigation Channel	No Action
20	Bear Creek/Small Diversion	Full Closure w/Navigation Channel	Restore
21	Bear Creek/Large Diversion	No Action	No Action
22	Bear Creek/Large Diversion	No Action	Restore
23	Bear Creek/Large Diversion	Full Closure w/Navigation Channel	No Action
24	Bear Creek/Large Diversion	Full Closure w/Navigation Channel	Restore
25	Relocate Mouth Bear Creek	No Action	No Action
26	Relocate Mouth Bear Creek	No Action	Restore
27	Relocate Mouth Bear Creek	Full Closure w/Navigation Channel	No Action
28	Relocate Mouth Bear Creek	Full Closure w/Navigation Channel	Restore
29	Bear Creek/Small Diversion/Slackwater	No Action	No Action
30	Bear Creek/Small Diversion/Slackwater	No Action	Restore
31	Bear Creek/Small Diversion/Slackwater	Full Closure w/Navigation Channel	No Action
32	Bear Creek/Small Diversion/Slackwater	Full Closure w/Navigation Channel	Restore
33	Bear Creek/Large Diversion/Slackwater	No Action	No Action
34	Bear Creek/Large Diversion/Slackwater	No Action	Restore
35	Bear Creek/Large Diversion/Slackwater	Full Closure w/Navigation Channel	No Action
36	Bear Creek/Large Diversion/Slackwater	Full Closure w/Navigation Channel	Restore

5.3.1. Eliminate Relocation of Mouth of Bear Creek

After the 36 preliminary alternatives had been developed and their evaluation had commenced, further field surveys of the potential site for a new Bear Creek channel originating at bend #4 revealed that the area is rich in bottomland hardwoods and is criss-crossed with small sloughs. A new channel would drain these sloughs and be very detrimental to the forested wetlands. Therefore, Alternatives #25 through #28 which include relocation of the mouth of Bear Creek were eliminated from further consideration, and the 36 preliminary alternatives were reduced to 32.

5.4. BENEFITS FROM PRELIMINARY ALTERNATIVES

5.4.1. Potential Increased Creek Flows

5.4.1.1. Preliminary Alternatives. Implementation of some preliminary restoration alternatives would result in an increase in water flow in the navigation bends and creeks which are modified under each alternative. As the number of alternatives were reduced through the evaluation and screening process, flow data was developed for the final alternatives.

5.4.1.2. Flow into Bear Creek. A major study objective was to restore flow into Bear Creek, which has a large watershed with valuable bottomland hardwood and aquatic habitat. From preliminary information, it appeared that a partial diversion structure at the entrance to cut #3 would be desirable. The bend below the mouth of Bear Creek would be plugged to divert all flows entering bend #3 to Bear Creek. However, the FWS was concerned that a large partial closure structure, approximately 1/3 the width of the river, might put too much flow into Bear Creek. Very high flows would put a large sediment load into the creek and high flows are not optimum for aquatic habitat.

Therefore, flows to Bear Creek were evaluated for several different widths of diversion structures. The smallest structure included only sheet piling of the point of cut and bend #3 island between the cut and the bend to create a small partial diversion structure and, with the plug in the bend, all flow entering the bend would go into Bear Creek. Three large partial diversion structures were examined, the largest being about 1/3 the width of the river. Two smaller partial diversion structures were also examined included a structure approximately half of the width of the larger diversion structure, or about 1/6 of the river width, and a structure about 1/4 of the river width. Figure 5-2 shows the various options considered for the mouth of Bear Creek. Table 5-3 shows the flows to Bear Creek for the various options.

Low flow conditions in the bends are considered to be 6,300 cfs and a navigation channel is defined at 6,300 cfs. However, a flow of 6,600 cfs based upon a low flow reading at the Clyo gage was used for hydraulic modelling of low flows into the creeks.

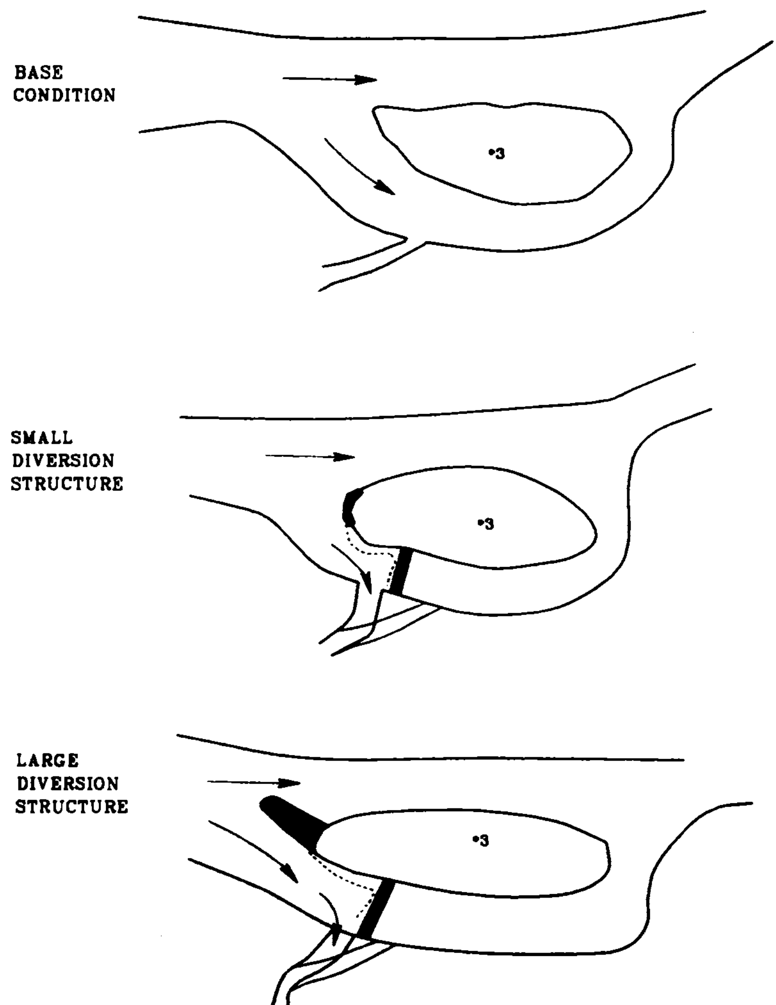


FIGURE 5-2
BEAR CREEK FLOW OPTIONS

TABLE 5-3
FLOW INTO BEAR CREEK
PARTIAL CLOSURE OF CUT #3

BEAR CREEK OPTION	FLOW INTO BEAR CREEK (cfs)			
	LOW RIVER FLOW (6,600 cfs)		HIGH RIVER FLOW (13,300 cfs)	
	FLOW (cfs)	% INCREASE OVER BASE	FLOW (cfs)	% INCREASE OVER BASE
Base Condition No Action	45.0 cfs	--	506.0 cfs	--
Small Diversion Structure at Cut #3 Plug in Bend #3 below Bear Creek	47.4 cfs	5 %	521.9 cfs	3 %
Large Partial Diversion Structure at Cut #3 1/6 width of river Plug in Bend #3 below Bear Creek	50.9 cfs	13 %	529.9 cfs	5 %
Large Partial Diversion Structure at Cut #3 1/4 width of river Plug in Bend #3 below Bear Creek	58.0 cfs	29 %	553.0 cfs	9 %
Large Partial Diversion Structure at Cut #3 1/3 width of river Plug in Bend #3 below Bear Creek	77.4 cfs	72 %	570.6 cfs	13 %

Table 5-3 shows there is an insignificant increase in flows to Bear Creek during low flow conditions with a small diversion structure, even though bend #3 is completely plugged and all flows entering the bend also enter Bear Creek. Significant low flow increases, 72 percent above base conditions, occur only with the largest partial diversion structure extending 1/3 of the width of the river. Even with this structure, high flows only increase by 13 percent, but this would improve the extent and frequency of overbank flooding.

5.4.1.3. Velocities in Bear Creek Approach Channel. It would not be desirable to dredge a deep channel from the river to the mouth of Bear Creek because a deep channel would become a sediment trap. The existing bend channel could be narrowed and confined to increase velocities to avoid sedimentation in the channel, as shown on Figure 5-2. Flows to Bear Creek would be essentially identical for either channel configuration. Table 5-4 shows the expected velocities in the channel from the river to the mouth of Bear Creek using the existing bend channel and with a new narrow approach channel.

TABLE 5-4
VELOCITIES IN BEAR CREEK APPROACH CHANNEL
PARTIAL CLOSURE OF CUT #3

BEAR CREEK OPTION	EXISTING APPROACH CHANNEL		NARROW APPROACH CHANNEL	
	LOW RIVER FLOW (6,600 cfs)	HIGH RIVER FLOW (13,300 cfs)	LOW RIVER FLOW (6,600 cfs)	HIGH RIVER FLOW (13,300 cfs)
Partial Diversion Structure at Cut #3 1/3 width of river Plug in Bend #3 below Bear Creek	0.11 fps	0.41 fps	0.44 fps	1.14.fps
Partial Diversion Structure at Cut #3 1/6 width of river Plug in Bend #3 below Bear Creek	0.07 fps	0.38 fps	0.29 fps	1.06 fps
No Diversion Structure at Cut #3 Riprap island point only Plug in Bend #3 below Bear Creek	0.07 fps	0.37 fps	0.27 fps	1.04 fps

Velocities in the approach channel to the mouth of Bear Creek increase from near zero to about 1.0 fps when the approach channel width is narrowed to the 40-foot width of Bear Creek. At low flow conditions, the large partial diversion structure should have velocities adequate to prevent shoaling within the approach channel. The maximum velocities encountered in the approach channel should approximate those found within Bear Creek.

5.4.2. Environmental Restoration Benefits

5.4.2.1. Without Project Conditions. Planning goals and objectives and desired future conditions for the study area were considered while developing the restoration alternatives. A joint evaluation of the study area without a restoration alternative was conducted by the Georgia Department of Natural Resources, U.S. Fish and Wildlife Service, and the Savannah District. The data obtained was used in the habitat evaluation procedures which served as the primary evaluation tool to compare the alternatives. The Fish and Wildlife Service evaluated current environmental habitat conditions in the study area and extrapolated these conditions into the future to reflect continuing degradation in some areas.

5.4.2.2. Threatened and Endangered Species. Improvements to the environment would directly benefit at least nine species of plants and animals found in the Lower Savannah River corridor that are included in the Federal list of threatened and endangered species. Of the nine threatened and endangered species, those with the greatest likelihood of being positively impacted by the environmental restoration efforts are the shortnose sturgeon, peregrine falcon, bald eagle, and wood stork. Another 10 species are officially considered vulnerable and have the potential to be added to the list.

Corrective actions include diverting a portion of the river flow through the old cutoff bends. Slower moving water, as opposed to faster main stream flow, is preferred by many species of fish for spawning, including the shortnose sturgeon. The peregrine falcon, bald eagle, and wood stork populations would directly benefit from the improved fishery. Although improving habitat for the endangered and threatened species is a high priority for environmental restoration, many of the environmental benefits would be related to enhancing ecosystem diversity within the river. According to a 1987 report, published by the Office of Technology Assessment entitled, *Technologies to Maintain Biological Diversity*, "...natural ecosystem diversity has declined in the United States historically and no evidence suggests that this long term trend has been arrested." Further, the report continues, "Twenty-three ecosystem types that once covered about half the conterminous United States now cover about 7 percent."

It would be more cost-effective to improve the habitat for threatened species and keep them off the endangered list than to leave the habitat in an unproductive state and incur the cost of saving the species if it becomes classified as endangered. This is particularly applicable to the 10 species occurring in the study area which are presently considered as vulnerable and having the potential to be added to the list of protected species.

5.4.2.3. Aquatic Habitat. The Habitat Evaluation Procedures, developed by the U.S. Fish and Wildlife Service (FWS), were the primary tool used to measure and evaluate environmental benefits of the alternatives. These procedures involved determining the quantity of various habitats by classifying the study area by cover types and measuring the area of each type. Representative species were then selected and habitat quality was determined by measuring habitat characteristics and applying them to suitability index models. The habitat quantity was multiplied by the habitat quality to determine habitat units. Because the restoration alternatives would affect stream habitat most directly, fish were the evaluation elements selected.

The habitat units were calculated for the current baseline condition, without project condition, and for various target years over the proposed 50-year project life. Average annual habitat units were determined for both the without project condition and the various restoration alternatives. The habitat evaluation study was conducted by a team consisting of representatives from the Savannah District, U.S. Fish and Wildlife Service, and Georgia Department of Natural Resources. The U.S. Fish and Wildlife Service used a modified version of the Habitat Evaluation Program (HEP) model to calculate the Average Annual Habitat Units (AAHUs) for each alternative.

5.4.2.4. Bottomland Hardwood. Bottomland hardwoods are prevalent in the study area, particularly adjacent to the bends, and have a very high environmental value. All of the restoration components would enhance bottomland hardwoods. The value of this wetland vegetation cannot be related to AAHUs. Therefore, a functional index was used to estimate bottomland hardwood benefits. A bottomland hardwood functional index is a measure of wetland value based upon the estimated amount of base flow in the tributary system and the estimated amount of floodwater provided to the wetland system. The functional index was multiplied by acres to provide a functional value. A functional value of one is equivalent to 1 acre of fully functioning, optimum, bottomland hardwood.

Impacts of each alternative on the functional index were based on the expected water flow in the creeks that would be produced by an alternative. Water flow was projected by the Savannah District using hydraulic models or extrapolated from the model results. The future without condition used the projected closure rate of flows in the creeks.

5.4.3. Habitat Unit Incremental Analysis

An incremental analysis is a process designed to identify the restoration alternative or alternatives that yield an optimum level of AAHUs in relation to the cost to produce those units. The process compares the change in costs as average annual habitat units increase. The resulting "incremental cost" measures the cost per habitat unit gained as habitat units increase from lower output alternatives to higher output alternatives.

This analysis was based on, and followed, guidance from previously referenced U.S. Army Corps of Engineers Institute For Water Resources Report 95-R-1. A description of the incremental analysis process and the corresponding tabular representations are included in Appendix E, *Economic Analysis*.

5.4.4. Economic Analysis. The evaluation of environmental restoration alternatives is based on a comparison of environmental outputs, including habitat units and hardwood functional values, against monetary costs. Due to the different value standards used, no benefit-cost ratio can be computed for this environmental restoration project. Instead, the economic evaluation follows the guidelines from the U.S. Army Corps of Engineers Institute For Water Resource publication "*Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analysis*," IWR Report 95-R-1, May 1995. Detailed information about the economic effects of the alternatives and the incremental cost process can be found in Appendix E, *Economic Analysis* .

5.5. ENVIRONMENTAL IMPACTS OF RESTORATION ALTERNATIVES

5.5.1. Loss of Aquatic Habitat Units

None of the preliminary alternatives would result in an identified loss of AAHUs.

5.5.2. Loss of Bottomland Hardwood due to Project Construction

Prior to construction of the navigation cuts, navigation passed through the bends and barge traffic was able to navigate this reach of the river, although perhaps with some difficulty under some flow conditions. However, if a navigation channel is constructed in a bend under present conditions, the channel would have to accommodate a design vessel with current safety requirements. This would result in a navigation channel with wider radius curves than existed in the bends prior to the navigation cuts. With the existing tight bend configurations, particularly in bend #3, a navigation channel would extend beyond the banks and destroy some bottomland hardwoods.

The restoration component to relocate the mouth of Bear Creek to bend #4 would require construction of a new creek channel from the bend to the existing creek channel. The new channel would be about 1,500 feet long, and an area about 50 feet wide would be cleared. This would result in the loss of almost two acres of bottomland hardwood.

Table 5-5 presents information provided by the U.S. Fish and Wildlife Service on estimated losses in bottomland hardwoods through implementation of the various restoration components. A bottomland hardwood functional index is a measure of the wetland value.

Appendix D, *U.S. Fish and Wildlife Service Coordination Report* , includes gains in bottomland hardwoods if either of the navigation cuts were fully closed and either cut was filled with dredged material and planted with bottomland hardwoods on the newly created uplands. However, estimated dredging volumes were not adequate to completely fill either cut. There are also technical concerns regarding the feasibility of establishing tree saplings with the periodic high flows from the river. Therefore, none of the restoration alternatives included the planting of hardwoods within a cut used for disposal of dredged material.

TABLE 5-5
LOSSES IN BOTTOMLAND HARDWOOD
FROM PROJECT CONSTRUCTION

RESTORATION COMPONENT	IMPACTED AREA	BLHW ACRES	AVERAGE ANNUAL FUNCTIONAL INDEX	AVERAGE ANNUAL FUNCTIONAL VALUE
Bend #3 Navigation Channel High Quality BLHW	Bend #3	-8	1.0	-8
Bend #3 Navigation Channel Low Quality BLHW	Bend #3	-2	0.3	-0.6
Bend #4 Navigation Channel High Quality BLHW	Bend #4	-1	1.0	-1
Bend #4 Navigation Channel Low Quality BLHW	Bend #4	-13	0.3	-3.9
Bend #3 Restoration Channel	Bend #3	-5	0.3	-1.5
Bend #4 Restoration Channel	Bend #4	-13	0.3	-3.9
Any Channel Dredging	Disposal Area	-2	0.5	-1
Relocate Mouth of Bear Creek	Bend #4 to Bear Creek	-2	1.0	-2
Bend #3 Slackwater Channel	Bend #3	-5	0.3	-1.5

5.6. ENVIRONMENTAL VALUES WITH AND WITHOUT RESTORATION

The detailed habitat evaluation analysis is included in Appendix D, *U.S. Fish and Wildlife Service Coordination Report*. Table 5-6 shows the AAHU and BLHW values with and without each of the preliminary restoration alternatives. Values without restoration include continued future degradation of the ecosystem in the study area. Values include any losses or gains resulting from implementation of any alternative from Table 5-5. BLHW values represent average annual functional values, which are measures of wetland value. Alternatives #25 through #28, which include relocation of the mouth of Bear Creek, were deleted during the evaluation of preliminary alternatives due to unacceptable losses to bottomland hardwoods and are deleted in all future listings of restoration alternatives.

5.7. NET ENVIRONMENTAL BENEFITS

Table 5-7 presents the net environmental benefits for the initial 32 alternatives from Table 5-6 with a brief description of each alternative. Details of the habitat evaluation and estimated benefits is included in Appendix D, *U.S. Fish and Wildlife Service Coordination Report*.

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TABLE 5-6
PRELIMINARY RESTORATION ALTERNATIVES
NET ENVIRONMENTAL BENEFITS

ALT	WITHOUT RESTORATION		WITH RESTORATION		NET BENEFITS	
	AAHU	BLIIW	AAHU	BLIIW	AAHU	BLIIW
1	574	1,186	574	1,186	0	0
2	574	1,186	946	1,704	372	518
3	574	1,186	1,643	3,146	1,067	1,960
4	574	1,186	1,666	3,519	1,092	2,333
5	574	1,186	1,359	1,770	785	584
6	574	1,186	1,578	2,024	1,004	838
7	574	1,186	2,255	3,752	1,681	2,566
8	574	1,186	2,281	4,079	1,707	2,893
9	574	1,186	1,439	1,770	865	584
10	574	1,186	1,760	2,024	1,186	838
11	574	1,186	2,074	3,752	1,500	2,566
12	574	1,186	2,496	4,079	1,922	2,893
13	574	1,186	1,439	2,935	865	1,749
14	574	1,186	1,760	3,467	1,186	2,281
15	574	1,186	2,074	4,228	1,500	3,042
16	574	1,186	2,496	4,684	1,922	3,498
17	574	1,186	1,324	1,770	750	584
18	574	1,186	1,641	2,024	1,067	838
19	574	1,186	2,221	3,752	1,647	2,566
20	574	1,186	2,362	4,079	1,788	2,893
21	574	1,186	1,324	2,546	750	1,360
22	574	1,186	1,641	3,146	1,067	1,960
23	574	1,186	2,221	4,312	1,647	3,126
24	574	1,186	2,248	4,684	1,788	3,498
29	574	1,186	1,423	1,770	849	584
30	574	1,186	1,727	2,228	1,153	1,042
31	574	1,186	2,328	3,752	1,754	2,566
32	574	1,186	2,422	4,079	1,848	2,893
33	574	1,186	1,423	2,546	849	1,360
34	574	1,186	1,727	3,146	1,153	1,960
35	574	1,186	2,328	4,312	1,754	3,126
36	574	1,186	2,422	4,684	1,848	3,498

TABLE 5-7
PRELIMINARY RESTORATION ALTERNATIVES
NET ENVIRONMENTAL BENEFITS

ALT	CUT & BEND #3	CUT & BEND #4	MILL CR	AAHU	BLHW
1	No Action	No Action	No Action	0	0
2	No Action	No Action	Restore	372	518
3	No Action	F/C w/Nav Chan	No Action	1,067	1,960
4	No Action	F/C w/Nav Chan	Restore	1,092	2,333
5	P/C w/P/C Rest Chan	No Action	No Action	785	584
6	P/C w/P/C Rest Chan	No Action	Restore	1,004	838
7	P/C w/P/C Rest Chan	F/C w/Nav Chan	No Action	1,681	2,566
8	P/C w/P/C Rest Chan	F/C w/Nav Chan	Restore	1,707	2,893
9	F/C w/Nav Chan	No Action	No Action	865	584
10	F/C w/Nav Chan	No Action	Restore	1,186	1,028
11	F/C w/Nav Chan	F/C w/Nav Chan	No Action	1,500	2,566
12	F/C w/Nav Chan	F/C w/Nav Chan	Restore	1,922	2,893
13	F/C w/F/C Rest Chan	No Action	No Action	865	1,749
14	F/C w/F/C Rest Chan	No Action	Restore	1,186	2,281
15	F/C w/F/C Rest Chan	F/C w/Nav Chan	No Action	1,500	3,042
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	1,922	3,498
17	Bear Cr/Small Diver	No Action	No Action	750	584
18	Bear Cr/Small Diver	No Action	Restore	1,067	1,042
19	Bear Cr/Small Diver	F/C w/Nav Chan	No Action	1,647	2,566
20	Bear Cr/Small Diver	F/C w/Nav Chan	Restore	1,788	2,893
21	Bear Cr/Large Diver	No Action	No Action	750	1,360
22	Bear Cr/Large Diver	No Action	Restore	1,067	1,960
23	Bear Cr/Large Diver	F/C w/Nav Chan	No Action	1,647	3,126
24	Bear Cr/Large Diver	F/C w/Nav Chan	Restore	1,788	3,498
29	Bear Cr/Small Diver/Slack	No Action	No Action	849	584
30	Bear Cr/Small Diver/Slack	No Action	Restore	1,153	1,042
31	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	No Action	1,754	2,566
32	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	Restore	1,848	2,893
33	Bear Cr/Large Diver/Slack	No Action	No Action	849	1,360
34	Bear Cr/Large Diver/Slack	No Action	Restore	1,153	1,960
35	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	No Action	1,754	3,126
36	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	Restore	1,848	3,498

5.8. MONITORING PLAN

5.8.1. Monitoring Requirements

Monitoring programs are designed to evaluate whether projects are working as designed. Monitoring is especially helpful when new, unproven techniques are being applied, and when significant levels of uncertainty prevail at the time of implementation. The information from monitoring can be used to ascertain whether:

- The project is functioning to meet objectives
- Adjustments for unforeseen circumstances are needed
- Changes to structures or their operation or management techniques are required

5.8.2. Monitoring Plan

A plan to monitor Mill Creek, Little Abercorn Creek, and Bear Creek would be included with any restoration plan in order to assure that the restoration project continues to function properly after completion of construction. Project costs for all restoration alternatives include funds for monitoring for the first 5 years of the project life, after which the city of Savannah would be responsible for initiating further monitoring.

Expensive continuous monitoring gages are not warranted since restoration of the study area habitat will be a gradual process. The U.S. Geological Survey would conduct annual flow and water quality measurements in the three study area creeks (Bear Creek, Raccoon Creek, Mill Creek). U.S. Fish and Wildlife Service personnel would make regular field visits to the study area for visual observations of the effectiveness of the restoration project.

Debris accumulation in the creeks, primarily logs and sediment, is a natural process and would not be affected by a restoration project. If the monitoring indicated that debris in the creeks should be removed from the three major creeks to provide adequate flows, dredging or clearing would be performed in the portions of the creeks identified as critical to maintaining flows. Due to limited access to these sites, the most feasible, although expensive, method of large amounts of sediment removal appears to be jet-spray dredging. Other means should be investigated if jet spray dredging is not acceptable. However, based upon historic conditions, debris would be primarily logs with minimal amounts of sediment. Debris removal would be a local sponsor responsibility in coordination with the U.S. Fish and Wildlife Service to minimize adverse environmental impacts.

5.8.3. Cost of Monitoring Plan

Based upon discussions with the U.S. Fish and Wildlife Service, the Savannah District estimates that the monitoring program could be conducted at an annual cost of $6,000 for each of the three major creeks. The monitoring program should be conducted for 5 years to ascertain the effectiveness of the restoration project.

5.9. REAL ESTATE REQUIREMENTS

Due to the complexity of real estate requirements in the study area for the various restoration alternatives, a real estate analysis was only conducted for the two Final Restoration Plans. The District assumed there were no real estate requirements which would preclude implementation of any of the 36 preliminary alternatives, so this information was not needed for the evaluation and screening of alternatives. Therefore, real estate costs were not included in the total project costs for any of the alternatives except the Final Restoration Plans. Easements would be required for sites where construction would occur. An easement would also be required for construction of the upland dredged material disposal area to be located on property of Fort Howard Corporation.

5.10. ENVIRONMENTAL ASSESSMENT

The District prepared an Environmental Assess. .nt (EA) on the restoration alternatives and the Recommended Environmental Restoration Plan, which is included in Appendix B, *Environmental Assessment*. The EA documents the environmental analysis performed as part of the evaluation and screening of alternatives. Both beneficial and adverse environmental impacts were identified.

5.11. COST OF PRELIMINARY ALTERNATIVES

5.11.1. Construction Costs

The following is a summary of the major cost components for the various restoration alternatives. The cost of some construction items, such as dredging and closure structure, are not additive for each of the two cuts because of savings in mobilization and demobilization of equipment when more than one area is included in a total study area alternative.

5.11.1.1. Dredging. Under the various alternatives, dredging might be conducted in bend #3 or bend #4. Channel configurations include a pre-cut channel or navigation channel in bend #3 and a navigation channel in bend #4. Dredging would be accomplished by an 18-inch hydraulic pipeline dredge and pumped through a pipeline to a new upland disposal area located on Fort Howard Corporation property. Table 5-8 summarizes the dredging volumes for the various restoration components. These are in situ volumes and the actual volumes might be slightly higher depending on actual dredge operations. The estimated higher bulked volumes, as described in Appendix A, *Engineering Analysis*, were used in the design of the upland disposal area. There is adequate capacity in the disposal area to accommodate the higher dredging volumes.

TABLE 5-8
PRELIMINARY RESTORATION ALTERNATIVES
DREDGING VOLUMES AND DISPOSAL AREA CAPACITIES

DREDGING VOLUMES	
RESTORATION COMPONENT	**VOLUME (cubic yards)**
BEND #3:	
Partial closure restoration channel	16,000
Full closure navigation channel	255,000
Full closure restoration channel	129,000
Slackwater channel	93,000
BEND #4:	
Full closure navigation channel	375,000
DISPOSAL AREA CAPACITIES	
Upland Disposal Area	450,000
Navigation Cut #4	131,000

5.11.1.2. Dredged Material Disposal Area. For those total study area alternatives which include full closure of cut #4, the navigation cut channel itself can be used as a disposal area for some or all of the dredged material from bend #3 to reduce the disposal costs. Navigation cut #4 would hold approximately 131,000 cubic yards. Any volume of material which exceeded the capacity of cut #4 would be placed in the upland diked disposal area. For those alternatives which include No Action at cut and bend #4, all dredged material from bend #3 would be placed in the upland diked disposal site.

For those alternatives which include full closure of cut #4, the possibility of placing dredged material from bend #4 channel dredging in cut #4 was considered. Since a channel must be opened in bend #4 before cut #4 could be closed, it would require two dredging passes in bend #4. The first pass would create a channel in bend #4 capable of handling the total river flow. Cut #4 would then be fully closed. The dredge would make a second pass to enlarge the bend to project limits and the dredged material would be placed in cut #4. However, due to the length of bend #4, the District Cost Engineering Branch determined that the cost of two dredge passes exceeded the cost savings of placing dredged material in cut #4 instead of pumping to the upland disposal site. Table 5-9 shows the volume and disposal of dredged material for the preliminary alternatives.

TABLE 5-9
PRELIMINARY RESTORATION ALTERNATIVES
DISPOSAL OF DREDGED MATERIAL

ALT	CUT & BEND #3	CUT & BEND #4	MILL CR	DREDGED MATERIAL (cu yds)	DISPOSAL	
					UPLAND	CUT #4
1	No Action	No Action	No Action	0	0	0
2	No Action	No Action	Restore	0	0	0
3	No Action	F/C w/Nav Chan	No Action	375,000	375,000	0
4	No Action	F/C w/Nav Chan	Restore	375,000	375,000	0
5	P/C w/P/C Rest Chan	No Action	No Action	16,000	16,000	0
6	P/C w/P/C Rest Chan	No Action	Restore	16,000	16,000	0
7	P/C w/P/C Rest Chan	F/C w/Nav Chan	No Action	391,000	375,000	16,000
8	P/C w/P/C Rest Chan	F/C w/Nav Chan	Restore	391,000	375,000	16,000
9	F/C w/Nav Chan	No Action	No Action	255,000	255,000	0
10	F/C w/Nav Chan	No Action	Restore	255,000	255,000	0
11	F/C w/Nav Chan	F/C w/Nav Chan	No Action	630,000	499,000	131,000
12	F/C w/Nav Chan	F/C w/Nav Chan	Restore	630,000	499,000	131,000
13	F/C w/F/C Rest Chan	No Action	No Action	129,000	129,000	0
14	F/C w/F/C Rest Chan	No Action	Restore	129,000	129,000	0
15	F/C w/F/C Rest Chan	F/C w/Nav Chan	No Action	504,000	375,000	129,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	504,000	375,000	129,000
17	Bear Cr/Small Diver	No Action	No Action	0	0	0
18	Bear Cr/Small Diver	No Action	Restore	0	0	0
19	Bear Cr/Small Diver	F/C w/Nav Chan	No Action	375,000	375,000	0
20	Bear Cr/Small Diver	F/C w/Nav Chan	Restore	375,000	375,000	0
21	Bear Cr/Large Diver	No Action	No Action	0	0	0
22	Bear Cr/Large Diver	No Action	Restore	0	0	0
23	Bear Cr/Large Diver	F/C w/Nav Chan	No Action	375,000	375,000	0
24	Bear Cr/Large Diver	F/C w/Nav Chan	Restore	375,000	375,000	0
29	Bear Cr/Small Diver/Slack	No Action	No Action	131,000	131,000	0
30	Bear Cr/Small Diver/Slack	No Action	Restore	131,000	131,000	0
31	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	No Action	506,000	375,000	131,000
32	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	Restore	506,000	375,000	131,000
33	Bear Cr/Large Diver/Slack	No Action	No Action	131,000	131,000	0
34	Bear Cr/Large Diver/Slack	No Action	Restore	131,000	131,000	0
35	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	No Action	506,000	375,000	131,000
36	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	Restore	506,000	375,000	131,000

5.11.1.3. Closure Structures. Various closure structures which might be constructed include a small, partial, or full closure structure at cut #3 and a full closure structure at cut #4. The District design personnel selected riprap for construction of partial and full closure structures. Access to the construction site was assumed to be limited to water transportation. Except for riprap, all equipment, material, and personnel would be transported from Savannah. Waterfront access areas are extremely limited and would not be available except at the construction sites. Riprap would be trucked from a quarry to an offloading area, assumed to be in Savannah Harbor, and loaded on barges for transport to the construction sites. A barge-mounted clamshell dredge would place the stone. Sheet piling would be installed by a barge-mounted pile driver.

5.11.1.4. Bear Creek Approach Channel. In conjunction with a partial closure structure at cut #3, a narrow approach channel approximately 30 to 60 feet wide would be constructed to route all flows entering bend #3 to Bear Creek. It would consist of a backfilled sheet pile wall on the island side of the channel and concrete precast mats over backfill on the opposite side and across the bend downstream of the mouth of Bear Creek. No channel dredging would be required. This work includes a complete plug of bend #3 below the mouth of Bear Creek.

5.11.2. Preconstruction Engineering and Design

Preconstruction engineering and design (PED) costs include detailed engineering analyses and design after the project has been authorized and funded. This work will include, but not be limited to, Waterways Experiment Station navigation studies of any navigation channels in bends, field surveys, additional hydraulic modelling if required, and other work as required to refine engineering and design in the feasibility study. For the preliminary alternatives, the PED costs were estimated to be 6 percent of total construction costs for each alternative, or $500,000 minimum for those alternatives which include a navigation channel in either bend.

5.11.3. Supervision and Administration

Supervision and administration (S&A) costs include contract administration for dredging and construction. For the preliminary alternatives, supervision and administration was estimated to be 5 percent of total construction costs for each alternative.

5.11.4. Lands and Damages

Real estate cost were not included in the preliminary alternatives, real estate costs were not included. For the wide range of easements required for the various restoration alternatives, this would have been a complex analysis and would not have significantly affected the total costs for the alternatives or the relative cost between alternatives. Detailed real estate costs were developed for the Final Restoration Plans.

5.11.5. Cultural Resources Investigations

The cultural resources investigations of the study area, included in Appendix C, *Cultural Resources Survey*, did not identify any artifacts, cultural strata, or archaeological sites. However, this investigation was limited to the mouth of Mill Creek and the banks of the cuts and bends. It is possible that construction of an upland dredged material disposal site might reveal the need for additional cultural resources investigations. Therefore, for those alternatives which required a disposal area, $145,000 was included to cover any additional investigations.

5.11.6. Total Project First Costs

Project first costs for a restoration alternative would normally include construction, preconstruction engineering and design (PED), supervision and administration (S&A), lands and damages (LERRD), and cultural resources (CR) investigations. Since O&M costs and monitoring costs occur at different times in the future following construction, the present value of these costs was added to the project first costs to determine total project costs, which were then annualized to show equivalent average annual costs.

5.11.7. Operation and Maintenance Costs

An objective, although not a constraint, was to provide environmental restoration with minimum or zero maintenance. In addition to additional project costs, maintenance dredging would be environmentally disruptive. Maintenance dredging would only be expected if a restoration action resulted in low velocities, with resultant sedimentation and shoaling. The only maintenance cost associated with periodic maintenance to remove shoaling is with partial closure of cut #3 with a partial closure restoration channel in bend #3. The volume is estimated to be 5,000 cubic yards per year and the present value of the estimated cost of sediment removal is $1,235,000 over the 50-year life of the project.

5.11.8. Monitoring Cost

In order to assess the functioning and effectiveness of a restoration project, it would be necessary to monitor flows into the major creeks in the study area. This would be accomplished by having the U.S. Geological Survey conduct annual flow and water quality measurements in the major creeks, primarily Bear Creek, Flat Ditch Creek, and Mill Creek. These flow measurements would be augmented by periodic field observations by U.S. Fish and Wildlife Service personnel.

The annual cost of a monitoring program is estimated to be $6,000 annually for each of the three creeks. Since some restoration alternatives include No Action at one or more of the three sites, Table 5-10 shows the approximate monitoring costs for the three restoration sites.

The monitoring program would be conducted for a period of 5 years in order to accurately assess the functioning of the restoration project. Monitoring cost were annualized at 7.625 percent for 50 years. For those alternatives restoration in only one of the three creeks, the monitoring cost would be $6,000 per year for 5 years, which has a present value of $24,000. For monitoring of two creeks, the cost would be $12,000 per year, or a present value $48,000. Monitoring in all three creeks would cost $18,000 per year or $72,000 present value.

TABLE 5-10
ANNUAL COST OF MONITORING PROGRAM

MONITORING TASK	BEAR CREEK	FLAT DITCH CREEK	MILL CREEK	TOTAL STUDY AREA
USGS annual flow measurements	$4,000	$4,000	$4,000	$12,000
USF&WS field observations	2,000	2,000	2,000	6,000
Total	$6,000	$6,000	$6,000	$18,000
Present Value	$24,000	$24,000	$24,000	$72,000

5.11.9. Total Project Costs

Table 5-11 summarizes the total project costs for the 32 preliminary alternatives. Costs were not developed for Alternatives #25 through #28 because these alternatives were deleted from the list of feasible preliminary alternatives. Total project costs include project first costs (LERRD, PED, S&A, and cultural resources investigations) plus recurring costs including O&M and monitoring costs. Real estate costs were not developed for the preliminary alternatives, so LERRD costs are shown as zero. Cultural resources costs are included only for those alternatives which require an upland disposal area. The present value of a monitoring program is included. The present value of O&M costs were included for Alternatives #5 through #8, which are the only restoration alternatives with anticipated periodic maintenance dredging. Total project costs were then annualized at 7.625 percent interest rate with a 50-year project life.

TABLE 5-11
PRELIMINARY RESTORATION ALTERNATIVES
TOTAL PROJECT COSTS

ALT	PROJECT FIRST COSTS					MONITORING (present value)	O&M (present value)	TOTAL PROJECT FIRST COSTS	EQUIVALENT AVERAGE ANNUAL COSTS
	CONSTRUCTION	PED	S&A	LERRD	CR				
1	0	0	0	0	0	0	0	0	0
2	$270,000	$17,000	$14,000	-	0	$24,000	0	$325,000	$25,000
3	9,586,000	572,000	490,000	-	$145,000	24,000	0	10,817,000	846,000
4	9,855,000	588,000	504,000	-	145,000	48,000	0	11,140,000	872,000
5	4,187,000	500,000	214,000	-	145,000	24,000	$1,235,000	6,305,000	493,000
6	4,457,000	500,000	228,000	-	145,000	48,000	1,235,000	6,613,000	517,000
7	12,003,000	716,000	614,000	-	145,000	48,000	1,235,000	14,761,000	1,155,000
8	12,272,000	732,000	628,000	-	145,000	72,000	1,235,000	15,084,000	1,180,000
9	6,173,000	500,000	316,000	-	145,000	24,000	0	7,158,000	560,000
10	6,442,000	500,000	330,000	-	145,000	48,000	0	7,465,000	584,000
11	13,321,000	795,000	681,000	-	145,000	48,000	0	14,990,000	1,173,000
12	13,590,000	811,000	695,000	-	145,000	72,000	0	15,313,000	1,198,000
13	5,212,000	500,000	267,000	-	145,000	24,000	0	6,148,000	481,000
14	5,482,000	500,000	281,000	-	145,000	48,000	0	6,456,000	505,000
15	12,602,000	752,000	645,000	-	145,000	48,000	0	14,192,000	1,110,000
16	12,871,000	768,000	658,000	-	145,000	72,000	0	14,514,000	1,136,000
17	2,053,000	500,000	105,000	-		24,000	0	2,682,000	210,000
18	2,323,000	500,000	119,000	-		48,000	0	2,990,000	234,000
19	11,639,000	695,000	595,000	-	145,000	48,000	0	13,122,000	1,027,000
20	11,908,000	711,000	609,000	-	145,000	72,000	0	13,445,000	1,052,000
21	3,070,000	500,000	157,000	-	0	24,000	0	3,751,000	293,000
22	3,339,000	500,000	171,000	-	0	48,000	0	4,058,000	318,000
23	12,749,000	761,000	652,000	-	145,000	48,000	0	14,355,000	1,123,000
24	12,925,000	771,000	661,000	-	145,000	72,000	0	14,574,000	1,140,000
29	4,516,000	500,000	231,000	-	145,000	24,000	0	5,416,000	424,000
30	4,785,000	500,000	245,000	-	145,000	48,000	0	5,723,000	448,000
31	11,650,000	695,000	596,000	-	145,000	48,000	0	13,134,000	1,028,000
32	11,920,000	711,000	610,000	-	145,000	72,000	0	13,458,000	1,053,000
33	5,591,000	500,000	286,000	-	145,000	24,000	0	6,546,000	512,000
34	5,861,000	500,000	300,000	-	145,000	48,000	0	6,854,000	536,000
35	12,726,000	759,000	651,000	-	145,000	48,000	0	14,329,000	1,121,000
36	12,995,000	775,000	665,000	-	145,000	72,000	0	14,652,000	1,146,000

5.12. BENEFITS AND COSTS OF PRELIMINARY ALTERNATIVES

Table 5-12 presents a summary of the net restoration benefits and total project costs of the preliminary restoration alternatives. Alternatives #25 through #28, which provided for relocation of the mouth of Bear Creek, were eliminated from further consideration due to undesirable adverse environmental impacts. Average annual costs were computed based on an interest rate of 7.625 percent and 50-year project life.

TABLE 5-12
PRELIMINARY RESTORATION ALTERNATIVES
SUMMARY OF BENEFITS AND COSTS

ALT	CUT & BEND #3	CUT & BEND #4	MILL CR	AAHUs	BLHW	AVERAGE ANNUAL COSTS
1	No Action	No Action	No Action	0	0	0
2	No Action	No Action	Restore	372	518	$25,000
3	No Action	F/C w/Nav Chan	No Action	1,067	1,960	846,000
4	No Action	F/C w/Nav Chan	Restore	1,092	2,333	872,000
5	P/C w/P/C Rest Chan	No Action	No Action	785	584	493,000
6	P/C w/P/C Rest Chan	No Action	Restore	1,004	838	517,000
7	P/C w/P/C Rest Chan	F/C w/Nav Chan	No Action	1,681	2,566	1,155,000
8	P/C w/P/C Rest Chan	F/C w/Nav Chan	Restore	1,707	2,893	1,180,000
9	F/C w/Nav Chan	No Action	No Action	865	584	560,000
10	F/C w/Nav Chan	No Action	Restore	1,186	1,028	584,000
11	F/C w/Nav Chan	F/C w/Nav Chan	No Action	1,500	2,566	1,173,000
12	F/C w/Nav Chan	F/C w/Nav Chan	Restore	1,922	2,893	1,198,000
13	F/C w/F/C Rest Chan	No Action	No Action	865	1,749	481,000
14	F/C w/F/C Rest Chan	No Action	Restore	1,186	2,281	505,000
15	F/C w/F/C Rest Chan	F/C w/Nav Chan	No Action	1,500	3,042	1,110,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	1,922	3,498	1,136,000
17	Bear Cr/Small Diver	No Action	No Action	750	584	210,000
18	Bear Cr/Small Diver	No Action	Restore	1,067	1,042	234,000
19	Bear Cr/Small Diver	F/C w/Nav Chan	No Action	1,647	2,566	1,027,000
20	Bear Cr/Small Diver	F/C w/Nav Chan	Restore	1,788	2,893	1,052,000
21	Bear Cr/Large Diver	No Action	No Action	750	1,360	293,000
22	Bear Cr/Large Diver	No Action	Restore	1,067	1,960	318,000
23	Bear Cr/Large Diver	F/C w/Nav Chan	No Action	1,647	3,126	1,123,000
24	Bear Cr/Large Diver	F/C w/Nav Chan	Restore	1,788	3,498	1,140,000
29	Bear Cr/Small Diver/Slack	No Action	No Action	849	584	424,000
30	Bear Cr/Small Diver/Slack	No Action	Restore	1,153	1,042	448,000
31	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	No Action	1,754	2,566	1,028,000
32	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	Restore	1,848	2,893	1,053,000
33	Bear Cr/Large Diver/Slack	No Action	No Action	849	1,360	512,000
34	Bear Cr/Large Diver/Slack	No Action	Restore	1,153	1,960	536,000
35	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	No Action	1,754	3,126	1,121,000
36	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	Restore	1,848	3,498	1,146,000

P/C = partial closure F/C = full closure

SECTION 6

SELECTION OF INTERMEDIATE ALTERNATIVES

6.1. SUMMARY OF PRELIMINARY RESTORATION ALTERNATIVES

A total of 36 preliminary environmental restoration alternatives were formulated. Net environmental benefits and preliminary cost estimates were developed for all alternatives except #25 through #28, which were deleted early in the screening process due to an undesirable loss of bottomland hardwoods. Table 6-1 summarizes the net benefits and costs of the 32 remaining preliminary alternatives. Total costs include preliminary construction costs, preconstruction engineering and design, construction management, cultural resources investigations, and monitoring. For the preliminary alternatives, real estate costs were not developed due to the complexity of real estate requirements.

6.2. SCREENING OF PRELIMINARY ALTERNATIVES

A detailed description of the formulation and screening of the preliminary restoration alternatives is included in Appendix H, *Formulation and Screening of Restoration Alternatives*. The screening process included a detailed incremental analysis of the preliminary 32 alternatives. Figure 6-1 is an example of how the intermediate alternatives were then compared based on preliminary project costs.

Based on study objectives, environmental cost-effectiveness analysis, and study team discussions, eight alternatives (#1, #2, #18, #22, #32, #24, #36, and #16) were brought forward for final analysis and screening of alternatives. While alternatives #24 and #36 are not among the most cost efficient in terms of quantified benefit production, the study team concluded they offer significant benefits for environmental restoration and should not be eliminated.

Alternative #16 (full closure of cut #3 with a full closure restoration channel in bend #3, full closure of cut #4 with a navigation channel in bend #4, restore Mill Creek) would provide the maximum AAHU and BLHW benefits. It was used as the maximum cost, or 100 percent of possible costs for the various alternatives. There are other alternatives which are more expensive, but Alternative #16 was used for comparison of alternatives since it provides 100 percent of attainable benefits at the least cost of other alternatives which also provide 100 percent benefits. The benefits and costs of the intermediate alternatives were then shown as a percent of the maximum benefits and costs of Alternative #16. The alternatives are listed in increasing amount of bottomland hardwood benefits, since this benefit category is more significant to both the regional ecosystem and at the National level.

The following is a brief description of the eight alternatives selected from the 32 preliminary alternatives.

TABLE 6-1
PRELIMINARY RESTORATION ALTERNATIVES
NET BENEFITS AND COSTS

ALT	CUT & BEND #3	CUT & BEND #4	MILL CR	AAHUs	BLHW	COST
1	No Action	No Action	No Action	0	0	0
2	No Action	No Action	Restore	372	518	$325,000
3	No Action	F/C w/Nav Chan	No Action	1,067	1,960	10,817,000
4	No Action	F/C w/Nav Chan	Restore	1,092	2,333	11,140,000
5	P/C w/P/C Rest Chan	No Action	No Action	785	584	6,305,000
6	P/C w/P/C Rest Chan	No Action	Restore	1,004	838	6,613,000
7	P/C w/P/C Rest Chan	F/C w/Nav Chan	No Action	1,681	2,566	14,761,000
8	P/C w/P/C Rest Chan	F/C w/Nav Chan	Restore	1,707	2,893	15,084,000
9	F/C w/Nav Chan	No Action	No Action	865	584	7,158,000
10	F/C w/Nav Chan	No Action	Restore	1,186	1,028	7,465,000
11	F/C w/Nav Chan	F/C w/Nav Chan	No Action	1,500	2,566	14,990,000
12	F/C w/Nav Chan	F/C w/Nav Chan	Restore	1,922	2,893	15,313,000
13	F/C w/F/C Rest Chan	No Action	No Action	865	1,749	6,148,000
14	F/C w/F/C Rest Chan	No Action	Restore	1,186	2,281	6,456,000
15	F/C w/F/C Rest Chan	F/C w/Nav Chan	No Action	1,500	3,042	14,192,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	1,922	3,498	14,514,000
17	Bear Cr/Small Diver	No Action	No Action	750	584	2,682,000
18	Bear Cr/Small Diver	No Action	Restore	1,067	1,042	2,990,000
19	Bear Cr/Small Diver	F/C w/Nav Chan	No Action	1,647	2,566	13,122,000
20	Bear Cr/Small Diver	F/C w/Nav Chan	Restore	1,788	2,893	13,445,000
21	Bear Cr/Large Diver	No Action	No Action	750	1,360	3,751,000
22	Bear Cr/Large Diver	No Action	Restore	1,067	1,960	4,058,000
23	Bear Cr/Large Diver	F/C w/Nav Chan	No Action	1,647	3,126	14,355,000
24	Bear Cr/Large Diver	F/C w/Nav Chan	Restore	1,788	3,498	14,574,000
29	Bear Cr/Small Diver/Slack	No Action	No Action	849	584	5,416,000
30	Bear Cr/Small Diver/Slack	No Action	Restore	1,153	1,042	5,723,000
31	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	No Action	1,754	2,566	13,134,000
32	Bear Cr/Small Diver/Slack	F/C w/Nav Chan	Restore	1,848	2,893	13,458,000
33	Bear Cr/Large Diver/Slack	No Action	No Action	849	1,360	6,546,000
34	Bear Cr/Large Diver/Slack	No Action	Restore	1,153	1,960	6,854,000
35	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	No Action	1,754	3,126	14,329,000
36	Bear Cr/Large Diver/Slack	F/C w/Nav Chan	Restore	1,848	3,498	14,652,000

P/C = partial closure F/C = full closure

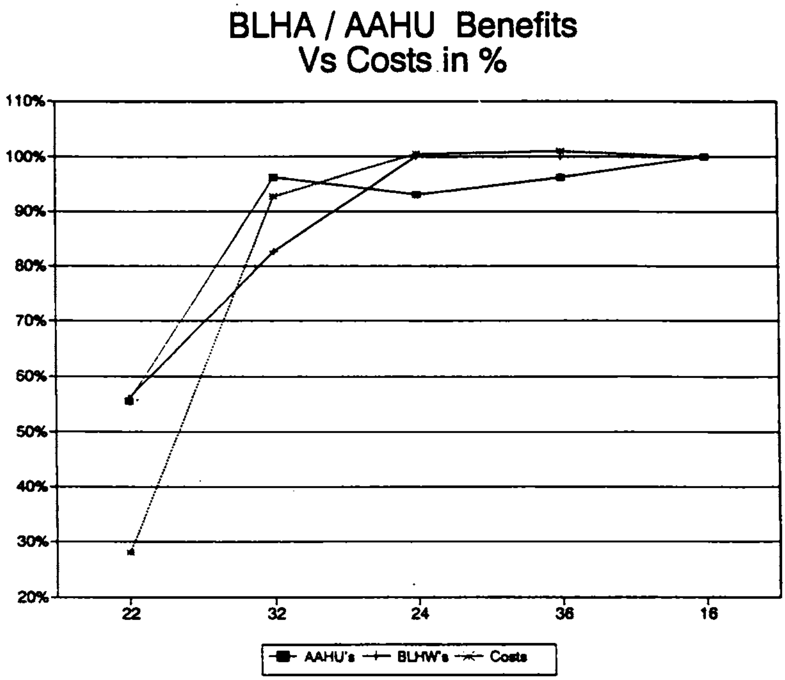


FIGURE 6-1
PRELIMINARY RESTORATION ALTERNATIVES
INCREMENTAL BENEFITS AND COSTS

6.2.1. Alternative #1 - No Action

This alternative will remain a possibility, but will not be one of the recommended plans for this study. The No Action or Without Project Condition shows a significant decline in habitat quality and quantity over the next 50 years. Existing AAHU would suffer an approximate 33 percent decrease and BLHW would suffer an approximate 60 percent decrease over the project life. While these values are significant and important, they will not effect this analysis and therefore Alternative #1 was removed from further discussion or analysis.

Alternative #1 was eliminated from further consideration.

6.2.2. Alternative #2 - Restoration of Mill Creek

Alternative #2 includes restoration of the mouth of Mill Creek with no action at bends #3 and #4. Mill Creek was not one of the areas directly impacted by Corps of Engineers actions during the construction of navigation cut #3 and #4, but is an adjacent area impacted by actions at bend #4 and, if restored, would provide significant benefits to the study area. Restoration of Mill Creek is also very inexpensive as compared to restoration of bends #3 and #4. However, at this point, based on the assumption that a selected restoration alternative should provide a substantial level of restoration for the total study area, this alternative is not considered an effective or viable solution for the study objective. Restoration of Mill Creek would provide 20 percent of potential AAHU and 15 percent of BLHW benefits at 2 percent of potential cost.

Alternative #2 was eliminated from further consideration.

6.2.3. Alternative #18 - Small Diversion Structure at the Upper End of Cutoff Bend #3 to the Mouth of Bear Creek, and Restoration of Mill Creek

Alternatives #18 and #22 differ only in that #18 has a small diversion structure on bend #3 and #22 has a large diversion structure on Bend #3. Based on #22 having higher BLHW benefits and greater flows into Bear Creek, Alternative #18 was removed from further consideration. Mill Creek would also be restored under both alternatives. Alternative #18 would provide 56 percent of potential AAHU and 30 percent of BLHW benefits at 21 percent of potential cost.

Alternative #18 was eliminated from further consideration.

6.2.4. Alternative #22 - Large Diversion Structure at the Upper End of Cutoff Bend #3 to the Mouth of Bear Creek, and Restoration of Mill Creek

Alternative #22 offers restoration action at only two of the three study area sites and has no action at bend #4, it provides 56 percent of the potential AAHU and BLHW benefits at 28 percent of the potential cost.

This alternative also provides maximum water flow into Mill and Bear Creeks, which is 54 percent of total capability for flow restoration. Although #22 does not provide restoration actions at all three locations, it does provide an acceptable level of benefits in order to be selected as a final alternative.

This is a self sustaining project which would not require O&M dredging. This plan has no impact on navigation. This alternative provides the best level of restoration effort for expenditures required, approximately 55 percent of the benefits for 28 percent of the cost. Under traditional Corps of Engineers Net Economic Development guidelines, this could be a recommended alternative since it provides the greatest net benefits of all alternatives considered. After some team discussion, this alternative was chosen as the least action restoration plan acceptable for this project.

Alternative #22 was retained for further evaluation.

6.2.5. Alternative #32 - Small Diversion Structure with Slack Water at the Upper End of Cutoff Bend #3 to the Mouth of Bear Creek, Full Restoration of Cutoff Bend #4, and Restoration of Mill Creek

Alternative #32 offers restoration action at all 3 locations and provides 96 percent and 83 percent of the potential AAHU and BLHW benefits, respectively, at 93 percent of the potential cost. Alternative #32 also provides a 77 percent improvement for water flow over the base condition.

This is a self sustaining project which would not require O&M dredging. This plan still accommodates navigation and, due to the nature and infrequent use of the river for navigation, this is not expected to impact river use. This alternative provides a good level of restoration to the study area, but stops short of maximizing water flow benefits into the project watershed.

Alternative #32 was retained for further evaluation.

6.2.6. Alternative #24 - Large Diversion Structure at the Upper End of Cutoff Bend #3 to the Mouth of Bear Creek, Full Restoration of Cutoff Bend #4, and Restoration of Mill Creek

Alternative #24 offers restoration at all 3 locations and provides 93 percent and 100 percent of the potential AAHU and BLHW benefits respectively at 101 percent of the most effective potential cost, or is 1 percent higher in cost than the most cost-effective alternative. Alternative #24 also provides 100 percent of the potential water flow improvement benefits.

This is a self sustaining project which would not require O&M dredging. This plan still accommodates navigation, and, due to the nature and infrequent use of the river for navigation, is not expected to impact river use.

Alternative #24 was retained for further evaluation.

6.2.7. Alternative #36 - Large Diversion Structure with Slack Water at the Upper End of Cutoff Bend #3 to the Mouth of Bear Creek, Full Restoration of Cutoff Bend #4, and Restoration of Mill Creek

Alternative #36 offers restoration at all 3 locations and provides 96 percent and 100 percent of the potential AAHU and BLHW benefits, respectively, at 101 percent of the most cost-effective potential cost. This is the second most productive plan remaining under consideration. Alternative #36 also provides 100 percent of the potential water flow improvement benefits.

This is a self sustaining project which would not require O&M dredging. This plan still accommodates navigation and, due to the nature and infrequent use of the river for navigation, is not expected to impact river use.

Alternative #36 was retained for further evaluation.

6.2.8. Alternative #16 - Restore Cutoff Bend #3 to Pre-Navigation Cut Conditions, Full Restoration of Cutoff Bend #4, and Restoration of Mill Creek

Alternative #16 offers restoration at all 3 locations and provides 100 percent and 100 percent of the potential AAHU and BLHW benefits respectively at 100 percent of the most cost-effective potential cost. Alternative #16 also provides 81 percent of the potential water flow improvement benefits.

This is a self sustaining project which would not require O&M dredging. This plan still accommodates navigation. With the restoration of cutoff bend #3 to its pre-cut condition, it would not be configured to safely handle navigation in accordance with Corps of Engineers and Waterways Experiment Station guidelines. This restoration is based on the theory that navigation occurred in bend #3 prior to construction of the cut and, under restricted conditions, could still be accommodated today. The purpose of the restoration channel is to restore flow to the bend and to preserve existing resources by not widening the bend to accommodate a full navigation design. Due to the nature and infrequent use of the river for navigation, it is not expected to impact river use.

The study team had some concern about this project maintaining its configuration if navigation increases on the river. If the federal project is moved to an active status or future traffic configurations change, bend #3 might have to be reconfigured and might heavily impact existing bottomland hardwoods which this restoration study tried to avoid. The study team sees this as a major drawback to this plan, and one which should be strongly considered during final plan selection. However, from a restoration objective, the alternative is feasible.

Alternative #16 was retained for further evaluation.

6.3. SELECTION OF INTERMEDIATE RESTORATION ALTERNATIVES

Based upon results of the incremental analysis, five intermediate alternatives were selected which optimized various study objectives. A very brief summary of the rationale for selecting each of the five intermediate alternatives is shown in Table 6-2. Table 6-3 presents a summary of the benefits, costs, and incremental benefits and costs of those five alternatives. Alternatives are listed in order of increasing bottomland hardwood benefits since these are considered the most important restoration benefits.

TABLE 6-2
RATIONALE FOR SELECTION OF INTERMEDIATE ALTERNATIVES

ALTERNATIVE	DESCRIPTION	RATIONALE
22	Bear Creek Large Diversion Restore Mill Creek	Over 55% of maximum attainable benefits at 28% of the cost of maximum restoration. Restores flows into Bear Creek and Mill Creek.
32	Bear Creek Small Diversion Slackwater Channel Bend #3 Full Closure Structure Cut #4 Navigation Channel Bend #4 Restore Mill Creek	Maximizes expenditures for AAHUs, but not for BLHW or flows into creeks
24	Bear Creek Large Diversion Full Closure Structure Cut #4 Navigation Channel Bend #4 Restore Mill Creek	Provides maximum BLHW benefits at higher cost than Alternative #16. Slight reduction in AAHU benefits and slight increase in cost over Alternative #32. Maximum flow into Bear Creek.
36	Bear Creek Large Diversion Slackwater Channel Bend #3 Full Closure Structure Cut #4 Navigation Channel Bend #4 Restore Mill Creek	Provides maximum BLHW benefits at higher cost than Alternative #16, slightly less AAHU benefits and maximum flow into Bear Creek over Alternative #16. Avoids marginal navigation safety conditions with restoration channel in bend #3 with Alternative #16.
16	Full Closure Structure Cut #3 Restoration Channel Bend #3 Full Closure Structure Cut #4 Navigation Channel Bend #4 Restore Mill Creek	Maximum AAHU and BLHW benefits. Lowest cost to produce maximum benefits. Intermediate flow into Bear Creek.

TABLE 6-3
FIVE INTERMEDIATE RESTORATION ALTERNATIVES

AVERAGE ANNUAL HABITAT UNITS					
	ALTERNATIVE				
	22	32	24	36	16
Bend #3	Bear Creek Large Diversion	Bear Creek Small Diversion Slackwater	Bear Creek Large Diversion	Bear Creek Large Diversion Slackwater	Full Closure Restoration Channel
Bend #4	No Action	Full Closure Nav Channel	Full Closure Nav Channel	Full Closure Nav Channel	Full Closure Nav Channel
Mill Cr	Restore	Restore	Restore	Restore	Restore
Net AAHU	1,067	1,848	1,788	1,848	1,922
Avg Ann Cost	$318,000	$1,053,000	$1,140,000	$1,146,000	$1,136,000

(Incremental AAHU)	781	-60	60	74
(Incremental Cost	$735,000	$87,000	$6,000	($10,000)
(Incremental $/AAHU)	$941	($1,450)	$100	($135)

BOTTOMLAND HARDWOOD FUNCTIONAL VALUES					
	ALTERNATIVE				
	22	32	24	36	16
Net BLHW	1,960	2,893	3,498	3,498	3,498
Avg Ann Cost	$318,000	$1,053,000	$1,140,000	$1,146,000	$1,136,000

(Incremental BLHW)	933	605	0	0
(Incremental Cost	$735,000	$87,000	$6,000	($10,000)
(Incremental $/BLHW)	$788	$146	0	0

6.4. DESCRIPTION OF INTERMEDIATE RESTORATION ALTERNATIVES

Table 6-4 presents a description of the five intermediate environmental restoration alternatives.

TABLE 6-4
DESCRIPTION OF FIVE INTERMEDIATE ALTERNATIVES

CUT AND BEND #3	CUT AND BEND #4	MILL CREEK
ALTERNATIVE #22		
●Large diversion structure about 1/3 width of river at cut #3. ●Narrow approach channel to Bear Creek. ●Plug bend below mouth of creek. ●Realign mouth of creek. ●No dredging in bend #3.	●No Action.	●Restore mouth.
ALTERNATIVE #32		
●Small diversion structure at cut #3. ●Narrow approach channel to Bear Creek. ●Plug bend below mouth of creek. ●Realign mouth of creek. ●Dredge slackwater channel in bend below plug, 182' top width x 13' deep. ●Disposal of 131,000 cubic yards in closed navigation cut #4.	●Full closure cut #4. ●Dredge navigation channel in bend #4, 204'-254' top width x 9' deep @6,300 cfs. ●Disposal of 375,000 cubic yards in upland disposal site.	●Restore mouth.
ALTERNATIVE #24		
●Large diversion structure about 1/3 width of river at cut #3. ●Narrow approach channel to Bear Creek. ●Plug bend below mouth of creek. ●Realign mouth of creek. ●No dredging in bend #3.	●Full closure cut #4. ●Dredge navigation channel in bend #4, 204'-254' top width x 9' deep @6,300 cfs. ●Disposal of 375,000 cubic yards in upland disposal site.	●Restore mouth.
ALTERNATIVE #36		
●Small diversion structure at cut #3. ●Narrow approach channel to Bear Creek. ●Plug bend below mouth of creek. ●Realign mouth of creek. ●Dredge slackwater channel in bend below plug, 182'top width x 13' deep. ●Disposal of 131,000 cubic yards in closed navigation cut #4.	●Full closure cut #4. ●Dredge navigation channel in bend #4, 204'-254' top width x 9' deep @6,300 cfs. ●Disposal of 375,000 cubic yards in upland disposal site.	●Restore mouth.
ALTERNATIVE #16		
●Full closure structure at cut #3. ●Dredge full closure restoration channel in bend #3, 182' top width x 13' deep. ●Minimal navigation condition. ●Disposal of 129,000 cubic yards in closed navigation cut #4.	●Full closure cut #4. ●Dredge navigation channel in bend #4, 204'-254' top width x 9' deep @6,300 cfs. ●Disposal of 375,000 cubic yards in upland disposal site.	●Restore mouth.

6.5. BENEFITS AND COSTS OF INTERMEDIATE ALTERNATIVES

Table 6-5 summarizes the net environmental restoration benefits and preliminary costs of the five intermediate alternatives. Preliminary cost estimates include project construction costs, preconstruction engineering and design, construction management, cultural resources investigations for those requiring a disposal area, and monitoring costs. None of the alternatives require future O&M.

TABLE 6-5
BENEFITS AND COSTS OF INTERMEDIATE ALTERNATIVES

ALT	DESCRIPTION			BENEFITS		AVERAGE ANNUAL COST
	CUT & BEND #3	CUT & BEND #4	MILL CR	AAHUs	BLHW	
22	Bear Cr/Large Divers	No Action	Restore	1,067	1,960	$318,000
32	Bear Cr/Small Divers/Slack	F/C w/Nav Chan	Restore	1,848	2,893	$1,053,000
24	Bear Cr/Large Divers	F/C w/Nav Chan	Restore	1,788	3,498	1,140,000
36	Bear Cr/Large Divers/Slack	F/C w/Nav Chan	Restore	1,848	3,498	1,146,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	1,922	3,498	1,136,000

SECTION 7

EVALUATION OF INTERMEDIATE ALTERNATIVES

7.1. INTRODUCTION

The study process resulted in the formulation and evaluation of 36 preliminary environmental restoration alternatives for the study area, which included cut and bend #3, cut and bend #4, Mill Creek, and the non-tidal portions of the creek watersheds. Through an incremental analysis of benefits and costs, these alternatives were narrowed to five intermediate alternatives which meet the overall environmental restoration objectives of the study. The major difference is that Alternative #22 includes No Action at cut and bend #4. Three of the remaining alternatives have a narrow approach channel to the mouth of Bear Creek with a plug in bend #3, while the fourth alternative has full closure of cut #3 and a restoration channel in bend #3.

7.2. INTERMEDIATE RESTORATION ALTERNATIVES

Table 7-1 presents a summary description of the five intermediate restoration alternatives. They are listed in order of increasing bottomland hardwood benefits provided.

Table 7-2 summarizes the benefits and costs of the intermediate restoration alternatives. As previously discussed, real estate costs were not developed for the 36 preliminary alternatives or the 5 intermediate alternatives. Real estate costs are not significant and would not effect the screening of alternatives. Estimated real estate costs for Alternative #22, which has the lowest total cost of the 5 intermediate alternatives, are less than 3 percent of total project costs for Alternative #22. Real estate costs for the more costly alternatives are an even smaller percentage of total project costs. Real estate costs were developed for the final restoration alternatives.

TABLE 7-1
DESCRIPTION OF INTERMEDIATE RESTORATION ALTERNATIVES

ALTERNATIVE	DESCRIPTION		
	CUT & BEND #3	CUT & BEND #4	MILL CREEK
22	Large partial diversion structure at cut #3 Narrow approach channel to Bear Creek Plug bend below mouth of Bear Creek No dredging in bend #3	No Action	Restore
32	Small partial diversion structure at cut #3 Narrow approach channel to Bear Creek Plug bend below mouth of Bear Creek Dredge slackwater channel in bend #3	Full closure of cut #4 Navigation channel in bend #4	Restore
24	Large partial diversion structure at cut #3 Narrow approach channel to Bear Creek Plug bend below mouth of Bear Creek No dredging in bend #3	Full closure of cut #4 Navigation channel in bend #4	Restore
36	Large partial diversion structure at cut #3 Narrow approach channel to Bear Creek, Plug bend below mouth of Bear Creek, Dredge slackwater channel in bend #3	Full closure of cut #4 Navigation channel in bend #4	Restore
16	Full closure of cut #3 Full closure restoration channel in bend #3 (minimal navigation condition)	Full closure of cut #4 Navigation channel in bend #4	Restore

TABLE 7-2
BENEFITS AND COSTS OF INTERMEDIATE ALTERNATIVES

ALT	DESCRIPTION			BENEFITS		AVERAGE ANNUAL COST
	CUT & BEND #3	CUT & BEND #4	MILL CR	AAHUs	BLHW	
22	Bear Cr/Large Divers	No Action	Restore	1,067	1,960	$318,000
32	Bear Cr/Small Divers/Slack	F/C w/Nav Chan	Restore	1,848	2,893	1,053,000
24	Bear Cr/Large Divers	F/C w/Nav Chan	Restore	1,788	3,498	1,140,000
36	Bear Cr/Large Divers/Slack	F/C w/Nav Chan	Restore	1,848	3,498	1,146,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	1,922	3,498	1,136,000

As discussed in Section 5, some of the restoration components would result in a loss of bottomland hardwoods, primarily through destruction of hardwoods during project construction. Based upon the summary of losses to bottomland hardwoods which was shown in Table 5-5, Table 7-3 shows the losses which would result from implementation of the intermediate restoration alternatives. Benefits which were shown in Table 7-2 are net benefits and include losses in Table 7-3. Alternative #22 has no losses since its restoration actions would not result in the loss of any bottomland hardwoods.

TABLE 7-3
INTERMEDIATE RESTORATION ALTERNATIVES
LOSSES TO BOTTOMLAND HARDWOODS

ALT	RESTORATION COMPONENT	BLHW ACRES	AVERAGE ANNUAL FUNCTIONAL INDEX	AVERAGE ANNUAL FUNCTIONAL VALUE
22	None	0	0	0
32	Bend #3 slackwater channel	-5	0.3	-1.5
	Bend #4 navigation channel, high quality	-1	1.0	-1.0
	Bend #4 navigation channel, low quality	-13	0.3	-3.9
	Upland disposal area	-2	0.5	-1.0
	Total loss			-7.4
24	Bend #4 navigation channel, high quality	-1	1.0	-1.0
	Bend #4 navigation channel, low quality	-13	0.3	-3.9
	Upland disposal area	-2	0.5	-1.0
	Total loss			-5.9
36	Bend #3 slackwater channel	-5	0.3	-1.5
	Bend #4 navigation channel, high quality	-1	1.0	-1.0
	Bend #4 navigation channel, low quality	-13	0.3	-3.9
	Upland disposal area	-2	0.5	-1.0
	Total loss			-7.4
16	Bend #3 restoration channel	-5	0.3	-1.5
	Bend #4 navigation channel, high quality	-1	1.0	-1.0
	Bend #4 navigation channel, low quality	-13	0.3	-3.9
	Upland disposal area	-2	0.5	-1.0
	Total loss			-7.4

7.3. DREDGING AND DISPOSAL

All material dredged from bend #4 would be transported by pipeline to the upland dredged material disposal site. For Alternatives #32 and #36 with a slackwater channel in bend #3 and Alternative #16 with a restoration channel in bend #3, all dredged material from bend #3 would be placed within cut #4 after closing of the cut. The cut could hold a total of approximately 131,000 cubic yards. Table 7-4 shows the dredged material volumes for the five alternatives. In bend #3, the dredging volume for a slackwater channel is 93,000 cubic yards and a full closure restoration channel is 129,000 cubic yards. A navigation channel in bend #4 would require removal of 375,000 cubic yards of material. Alternative #22 does not include any channel dredging and thus does not need an upland disposal area.

TABLE 7-4
INTERMEDIATE RESTORATION ALTERNATIVES
DREDGING AND DISPOSAL OF DREDGED MATERIAL

ALT	DESCRIPTION			DREDGED MATERIAL		
	CUT & BEND #3	CUT & BEND #4	MILL CR	TOTAL VOLUME (cu yds)	DISPOSAL AREA	
					UPLAND (cu yds)	CUT #4 (cu yds)
22	Bear Cr/Large Divers	No Action	Restore	0	0	0
32	Bear Cr/Small Divers/Slack	F/C w/Nav Chan	Restore	468,000	375,000	93,000
24	Bear Cr/Large Divers	F/C w/Nav Chan	Restore	375,000	375,000	0
36	Bear Cr/Large Divers/Slack	F/C w/Nav Chan	Restore	468,000	375,000	93,000
16	F/C w/F/C Rest Chan	F/C w/Nav Chan	Restore	504,000	375,000	129,000

7.4. INCREMENTAL BENEFITS AND COSTS

As presented in Section 6, *Selection of Intermediate Alternatives*, Table 7-5 shows the incremental AAHU and BLHW benefits and project costs for each of the intermediate alternatives. It also shows the cost of providing the incremental benefits for each alternative. The alternatives are listed in order of increasing bottomland hardwood benefits.

TABLE 7-5
INTERMEDIATE RESTORATION ALTERNATIVES
INCREMENTAL BENEFITS AND COSTS

AVERAGE ANNUAL HABITAT UNITS					
	ALTERNATIVE				
	22	32	24	36	16
Bend #3	Bear Creek Large Diversion	Bear Creek Small Diversion Slackwater	Bear Creek Large Diversion	Bear Creek Large Diversion Slackwater	Full Closure Restoration Channel
Bend #4	No Action	Full Closure Nav Channel	Full Closure Nav Channel	Full Closure Nav Channel	Full Closure Nav Channel
Mill Cr	Restore	Restore	Restore	Restore	Restore
Net AAHU	1,067	1,848	1,788	1,848	1,922
Avg Ann Cost	$318,000	$1,053,000	$1,140,000	$1,146,000	$1,136,000

(Incremental AAHU)	781	-60	60	74
(Incremental Cost	$735,000	$87,000	$6,000	($10,000)
(Incremental $/AAHU)	$941	($1,450)	$100	($135)

BOTTOMLAND HARDWOOD FUNCTIONAL VALUES					
	ALTERNATIVE				
	22	32	24	36	16
Net BLHW	1,960	2,893	3,498	3,498	3,498
Avg Ann Cost	$318,000	$1,053,000	$1,140,000	$1,146,000	$1,136,000

(Incremental BLHW)	933	605	0	0
(Incremental Cost	$735,000	$87,000	$6,000	($10,000)
(Incremental $/BLHW)	$788	$146	0	0

Alternative #36 is the most expensive of the intermediate alternatives, Alternative #22 is the least expensive, while Alternative #16 provides the most benefits of the five intermediate alternatives.

7.5. INCREASED FLOWS IN CREEKS

Four of the five intermediate restoration alternatives provide improved flows into the three major creek watersheds (Bear Creek, Raccoon Creek, Mill Creek). Alternative #22 would not restore any flows to Raccoon Creek or Flat Ditch Creek, which flows to Mill Creek. Since the mouth of Mill Creek is presently blocked and the creek does not receive any river flows during low flow conditions, it was not possible to model low flow in the creek. However, field observations by District hydraulic personnel of creek configurations and gradient, plus channel configurations of Flat Ditch Creek which flows from bend #4 to Mill Creek, indicated that a conservative estimate would be that restored Mill Creek would convey the same flow as restored Flat Ditch Creek. Therefore, the assumed flow restored in Mill Creek was 38.6 cfs, the same as in the restored Flat Ditch Creek.

Table 7-6 summarizes the increased flows in the creeks with each of the five intermediate restoration alternatives. The percentage of flows is based upon the maximum flows which could be attained with any of the restoration alternatives. There is presently no flow into Mill Creek or the two unnamed creeks during low flow conditions.

The maximum flow in Bear Creek would result from Alternatives #22, #24, and #36 with a large diversion structure to divert partial river flows to bend #3 and to the mouth of Bear Creek. Alternative #16 would moderately increase flows in Bear Creek, and Alternative #32 with a small diversion structure would have the smallest.

At bend #4, dredging the navigation channel under all of the alternatives except #22 would open the mouths of Flat Ditch Creek and the two unnamed creeks which flow to Raccoon Creek. Some minor debris clearing would be required to fully open the creeks. Realignment and restoration of the mouth of Mill Creek would restore flow in the creek.

Total flows in the creeks would range from the current 45.8 cfs to 144.5 cfs with Alternative #16 to 176.9 cfs with Alternatives #24 and #36. Alternative #16 provides the lowest increase in creek flows, since it does not include modifications to force flows to the mouth of Bear Creek. Alternatives #24 and #36 provide the maximum attainable flows in the creeks, with a 290 percent increase over current conditions.

Without restoration in the study area, low flows in all of the creeks will gradually be eliminated as the two bends become totally blocked by sediment. This would result in a total loss of the current 45.8 cfs at low flow in Bear Creek and Flat Ditch Creek.

TABLE 7-6
INTERMEDIATE RESTORATION ALTERNATIVES
RESTORED CREEK FLOWS

CREEK	CURRENT FLOWS	WITHOUT PROJECT FLOWS	ALTERNATIVE									
			22		32		24		36		16	
	(cfs)	(cfs)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)
Bear Creek	45.0	0	77.4	100%	47.4	7%	77.4	100%	77.4	100%	45.0	0%
Flat Ditch Creek	0.8	0	0.8	2%	38.6	100%	38.6	100%	38.6	100%	38.6	100%
Unnamed Creeks	0	0	0	0	22.3	100%	22.3	100%	22.3	100%	22.3	100%
Mill Creek	0	0	38.6	100%	38.6	100%	38.6	100%	38.6	100%	38.6	100%
Total Flows*	45.8	0	116.8	66%	146.9	77%	176.9	100%	176.9	100%	144.5	75%
Total Increase**			71.0	155%	100.5	219%	132.9	290%	132.9	290%	98.1	214%

* Percent increase is percent of maximum attainable flows under any alternative (176.9 cfs).
** Percent increase is percent over current flows (45.8 cfs).

7.6. FUTURE OPERATION AND MAINTENANCE

None of the intermediate restoration alternatives requires periodic maintenance to remove shoals and sediments from the bends. In bend #3, the narrow approach channel was designed to maintain adequate velocities to prevent sedimentation. Sedimentation in the slackwater channel should be minimal over the project life. In bend #4, the navigation channel would have sufficiently high velocities to prohibit sedimentation.

7.7. OVERALL ENVIRONMENTAL RESTORATION

The five intermediate alternatives represent the most cost-effective options for meeting the environmental restoration objectives for the study area. All provide a substantial improvement in both fish habitat and bottomland hardwoods by restoring a large amount of flow in the creeks during low flow conditions and increasing the frequency of overbank flooding in the watersheds. Alternative #16 provides the most fish habitat benefits with the same high bottomland hardwood benefits as Alternatives #24 and #36. However, the restoration channel in Alternative #16 does not maximize flows into the creeks, particularly Bear Creek, like the alternatives with a narrow approach channel to Bear Creek.

There is also a serious question about the safety factors and vessel maneuverability with the minimal navigation channel with Alternative #16. Of particular concern to resource agencies is the possibility that at some time in the future, safety requirements and navigation demands might require construction of a full navigation channel in bend #3, which would result in the loss of critical flows in Bear Creek and the possible loss of aquatic benefits from a slackwater channel.

Alternatives #24, #32, and #36 provide the maximum bottomland hardwood benefits. Alternative #36, along with Alternative #24, provide the highest increase in flows into the creeks and watersheds, but has additional fish habitat benefits over Alternative #24 due to addition of the slackwater channel. Alternative #22 provides the least total flows to the creeks, but does provide maximum attainable flows into Bear Creek.

Alternative #36 has the highest project costs of the five intermediate alternatives, but the four alternatives which provide restoration of bend #4 have a maximum average annual cost difference of only $93,000. Alternative #22 has the lowest cost because it does not include any dredging of bend #4 and the creeks which originate off bend #4, and therefore does not require a disposal area. With an average annual cost of $318,000, Alternative #22 is 28 percent of the cost of the maximum restoration alternative, yet still provides 56 percent of maximum attainable benefits.

7.8. SCREENING OF INTERMEDIATE RESTORATION ALTERNATIVES

The overall goal of this restoration study was to provide the maximum amount of restoration attainable at a reasonable cost. All of the five intermediate alternatives except #22 offer some degree of restoration at all three study locations: (1) cut and bend #3 plus Bear Creek, (2) cut and bend #4 plus Flat Ditch and two unnamed creeks flowing to Racoon Creek, and (3) Mill Creek).

7.8.1. Preliminary Screening of Intermediate Alternatives

During evaluation of the five intermediate alternatives, the District study team made the following decisions:

- Alternative #24 should be discarded because the study team felt the additional gain in AAHU benefits of the slackwater feature in Alternative #36 (60 AAHUs) was worth the additional/incremental $6,000 cost.

- Alternative #32 should be discarded because the study team felt the additional BLHW benefits (605) and flows (77 percent versus 100 percent) provided by Alternative #36 were worth the additional $93,000 expenditures.

- Alternative #16 should be discarded because of the potential for future navigation actions to negatively impact existing resources. In addition, Alternative #36 provides 100 percent potential water flow versus 81 percent provided by #16.

- Alternative #22 would provide a high production of benefits at a relatively low cost, has few negative impacts, and would provide substantially improved flows. In addition, the city of Savannah prefers a minimum cost plan which maximizes flow to and through the creeks. Therefore, Alternative #22 should not be discarded.

- Alternative #36 would provide a high production of benefits, 100 percent of potential improved flows, few negative impacts, and restorations to all three study locations. U.S. Fish and Wildlife Service and Georgia Department of Natural Resources prefer a plan which maximizes flow through the entire study area with minimum negative impacts on existing resources, which would be Alternative #36. Therefore, Alternative #36 should not be discarded.

In summary, Alternative #22 provides the best, or largest, amount of restoration for the smallest dollar amount expended. Alternative #36 best satisfies all restoration objectives. Restoration of bends #3 and #4 plus Mill Creek on the Savannah River would result in a more diverse ecosystem that will benefit commonly occurring plants and animals, in addition to threatened and endangered species, the surrounding wetlands, water quality, and anadromous fish.

Water supply interests would receive incidental benefits from decreased operating expenses as a direct result of improved water quality and increased quantity. Recreational interests would also benefit from improved habitat, since it will result in greater wildlife production and provide better access to fishing and hunting areas within the improved bends and creeks.

7.8.2. Coordination

Based upon study goals and objectives, the District study team felt that Alternative #36 would provide the optimum level of environmental restoration plus include some amount of restoration within the total study area. The study team further concluded that the study objectives required the District to propose a plan which would represent the most cost-effective method of maximizing environmental restoration. Costs of the various restoration alternatives were considered in the incremental benefit evaluation of alternatives, but the District did not seek to minimize project construction costs. During discussions of preliminary alternatives, the FWS had indicated a preference for Alternative #36.

However, the District recognized that the local sponsor would have to pay the total cost-share for any recommended plan while only receiving incidental benefits from any restoration project.

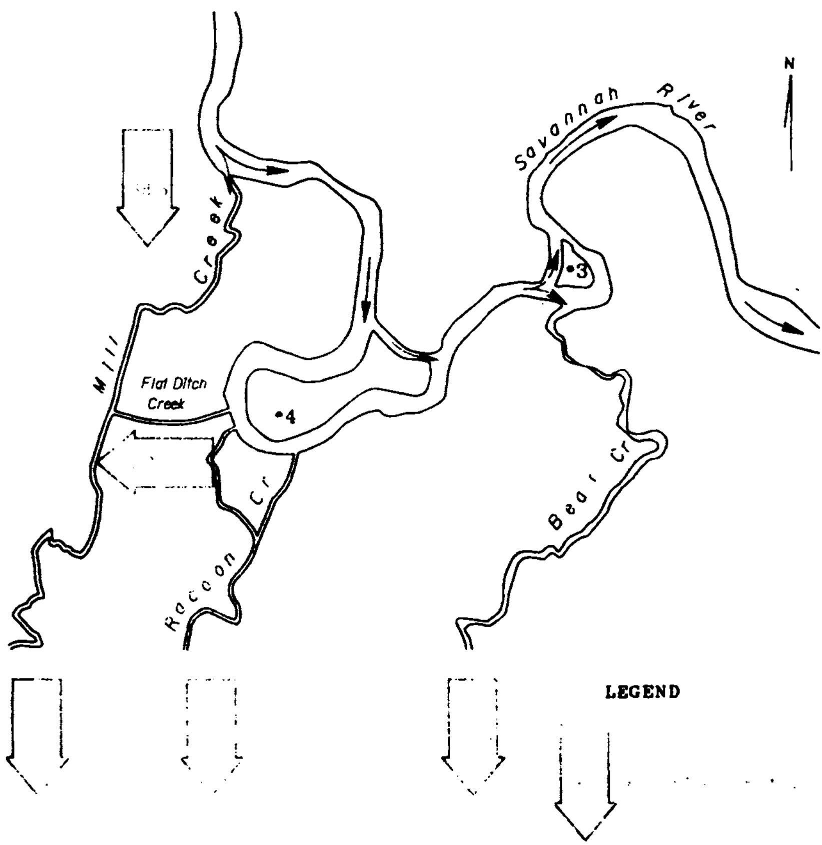
Therefore, the District study team presented the five intermediate alternatives to the local sponsor and the FWS, and identified Alternatives #22 and #36 as the two most desirable alternatives.

7.8.2.1. City of Savannah. The city of Savannah, the local sponsor, was very concerned about being able to justify the additional cost of Alternative #36 over Alternative #22, which was equal to $10,595,000 first cost. Although incidental improved water quality at the city intake was not a study objective, water quality would be improved by any restoration action which restores flows in any or all of the three major creeks. Thus, restored flows in the creeks, especially Bear Creek, with the resulting increase in water quantity and quality at the intake was of major concern to the city.

Alternative #22 would provide a substantial increase in flows in Bear Creek and Mill Creek, although there would be no improvement of flows from bend #4 in Flat Ditch Creek and Raccoon Creek. Total flows in those creeks would increase from the current 45.8 cfs to 116.8 cfs, which is equal to 66 percent of maximum attainable flows.

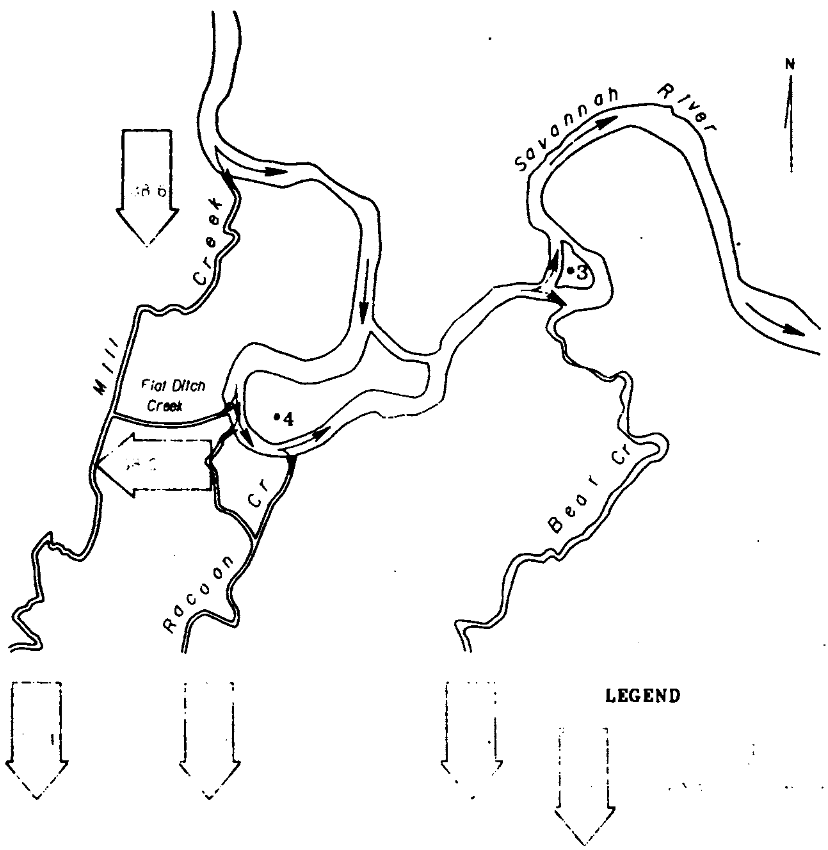
Alternative #36 would provide a total of 176.9 cfs, the maximum attainable in the creeks, by the restoration of bend #4 and creek flows from bend #4.

Figures 7-2 and 7-3 show the restored flows to the creeks and watersheds which would result from implementation of Alternatives #22 and #36. All flows shown as "Current" would eventually be reduced to zero with no restoration project and eventual complete sedimentation of the bends.



	[illegible]
BEAR CREEK	[illegible]
RACOON CREEK	[illegible]
FLAT DITCH CREEK	0 8
MILL CREEK	3[illegible] 6
	11[illegible] 8

FIGURE 7-1
RESTORED FLOWS
WITH ALTERNATIVE #22



BEAR CREEK	[illegible]
RACOON CREEK	[illegible]
FLAT DITCH CREEK	38.6
MILL CREEK	38.6
	176.9

FIGURE 7-2
RESTORED FLOWS
WITH ALTERNATIVE #36

Preliminary cost estimates were $4,058,000 for Alternative #22 and $14,652,000 for Alternative #36. The city recognized the desirability of restoring the ecosystem in bend #4 and Raccoon Creek. However, they concluded that they could not support the large increase in costs from Alternative #22 to Alternative #36 to obtain a 36 percent gain in creek flows. The city did note that if a new or additional sponsor were found to cost share for restoration of bend #4, the city would support Alternative #36. However, there were no apparent or obvious State or resource organizations which might be willing to share the increase in costs from Alternative #22 to #36.

7.8.2.2. U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service concluded that, although they strongly desired a maximum restoration project such as Alternative #36, they recognized that the city of Savannah is the project sponsor and will have to cost share in the recommended plan. The FWS does not expect the city to use its limited funds to pay for a larger restoration project which provides only limited increases in water quality at the city intake. Therefore, the FWS would not oppose Alternative #22, if the decision came down to Alternative #22 or no restoration project.

Although it is possible that if bend #3 and Mill Creek were restored under Alternative #22 with no action at bend #4, future conditions and continued deterioration of bend #4 and Raccoon Creek might emphasize the need for restoration of these remaining areas. However, if the total study area is not restored as a single entity under one project, future funding may not become available under the Federal environmental restoration program. There will be increasingly intense competition in the future for funding for other restoration projects around the nation.

7.8.3. Conclusions

Normally, the District study team would have selected a recommended plan from the five intermediate alternatives. However, circumstances led the Savannah District to conclude there were two alternatives which warranted further evaluation prior to selection of a recommended plan.

After consideration of the views of the city of Savannah and the U.S. Fish and Wildlife Service, the Savannah District concluded that a more detailed evaluation should be conducted of Alternatives #22 and #36. Of particular concern was the cost estimate for the two alternatives. Since the only apparent cost-sharing sponsor for a recommended restoration plan would be the city of Savannah, the city was naturally concerned about the accuracy of the cost estimates for the alternatives, particularly Alternatives #22 and #36.

For the 36 preliminary and 5 intermediate alternatives, the District had necessarily developed only preliminary cost estimates and not detailed MCACES (Micro-Computer Assisted Cost Engineering System) estimates. In a feasibility report, MCACES estimates are normally developed only for a recommended plan. Due to the uncertainties, judgment, and high contingencies included in preliminary cost estimates, MCACES cost estimates are not only more accurate, MCACES estimates are usually lower than preliminary estimates. In addition, the preliminary cost estimates did not include real estate costs.

Therefore, it was concluded that additional detailed information should be developed for the two final restoration alternatives, Alternatives #22 and #36.

7.9. FINAL RESTORATION ALTERNATIVES

After coordination with the city of Savannah and the U.S. Fish and Wildlife Service and a review of the benefits, costs, and overall impacts of each of the five intermediate restoration alternatives, Alternatives #22 and #36 were selected as the Final Restoration Alternatives. Either plan would provide a cost-effective solution for environmental restoration of the study area.

Alternative #22 includes a large diversion structure and narrow approach channel to the mouth of Bear Creek in bend #3 with no dredging in the bend. It also includes realignment and restoration of the mouth of Mill Creek. It does not include any restoration of bend #4. Alternative #22 represents the optimum investment of Federal and non-Federal funds for environmental restoration, with a gain of 56 percent of maximum attainable restoration benefits at a cost of only 28 percent of the most expensive alternative.

Alternative #36 includes a large diversion structure and narrow approach channel to the mouth of Bear Creek in bend #3 and a slackwater channel in the remainder of the bend. A full closure structure would be constructed at navigation cut #4 and a navigation channel dredged in bend #4. The mouth of Mill Creek would be realigned and restored. It provides the maximum attainable of restoration benefits.

7.9.1. Total Project Cost of Final Restoration Alternatives

Detailed MCACES cost estimates were developed for Alternatives #22 and #36, including cost estimates for real estate. Table 7-7 shows the refined total project costs based upon the MCACES construction cost estimates. Equivalent average annual costs based upon a 7.625 percent discount rate and 50-year project life. Also shown for information purposes are the original preliminary cost estimates developed for the preliminary alternatives from Table 5-11. All cost estimates include costs for a 5-year monitoring program to assure the implemented restoration project will function as predicted.

TABLE 7-7
ALTERNATIVES #22 AND #36
REFINED TOTAL PROJECT COSTS

COST ESTIMATE	ALTERNATIVE #22	ALTERNATIVE #36
Preliminary Total Project Cost Estimate (Table 5-11)	$4,058,000	$14,652,000
Refined Cost Estimate using MCACES Construction Costs	3,419,000	12,676,000
Equivalent Average Annual Cost of MCACES estimates	$267,000	$992,000

As shown in Table 7-7, the refined cost estimates for both alternatives are about 15 percent lower than the original preliminary cost estimates, even with the addition of real estate costs. The major reason for the significant increase in project costs from Alternative #22 to Alternative #36 is the large volume of dredging of a navigation channel in bend #4 under Alternative #36. This dredging also requires construction of an upland confined disposal site, which is not needed under Alternative #22. Real estate costs would be slightly higher for Alternative #36 due to the additional work at cut and bend #4 which is not included in Alternative #22.

7.9.2. Impacts of Final Restoration Alternatives

The draft environmental assessment included an evaluation of both Alternatives #22 and #36. No significant impacts were found which would preclude implementation of either alternative.

7.9.3. Public Review of Final Restoration Alternatives

The District decided that the draft feasibility report and draft environmental assessment should present both of the final restoration alternatives for public and agency review prior to selection of a recommended restoration plan. There was a possibility, although unlikely, that a second local sponsor might be identified who could assist the city of Savannah in cost-sharing of Alternative #36. Comments received following the review period indicated support for Alternative #22, although two agencies did express concern that Alternative #36 apparently could not be implemented through lack of local sponsorship.

7.10. RECOMMENDED ENVIRONMENTAL RESTORATION PLAN

The District concluded that Alternative #22 should be the Recommended Environmental Restoration Plan. It does provide significant restoration benefits at a reasonable cost, and the city of Savannah is willing to cost share in the project.

SECTION 8

FINAL RESTORATION PLANS

8.1. INTRODUCTION

During the study process, 36 preliminary environmental restoration alternatives were developed. These were evaluated and screened to 32, eight, then five intermediate alternatives. These were then narrowed to two final restoration plans which best accomplish two diverse study objectives:

- Maximum environmental restoration of area degraded by construction of navigation cuts.

- Most cost-effective investment of funds to meet the study objectives.

Throughout the study, all restoration alternatives were formulated for environmental restoration. However, all of the alternatives also provided incidental benefits by improving water quality at the city of Savannah water intake. The degree of water quality improvement at the intake varied widely among the alternatives with various amounts of restored flows into the creeks. Those alternatives which restored a higher level of flows in the creeks upstream of the water intake would also incidentally provide a higher level of water quality at the intake.

No restoration alternatives were specifically formulated to enhance water quality at the city water intake. However, since the primary restoration benefits would result from restoring flows in the creeks in the study area, restoration of creek flows became a primary study objective and created incidental water quality benefits at the water intake.

Through the iterative process of formulation and screening of potential restoration alternatives presented in earlier sections of this report. Alternative #22 was selected as the Recommended Environmental Restoration Plan. The Recommended Plan is shown in Figure 8-1.

The Recommended Restoration Plan provides a significant amount of environmental restoration benefits at a relatively low total project cost. The local sponsor, the city of Savannah, supports the Recommended Plan and is willing to cost share in project implementation.

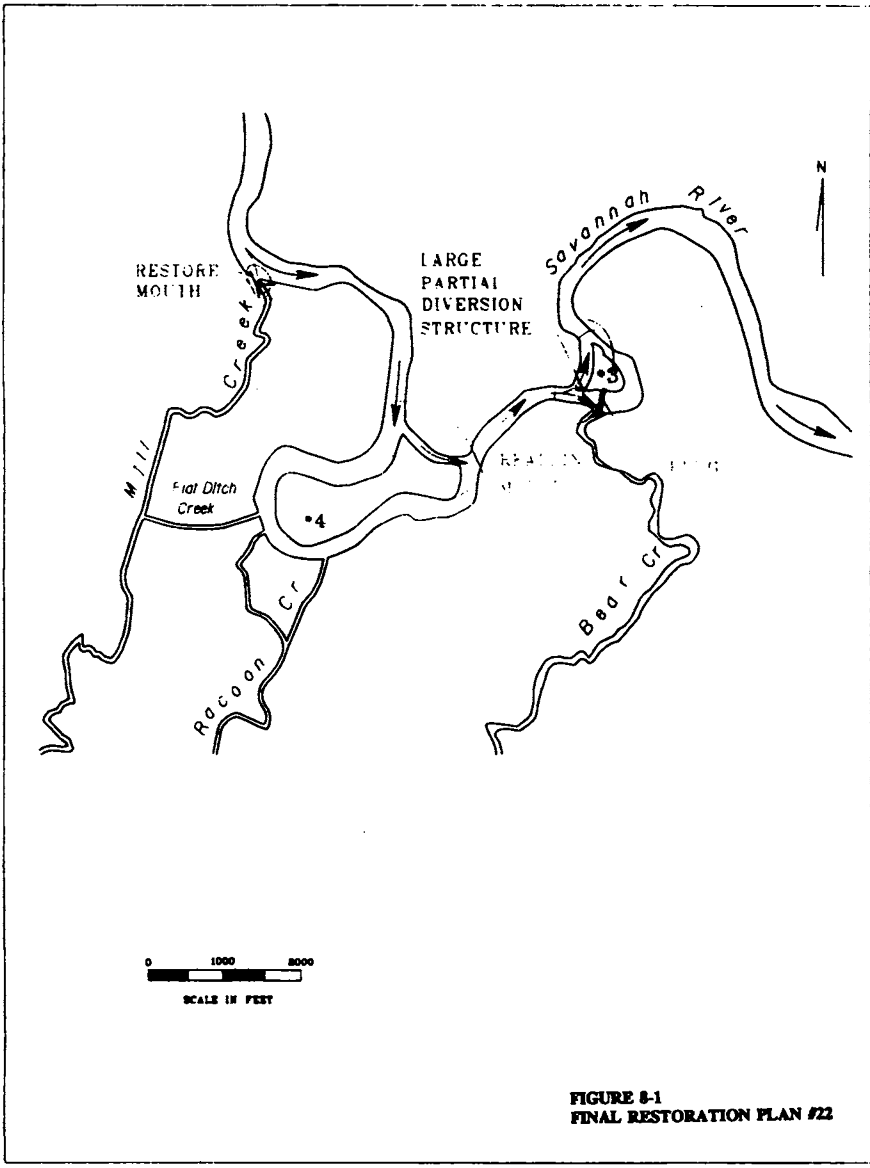


FIGURE 8-1
FINAL RESTORATION PLAN #22

8.2. RECOMMENDED ENVIRONMENTAL RESTORATION PLAN

8.2.1. Description of Recommended Restoration Plan

The Recommended Restoration Plan, Alternative #22, includes:

- **Cut and Bend #3**
  - Construct large diversion structure at the entrance of navigation cut #3
  - Realign the mouth of Bear Creek to enhance flows into the creek
  - Construct narrow approach channel to the mouth of Bear Creek
  - Plug bend #3 below the mouth of Bear Creek

- **Cut and Bend #4**
  - No Action

- **Mill Creek**
  - Realign mouth of Mill Creek

8.2.2. Cut and Bend #3

8.2.2.1. Large Diversion Structure. To restore some river flows to the mouth of Bear Creek in bend #3, a diversion structure would be constructed from the tip of the island between the cut and the bend out into the river. The length would be approximately 1/3 the width of the river. The structure would be constructed of rip rap.

8.2.2.2. Realign Mouth of Bear Creek. The present mouth of Bear Creek is aligned toward the lower part of the bend. This impedes flow into the creek. The mouth would be reoriented so it faces the upstream end of the bend and the river. This would enhance the flow of water from the river, into the bend, and in the mouth of Bear Creek.

8.2.2.3. Narrow Approach Channel. In order to maintain adequate velocities in the bend from the river to the mouth of Bear Creek, a narrow approach channel would be constructed from the river to the mouth of Bear Creek. The island side of the channel would be constructed with sheet pile. The opposite side would be a sloped bank with bank stabilization.

8.2.2.4. Plug Bend #3. The sheet pile for the approach channel would extend and curved across the bend to create a total bend plug. By plugging the bend, all water entering the approach channel would be directed into the mouth of Bear Creek.

8.2.2.5. Bank Stabilization. During high river flow conditions, there would be considerable scouring forces along the outside bank of the approach channel and the downstream side of the bend plug. An articulated concrete mattress was selected for maximum bank protection. Subaqueous backfill and semicompacted fill with high sand content is required to support the concrete mattress. This select fill would be borrowed from bend #4.

8.2.2.6. Flows into Bear Creek. With the large diversion structure, narrow approach channel, and mouth realignment, there would be a significant increase in flows in Bear Creek. Under current conditions, low flows in the Savannah River result in flows of about 45 cfs into the mouth of Bear Creek. With high river flows, the flows in Bear Creek reach about 506 cfs. Table 8-1 shows the estimated amount of restored flows in Bear Creek and velocities in the approach channel with the Recommended Restoration Plan.

TABLE 8-1
RECOMMENDED RESTORATION PLAN
FLOWS AND VELOCITIES INTO BEAR CREEK

	LOW RIVER FLOW (6,600 cfs)		HIGH RIVER FLOW (13,300 cfs)	
	FLOW (cfs)	VELOCITY (fps)	FLOW (cfs)	VELOCITY (fps)
Base Condition	45.0	0.11	506	0.41
Tentative Plan	77.4	0.44	570	1.14
Increase over Base	72 %		13 %	

The Recommended Restoration Plan would result in a 72 percent increase in flows into the mouth of Bear Creek at low flow conditions, which is the critical flow regime for restoration. The velocities in the approach channel would be sufficient to prohibit shoaling and the need for periodic maintenance dredging.

8.2.3. Cut and Bend #4

Under the Recommended Restoration Plan, Alternative #22, there would be No Action at cut and bend #4.

8.2.4. Mill Creek

Under the Recommended Restoration Plan, the mouth of Mill Creek would be realigned toward the river flow and the mouth restored to allow river flows to enter the creek.

8.3. DREDGING AND DISPOSAL OF DREDGED MATERIAL

The Recommended Restoration Plan does not include any dredging. Therefore, a dredged material disposal site is not required for this plan.

8.4. BENEFITS FROM RECOMMENDED RESTORATION PLAN

8.4.1. Average Annual Habitat Units

Implementation of the Recommended Restoration Plan would result in the creation of average annual habitat units (AAHU) within the three major creeks. There would be no losses of AAHUs associated with the plan.

8.4.2. Bottomland Hardwood

Implementation of the Recommended Restoration Plan would result in substantial improvements to bottomland hardwoods in the study area, which have a high significance for environmental restoration. Primary benefits, measured in bottomland hardwood average annual functional values, would accrue within the watersheds of the three major creeks. Wetlands adjacent to bend #3 would also benefit from the increased frequency of overbank flooding. There would be no losses of bottomland hardwoods associated with implementation of the Recommended Plan.

8.4.3. Net Environmental Restoration Benefits

Table 8-2 presents a summary of the net AAHU and bottomland hardwood (BLHW) benefits which would result from implementation of the Recommended Restoration Plan.

TABLE 8-2
RECOMMENDED RESTORATION PLAN
NET RESTORATION BENEFITS

BENEFIT TYPE	AVERAGE ANNUAL BENEFITS	
Average Annual Habitat Units	1,067	1,922
Bottomland Hardwood Functional Value	1,960	3,498

8.5. ENVIRONMENTAL IMPACTS

The following is a summary of the Environmental Assessment which is included in Appendix B. The Environmental Assessment includes an evaluation of the environmental impacts of the five intermediate alternatives, including the Recommended Restoration Plan, Alternative #22. The following is an excerpt of impacts which would result from implementation of the Recommended Plan.

8.5.1. No Action Alternative

Siltation and shoaling within the bends is a natural process which has been severely aggravated by construction of the navigation cuts. Degradation of the bends will continue under the No Action alternative, or Without Project condition.

This degradation will directly affect the available fisheries habitat, larval and juvenile fish movement, and streamflow into the creeks feeding Bear Creek and Mill Creek. All flow to Bear Creek will be lost when bend #3 closes in less than 10 years. Likewise, all flow to Raccoon Creek and Mill Creek will be lost when bend #4 closes in less than 15 years. It is expected that both the surface area and volume of water in the bends and creeks will continue to decrease. Loss and degradation of forested wetlands in the study area will continue to occur. Succession will occur as many of the remaining forested wetland communities convert to drier habitat types. This will reduce the richness and diversity of the river swamp and will degrade or eliminate the values and functions of wetland habitats that are important for fish and wildlife resources. There will be increasing commercial pressure to convert land, which was once wetland, to agriculture and pine plantations that are less productive for wildlife. The hydrologic conditions in the forested wetlands will continue to be affected by the existence of the navigation cuts.

There are no other proposed opportunities to restore this valuable wetland area and wildlife habitat to those conditions which existed before construction of the navigation cuts, nor to increase degraded water quality and quantity within the study area. With the No Action alternative, no habitat units would be added to the 574 average annual habitat units present in the base condition. The actual functional value of the bottomland hardwoods (2,354 acres) would decrease throughout the 50-year life of a restoration project, to 942 acres. The forested wetlands would eventually lose their hydric characteristics, functions, and values, and would no longer support the existing wildlife and fauna diversity.

8.5.2. Environmental Impacts of the Recommended Restoration Plan

The Recommended Environmental Restoration Plan does not include channel dredging in either bend #3 or bend #4, and does not require a dredged material disposal site. It does include construction of a partial diversion structure at the entrance to bend #3, constricted channel to the mouth of Bear Creek, plug across bend #3, and modifications to the mouth of Mill Creek.

8.5.2.1. Endangered Species. Dredging can adversely affect endangered species, such as the shortnose sturgeon, which occur in the Savannah River. However, no dredging is required under the Recommended Plan.

8.5.2.2. Water Quality. Construction of closure structures and the Bear Creek approach channel would result in a temporary increase in turbidity during construction and increased suspended solids in the project area.

Water Quality Certification from Georgia and South Carolina is included in Appendix B, *Environmental Assessment, Enclosure 9, Water Quality Certification.*

8.5.2.3. Suspended Solids. Impacts to fish in Mill Creek would occur during construction, but they would be minor, temporary, and diminish over time. Improvements to the mouth of Mill Creek would increase flows into the creek, which would dilute and minimize impacts of turbidity from the weir effluent. Alternative #22 does not include dredging and therefore does not include a disposal site.

8.5.2.4. Water Quantity. The Recommended Restoration Plan would result in a restoration of some amount of flows in the creeks. Flows in Bear Creek and Mill Creek would be restored, but with no improvement at bend #4, there would be no flow restoration in Flat Ditch Creek or Racoon Creek. Total flow in those creeks would increase from 45.8 cfs to 116.2 cfs.

8.5.2.5. Other Water Quality Parameters. The Recommended Restoration Plan would have no impact on dissolved oxygen or other significant water quality parameters.

8.5.2.6. Air Quality. The project area is located on an attainment area as determined by the Clean Air Act and the State Implementation Plan. Some limited and one-time land clearing and burning of debris at Mill Creek is included under the Recommended Plan. Construction actions are not expected to significantly affect air quality in the area.

8.5.2.7. Sediment Quality. Joint U.S. Environmental Protection Agency/U.S. Army Corps of Engineers agreements require an initial assessment to determine if sediments to be disturbed by construction activities contain any contaminants in forms and concentrations that are likely to cause unacceptable impacts to the environments. Samples were obtained from bends #3 and #4 and analyzed for contaminants.

8.5.2.8. Sediment Analysis. Results of the sediment tests are included in Appendix B, *Environmental Assessment*. The Recommended Plan would not result in the disturbance of material since no dredging is included.

8.5.2.9. Fishery Resources. There would be no impact to the fishery resources under the Recommended Plan.

8.5.2.10. Benthic Resources. There would be no impact to the benthic resources under the Recommended Plan.

8.5.2.11. Vegetation and Wildlife. The Recommended Plan would not have an adverse impact on vegetation or wildlife.

8.5.2.12. Wetlands. There would be no appreciable adverse impacts to bottomland hardwoods or wetlands under the Recommended Plan.

8.5.2.13. Cultural Resources. Intensive shovel testing along the river banks of the two bends and on the cutoff islands and visual inspections of the river banks in the project area showed no artifacts or archaeological sites within the area. The Recommended Plan would not have an adverse impact on known cultural resources.

8.5.2.14. Savannah National Wildlife Refuge. The refuge was originally created, and is presently managed, as a freshwater refuge. The refuge is very susceptible to impacts from development, construction of the navigation cuts, and harbor activities. This Federal wildlife refuge would be a direct and very important beneficiary from the Recommended Plan.

8.5.2.15. Recreation. Adverse impacts to recreation activities would be concentrated around immediate construction activities. After construction, both the Recommended Plan would provide improved opportunities for fishing and boating.

8.5.2.16. Secondary Impacts. Improved quantity and quality of flows at the city of Savannah water intake would be positive secondary impacts and provide incidental benefits.

8.5.2.17. Cumulative Impacts. Cumulative impacts are the effects on the environment which result from the incremental impact from a project added to those experienced as a result of other past, present, and reasonably foreseeable future. Modifications to the natural flow regime from construction of the navigation cuts have caused degradation and loss of forested wetlands.

The bends have been impacted by heavy sedimentation, and are projected to become completed closed in less than 15 years. No action at bend #4, as included under the Recommended Plan, would result in the elimination of fish habitat in the bend. Flows to creeks originating at that bend would reduce to zero, and the Raccoon Creek watershed would be completely isolated from the Savannah River during low flow conditions.

The effects of a restoration project should be more observable in the first few years after construction as vegetation and wetlands respond to the increased flows and flooding.

8.6. REAL ESTATE REQUIREMENTS

8.6.1. Scope

The lands where construction would occur is on private property with the exception of the Bear Creek area which involves U.S. Fish and Wildlife Service lands. The construction area is estimated to be less than 10 percent of the overall lands involved. There are three ownerships in Georgia and one in South Carolina which would be affected by the project. Lands that would be impacted are the mouth of Mill Creek, cut and bend #3, and the mouth of Bear Creek. The Recommended Restoration Plan does not include any action at cut and bend #4. A perpetual channel improvement easement is necessary since permanent structures will be placed in the current navigation channel and tie into the river banks. Detailed information is included in Appendix F, *Real Estate Analysis*.

The Recommended Plan will require a permit from the State of Georgia and USFWS. The state requires a permit and is based on their claim of ownership of all navigable river bottoms. The USFWS will require a permit for the construction and flooding to occur on their lands.

Contacts with the various property owners have been very positive and informative. The owners did not indicate an unwillingness to sell. No opposition is anticipated.

8.6.2. Real Estate Requirements

The real estate requirements are 4.09 acres in a perpetual channel improvement easement and 2.03 acres for a temporary work area easement, as shown in Table 8-3.

TABLE 8-3
RECOMMENDED RESTORATION PLAN
ACREAGE REQUIREMENTS

	GA	SC	TOTAL
Perpetual Channel Improvement Easement	2.93	1.16	4.09
Temporary Work Area Easement	1.33	0.70	2.03
TOTAL	4.26	1.86	6.12

8.6.3. Mill Creek Restoration

The modifications on Mill Creek would require relocating the mouth of the creek. The river flows in a southeasterly direction and this mouth realignment is necessary to increase the flow to the creek. The lands involved are all on the Georgia side of the river and involves one ownership

Construction would involve cutting, clearing and grubbing for the new mouth to be established. Debris would be placed on the side of the creek or hauled to an appropriate disposal site. This would be a provision of the general contract and anticipate a site is available. All of the excavated material would be used in the modifications to the mouth of the river. The area would involve approximately 0.21 acre of a perpetual channel improvement easement and a 0.17 acre for a temporary construction easement for two years. Finished work would include grassing of the areas along the river banks. There would be no future dredging on Mill Creek.

8.6.4. Cut and Bend #3

The Recommended Plan includes partial closure consisting of a diversion or wing dike in the main channel, relocation and constriction of the mouth of Bear Creek, and construction of a plug within the bend downstream of Bear Creek. Lands in both Georgia and South Carolina are involved. Cut and bend #3 would require approximately 3.88 acres for the perpetual channel improvement easement and 1.86 acres for the temporary construction easement.

The diversion or wing dike structure would be a permanent structure, constructed of natural materials. The only land based activity would include points for the tie-in, with the majority of the work being subaqueous with barge mounted equipment and materials. A small area would be required for a temporary construction easement. The wing dike would be completed using a hardened, permanent slope protection and grassing of the top soil. Signs would be posted in the area for safety reasons warning of the wing dike structure's presence.

Restricting the mouth of Bear Creek would involve a driven steel sheet pile wall and a subaqueous fill embankment. The channel would be restricted to about 30 feet, measured at the bottom. All flow entering the bend from the main channel would be diverted to Bear Creek. A plug would be formed downstream of Bear Creek with sheet pilings.

8.6.5. Bear Creek

The mouth of Bear Creek would be moved in a manner similar to Mill Creek in order to increase the flow into the mouth of the creek. A perpetual channel improvement easement and a temporary construction easement would be required. Acreages are included above in the description of cut and bend #3. Two ownerships would be impacted by this construction.

8.6.6. Mitigation

There would be no mitigation of lands since this is an environmental restoration project and what is being restored will more than offset the minor loss of any wetlands. These lands lie in the existing flood plain and are designated wetlands, therefore it was determined that a conservation easement was not necessary. In addition, the regulatory requirements under Section 404 would protect the benefits earned from this project.

8.6.7. Monitoring

The Recommended Plan includes provisions for monitoring the results of the Project for five years after construction. The U.S. Geological Survey and the U.S. Fish and Wildlife Service would monitor the streams in the study area periodi- ılly. These agencies would be responsible for acquiring any rights-of-entry necessary to do this work.

8.6.8. Relocation of Highways, Roads, Railroads, Pipelines, and Utilities

There would be no relocations of highways, roads, railroads, pipelines and utilities.

8.6.9. Uniform Relocation Assistance Cost (P.L. 91-646), As Amended

There would be no alterations or relocations of facilities, structures and improvements, necessary for construction of the project.

8.6.10. Navigational Servitude/Taking Analysis

An investigation of issues involving applicability of navigational servitude and the possibility of a taking of private lands because of increases in surface water/flooding as a result of this project has not been completed. The areas of potential impact are Mill Creek and Bear Creek and their watersheds, not the river itself.

In addressing the issue of a potential "taking", it is necessary to evaluate the conditions that exist before and after project construction and determine whether or not the project would cause: (1) any increase in the frequency, extent, or duration of flooding on land and if there would be a significant increase, and (2) would it cause significant and continuing loss of value and property sufficient to amount to an appropriation or taking of property. Given the fact that the water level will not exceed pre-project levels, the only way there will be a takings is if a legal determination is made that the government does not have the right to return the land to its pre-project conditions. Guidance from HQUSACE indicates that this action would come within the court-upheld rights of the Corps of Engineers to modify its projects. Based on this guidance, it appears there will be no takings.

Due to the complexity of the takings analysis and the lack of known precedents directly applicable to the project, the legal research and taking analysis will be completed during the preconstruction engineering and design (PED) phase. Funding has been included in the PED costs for this work. If the final taking analysis concludes there is a takings, the cost of flowage easements will be developed and this will be added to the project costs.

8.6.11. Project Sponsor Responsibilities

The project sponsor for the project would be the city of Savannah, Georgia. Title to this project would not be vested in the name of the United States. The Government would require all necessary rights-of-way from the sponsor for entry to the project. Prior to advertisement of any construction contract, the sponsor shall furnish to the Government all necessary rights for construction of this project. The sponsor shall also furnish to the Government evidence supporting their legal authority to grant such rights to the land.

The sponsor is financially capable but does not have condemnation authority outside of their jurisdiction. Through a formal request from the city, if necessary the Savannah District would perform the condemnation on behalf of the sponsor. At this time, it is anticipated that the District would have the manpower necessary and capability to perform this action on behalf of the sponsor. For purposes of this report, it is assumed the Savannah District would perform this function rather than the State of Georgia since the state of South Carolina is also involved.

8.6.12. Government-Owned Property

The only known Government-owned lands in the study area are the Savannah River Below Augusta Navigation Project, which is the navigation project for this portion of the Savannah River, and the lands owned by the USFWS. The Government acquired 20.98 acres in Perpetual Channel Right-of-Way Easements in 1961 when the navigation cuts were constructed. These easements represent the areas that were actually removed to create the existing channel as it is known today.

8.6.13. Real Estate Cost Estimate

The Baseline Cost Estimate (BCE) for real estate land values and both federal and non-federal administrative costs and contingencies are shown in Table 8-4. These costs are obtained from Table F-2 in Appendix F, *Real Estate Analysis*, with contingencies included in each line item.

TABLE 8-4
RECOMMENDED RESTORATION PLAN
REAL ESTATE COST ESTIMATE

ITEM	ESTIMATED COST	CODE OF ACCOUNTS
a. Lands: Perpetual Channel Improvement Easement Temporary Work Area Easement Total	$1,000	01 Lands and Damages
b. Improvements	0	
c. Mineral Rights	0	
d. Damages	0	
e. P.L. 91-646, Title III	1,000	01 PL 91-646 Relocations
f. Acquisition (4 ownerships) Federal ($23,000) Non-Federal ($51,000)	74,000	01 Acquisition
g. Local Cooperation Agreement	4,000	30 Planning, Engineering, & Design
h. Audit	1,000	01 Acquisition
i. Takings Analysis	12,000	30 Planning, Engineering, & Design
Total	$93,000	

8.6.14. Real Estate Summary

The Savannah District Real Estate Division would be actively involved in Project Cooperation Agreement (PCA) negotiations and would review the final document, all real estate acquisitions, and all credits associated with real estate activities for the project. Real Estate would be available to assist and provide guidance to the project sponsor throughout implementation of the project. The District would provide support to the sponsor for condemnation if necessary.

8.7. CONSTRUCTION OF RECOMMENDED RESTORATION PLAN

Costs estimates and summary sheets were prepared in accordance with requirements in ER 1110-2-1150. The cost estimates are summarized in the Code of Accounts format to identify costs for various features. The estimates were developed using a team approach, where the cost engineers received input from the design engineers, life-cycle project manager, study manager, and the local sponsor.

Detailed MCACES (Micro-Computer Aided Cost Engineering System) version 5.30 which includes the Cost Engineering Dredge Estimating Program (CEDEP) for hydraulic pipeline dredges and mechanical dredges), estimates were prepared for the Recommended Plan. The MCACES cost estimate for the Recommended Plan is included in Appendix K. The Total Project Cost Summary is shown in Table 8-5.

The environmental sensitivity of the project area dictated the construction methodology. Access to the construction site would be limited to water transportation. All equipment, construction material, and personnel were assumed to mobilize/demobilize from the vicinity of the Ocean Terminal docking facility in Savannah, Georgia. Tows to and from the project site would be hampered by the unmanned swing bridge at Port Wentworth (U.S. Highway 17), unknown channel conditions including snags and shoaling, unknown controlling depth, and bendways.

The study assumed waterfront access in the project vicinity is extremely limited and would not be provided to the contractor, except at the construction sites where upland construction is required, such as at the closure structure tie-in. Construction material would have to be stored on barges if the contractor elected to maintain a stockpile of material. Land access to the constructions sites would be limited to the areas immediately adjacent to the work areas. No staging areas would be provided, with the exception of modification of the entrance to Mill Creek.

Realignment of the entrance to Mill Creek would be accomplished using mechanical equipment and hand labor. Clearing and grubbed material from the mouth entrance would be burned on a bend sandbar.

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY

ALT. #23, MILL CR. - RESTORED, #3 - PART. ROCK CLOSURE **** TOTAL PROJECT COST SUMMARY **** PAGE 1 OF 2

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY STUDY, DATED: 10 December 1995

PROJECT: ENVIRONMENTAL RESTORATION PROJECT (with flow easement)
LOCATION: LOWER SAVANNAH RIVER
DISTRICT: CESAS-EN-C
P.O.C.: EARL P. COPPEDGE, P.E., BRANCH CHIEF

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: 21 November; EFFECTIVE PRICING LEVEL: 21 November — COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 1996; EFFECT. PRICING LEVEL: 1 OCT 96 — COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE — COST ($K)	CNTG ($K)	FULL ($K)
09---	CHANNELS AND CANALS	1,885	438	23%	2,323	1,927	448	2,375	2,118	492	2,610
	TOTAL CONSTRUCTION COSTS ======>	1,885	438	23%	2,323	1,927	448	2,375	2,118	492	2,610
01---	LANDS AND DAMAGES	62	16	26%	78	63	16	79	67	17	84
30---	PLANNING, ENGINEERING AND DESIGN	674	169	25%	843	689	173	862	716	180	896
31---	CONSTRUCTION MANAGEMENT	111	17	15%	128	113	17	130	124	19	143
	TOTAL PROJECT COSTS ==========>	2,732	640	23%	3,372	2,792	654	3,446	3,025	708	3,733

TOTAL FEDERAL COSTS ==============> 2,758

TOTAL NON-FEDERAL COSTS ===========> 975

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $ 0

THE MAXIMUM PROJECT COST IS =======> $ ____________

DISTRICT APPROVED:

Earl P. Coppedge CHIEF, COST ENGINEERING
CHIEF, REAL ESTATE
CHIEF, PLANNING
CHIEF, ENGINEERING
CHIEF, CONSTRUCTION
CHIEF, OPERATIONS
CHIEF, PROGRAMS MANAGEMENT
PROJECT MANAGER
DDE (DP)

DIVISION APPROVED:

CHIEF, COST ENGINEERING
DIRECTOR, REAL ESTATE
CHIEF, PROGRAMS MANAGEMENT
DIRECTOR OF PPMD

APPROVED DATE: 3/21/96

ALT23SR3.TE1

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY STUDY, DATED: 30 December 1995

PROJECT: ENVIRONMENTAL RESTORATION PROJECT (with flow easement) DISTRICT: CESAS-EN-C
LOCATION: LOWER SAVANNAH RIVER P.O.C.: EARL P. COPPEDGE, P.E., BRANCH CHIEF

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: 21 November; EFFECTIVE PRICING LEVEL: 21 November — COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 1996; EFFECT. PRICING LEVEL: 1 OCT 96 — OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE — FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
09---	CHANNELS AND CANALS	1,885	436	23%	2,323	2.3%	1,927	448	2,375	OCT 99	9.9%	2,118	492	2,610
	TOTAL CONSTRUCTION COSTS =====>	1,885	438	23%	2,323		1,927	448	2,375			2,118	492	2,610
01---	LANDS AND DAMAGES	62	16	26%	78	2.3%	63	16	79	SEP 98	6.3%	67	17	84
30---	PLANNING, ENGINEERING AND DESIGN	674	169	25%	843	2.3%	689	173	862	DEC 97	3.9%	716	180	896
31---	CONSTRUCTION MANAGEMENT	111	17	15%	128	2.3%	113	17	130	OCT 99	9.9%	124	19	143
	TOTAL COSTS ==================>	2,732	640	23%	3,372		2,792	654	3,446			3,025	708	3,733

ALT22SR3.WK1

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

Lower Savannah River Environmental Restoration Study
Savannah River, Georgia & South Carolina (w flow ease)
Alternative #22 Mill & Bear Creek Restoration and Cut #3 Partial Closure
PROJECT COST SUMMARY

		Estimated Cost		Contingency	Total Cost
09------	CHANNELS AND CANALS (Except Navigation and Harbors)				
	Mill Creek Restoration	30,000		6,000	36,000
	Bear Creek Restoration	4,000		1,000	5,000
	Cut #3, Partial Closure	1,851,000		431,000	2,282,000
	Subtotal, Construction Costs:	$1,885,000			
	Contingencies @ Average of 23.7 %			$438,000	
	TOTAL CONSTRUCTION COST				$2,323,000
01------	LANDS AND DAMAGES	62,000	25	16,000	$78,000
30------	PLANNING, ENGINEERING AND DESIGN	674,000	25	169,000	$843,000
31------	CONSTRUCTION MANAGEMENT	111,000	15	17,000	$128,000
	TOTAL PROJECT COSTS	$2,733,000		$640,000	$3,372,000

December 30, 1993

ESTIMATED BY: J. A. DICK

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

Alternative #22 Mill Creek Restoration

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	%	CONTINGENCY	CONTINGENCY REASON
09------	CHANNELS AND CANALS (Except Navigation and Harbors)							
0901----	CHANNELS							
090101--	Mobilization, Demobilization and Preparatory Work (1 Mechanical Dredge)	1	JOB	LS	13,820	20	3,000	1
090115--	Mechanical Dredging							
09011502	Site Work							
	Clearing and Grubbing	0.50	Acre	3769.00	1,805	15	0	3
	Clearing and Snagging	106.08	LF	13.43	1,424	50	1,000	4
	Debris Disposal	48	HR	105.05	5,042	15	1,000	3
	Unclassified Excavation	420	CY	15.84	6,653	15	1,000	3
	Slope Shaping	334	SY	1.38	461	15	0	3
	Grassing	2,420	SY	0.22	532	15	0	3
	Subtotal, Construction Costs, Mill Creek Restoration				$30,000			
09---Z--	Contingencies @ Average of 20.0 %						$6,000	
09------	Channels And Canals Total: Mill Creek Restoration						$36,000	

REASONS FOR CONTINGENCIES

1. Uncertain Mobilization Requirements; Equipment, Distance, Etc. (25%)
2. Variations in Estimated Quantities (25%)
3. Minor Variations (15%)
4. Lack of Design and Unknown Conditions (50%)

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

Alternative #22 Bear Creek Restoration

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	% CONTINGENCY	CONTINGENCY	CONTINGENCY REASON
09------	CHANNELS AND CANALS (Except Navigation and Harbors)							
0901----	CHANNELS							
090101--	Mobilization, Demobilization and Preparatory Work (1 Mechanical Dredge)	1	JOB	LS	2,473	20	0	1
090115--	Mechanical Dredging							
09011502	Site Work Clearing and Snagging	106.00	LF	13.43	1,424	50	1,000	2
	Subtotal, Construction Costs, Bear Creek Restoration				$4,000			
09---Z--	Contingencies @ Average of 25.0 %						$1,000	
09------	Channels And Canals Total: Bear Creek Restoration						$5,000	

REASONS FOR CONTINGENCIES

1. Uncertain Mobilization Requirements: Equipment, Distance, Etc. (25%)
2. Lack of Design and Unknown Conditions (50%)

December 30, 1995 Bear Creek Restoration ESTIMATED BY: J. A. DICK

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

Alternative #22 Cut #3 Partial Closure

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	% CONTINGENCY	CONTINGENCY REASON
09------	CHANNELS AND CANALS (Except Navigation and Harbors)						
0901----	CHANNELS						
	Subtotal, Construction Costs, Cut #3 Partial Closure				$1,851,000		
09---Z--	Contingencies @ Average of 23.3 %					$431,000	
09------	Channels And Canals (Except Navigation And Harbors) Total: Cut #3 Partial Closure					$2,282,000	

REASONS FOR CONTINGENCIES

1. Uncertain Mobilization Requirements: Equipment, Distance, Etc. (25%)
2. Variations in Estimated Quantities (25%)
3. Minor Variations (15%)
4. Lack of Design and Unknown Conditions (50%)

December 30, 1995 | Cut No.3 Partial Closure | ESTIMATED BY: J. A. DICK

TABLE 8-5
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COST SUMMARY
(cont'd)

Alternative #22 Mill & Bear Creek Restoration and Cut #3 Partial Closure

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	%	CONTINGENCY	CONTINGENCY REASON
09------	CHANNELS AND CANALS (Except Navigation and Harbors)							
0901----	CHANNELS							
090101--	Mobilization, Demobilization and Preparatory Work (1 Mechanical Dredge)	1	JOB	LS	186,116	20	37,000	1
090103--	Care and Diversion of Water							
09010302	Site Work							
	Georgia D.O.T. Type I Riprap	7000	CY	26.02	182,140	25	46,000	2
	Transportation of Riprap to Worksite	720	MI	84.46	60,811	25	15,000	2
	Riprap Placement	7,000	SY	27.18	190,260	15	29,000	3
	Geotextile Membrane	2,800	SY	2.55	7,140	15	1,000	3
	Topsoil	3,500	SY	0.50	1,750	15	0	3
	Grassing	3,500	SY	0.61	2,135	15	0	3
090118--	Mechanical Dredging							
09011802	Site Work							
	Clamshell Dredging	22,140	CY	4.29	94,981	25	24,000	2
	Shaping Select Fill	22,140	CY	0.99	21,919	25	5,000	2
090103--	Bank Stabilization, Dikes, and Jetties							
09010302	Site Work							
	Clearing and Grubbing	2	AC	4524.00	9,048	25	2,000	2
	Topsoil and Grassing	7,750	SY	1.09	8,448	25	2,000	2
	6-inch Concrete Articulated Mattress	2,980	SY	46.00	137,080	25	34,000	2
090199--	Associated General Items							
09019902	Site Work							
	Cantilevered Sheet Pile	19,600	SF	28.67	561,932	25	140,000	2
	Constricted Channel Sheet Pile	12,600	SF	30.56	385,056	25	96,000	2

December 30, 1995

ESTIMATED BY: J. A. DICK

Restoration, including clearing and snagging, of the first 100 feet of Mill Creek would be accomplished by hand labor crews using small or power tools. Hand labor crews would be used to minimize environmental impacts. No survey data was available to quantify the amount of work required for the clearing of the creek channel entrance. The cost estimate contains assumptions made as a result of a field trip by Savannah District personnel. There are no required dimensions for the clear and snagged restored channel. Debris from the cleared channel would be placed along the channel sides in the flood plain.

A barge-mounted clamshell would place stone for construction of the partial closure structure at cut #3. After completion of the partial closure structure, areas above the water would be covered with topsoil and seeded. Sheetpiling would be installed by a barge-mounted pile driver.

The estimate for streambank erosion control was based upon the use of a concrete articulated mattress. The mattresses would be constructed on barges and lowered into place.

Material would be borrowed from bend #4 when select fill was required for a foundation for the concrete mattress. A barge-mounted clamshell would excavate the material and place it on a barge for hauling to the fill site. The material would be rehandled and placed on the required areas by clamshell or bulldozer

8.8. TOTAL PROJECT COSTS

The MCACES cost estimates developed to refine total project costs are not comparable to the preliminary cost estimates developed for the 36 preliminary alternatives, which used information available at that time and engineering judgment. The refined MCACES cost estimates represent Savannah District's best estimate of project costs, using best available and refined technical information. Some design and cost estimates may be further refined during the preconstruction engineering and design phase.

8.8.1. Total Project First Costs

Total project first costs include construction, real estate, planning, engineering, and design, and supervision and administration. Total project first costs for the Recommended Restoration Plan are estimated to be $3,371,000, as described in the following.

8.8.1.1. Construction Costs. Code 09, *Channels and Canals*, construction costs for the Recommended Plan are estimated to be $2,323,000, including 23 percent contingencies.

8.8.1.2. Real Estate Costs. All real estate cost estimates include 25 percent contingencies. Detailed real estate cost are included in Appendix F, *Real Estate Analysis* and were summarized in Table 8-4.

Code 01, *Lands and Damages*, costs are estimated to be $1,000.

Code 01, *Acquisition*, costs are estimated to be $75,000.

Code 01, *PL 91-646 Relocations*, costs are estimated to be $1,000.

8.8.1.3. Planning, Engineering, and Design. Code 30, *Planning, Engineering, and Design*, costs are estimated to be $843,000, including 25 percent contingencies. These costs were based upon estimates from various District elements, including Engineering, Real Estate, Contracts, Planning, and Programs Management.

8.8.1.4. Supervision and Administration. Code 31, *Supervision and Administration*, costs are estimated to be 6 percent of construction costs, equal to $128,000 including 15 percent contingencies.

8.8.2. Total Project Costs

Total project costs for the Recommended Plan, as shown on Table 8-6, include total project first costs plus any recurring costs after completion of construction, such as maintenance or monitoring.

8.8.2.1. Operation and Maintenance Costs. The Recommended Plan does not include any anticipated future Federal or non-Federal operation and maintenance. The approach channel in bend #3 was designed to maintain velocities to preclude shoaling within the channel. The diversion structure, sheet piling, and revetments would be designed to not require maintenance for the life of the project. Design criteria include such structures must be permanent, and structurally sound, over a variety of conditions.

8.8.2.2. Monitoring Program. In order to determine if the completed project achieves objectives for environmental restoration within the study area, a 5-year monitoring program would be initiated after construction. Every year, the U.S. Geological Survey would assess stream flow and water quality at several locations within the study area. In addition, personnel from the U.S. Fish and Wildlife Service would make periodic field observations of the conditions of the creeks and forested wetlands within the study area. If the stream flow, water quality, or field surveys indicated the project was not performing adequately, measures such as selected clearing and snagging or sediment removal would be performed by the city. One indicator for debris removal would be when stream segments reach Condition Three with unacceptable flow problems, as defined in the *Stream Obstruction Removal Guidelines*. Stream Renovation Guidelines Committee, Wildlife Society and American Fisheries Society, 1983. Debris removal is a normally occurring event and is not project-related O&M.

TABLE 8-6
RECOMMENDED RESTORATION PLAN
TOTAL PROJECT COSTS

ITEM	TOTAL PROJECT COSTS
09 Construction Costs	$2,323,000
01 Lands and Damages 01 Acquisition 01 PL 91-646 Relocations	1,000 75,000 1,000
30 Planning, Engineering, & Design	843,000
31 Supervision & Administration	128,000
Project First Costs	$3,371,000
Monitoring	48,000
Total Project Costs	$3,419,000

The monitoring program would be for two of the three major creeks, Bear Creek and Mill Creek, and would cost $12,000 per year for the 5-year program, or a present value of $48,000. According to Engineering Circular 1165-2-201, June 30, 1994, "*When it is determined that adaptive management and extensive post-construction monitoring is warranted, it will be cost-shared with the local sponsor in accordance with the cost-sharing breakdown for environmental projects (75 percent Federal, 25 percent non-Federal).*"

8.8.3. Interest During Construction

In order to estimate present worth costs for the project construction, the interest during construction must be computed for the project first costs. According to EP 1105-2-45, interest during construction (IDC) accounts for the cost of capital incurred during the construction period. Costs incurred during the construction period are increased by adding compound interest at the applicable project discount rate, 7.625 percent, from the date the expenditures are incurred to the beginning of the period of analysis, or base year. For this analysis, the IDC was determined based on mid-month convention with estimated construction time. IDC is used for the benefit cost analysis but is not included for cost sharing.

The following formula is used for computation of the IDC.

$$IDC=\sum P_m[(1+i)^{n-1}-1]$$

where:

- P_m = the mth monthly payment
- n = number of periods, in months
- i = monthly interest rate

8.8.4. Financial Analysis

Table 8-7 presents the project first cost and interest during construction for the Recommended Plan based upon an interest rate of 7.625 percent, 50-year project life, and 6 months construction. For computation of the IDC, project costs include construction costs plus supervision and administration, but do not include lands and damages or preconstruction engineering and design.

TABLE 8-7
RECOMMENDED RESTORATION PLAN
FINANCIAL ANALYSIS

ITEM	ESTIMATED COST
Project IDC Costs	$2,451,000
Interest During Construction	50,000
Total Project Cost	3,419,000
Total Economic Cost	$3,469,000

8.9. BENEFITS AND COSTS OF RECOMMENDED RESTORATION PLAN

Table 8-8 summarizes the net restoration benefits and total average annual project costs associated with the Recommended Restoration Plan.

TABLE 8-8
RECOMMENDED RESTORATION PLAN
NET RESTORATION BENEFITS AND PROJECT COSTS

ITEM	AMOUNT
Restoration Benefits:	
Average Annual Habitat Units	1,067
Bottomland Hardwood Functional Values	1,960
Total Project Annual Costs	$267,000

8.10. COST SHARING

Table 8-9 presents the cost sharing of total project costs of the Recommended Restoration Plan between the Federal government and the city of Savannah, the local project sponsor. Project cost estimates are based upon November 1995 estimates from Table 8-5, *Total Project Cost Summary*. All lands, easements, rights-of-way, relocations, and dredged material disposal sites are the responsibility of the local sponsor, and local sponsor costs to secure these items are credited toward the sponsor's share of total project costs. Under current policy of Headquarters, U.S. Army Corps of Engineers, for environmental restoration projects, all remaining project costs are cost-shared 75 percent Federal and 25 percent non-Federal.

Table 8-9 also presents total project cost estimates and cost sharing based upon fully funded cost estimates from Table 8-6, *Total Project Cost Summary*. As shown in Table 8-5, November 1995 costs were escalated to October 1996, and then escalated to the midpoint of construction to obtain fully funded costs.

TABLE 8-9
RECOMMENDED RESTORATION PLAN
FEDERAL AND LOCAL SPONSOR COST SHARING

ITEM	TOTAL PROJECT COSTS
DECEMBER 1995 COST ESTIMATE	
09 Construction Costs	$2,323,000
01 Lands and Damages 01 Acquisition 01 PL 91-646 Relocations	1,000 75,000 1,000
30 Planning, Engineering, & Design	843,000
31 Supervision & Administration	128,000
Project First Costs	$3,371,000
Monitoring	48,000
Total Project Costs	$3,419,000
FEDERAL COSTS 75% of Total Project Costs	 $2,564,00
NON-FEDERAL COSTS Cash Real Estate 25% of Total Project Costs	 $802,000 $3,000 $855,000
FULLY FUNDED COST ESTIMATE	
Total Project Costs	$3,733,000
TOTAL FEDERAL COSTS	2,784,000
TOTAL NON-FEDERAL COSTS	949,000

46-054 98 - 7

8.11. VIEWS OF LOCAL SPONSOR AND OTHER AGENCIES

8.11.1. City of Savannah

The city of Savannah prefers the Recommended Restoration Plan, Alternative #22. It provides a significant amount of restored flow to the watersheds above their water intake, while also providing significant restoration of the environment in the study area. A letter from the city expressing a willingness to participate in the project is included in Appendix G, *Pertinent Correspondence*.

8.11.2. U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service prefers any alternative which would maximize environmental restoration in the Savannah National Wildlife Refuge and other lands within the study area. Therefore, they prefer Alternative #36, which almost maximizes attainable benefits of all alternatives.

However, they recognize the position of the city and have indicated they would not oppose implementation of Plan #22, although they are concerned about the continued degradation of bend #4 and Raccoon Creek which would occur under Plan #22. A letter from the U.S. Fish and Wildlife Service regarding the two Final Restoration Plans is included in Appendix D, *U.S. Fish and Wildlife Service Coordination Report*.

8.12. PLAN IMPLEMENTATION

8.12.1. Federal Responsibility

The U.S. Army Corps of Engineers will review and approve all preconstruction reports, plans, and specifications for the proposed work prior to commencement of construction.

8.12.2. Non-Federal Responsibility

The local sponsor shall provide all lands, easements, rights-of-way, and dredged material disposal areas required for the project, and perform all necessary relocations. The value of any contributions thus provided will be credited in the non-Federal share of the project, as specified by Section 103(i) of Public Law 99-662.

8.12.3. Project Cooperation Agreement

A new Project Cooperation Agreement (PCA) for the project must be signed by the Federal government and the local sponsor before the Federal government can participate in construction of the project. This agreement will specify the details of the Federal and non-Federal responsibilities for the project. No Federal commitments relating to a construction schedule or specific provisions of the PCA can be made on any aspect of this project or separable element until:

(1) The project is budgeted for construction, or construction funds are added by Congress, apportioned by the Office of Management and Budget, and their allocation is approved by the Assistant Secretary of the Army (Civil Works) (ASA(CW)); and

(2) The draft PCA has been reviewed and approved by the office of the ASA(CW).

8.12.4. Items of Local Cooperation

The Water Resources Development Act of 1986, Public Law 99-662, specifies cost sharing for water resource projects. Under the provisions of Public Law 99-662, the city of Savannah will sponsor the continuation of the Lower Savannah River Basin through a new Project Cooperation Agreement. The new PCA must include the following non-Federal responsibilities in addition to the responsibility for fulfilling the requirements of Engineering Regulation 1165-2-130:

(1) Provide 25 percent of total project costs assigned to environmental restoration, as further specified below:

a. Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project.

b. Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

c. Provide any additional amounts as are necessary to make its total contribution equal to 25 percent of total project costs assigned to environmental restoration.

(2) Provide 100 percent of total project costs assigned to municipal and industrial water supply.

(3) For so long as the project remains authorized, operate and maintain the physical construction features and excavated channels associated with the project and the hydraulic integrity of the distributary streams in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

(4) Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(5) Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project, any betterments, except for damages due to the fault or negligence of the United States or its contractors.

(6) Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20.

(7) Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

(8) Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

(9) To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

(10) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(11) Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

(12) Provide 25 percent of that portion of total historic preservation, mitigation and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration.

(13) Provide 100 percent of that portion of total historic preservation, mitigation and data recovery costs attributable to municipal and industrial water supply that are in excess of 1 percent of the total amount authorized to be appropriated for municipal and industrial water supply.

8.12.5. Financial Analysis Requirements

A financial analysis is required for any plan being considered for implementation by the Corps of Engineers that involves non-Federal cost sharing. The purpose of the financial analysis is to ensure that the local sponsor understands the financial commitment involved and has a reasonable plan for meeting that commitment. The financial analysis includes:

(1) The local sponsor's statement of financial capability;

(2) The local sponsor's financing plan; and

(3) An assessment of the sponsor's financial capability, to be made by the Corps of Engineers.

Prior to finalization of the Project Cooperation Agreement, the local sponsor or its financial consultant must prepare and submit a financing plan and the statement of financial capability. The statement of financial capability must be signed by the appropriately empowered official representing the sponsor. If a sponsor's financing depends on the contribution of funds by a third party or parties, and the sponsor does not have the capability to meet its financial obligations without this contribution, a separate statement of financial capability and financing plan must also be provided for the contributions for the third party or parties. This must include the source of funds, authority, capability to obtain remaining funds, and evidence of the third party's legal obligation to provide its contribution. The Savannah District believes a detailed statement on financial capability from the sponsor is not necessary at this time. It is anticipated that construction will begin in Fiscal Year 1999. The District's assessment of the local sponsor's financial capability is included in Appendix I, *Local Sponsor Financial Capability*.

SECTION 9

CONCLUSIONS

9.1. NEED FOR ENVIRONMENTAL RESTORATION

The Lower Savannah River Basin environmental restoration study conclusively showed the need for environmental improvement in the study area. With no action, the cutoff bends, creeks, and watershed will continue to experience severe degradation which originated with construction of the navigation cuts. The bends have experienced heavy sedimentation due to low velocities resulting from construction of the navigation cuts, and are approaching zero flow during low flow conditions in the river. The mouths of the creeks which originate in the two bends plus Mill Creek are almost completely blocked and receive little or no flow during low flow conditions. The creeks which provide the critical hydrologic regime for the aquatic habitat and forested wetlands along the creeks must have minimum flows and periodic flooding to remain viable. Low flows and periodic flooding in the bends and creeks have been reduced to the point where the survival of the aquatic habitat and bottomland hardwoods is threatened by irreversible degradation.

The study area, particularly land within the Savannah National Wildlife Refuge, contains an abundance of valuable aquatic and terrestrial habitat. Most of the land within the study area which is not already within the refuge is planned for acquisition. The environmental restoration program offers a unique opportunity to restore and protect these diminishing resources. Without a restoration project, much of the present resources will be lost or permanently degraded.

9.2 OPTIONS FOR ENVIRONMENTAL RESTORATION

The study considered all feasible potential measures to restore the environmental resources of the study area. Since extensive sedimentation in the bends and the mouths of the creeks is the primary cause of the present degradation, removal of some or all of this material is necessary for restoration. No nonstructural measures to restore flows to the bends and creeks were identified. Restoration of flows and frequency of flooding within the study area was identified as the major restoration objective. Although fish habitat is important, preservation of the forested wetlands was considered the more significant environmental benefit from restoration measures. Minimum or no periodic maintenance dredging was also an objective due to the adverse environmental impacts of dredging operations.

The Savannah District study team used best available hydraulic and engineering design information, coupled with a detailed incremental benefit analysis, to evaluate various restoration alternatives. From a broad array of 360 combinations of potential restoration measures in the three study sites, restoration alternatives were narrowed to 36 preliminary alternatives, then screened to 32, eight, and five alternatives.

The District identified two final restoration plans which would provide substantial environmental restoration improvements to the study area, Alternatives #22 and #36. Alternative #36 would provide the maximum amount of restoration benefits, but the project cost would be almost four times the cost of Alternative #22. The city of Savannah, the local sponsor, supports Alternative #22 but cannot justify the large additional increase in costs for Alternative #36, since the water quality improvement benefits which the city would receive are only incidental to the restoration project. In light of fiscal constraints and responsibility to its taxpayers, the city believes it must support the most cost-effective plan rather than a full restoration plan. An additional cost-sharing sponsor for Alternative #36 could not be identified. Therefore, Alternative #22 was selected as the Recommended Environmental Restoration Plan.

9.3. RECOMMENDED RESTORATION PLAN

Following an extensive review of potential restoration alternatives, Alternative #22 was selected as the Recommended Restoration Plan. It would provide 1.067 average annual habitat units and 1.960 bottomland hardwood values in environmental benefits. The Plan includes a large diversion structure and approach channel to the mouth of Bear Creek in bend #3 and restoration of the mouth of Mill Creek, as shown on Figure 9-1. Plan #22 would provide 56 percent of maximum attainable restoration benefits at only 28 percent of the cost of the most productive alternative. It would not provide any restoration of bend #4 or improvement of flows in creeks which originate at bend #4. It does provide a significant increase in flows in Bear Creek and Mill Creek, which will improve water quality at the city water intake. The total project cost of the Recommended Plan is $3,419,000, or an average annual cost of $267,000.

Table 9-1 presents the total project costs, average annual costs, and local cost share of the Recommended Restoration Plan based upon November 1995 cost estimates and fully funded costs.

TABLE 9-1
RECOMMENDED RESTORATION PLAN
TOTAL COSTS AND COST SHARING

ITEM	NOVEMBER 1995 COST ESTIMATE	FULLY FUNDED COST ESTIMATE
Total Project Costs	$3,419,000	$3,733,000
Equivalent Average Annual Costs	267,000	292,000
Federal Cost Share	2,564,000	2,784,000
Non-Federal Cost Share	855,000	949,000

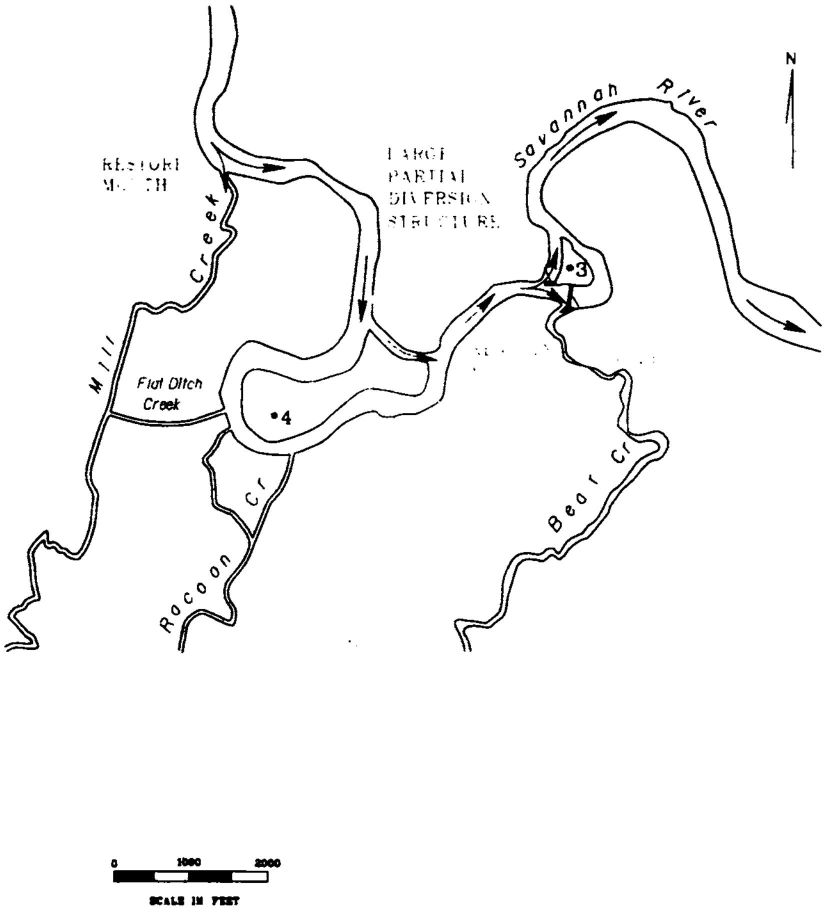


FIGURE 9-1
RECOMMENDED ENVIRONMENTAL RESTORATION PLAN
ALTERNATIVE #22

SECTION 10

RECOMMENDATIONS

I have given full consideration to all significant aspects of this study in the overall public interest, including engineering and economic feasibility, as well as social and environmental effects. The selected plan for improvement described in this report provides the optimum solution for environmental restoration of a portion of the Savannah River below Augusta Navigation Project, Georgia and South Carolina.

I have also assessed the city of Savannah's financial capability and ascertained that it is reasonable to expect that ample funds will be available to satisfy the non-Federal partner's financial obligation for the project. The city's letter of intent to sponsor the project is included in an appendix to this report.

I recommend that the existing Federal navigation project on the Savannah River below Augusta, first authorized by the River and Harbor Act of 1890 and modified by the River and Harbor Act of 1950, have the following improvements made:

1) Construction of a partial diversion structure at the entrance to navigation cut #3 and cutoff bend #3 (River Mile 40.9).

2) Construction of a constricted channel from the entrance of cutoff bend #3 to the mouth of Bear Creek.

3) Realignment of the mouth of Bear Creek within cutoff bend #3.

4) Construction of an earthen closure in cutoff bend #3 downstream of the mouth of Bear Creek.

5) Realignment of the mouth of Mill Creek (River Mile 42.0) at the Savannah River.

The non-Federal sponsor shall comply with all items of local cooperation outlined in Section 8.12.4. of this report.

Further modifications may be made at the discretion of the Chief of Engineers when advisable. The total initial construction cost is estimated to be $3,371,000. The project includes a 5-year monitoring program with a present value of $48,000. for a total project cost of $3,419,000. There are no Federal or non-Federal maintenance costs associated with this project. The non-Federal cost share is estimated to be $855,000 for 25 percent of the environmental restoration features, and the Federal cost share is estimated to be $2,564,000 for 75 percent of the restoration features.

Based on an analysis of overall economic, environmental, and social impacts, the above plan was found to be in the Federal interest and justified for implementation. Therefore, this proposed modification plan for wetland restoration is recommended for approval for Federal construction.

The recommendations contained herein reflect the information available at this time and current Department 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. Consequently, the recommendations may be modified before transmittal to the Congress as proposals for authorization and/or funding.

3/7/96
DATE

GRANT M. SMITH
Colonel, Corps of Engineers
Commander

APPENDICES

APPENDIX A

ENVIRONMENTAL ASSESSMENT
OF NAVIGATION CHANNELS AND CUTOFF BENDS 3 AND 4
LOWER SAVANNAH RIVER RESTORATION PROJECT
EFFINGHAM COUNTY, GEORGIA AND JASPER COUNTY, SOUTH CAROLINA

Prepared by

Environmental Resources Branch
U.S. Army Corps of Engineers
Savannah District
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Savannah, Georgia 31402-0889

MARCH 1996

Appendix A

ENVIRONMENTAL ASSESSMENT

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FIGURES

SUMMARY

The proposed project involves the environmental restoration of the wetland areas and associated habitat around cutoff bends 3 and 4, located approximately at River Mile 41, and modifications to the entrance to Mill Creek as proposed in the Lower Savannah River Environmental Restoration Report. That report documents a study conducted to develop a cost effective strategy to:

-increase flow through cutoff bends 3 and 4 and into Mill Creek;
-increase flow into creeks originating in cutoff bends 3 and 4; and
-restore bottomland hardwoods and fish habitat around the cutoff bends and along the creeks.

Five final alternatives were identified to accomplish the environmental restoration, based on the maximum benefits of bottomland hardwoods restored, Habitat Units derived, and construction costs. A modified version of the Habitat Evaluation Program (HEP) model was developed by U.S. Fish and Wildlife Service to quantify the environmental value of a habitat. These Habitat Units represent the value of fish and wildlife habitats resulting from implementation of each alternative. To estimate impact of restoration activities on bottomland hardwoods, a functional index of wetland value was developed. This functional index was based on the estimated amount of base flow in the tributary system and estimated amount of flood water provided to the wetland system.

Alternative #22 - Realignment and Constriction of the Mouth of cutoff bend 3 to the mouth of Bear Creek; Restoration of Mill Creek, and No Action in cut 4 is the recommended plan to accomplish the environmental restoration.

This Environmental Assessment (EA) documents the environmental impacts of the proposed project, in compliance with the requirements of the National Environmental Policy Act (NEPA), the Fish and Wildlife Coordination Act, Clean Water Act - Section 404 (b) (1) and Section 401, the Clean Air Act, the Endangered Species Act of 1973, and the National Historic Preservation Act. The draft EA was circulated for review and comment from other Federal, State, and local agencies. The public was also informed of the availability of the draft EA for review and comment through a Public Notice issued on December 27, 1995. Response to comments received during the public review period is included in Enclosure 7. The Corps' final decision on the project is documented in this final EA and Finding of No Significant Impact (FONSI).

1.00 **BACKGROUND.** Savannah District maintains the Federal Navigation Project known as the "Savannah River Below Augusta" (SRBA). This project includes the Savannah River and surrounding wetlands from the vicinity of Augusta, Georgia to the upper end of the Savannah Harbor (River Mile 21.3). The SRBA has an authorized depth of 9 feet and width of 90 feet. The total length of the navigation channel is 180.85 miles. This project also includes a lock and dam at New Savannah Bluff (River Mile 203.0), approximately 15 miles downstream from Augusta.

1.02 Although the navigation channel has not been maintained in recent years, the river remains a navigable waterway and is periodically used for transporting equipment and materials to industries located upstream of the project. Navigation Cuts 3 and 4 were made to improve navigation after the project was authorized by Section 101 of the River and Harbor Act of 17 May 1950 and remain open, while the cutoff bends have filled in with sediment, from both natural sedimentation processes and past disposal of dredged maintenance materials.

1.03 A Reconnaissance Report title "Lower Savannah River Environmental Restoration" was completed in April, 1992. This study was authorized in a resolution passed on 1 August 1990 by the U.S. House of Representatives, Committee on Public Works and Transportation. The Reconnaissance report resulted in a determination that there was a federal interest in restoring the environment of the Lower Savannah River. The City of Savannah was identified as a cost-sharing partner for a feasibility level study for Navigation Cuts 3 and 4.

2.00 **PROJECT DESCRIPTION.** The proposed project is the environmental restoration of cutoff bend 3 located approximately at River Mile 41, thereby increasing water flow in Bear Creek, Little Abercorn Creek, Mill Creek, and the surrounding wetlands. The restoration will include the partial closure of the navigation cut, realignment and constriction of the mouth of cutoff bend 3 to Bear Creek, and restoration of flow to the entrance of Mill Creek. The creeks that originate in the cutoff bend and Mill Creek flow through the Savannah National Wildlife Refuge and eventually discharge into Abercorn Creek. The City of Savannah's water intake is located on Abercorn Creek (Project Area Map - Figure 1).

2.01 Project alternatives included the construction of diversion structures in cutoff bend #3, closure structure on cut 4, construction of a navigation channel through cutoff bend #4, restore cutoff bend #3 to pre-navigation cut conditions, modifications and relocation of Bear Creek entrance, modifications to the Mill Creek entrance onto the Savannah River, construction of an upland disposal area, hydraulic dredging, clearing and grubbing, placement of dredged material behind the closure structures, and possible jet-spray maintenance dredging.

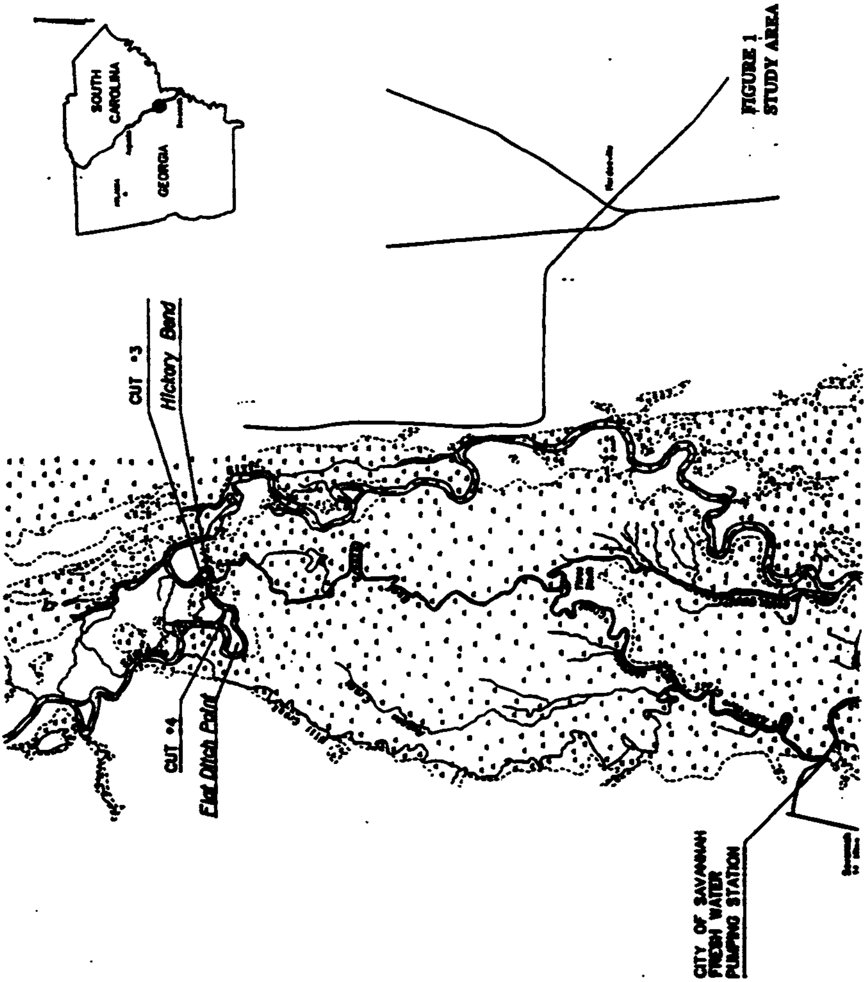

FIGURE 1
STUDY AREA

3.00 PURPOSE AND NEED FOR PROJECT. The forested wetlands on the study area represent the largest contiguous block of palustrine forested wetlands on the Georgia side of the Savannah River. Most of the ecosystem benefiting from the proposed environmental restoration project is within the Federal Savannah National Wildlife Refuge. These forested wetlands are important habitat to many significant commercial and recreational fish and wildlife species, as well as to endangered and threatened plants and animals, and to migratory birds that utilize the area for reproduction and shelter.

3.01 Modifications to the natural flow regime have caused loss and degradation of forested wetlands along the lower Savannah River. The hydrologic conditions in the forested wetlands have been affected by these modifications. The cutoff bends have filled with sediment and navigation is almost impossible through the meanders.

3.02 The City of Savannah has experienced declining water quality (pH) at its municipal and industrial fresh water intake facility on Abercorn Creek. The tributaries that flow into Little Abercorn Creek and eventually to Abercorn Creek include Bear Creek, Raccoon Creek and Mill Creek. The entrance to Bear Creek is located on Savannah River cutoff bend #3. The City believes that the creek has silted as a result of the navigation cut and reduced flows into Bear Creek.

3.03 The proposed project would provide the opportunity to restore the natural flow regime in creeks and wetland areas, while simultaneously restoring the environment and wildlife habitat and the associated 4,708 acres of functional value wetlands to conditions similar to the pre-navigation project. The new flow regime will provide diverse and productive fish and wildlife habitat in the lower Savannah River. Modifications to the entrance of Mill Creek on the Savannah River would also increase flow to the wetland areas. Frequency and duration of overbank flooding would increase with the restoration project. Restoration of flow to Bear Creek would provide an additional benefit of improving the quality and quantity of water used by the City of Savannah. This action should reduce the amount of stain present in the water and consequently the cost of treating the water. The City spends in excess of $100,000 a year to remove this stain from the city's drinking water.

4.00 ENVIRONMENTAL SETTING WITHOUT THE PROJECT. The project area begins on the east at Savannah River Mile 29 at the juncture of Abercorn Creek and extends upstream to approximately River Mile 42 at the mouth of Mill Creek.

4.01 **Geography.** The area is best characterized as forested bottomland hardwood swamp and tupelo gum-cypress swamp at the upper reaches of tidal influence. Topographic gradients are extremely slight, varying from 2 feet to 15 feet above mean sea level (msl). High areas are associated with the oxbows, where downstream overflows have constructed levees of varying widths and consistency.

4.02 On the west bank of the Savannah River floodplain and directly west of Mill Creek rises a shallow to steep slope that faces east to northeast to an elevation of 15 feet at the Abercorn Creek pumping station then to 50 feet msl for several miles. The bluff to the northwest along the Savannah River, known as Old Wood Landing, increases from an elevation of 50 feet southwest toward Rincon to 75 feet msl. The bluff contains the Savannah Electric and Power Company fossil fuel plant and water intake/outfall structures. To the south of Savannah Power and west of Mill Creek, the Fort Howard Paper Mill and settling ponds occupy much of the high ground. The Beaufort-Jasper Water Authority Freshwater Canal junctures with the Savannah River at mile 39.2 and courses northeast. Becks Ferry Boat Ramp on the South Carolina side is located at mile 38.9 across from Bridge Point. Mayer's Lake and Coleman Lake are old natural oxbow channels that empty into the river from the northeast bank. Bear Creek divides the project area. It originates at cutoff bend 3 and courses south, where at Three Mouths, it divides into Little Abercorn Creek that flows southwest and Little Collis Creek that flows south into Big Collis Creek and the Savannah River. Sloughs originate at overflow points on cutoff bend 4 and flow southeast to Bear Creek and south-southwest to Raccoon Creek then Abercorn Creek. Dasher Creek and Sweigoffer Creek both flow from the southwest through old backbarrier lagoonal systems northeast into Mill Creek before the latter empties into Abercorn Creek (See Figure 2). Although no saltwater reaches the project site, the lower half of the study area is strongly influenced by tidal flooding. The South Carolina bank is characteristic bottomland hardwood swamp with some clear-cut timber harvest areas. Recent timber harvests on the Georgia bank occur opposite Flat Ditch Point (cutoff bend 4).

4.03 **Geology**. The project area lies in the Lower Coastal Plain Region, known widely as the Atlantic Coast Flatwoods, characterized by a series of incompletely preserved marine terraces and associated barrier island-type sandy ridge structures (Huddlestun, 1988). These old shorelines are associated with different stages of the sea as it reached equilibrium during each melt of the glacial ice caps during the Pleistocene Epoch (1-2 million years BP). The sandy ridge structure occupied by Rincon to the southwest of the project area represents a stand of the sea known as the Penholoway Terrace Barrier (+75' or 24.6m. msl). Seaward of that terrace are remnants of the Talbot Shoreline at +45' msl, the Pamlico Shoreline at +25' msl, the Princess Anne Shoreline at 15' msl, and the Silver Bluff Shoreline at +5' msl. Seaward of the Silver Bluff Shoreline are Holocene deposits less than 5,000 years in age. The unconsolidated surface sediments of the project area are alluvial deposits of Holocene age or of the historic period of European occupation. The stratigraphy of the outcroppings in the Rincon area are described by Huddlestun (1988) as the Cypresshead Formation, 55 to 60 feet in thickness, underlain by the Ebenezer and Berryville Clay Members of the Coosawhatchie Formation, which is underlain by the Marks Head Formation and the Lazaretta Creek Formation. The Cypresshead sediments are Pliocene ($3x10^6$ yrs.) and the Coosawhatchie and Marks Head are middle and lower Miocene (14 to $18x10^6$ yrs.) in age (Huddlestun, 1988). The Satilla Formation which occurs to the east in Chatham County does not occur in the Rincon area. One can safely assume that the project area (+2' to 15' msl) was inundated by the sea several times during the Pleistocene period. Some sediments were reworked and redistributed by the sea during these events.

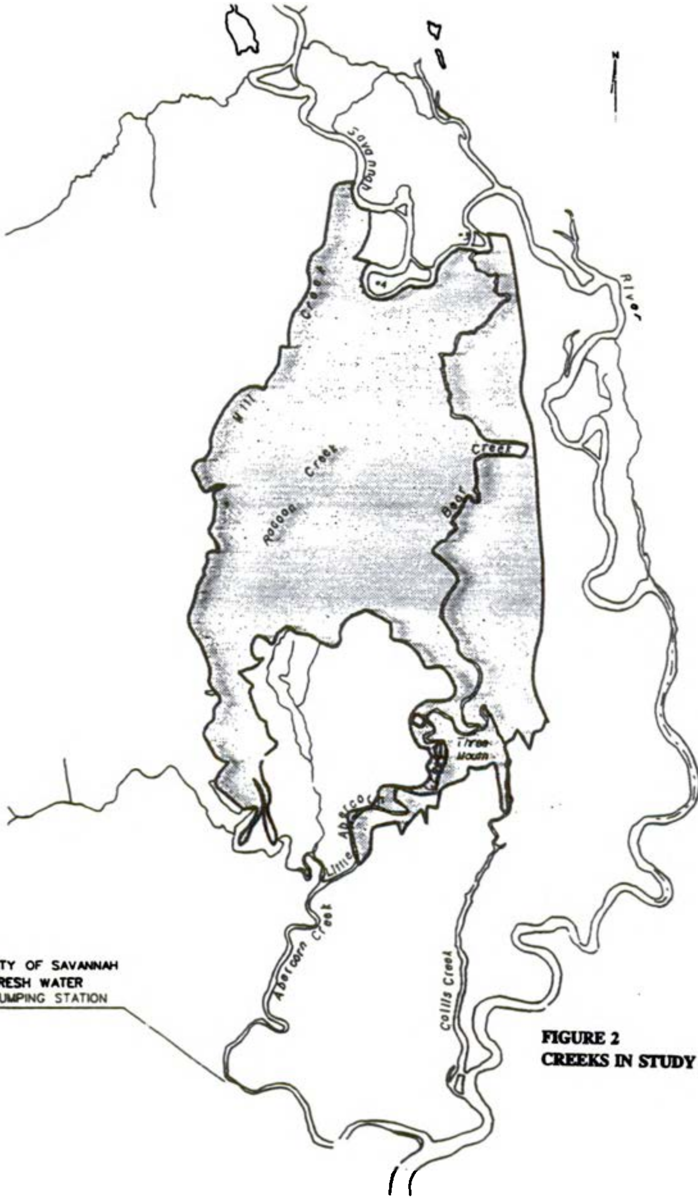

FIGURE 2
CREEKS IN STUDY AREA

4.04 **Soils**. The two prevailing soil types found on the area are the Chastain and Tawcaw soil series. According to Mack Thomas (1994) these soils are mapped as the Chastain-Tawcaw Complex. Although not differentiated on the advanced field soil sheets, Chastain is typical of the semi-permanently flooded region below Bear Creek, and in a line running east and west from Three Mouths. The Chastain loam is a fine, kaolinitic, acid, thermic, typic fluvaquent that developed in clayey fluvial sediments (U.S.D.A., 1978). The Chastain soil is poorly drained, slowly permeable, with slopes less than 2 percent. The soil has fine stratifications at a shallow depth or it lacks a cambic horizon. Mottling may extend downward from a point very close to the surface, and the water table is at or close to the surface most of the year. The soil supports cypress and gum species. Kaolinite content is more than 50 percent by weight (U.S.D.A., 1975). The Tawcaw soil series occurs on low ridges and flats throughout the northern part of the project area. It is subject to occasional flooding and supports deciduous hardwood species. The Tawcaw series is a fine, kaolinitic, thermic, fluvaquentic dystrochrept that formed from alluvium of Holocene deposits or from deposition associated with European settlement of the upland (U.S.D.A., 1975, 1978). The series is a silty clay loam, somewhat poorly drained, with slow permeability (U.S.D.A - S.C.S. Soil Descriptions: 1981, 1984). This series has mottles of low chroma in a brownish matrix. Associated series on blackwater creeks are Rutledge and Surrency soils. Effingham County, Georgia, lies in the same physiographic province as Jasper County, South Carolina. No soil survey is currently available for Effingham County and the soil description relies on that for Jasper County since the environmental setting is similar to that just across the river. In addition, soils in this area of the Savannah River floodplain appear to be very much alike on both sides of the river (Stuck, 1980).

4.05 **Hydrology**. The nearest stream flow gage is located at River Mile 60.9, about 3 miles north of Clyo on the bridge of the Seaboard Coast Line Railroad. The period of record is October 1929 to September 1933, and October 1937 to the current year. Recorded gage at site since 1945. The Savannah River flow is regulated by Lake Burton, Mathis Reservoir, Hartwell Lake, Richard B. Russell Reservoir, and Thurmond Lake, which are multi-use hydroelectric reservoirs. The drainage area for the Savannah River above Clyo is 9,850 mi^2, approximately (U.S.G.S.-1992, station 02198500, Savannah River). Ebenezer Creek is the largest stream emptying into the Savannah River below the gage site. The annual mean discharge rate is 11,740 cfs, the annual runoff for the period of record is 16.19 inches. The maximum annual mean discharge is 20,900 cfs (1964) whereas the minimum annual mean is 6,399 (1988). The extreme flows for the period of record are a maximum discharge of 270,000 cfs (estimated) on Oct. 6, 1929 and a minimum daily discharge of 1,950 cfs (Sept. 27, 1931). The highest daily mean is 203,000 cfs on Oct. 21, 1929. The annual seven-day minimum flow of record is 2,470 cfs, whereas in recent years (1991-1992) this is maintained at 6,030 cfs. Tidal fluctuations within the Savannah estuary are semi-diurnal, averaging 6.8 feet at the mouth of the harbor and 7.9 feet at the upstream limit of the harbor, with tidal influences extending upstream to River Mile 44. The point of flow reversal is at River Mile 31, approximately 2 miles upstream of the mouth of Abercorn Creek. The limit of salt water influence is downstream of U.S. Interstate 95. The mean slope of the river in the lower Coastal Plain is 0.50 feet per mile (U.S. C.O.E., 1992).

4.06 **Climate**. The project area is located approximately 30 miles inland from the Atlantic shoreline. The nearest meteorological station is located at the Savannah Airport. The area has a temperate climate, with a seasonal low temperature of 51 degrees in winter, 65 degrees in spring, 80 degrees in summer, and 66 degrees in autumn. The mean annual temperature is 66.9 degrees F. (N.O.A.A., 1993). Summer temperature highs and winter lows are moderated by the nearness to the ocean. The Gulf Stream passes within 60-80 miles offshore. Summer daytime temperatures are typically in the high 80's and 90's from May through September (Carter, 1974). Minimum temperatures in the summer are in the low 70's or upper 60's. Summer humidity is high with averages ranging from 90 percent between 1 and 7 a.m. to about 60 percent between noon and 3 p.m. Winters are mild and short. Cold fronts usually last 2 or 3 days and alternate with longer periods of mild weather. The freeze-free growing season is about 265 days, slightly longer on the coastline. Based on the 1951-1980 period, the average first occurrence of 32 degrees F. in the fall is November 15 and the average last occurrence in the spring is March 10. The normal annual rainfall is about 49 inches. Extreme ranges in precipitation for the 30-year period from 1964-1993 are 73.17 inches in 1964 to 35.41 inches in 1978 (N.O.A.A., 1993). Afternoon thunderstorms are frequent in mid-summer. The heaviest rainfall in the area occurs in association with tropical cyclones. Hurricane frequency for class one (1) storms on the Georgia Coast is 1 in 10 years. The last hurricane to impact the area was Hurricane David, which had a land-fall on Ossabaw Island in September 1979. Snowfall is insignificant for the Georgia coast.

4.07 **Wetlands**. The entire area is classified as palustrine forested wetlands except for the stream/river courses, which are classed as riverine wetlands (U.S.D.O.I., 1981,1989). Georgia Department of Natural Resources conducted a vegetation survey in the vicinity of the project area in 1994. Cutoffbends 3 & 4 and overflow areas are palustrine broad-leaved deciduous forests that are seasonally flooded. Dominant species are green ash, red maple, swamp laurel oak, water hickory, tupelo gum, overcup oak, sweetgum, ironwood, and American elm. Understory shrubs, seedlings, and vines include green-briar, sycamore, swamp privet, poison ivy, green ash, red maple, and several other vines including cross-vine and trumpet-creeper. Giant cane is also common in patches. Slightly higher terraces are temporarily flooded and are dominated by sweetgum, swamp laurel oak, sycamore, water hickory, green ash, ironwood, river birch, red maple, American elm, poplar, and overcup oak. Old sandbars are classed as palustrine broad-leaved deciduous scrub-shrub, temporarily flooded. These are dominated by green ash, black willow, silver maple, river birch, sycamore, water hickory, and American elm. These old sandbars are areas in the cutoff bends that have accumulated sediments and have become vegetated. Wharton (1982) described the moderately wet to drier alluvial floodplain flats on Bear Island (east of Bear Creek) as a rare, nearly virgin, sweetgum-diamondleaf oak-green ash forest.

4.08 Some areas south of cutoff bend 4 and between Raccoon Creek and Mill Creek were previously palustrine forested wetlands but timber has been harvested in the recent past. These areas are in various stages of regeneration and are now classified as palustrine broad-leaved deciduous scrub-shrub, seasonally flooded. These areas are expected to eventually return to the seasonally flooded palustrine broad-leaved deciduous forest category as the vegetation continues to grow.

4.09 The southern half of the project area is under tidal influence and is classed as palustrine deciduous forest, semi-permanently flooded. Dominant species are tupelo gum, swamp blackgum, bald cypress, and sweetgum. The riverine habitat is lower perennial, unconsolidated bottom, and permanently flooded. This area includes all flowing streams and sloughs. Some marginal areas along the tidally influenced streams have freshwater marsh habitat classed as palustrine, persistent emergent, and semi-permanently flooded. The dominant species are giant cutgrass (Zizaniopsis), wild rice, tidemarsh amaranth, arrow-heads, false-nettle, and pickerelweed.

4.10 **Wildlife.** The river, meanders, permanent streams, sloughs, depressions, forested, scrub-shrub, and emergent wetlands provide a diversity of habitat for migratory and resident wildlife species. The mid-age hardwood bottoms provide cavity and rotting log habitats for many birds, reptiles, amphibians, and small mammals. Edge habitat is provided along waterways and around clear-cuts. Natural openings occur in the forest canopy where old trees are blown down or die of other natural causes. The entire project area is free of any naturally caused fire. Timber harvesting in recent decades is limited to a small clearcut (<30 acres) just south of cutoff bend 4.

4.11 Common game species occurring on the area are white-tailed deer, feral hog, raccoon, gray squirrel, marsh rabbit, opossum, mourning dove, wood duck, and turkey. Other fur bearing species potentially occurring on the site are bobcat, river otter, mink, gray fox, coyote, and beaver.

4.12 A list of potentially occurring terrestrial vertebrate species developed by Winn & Schneider (1994) includes 49 amphibians, many of which are salamander, tree frog, chorus frog, and other frog species; 58 reptiles, including many turtles, lizards, and snakes; 245 birds, including many species of herons, ducks, hawks, rails, owls, woodpeckers, wrens, thrushes, vireos, warblers, sparrows, and blackbirds; and 41 mammals, including shrews, moles, bats, and rats (Tables 1 to 4 - Enclosure 7). The project area is part of the Atlantic Flyway. Many waterfowl species as well as neotropical migratory birds depend upon forested wetlands for food and shelter.

4.13 **Fisheries.** Dahlberg and Scott (1971) provide the definitive listing of 106 freshwater species indigenous to the Savannah River basin. The Georgia Department of Natural Resources surveyed the fishery resources of the lower Savannah River basin between the New Savannah Bluff Lock & Dam and the Savannah River estuary (Schmitt and Hornsby, 1985). Survey activities were conducted between December 1979 and October 1983 and listed 82 freshwater species. Principal species from flowing oxbow rotenone samples were numerically represented by redbreast sunfish (Lepomis auritus), snail/flat bullheads (Ictalurus brunneus/I. platycephalus), channel catfish (I. punctatus), and spotted sucker (Minytrema melanops). Game fish in oxbows represented 27 percent of the population by number and 30 percent by weight.

4.14 Freshwater electrofishing samples from the Georgia survey showed minnows to be numerically most abundant in mainstream habitats followed by redbreast sunfish, striped mullet (Mugil cephalus), and spotted sucker. Game fish represented 30 percent of the number and 14 percent of the species' weight collected in the mainstream area. Similar electrofishing samples from oxbow habitats showed bluegill (Lepomis macrochirus) to be numerically most abundant followed by minnows, redbreast sunfish, and spotted sucker. Game fish in oxbow habitats represented 42 percent of the number and 11 percent of the weight of species collected in electrofishing samples.

4.15 The Georgia Department of Natural Resources conducted recent limited electrofishing samples in oxbows and the adjacent mainstream habitats of navigational cuts #3 and #4 during September and October 1993. Redbreast sunfish were numerically most abundant in mainstream habitat followed by bowfin (Amia calva), striped mullet, spotted sucker, snail bullhead, and shiner spp. Game fish represented 52 percent of the number and 24 percent of the species' weight collected in the mainstream habitat. Results from oxbow habitat sampling again showed redbreast sunfish to be numerically most abundant followed by shiner spp., spotted sucker, bowfin, and bluegill. Game fish in oxbow habitat samples represented 53 percent of the number and 21 percent of the weight of all species captured.

4.16 Anadromous species collected in Georgia surveys and known to pass through freshwater river oxbow and mainstream habitats include striped bass (Morone saxitilis), American shad (Alosa sapidissima), hickory shad (A. mediocris), and blueback herring (A. aestivalis). Atlantic (Acipenser oxyrhynchus) and shortnose sturgeon (A. brevirostrum) are known to inhabit and spawn in the Savannah River basin, but neither species was collected in the Georgia survey. South Carolina, in cooperation with the U. S. Fish and Wildlife Service, has been propagating, rearing, and releasing juvenile shortnose sturgeon into the Savannah River in recent years.

4.17 **Threatened and Endangered Species.** Threatened and Endangered Species have been identified for Effingham and Jasper counties that have the potential for being in the project area at some time during the year. These species include: Bald eagle (Haliaeetus leucocephalus), Shortnose sturgeon (Acipenser brevirostum), and Wood stork (Mycteria americana). (See Enclosure 1 - Biological Assessment of Threatened and Endangered Species (BATES) for a complete list).

4.18 In addition, the Georgia Department of Natural Resources has identified other species which are protected by the State and that occur in Effingham County. The American swallow-tailed kite, a South Carolina State listed endangered species, can be observed on the project area. This species nests near or in palustrine wetlands and are closely associated with them. (See Enclosure 1 - BATES)

4.19 **Vegetation.** Habitats in the immediate project area are bar sediments, old bar or cutoff that include old swale deposits, and overflow banks south of cutoff bends 3 & 4. The over-flow banks consist of sloughs, flats, and low ridges or former levees.

4.20 The Georgia Department of Natural Resources conducted vegetation sampling in the project area. Sampling of existing vegetation was conducted in six (6) transect lines that correspond to the topographic survey of cutoff bends 3 & 4 (see Fig. 3). Canopy sampling consisted of 0.1 acre (ac) plots for tree species greater than 4 inches diameter at breast height (dbh) arranged along the transect at 100 ft intervals. Stem density was recorded for seedlings, saplings (less than 4 in. dbh), shrubs and vines in 10x10 ft plots centered in each of the 0.1 ac plots. Herbaceous species density was recorded in 10x10 ft plots centered in each of the 0.1 ac plots. Importance values were calculated for tree species occurring in each of the habitat types.

4.21 Dominant trees on the point bar habitat of cutoff bend 4 are green ash, black willow, silver maple, river birch, sycamore, water hickory, American elm, overcup oak, red maple, bald cypress, and laurel oak (Table 5- Enclosure 7). Important shrubs and vines in this habitat are green-briar, swamp privet, poison ivy, redvine, trumpet-creeper, cross-vine, and muscadine grape (Table 6 - Enclosure 7). On the old meander point bar of Cutoff4, green ash, red maple, swamp laurel oak, water hickory, water tupelo, and overcup oak are dominant. Stump holes and remnant stumps of water tupelo and bald Figure 3
cypress were noted on these swale deposits. Dominant shrubs and vines include green-briar, poison ivy, trumpet-creeper, and cross-vine. The overflow banks south of Cutoffs 3 & 4 are dominated by sweetgum, swamp laurel oak, sycamore, water hickory, green ash, ironwood, river birch, red maple, American elm, cotton-wood, overcup oak, American holly, swamp blackgum, red bay, silver maple, and swamp chestnut oak. Dominant shrubs and vines are poison ivy, cross-vine, trumpet-creeper, giant cane, green-briar, blackberry, muscadine grape, Virginia creeper, deciduous holly, dwarf palm, and Virginia willow. Relict bald cypress occur along the old sloughs.

4.22 Needle palm occurred in flats outside of the sample area. Common herbaceous species are listed in Table 7 - Enclosure 7. The project area, being located in a tidal delta of a major river system, lacks the multiple terraces and hydrologic regimes characteristic of mid-perennial riverine systems (Sharitz & Mitsch, 1993; Wharton, et al., 1982). As described earlier, the tidally-influenced forests on the southern one-third to one-half of the project area are dominated by water tupelo, swamp blackgum, bald cypress, sweetgum, and other water tolerant species.

4.23 **Cultural Resources.** In June, 1994, a cultural resources survey for cuts 3 and 4, Lower Savannah River Environmental Restoration Project, was conducted by Panamerican Consultants, Inc., under contract with the Corps of Engineers. The survey area included the waterlogged area at the confluence of Mill Creek and the Savannah River, the south bank of the Savannah from opposite the middle of Bay Bush Point around Flat Ditch Point up to Hickory Bend, Flat Ditch Point, cutoff bend 3 island, and the north bank of the Savannah River from cut 4 to cut 3. (See Figure 4). The results of this survey showed no cultural strata or archaeological sites in the survey area. No remains of historic watercraft were observed within the project area boundaries. Savannah District Archaeologists, are aware of no records of historic steamboat wrecks in the area (Wood, 1995).

4.24 Between 1985 and 1986, a cultural resource survey was conducted on Fort Howard Paper Company plant site in Effingham County, Georgia, where the proposed disposal area for some of the alternatives would be located. This cultural resource survey was done in compliance with requirements set forth in the U.S. Army Corps of Engineers Permit Number 074 OYN 005851. A number of archaeological sites were tested and some of them were found to have important scientific data. The proposed disposal area was delineated not to disturb these sites.

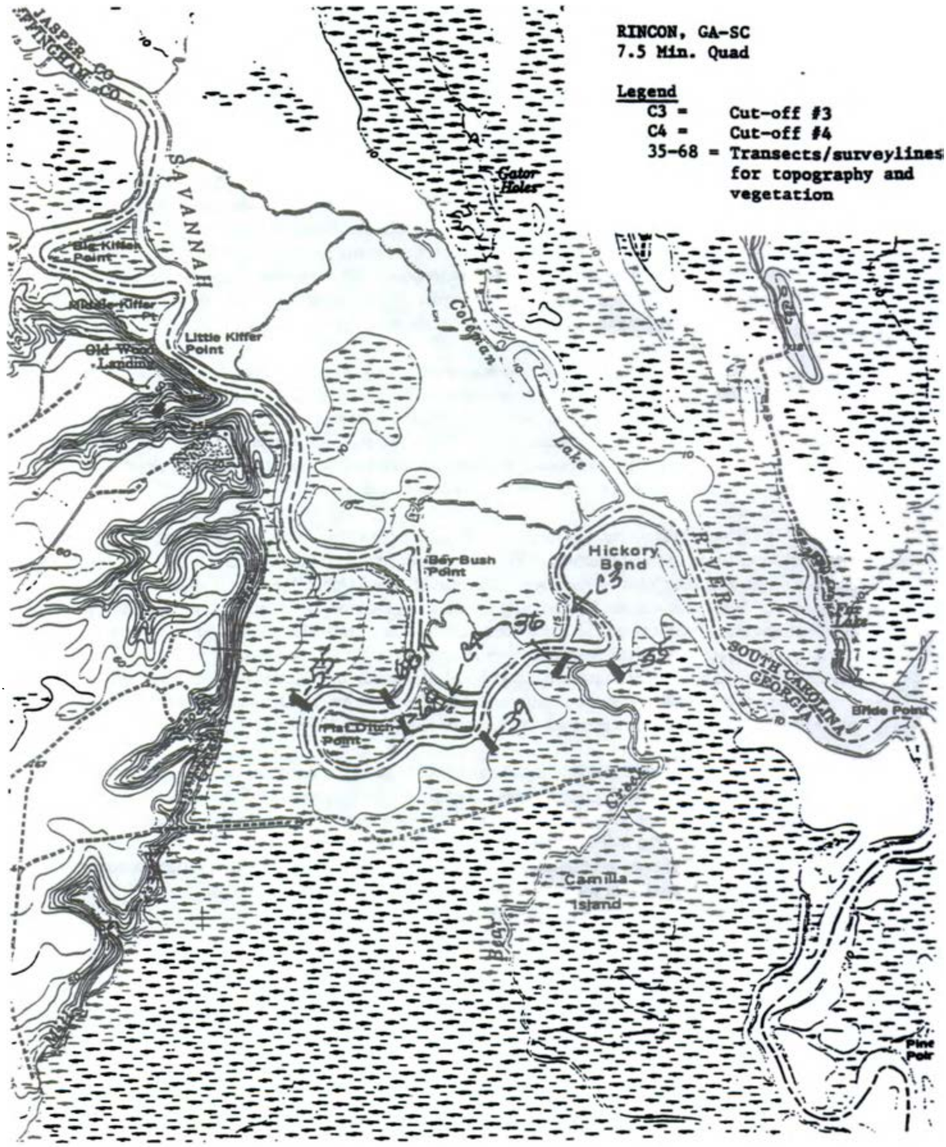

FIGURE 3
CUT AND BEND #3 AND #4

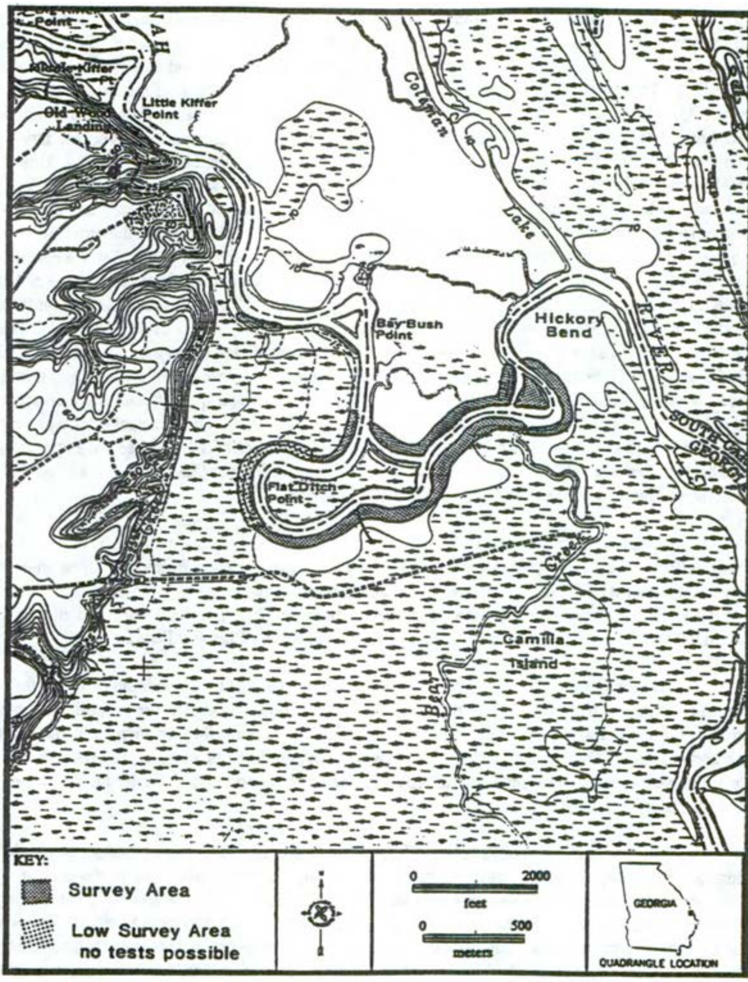

FIGURE 4
CULTURAL RESOURCES STUDY AREA

4.25 **Water Quality.** Water quality standards, water intake structures, and effluent discharge permits are jointly regulated by the Georgia Department of Natural Resources, Environmental Protection Division (EPD) and the South Carolina Department of Health and Environmental Control (SCDHEC). The water quality classification for the middle and lower reach of the Savannah River - between RM 129 to RM 27.4 - is drinking water. EPD's standards for drinking water are published in Rules Chap. 391-3-6 (Revised - August 1993)- Primary Maximum Contaminant Levels for Drinking Water, and 391-3-5-.19 - Secondary Maximum Contaminant Levels for Drinking Water - Amended (Rev. March 1994). Turbidity Sampling and Analytical Requirements are published in 391-3-5-.20 - Amended. EPD rules set standards for maximum contaminant levels for specific inorganic chemicals, for organic chemicals, for volatile organic contaminants, turbidity, radioactivity, trihalomethanes, and unregulated organic and inorganic contaminants. South Carolina Primary Drinking Water Regulations are published in Regulations 61-58). SCDHEC classifies the Savannah River from headwaters of Lake Russell to Seaboard Coastline RR as freshwater (FW). Water Classifications and Standards and Classified Waters for South Carolina are published in Regulations 61-68 and 61-69 - Amended (Rev. May 1993). Each state's classification system has standards for dissolved oxygen, temperature, pH, bacteria, and toxic substances. Monthly water quality measurements are made at the Clyo, Georgia station. Analyses are conducted by EPD and USGS. Additional water quality studies are conducted on the river by EPD and the US EPA research lab at Athens, Georgia. The principal discharge points on the middle and lower Savannah River are the City of Augusta (RM 187.2), Federal Paper Board (RM 182.1), Allendale WWTP (RM 118.8), and the Fort Howard Paper (RM 44.2). Water quality in the middle to lower reach is generally good (GDNR-EPD, 1993).

4.26 Chemical Data from seven sampling sites in the vicinity of cuts and cutoff bends #3 and #4 was collected between April and June of 1994 by the Environmental Protection Division of the Georgia Department of Natural Resources. Suspended solids in the sampling sites fluctuated between 15 to 17 mg/L. Dissolved oxygen was consistently between 7.72 and 7.99 mg/l and pH ranged between 6.87 to 7.22 std. units (See Enclosure 2- Savannah River - Chemical Data).

4.27 **Water Quantity.** Savannah District's data indicates that base condition of water flow in the main river ranges from 6,600 (low flow) to 13,300 (high flow) cubic feet per second (cfs) in the vicinity of the project area. The following table describes the existing flow conditions in the cutoff bends and in some of the tributaries. Clearing, snagging, and dredging of some of the creeks has been done in the past in order to maintain and improve the water flow into the city's water intake located at Abercorn Creek.

4.28 **Recreation.** Recreational use of the lower Savannah River area consists primarily of fishing, boating, camping, hiking, bird watching, and hunting. Access points close to the project area are Woods, Becks Ferry, and Ebenezer Creek landings at River Mile 33.9, 39, and 44.7, respectively. Additional access is provided at the City of Savannah-Abercorn Creek water intake station. Important game fish are largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, redear sunfish, and warmouth. Additional species taken are channel catfish, white catfish, and brown bullhead. Anadromous species occur in the river, but in low numbers in the project area (GDNR, 1994). Hunters use boat ramps and at least two roads for access to the area. The principal game species hunted are deer, feral hog, and squirrel. The area is also used for camping, hiking and bird watching.

	EXISTING	FLOW	CONDITIONS	
LOCATION	LOW (cfs)	STAGE	HIGH (cfs)	STAGE
Cutoff bend 4	92.1	199.09	1,088.0	204.34
Flat Ditch	0.8	198.94	154.0	204.2
Unknown Creek	0.0	198.93	94.7	204.19
Cutoff bend 3	67.7	198.68	1.773.4	203.85
Bear Creek	45.0	198.68	506.0	203.87

4.29 **Aesthetics**. The project area is set in the Lower Coastal Plain and is best characterized as a deciduous floodplain forest with high tree species diversity. The entire project area is forested except for a small acreage that was clearcut south of Flat Ditch Point. An area opposite Cutoff#4 on the South Carolina boundary has also been harvested down to the river bank. Water intake and/or effluent structures occur at the Savannah Electric and Power Plant, the Ft. Howard Paper Mill, and the Beaufort-Jasper Water Authority canal. Man-made oxbows occur at Cutoffs 2, 3, and 4. Natural oxbow lakes occur at Coleman Lake and Mayer's Lake on the South Carolina bank (U.S.C.O.E., 1980). Channel banks are typical for a river of this size, except for piling placed along long, shallow stretches to maintain a deeper channel, and remnants of stone rip-rap placed on cut banks at the cutoffs. Channel maintenance (9'depth & 90'width) ceased several years past, but there are still few log/leaf rafts for fish habitat along the main channel of the river. There is an abundance of wildlife along the river, larger creeks, and sloughs.

4.30 **Proposed Disposal Area.** This section describes the environmental setting without the project for the tract identified for the construction of an upland dredged material disposal area. The property is within the Fort Howard Paper Company plant site in Effingham County, Georgia, The 85 acres of land support an 8 year old pine plantation. The site is easily accessed by a dirt road from the paper plant site. Several fire break roads divide the property in sections. Isolated areas of wetlands within the tract were identified, first on an aerial photograph and later by a field inspection (2.37 acres). Vegetation identified on these wetlands included: Virginia chain fern (OBL), wax myrtle (FAC+), red bay (FACW), ink-berry (FACW), Lyonia lucida (FACW), Pteridium aquilinum (FACU), Clethra alnifolia (FACW), and Magnolia virginia (FACW). The wetlands have been negatively impacted by the pine plantation activity and the construction of roads which have modified the hydrology of the area. The value of these wetlands has declined and the site now exhibits the effects of a much drier regime and upland species succession.

4.31 **Future Conditions Without the Project.** Siltation and sedimentation in the cutoff bends and tributaries associated with them would continue to occur. Based on Corp's analysis, only five percent of the original volume remained in cutoff bend 3 and eleven percent of the original volume remained in cutoff bend four in 1993. By the year 2000, only three and six percent of the original volume, respectively, would remain. Connectivity with the main river would be interrupted affecting species richness. It could be expected that these areas and the tributaries they support, would be isolated from the main river, particularly during low flows. Degradation of water quality and fish habitat would result in these areas from elevated temperatures and decrease in dissolved oxygen. Stream flow into Bear Creek and Mill Creek would be interrupted during low flows. Loss and degradation of forested wetlands along the Lower Savannah River would continue to occur leading to a drier habitat. Because of this reducion in wetland flooding, regeneration of a less desirable forest type is expected, especially after disturbances such as storm damages and timber cutting. This would directly affect the available fish and wildlife habitat and would reduce the diversity of the wetlands along the river. The quality and quantity of water at the Abercorn Creek pump station for the City of Savannah would continue to decrease if restoration of the cutoff bends is not accomplished.

5.00 ALTERNATIVES.

5.01 **Introduction.** An interdisciplinary team developed an array of restoration actions to address issues and achieve the project purposes. Some of these actions were eliminated early in the study as a result of preliminary analyses of expected benefits and costs. The main Report describes the plan formulation process in detail. Table 8 shows the description of the final restoration components. These components were combined for development of the alternatives. Thirty-two preliminary alternatives were identified for the proposed project including the No Action alternative. Table 9 shows the range of alternatives considered by the study team.

5.02 **The Process Used to Develop the Alternatives.** Planning goals and objectives, and desired future conditions for the project area were considered while developing the alternatives. A cooperative evaluation of the area without the proposed project was conducted by U.S. Army Corps of Engineers, Georgia Department of Natural Resources and U.S. Fish and Wildlife Service. This data was used in the habitat evaluation procedures to compare the alternatives.

Table 8 - FINAL RESTORATION COMPONENTS

RESTORATION COMPONENT	DESCRIPTION
	CUT & CUTOFF BEND #3
No Action	No Action
Partial Closure w/Partial Restoration Channel	Construct Partial Closure Structure in cut, increase flow through cutoff bend, dredge restoration channel (76' top width x 10' deep, 1:3 side slopes), clear mouth Bear Creek.
Full Closure w/Navigation Channel	Construct full closure structure in cut #3, restore bend to accommodate navigation, dredge navigation channel (229-259' top width x 9' deep @ 6,600 cfs, 1:3 side slopes), clear mouth Bear Creek.
Full Closure w/restoration channel	Construct full closure structure in cut, dredge restoration channel (182' top width x 13' deep, 1:3 side slopes), clear Bear Creek.
Realign and Constrict Mouth of cutoff bend to mouth of Bear Creek/Small Diversion	Construct small diversion structure in the cut, narrow channel to mouth of Bear Creek, plug cutoff bend below Bear Creek, clear Bear Creek
Realign and Constrict Mouth of cutoff bend to mouth of Bear Creek/Large Diversion	Same as above, but with a larger diversion structure in the cut.
Realign and Constrict Mouth of cutoff bend to mouth of Bear Creek/Small Diversion Slackwater	Construct small diversion structure in the cut, narrow channel to mouth of Bear Creek, plug cutoff bend below Bear Creek, dredge slackwater channel in remainder of bend (182' top width x 13' deep, 1:3 side slopes, clear Bear Creek.
Realign and Constrict Mouth of cutoff bend to mouth of Bear Creek/Large Diversion Slackwater	Same as above but with a larger diversion structure in the cut.
	CUT #4
No Action	No Action
Full Closure w/Navigation Channel	Construct full closure structure in the cut, dredge navigation channel in cutoff bend (204-254' top width x 9' deep, 1:3 side slopes)
	MILL CREEK
No Action	No Action
Restore	Reorient mouth alignment, deepen entrance channel.

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Table 9- PRELIMINARY ALTERNATIVES

ALTS	CUT #3	CUT #4	MILL CREEK	NET AAHU	NET BLHW	AVERAGE ANNUAL COSTS	TOTAL PROJECT COSTS *
1	No Action	No Action	No Action	0	0	0	0
2	No Action	No Action	Restore	372	518	$ 25,000	$ 325,000
3	No Action	Full Closur	No Action	1067	1960	846,000	10,817,000
4	No Action	Full Closur	Restore	1092	2333	872,000	11,140,000
5	Partial Closure	No Action	No Action	785	584	493,000	6,305,000
6	Partial Closure	No Action	Restore	1004	838	517,000	6,613,000
7	Partial Closure	Full Closur	No Action	1681	2566	1,155,000	14,761,000
8	Partial Closure	Full Closur	Restore	1707	2893	1,180,000	15,084,000
9	Full Closure w/Navigation C	No Action	No Action	865	584	560,000	7,158,000
10	Full Closure w/Navigation C	No Action	Restore	1186	1028	584,000	7,465,000
11	Full Closure w/Navigation C	Full Closur	No Action	1500	2566	1,173,000	14,990,000
12	Full Closure w/Navigation C	Full Closur	Restore	1922	2893	1,198,000	15,314,000
13	Full Closure w/Restoration C	No Action	No Action	865	1749	481,000	6,148,000
14	Full Closure w/Restoration C	No Action	Restore	1186	2281	505,000	6,456,000
15	Full Closure w/Restoration C	Full Closur	No Action	1500	2042	1,110,000	14,192,000
16	Full Closure w/Restoration C	Full Closur	Restore	1922	3498	1,136,000	14,515,000
17	Realign-Constrict/Small	No Action	No Action	750	584	210,000	2,682,000
18	Realign-Constrict/Small	No Action	Restore	1067	1042	234,000	2,990,000
19	Realign-Constrict/Small	Full Closur	No Action	1647	2566	1,027,000	13,122,000
20	Realign-Constrict/Small	Full Closur	Restore	1788	2893	1,052,000	13,446,000
21	Realign-Constrict/Large	No Action	No Action	750	1360	293,000	3,751,000
22	Realign-Constrict/Large	No Action	Restore	1067	1960	318,000	4,058,000
23	Realign-Constrict/Large	Full Closur	No Action	1647	3126	1,123,000	14,355,000
24	Realign-Constrict/Large	Full Closur	Restore	1788	3498	1,140,000	14,575,000
29	Realign-Constrict/Small W/Sl	No Action	No Action	849	584	424,000	5,416,00
30	Realign-Constrict/Small W/Sl	No Action	Restore	1153	1042	448,000	5,723,00
31	Realign-Constrict/Small W/Sl	Full Closur	No Action	1754	2566	1,028,000	13,134,00
32	Realign-Constrict/Small W/Sl	Full Closur	Restore	1848	2893	1,053,000	13,459,00
33	Realign-Constrict/Large W/Sl	No Action	No Action	849	1360	512,000	6,546,00
34	Realign-Constrict/Large W/Sl	No Action	Restore	1153	1960	536,000	6,854,00
35	Realign-Constrict/Large W/Sl	Full Closur	No Action	1754	3126	1,121,000	14,329,00
36	Realign-Constrict/Large W/Sl	Full Closur	Restore	1848	3498	1,146,000	14,653,00

* These are Preliminary Project Costs

5.03 **Fish Habitat Evaluation.** Average Annual Habitat Units (AAHU's) which would be created and impacted by the implementation of each alternative were calculated. Habitats Units were determined for the current condition and for various target years over the 50 year life of the project. The modified version of the Habitat Evaluation Procedure (HEP) model was developed by U.S. Fish and Wildlife Service and is commonly used to quantify the environmental value of a habitat based on basic physical and chemical habitat variables. Acreage of available habitat, habitat suitability index at various target years, and the average annual habitat units for five fish species were calculated for the alternatives (See Fish and Wildlife Service Report). The fish models do not account for beneficial functions such as increased flooding duration and frequency that results in increased fish spawning and nursery habitat on the flood plain. Because of this, the model is not sensitive to changes in amount of water flow.

5.04 **Bottomland Hardwood Evaluation.** The bottomland hardwood evaluation was designed to be more sensitive to changes in the amount of wetland flooding. This evaluation was a team effort between U.S. Fish and Wildlife Service, Georgia Department of Natural Resources and U.S. Army Corps of Engineers. The study area was divided into three restoration zones based on landscape position and location of stream channels (See Figure 5). The three zones extend downstream to the zone of dominant tidal influence, where tidal effects control the vegetative community. The Bear Creek zone consists of 2,367 acres and water flow to the zone is controlled primarily from cutoff bend #3 and Bear Creek. The Bear Creek zone is also affected during high flow conditions by a network of sloughs and overland flow carrying water from cutoff bend #4 to Bear Creek. Water flow to the area east of the Bear Creek zone is controlled primarily by the Savannah River. The Raccoon Creek zone consists of 1,633 acres and water flow is controlled from cutoff bend #4. The Mill Creek zone consists of 708 acres and water flow is currently controlled by flows form Flat Ditch which arises on cutoff bend #4 and runs west to Mill Creek.

5.05 To estimate the impact of restoration activities on bottomland hardwoods, the team developed a functional index of wetland value. This functional index was based on the estimated amount of flow in the tributary system and the estimated amount of flood water provided to the wetland system. A functional value of one is equivalent to one acre of fully functioning (optimum) bottomland hardwood. Table 9 also shows the net average annual bottomland hardwood values and the net average annual habitat units for each plan.

5.06 The methodology used to calculate AAHUs and Bottomland Hardwood Values is discussed in more detail in the Fish and Wildlife Coordination Report section of the Environmental Restoration Report.

5.07 **Economic Evaluation.** The evaluation of alternative environmental restoration plans is based on a comparison of environmental outputs against monetary effects. Due to the different value standards used, no benefit-cost ratio can be computed for this environmental restoration project. Instead, the economic evaluation follows the guidelines from the U.S. Army Corps of Engineers Institute For Water Resource publication "Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps, IWR Report 94-PS-2, October 1994. Alternatives were ranked from least to greatest

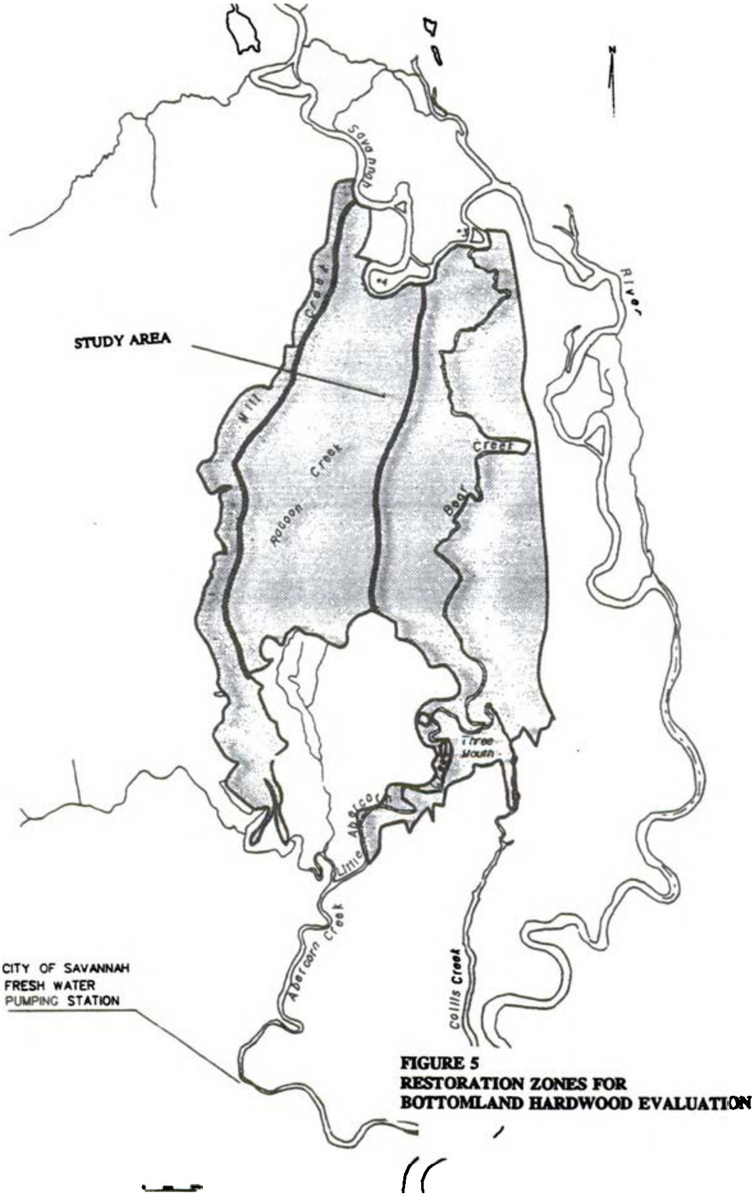

FIGURE 5
RESTORATION ZONES FOR
BOTTOMLAND HARDWOOD EVALUATION

output. Average cost per habitat unit created and acres of bottomland hardwood benefited was then calculated. Detailed information about the economic effects of the alternatives and the incremental cost process used in this analysis can be found in the Economic Analysis Section of the Restoration Report.

5.08 **ALTERNATIVES CONSIDERED.** Those alternatives which didn't consider restoration of Mill Creek (3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 29, 31, 33, and 35) were eliminated early in the plan formulation process along with alternative 2 (No Action in cuts 3 and 4). Those alternatives that would produce less output at equal or greater cost than a subsequently ranked alternative were also eliminated (Alternatives 6, 4, 8, 12,). In addition, alternatives 4, 10, and 12 would produce 0 percent increase in water flow into Bear Creek and would not maximize outputs. Alternatives 10 and 12 would result in direct loss of wetland and bottomland hardwood of high value (approx. 8 acres). Because of the adverse environmental impacts resulting from this action, a navigation channel through cutoff bend #3 has been eliminated as an alternative.

5.09 The slack water component for cutoff bend 3 resulted too expensive when considered No Action for cutoff bend 4 at the same time (Alternatives 30 and 34). Alternative 20 would produce a 5 percent increase in water flow into Bear Creek and would not maximize bottomland hardwood benefits.

5.10 **Full Closure of Cuts 3 and 4 With Restoration Channels.** This alternative considered the total restoration of cutoff bends 3 and 4, with the construction of restoration channels. The initial design proposed a restoration channel using the existing configuration of the bends. In order to accommodate all the flow from the main river into the already filled bends and to avoid possible unstable hydraulic conditions and uncontrolled erosion, the dimensions for these channels would have to be similar in width and depth as the main channel. Significant amounts of material would have to be dredged. The channel would not be navigable by the design barge configuration (40 foot wide by 250 foot long barge/pusher combination). A positive impact from this alternative was the fact that no significant dredging and cutting outside the boundaries of the natural channel would have to be performed. In turn, minimal mature bottomland forest would be disturbed.

5.11 **ALTERNATIVES CONSIDERED IN DETAIL.** For the purpose of this analysis, five preferred alternatives (Alternatives 16, 22, 24, 32, and 36) were identified to accomplish the restoration, based on the Habitat Units derived, the net functional value of bottomland hardwood that would benefit, and the construction costs (See Table 10). Alternatives 16, 22, 24, 32, 36 and the No Action alternative are described in the following sections. Environmental impacts resulting from the implementation of Alternatives 16, 22, 24, 32, and 36 are described in Section 6.00.

5.12 **NO ACTION ALTERNATIVE.** This alternative entails the continued navigational use of cuts 3 and 4, with no restoration of the cutoff bends and Mill Creek. With this alternative, no AAHU would be created, no bottomland hardwood would be benefited and no construction cost would be incurred since no maintenance or construction would be performed. The navigation channel would continue to remain unmaintained.

5.13 **Environmental Impacts of the No Action Alternative.** A surface area and volume analysis was made for the river at Hickory Bend (cutoff bend 3) and Flat Dutch Ditch (cutoff bend 4) using "Condition Survey, Savannah River Below Augusta, Navigation Charts", topographic and hydrographic surveys. The surface area (square feet) was estimated for various years between 1950 and 1993 for both bends (See Enclosure 2). The analysis showed a 49.5 percent decrease in surface area for Hickory Bend and 56 percent decrease for Flat Ditch Point in 1993, compared to 17.2 percent and 14.4 percent decrease observed in 1950, respectively.

5.14 The volume channel analysis based on the hydrographic data shows 95.3 percent and 89.4 percent decrease in channel volume for Hickory Bend and Flat Ditch Point, respectively from 1950 to 1993. Over the past 50 years the cutoff bends have filled in significantly and their original flow volume has reduced over 90 percent.

5.15 This situation will continue to deteriorate with the No Action Alternative. This will directly affect the available fisheries habitat, larval and juvenile fish movement, and streamflow into the creeks feeding Mill Creek and Bear Creek. All flow to Mill Creek and Raccoon Creek will be lost when cutoff bend #4 closes at year 15. All flow to Bear Creek will be lost when cutoff bend #3 closes at year 10. It is expected that both the surface area and volume of water in the cutoff bends and in the creeks would continue decreasing. Loss and degradation of forested wetlands along the Lower Savannah River would continue to occur. Succession of many of the remaining forested wetland communities to drier habitat types would result. This, in turn, would reduce the richness and diversity of the river swamp, and would degrade or eliminate the values and functions of wetland habitats that are important for fish and wildlife resources. Landowners would continue to convert land, which was once wetland, to agriculture and pine plantations that are less productive for wildlife. The hydrologic conditions in the forested wetlands would continue to be affected by the existence of the navigation cuts.

5.16 There would not be opportunities to restore this valuable wetland area and wildlife habitat to those conditions which existed before construction of the navigation channels, nor to increase water quantity and improve water quality at the Abercorn Creek pump station for the City of Savannah. With the No Action Alternative, no habitat units would be added to the 574 habitat units present in the base condition. The actual functional value of the bottomland hardwood (2354 acres) would decrease in 50 years to 942 acres (See Table 11). The forested wetlands would eventually lose their hydric characteristics, functions, and values, and would no longer support the existing wildlife and fauna diversity.

Table 10 - FINAL ALTERNATIVES - HABITAT UNITS/BOTTOMLAND HARDWOODS/COST

ALTS	CUT #3	CUT #4	MILL CREEK	NET AAHU	NET BLHW	PROJECT COST
1	No Action	No Action	No Action	0	0	0
16	Full Closure w/Restoration Channel	Full Closure	Restore	1922	3498	$ 14,515,000
22	Realign-Constrict/Large	No Action	Restore	1087	1960	4,058,000
24	Realign-Constrict/Large	Full Closure	Restore	1788	3498	14,575,000
32	Realign-Constrict/Small W/Slack	Full Closure	Restore	1848	2893	13,459,000
36	Realign-Constrict/Large W/Slack	Full Closure	Restore	1848	3498	14,653,000

Table 11 - NO ACTION - Acreage, functional index and functional value at various target years.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	0.5	2354
1	4708	0.5	2354
10	4708	0.3	1412
20	4708	0.2	942
50	4708	0.2	942

5.17 **ALTERNATIVE #16: FULL CLOSURE OF CUT #3 WITH RESTORATION CHANNEL, FULL CLOSURE OF CUT #4, AND RESTORATION OF MILL CREEK.** This alternative has various components. A general description of the activities and actions involved for each component is described in the following sections and the environmental impacts associated with these activities are described in section 6.00.

5.18 **Full Closure of Cut #3.** Alternative #16 proposes the full closure of cut #3 by constructing a closure structure. The diversion structure would be constructed either with dredge material-filled geotextile containers or with dumped rock. The structure would be constructed across the Savannah River to divert the main stream flow into the cutoff bend. Some of the dredged material would be placed behind the closure structure in the existing cut. The dike surface and abutment slope protection above low water would be filled with dredged sediments and planted with vegetation common to the area.

5.19 **Restoration Channel.** The restoration channel in cutoff bend #3 would have a 182- feet top width, 13 foot depth, and 1V:3H side slopes. Most of the material excavated from the restoration channel (Aprox. 129,000 cubic yards of insitu material) would be placed in the disposal area downstream of the cut #4 closure dike. All dredging would occur within the top of existing riverbanks. The material would be excavated with a hydraulic dredge and pumped in dredge pipes to the disposal site.

5.20 **Full Closure of cut #4.** This action would require construction of a closure dike across the main channel, filling of the navigation cut, construction of a navigation channel within cutoff bend #4, and slope protection. The closure structure would consist of either dredge material-filled geotextile containers or homogeneous dumped rock. A temporary sheet pile wall would be placed on the downstream end of the cut to contain the hydraulic fill. The downstream end of the fill would have a sloped surface which would extend into a slack water adjacent to the new navigation channel.

5.21 **Navigation channel.** The proposed navigation channel for cutoff bend #4 extends outside of the existing channel at some locations. It involves the dredging of approximately 375,000 cubic yards of material. Other construction activities include clearing, grubbing and disposal of woody vegetation and trees, and the construction of two large areas of slope protection. The navigation channel for cutoff bend #4 would be approximately 9-feet deep and would vary in width from 150 to 200 feet.

5.22 **Mill Creek.** The purpose of the modifying the Mill Creek entrance is to increase the quantity and frequency of flow in the creek and downstream wetlands. Proposed modifications to the Mill creek entrance include the construction of a new entrance onto the Savannah River and deepening of the entrance channel. An estimated 420 cubic yards would be excavated from the entrance using conventional land-base construction equipment. Material excavated from the new entrance would be used to obstruct the adjacent portion of the existing creek channel. This would redirect the flow into the downstream portions of the creek (See Fig. 6).

5.23 **Disposal Area.** Three alternative methods considered for disposal of the dredged material were: placement of material behind closure structures, jet-spray dredging, and placement of the material in an upland confined disposal area. Dredged material would be placed behind the full closure of cut #4 which would have a capacity of 177,200 cubic yards. Jet-spray dredging would be limited to any future maintenance of the small creeks. Jet-spray would not be used for initial project construction.

5.24 The proposed site to construct the confined upland disposal area is an 85-acre area located west of the dredging site (See Fig. 7). Use of this site would require a temporary real estate easement for the duration of the project. In addition, a 15-foot easement would be required along an existing dirt road between the disposal site and the front entrance of the Fort Howard Corporation property. This easement would be used for access for disposal area construction, as well as maintenance during dredging operations. Two additional easements, each 20-foot wide, would also be required for pipeline access to the site and pipeline discharge between the disposal area and Mill Creek.

5.25 **Maintenance of Creeks.** A monitoring plan for a five-year period would be designed to evaluate the restoration project. This plan would include the evaluation of conditions at Mill Creek, Little Abercorn Creek, and Bear Creek after completion of construction. The plan will have both water quality/quantity and vegetation components. The U.S. Geological Survey would conduct annual flow measurements in the creeks. U.S. Fish and Wildlife Service personnel would make regular field visits to the area for visual observations of the effectiveness of the restoration project. The collected data would help determine the rate of decay of the creeks and the need for maintenance of the creeks. Any dredging maintenance needed in the future would be conducted by the City of Savannah. Due to the limited access to these sites, the most feasible method of removal of deposited maintenance sediments from the creeks is jet-spray dredging. The necessary frequency of channel maintenance would be determined by both the water quality at the City of Savannah's fresh water intake and by degraded conditions in the creeks.

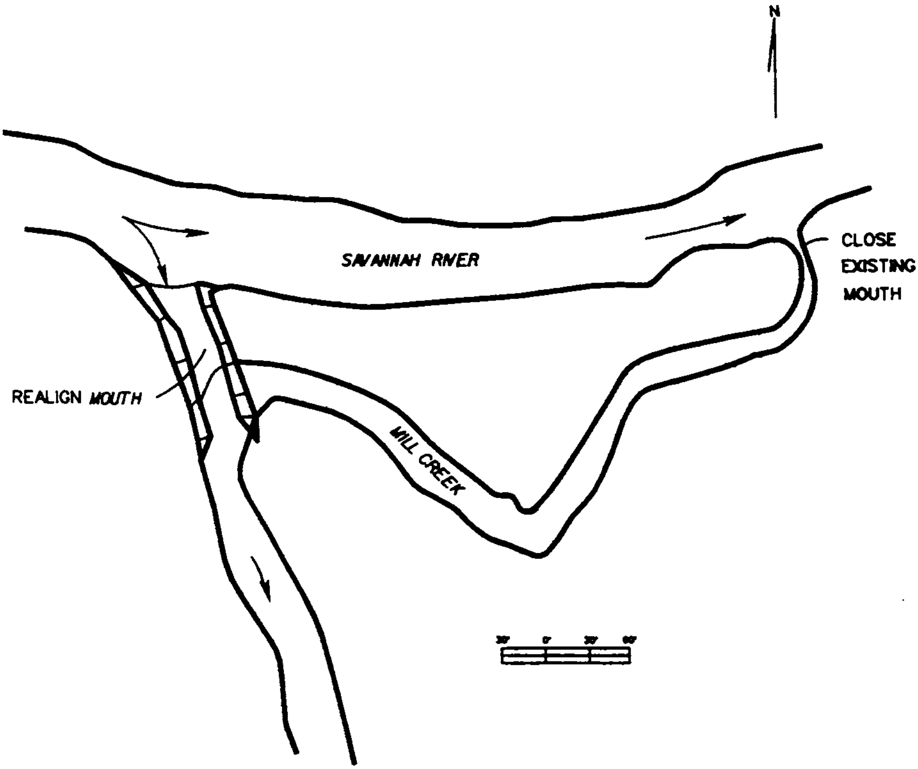

FIGURE 6
PROPOSED MODIFICATIONS TO MILL CREEK

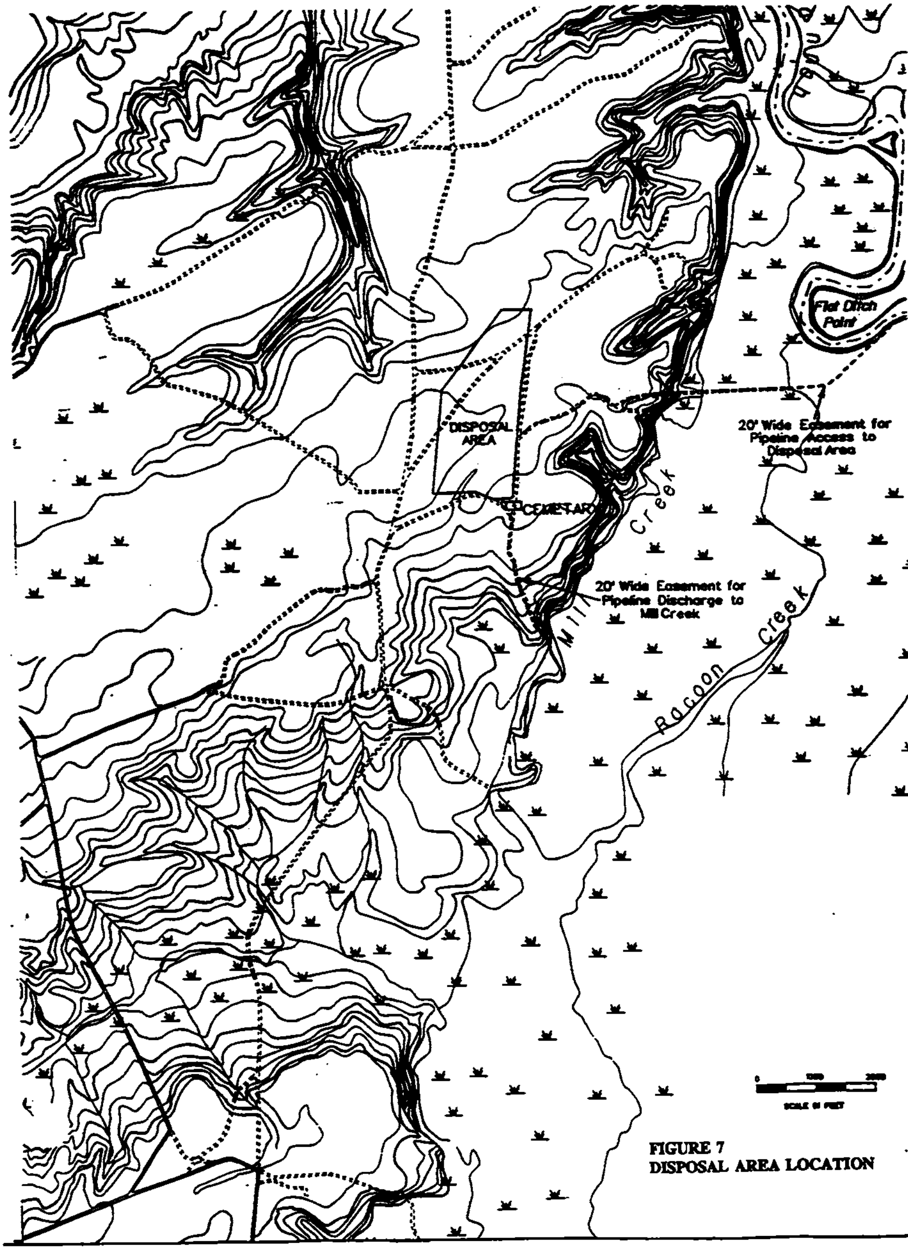

FIGURE 7
DISPOSAL AREA LOCATION

5.26 ALTERNATIVE #22: PARTIAL CLOSURE OF CUT #3/LARGE DIVERSION STRUCTURE, REALIGNMENT AND CONSTRICTION OF MOUTH OF CUTOFF BEND #3 TO BEAR CREEK, NO ACTION ON CUT #4, AND RESTORATION OF MILL CREEK. This alternative proposes the partial closure of cut #3 with the construction of a closure structure across the Savannah River, realignment and constriction of the mouth of the cutoff bend to the mouth of Bear Creek, and restoration of the entrance of Mill Creek into the Savannah River.

5.27 **Partial Closure of cut #3.** A diversion structure would be constructed in the main channel. This would divert a portion of the river flow into the cutoff bend. The structure would be designed to cover 1/3 of width of the main channel, so that navigation would not be impeded. The diversion structure would consist of a wing dike to be constructed at the upstream point bar of the cutoff island which would split the flow.

5.28 **Constricted Entrance to Cutoff bend #3.** This alternative proposes the realignment and constriction of the mouth of cutoff bend #3 to the mouth of Bear Creek and construction of a plug within the cutoff bend downstream of the mouth of Bear Creek. In order to provide a smooth flow of water from the main river channel to Bear Creek and to provide scour protection, the constriction in the cutoff bend would be accomplished with a driven steel sheet pile wall on the downstream side. The upstream bank of the new entrance would be constructed of sub-aqueous and semi-compacted fill, with precast concrete mattress armoring. The restricted channel would be constructed to a top elevation of +5 feet to match the height of the existing top of bank. The plug downstream of the constricted channel would be a continuation of the same sheet pile wall on the downstream side. Filling behind the sheet pile wall would be required to provide stability and maintain its function. Overtopping protection would be used to protect fill areas in the new channel and plug from erosion during high river levels.

5.29 **No Action Cut #4:** There would not be any restoration action for cutoff bend #4. Consequently, an upland disposal area is not needed for this alternative.

5.30 **Mill Creek.** Modifications to the entrance of Mill Creek are proposed for this alternative, as previously explained in Section 5.22.

5.31 ALTERNATIVE #24: PARTIAL CLOSURE OF CUT #3/LARGE DIVERSION STRUCTURE, REALIGNMENT AND CONSTRICTION OF MOUTH OF CUTOFF BEND #3 TO BEAR CREEK, FULL CLOSURE ON CUT #4, AND RESTORATION OF MILL CREEK. This alternative proposes the same actions for cut and cutoff bend #3 and for the entrance of Mill Creek as alternative 22, but in addition, it proposes total closure of cut #4.

5.32 **Total closure of Cut #4.** Total closure of cut #4 with a navigation channel through the cutoff bend are proposed for this alternative, as previously explained in Section 5.20.

5.33 **Mill Creek.** Modifications to the entrance of Mill Creek are proposed for this alternative, as previously explained in Section 5.22.

5.34 **Disposal Area.** Although this alternative includes a smaller volume of dredged material if compared to alternative 16, construction of an upland disposal area, as described in Section 5.23, is still needed. An estimated 375,000 cubic yards of material would be dredged in Alternative #24.

5.35 **ALTERNATIVE #32: PARTIAL CLOSURE OF CUT #3/SMALL DIVERSION STRUCTURE, REALIGNMENT AND CONSTRICTION MOUTH OF CUTOFF BEND #3 TO BEAR CREEK, SLACK WATER, FULL CLOSURE ON CUT #4, AND RESTORATION OF MILL CREEK.** This alternative proposes the construction of a smaller diversion structure at the upstream point of the island in cutoff bend #3, a constricted channel from the mouth of cutoff bend #3 to the mouth of Bear Creek, construction of a plug within the bend downstream of the mouth of Bear Creek, create a slackwater habitat in the remaining cutoff bend area below the plug, full closure with navigation channel in cut #4, and restoration of Mill Creek as described before.

5.36 **Small diversion structure.** This alternative proposes construction of a small diversion structure, instead of the larger diversion structure proposed in Alternative #24, to divert water from the main channel to the new constricted mouth of cutoff bend #3. This structure would reestablish the upstream point of the island in cutoff bend #3. The small diversion structure would be constructed by installing a permanent steel sheet piling wall, approximately 45 to 50 feet long, at an elevation of +5 feet. Backfilling behind the sheet pile wall would be performed to provide stability and maintain its function. Its surface would be planted with grass.

5.37 **Slackwater.** This alternative proposes dredging a small slackwater channel in the remainder of cutoff bend #3 behind the plug at the mouth of Bear Creek. The channel would have a width of 182 feet at the top and would be 13 feet deep with 1V:3H side slopes. Dredged material from the slackwater channel would be placed behind the closure structure in cut #4 to partially fill the cut.

5.38 **Full Closure of Cut #4 and Restoration of Mill Creek.** Description of these actions are explained in Sections 5.20 to 5.22.

5.39 **Disposal Areas.** Confined upland disposal and placement of the dredged material behind the closure structure in cut 4 would be considered for Alternative #32. Approximately 468,000 cubic yards of material would be dredged for this alternative. It has been estimated that 70 acres of surface area would be required within the upland disposal area for sedimentation.

5.40 **ALTERNATIVE #36: PARTIAL CLOSURE OF CUT #3/LARGE DIVERSION STRUCTURE, REALIGNMENT AND CONSTRICTION MOUTH OF CUTOFF BEND #3 TO BEAR CREEK, SLACK WATER, FULL CLOSURE ON CUT #4, AND RESTORATION OF MILL CREEK.** This alternative has the same restoration components as Alternative 32, except that it proposes the construction of a larger diversion structure as explained before in Alternative 24.

5.41 **Partial Closure of cut #3 with Large Diversion Structure.** A diversion structure as described in Section 5. 27 would be constructed in the main channel.

5.42 **Constricted Entrance to Cutoff bend #3.** This alternative proposes the realignment and constriction of the mouth of cutoff bend #3 to the mouth of Bear Creek and construction of a plug within the cutoff bend downstream of the mouth of Bear Creek as described in Section 5.28 above.

5.43 **Slackwater.** This alternative proposes dredging a small slackwater channel in the remainder of cutoff bend #3 behind the plug at the mouth of Bear Creek. The channel would have a width of 182 feet at the top and would be 13 feet deep with 1V:3H side slopes. Dredged material from the slackwater channel (Aprox. 93,000 c.y.) would be placed behind the closure structure in cut #4 to partially fill the cut.

5.44 **Total closure of Cut #4.** Total closure of cut #4 with a navigation channel through the cutoff bend are proposed for this alternative, as previously explained in Section 5.20.

5.45 **Mill Creek.** Modifications to the entrance of Mill Creek are proposed for this alternative, as previously explained in Section 5.22.

5.46 **Disposal Areas.** Confined upland disposal and placement of the dredged material behind the closure structure in cut #4 would be considered for Alternative #36. Approximately 468,000 cubic yards of material would be dredged for this alternative.

5.47 **Recommended Environmental Restoration Plan.** Alternative #22 is the recommended alternative to accomplish the environmental restoration for the Lower Savannah River Basin at cutoff bend 3 and Mill Creek. There would be no action for cutoff bend 4 with this plan and construction of an upland disposal site would not be necessary. Alternative #22 would substantially increase flows to the city of Savannah water intake. Although flows to the intake would not be maximized, this plan would cost about one-fourth that of Alternative #36, which would maximize those flows. Adverse environmental impacts resulting from the implementation of this alternative would be minimal.

6.00 ENVIRONMENTAL IMPACTS OF THE PROPOSED ALTERNATIVES.

6.01 **Introduction.** This section reviews the environmental consequences of alternatives #16, #22, #24, #32, and #36. The impacts are identified and compared based on the environmental resource which would be impacted. The No Action Alternative serves as the basis for impact assessment and comparison of the plans. The following resources were considered in detail:

- Threatened and Endangered Species
- Water quality and quantity
- Air Quality
- Vegetation and Wildlife Resources
- Wetlands
- Fishery Resources
- Cultural Resources
- Savannah National Wildlife Refuge
- Recreation

6.02 **Endangered Species.** Dredging and disposal operations, as well as disposal area maintenance, have the potential to physically impact threatened and endangered species or their habitat. Impacts from the dredging operation could be produced by the dredge itself, the underwater plume it produces, or the attendant vessels which accompany a dredge. Disposal operations could affect endangered species primarily through the turbidity plume at the openwater disposal sites, turbidity associated with effluent from the confined disposal area, or encounters with equipment at the disposal site.

6.03 Dredging can adversely affect endangered species, such as the shortnose sturgeon, which occur in the Savannah River. This species is known to inhabit and spawn in the Savannah River Basin, but it was not collected in the Georgia survey of 1985. Based on information about the species' general pattern of seasonal movement and known feeding areas, the dredging operation at cutoff bends #3 and #4 is not likely to affect the shortnose sturgeon. A more detailed description of this species and precautions that could be included in each construction action to minimize the possible impacts can be found in Enclosure 1 - Biological Assessment of Threatened and Endangered Species.

6.04 **Water quality.** The proposed actions for cuts and cutoff bends #3 and #4 for Alternatives 16,24,32, and 36 would require dredging a large volume of sediment (468,000 c.y.) and construction of an upland disposal area. An increase in turbidity due to the dredging operations would be expected to occur during construction. Realignment and constriction of the mouth of cutoff bend #3 would be accomplished with a driven sheet pile wall on the downstream side and construction of an upstream bank that would be constructed of sub-aqueous and semi-compacted fill, with concrete mattress armoring. Filling behind the closure structure in cut #4 would increase turbidity during construction. These actions are expected to temporally increase the suspended solids in the area.

6.05 In general, suspended solids affect aquatic biota less as the age of an organism increases. Larvae are generally the most sensitive life stage to environmental stresses. Direct mechanical abrasion of egg and larval surficial membranes, reduction of available light in the water column, and adsorption of contaminants carried by the sediments could be expected during a dredging operation. La Salle et. al., (1991) reported that acceptable ranges of turbidity for survival of aquatic organisms was between 500 and 1,000 mg/L and that turbidity greater than 500 mg/L significantly reduced survival of striped bass larvae.

6.06 Based on this information, the turbidity plumes generated at the dredge sites during hydraulic dredging for any of the alternatives involving dredging in cutoff bends #3 and #4 are expected to produce only minimal and temporary impacts to aquatic species.

6.07 Based on a literature review of existing research, all life stages of anadromous fish species appear to be very tolerant of elevated suspended sediment concentrations. Species that use naturally turbid habitats as spawning and nursery grounds are adapted to elevated suspended sediment concentrations.

6.08 Savannah District contacted the States of Georgia and South Carolina regarding water quality certification. These documents are included in Enclosure 9. A Section 404 (b) (1) Evaluation has been prepared and is included in Enclosure 4.

6.08 **Suspended Solids in the Weir Effluent.** Neither South Carolina or Georgia have a numeric turbidity standard in their Water Quality Standards. The water quality classification for the middle and lower reach of the Savannah River - between RM 118.7 to RM 27.4 - is drinking water (Class B). Class B is defined as fresh waters suitable for secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control. These waters are suitable for fishing, industrial, and agricultural uses.

6.09 It has been estimated that the weir effluent at the proposed upland disposal area would have a turbidity level of 1,000 mg/L. The weir effluent at the disposal site on cut 4 would have a higher turbidity level than the upland disposal site during construction. Water levels would be managed within the confined disposal facility to obtain the settling time necessary to produce an effluent with the minimum level of suspended solids. The maximum design height at which water can be held, in accordance with present dike construction practices, is 2 feet below the dike crest. Water held at those levels would result in maximum retention time of the sediment/water slurry, and thereby, maximum removal of the suspended solids. A method similar to placement of baffles to maximize retention time and removal of most of the suspended solids has not been identified for the disposal area on cut 4. We would like to consider any practical suggestion to address this concern.

6.10 Impacts to fish would be expected from this operation. Impacts on Mill Creek and on the Savannah River from the weir effluent would occur during the construction phase. This impact would be temporary and diminish over time. Construction of the new entrance into the creek would occur early in the construction phase. An increased water flow would be experienced in the creek by the time of the dredging operations. This action would minimize the effects of the turbidity from the weir effluent in the creek. Rip-rap would be placed at the discharge point to minimize soil erosion.

6.11 **Water Quantity.** Increased water quantity into Mill Creek, the cutoff bends and creeks that flow from them is expected to improve the water quality at the City of Savannah's water intake. Based on the existing information about the current water flows (Table 8-Section 4.27) and using the hydrologic model, the District can predict the amount of water flow into these areas for the different alternatives. Potential water flow increase was calculated for each of the proposed final alternatives. The constricted channel in cutoff bend #3 would yield a significant flow increase into Bear Creek. Full closure of cut #4 would bring the most significant increase in water flow into the cutoff bend and associated creeks.

LOW FLOW CONDITION	EXISTING CONDITIONS (cfs)	ALT #16	ALT #22	ALT #24	ALT #32	ALT #36
Flow into Flat Ditch	0.80	38.6	0.80	38.6	38.6	38.6
Flow into unknown creek	0.01	22.3	0.01	22.3	22.3	22.30
Flow into Bear Creek	45.00	45.0	77.4	77.4	47.4	77.4
Flow into Mill Creek	0	38.6	38.6	38.6	38.6	38.6
Total	45.81	144.5	116.8	176.9	146.9	176.9
% Potential Water Flow Increase		75%	66%	100%	77%	100%

In summary, the potential for water flow increase into the creeks at the cutoff bends for Alternative #16 would be 75 percent, for Alternative #22 would be 66 percent, for Alternative #32 would be 77 percent, and for Alternatives #24 and #36 would be 100 percent increase.

6.12 **Other Water Quality Parameters.** Dissolved oxygen can also decrease in a dredge plume as a result of the additional respiration of organisms breaking down the newly available material. Results from District monitoring of hydraulic dredge plumes in the harbor over a three year period reveal only minor impacts to dissolved oxygen from the plume. In no case did the plume decrease the river's dissolved oxygen below either the Georgia or the South Carolina Water Quality Standards.

6.13 Low dissolved oxygen has periodically been observed in weir effluent from confined disposal facilities. Some organisms can survive low dissolved oxygen conditions indefinitely, as much of their ecology is predicated on such conditions. However, low dissolved oxygen may produce stress in other organisms as a result of the species' increased respiration in response to those conditions. To address this situation, a component for all alternatives is the following procedure which would be followed at the confined disposal area:

(1) Should low dissolved oxygen levels (below GA water quality standards) be observed during the weekly monitoring of weir effluent overflows during a disposal operation, daily monitoring would begin.

(2) Should sustained low dissolved oxygen levels (three consecutive days below state water quality standards) be observed in weir effluent overflows during the disposal operation, the pool elevation would be raised to the maximum height allowed by the condition of the dike (designed for full pool to be 2 feet below the dike crest).

(3) The pool elevation would be held at that height until the effluent dissolved oxygen levels exceeded state water quality standards for three consecutive days.

(4) The pool elevation may then be reduced as long as state water quality standards are maintained in the effluent.

(5) If the dissolved oxygen levels continue to remain below state water quality standards even with full pool conditions, the appropriate state water quality office would be notified by telephone (by District Environmental staff) and in writing (from the District Engineer or Contracting Officer's Representative) of the situation and what further actions were being taken to bring the Project back into compliance with its Water Quality Certification.

(6) After dissolved oxygen levels above GA water quality standards are recorded for 14 consecutive days, the monitoring frequency would be shifted back to a weekly basis.

6.14 Alternative 22 would have less impact on water quality than the other four alternatives, since there would be no dredging actions for the cutoff bends and no disposal areas would be required. Alternative 24 would have less impacts on water quality than Alternatives 16, 32, and 36 since approximately 93,000 cubic yards less (slackwater channel) would be dredged. A larger volume of material would be dredged for Alternative 16 with the restoration channel in cutoff bend #3 (36,000 c.y. more). No impacts on water quality are expected from construction and use of an access road to the proposed upland disposal area.

6.15 In summary, Alternatives 16, 22, 24, 32, and 36 would result in water quality impacts which are expected to be acceptable. All four alternatives contain features to limit adverse impacts to the environment.

6.16 **Air Quality.** The project area is located on an attainment area as determined by the Clean Air Act and the State Implementation Plan. Except for Alternative 22, the proposed alternatives would require clearing and burning of trees and shrubs for the purpose of land clearing during construction. Approximately 9 acres in total would be cleared in cutoff bend #4. Open burning activities are regulated by the Environmental Protection Division, Air Protection Branch, GADNR, under Chapter 391-3-1.02 (5) of November 1992 of the State Implementation Plan. This activity would not result in a significant visibility impairment, and would not cause or contribute to any violation of any standard in the area and would not impact any residential area close to the project area. Burning would be limited to stumps, logs, roots, and large brush and would meet the following conditions:

(a) the amount of dirt on or in the material being burned would be minimize;
(b) not other materials other than wood waste would be burned;

Given that this would be a one time activity and the limited geographic area, it is not expected to significantly affect the air quality in the area. This action conforms to the applicable implementation plan in accordance with the requirements contained in 40 CFR, Part 93.

6.17 Sediment Quality. The joint EPA/Corps framework document for Evaluating Environmental Effects of Dredged Material Management Alternatives requires an initial assessment, based on available information, to determine if the sediments to be dredged contain any contaminants in forms and concentrations that are likely to cause unacceptable impacts to the environment. GADNR analyzed surface sediment samples (1-6 inches) along the Savannah River for the presence of radionuclides. Their investigations reveal levels of radionuclides which are below concentrations which would cause concern. However, dredging depths would be up to 15 feet deep. For this reason, sediment samples in the study area were collected by CESAS-EN-GH on 16 August 1995. The sediments were analyzed by CompuChem Environmental Corporation and their findings were reviewed by a District biologist (See Enclosure 6).

6.18 Sediment Analysis. The data reveal no concern for heavy metals, as all observed levels are within the range for uncultivated soils in Georgia. The levels of radionuclides in the sediments are similar to levels in soils in several other areas of the United States. No organic contaminants were identified above the method detection limit. Detection limits for the pesticides and most semivolatile compounds are considered adequate to conclude that these substances are unlikely to be present at levels that would cause environmental impacts.

The detection limits for five polynuclear aromatic hydrocarbons (PAHs) are above the Effects Range Median (ERM). The ERM is the median level of a compound in sediments observed to cause effects to aquatic organisms (Long et al., 1993). The ERM is a level above which one would be concerned that effects to aquatic organisms could be expected to occur. There are some uncertainties concerning possible environmental effects associated with the project sediment data because all PAHs were not analyzed at levels below the ERMs. However, the lack of detection of other contaminants at levels of concern indicates it is unlikely that these PAHs are present at levels that would impact the aquatic environment. Confined upland disposal would minimized potential impacts. Deposited sediments should be raised to high ground elevation to minimize potential environmental impacts during disposal behind the closure structure and filling of cut #4.

6.19 **Fishery Resources.** There is a potential for impacts to fish and other mobile aquatic life stemming from dredging and disposal operations. Impacts during the dredging operation could result from physical impacts from the dredge and resuspension of solids at the dredge site. Impacts from disposal operations could result from water quality aspects (suspended solids, low dissolved oxygen, etc.) of effluent from the confined disposal site to Mill Creek. Potential impacts to fish from discharges from the disposal area were evaluated in the sections describing water quality impacts.

6.20 Since adult fish are mobile and dredging impacts would be very localized, the potential for adult fish being harmed due to physical impacts from this activity is quite low. In summary, each of the proposed alternatives would result in impacts to fishery resources which are acceptable. Although dredging and disposal operations do adversely impact these resources, the amount of impact is within acceptable limits and does not affect the viability of any population.

6.21 It is expected that with the proposed restoration habitat condition and fishery composition would be similar to that found in a maintained navigation channel.

6.22 **Benthic Resources.** Benthic communities in a dredging area are physically disturbed by dredging activities and most benthic communities would be lost where excavation actually occurs. After the excavation is complete, the area would be available for recolonization. A stable bottom surface would be produced. No maintenance dredging would occur in the future for any of the alternatives and the area would support a benthic community in an equilibrium condition after construction.

6.23 Since most of the biota in sediments exists within the top foot of the water/sediment interface, excavation of a thicker layer of sediments results in fewer impacts to benthic communities than does normal maintenance dredging in a channel. Each of the alternatives would result in impacts to benthic resources, but those impacts would be acceptable and would not affect the viability of any benthic community in the area.

6.24 **Vegetation and Wildlife.** Clearing of vegetation would be required to place the disposal pipelines and to construct the disposal area. The existing 8-year old pine plantation in the proposed disposal area would be removed. It is expected that approximately 13 acres of low value (average annual functional index = 0.3; average annual functional value = 3.9 acres) bottomland hardwoods would be removed as a result of navigation channel construction in cut #4. The vegetation along the cutoff bend consists mainly of black willow trees (Salix nigra) growing on the lower river banks.

6.25 Potential impact to wildlife species could result from the dredging and disposal operations and from the disposal maintenance activities. The main areas where direct adverse impacts would be possible are the proposed upland disposal facility and the wetland areas that would be affected by the navigation channel. The vegetation supporting the wildlife in these specific areas would be removed as a result of the proposed activities. The positive effects of the restoration project on the surrounding wetlands would replace the functional values of those wetlands which would be lost (See Table 12).

6.26 **Wetlands.** The functional values of wetlands are being increasingly recognized by the public. Wetlands serve several purposes, including the following: nursery areas for aquatic species, nesting areas for wildlife (primarily birds), food source for aquatic species, and to filter pollutants from water.

6.27 The proposed design for the navigation channel for cutoff bend #4 shows that cuts into the pre-project (1961) river bank would be required in few areas but, in general, the excavation stays within tne old cutoff bend. Removal of trees and general clearing and grubbing would be required where construction occurs into the pre-project river bank..

6.28 *Total closure of Cut #4.* Although some areas within Flat Ditch Point will be affected by construction of the navigation channel through cutoff bend #4, most of the area is characterized by recent deposits of river sediments, with black willow trees (Salix nigra) growing on the lower river banks. These areas are of limited value if compared to the more mature bottomland hardwood forest growing on top of the river banks where soils are fluvial deposits of sandy silts and clays, especially on the easternmost part of the cutoff bend. The final design for the navigation channel will protect this area from construction activities. Concrete mats would be used for slope protection on two sites of the cutoff bend to prevent bank erosion.

6.29 *Realignment and Constriction of Entrance to Cutoff bend #3.* The new mouth of cutoff bend #3 to the mouth of Bear Creek would require some clearing and grubbing of willow trees and underbrush growth within the area of the constricted channel and downstream plug. Pure stands of black willow grow in the lower river banks. Because of the low value of this vegetation, impacts from the proposed realignment is considered minimal.

.6.30 *Disposal Area.* The areas identified as wetlands in the proposed upland disposal area would be eliminated through the construction (estimated 2.3 acres). As described in Section 4.29, these wetlands are isolated and have already been impacted by pine plantation activities. Construction of fire break roads and access to the area have modified the hydrology of the area over the years. These wetlands exhibit effects of a more drier regime and upland species succession. An average annual functional index of 0.5 has been determined for this area, which represents an average annual functional value of direct construction related loss of 1 acre (See table 12).

6.31 *Overbank Areas.* Sharp bends in coastal rivers are generally the areas where flood waters leave the banks of the river and filter through the forested wetlands via small streams. By restoring flow to cutoff bends #3 and #4, the wetlands in the project area would receive more frequent flooding. The net effect of the restoration project would be to provide more frequent flooding of the wetlands in the immediate area of the restoration project and increase the frequency, duration, and amount of flow into the creeks. More natural flow conditions would be restored to that section of the river. Flow to

Table 12 - Impacted area of Bottomland Harwoods due to Construction and BHW Benefits

ALTS	CUT #3	CUT #4	MILL CREEK	ACRES	AVERAGE ANNUAL FUNCTIONAL INDEX	AVERAGE ANNUAL FUNCTIONAL VALUE	TOTAL ANNUAL FUNCTIONAL VALUE	NET AAFV BENEFI
16	Full Closure w/Restoration Channe	Full Closure	Restore	1	1	1	6.4	3498
				18	0.3	5.4		
22	Realign-Constrict/Large	No Action	Restore	0	0	0	0	1960
				0	0	0		
24	Realign-Constrict/Large	Full Closure	Restore	13	0.3	3.9	4.9	3498
				1	1	1		
32	Realign-Constrict/Small W/Slack	Full Closure	Restore	18	0.3	5.4	6.4	2893
				1	1	1		
36	Realign-Constrict/Large W/Slack	Full Closure	Restore	18	0.3	5.4	6.4	3498
				1	1	1		

Note: **(a) Filling and planting** cut #4 would have a gain of 1.6 Average Annual Functional Value (Alternatives 16, 32, and 36)

(b) Impacts to wetlands on the Disposal Area would have a loss of 1 Aver. Annual Functional Value for Alternatives 16, 24, 32, and 36 tributaries and adjacent wetlands would be increased.

6.32 In summary, the proposed alternatives would result in minimal direct loss of wetland and associated values if compared to the average annual functional values that would be gained from the implementation of the restoration project. Alternative #22 would have the less impact on existing wetland areas during construction while Alternative #36 would produce the greatest possible combination of restoration effects in the surrounding wetlands and tributaries.

6.33 **Cultural Resources.** Intensive shovel testing along the river banks and on the cutoff islands, and visual inspections of the river banks in the project area, showed no artifacts or archaeological sites within the boundaries of the project. Nevertheless, no testing was performed on the sediments within the cutoff bends channels. The present under-water detection technology will not be capable of detecting the existence of any artifacts that may be located in the old channel due to the 12-foot average sediment depth. Based on the inability to detect artifacts in sediments of this depth, a cultural resource survey would not conclusively determine their existence and, therefore, is not warranted.

6.34 No impacts to cultural resources would occur from the disposal area construction and operation. The proposed easement for pipeline discharge to Mill Creek would not impact any historic site close to the area. Cultural resources discovered in the future within the area of operation and management of the Restoration Project would be addressed in conformance to existing laws.

6.35 **Savannah National Wildlife Refuge.** The Savannah Refuge is located south of cutoff bends 3 and 4. The Refuge was originally created and is managed as a freshwater Refuge. The Refuge is very susceptible to impacts from development and from the operation of the navigation cuts and the Savannah Harbor activities. The main purpose of the Lower Savannah River Environmental Restoration Project is to restore wetlands adjacent to the Lower Savannah River and enhance fish and wildlife habitat and water quality. The Refuge would be a direct and very important beneficiary from the proposed project. The expected increase in duration and depth of flooding in wetland tributaries that feed the Savannah National Wildlife Refuge would increase flushing of detritus and nutrients from the wetlands. Wildlife habitat would be maintained and enhanced from this action.

6.36 **Recreation.** Adverse impacts to recreation activities would be concentrated around the immediate project area during construction activities. After project implementation, the three alternatives are expected to provide extensive opportunities for fishing, boating, and hunting as fish and wildlife habitat improve after project implementation.

6.37 **Secondary impacts.** A source of secondary adverse impacts would be from the transit of barges through the bends as turbidity plumes could be produced as they pass through the river. This represents a minimal impact since barge traffic only occurs a few per year.

6.38 Another potential secondary impact is the erosion of the adjacent shoreline. Flows tend to concentrate in areas of deep water on the outside of the bends, while shallow areas on the inside of bends tend to shoal. This natural variation tends to result in erosion of portions of a river's shoreline. Currents and waves from barges and boats can impact the nearby shoreline, causing it to erode. With total closure of cutoff bend #4, the velocities would be high in the bend. It is assumed that minimum shoaling would occur in this case.

6.39 Improvement to the quality and quantity of water used by the City of Savannah would be a positive secondary impact from the proposed restoration plans.

6.40 **Cumulative impacts.** Cumulative impacts are the effects on the environment which result from the incremental impact from the proposed project added to those experienced as a result of other past, present, and reasonably foreseeable future actions. As described in Sections 3 and 5.13, modifications to the natural flow regime from the construction of the navigation channels and reservoirs in the Piedmont during the past 50 years, have caused degradation and loss of the forested wetlands along the lower Savannah River. The cutoff bends have been impacted by heavy sedimentation since the navigation modifications in 1962. The fill rate of the cutoff bends is linear and most of the fish habitat in cutoff bends will be completely eliminated in less than 15 years. Tributaries have also being affected by the limited flow and siltation in the cutoff bends. This is specially true at typical summer (low) river flow. No Action on cut and cutoff bend #4, as proposed in Alternative 22, would result in the elimination of fish habitat in the bend, flow to Raccoon Creek, Flat Ditch, and the unknown creek would be zero, and the Raccoon Creek Zone would be completely isolated from the main river during low flow conditions.

6.41 The effects of the proposed environmental restoration for the Lower Savannah River should be more observable in the first few years after the project is constructed, as vegetation and the wetlands areas initially respond to the increased flow. The proposed plans would provide significant habitat unit benefits due to the large amount of bottomland hardwood habitat restored in cutoff bends 3 and 4, Mill Creek and the substantial additional flow into the other creeks. Water quality and quantity at the Savannah water intake in Abercorn Creek would improve gradually as a result of the proposed plans. Costs associated with water treatment would be reduced.

6.42 The proposed plans are not expected to adversely affect navigation activities or transportation patterns through the river, nor they are expected to adversely affect recreation activities in the project area. The increase in habitat units and benefits to the bottomland hardwoods, along with a more constant water quality, are expected to improve wildlife habitat in the area. This would provide more recreation opportunities for fishing, hunting, and wildlife observation in the future.

6.43 **Preferred Alternative: Summary of Environmental Impacts.** Alternative #22 would not affect threatened and endangered species or their habitats. The potential to physically impact threatened and endangered species from dredging and disposal operations, or from disposal area maintenance would be minimal, since no significant dredging would occur with this alternative and disposal areas are no longer needed. Alternative #22 would have less impacts on water and air quality than any the other four alternatives. The potential for water flow increase into the creeks would be 66 percent for Alternative #22. Adverse impacts to fishery resources from the construction activity are considered to be low. Impacts to benthic communities would be acceptable and would not affect their viability in the area. The preferred alternative would have less adverse impact on existing wetland areas during construction than the other four alternatives.

7.00 **COORDINATION.** Savannah District has coordinated this proposed action with U.S. Fish and Wildlife Service pursuant to the Fish and Wildlife Coordination Act. A report evaluating the Lower Savannah River Restoration Study was submitted to the Corps of Engineers by that agency in fulfillment of the FWCA (48 Sta. 401, as amended; 16 U.S.C. 661 et seq.; Section 2(b)). This FWCA report was coordinated with National Marine Fisheries Service, the Georgia Department of Natural Resources, and the South Carolina Department of Natural Resources, and it is an appendix of the Feasibility Study. Information contained in that report was used in the analysis of the alternatives for this EA. The proposed action was coordinated with the South Carolina Department of Health and Environmental Control, Office of Ocean and Coastal Resources Management pursuant to 15 CFR Part 930 for a Federal Consistency Determination under the SC Coastal Management Program. The Georgia State Clearinghouse, Office of Planning and Budget has found the proposed project to be consistent with State goals, policies, plans, objectives, and programs. Coordination pursuant to Section 106 of the National Historic Preservation Act was initiated with Georgia Department of Natural Resources, Historic Preservation Division and with the South Carolina Department of Archives and History. Copies of the final report, "Cultural Resources Survey of Cuts 3 and 4, Lower Savannah River Environmental Restoration", was submitted to each department. Letters concurring with the District determination of no impact to cultural resources were received from both departments (See Enclosure 4).

7.01 The Georgia Department of Natural Resources, Wildlife Resource Division conducted the vegetation sampling in the project area. The Environmental Setting Report submitted by this Division was used for the Environmental Setting Section in this EA.

7.02 U.S. Fish and Wildlife Service conducted the Bottomland Hardwood and Habitat Evaluation Program analysis that resulted in determination of Bottomland Hardwoods and Habitat Units for the various alternatives.

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FINDING OF NO SIGNIFICANT IMPACT

1. **Project Description.** The proposed project is the restoration of cutoff bend 3, located approximately at River Mile 41, to increase water flow in Bear Creek, Little Abercorn Creek, Mill Creek, and their surrounding wetlands. Bear Creek and Mill Creek flow through the Savannah National Wildlife Refuge, and eventually discharge into Abercorn Creek, where the City of Savannah's water intake is located. The final restoration plan is the plan preferred by the non-Federal sponsor, consisting of the realignment and constriction of the mouth of cutoff bend 3, restoration of flow to the entrance of Mill Creek, and No Action on cut 4. The restoration plan includes the construction of a partial diversion structure in cut 3, realignment and constriction of the mouth of cutoff bend 3 to the mouth of Bear Creek, and modifications to the Mill Creek entrance on the Savannah River.

2. **Coordination.** Savannah District has coordinated this proposed action with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Georgia State Clearinghouse, Georgia Department of Natural Resources, South Carolina Department of Health and Environmental Control, SCDHEC Office of Ocean and Coastal Resource Management, South Carolina Department of Archives and History, GADNR Historic Preservation Division, and with the City of Savannah. On December 27, 1995, the District issued a Notice of Availability of the draft Environmental Assessment to solicit comments from the general public

3. **Environmental Impacts.** The project is in compliance with all environmental laws. The turbidity increases during construction would be minor in scope and temporary in nature. The overall environmental impacts of the proposed project are judged to be minor in scope.

4. **Determinations.** I have determined that this action does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, the action does not require preparation of a detailed statement under Section 102 (2) (C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et. seq.). My determination was made considering the following factors discussed in the Environmental Assessment prepared for this project:

a. The proposed project would not adversely affect any threatened or endangered species potentially occurring in the project area.

b. No apparent adverse cumulative or secondary impacts would result from project implementation.

c. The proposed environmental restoration project would meet both Federal and State water and air quality standards. Any impacts to water or air quality would be temporary and localized. There would be no discharge resulting from the proposed action. No significant degradation of the Waters of the United States would result from the bank slope protection and fill areas in the new channel and plug downstream of the constricted channel. There will be no significant adverse effects on human health and welfare, municipal and private water supplies, recreational and commercial fisheries, plankton, fish, shellfish, wildlife, special aquatic sites, life stages of aquatic life and other wildlife dependent on aquatic ecosystem diversity, productivity and stability, or recreational, aesthetic and economic values.

The proposed action complies with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations", and does not represent disproportionately high and adverse human health or environmental effects on minority populations and low-income populations in the United States.

Based on the determinations made in the Section 404 (b)(1) Evaluation, the finding is made that the proposed construction of a diversion structure in cut 3, the realignment and constriction of the mouth of cutoff bend 3 to the mouth of Bear Creek, and the new entrance to Mill Creek, have been specified through the application of the Section 404 (b)(1) Guidelines and comply with these guidelines.

d. Unavoidable wetland impacts would be offset by the environmental restoration of wildlife habitat and associated 4,708 acres of functional value wetlands to conditions similar to the pre-navigation project.

e. The proposed project would not impact any cultural resources in the project area.

5. **Findings.** Modifications to cut and cutoff bend 3, no action on cut and cutoff bend 4, and restoration of flow to Mill Creek is the preferred plan to accomplish the intended project purpose of environmental restoration, while maintaining the commercial navigation channel in this reach of the Savannah River.

Date: 3/22/96

GRANT M. SMITH
Colonel, U.S. Army
District Engineer

ENCLOSURES

ENCLOSURE 1

BIOLOGICAL ASSESSMENT OF THREATENED AND ENDANGERED SPECIES

LOWER SAVANNAH RIVER ENVIRONMENTAL RESTORATION OF CUTOFF BENDS 3 AND 4 EFFINGHAM COUNTY, GEORGIA AND JASPER COUNTY, SOUTH CAROLINA

1.00 **Project Description.** The proposed project is the environmental restoration of cutoff bends 3 and 4, located approximately at River Mile 41, thereby increasing water flow in Bear Creek, Little Abercorn Creek, Mill Creek, and the surrounding wetlands. The recommended plans includes the full closure of navigation cut 4, realignment and constriction of the mouth to cutoff bend 3, no action on cut 4, slackwater chanel on cutoff bend 3, and restoration of flow to the entrance of Mill Creek. The creeks that originate in the cutoff bends and Mill Creek flow through the Savannah National Wildlife Refuge and eventually discharge into Abercorn Creek. The City of Savannah's water intake is located on Abercorn Creek.

1.01 The recommended plan would provide the opportunity to restore the natural flow regime in the cutoff bends, while simultaneously restoring the environment and wildlife habitat and the adjacent wetlands to their pre-navigation conditions. The new flow regime will provide diverse and productive bottomland hardwoods and fish and wildlife habitat in the Lower Savannah River. Modifications to the entrance of Mill Creek on the Savannah River would also increase flow to the wetland areas. Restoration of flow to Bear Creek would be an opportunity to improve the quality and quantity of water used by the City of Savannah. The plans also propose the construction of an upland disposal area.

2.00 **Environmental Setting.** The project area is located in Effingham County, Georgia and Jasper County, South Carolina. These counties lie in the Lower Coastal Plain Region, known as the Atlantic Flatwoods. The area is best characterized as forested bottomland hardwood swamp and tupelo gum-cypress swamp at the upper reaches of tidal influence. Although no saltwater reaches the project site, the lower site of the study area is strongly influenced by tidal flooding. The South Carolina bank is characteristic bottomland hardwood swamp with some clear-cut timber harvest areas. Recent timber harvests in the Georgia bank occur opposite Flat Ditch Point (Cutoff bend 4).

2.01 The river, meanders, permanent streams, sloughs, depressions, forested, scrub-shrub, and emergent wetlands provide a diversity of habitat for migratory and resident wildlife species that depend upon these forested wetlands for food and shelter. The Savannah River and permanent streams contain an abundance of freshwater species some of which have great recreational value.

2.02 The water quality classification for the middle and lower reach of the Savannah River - between River Mile 118.7 to River Mile 27.4 - is drinking water (Class B). Class B is defined as fresh waters suitable for secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control. These waters are suitable for fishing, industrial, and agricultural uses, and for the survival and propagation of a balanced indigenous aquatic community of fauna and flora.

2.03 The City of Savannah has experienced declining water quality (pH) at its municipal and industrial water intake facility on Abercorn Creek. Bear Creek, Racoon Creek, Little Abercorn Creek, and Mill Creek are tributaries that eventually flow from cutoff bends 3 and 4 to Abercorn Creek. These creeks have been affected by sedimentation and reduced flow as a result of the navigation cuts.

2.04 In 1927, the U.S. Fish and Wildlife Service established the Savannah National Wildlife Refuge which encompasses 26,000 acres of lowlands and marshes along the Savannah River. It is located south of cutoff bends 3 and 4. The Refuge was originallv created and is managed as a freshwater Refuge. The Refuge is an important nesting area for the wood duck and provides excellent habitat for many other species of birds, mammals, reptiles, and amphibians. It is also located in the Atlantic flyway of migratory waterfowl. The refuge help serve the recreational needs of the area through its fishing, hunting, and wildlife observation opportunities.

3.00 <u>Threatened and Endangered Species.</u> Table 1 is a list of the threatened and endangered species that might be in the project area. The list contains Threatened and Endangered Species which can be found in the vicinity of cutoff bends 3 and 4 in Effingham County, Georgia and Jasper County, South Carolina. These species were excerpted form a list provided by FWS, dated May 1995. In accordance with Section 7 of the Endangered Species Act of 1973, we have evaluated the impacts the proposed action could have on any threatened or endangered species potentially occurring in the project area.

TABLE 1

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

Eastern cougar	Felis concolor cougar	E
American peregrin falcon	Falcon peregrinus anatum	E
Bald eagle	Haliaeetus leucocephalus	E
Red-cockaded woodpecker	Picoides borealis	E
Wood storck	Mycteria americana	E
Kirtland's warbler	Dendroica kirtlandii	E
Eastern indigo snake	Drymarchon corais couperi	T
Shortnose sturgeon	Acipenser brevirostrum	E
Candy's dropwort	Oxypolis canbyi	E
Chaff-seed	Schwalbea americana	E

3.01 In addition, the following species have been identified by Fish and Wildlife Service as candidates to be included in the Federal list: loggerhead shrike (Lanius ludovicianus), flatwoods salamander (Ambystoma cingulatum), gopher tortoise (Gopherus polyphemus), Florida pine snake (Pituophis melanoleucus mugitus), creeping St. Johns'-wort (Hypericum adpressum), ponspice (Litsea aestivalis), pineland plantain (Plantago sparciflora), and eulophia (Pteroglossaspis ecristata).

3.02 The gopher tortoise, pondspice, and the granite rock stonecrop (Sedum pusillum) are classified as Threatened species by the Georgia Department of Natural Resources and are protected by the State. The American swallow-tailed kite, a South Carolina State listed endangered species, can be observed on the project area. This species nests near or in palustrine wetlands and is closely associated with them.

3.03 The proposed project would not destroy or modify any habitat determined critical for these species' survival.

4.00 Discussion of Potential Impacts. Savannah District has reviewed information concerning each of these species and evaluated the potential for the proposed action to impact these species. The results of our evaluation are contained in the following paragraghs:

4.01 **Eastern Cougars (Felis concolor cougar).** The proposed project would not include land-use changes that would degrade any habitat suitable for these cats. Neither would the proposed actions destroy of modify any habitat determined critical for the species' survival. The environmental restoration project would enhance wetland habitats.

4.02 **Wood Stork (Mycteria Americana).** Wood storks are known to frequent the more protected estuarine areas of the region for both feeding and nesting. This species has been observed in the Savannah National Wildlife Refuge and in the project area. Optimal water regimes for the wood stork involve periods of flooding, during which prey (fish) populations increase, alternating with dryer periods during which receding water levels concentrate fish at high densities. The proposed project would increase the depth and frequency of flooding regimes in the surrounding wetlands. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.03 **Bald Eagle (Haliaeetus leucocephalus).** Bald eagles have been observed in the Lower Savannah River Floodplain. Active nests are located at the Savannah National Wildlife Refuge. The proposed project would not affect the existing nest sites or areas immediately adjacent to them. The proposed environmental restoration project would enhance their habitat by attracting migrating birds to the wetland areas and possibly to the upland disposal site. It is known that standing water in disposal areas is used by waterfowl in winter and during their migrations, and eagles feed on waterfowl. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.04 **Red-cockaded Woodpecker (Picoides borealis).** This species requires forested habitat of at least 50% pine 30 years or older. No habitat that could potentially be used by this species would be impacted by the proposed project. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.05 **Kirtland's warbler (Dendroica kirtlandii).** This very rare warbler breeds in Michigan and winters in the Bahamas. It is a rare transient along the Southern Atlantic Coast, including Georgia and South Carolina. We are aware of no estimate of the number of individuals migrating through the state. It would be expected to occur as a very rare migrant in coastal scrub and forest land, specially after storms. No habitat would be impacted by this project that this species might use. Moreover, the proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.06 **American peregrin falcon (Falco peregrinus anatum).** The American peregrin falcon breeds from the subartic boreal forest to Mexico. American peregrin falcons that nest in subartic areas also winter in Latin America, while those that nest in lower latitudes migrate shorter distances or are nonmigratory. They are a cosmopolitan species and have never occurred in large numbers. They live mainly in areas where prey is abundant. They prefer to nest on cliffs or high hills. In Georgia, peregrins are most likely to be seen migrating along the coast, but can occur anywhere in the state. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.07 **Eastern indigo snake** (Drymarchon corais couperi). This snake seems to prefer high, well-drained sandy soils, such as the sandhill habitat preferred by the gopher tortoise. During the warmer months, these snakes also frequent streams, swamps, and occasionally flat woods. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.08 **Shortnose Sturgeon** (Acipenser brevirostrum). The shortnose sturgeon is an anadromous species restricted to the east coast of North America. They have been recorded from New Brunswick to Florida. Throughout its range, shortnose sturgeon occur in rivers, estuaries, and the sea. The majority of populations have their greatest abundance in the estuary of their respective river. The most upstream record appears to be river mile 153 in the Hudson River in New York State (U.S. Department of Commerce, National Marine Fisheries Service 1984)(NMFS, 1984), river mile 172 in the Savannah River (Hall et al., 1991) and river mile 148 in the Delaware River. New information indicates this species is more abundant than previously thought (NMFS, 1984). Although listed as endangered in the United States, a small commercial fishery exists in Canada. The sturgeon is a suctorial bottom feeder. The preferred prey is small gastropods (NMFS, 1984).

4.09 The species' general pattern of seasonal movement appears to involve an upstream migration from late January through March when water temperatures range from 9 C to 12 C. Post-spawning fish begin moving back downstream in March and leave the freshwater reaches of the river in May. Juvenile and adult sturgeon use the area located 1 to 3 miles from the freshwater/saltwater interface throughout the year as a feeding ground. During the summer, this species tends to use deep holes at or just above the freshwater/saltwater boundary (Flournoy et al., 1992, Rogers and Weber, 1994, Hall et al., 1991). This boundary was thought to occur in the Savannah River between river miles 20.5 and 23.6 in 19 7 (Hall et al., 1991).

4.10 Shortnose sturgeon may be present in the project area during dredging operation. Adult and juvenile sturgeons are believed to be very mobile, even when occupying resting areas during the summer months. The potential for the adult and juvenile fish being hit by the cutterhead is very low. The eggs and the larval sturgeons are not as mobile. Therefore, there is a potential for them being impacted either by being entrained by the dredge or being smothered/physically damaged by the materials in the dredge plume. However, its is highly likely that the sturgeons using the Savannah River have experienced frequent natural increased sediment loads well above those created by a hydraulic dredge. Based on information about the species' general pattern of seasonal movement and known feeding areas, the dredging operation at cutoff bends 3 and 4 is not expected to have more than minimal adverse impact on the shortnose sturgeon. The proposed project would not destroy or modify any habitat determined critical for the species' survival.

4.11 **Canby's dropwort (Oxypolis canbyi) and Chaff-seed (Schwalbea americana)**. These two plant species are listed as endangered species for Jasper County, South Carolina. Canby's dropwort grows in coastal plain habitats including wet meadows, wet pineland savannas, ditches, sloughs, and around edges of Cypress-pine ponds. The healthiest populations seem to occur in open bays or ponds which are wet most of the year and have little or no canopy cover. Changes in the soil moisture levels and ditching and draining of lowland areas, primarily for agricultural and silvicultural purposes are the most significant threats to the species' survival. American chaffseed occurs in sandy acidic, seasonally moist to dry soils. It is generally found in habitats described as open, moist pine flatwodds, fire-maintained savannas. Chaffseed is dependent on factors such as fire, mowing, or fluctuating water tables to maintain the crucial open to partly-open conditions that it requires. The most serious threats to its continued existence are fire-suppression, conversion of habitat for commercial and residential purposes, and incompatible agriculture and forestry practices. Since most of the construction activities will be concentrated on Effingham County, Georgia, the proposed project would not destroy or modify any habitat determined critical for these species' survival.

5.00 **Determination.** Based on the above evaluation, we find that the proposed environmental restoration project for the Lower Savannah River, cutoff bends 3 and 4, will not have significant adverse impacts on these species. The proposed project will enhance and improve the wetland habitat that supports these species.

6.00 **References.**

Flournoy, Phyllip H., S. Gordon Rogers, and Paulette S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. USFWS Project Number AFS-2, Segments One and Two, Coastal Resource Division, Georgia Department of Natural Resources, Final Report.

Hall, J.W., T.I.J. Smith and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon, Acipenser brevirostrum in the Savannah River. Copeia 1991(3):695-702.

Rogers, S. Gordon, and Wendi Weber. 1994. Occurrence of shortnose sturgeon (Acipenser brevirostrum) in the Ogeechee-Canoochee River System, Georgia during the summer of 1993. Final

Report to the Nature Conservancy of Georgia, for the U.S. Army, Fort Steward, Georgia, January 1994, Coastal Resources Division, Georgia Department of Natural Resources.

U.S. Department of Commerce, National Marine Fisheries Service. 1984. Synopsis of biological data on shortnose sturgeon Acipenser brevirostrum. NOAA Technical Report NMFS 14.

U.S. Fish and Wildlife Service. 1992. Endangered and Threatened Species of the Southeastern United States (The Red Book), Vol.2.

ENCLOSURE 2

WATER CHEMICAL DATA

SAVANNAH RIVER
CHEMICAL DATA

STATION NUMBER	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5	STATION 6	STATION 7
DATE	4/20/94	4/20/94	4/20/94	4/20/94	4/20/94	4/20/94	4/20/94
TIME	1310	1320	1328	1416	1343	1356	1423
Ammonia-Nitrogen (mg/l)	0.05	0.05	<0.03	<0.03	<0.03	0.08	0.04
Biochemical Oxygen Demand (mg/l	0.9	0.8	0.8	0.8	0.8	0.8	0.9
Color (PCU)	30	35	35	25	30	30	30
Fecal Coliform (MPN/100 ml)	70	<20	20	110	50	70	80
Hardness (mg/l)	--	18	20	20	16	18	16
Nitrate + Nitrogen (mg/l)	0.21	0.22	0.21	0.21	0.21	0.21	0.21
Suspended Ssolids (mg/l)	16	15	16	16	15	15	17
Total Alkilinity (mg/l as $CaCO_3$)	25	24	23	23	23	25	23
Total Organic Carbon (mg/l)	4.0	4.0	4.0	4.0	3.0	4.0	4.0
Total Phosphorous (mg/l)	0.11	0.14	0.11	0.11	0.11	0.11	0.11
Turbidity (NTU)	9.0	8.0	9.0	8.0	7.0	8.0	8.0
Air Temperature (°C)	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Water Temperature (°C)	19.4	19.5	19.3	19.4	19.5	19.6	19.4
Dissolved Oxygen (mg/l)	7.72	7.93	7.89	7.89	7.99	7.85	7.85
Conductivity (µmho/cm @ 25C)	96	98	96	96	98	99	95
pH (std units)	7.04	7.08	6.87	6.98	7.22	7.18	6.98

ENCLOSURE 3

SURFACE AREA AND VOLUME ANALYSIS
FOR
CUTOFF BENDS 3 AND 4

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ENCLOSURE 3

LOWER SAVANNAH RIVER ENVIRONMENTAL RESTORATION
SURFACE AREA CHANNEL COMPARISON
HICKORY BEND AND FLAT DUTCH DITCH

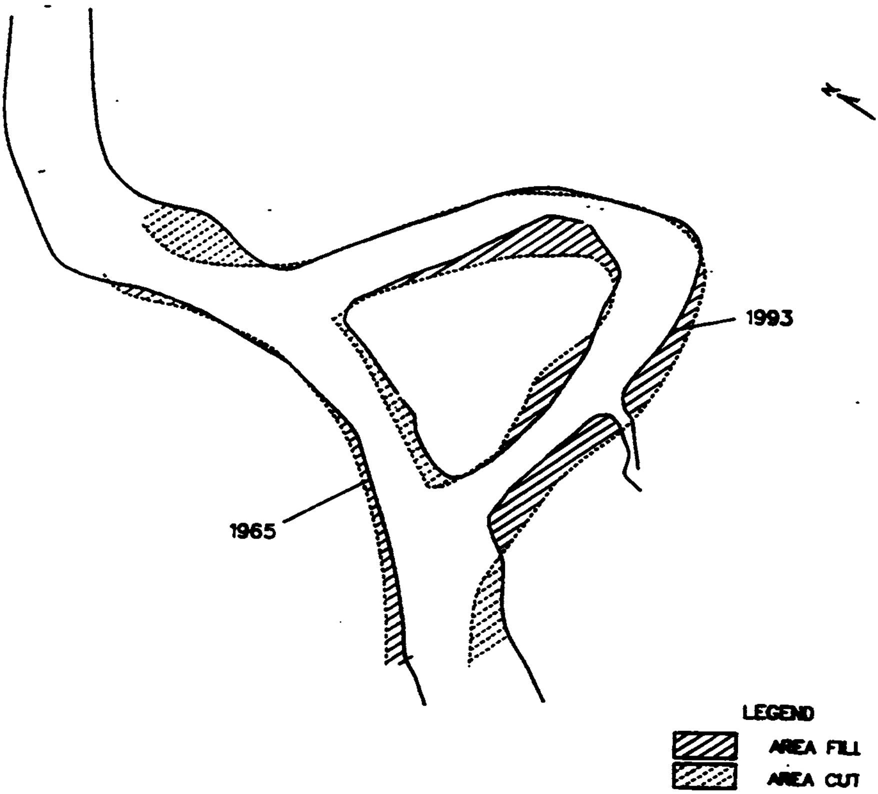
HICKORY BEND (CUT #3)

YEAR	SURFACE AREA (sq. ft.)	DECREASE IN SURFACE AREA (%)
1950	534,816.9	NA
1965	442,352.7	17.2
1972	383,445.1	28.3
1989	268,052.2	49.5
1993	269,691.4	49.5

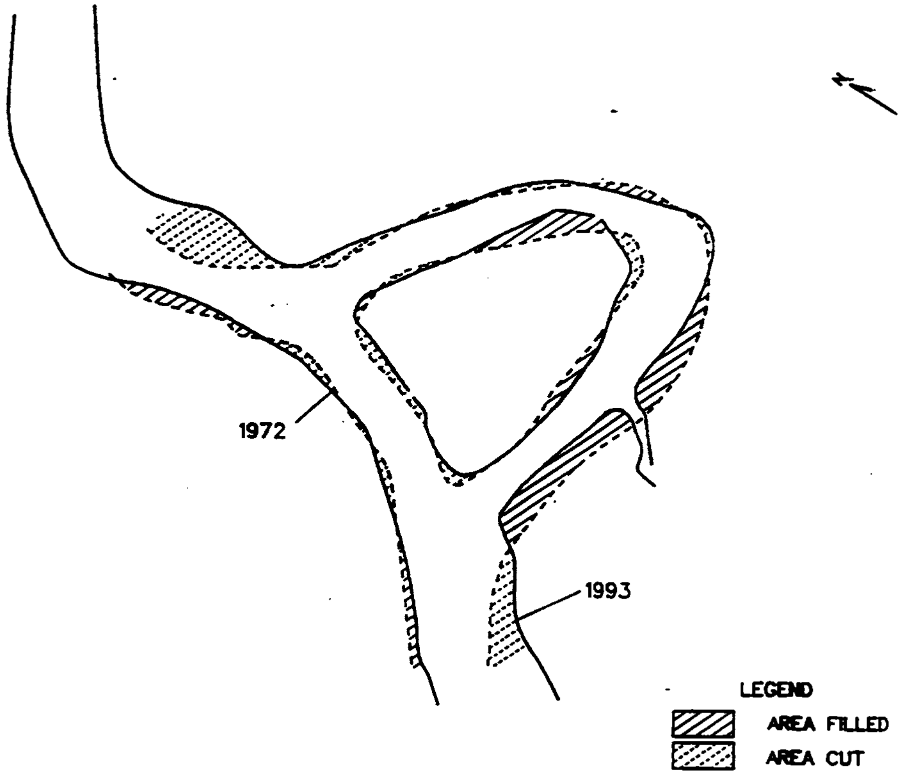
FLAT DUTCH DITCH (CUT #4)

YEAR	SURFACE AREA (sq. ft.)	DECREASE IN SURFACE AREA (%)
1950	1,734,247.6	NA
1965	1,483,929.8	14.4
1972	1,012,301.1	41.6
1989	790,169.6	54.4
1993*	762,284.9	56.0

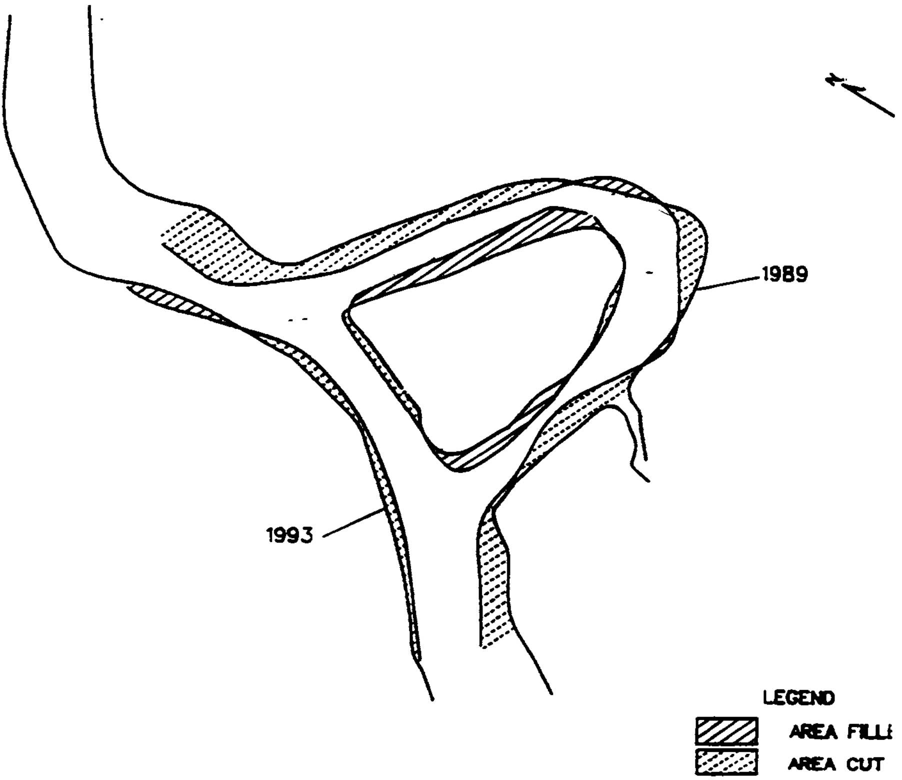
* 1993 surface area estimates were made from actual topographic survey. All other estimates were made from "Condition Survey, Savannah River Below Augusta. Navigation Charts."



HICKORY BEND - CUT 3
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORAT
CHANNEL COMPARISION 19



HICKORY BEND - CUT 3
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORATION
CHANNEL COMPARISION 1972



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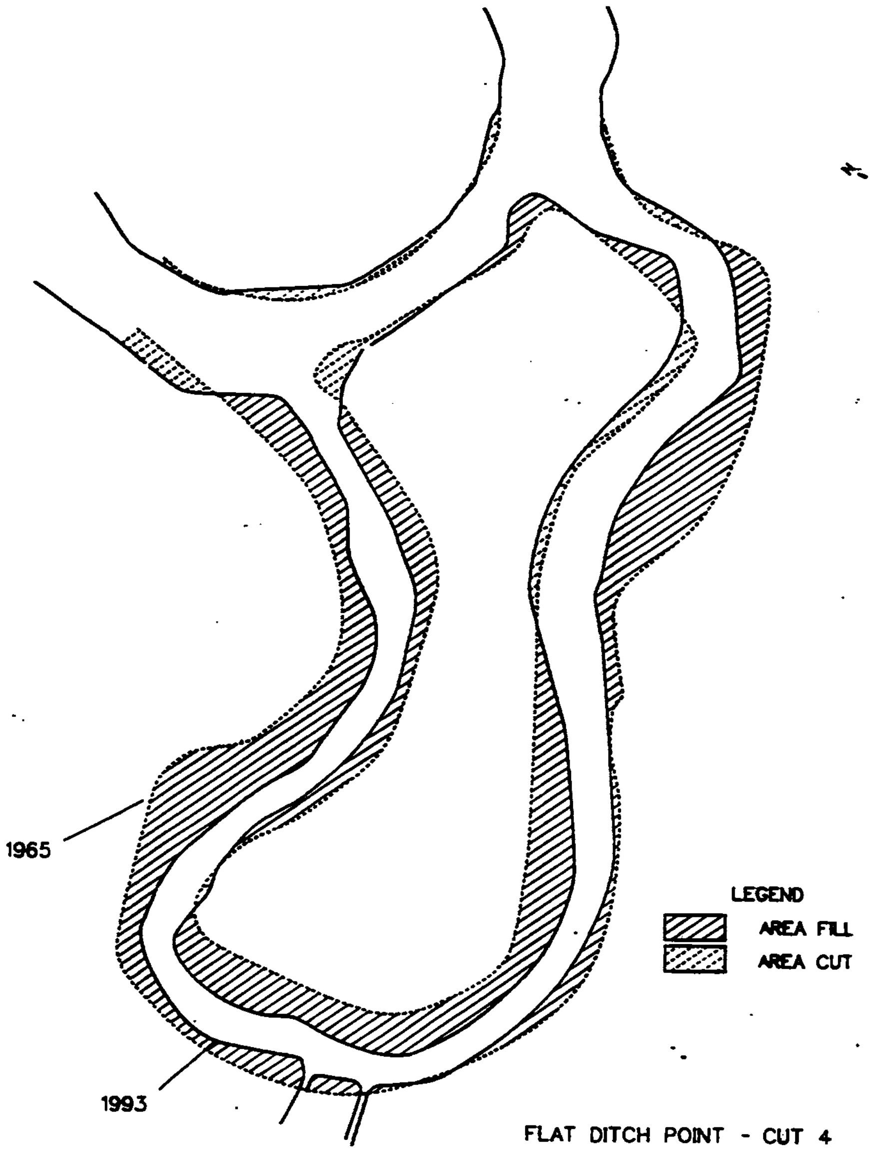
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORATI
CHANNEL COMPARISION 198



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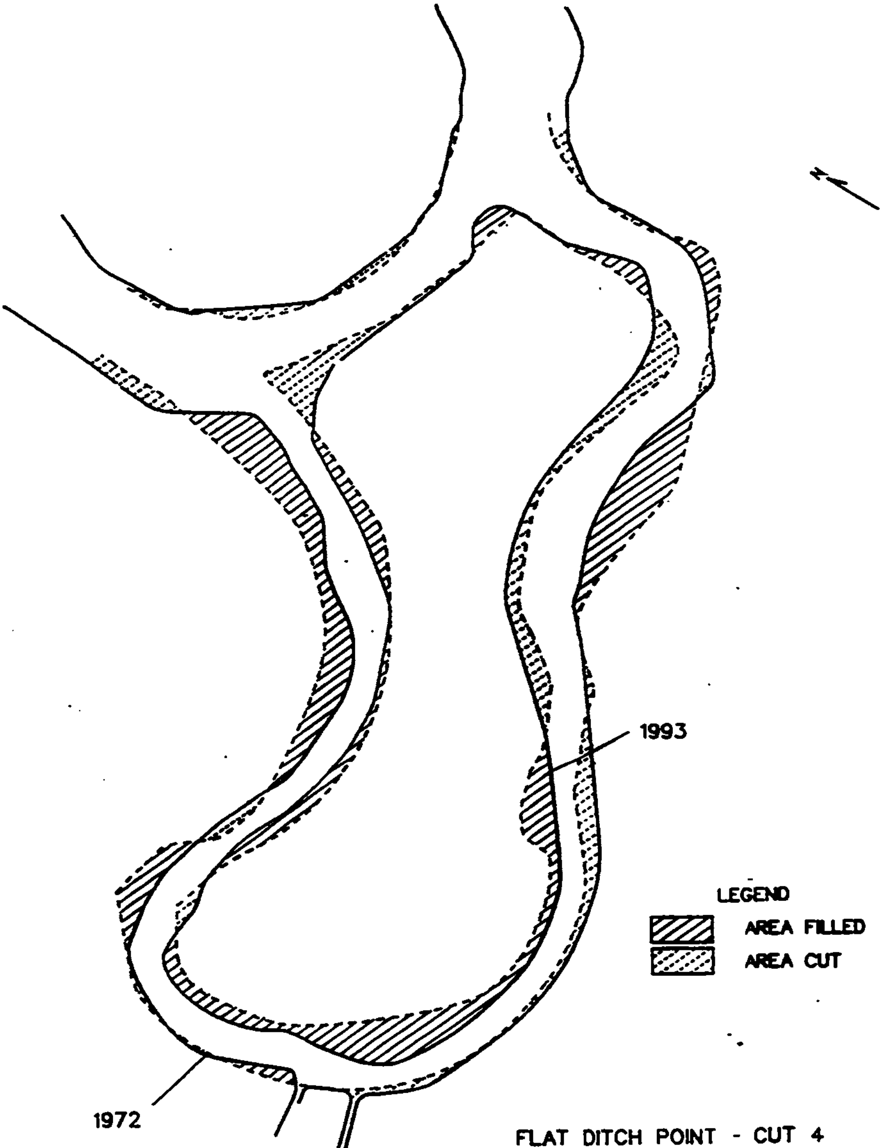
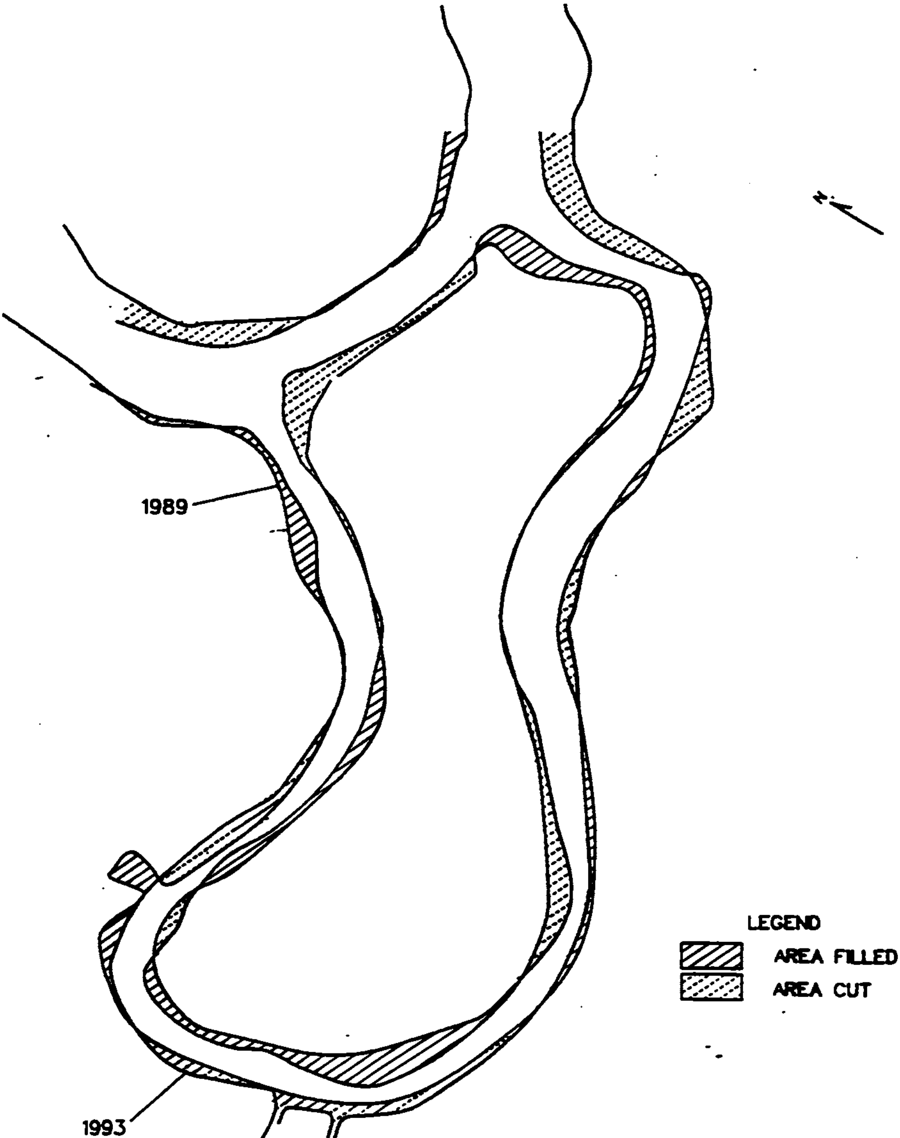
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORATION
CHANNEL COMPARISION 1965-



FLAT DITCH POINT - CUT 4
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORATION
CHANNEL COMPARISION 1972-1993



FLAT DITCH POINT - CUT
LOWER SAVANNAH RIVER
ENVIRONMENTAL RESTORATION
CHANNEL COMPARISION 1989-199.

ENCLOSURE 4

SECTION 404 (b)(1) EVALUATION

ENCLOSURE 4

SECTION 404(b)(1) EVALUATION

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ENCLOSURE 4

**Section 404 (b)(1) Evaluation
For the Lower Savannah River
Environmental Restoration Project**

Section 404 (b)(1) of the Clean Water Act of 1977 requires that any proposed discharge of dredged or fill material into waters of the United States must be evaluated using the guidelines developed by Administrator of the U.S. Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. These guidelines can be found in Title 40, Part 230 of the Code of Federal Regulations.

PROJECT DESCRIPTION.

Location. The Savannah District maintains the Federal Navigation Project known as the "Savannah River Below Augusta". This project includes the Savannah River and surrounding wetlands from the vicinity of Augusta, Georgia, to the upper end of the Savannah Harbor (River Mile 21.3).

General Description. The proposed project involves the environmental restoration of cutoff bends 3 and 4, located approximately at River Mile 41. This evaluation covers the construction activities proposed for the restoration of the bends and modifications to the Mill Creek entrance, as proposed by the Lower Savannah River Environmental Restoration Study. This study was conducted to develop a strategy which would:

- increase flow through cutoff bends 3 and 4 and into Mill Creek;
- increase flow into creeks originating in cutoff bends 3 and 4; and
- restore bottomland hardwoods and fish habitat around the cutoff bends and along the creeks.

The proposed components of the restoration project include the following:

1. No action on cut 4;
2. construction of a diversion structure on cut 3;
3. realignment and constriction of the mouth of cutoff bend 3 to Bear Creek;
4. construction of a new entrance from the Savannah River to Mill Creek;
5. bank slope protection adjacent to abutments in cutoff bend 3.

Description of the Construction of the Diversion Structure on Cut 3. A diversion structure will be constructed in the main channel to divert a portion of the river flow into the first upstream portion of the cutoff bend and into Bear Creek. The structure would be designed to cover 1/3 of the width of the main channel, so that navigation will not be impeded. The structure will consist of a wing dike to be constructed at the upstream point bar of the cutoff island which will split the flow. Dumped rock would be used to construct the structure and steel sheet pile would be used along the sides of the toe of the diversion structure. The existing bank areas upstream and downstream of the proposed structure will be protected with articulated cellular concrete mats (precast).

Description of the Constricted Entrance to Cutoff Bend 3. The constriction in the cutoff bend will be accomplished with a driven steel sheet pile wall on the downstream side. The upstream bank of the new entrance will be constructed of sub-aqueous and semi-compacted fill, with precast concrete mattress armoring. The restricted channel would be constructed to a top elevation of +5 feet to match the height of the existing top bank. The plug downstream of the constricted channel would be a continuation of the same sheet pile on the downstream side. Filling behind the sheet pile wall would be required to provide stability and maintain its function. Approximately 19,000 cubic yards of fill material would be excavated from the adjacent sand bars in the cutoff bend to fill the area between the existing bank and the sheet pile wall and for the plug. This activity would require a total of 15,100 cubic yards. The material consists of approximately 90 percent sand and 10 percent fines (silt and clay). Overtopping protection consisting of articulated concrete block mattresses and grassing would be used to protect fill areas in the new channel and plug from erosion during high river levels. Two (2) acres of open water substrate would be impacted by dredging.

Description of the Modifications to Mill Creek. The modifications to Mill Creek consist of the construction of a new entrance onto the Savannah River and deepening the entrance channel to increase the quantity and frequency of flow into the creek and through the downstream wetlands. An estimated 420 cubic yards of material would be excavated and used to obstruct the adjacent portion of the existing creek entrance. The total area that would be impacted by modifications to the entrance of Mill Creek is 0.5 acres. This area would be grassed after construction.

A. Ecological impacts from placement of dredged material can be divided into two main categories: (1) physical effects, and (2) chemical-biological effects.

1. Physical Effects. Physical effects of the project on the aquatic environment include impairment of the water column, and impacts to benthic organisms during construction of the diversion structure along cut 3, realignment and constriction of the mouth of cutoff bend 3 to Bear Creek, and relocation of the entrance to Mill Creek.

(a) Wetlands. The impacts to wetlands would be minimal and would result mainly from the construction of a new entrance from the Savannah River to Mill Creek. By restoring the flow into Mill Creek and Bear Creek, the proposed environmental restoration would benefit the adjacent wetlands along these creeks which have been negatively impacted since 1962 by the reduced flow volume. This action will improve degraded forested wetlands areas and will maximize habitat units created.

(b) Impairment of the Water Column. Effects on the water column would be short-term, associated with construction of the diversion structure on cut 3, construction of plug downstream of cutoff bend 3, filling behind the sheet pile wall, and at Mill Creek entrance.

During construction, resuspension would occur resulting in reduced light transmission, aesthetic values, and direct destructive effects on nektonic and plankton populations.

(c) Effect on Benthos. The benthic community in the project area would be physically disturbed by the construction of the diversion structure, plug and sheet pile wall. However, the materials used for construction would provide new substrate for some benthic organisms to recolonize.

2. Chemical-Biological Effects. Based on field observations and sediment analysis, no hazardous or toxic materials were encountered at the project site. In view of the history of land-use at the site, no hazardous or toxic materials are anticipated. Georgia Department of Natural Resources has analyzed surface sediment samples (1 to 6 inches) along the Savannah River for the presence of radionuclides. Their investigations reveal levels of radionuclides which are below concentrations which would cause concern. Sediment samples in the study area were collected by CESAS-EN-GH on 16 August 1995. The sediments were analyzed by CompuChem Environmental Corporation and their findings were reviewed by a District biologist.

The data reveal no concern for heavy metals, as all observed levels are within the range for uncultivated soils in Georgia. The levels of radionuclides in the sediments are similar to levels in soils in several other areas of the United States. No organic contaminants were identified above the method detection limit. Detection limits for the pesticides and most semivolatile compounds are considered adequate to conclude that these substances are unlikely to be present at levels that would cause environmental impacts.

The detection limits for five polynuclear aromatic hydrocarbons (PAHs) are above the Effects Range Median (ERM). The ERM is the median level of a compound in sediments observed to cause effects to aquatic organisms (Long et al., 1993). The ERM is a level above which one would be concerned that effects to aquatic organisms could be expected to occur. There are some uncertainties concerning possible environmental effects associated with the project sediment data because all PAHs were not analyzed at levels below the ERMs. However, the lack of detection of other contaminants at levels of concern indicates it is unlikely that these PAHs are present at levels that would impact the aquatic environment.

B. General Considerations and Objectives. The following objectives should be considered in making a determination of any proposed discharge of fill material into waters of the United States:

(1) Avoid discharge activities that significantly disrupt the chemical, physical and biological integrity of the aquatic ecosystem, of which the aquatic biota, the substrate and the normal fluctuations of water level are integral components. The proposed actions would not seriously disrupt the normal ecological functions of the aquatic system. The short-term effect on benthic organisms and water quality would be small and localized. These effects should have only a minimal impact on the existing ecosystem.

(2) Avoid discharge activities that significantly disrupt the food chain including alterations or decrease in diversity of plant and animal species. The project would have little

effect on the food chain in this area. Also, the project would not decrease plant and animal diversity due to the large amount of similar habitat available in the project area and the habitat units that would be created as a result of the restoration project.

(3) Avoid discharge activities that inhibit the movement of fauna, especially their movement into and out of feeding, spawning, and nursery areas. Discharge activities associate with the relocation of the mouth of Mill Creek and filling behind the sheet pile wall in cutoff bend 3 would not seriously affect the movement of fauna in these areas.

(4) Avoid discharge activities that will destroy wetland areas having significant functions in maintenance of water quality. The main goal of this project is to restore the wetland area and wildlife habitats to conditions similar to the pre-navigation project. Water quality is expected to improve as a result of this action. The project would minimize adverse effects to wetlands to the maximum extent practicable, while accomplishing project goals. No on-site land staging area would be available to the contractor due to the necessity to minimize further impacts to wetland areas.

(5) Recognize that discharge activities might destroy or isolate areas that serve the function of retaining natural high water or flood water. The project would restore wetland functions and values including the retention of natural high water or flood water. No water retaining areas would be isolated or destroyed from this project.

(6) Minimize, where practicable, adverse turbidity levels resulting from the discharge of material. There would be no impacts from disposal operations since this activity would not occur with the proposed restoration plan. The short term effect on the water quality of the creek and the Savannah River resulting from the construction of the diversion structure, constriction of cutoff bend 3, and relocation of the entrance to Mill Creek would not seriously affect or inhibit the movement of fauna.

(7) Minimize discharge activities that will degrade aesthetics, recreational, and economic values. There would be only minimal impacts on aesthetics during construction. The restoration of these creeks would increase the recreational value of the area.

(8) Avoid degradation of water quality. Construction of the diversion structure, plug, sheet pile wall, slope protection structures, and relocation of the entrance to Mill Creek would not result in a long-term degradation of water quality. The adverse effect of the increased turbidity during the construction phase would be temporary and diminish over time.

C. Section 404 (b)(1) Determinations and Findings.

(1) Determinations.

(a) An ecological evaluation was made of the proposed environmental restoration project. There would be no discharge of fill material from disposal areas. Filling behind the sheet pile wall, construction of the diversion structure on cut 3, realignment and constriction of the mouth of cutoff bend 3 to Bear Creek, and construction of a new entrance from the Savannah River to Mill Creek would have only temporary and localized impacts on water quality. This determination has been made following the evaluation guidance in 40 CFR 230.6, in conjunction with the evaluation considerations in 40 CFR 230.5.

(b) Appropriate measures have been identified and incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the construction project.

(c) Consideration has been given to the need for the proposed activity, the availability of alternative methods that are less damaging to the environment, and such water quality standards as are appropriate and applicable by law.

(2) Findings. There will be no significant degradation of the Waters of the United States resulting from the proposed project. There will be no significant adverse effects on human health and welfare, municipal and private water supplies, recreational and commercial fisheries, plankton, fish, shellfish, wildlife, special aquatic sites, life stages of aquatic life and other wildlife dependent on aquatic ecosystem diversity, productivity and stability, or recreational, aesthetic and economic values.

Based on the determinations made in this Section 404 (b)(1) Evaluation, the finding is made that the proposed construction of the partial diversion structure in cut 3, realignment and constriction of the mouth of cutoff bend 3 to Bear Creek, and construction of a new entrance from the Savannah River to Mill Creek, have been specified through the application of the Section 404 (b)(1) Guidelines and complies with these guidelines.

ENCLOSURE 5

COMMENTS ON CULTURAL RESOURCES

ENCLOSURE 5

COMMENTS ON CULTURAL RESOURCES

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South Carolina Department of Archives and History

1430 Senate Street, P.O. Box 11,669, Columbia, South Carolina 29211 (803) 7...
State Records (803) 734-7914; Local Records (803) 734-7917

August 16, 1994

Mr. M. J. Yuschishin
Chief, Planning Division
Savannah District, Corps of Engineers
P.O. Box 889
Savannah, Georgia 31402-0889

Re: Comments on Cultural Resources Survey of Cuts Three and Four, Lower Savannah River Environmental Restoration, Effingham County Georgia, and Jasper County, South Carolina

Dear Mr. Yuschishin:

I have reviewed the above referenced draft report. It meets both federal and state standards for the identification and documentation of cultural resources. We note that no archaeological sites or other historic properties were located within the areas to be affected by the proposed undertaking. Consequently, we have no objection to the advancement of this project as planned. We concur with the recommendation of the consulting archaeologist that any late discovery of cultural material within the project's boundary should trigger an evaluation by a qualified archaeologist.

These comments are offered to assist you with your responsibilities under Section 106 of the National Historic Preservation Act of 1966, as amended, and the regulations codified at 36 CFR 800. Please contact me at 803-734-8478, if you have any questions or comments regarding this matter.

Sincerely,

Lee Tippett

Lee Tippett
Staff Archaeologist
SCSHPO

cc: Dr. Laura Henry-Dean, Advisory Council

Georgia Department of Natural Resourc

Joe D. Tanner, Commissioner

Historic Preservation Divis

Elizabeth A. Lyon, Director and State Historic Preservation C
205 Butler Street, S.E., Suite 1462, Atlanta, Georgia :
Telephone (404) 656

August 5, 1994

M.J. Yuschishin
Chief, Planning Division
Department of the Army
Savannah District, Corps of Engineers
Post Office Box 889
Savannah, Georgia 31402-0889

RE: CRS - Cuts 3 and 4, Lower Savannah River
Effingham County, Georgia and Jasper County, South Carolina
HP940722-072

Dear Mr. Yuschishin:

The Historic Preservation Division has reviewed the draft report entitled "Cultural Resources Survey of Cuts 3 and 4, Lower Savannah River Environmental Restoration, Effingham County, Georgia and Jasper County, South Carolina," carried out under the direction of Jeffrey P. Blick, Principal Investigator. Based on the information provided, we agree that the Cuts 3 and 4 project will not impact historic structural or archaeological resources included in or eligible for listing in the National Register of Historic Places.

If we may be of further assistance, please contact Rodney Wadkins, Review and Compliance Program Assistant, at (404) 656-2840.

Sincerely,

Jeffrey L. Durbin
Review and Compliance Coordinator

CG:rrw
cc: Dr. George Vogt, South Carolina SHPO
Kirk Schlemmer, Coastal Georgia RDC

ENCLOSURE 6

SEDIMENT SAMPLING

LOWER SAVANNAH RIVER SEDIMENT QUALITY EVALUATION 6 November 1995

Note: This report is based on sediment samples collected by CESAS-EN-GH on 16 August 1995. The sediments were analyzed by CompuChem Environmental Corporation. Their reports were submitted to EN-GH by letters dated 29 August 1995 and 7 September 1995.

1. Sediment Analysis. Five sediment samples were analyzed (four project samples plus one duplicate). No physical data were found in the reports reviewed.

I. Heavy metals. None of the observed concentrations from the five samples exceeded reported levels in naturally-occurring soils (see discussion of individual metals below). Based on the reported data, there is no concern for environmental impacts from these elements. All of the measured arsenic levels and some of the measured zinc levels were reported as lower than the reported range for natural levels in Georgia and the eastern U.S. (Conner & Shacklette, 1975).

a. Aluminum (Al). Observed levels for the five samples is this study= 5680, 3570, 10200, 8240, and 7530 ppm. Savannah Harbor reference values range from 2380 to 8010 ppm. Uncultivated A horizon soils in Georgia 0.3 to >10 percent (3000 to 100,000 ppm). Observed levels are within the expected range for natural soils.

b. Antimony (Sb). Alexander et al. (1994) found evidence of surface enrichment in two cores taken from the Savannah Harbor. Observed range in easter U.S. soils is <150-500 ppm. Flagged data from this study are reported as ranging from 0.25 to 0.31 ppm. No environmental concern.

c. Arsenic (As). Flagged readings from 0.36 to 0.81 ppm were reported. Naturally-occurring levels in Georgia and the eastern U.S. range from 1.2 to 24 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally occurring limit of 20 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 3.18 to 17.8. Alexander et al. (1994) found in some cores possible small anthropogenic inputs into Savannah harbor. Observed levels in this study are below expected naturally occurring values.

d. Barium (Ba). Naturally-occurring levels in uncultivated soil in Georgia were found to range from 50 to 1500 ppm (Conner and Shacklette, 1975). Observed values in this study range from a flagged value of 24.8 ppm to 68.2 ppm. Observed values are within expected naturally-occurring values.

e. Beryllium (Be). Naturally-occurring levels in uncultivated soil in Georgia were found to range from <1 to 1.5 ppm (Conner and Shacklette, 1975). This study had results ranging from <0.28 ppm to a flagged value of 0.61 ppm. Observed values are within expected range of natural soils.

f. Cadmium (Cd). This study produced flagged values of 0.07 to 0.08 ppm. Naturally-occurring levels in the eastern U.S. range up to 1 ppm (Conner and Shacklette, 1975; Korte, 1983). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 2 ppm (GaDNR, 1994, draft). Alexander et al. (1994) found evidence in two of their cores from the Savannah Harbor of enrichment towards the surface. Observed levels from this study are compatible with expected naturally-occurring values.

g. Chromium (Cr). Observed levels for the five samples = 12.6, 6.7, 18.7, 14.9, and 16.6 ppm. Naturally-occurring levels in Georgia and the eastern U.S. range from 3 to 100 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 100 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 9.0 to 17.6 ppm. Alexander et al. (1994) found evidence of enrichment in the upper parts of most of their cores from the Savannah Harbor. Observed levels found in this study are compatible with expected naturally-occurring values.

h. Cobalt (Co). Naturally-occurring levels in uncultivated soil in Georgia were found to range from 5 to 30 ppm (Conner and Shacklette, 1975). This study found flagged values ranging from 3.0 to 6.1 ppm. Readings from this study are compatible with expected naturally-occurring values.

i. Copper (Cu). Observed levels for the five samples = 5.9, <2.6, 7.7, 6.6, and 7.2 ppm. Naturally-occurring levels in Georgia and the eastern U.S. range from 3 to 50 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 100 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 1.90 to 4.34 ppm. Alexander et al. (1994) found no evidence of anthropogenic enrichment in the harbor. Observed levels found in this study are compatible with expected naturally-occurring values.

j. Iron (Fe). Observed levels for the five samples = 10800, 5340, 13000, 11400, and 12400 ppm. Savannah Harbor reference values range from 7500 to 16400 ppm. Uncultivated A horizon soils in Georgia range from 0.1 to 5 percent (1000 to 50,000 ppm) (Conner and Shacklette, 1975). Alexander et al.

(1994) found no evidence of anthropogenic enrichment in Savannah Harbor. Observed levels found in this study are compatible with expected naturally-occurring values.

k. Lead (Pb). Observed levels for the five samples = 5.3, 2.9, 7.1, 6.1, and 6.9 ppm. Naturally-occurring levels in Georgia and the eastern U.S. soils range from <10 to 70 ppm (Conner and Shacklette, 1975). Lead in deep ocean sediments can vary from < 10 to more than 80 ppm dry weight, with near shore sediments averaging 20 ppm (Demayo et al., 1982) and lead concentrations have been recorded at 110 ppm dry weight in a reference lake in Sweden (Haux et al., 1986). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 75 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 4.34 to 9.31 ppm. Alexander et al. (1994) found evidence of anthropogenic enrichment in the upper portions of all cores taken in Savannah Harbor. However, observed levels from this study are compatible with expected naturally-occurring values.

l. Magnesium (Mg). Observed levels from this study were 953, <391 (flagged), 1220, 1100, and 1160 ppm. Naturally-occurring levels in uncultivated soil in Georgia were found to range from 0.01 t 0.7% (100 to 7000 ppm)(Conner and Shacklette, 1975). Observed levels from this study are compatible with expected naturally-occurring values.

m. Manganese (Mn). Observed levels for the five samples from this study are 375, 115, 307, 395, and 345 ppm. Naturally-occurring levels in uncultivated A horizon soil in Georgia were found to range from 50 to 700 ppm (Conner and Shacklette, 1975). Savannah Harbor reference values range from 81.8 to 240 ppm, with one value of 3430 ppm. Observed levels from this study are compatible with expected naturally-occurring values.

n. Mercury (Hg). Readings for the five samples were all below detection at detection limits ranging from <0.13 to <0.16 ppm. Naturally-occurring levels in soils in the eastern U.S. range from 10 to 3,400 ppb, mean of 96 ppb (Conner and Shacklette, 1975). As reported by NAS (1978) uncontaminated sediment usually had concentrations of <1,000 ppb. Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 0.5 ppm (GaDNR, 1994, draft). Alexander et al. (1994) found evidence of anthropogenic enrichment in the upper portions of two cores (of six) taken in the Savannah River. However, the results from this study are compatible with expected naturally-occurring values.

o. Nickel (Ni). Observed values for the five samples ranged from a flagged value of 4.1 ppm to 6.1 ppm. Naturally-occurring levels in Georgia A horizon uncultivated soils range from <3 to 70 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 50 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 2.51 to 6.78. Alexander et al. (1994) found no evidence of anthropogenic enrichment in Savannah Harbor. Observed levels found in this study are compatible with expected naturally-occurring values.

p. Selenium (Se). Readings from this study were flagged values ranging from 0.54 to 0.97 ppm. Alexander et al. (1994) found evidence of anthropogenic enrichment in the surface portions of three cores, although concentrations were found to be extremely low. Naturally-occurring levels in eastern U.S. soils range from <0.1 to 1.4 ppm (Conner and Shacklette, 1975). Readings from this study are compatible with expected naturally-occurring values.

q. Silver (Ag). Readings for this study were all non-detects ranging from <0.08 to <0.1 ppm. Naturally-occurring levels in the western U.S. range from <0.5 to 5 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 2 ppm (GaDNR, 1994, draft). Readings from this study are compatible with expected naturally-occurring values.

r. Thallium (Tl). Readings were all non-detect at levels ranging from <0.48 to <0.57 ppm. No environmental effects would be expected.

s. Tin (Sn). Alexander et al. (1994) found evidence of anthropogenic enrichment in the upper portions of most cores taken in Savannah Harbor. Although not tested for in this study, no environmental impact would be expected from this element because of its low toxicity in upland environments.

t. Vanadium (V). Observed levels for the five samples in this study were 18.2, 10.7, 25.2, 20.6, and 24.1 ppm. Naturally-occurring levels in uncultivated A horizon soil in Georgia were found to range from <5 to 150 ppm (Conner and Shacklette, 1975). Observed levels found in this study are compatible with expected naturally-occurring values.

u. Zinc (Zn). Observed levels for the five samples = 22.9, 11.3, 30.9, 26.3, and 28.4 ppm. Naturally-occurring levels in Georgia and the eastern U.S. range from 25 to 50 ppm (Conner and Shacklette, 1975). Table 2 of the April, 1994, draft GaDNR Hazardous Site Response document presents an upper naturally-occurring limit of 100 ppm (GaDNR, 1994, draft). Savannah Harbor reference values range from 12.4 to 20.0 ppm. Alexander et al.

(1994) found evidence of anthropogenic enrichment in most of their cores taken in Savannah Harbor. Values found in this study are compatible with expected naturally-occurring levels.

II. Non-metal inorganics: cyanide, ammonia, total phos., Kjeldahl N. During a pre-testing conference, PD-EI agreed with EN-GH that a search for these substances was unnecessary.

III. Organic compounds. Unfortunately, only four samples were analyzed for organics. The samples from site 1 are unaccounted for. The organics data labelled site 3 may actually be from site 1, site 3, or a combination of the two. Data is available for Site 3 from the site 3 duplicate that was collected and labeled site "0". The site 1 sample was from the river bottom in Hickory Bend (bend #3). The river bottom sample from Flat Ditch Bend (sample 0) is known to be correct. The sample labeled as from the river bottom of Hickory Bend does represent a river bottom sample, but it may or may not reflect sediments from Hickory Bend. The metals data for the five samples shows Site 1 as having lower readings than the other four samples. Since one would expect less contaminants to be present at Site 1, data from the other sites can be used as a screen for assessing sediment contaminant environmental effects.

a. Dioxins. Existing Savannah River sediment data from the Stone Container and GPA Berth 7 studies revealed little concern for these compounds. Because of the limited amount of dredging involved, PD-EI agreed with EN-GH that no additional testing for these compounds would be necessary.

Available dioxin data for the Savannah harbor area is summarized in Table 1 below. All the samples show similar theoretical bioaccumulation potential (TBP) estimates when using zero for non-detects in the calculations. The two samples taken within the bar channel show the highest TBP when the detection limit is used for non-detects. EPA has concurred with the Savannah District finding that the bar channel sediments are suitable for ocean disposal.

d. Pesticides. No pesticides were detected above detection limits. Some pesticide values were "J" flagged, indicating the substance was present but at an uncertain level below the method detection limit. Two pesticides have ERLs, dieldrin (1.58 ppb) and 4,4'DDD (2.2 ppb). Detection limits were at or below these levels. All pesticide detection limits were orders of magnitude less than Georgia HSRA Appendix I levels. There are no concerns for pesticide levels in the sediments.

e. Polychlorinated biphenyls (PCB's). Alexander et al., 1993, dated sediments in three cores from the Savannah Harbor. The dated sediments were analyzed for 20 PCB congeners. The mean total PCB concentration for 34 segments was 24.0 ppb (n-

1 st.dev=21). In their core F (South Channel at Bird Island), sediments from 1959 - 1992 ranged from 32.75 to 64.22 ppb (with the segment from 1967 showing 106 ppb). Eight segments from the last 10 years showed a mean of 24.0 ppb (n-1 st. dev.= 9.8). Given that the ER-L is 22.7 ppb, and the ER-M is 180 ppb), there data shows little concern for PCB's in recent sediments in Savannah Harbor. The only congeners showing concentrations at 3 ppb or above are #18 - #101. Of those, congeners #29 - #66 showed high concentrations of 10.2 - 35.4 ppb in sediments from 1967-1983. It appears possible that sediments from the 1960's to 1980's may contain higher amounts of PCB's.

No PCBs were detected in the subject sediments. Aroclor detection limits ranged from <13 ppb to <16 ppb. For the individual samples, aroclor sums (total PCBs) are <91 ppb, <91 ppb, <98 ppb, and <112 ppb. The ERL for total PCBs is 22.7 ppb and the ERM is 180 ppb. The detection limits are for the most part about one half the ERM. Human health risks would be extremely small, since the Georgia HSRA Appendix I value for total PCBs is 15,500 ppb. The overall likelihood of environmental effects from PCBs is therefore low.

Table 2. Lower Savannah River PCB Data (ppb)

	0-1	2-1	3-1	4-1	ERL/ERM	GA HSRA App.I
Aroclor-1260	<16	<13	<13	<14		
Aroclor-1016	<16	<13	<13	<14		
Aroclor-1221	<16	<13	<13	<14		
Aroclor-1232	<16	<13	<13	<14		
Aroclor-1242	<16	<13	<13	<14		
Aroclor-1248	<16	<13	<13	<14		
Aroclor-1254	<16	<13	<13	<14		
Total PCBs	<112	<91	<91	<98	22.7/180	15500

f. Polynuclear aromatic compounds (PAH's). No PAHs were detected. However, detection limits for all the PAHs studied were above the ERLs and were above the ERMs for five of the compounds. The ERL/ERM data apply to aquatic sediments, where the ERM is the median level of the compound in studies showing environmental effects (Long & Morgan, 1993). Because of the high detection limits, no conclusion can be made as to the impact from open water discharges of these sediments on the aquatic environment. All of the PAH detection limits are below the Georgia HSRA Appendix I levels. The likelihood of human

Table 3. Lower Savannah River PAH Data (ppm)**

Analyte	Site	Site	Site	Site		
	0-1	2-1	3-1	4-1	ER-M	ER-L
Acenapthene*	<1	<.87	<.84	<.9	.500	.016
Acenaphthylene*	<1	<.88	<.85	<.92	.640	.044
Anthracene	<1.2	<.97	<.94	<1.0	1.1	.085
Benzo(a)anthracene	<1	<.87	<.84	<.9	1.6	.261
Benzo(a)pyrene	<1	<.87	<.84	<.9	1.6	.430
Benzo(b)fluoranthene	<1.2	<1.0	<.97	<1.1	NA	NA
Benzo(k)fluoranthene	<.97	<.82	<.78	<.85	NA	NA
Benzo(g,h,i)perylene	<.97	<.82	<.78	<.85	NA	NA
Chrysene	<.84	<.71	<.68	<.74	2.8	.384
Dibenzo(a,h)anthracene *	<.67	<.57	<.54	<.59	.260	.063
Fluoranthene	<1.4	<1.2	<1.2	<1.3	5.1	.600
Fluorene*	<1.1	<.91	<.87	<.95	.540	.019
Indeno(1,2,3-cd)pyrene	<.72	<.61	<.58	<.63	NA	NA
2-Methylnaphthalene*	<1.3	<1.1	<1.1	<1.2	.670	.070
Naphthalene	<1	<.87	<.84	<.9	2.1	.160
Phenanthrene	<.97	<.82	<.78	<.85	1.5	.240
Pyrene	<1.1	<.96	<.92	<1.0	2.6	.665

* This compound has a detection limit greater than the ER-M.
** Detection limit is greater than ER-L for all these compounds.

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effects is thus low. Possible effects from upland disposal are unknown. Because no PAH's were detected, the likelihood of the presence of toxic amounts of PAHs in the sediments is probably low.

g. Organotins. Not tested. PD-EI agreed with EN-GH that because the sediments would be placed in a high ground disposal area, there was no need to test for these compounds.

f. Other compounds. Semivolatile organics were analyzed using EPA Method 8270. None were detected. However, the detection limits for the compounds listed in Table 4 were higher than the Georgia HSRA Appendix I values. No data were reported for sample SRC1-2. That sample may have been combined with sample SRC3-2. Sample SRCO-2 is a duplicate of sample SRC3-2. Although some concern exists that these compounds were not analyzed at appropriate detection limits, the lack of detection of other contaminants is an indication that these substances probably do not exist in the sediments at levels of concern.

Table 4. Lower Savannah River, Other Organics (ppb)

compound	SRC01	SRC21	SRC31	SRC41	Ap.I	mean DL/ApI
2-chlorophenol	<980	<830	<800	<860	680	1.28
nitrobenzene	<1100	<890	<860	<930	700	1.35
2,4,6-trichloro-phenol	<2000	<1700	<1600	<1800	660	2.69
dimethylphthalate	<1500	<1300	<1200	<1300	660	2.01
2,6-dinitrotoluene	<1200	<990	<950	<1000	760	1.36
4-nitrophenol	<7000	<5900	<5700	<6200	3300	1.89
2,4-dinitrotoluene	<1000	<870	<840	<900	660	1.37
diethylphthalate	<60*	<950	<910	<990	740	1.28**

* Indicates "B" and "J" flags.
** Does not include flagged data.

IV. Radioactive Elements. The contractor reported Cs-137 as the only non-natural gamma emitting isotope detected in the samples. They stated that other radionuclides detected were the naturally-occurring U and Th decay series products and K-40, all present at ordinary environmental levels. Reported levels are shown below. The contractor states that Bi-214 represents the U-238 decay series and Pb-212 represents the Th-232 decay series, both giving the approximate activities of their respective decay series.

a. Ce-137. Maximum background Ce-137 levels for a 100 mile radius of the SRS plant is 0.352 picocuries per gram; maximum surface soil levels from different areas of the plant site range from 0.271 to 1.57 picocuries per gram (page 3-62, SRS EIS, 1995). That EIS also states that an average of 50 millicuries of cesium-137 per square kilometer are in the upper 5 centimeters of the soil column (page 3-59, SRS EIS, 1995). This translates to 1 picocurie per cubic centimeter or 0.37-0.38 picocuries/g (assuming a specific gravity of 2.6-2.7 grams per cubic centimeter. One half of the cesium-137 deposited by atmospheric testing is thought to have either moved down into the soil column or been transported by surface water to the Savannah River (page 3-59, SRS EIS, 1995). The Savannah River Plant Area has been reported to contain 0.33 to 3.5 picocuries/gram (Cummings et al., 1990) and residential areas in the Northeastern U.S. are reported to contain <0.01 to 11 picocuries/gram (Wallo, 1993). These data indicate that observed levels of Cs-137 in the project sediments are typical of the Savannah area and the Northeast.

Table 5. Lower Savannah River Reported Radionuclides Present (in picocuries/gram).

	1-3/Dup	2-3	3-3	4-3
Cs-137	0.07/.07	0.22	0.42	0.81
Bi-214	0.58/.56	0.76	0.98	1.02
Pb-212	0.89/.86	0.96	1.25	1.07
gross alpha	0.36	1.26	2.75	3.43
gross beta	<0.16	<0.31	0.68	1.32

b. Bi-214. This radioisotope is stated by the contractor to be typical of natural U-238 decay products. U.S. soils have been reported to range from 0.12 to 3.8 picocuries/gram U-238 (Myrick et al., 1983) or 0.2 to 1.0 picocuries/gram (Eisenbud, 1987). Bismuth is typically in equilibrium with its parent radionuclide radium-226, which has activity equal to U-238 (EPA, 1995). Radium-226 in U.S. soils is reported to range from 0.23 to 4.2 picocuries/gram (Myrick et al., 1983). Project sediment values are similar to reported natural values.

c. Pb-212. Lead-212 is stated by the contractor to be typical of natural Thorium-232 decay products. Lead-212 is also reported to be in equilibrium with thorium-228 (EPA, 1995). A study of RCRA facilities (non-nuclear) in the U.S. found Th-238 activity to range from 0.2 to 4.4 picocuries/gram (Oak Ridge, in progress). Thorium-232 soil activity is reported to range from 0.11 to 2.7 picocuries/gram (Maul and O'Hara, 1989). U.S. soils have also been reported to range from 0.1 to 3.4 picocuries/gram (Myrick et al., 1983). Reported project sediment values are similar to reported natural values.

d. Gross alpha and beta activity. The values obtained for the sediments from Flat Ditch Bend are higher than those for Hickory Bend. This was also true for the Cs-137 readings. Sample sizes are not adequate to determine whether there is a significant difference in the two locations. The gross alpha and beta readings are generally at the same level as naturally-occurring gamma emitters. Moreover, the drinking water standard for gross alpha radioactivity is 15 picocuries per liter (0.015 picocuries/gram water)(CFR 141.15(b)) and the drinking water standard for gross beta particle activity is 50 picocuries per liter (0.05 picocuries/gram water)(CFR 141.26(b)(1)). Since gamma radiation has a much higher potential for environmental harm, the observed alpha and beta activities are not thought to pose any problems.

2. Conclusions.

a. There are questions about the location of the sediments used in the organics analyses labelled as the Hickory Bend river bottom sample. This makes comparison of the two sites difficult. However, other samples are available on which an overall environmental assessment may be based.

b. The data reveal no concern for heavy metals, as all observed levels were within the range for uncultivated soils in Georgia as reported in a 1975 paper by Conner & Shacklette (Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States, Geological Survey Professional Paper 574-F).

c. No organic contaminants were identified above method detection limits. Detection limits for the pesticides and most semivolatile compounds are considered adequate to conclude that these substances are unlikely to be present at levels that would cause environmental impacts. Some questions do remain concerning some PAHs and other semivolatile compounds. These are discussed below.

d. The detection limits for five PAHs are above the ERMs of Long and Morgan. The ERM is the median level of a compound in sediments observed to cause effects to aquatic organisms. The ERM is a level above which one would be concerned that effects to aquatic organisms could be expected to occur. These data are thus inadequate to render an assessment as to the suitability of the sediment for placement in an aquatic environment, were these data to be considered by themselves. Although the detection limits for all the PAHs were above ERLs (the level of the substance in the lowest 10 percentile of sediments observed to cause effects to aquatic organisms), the majority of the detection limits were below the ERMs. In addition, the PAH detection limits were well below Georgia HSRA Appendix I values. These facts, coupled with the low concentrations of contaminants observed in the samples, render it unlikely that PAH contamination exists in the sediments at a level that would cause environmental impact.

e. Several semi-volatile organic compounds were analyzed at high detection limits, limits above the Georgia HSRA Appendix I values. Therefore, the detection limits are not low enough to provide direct evidence that these compounds do not exist in the sediments at levels of human health concern. However, the fact that no other contaminants were identified in the sediments gives some indication that these substances are probably not present at levels of concern.

f. A comparison of the radionuclide data with available background information reveals that the levels of radionuclides in the sediments are similar to levels in soils in other areas of the United States.

g. In summary, there are some uncertainties concerning possible environmental effects associated with the incomplete project sediment data. Therefore, measures should be taken to minimize potential environmental impacts from possible contaminants. These measures include confined upland disposal, isolated openwater disposal where the disposed sediments are raised to high ground elvation, and use of a silt curtain for open water disposal.

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CESAS-EN-GH 23 Oct 1995

MEMORANDUM for PD-P (Simon-Dodd)

THRU:
EN-GH
EN-GS
EN-G
EN-EM

SUBJECT: Lower Savannah River Study: Chemistry

1. On 16 Aug 95 a sample collecting trip was made to two abandoned oxbow river bends on the Lower Savannah River, first on the larger called Flat Ditch Point Bend at Mile 29, and then on the smaller called Hickory Bend at mile 28. The team gathering the samples were Eric Halpin, Gus Anderson, Danny Hewitt, Franz Froelicher, PhD. Please refer to the sampling report of 16 August 95 for details on the sampling process. Only soils were samples and tested because the flowing waters were of no concern for this study.

2. Three types of analysis were done; 1) semi-volatile and pesticide compounds; 2) Total Analyte List (TAL) Metals, which includes analysis for all 21 of the EPA regulated toxic and non-toxic metals; 3) radiological analysis, which included gross alpha and gross beta activity, and for gamma emitting radionuclides, which would have identified any occurring species of radiological emissions.

3. Item; 1) The semi-volatile and pesticide compounds: These samples were analyzed using EPA SW-846 protocol. All results from the laboratory were validated by the COE chemist, Dr. Franz Froelicher and no discrepancies were found. There were no semivolatile Target Compound List (TCL) analytes identified above the minimum limits. Tentatively Identified Compounds (TIC's) found in all of these samples could be characterized as alcohols, unknowns, and laboratory artifacts. These compounds commonly come from sampling equipment, container walls, or the laboratory environment.

4. Item; 2) Total Analyte List (TAL) Metals, which includes analysis for 21 all the EPA regulated toxic and non-toxic metals: The data reported in this section were analyzed using the EPA Contract Laboratory Program, a stricter protocol than is normally used in cases like these. There was one quality control matrix spike (a sample that is artificially spiked with certain metals) which was outside of control limits for antimony, arsenic, cadmium, and selenium. Normally this is the consequence of a relatively high anionic content in the sample or of an inconsistent or interfering other ion in the sample matrix. There were no metal TAL analytes identified above the minimum limits.

5. Item; 3) radiological analysis, gross alpha and gross beta activity and for gamma emitting radionuclides spectroscopy: The uncertainties reported are relative to counting errors at the 95% confidence level (i.e., 2-sigma errors). No gross alpha or beta emitters were found, [illegible] —

Cs-137 was the only non-natural gamma emitting isotope detected, but at very low levels in these samples, but the levels that are seen, at less than 1 pCi/g, are significantly lower than toxicity levels which, according to some authors is above 15 pCi/g. The other gamma emitting radionuclides present are the naturally occurring U (uranium) and Th (thorium) decay series products, and K-40 (potassium). The activity levels of these natural products are at ordinary environmental levels. Two of these natural decay products, Bi-214 (bismuth) and Pb-212 (lead) are reported. These two isotopes give the approximate activities of the U-238 and Th-232 decay series, respectively.

6. If you have any further questions please contact me at 912-652-5677.

Franz Froelicher, Ph.D., Chemist
Hazardous Toxic & Radioactive Waste Section

Appendix A:

Raw Data

From Compuchem Reports dated 27 August and 7 September, 1995

CompuChem Environmental Corporation

DATA REPORTING QUALIFIERS

On the Form I, under the column labeled "Q" for qualifier, flag each result with the specific data reporting qualifiers listed below. Up to five qualifiers may be reported on Form I for each compound. The qualifiers to be used are:

U – This flag indicates the compound was analyzed for but not detected. The CRQL shall be adjusted to reflect any dilution and/or percent moisture.

J – This flag indicates an estimated value. This flag is used (1) when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, (2) when the mass spectral and retention time data indicate the presence of a compound that meets the volatile and semivolatile GC/MS identification criteria, and the result is less than the CRQL but greater than zero, and (3) when the retention time data indicate the presence of a compound that meets the pesticide/Aroclor identification criteria, and the result is less than the CRQL but greater than zero. For example, if the sample quantitation limit is 10 ug/L, but a concentration of 3 ug/L is calculated, report it as 3J.

N – This flag indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds (TICs), where the identification is based on a mass spectral library search. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the N flag is not used.

P – This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a P.

C – This flag applies to pesticide results where the identification has been confirmed by GC/MS. If GC/MS confirmation was attempted but was unsuccessful, do not apply this flag; use a laboratory-defined flag instead (see the X qualifier).

B – This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates probable blank contamination and warns the data user to take appropriate action. This flag shall be used for a tentatively identified compound as well as for a positively identified target compound.

The combination of flags BU or UB is expressly prohibited. Blank contaminants are flagged B only when they are detected in the sample.

E – This flag identifies compounds whose concentrations exceed the upper level of the calibration range of the instrument for that specific analysis. If one or more compounds have a response greater than the upper level of the calibration range, the sample or extract shall be diluted and reanalyzed. All such compounds with a response greater than the upper level of the calibration range shall have the

DATA REPORTING QUALIFIERS

concentration flagged with an E on Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate copies of Form I. The Form I for the diluted sample shall have the DL suffix appended to the sample number.

D – This flag is used for all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is reanalyzed at a higher dilution factor, as in the E flag, the DL suffix is appended to the sample number on Form I for the diluted sample, and all concentration values reported on that Form I are flagged with the D flag. This flag alerts data users that any discrepancies between the reported concentrations may be due to dilution of the sample or extract.

A – This flag indicates that a tentatively identified compound is a suspected aldol-condensation product.

X – Other specific flags may be required to properly define the results. If used, the flags shall be fully described, with the description attached to the sample data summary package and the SDG Narrative. Begin by using X. If more than one flag is required, use Y and Z as needed. If more than five qualifiers are required for a sample result, use the X flag to represent a combination of several flags. For instance, the X flag might combine the A, B, and D flags for some samples. The laboratory-defined flags are limited to X, Y, and Z.

COMPUCHEM
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Research Triangle Park, NC 27709-4998
(919) 406-1600

Notification To Clients Regarding Deliverables Generated By New Gas Chromatograph/Mass Spectrometer (GC/MS) Data System

CompuChem Environmental Corporation has upgraded their GC/MS data systems in order to provide state-of-the-art data review an format/hardcopy generation capabilities. While our GC/MS instruments are products of Finnigan, they now will be networked to systems consistin of the Hewlett-Packard (H-P) ChemServer utilizing ThruPut's Envision product. Clients familiar with the hardcopy output from H-P GC/M instruments will notice similarities to our new deliverables. These new hardware/software systems, however, provide dramatic speed an performance enhancements.

As a service to our clients, the following is a listing of the major differences that will be observed when comparing our new deliverables package against the old ones:

1. The new GC/MS Reconstructed Ion Chromatogram (RIC) presentation has the following features:

- the retention time, along the x-axis is labeled at exact minute intervals,
- separate line items in the RIC header are included for instrument ID, sample ID, and volume injected,
- header information includes the GC column phase and diameter,
- all internal standard and surrogate peaks are labeled with the compound name and the exact retention time rather than "IS#, "SS#," and associated scan number,
- on the two page RIC for semivolatile injections, there is a display overlap between the two pages.
- some peaks may be flagged with a "+." This indicates that more than one compound is eluting at that retention time.

2. The new quantitation report presentation has the following features:

- the number of quantitation report pages is reduced for CLP analyses,
- the internal standards are presented first, followed by the surrogate compounds, all in increasing retention time order,
- the retention time is presented as minute and decimal minutes,
- the compound name appears on the same line as the data/results for that compound (rather than on a separate pr   ad th displays include both on-column and final concentrations,
- for assistance in data review/validation a number of flags are utilized - on the left hand side of the quantitation report page an on the right side.

Left Side Flags

- * denotes internal standard compound.
- $ denotes surrogate compound.
- M denotes summary compounds: e.g. - total xylenes.

Right Side Flags

- (a) denotes those compounds whose results will be flagged with a "J" (estimate) on the Form I.
- (A) denotes those compounds whose results will be flagged with an "E" (concentration greater than highest calibration standard on the Form I.
- (H) denotes that the data reviewer selected a peak other than the one selected by the software routine.
- (M) denotes that the data reviewer has manually integrated a compound.
- (R) denotes that a recovery for a surrogate or spike compound has failed acceptance criteria.
- (T) denotes that the retention time for an internal standard has shifted outside of acceptance criteria.
- (Q) denotes that unexpected ion ratios obtained.

3. The mass spectra of target analytes will be presented on one page rather than the two from the Finnigan data system. The printing of the spectra will be portrait (tall) instead of landscape (wide).

4. The mass spectra for tentatively identified compounds (TICs) will also be presented as a portrait view. The compound matchin information summary is contained below the header information and includes a "quality" ranking, similar to the Finnigan "PUR" (purity ranking.

We hope this information is beneficial to you. If, however, there are any questions or, if you need any more information please feel fre   ntac a member of your project management team at 1-800-833-5097.

Robert E. Meierer

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(919) 406-1600

Quality Assurance Notice

In some instances, manual adjustments of the software are necessary to provide an accurate quantitation of a compound. These adjustments are performed by the data reviewer, GC/MS operator or GC chemist. An Extracted Ion Current Profile (EICP) or a GC chromatographic peak have been provided for each compound to demonstrate the accuracy of the adjustment. The adjustments are flagged on the quantitation report in the far right column beyond the FINAL concentration as follows:

M — Denotes that a manual integration has been performed for this compound. The manual integration was performed by the data reviewer, GC/MS operator or GC chemist in order to provide the most accurate area count as possible for the peak.

For GC analyses an "M" flag may also indicate instances in which a peak is "unassigned" to a particular compound and "reassigned" to another compound. This situation would occur when two compounds co-elute on only one column.

H — Denotes that the data reviewer or GC/MS operator has chosen an alternate peak within the retention time window from that chosen by the software for that compound. No manual integration is performed in choosing an alternate peak. The software still performs the integration.

MH — Denotes that the data reviewer or GC/MS operator has chosen an alternate peak within the retention time window from that chosen by the software for that compound, and that the data reviewer or GC/MS operator performed a manual integration of the chosen peak. The manual integration was performed by the data reviewer or GC/MS operator in order to provide the most accurate area count as possible for the peak.

With the introduction of the current EPA CLP SOW (Document Number OLM03.0 plus revisions) additional explanations for manual editing/integration are required. In the accompanying raw data packages, additional codes have been applied to the "M" flag and carry the following meanings:

M1 - The compound was not found by the automatic integration routine.

M2 - The compound was incorrectly integrated by the automatic integration routine.

M3 - The co-eluting compounds were incorrectly integrated by the automatic integration routine.

These codes will appear in GC/MS and GC data packages.

Robert E. Meierer

Robert E. Meierer
Vice President & General Manager

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

SRBA-CO-2

Lab Name: COMPUCHEM_ENV._CORP. Contract: SW-846

Lab Code: COMPU_ Case No.: 50093_ SAS No.: ______ SDG No.: 312471

Matrix (soil/water): SOIL_ Lab Sample ID: 748432

Level (low/med): LOW__ Date Received: 08/17/95

% Solids: _66.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	5680			P
7440-36-0	Antimony	0.29	U	N	P
7440-38-2	Arsenic	0.67	B	N	P
7440-39-3	Barium	58.4			P
7440-41-7	Beryllium	0.46	B		P
7440-43-9	Cadmium	0.08	U	N	P
7440-70-2	Calcium	476	B		P
7440-47-3	Chromium	12.6			P
7440-48-4	Cobalt	5.3	B		P
7440-50-8	Copper	5.9			P
7439-89-6	Iron	10800			P
7439-92-1	Lead	5.3			P
7439-95-4	Magnesium	953			P
7439-96-5	Manganese	375			P
7439-97-6	Mercury	0.15	U		CV
7440-02-0	Nickel	4.1	B		P
7440-09-7	Potassium	520	B		P
7782-49-2	Selenium	0.60	B	N	P
7440-22-4	Silver	0.09	U		P
7440-23-5	Sodium	325	B		P
7440-28-0	Thallium	0.54	U		P
7440-62-2	Vanadium	18.2			P
7440-66-6	Zinc	22.9			P
	Cyanide				NR

Color Before: BROWN Clarity Before: ______ Texture: MEDIUM

Color After: YELLOW Clarity After: ______ Artifacts: ______

Comments:

Duplicate_(SRBA-CO-2D)

FORM I - IN ILM03.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

SRBA-C1-2___

Lab Name: COMPUCHEM_ENV._CORP._____ Contract: SW-846____

Lab Code: COMPU_ Case No.: 50093_ SAS No.: ______ SDG No.: 312471

Matrix (soil/water): SOIL_ Lab Sample ID: 748440

Level (low/med): LOW__ Date Received: 08/17/95

% Solids: _75.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	3570			P_
7440-36-0	Antimony_	0.25	U	N	P_
7440-38-2	Arsenic__	0.36	U	N	P_
7440-39-3	Barium	24.8	B		P_
7440-41-7	Beryllium	0.28	B		P_
7440-43-9	Cadmium_	0.07	U	N	P_
7440-70-2	Calcium__	331	B		P_
7440-47-3	Chromium_	6.7			P_
7440-48-4	Cobalt___	3.0	B		P_
7440-50-8	Copper___	2.6	B		P_
7439-89-6	Iron_____	5340			P_
7439-92-1	Lead	2.9			P_
7439-95-4	Magnesium	391	B		P_
7439-96-5	Manganese	115			P_
7439-97-6	Mercury__	0.13	U		CV
7440-02-0	Nickel	2.4	B		P_
7440-09-7	Potassium	227	B		P_
7782-49-2	Selenium_	0.60	B	N	P_
7440-22-4	Silver___	0.08	U		P_
7440-23-5	Sodium___	219	B		P_
7440-28-0	Thallium_	0.48	U		P_
7440-62-2	Vanadium_	10.7			P_
7440-66-6	Zinc	11.3			P_
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: ______ Texture: MEDIUM

Color After: YELLOW___ Clarity After: ______ Artifacts: ______

Comments:

FORM I - IN ILM03.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

SRBA-C2-2

Lab Name: COMPUCHEM_ENV._CORP. Contract: SW-846

Lab Code: COMPU_ Case No.: 50093_ SAS No.: ______ SDG No.: 312471

Matrix (soil/water): SOIL_ Lab Sample ID: 748448

Level (low/med): LOW__ Date Received: 08/17/95

% Solids: _71.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	10200			P
7440-36-0	Antimony	0.27	U	N	P
7440-38-2	Arsenic	0.81	B	N	P
7440-39-3	Barium	68.2			P
7440-41-7	Beryllium	0.61	B		P
7440-43-9	Cadmium	0.07	U	N	P
7440-70-2	Calcium	585	B		P
7440-47-3	Chromium	18.7			P
7440-48-4	Cobalt	6.1	B		P
7440-50-8	Copper	7.7			P
7439-89-6	Iron	13000			P
7439-92-1	Lead	7.1			P
7439-95-4	Magnesium	1220			P
7439-96-5	Manganese	307			P
7439-97-6	Mercury	0.14	U		CV
7440-02-0	Nickel	6.1			P
7440-09-7	Potassium	695	B		P
7782-49-2	Selenium	0.85		N	P
7440-22-4	Silver	0.08	U		P
7440-23-5	Sodium	253	B		P
7440-28-0	Thallium	0.51	U		P
7440-62-2	Vanadium	25.2			P
7440-66-6	Zinc	30.9			P
	Cyanide				NR

Color Before: BROWN Clarity Before: ______ Texture: MEDIUM

Color After: YELLOW Clarity After: ______ Artifacts: ______

Comments:

FORM I - IN ILM03.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

SRBA-C3-2

Lab Name: COMPUCHEM_ENV._CORP. Contract: SW-846

Lab Code: COMPU_ Case No.: 50093_ SAS No.: SDG No.: 312471

Matrix (soil/water): SOIL_ Lab Sample ID: 748446

Level (low/med): LOW__ Date Received: 08/17/95

% Solids: _62.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	8240			P
7440-36-0	Antimony	0.30	U	N	P
7440-38-2	Arsenic	0.51	B	N	P
7440-39-3	Barium	64.0			P
7440-41-7	Beryllium	0.53	B		P
7440-43-9	Cadmium	0.08	U	N	P
7440-70-2	Calcium	546	B		P
7440-47-3	Chromium	14.9			P
7440-48-4	Cobalt	5.6	B		P
7440-50-8	Copper	6.6			P
7439-89-6	Iron	11400			P
7439-92-1	Lead	6.1			P
7439-95-4	Magnesium	1100			P
7439-96-5	Manganese	395			P
7439-97-6	Mercury	0.16	U		CV
7440-02-0	Nickel	5.1	B		P
7440-09-7	Potassium	618	B		P
7782-49-2	Selenium	0.54	U	N	P
7440-22-4	Silver	0.10	U		P
7440-23-5	Sodium	281	B		P
7440-28-0	Thallium	0.57	U		P
7440-62-2	Vanadium	20.6			P
7440-66-6	Zinc	26.3			P
	Cyanide				NR

Color Before: BROWN Clarity Before: Texture: MEDIUM

Color After: YELLOW Clarity After: Artifacts:

Comments:

FORM I - IN ILM03.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

SRBA-C4-2___

Lab Name: COMPUCHEM_ENV._CORP.______ Contract: SW-846____

Lab Code: COMPU_ Case No.: 50093_ SAS No.: ______ SDG No.: 312471

Matrix (soil/water): SOIL_ Lab Sample ID: 748447

Level (low/med): LOW__ Date Received: 08/17/95

% Solids: _67.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	7530			P
7440-36-0	Antimony	0.31	B	N	P
7440-38-2	Arsenic	0.54	B	N	P
7440-39-3	Barium	66.2			P
7440-41-7	Beryllium	0.58	B		P
7440-43-9	Cadmium	0.07	U	N	P
7440-70-2	Calcium	589	B		P
7440-47-3	Chromium	16.6			P
7440-48-4	Cobalt	5.9	B		P
7440-50-8	Copper	7.2			P
7439-89-6	Iron	12400			P
7439-92-1	Lead	6.9			P
7439-95-4	Magnesium	1160			P
7439-96-5	Manganese	345			P
7439-97-6	Mercury	0.15	U		CV
7440-02-0	Nickel	5.1	B		P
7440-09-7	Potassium	624	B		P
7782-49-2	Selenium	0.97		N	P
7440-22-4	Silver	0.09	U		P
7440-23-5	Sodium	267	B		P
7440-28-0	Thallium	0.53	U		P
7440-62-2	Vanadium	24.1			P
7440-66-6	Zinc	28.4			P
	Cyanide				NR

Color Before: BROWN____ Clarity Before: ______ Texture: MEDIUM

Color After: YELLOW___ Clarity After: ______ Artifacts: ______

Comments:

FORM I - IN ILM03.0

1D
ORGANOCHLORINE PESTICIDES AND PCBs ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-CO-1

Lab Name: COMPUCHEM, RTP   Contract: 3817

Lab Code: COMPU   Case No.: 31247   SAS No.: 081695   SDG No.: 00014

Matrix: (soil/water) SOIL   Lab Sample ID: 748524

Sample wt/vol: 30.10 (g/ml) G   Lab File ID:

% Moisture: 36   decanted: (Y/N) N   Date Received: 08/17/95

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 08/19/95

Concentrated Extract Volume: 2000 (uL)   Date Analyzed: 08/24/95

Injection Volume: 2.0 (uL)   Dilution Factor: 1

GPC Cleanup: (Y/N) N   pH: 6.8   Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
58-89-9	gamma-BHC (Lindane)	0.78	U
76-44-8	Heptachlor	0.037	JP
309-00-2	Aldrin	0.080	JBP
959-98-8	Endosulfan I	0.12	JBP
60-57-1	Dieldrin	1.2	U
33213-65-9	Endosulfan II	0.38	JP
50-29-3	4,4'-DDT	0.40	JP
72-43-5	Methoxychlor	1.2	BJP
319-84-6	alpha-BHC	0.12	JBP
319-85-7	beta-BHC	0.14	JP
319-86-8	delta-BHC	0.093	JP
1024-57-3	Heptachlor epoxide	0.017	JP
72-55-9	4,4'-DDE	0.028	JBP
72-20-8	Endrin	0.089	JP
72-54-8	4,4'-DDD	2.7	U
7421-93-4	Endrin aldehyde	0.23	JP
1031-07-8	Endosulfan sulfate	0.26	JP
11096-82-5	Aroclor-1260	16	U
12674-11-2	Aroclor-1016	16	U
11104-28-2	Aroclor-1221	16	U
11141-16-5	Aroclor-1232	16	U
53469-21-9	Aroclor-1242	16	U
12672-29-6	Aroclor-1248	16	U
11097-69-1	Aroclor-1254	16	U
8001-35-2	Toxaphene	16	U
57-74-9	Chlordane (Technical)	3.1	U

1D
ORGANOCHLORINE PESTICIDES AND PCBs ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C2-1

Lab Name: COMPUCHEM.RTP Contract: 3817

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00014

Matrix: (soil/water) SOIL Lab Sample ID: 748527

Sample wt/vol: 30.00 (g/ml) G Lab File ID:

% Moisture: 24 decanted: (Y/N) N Date Received: 08/17/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 08/19/95

Concentrated Extract Volume: 2000 (uL) Date Analyzed: 08/24/95

Injection Volume: 2.0 (uL) Dilution Factor: 1

GPC Cleanup: (Y/N) N pH: 6.0 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
58-89-9	gamma-BHC (Lindane)	0.66	U
76-44-8	Heptachlor	0.66	U
309-00-2	Aldrin	0.0081	JBP
959-98-8	Endosulfan I	0.32	JBP
60-57-1	Dieldrin	0.99	U
33213-65-9	Endosulfan II	0.64	JP
50-29-3	4,4'-DDT	0.13	JP
72-43-5	Methoxychlor	0.32	BJP
319-84-6	alpha-BHC	0.13	JBP
319-85-7	beta-BHC	0.64	U
319-86-8	delta-BHC	0.66	U
1024-57-3	Heptachlor epoxide	0.049	JP
72-55-9	4,4'-DDE	0.20	JB
72-20-8	Endrin	0.069	JP
72-54-8	4,4'-DDD	2.3	U
7421-93-4	Endrin aldehyde	0.18	JP
1031-07-8	Endosulfan sulfate	0.32	JP
11096-82-5	Aroclor-1260	13	U
12674-11-2	Aroclor-1016	13	U
11104-28-2	Aroclor-1221	13	U
11141-16-5	Aroclor-1232	13	U
53469-21-9	Aroclor-1242	13	U
12672-29-6	Aroclor-1248	13	U
11097-69-1	Aroclor-1254	13	U
8001-35-2	Toxaphene	13	U
57-74-9	Chlordane (Technical)	2.6	U

1D
ORGANOCHLORINE PESTICIDES AND PCBs ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C3-1

Lab Name: COMPUCHEM.RTP Contract: 3817

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00014

Matrix: (soil/water) SOIL Lab Sample ID: 748528

Sample wt/vol: 30.20 (g/ml) G Lab File ID:

% Moisture: 21 decanted: (Y/N) N Date Received: 08/17/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 08/19/95

Concentrated Extract Volume: 2000 (uL) Date Analyzed: 08/24/95

Injection Volume: 2.0 (uL) Dilution Factor: 1

GPC Cleanup: (Y/N) N pH: 6.5 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
58-89-9	gamma-BHC (Lindane)	0.63	U
76-44-8	Heptachlor	0.63	U
309-00-2	Aldrin	0.049	JBP
959-98-8	Endosulfan I	0.25	JBP
60-57-1	Dieldrin	0.94	U
33213-65-9	Endosulfan II	2.2	U
50-29-3	4,4'-DDT	2.2	U
72-43-5	Methoxychlor	0.63	JBP
319-84-6	alpha-BHC	0.12	JBP
319-85-7	beta-BHC	0.63	U
319-86-8	delta-BHC	0.63	U
1024-57-3	Heptachlor epoxide	0.029	JP
72-55-9	4,4'-DDE	2.2	U
72-20-8	Endrin	1.6	U
72-54-8	4,4'-DDD	2.2	U
7421-93-4	Endrin aldehyde	0.63	U
1031-07-8	Endosulfan sulfate	1.6	U
11096-82-5	Aroclor-1260	13	U
12674-11-2	Aroclor-1016	13	U
11104-28-2	Aroclor-1221	13	U
11141-16-5	Aroclor-1232	13	U
53469-21-9	Aroclor-1242	13	U
12672-29-6	Aroclor-1248	13	U
11097-69-1	Aroclor-1254	13	U
8001-35-2	Toxaphene	13	U
57-74-9	Chlordane (Technical)	2.5	U

1D

ORGANOCHLORINE PESTICIDES AND PCBs ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C4-1

Lab Name: COMPUCHEM.RTP Contract: 3817

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00014

Matrix: (soil/water) SOIL Lab Sample ID: 748529

Sample wt/vol: 30.00 (g/ml) G Lab File ID:

% Moisture: 27 decanted: (Y/N) N Date Received: 08/17/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 08/19/95

Concentrated Extract Volume: 2000 (uL) Date Analyzed: 08/24/95

Injection Volume: 2.0 (uL) Dilution Factor: 1

GPC Cleanup: (Y/N) N pH: 6.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
58-89-9	gamma-BHC (Lindane)	0.68	U
76-44-8	Heptachlor	0.086	JP
309-00-2	Aldrin	0.68	U
959-98-8	Endosulfan I	0.42	JPB
60-57-1	Dieldrin	0.33	JP
33213-65-9	Endosulfan II	2.4	U
50-29-3	4,4'-DDT	0.20	JP
72-43-5	Methoxychlor	0.66	JPB
319-84-6	alpha-BHC	0.099	JPB
319-85-7	beta-BHC	0.081	JP
319-86-8	delta-BHC	0.086	JP
1024-57-3	Heptachlor epoxide	0.099	JP
72-55-9	4,4'-DDE	0.13	JPB
72-20-8	Endrin	0.13	JP
72-54-8	4,4'-DDD	0.055	JP
7421-93-4	Endrin aldehyde	0.10	JP
1031-07-8	Endosulfan sulfate	0.41	JP
11096-82-5	Aroclor-1260	14	U
12674-11-2	Aroclor-1016	14	U
11104-28-2	Aroclor-1221	14	U
11141-16-5	Aroclor-1232	14	U
53469-21-9	Aroclor-1242	14	U
12672-29-6	Aroclor-1248	14	U
11097-69-1	Aroclor-1254	14	U
8001-35-2	Toxaphene	14	U
57-74-9	Chlordane (Technical)	2.7	U

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-CO-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748437

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048437A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 36 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.8

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	890	U
111-44-4	Bis(2-chloroethyl)ether	920	U
95-57-8	2-Chlorophenol	980	U
541-73-1	1,3-Dichlorobenzene	800	U
106-46-7	1,4-Dichlorobenzene	810	U
100-51-6	Benzyl Alcohol	860	U
95-50-1	1,2-Dichlorobenzene	920	U
95-48-7	2-Methylphenol	1000	U
39638-32-9	bis(2-Chloroisopropyl)ether	1000	U
106-44-5	4-Methylphenol	2000	U
621-64-7	N-Nitroso-di-N-propylamine	950	U
67-72-1	Hexachloroethane	940	U
98-95-3	Nitrobenzene	1100	U
78-59-1	Isophorone	1100	U
88-75-5	2-Nitrophenol	970	U
105-67-9	2,4-Dimethylphenol	950	U
65-85-0	Benzoic Acid	3000	U
111-91-1	Bis(2-chloroethoxy)methane	1000	U
120-83-2	2,4-Dichlorophenol	860	U
120-82-1	1,2,4-Trichlorobenzene	860	U
91-20-3	Naphthalene	1000	U
106-47-8	4-Chloroaniline	1100	U
87-68-3	Hexachlorobutadiene	880	U
59-50-7	4-Chloro-3-methylphenol	1200	U
91-57-6	2-Methylnaphthalene	1300	U
77-47-4	Hexachlorocyclopentadiene	1000	U
88-06-2	2,4,6-Trichlorophenol	2000	U
95-95-4	2,4,5-Trichlorophenol	2000	U
91-58-7	2-Chloronaphthalene	1500	U
88-74-4	2-Nitroaniline	1700	U
131-11-3	Dimethylphthalate	1500	U
606-20-2	2,6-Dinitrotoluene	1200	U
208-96-8	Acenaphthylene	1000	U

FORM I SV-1

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-CO-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748437

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048437A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 36 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.8

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
99-09-2	3-Nitroaniline	1100	U
83-32-9	Acenaphthene	1000	U
51-28-5	2,4-Dinitrophenol	2700	U
100-02-7	4-Nitrophenol	7000	U
121-14-2	2,4-Dinitrotoluene	1000	U
132-64-9	Dibenzofuran	1100	U
84-66-2	Diethylphthalate	60	BJ
7005-72-3	4-Chlorophenyl-phenylether	940	U
86-73-7	Fluorene	1100	U
100-01-6	4-Nitroaniline	1700	U
534-52-1	4,6-Dinitro-2-methylphenol	2800	U
86-30-6	N-Nitrosodiphenylamine (1)	2200	U
101-55-3	4-Bromophenyl-phenylether	1200	U
118-74-1	Hexachlorobenzene	1200	U
87-86-5	Pentachlorophenol	2200	U
85-01-8	Phenanthrene	970	U
120-12-7	Anthracene	1200	U
84-74-2	Di-n-butylphthalate	1200	U
206-44-0	Fluoranthene	1400	U
129-00-0	Pyrene	1100	U
85-68-7	Butylbenzylphthalate	1100	U
117-81-7	bis(2-ethylhexyl)Phthalate	1200	U
91-94-1	3,3'-Dichlorobenzidine	780	U
56-55-3	Benzo(a)Anthracene	1000	U
218-01-9	Chrysene	840	U
117-84-0	Di-n-octylphthalate	750	U
205-99-2	Benzo(b)fluoranthene	1200	U
207-08-9	Benzo(k)fluoranthene	970	U
50-32-8	Benzo(a)pyrene	1000	U
193-39-5	Indeno(1,2,3-c,d)pyrene	720	U
53-70-3	Dibenzo(a,h)anthracene	670	U
191-24-2	Benzo(g,h,i)perylene	970	U

(1) - Cannot be separated from Diphenylamine

FORM I SV-2

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

SRBA-CO-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748437

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048437A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 36 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.8

Number TICs found: 5

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	14.42	810	J
2.	UNKNOWN	14.61	630	J
3.	UNKNOWN	15.35	250	J
4.	UNKNOWN ALCOHOL	15.94	690	J
5.	UNKNOWN	17.34	220	J
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FORM I SV-TIC

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C2--

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748458

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048458A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 24 decanted: (Y/N) N Date Extracted:08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	750	U
111-44-4	Bis(2-chloroethyl)ether	780	U
95-57-8	2-Chlorophenol	830	U
541-73-1	1,3-Dichlorobenzene	670	U
106-46-7	1,4-Dichlorobenzene	680	U
100-51-6	Benzyl Alcohol	720	U
95-50-1	1,2-Dichlorobenzene	780	U
95-48-7	2-Methylphenol	860	U
39638-32-9	bis(2-Chloroisopropyl)ether	860	U
106-44-5	4-Methylphenol	1700	U
621-64-7	N-Nitroso-di-N-propylamine	800	U
67-72-1	Hexachloroethane	790	U
98-95-3	Nitrobenzene	890	U
78-59-1	Isophorone	890	U
88-75-5	2-Nitrophenol	820	U
105-67-9	2,4-Dimethylphenol	800	U
65-85-0	Benzoic Acid	2500	U
111-91-1	Bis(2-chloroethoxy)methane	880	U
120-83-2	2,4-Dichlorophenol	720	U
120-82-1	1,2,4-Trichlorobenzene	720	U
91-20-3	Naphthalene	870	U
106-47-8	4-Chloroaniline	910	U
87-68-3	Hexachlorobutadiene	740	U
59-50-7	4-Chloro-3-methylphenol	990	U
91-57-6	2-Methylnaphthalene	1100	U
77-47-4	Hexachlorocyclopentadiene	870	U
88-06-2	2,4,6-Trichlorophenol	1700	U
95-95-4	2,4,5-Trichlorophenol	1700	U
91-58-7	2-Chloronaphthalene	1300	U
88-74-4	2-Nitroaniline	1400	U
131-11-3	Dimethylphthalate	1300	U
606-20-2	2,6-Dinitrotoluene	990	U
208-96-8	Acenaphthylene	880	U

FORM I SV-1

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C2-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748458

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048458A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 24 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
99-09-2	3-Nitroaniline	910	U
83-32-9	Acenaphthene	870	U
51-28-5	2,4-Dinitrophenol	2200	U
100-02-7	4-Nitrophenol	5900	U
121-14-2	2,4-Dinitrotoluene	870	U
132-64-9	Dibenzofuran	910	U
84-66-2	Diethylphthalate	950	U
7005-72-3	4-Chlorophenyl-phenylether	790	U
86-73-7	Fluorene	910	U
100-01-6	4-Nitroaniline	1400	U
534-52-1	4,6-Dinitro-2-methylphenol	2400	U
86-30-6	N-Nitrosodiphenylamine (1)	1800	U
101-55-3	4-Bromophenyl-phenylether	990	U
118-74-1	Hexachlorobenzene	1000	U
87-86-5	Pentachlorophenol	1800	U
85-01-8	Phenanthrene	820	U
120-12-7	Anthracene	970	U
84-74-2	Di-n-butylphthalate	1000	U
206-44-0	Fluoranthene	1200	U
129-00-0	Pyrene	960	U
85-68-7	Butylbenzylphthalate	890	U
117-81-7	bis(2-ethylhexyl)Phthalate	990	U
91-94-1	3,3'-Dichlorobenzidine	660	U
56-55-3	Benzo(a)Anthracene	870	U
218-01-9	Chrysene	710	U
117-84-0	Di-n-octylphthalate	630	U
205-99-2	Benzo(b)fluoranthene	1000	U
207-08-9	Benzo(k)fluoranthene	820	U
50-32-8	Benzo(a)pyrene	870	U
193-39-5	Indeno(1,2,3-c,d)pyrene	610	U
53-70-3	Dibenzo(a,h)anthracene	570	U
191-24-2	Benzo(g,h,i)perylene	820	U

(1) - Cannot be separated from Diphenylamine

FORM I SV-2

1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

SRBA-C2

Lab Name: COMPUCHEM ENV. CORP.   Contract: 500935

Lab Code: COMPU   Case No.: 31247   SAS No.:   SDG No.: 00002

Matrix: (soil/water) SOIL   Lab Sample ID: 748458

Sample wt/vol: 30.0 (g/mL) G   Lab File ID: GH048458A15.D

Level: (low/med) LOW   Date Received: 08/17/95

% Moisture: 24   decanted: (Y/N) N   Date Extracted:08/21/95

Concentrated Extract Volume: 1000(uL)   Date Analyzed: 08/23/95

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: 6.0

Number TICs found: 1

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	15.94	260	J
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FORM I SV-TIC

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C3-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748459

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048459A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 21 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.5

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	720	U
111-44-4	Bis(2-chloroethyl)ether	750	U
95-57-8	2-Chlorophenol	800	U
541-73-1	1,3-Dichlorobenzene	650	U
106-46-7	1,4-Dichlorobenzene	660	U
100-51-6	Benzyl Alcohol	700	U
95-50-1	1,2-Dichlorobenzene	750	U
95-48-7	2-Methylphenol	820	U
39638-32-9	bis(2-Chloroisopropyl)ether	820	U
106-44-5	4-Methylphenol	1600	U
621-64-7	N-Nitroso-di-N-propylamine	770	U
67-72-1	Hexachloroethane	760	U
98-95-3	Nitrobenzene	860	U
78-59-1	Isophorone	860	U
88-75-5	2-Nitrophenol	780	U
105-67-9	2,4-Dimethylphenol	770	U
65-85-0	Benzoic Acid	2400	U
111-91-1	Bis(2-chloroethoxy)methane	850	U
120-83-2	2,4-Dichlorophenol	700	U
120-82-1	1,2,4-Trichlorobenzene	700	U
91-20-3	Naphthalene	840	U
106-47-8	4-Chloroaniline	870	U
87-68-3	Hexachlorobutadiene	710	U
59-50-7	4-Chloro-3-methylphenol	950	U
91-57-6	2-Methylnaphthalene	1100	U
77-47-4	Hexachlorocyclopentadiene	840	U
88-06-2	2,4,6-Trichlorophenol	1600	U
95-95-4	2,4,5-Trichlorophenol	1600	U
91-58-7	2-Chloronaphthalene	1200	U
88-74-4	2-Nitroaniline	1400	U
131-11-3	Dimethylphthalate	1200	U
606-20-2	2,6-Dinitrotoluene	950	U
208-96-8	Acenaphthylene	850	U

FORM I SV-1

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C3-2

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748459

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048459A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 21 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 08/23/95

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.5

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
99-09-2	3-Nitroaniline	870	U
83-32-9	Acenaphthene	840	U
51-28-5	2,4-Dinitrophenol	2200	U
100-02-7	4-Nitrophenol	5700	U
121-14-2	2,4-Dinitrotoluene	840	U
132-64-9	Dibenzofuran	870	U
84-66-2	Diethylphthalate	910	U
7005-72-3	4-Chlorophenyl-phenylether	760	U
86-73-7	Fluorene	870	U
100-01-6	4-Nitroaniline	1400	U
534-52-1	4,6-Dinitro-2-methylphenol	2300	U
86-30-6	N-Nitrosodiphenylamine (1)	1800	U
101-55-3	4-Bromophenyl-phenylether	950	U
118-74-1	Hexachlorobenzene	970	U
87-86-5	Pentachlorophenol	1800	U
85-01-8	Phenanthrene	780	U
120-12-7	Anthracene	940	U
84-74-2	Di-n-butylphthalate	970	U
206-44-0	Fluoranthene	1200	U
129-00-0	Pyrene	920	U
85-68-7	Butylbenzylphthalate	860	U
117-81-7	bis(2-ethylhexyl)Phthalate	950	U
91-94-1	3,3'-Dichlorobenzidine	630	U
56-55-3	Benzo(a)Anthracene	840	U
218-01-9	Chrysene	680	U
117-84-0	Di-n-octylphthalate	610	U
205-99-2	Benzo(b)fluoranthene	970	U
207-08-9	Benzo(k)fluoranthene	780	U
50-32-8	Benzo(a)pyrene	840	U
193-39-5	Indeno(1,2,3-c,d)pyrene	580	U
53-70-3	Dibenzo(a,h)anthracene	540	U
191-24-2	Benzo(g,h,i)perylene	780	U

(1) - Cannot be separated from Diphenylamine

FORM I SV-2

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

SRBA-C3-1

Lab Name: COMPUCHEM ENV. CORP.   Contract: 500935

Lab Code: COMPU   Case No.: 31247   SAS No.:   SDG No.: 00002

Matrix: (soil/water) SOIL   Lab Sample ID: 748459

Sample wt/vol: 30.0 (g/mL) G   Lab File ID: GH048459A15.D

Level: (low/med) LOW   Date Received: 08/17/95

% Moisture: 21   decanted: (Y/N) N   Date Extracted: 08/21/95

Concentrated Extract Volume: 1000 (uL)   Date Analyzed: 08/23/95

Injection Volume: 1.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: 6.5

Number TICs found: 2

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	15.40	200	BJ
2.	UNKNOWN ALCOHOL	15.94	130	J
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FORM I SV-TIC

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C4-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748465

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048465A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 27 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	780	U
111-44-4	Bis(2-chloroethyl)ether	810	U
95-57-8	2-Chlorophenol	860	U
541-73-1	1,3-Dichlorobenzene	700	U
106-46-7	1,4-Dichlorobenzene	710	U
100-51-6	Benzyl Alcohol	750	U
95-50-1	1,2-Dichlorobenzene	810	U
95-48-7	2-Methylphenol	890	U
39638-32-9	bis(2-Chloroisopropyl)ether	890	U
106-44-5	4-Methylphenol	1800	U
621-64-7	N-Nitroso-di-N-propylamine	840	U
67-72-1	Hexachloroethane	820	U
98-95-3	Nitrobenzene	930	U
78-59-1	Isophorone	930	U
88-75-5	2-Nitrophenol	850	U
105-67-9	2,4-Dimethylphenol	840	U
65-85-0	Benzoic Acid	2600	U
111-91-1	Bis(2-chloroethoxy)methane	920	U
120-83-2	2,4-Dichlorophenol	750	U
120-82-1	1,2,4-Trichlorobenzene	750	U
91-20-3	Naphthalene	900	U
106-47-8	4-Chloroaniline	950	U
87-68-3	Hexachlorobutadiene	770	U
59-50-7	4-Chloro-3-methylphenol	1000	U
91-57-6	2-Methylnaphthalene	1200	U
77-47-4	Hexachlorocyclopentadiene	900	U
88-06-2	2,4,6-Trichlorophenol	1800	U
95-95-4	2,4,5-Trichlorophenol	1800	U
91-58-7	2-Chloronaphthalene	1300	U
88-74-4	2-Nitroaniline	1500	U
131-11-3	Dimethylphthalate	1300	U
606-20-2	2,6-Dinitrotoluene	1000	U
208-96-8	Acenaphthylene	920	U

FORM I SV-1

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

SRBA-C4-1

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748465

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048465A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 27 decanted: (Y/N) N Date Extracted: 08/21/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 08/23/95

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
99-09-2	3-Nitroaniline	950	U
83-32-9	Acenaphthene	900	U
51-28-5	2,4-Dinitrophenol	2300	U
100-02-7	4-Nitrophenol	6200	U
121-14-2	2,4-Dinitrotoluene	900	U
132-64-9	Dibenzofuran	950	U
84-66-2	Diethylphthalate	990	U
7005-72-3	4-Chlorophenyl-phenylether	820	U
86-73-7	Fluorene	950	U
100-01-6	4-Nitroaniline	1500	U
534-52-1	4,6-Dinitro-2-methylphenol	2500	U
86-30-6	N-Nitrosodiphenylamine (1)	1900	U
101-55-3	4-Bromophenyl-phenylether	1000	U
118-74-1	Hexachlorobenzene	1100	U
87-86-5	Pentachlorophenol	1900	U
85-01-8	Phenanthrene	850	U
120-12-7	Anthracene	1000	U
84-74-2	Di-n-butylphthalate	1100	U
206-44-0	Fluoranthene	1300	U
129-00-0	Pyrene	1000	U
85-68-7	Butylbenzylphthalate	930	U
117-81-7	bis(2-ethylhexyl)Phthalate	160	J
91-94-1	3,3'-Dichlorobenzidine	680	U
56-55-3	Benzo(a)Anthracene	900	U
218-01-9	Chrysene	740	U
117-84-0	Di-n-octylphthalate	660	U
205-99-2	Benzo(b)fluoranthene	1100	U
207-08-9	Benzo(k)fluoranthene	850	U
50-32-8	Benzo(a)pyrene	900	U
193-39-5	Indeno(1,2,3-c,d)pyrene	630	U
53-70-3	Dibenzo(a,h)anthracene	590	U
191-24-2	Benzo(g,h,i)perylene	850	U

(1) - Cannot be separated from Diphenylamine

FORM I SV-2

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

SRBA-C4-2

Lab Name: COMPUCHEM ENV. CORP. Contract: 500935

Lab Code: COMPU Case No.: 31247 SAS No.: SDG No.: 00002

Matrix: (soil/water) SOIL Lab Sample ID: 748465

Sample wt/vol: 30.0 (g/mL) G Lab File ID: GH048465A15.D

Level: (low/med) LOW Date Received: 08/17/95

% Moisture: 27 decanted: (Y/N) N Date Extracted:08/21/95

Concentrated Extract Volume: 1000(uL) Date Analyzed: 08/23/95

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 6.1

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

Number TICs found: 1

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	15.94	520	J
2.				
3.				
4.				
5.				
6.				
7.				
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29.				
30.				

FORM I SV-TIC

FORM 1

RADIOMETRIC ANALYSIS RESULTS

Date: 29-Aug-95

Lab Name: CompuChem Environmental Corporation
Analytical Method: Gamma Spectroscopy

Case No. 31247
SDG No. 07

Client Sample No.	Lab ID No.	Sample Type	Radio-Nuclide	Result	Q	Uncertainty	MDA	Units	Analysis Date	Sample Size (g)	Method No.	Instrument ID
SRBA-C1-3	748450	REG	Cs-137	0.07		0.03	0.03	pCi/g	08/25/95	343.0	EPA 901.1 M	Gamma1
SRBA-C1-3	748450	REG	Bi-214	0.58		0.08	0.08	pCi/g	08/25/95	343.0	EPA 901.1 M	Gamma1
SRBA-C1-3	748450	REG	Pb-212	0.89		0.07	0.04	pCi/g	08/25/95	343.0	EPA 901.1 M	Gamma1
SRBA-C2-3	748452	REG	Cs-137	0.22		0.56	0.04	pCi/g	08/25/95	260.5	EPA 901.1 M	Gamma1
SRBA-C2-3	748452	REG	Bi-214	0.76		0.10	0.10	pCi/g	08/25/95	260.5	EPA 901.1 M	Gamma1
SRBA-C2-3	748452	REG	Pb-212	0.96		0.08	0.06	pCi/g	08/25/95	260.5	EPA 901.1 M	Gamma1
SRBA-C3-3	748454	REG	Cs-137	0.42		0.07	0.05	pCi/g	08/25/95	218.6	EPA 901.1 M	Gamma1
SRBA-C3-3	748454	REG	Bi-214	0.98		0.13	0.11	pCi/g	08/25/95	218.6	EPA 901.1 M	Gamma1
SRBA-C3-3	748454	REG	Pb-212	1.25		0.11	0.07	pCi/g	08/25/95	218.6	EPA 901.1 M	Gamma1
SRBA-C4-3	748456	REG	Cs-137	0.81		0.09	0.04	pCi/g	08/27/95	268.0	EPA 901.1 M	Gamma1
SRBA-C4-3	748456	REG	Bi-214	1.02		0.12	0.10	pCi/g	08/27/95	268.0	EPA 901.1 M	Gamma1
SRBA-C4-3	748456	REG	Pb-212	1.07		0.09	0.06	pCi/g	08/27/95	268.0	EPA 901.1 M	Gamma1
SRBA-C1-3 (DUP)	748466	DUP	Cs-137	0.07		0.03	0.03	pCi/g	08/25/95	315.9	EPA 901.1 M	Gamma1
SRBA-C1-3 (DUP)	748466	DUP	Bi-214	0.56		0.09	0.08	pCi/g	08/25/95	315.9	EPA 901.1 M	Gamma1
SRBA-C1-3 (DUP)	748466	DUP	Pb-212	0.86		0.07	0.04	pCi/g	08/25/95	315.9	EPA 901.1 M	Gamma1
Blank Spike	748467	LCS	Cs-137	1.43		0.14	0.10	pCi/g	08/28/95	175.0	EPA 901.1 M	Gamma1
Blank Spike	748467	LCS	Bi-214	1.97		0.20	0.12	pCi/g	08/28/95	175.0	EPA 901.1 M	Gamma1
Method Blank	ACMB01	BLK	Cs-137	< 0.03	U	N/A	0.03	pCi/g	08/27/95	334.9	EPA 901.1 M	Gamma1
Method Blank	ACMB01	BLK	Bi-214	< 0.08	U	N/A	0.08	pCi/g	08/27/95	334.9	EPA 901.1 M	Gamma1
Method Blank	ACMB01	BLK	Pb-212	< 0.04	U	N/A	0.04	pCi/g	08/27/95	334.9	EPA 901.1 M	Gamma1

FORM 1

RADIOMETRIC ANALYSIS RESULTS

Date: 29-Aug-95

Lab Name: CompuChem Environmental Corporation

Analytical Method: Gross Alpha/Beta Analysis

Case No. 31247

SDG No. 07

Client Sample No.	Lab ID No.	Sample Type	Radio-Nuclide	Result	Q	Uncertainty	MDA	Units	Analysis Date	Sample Size (g)	Method No.	Instrument ID
SRBA-C1-3 (DUP)	748463	DUP	Alpha	0.36		0.16	0.17	pCi/g	08/25/95	1.842	EPA 9310 M	LB 5100
SRBA-C1-3 (DUP)	748463	DUP	Beta	0.26	U	0.17	0.32	pCi/g	08/25/95	1.842	EPA 9310 M	LB 5100
Blank Spike (LCS)	748464	LCS	Alpha	14.08		1.16	0.27	pCi/g	08/25/95	1.000	EPA 9310 M	LB 5100
Blank Spike (LCS)	748464	LCS	Beta	86.42		2.33	0.59	pCi/g	08/25/95	1.000	EPA 9310 M	LB 5100
Method Blank	USACEMB	MB	Alpha	0.17	U	0.17	0.27	pCi/g	08/25/95	1.000	EPA 9310 M	LB 5100
Method Blank	USACEMB	MB	Beta	0.15	U	0.28	0.59	pCi/g	08/25/95	1.000	EPA 9310 M	LB 5100
SRBA-C1-3	748450	REG	Alpha	0.36		0.15	0.14	pCi/g	08/25/95	2.602	EPA 9310 M	LB 5100
SRBA-C1-3	748450	REG	Beta	0.16	U	0.12	0.23	pCi/g	08/25/95	2.602	EPA 9310 M	LB 5100
SRBA-C2-3	748452	REG	Alpha	1.26		0.37	0.29	pCi/g	08/25/95	1.527	EPA 9310 M	LB 5100
SRBA-C2-3	748452	REG	Beta	0.31	U	0.22	0.39	pCi/g	08/25/95	1.527	EPA 9310 M	LB 5100
SRBA-C3-3	478454	REG	Alpha	2.75		0.74	0.53	pCi/g	08/25/95	1.639	EPA 9310 M	LB 5100
SRBA-C3-3	478454	REG	Beta	0.68		0.25	0.38	pCi/g	08/25/95	1.639	EPA 9310 M	LB 5100
SRBA-C4-3	748456	REG	Alpha	3.43		0.99	0.76	pCi/g	08/25/95	1.125	EPA 9310 M	LB 5100
SRBA-C4-3	748456	REG	Beta	1.32		0.38	0.55	pCi/g	08/25/95	1.125	EPA 9310 M	LB 5100

Appendix A.

Data Summary Sheets
(From EN-GH)

REPORT ON THE SAMPLING of the
RIVER OXBOW SEDIMENT of the
SAVANNAH RIVER BELOW AUGUSTA ENVIRONMENTAL RESTORATION PROJECT
At Flat Ditch Point, Mile 29 and Hickory Bend, Mile 28
16 August 1995

Participants: Eric Halpin, Gus Anderson, Danny Hewitt, Franz Froelicher, PhD

Narrative: The team left the Savannah District offices at 0730 on 8/16/95. The day was sunny and temperatures the entire day ranged in the high 90s° (F) and the humidity was near 90%.

After gathering our equipment, the sampling team made their way to Ebenezer Landing on the Savannah River and launched the boat from which the sampling was to be done. After reconnoitering the two abandoned oxbows, we started sampling at 1045 at Hickory Bend (Bend #3) and in the afternoon moved on to sample Flat Ditch Bend (Bend # 4).

From the start, some difficulty sampling the underwater sediments was encountered. The PVC pipe, which were used to collect samples, was driven up to 5 ft into the sediment under 1 to 3 feet of flowing water. The difficulty was in the retrieval of the full core barrel. Attempting to maintain suction on the pipe and simultaneously pulling the pipe out of the quite liquid sediment was arduous and caused occasional loss of some of the core, however techniques improved as sampling continued. It was both necessary and desirable to take many small samples and combine them in a plastic wash tub which was brought for the purpose. Thus all samples taken during the entire day were composites. The total was 4 composite, but discrete, samples. The samples were all of good quality and are considered representative of their respective sediment types and sampling venues.

As each sediment core was placed in the tub, the sediment was scanned with a Geiger-Mueller Counter, after resetting and zeroing, to ascertain if any radioactivity was present. No sediment or any other object, such as peat, twigs or rootlets, or any other organic or mineral matter, showed any radioactivity above background.

In each oxbow two composite samples were taken: 1) river floor or bottom sediment and 2) bank sediment. The first type, designated C1 and C3, were river floor sediment samples and the second, designated C2 and C4, were bank sediment samples. The sampling task was finished by 1530. The sample coolers were re-iced and the QC and samples were sent to CompuChem in Research Triangle Park, NC. QA samples were sent to SAD Laboratories in Marietta, GA. Samples were dispatched via UPS by 1700 on 8/16/95.

Sample Identification:
SRBA-C1-1 8270/8080 Semi-volatile compounds/BNA /pesticides
SRBA-C1-2 TAL Metals
SRBA-C1-3 Radiological
SRBA-C2-1 8270/8080 Semi-volatile compounds/BNA /pesticides
SRBA-C2-2 TAL Metals
SRBA-C2-3 Radiological
SRBA-C3-1 8270
Two each, QA (CO2-QA) and QC (CO2-QC) samples were taken from site C3 and marked SRBA-CO-1 (8270) and 2 (TAL Metals)
SRBA-C3-2 TAL Metals
SRBA-C3-3 Radiological
SRBA-C4-1 8270/8080 Semi-volatile compounds/BNA /pesticides
SRBA-C4-2 TAL Metals
SRBA-C4-3 Radiological

Signed,

Dr. Franz Froelicher, Chemist
HTRW Section, Savannah District, U. S. Army Corps of Engineers

Table 1
Lower Savannah River Chemical Data
Soils

LOWER SAVANNAH RIVER STUDY Table SAMPLE LOCATION: Savannah River Below Agusta FIELD ID: SRBA C- MATRIX OF SAMPLE: Soil TEST METHOD: TAL Metal Methods COMPOUND / CAS NUMBER: * = B or N FLAG	LEVELS FOUND					Connor & Shacklette (ppm)	REGULATORY LIMIT mg/l. Georgia HSRA Appendix I
	sr C0-2	sr C1-2	sr C2-2	sr C3-2	sr C4-2		
Metals TEST METHOD: Various							
DATE LAST METAL WAS TESTED	8/25/95	8/25/95	8/25/95	8/25/95	8/25/95		
ALL IN PPM (mg/kg)							
Aluminum 7429-90-5	5680	3570	10200	8240	7530	0.3-210%	N/A
Antimony 7440-36-0	<0.29*	<0.25*	<0.27*	<0.30*	<0.31*	<150-500	10/BG
Arsenic 7440-38-2	<0.67*	<0.36*	<0.81*	<0.51*	<0.54*	<2-24.0	41
Barium 7440-39-3	58.4*	<24.8*	68.2	64	66.2	50-1500	500/BG
Beryllium 7440-41-7	<0.46	0.28	<0.61*	<0.53*	<0.58*	<1-1.5	3 BG
Cadmium 7440-43-9	<0.08*	0.07*	<0.07*	<0.08*	<0.07*	<1	39
Calcium 7440-70-2	<476*	<331*	<585*	<546*	<589*	0-26%	N/A
Chromium 7440-47-3	12.6	6.7	18.7	14.9	16.6	3-100	1200
Cobalt 7440-48-4	<5.3*	<3.0*	<6.1*	<5.6*	<5.9*	5-30	25/BG
Copper 7440-50-8	5.9	2.6*	7.7	6.6	7.2	3-50	1500
Iron 7439-89-6	10000	5340	13000	11400	12400	0.1-5.0%	N/A
Lead 7439-92-1	5.3	2.9	7.1	6.1	6.9	<10-70	300
Magnesium 7439-95-4 (Mg)	953	<391*	1220	1100	1160	.1-.9%	N/A
Manganese 7439-96-5	375	115	307	395	345	50-700	N/A
Mercury 7439-97-6	<0.15	<0.13	<0.14	<0.16	<0.15	<.01-3.4	17
Nickel 7440-02-0	<4.1*	<2.4*	6.1	<5.1*	<5.1*	<3-70	420
Potassium 7440-09-7	<520*	<227*	<995*	<618*	<624*	0.2-3.7	N/A
Selenium 7782-49-2	<0.60*	<0.60*	0.85*	<0.54*	<0.97*	<0.1-1.4	36
Silver 7440-22-4	<0.09	<0.08	<0.08	<0.1	<0.09	<.5-5	10/BG
Sodium 7440-23-5	<325*	<219*	<253*	<281*	<267*	<0.02-1.0%	N/A
Thallium 7440-28-0	<0.54	<0.48	<0.51	<0.57	<0.53	—	10/BG
Vanadium 7440-62-2	18.2	10.7	25.2	20.6	24.1	15-150	100/BG
Zinc 7440-66-6	22.9	11.3	30.9	26.3	28.4	25-60	2800

TABLE FROM REV. 4H.
WRITTEN NOTES ADDED BY PD-EC.
Page 1

Table 1
Lower Savannah River Chemical Data
Soils

8080 TEST METHOD:							
Units all in PPB (ug/kg)	C3			C1/C3			
* = J, P, or B FLAG	ar C0-1	ar C1-1	ar C2-1	ar C3-1	ar C4-1		
3510 PESTICIDE EXTRACTION DATE:							
ANALYSIS DATE: 8/25/95							
Aldrin	<.088*		<.081*	<.049*	<.042*		660
Chlordane, Technical 12789-03-6	<3.1		<2.6	<2.5	<2.7		9200
Dieldrin	<1.2		<0.99	<0.94	<0.33*		660
4,4'DDT	<0.40*		<0.13*	<2.2	<0.20*		660
4,4'DDD	<2.7		<2.3	<2.2	<0.055*		660
4,4'DDE	<0.028*		<0.02*	<2.2	<0.13*		660
Endosulfan I	<.12*		<0.32*	<0.25*	<0.42*		1000
Endosulfan II	<0.38*		<0.64*	<2.2	<2.4		10000
Endosulfan sulfate	<0.26*		<0.32*	<1.3	<0.41*		1650
Endrin 72-20-8	<0.089*		<0.069*	<1.6	0.016*		10000
Endrin aldehyde 7421-36-3	<0.23*		<0.18*	<0.63*	<0.10*		10000
Heptachlor 76-44-8	<.034*		<.66	<.63	<.006*		660
Heptachlor epoxide 1024-57-3	<0.017*		<0.049*	<0.029*	<0.096*		1650
alpha-BHC	<0.12*		<0.11*	<0.13*	<0.099*		660
beta-BHC	<0.12*		<0.66	<0.63	<0.081*		660
delta-BHC	<0.14*		<0.66	<0.63	<0.083*		[2500]
gamma BHC Lindane 58-89-9	<.78		<.66	<.63	<.68		660
Methoxychlor 72-43-5	<1.2		<0.32*	<0.63*	<0.66*		10000
Toxaphene 8001-35-2	<16		<13	<13	<14		10000
Aroclor-1260	<16		<13	<13	<14		see below
Aroclor-1016	<16		<13	<13	<14		see below
Aroclor-1221	<16		<13	<13	<14		see below
Aroclor-1232	<16		<13	<13	<14		see below
Aroclor-1242	<16		<13	<13	<14		see below
Aroclor-1248	<16		<13	<13	<14		see below
Aroclor-1254	<16		<13	<13	<14		see below
Total PCBs							15500 total

Page 2

Table 1
Lower Savannah River Chemical Data
Soils

8150 TEST METHOD:							
ANALYSIS DATE:							
Units all in PPB (ug/kg)							
8270 TEST METHOD:							
3510 EXTRACTION DATE:							
ANALYSIS DATE: 8 24 95							
Units all in PPB (ug/kg)							
phenol 108-95-2	<890		<750	<720	<780		50000
bis(2-chloroethyl) ether 111-44-4	<920		<780	<750	<810		DL/.60
2-chlorophenol 95-57-8	<980		<830	<800	<860		680
1,3- dichlorobenzene 541-73-1	<800		<670	<650	<700		2220
1,4-dichlorobenzene 106-46-7	<810		<680	<660	<710		6840
benzyl alcohol 100-51-6	<860		<720	<700	<750		
1,2-dichlorobenzene 95-50-1	<920		<780	<750	<810		2500
2-methylphenol 95-48-7	<1000		<860	<820	<890		3800
bis (2-chloroisopropyl) ether 39638-32-9	<1000		<860	<820	<890		170910
4-methylphenol 106-44-5	<2000		<1700	<1600	>1800		3800
N-nitroso-di-N-propylamine 621-64-7	<950		<800	<770	<840		1710
hexachloroethane 67-72-1	<940		<790	<760	<820		9990
nitrobenzene 98-95-3	<1100		<890	<860	<930		700
isophorone 78-59-1	<1100		<<890	<860	<930		DL.19
2-nitrophenol 88-75-5	<970		<820	<780	<850		[$1x10^{6}$]
2,4-dimethylphenol 105-67-9	<950		<800	<770	<840		1510
benzoic acid 65-85-0	<3000		<2500	<2400	<2600		$1x10^{6}$
bis (2chloroethoxy) methane 111-91-1	<1000		<800	<850	<920		DL/.027
2,4-dichlorophenol 120-83-2	<880		<720	<700	<750		960
1,2,4-trichlorobenzene 120-82-1	<860		<720	<700	<750		10830
napthalene 91-20-3	<1000		<870	<840	<900		100000
4-chloroaniline 106-47-8	<1100		<910	<870	<950		DL(P)
hexachlorobutadiene 87-68-3	<880		<740	<710	<770		17500
4-chloro-3-methylphenol 59-50-7	<1200		<990	<950	<1000		13200
2-methyl napthalene 91-57-6	<1300		<1100	<1100	<1200		
hexachlorocyclopentadiene 77-47-4	<1000		<870	<840	<900		15200
2,4,6-trichlorophenol 88-06-2	<2000		<1700	<1600	<1800		660
2,4,5-trichlorphenol 95-95-4	<2000		<1700	<1600	<1800		4560
2-chloronaphthalene 91-58-7	<1500		<1300	<1200	<1300		25000

Table 1
Lower Savannah River Chemical Data
Soils

2-nitroaniline 88-74-4	<1700		<1400	<1400	1500		
dimethylphthalate 131-11-3	<1500		<1300	<1200	<1300		660
2,6-dinitrotoluene 606-20-2	1200		<990	<950	1000		760
acenaphthylene 208-96-8	<1000		<800	<850	<9520		130000
3-nitroaniline 99-09-2	<1100		<910	<870	950		
acenaphthene 83-32-9	<1000		<870	<840	900		300000
2,4-dinitrophenol 51-28-5	<2700		<2200	<2200	2300		3300
4-nitrophenol 100-02-7	<7000		<5900	<5700	<6200		3300
2,4-dinitrotoluene 121-14-2	<1800		<870	<840	<900		660
dibenzofuran 132-64-9	<1100		<910	<870	<950		
diethylphthalate 84-66-2	<60*		<950	<910	<990		740
4-chlorophenyl-phenylether 7005-72-3	<940		<790	<760	<820		[1x10^{4}]
fluorene 86-73-7	1100		<910	<870	<950		360000
4-nitroaniline 100-01-6	<1700		<1400	<1400	<1500		
4,6-dinitro-2-methylphenol 534-52-1	<2800		<2400	<2300	<2500		
N-nitrosodiphenylamine (1) 86-30-6	<2200		<1800	<1800	<1900		6460
4-bromophenyl-phenylether 101-55-3	<1200		<990	<950	<1000		[1x10^{4}]
hexachlorobenzene 118-74-1	<1200		<1600	<970	<1100		2140
pentachlorophenol 87-86-5	<2200		<1800	<1800	<1900		3300
phenanthrene 85-01-8	<970		<820	<780	<850		110000
anthracene 120-12-7	<1200		<970<	<940	<100		500000
di n-butylphthalate 84-74-2	<1200		<1000	<970	<1100		
flouranthene 206-44-0	<1400		<1200	<1200	<1300		500000
pyrene 129-00-0	<1100		<960	<920	<100		500000
butylbenzylphthalate 85-68-7	<1100		<890	<860	<930		50000
bis(2-ethylhexyl)phthalate 117-81-7	<1200		<990	<950	<160		50000
3,3'-Dichlorobenzidine 91-94-1	<780		<660	<630	<680		25000
Benzo(a)Anthracene 56-55-3	<1800		<870	<840	<900		5000
Chrysene 218-01-9	<840		<710	<680	<740		5000
Di-n-octylphthalate 117-84-0	<750		<630	<610	<680		50000
Benzo(b)flouranthene 205-99-2	<1200		<1000	<970	<1100		5000
Benzo(k)flouranthene 207-08-9	<970		<820	<780	<850		5000
Benzo(a)pyrene 50-32-8	<1000		<870	<840	<900		1640
Indeno(1,2,3-c,d)pyrene	<720		<610	<580	<630		5000
Dibenzo(a,h)anthracene 53-70-3	<670		<570	<540	<590		5000
Benzo(g,h,i)perylene 191-24-2	<970		<820	<780	<850		500000

ENCLOSURE 7

TABLES 1-7 FROM ENVIRONMENTAL ASSESSMENT

TABLE 1 - AMPHIBIANS OF THE LOWER SAVANNAH RIVER FLOODPLAIN

Dwarf Siren	*Pseudobranchus striatus*
Lesser Siren	*Siren intermedia*
Greater Siren	*Siren lacertina*
Dwarf Waterdog	*Necturus punctatus*
Two-toed Amphiuma	*Amphiuma means*
Eastern Newt	*Notophthalmus viridescens*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Mole Salamander	*Ambystoma talpoideum*
Tiger Salamander	*Ambystoma tigrinum*
Southern Dusky Salamander	*Desmognathus auriculatus*
Three-lined Salamander	*Eurycea longicauda guttolineata*
Southern Two-lined Salamander	*Eurycea cirrigera*
Dwarf Salamander	*Eurycea quadridigitata*
Northern Slimy Salamander	*Plethodon glutinosus*
Chattahoochee Slimy Salamander	*Plethodon chattahoochee*
Atlantic Coast Slimy Salamander	*Plethodon chlorobryonis*
Southeastern Slimy Salamander	*Plethodon grobmani*
Ocmulgee Slimy Salamander	*Plethodon ocmulgee*
South Carolina Slimy Salamander	*Plethodon variolatus*
Mud Salamander	*Pseudotriton montanus*
Red Salamander	*Pseudotriton ruber*
Many-lined Salamander	*Stereochilus marginatus*
Eastern Spadefoot	*Scaphiopus holbrookii*
Oak Toad	*Bufo quercicus*
Southern Toad	*Bufo terrestris*

Bird-voiced Treefrog	*Hyla avivoca*
Cope's Gray Treefrog	*Hyla chrysocelis*
Green Treefrog	*Hyla cinerea*
Pine Woods Treefrog	*Hyla femoralis*
Barking Treefrog	*Hyla gratiosa*
Squirrel Treefrog	*Hyla squirella*
Brimley's Chorus Frog	*Pseudacris brimleyi*
Spring Peeper	*Pseudacris crucifer*
Southern Chorus Frog	*Pseudacris nigrita*
Little Grass Frog	*Pseudacris ocularis*
Ornate Chorus Frog	*Pseudacris ornata*
Upland Chorus Frog	*Pseudacris feriarum*
Northern Cricket Frog	*Acris crepitans*
Southern Cricket Frog	*Acris gryllus*
Gopher Frog	*Rana capito*
Bullfrog	*Rana catesbeiana*
Bronze Frog	*Rana clamitans*
Pig Frog	*Rana grylio*
River Frog	*Rana heckscheri*
Pickerel Frog	*Rana palustris*
Southern Leopard Frog	*Rana utricularia*
Carpenter Frog	*Rana virgatipes*
Eastern Narrowmouth Toad	*Gastrophryne carolinensis*

TABLE 2 - REPTILES OF THE LOWER SAVANNAH RIVER FLOODPLAIN

American Alligator	*Alligator mississippiensis*
Common Snapping Turtle	*Chelydra serpentina*
Common Musk Turtle	*Sternotherus odoratus*
Striped Mud Turtle	*Kinosternon baurii*
Eastern Mud Turtle	*Kinosternon subrubrum*
Chicken Turtle	*Deirochelys reticularia*
Spotted Turtle	*Clemmys guttata*
Florida Cooter	*Pseudemys floridana*
River Cooter	*Pseudemys concinna*
Yellow-bellied Slider	*Trachemys scripta*
Box Turtle	*Terrapene carolina*
Florida Softshell	*Apalone ferox*
Spiny Softshell	*Apalone spinifera*
Green Anole	*Anolis carolinensis*
Southern Fence Lizard	*Sceloporus undulatus*
Ground Skink	*Scincella lateralis*
Five-lined Skink	*Eumeces fasciatus*
Southeastern Five-lined Skink	*Eumeces inexpectatus*
Broadhead Skink	*Eumeces laticeps*
Six-lined Racerunner	*Cnemidophorus sexlineatus*
Eastern Glass Lizard	*Ophisaurus ventralis*
Slender Glass Lizard	*Ophisaurus attenuatus*
Southern Water Snake	*Nerodia fasciata*
Redbelly Water Snake	*Nerodia erythrogaster erythrogaster*
Brown Water Snake	*Nerodia taxispilota*
Florida Green Water Snake	*Nerodia floridana*

Glossy Crayfish Snake	*Regina rigida*
Black Swamp Snake	*Seminatrix pygaea*
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
Eastern Ribbon Snake	*Thamnophis sauritus sauritus*
Brown Snake	*Storeria dekayi*
Redbelly Snake	*Storeria occipitomaculata*
Rough Earth Snake	*Virginia striatula*
Smooth Earth Snake	*Virginia valeriae*
Southern Ringneck Snake	*Diadophis punctatus punctatus*
Southern Hognose Snake	*Heterodon simus*
Eastern Hognose Snake	*Heterodon platirhinos*
Eastern Worm Snake	*Carphophis amoenus amoenus*
Scarlet Snake	*Cemophera coccinea*
Rough Green Snake	*Opheodrys aestivus*
Rainbow Snake	*Farancia erytrogramma*
Mud Snake	*Farancia abacura*
Southern Black Racer	*Coluber constrictor priapus*
Eastern Coachwhip	*Masticophis flagellum flagellum*
Eastern Indigo	*Drymarchon corais couperi*
Pine Snake	*Pituophis melanoleucus*
Rat Snake	*Elaphe obsoleta*
Corn Snake	*Elaphe guttata guttata*
Scarlet Kingsnake	*Lampropeltis triangulum*
elapsoides	
Eastern Kingsnake	*Lampropeltis getula getula*
Mole Kingsnake	*Lampropeltis calligaster*
rhombomaculata	

Southeastern Crowned Snake	*Tantilla coronata*
Cottonmouth	*Agkistrodon piscivorus*
Copperhead	*Agkistrodon contortrix*
Eastern Coral Snake	*Micrurus fulvius fulvius*
Pigmy Rattlesnake	*Sistrurus miliarius*
Timber Rattlesnake	*Crotalus horridus*
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*

TABLE 3 - BIRDS OF THE LOWER SAVANNAH RIVER FLOODPLAIN

Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Brown Pelican	*Pelecanus occidentalis*
Double-crested Cormorant	*Phalacrocorax auritus*
Anhinga	*Anhinga anhinga*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Cattle Egret	*Bubulcus ibis*
Green-backed Heron	*Butorides striatus*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nycticorax violaceus*
White Ibis	*Eudocimus albus*
Glossy Ibis	*Plegadis falcinellus*
Wood Stork	*Mycteria americana*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mottled Duck	*Anas fulvigula*

Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Wild Turkey	*Meleagris gallopavo*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Purple Gallinule	*Porphyrula martinica*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Black-bellied Plover	*Pluvialis squatarola*
Wilson's Plover	*Charadrius wilsonia*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Actitis macularia*
Whimbrel	*Numenius phaeopus*
Semipalmated Sandpiper	*Calidris pusilla*

Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Stilt Sandpiper	*Calidris himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Wilson's Phalarope	*Phalaropus tricolor*
Laughing Gull	*Larus atricilla*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Great Black-backed Gull	*Larus marinus*
Gull-billed Tern	*Sterna nilotica*
Caspian Tern	*Sterna caspia*
Royal Tern	*Sterna maxima*
Sandwich Tern	*Sterna sandvicensis*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Tern	*Chlidonias niger*
Black Skimmer	*Rynchops niger*
Rock Dove	*Columba livia*

Mourning Dove	*Zenaida macroura*
Common Ground-Dove	*Columbina passerina*
Yellow-billed Cuckoo	*Coccyzus americanus*
Common Barn-Owl	*Tyto alba*
Eastern Screech-Owl	*Otus asio*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Long-eared Owl	*Asio otus*
Common Nighthawk	*Chordeiles minor*
Chuck-will's-widow	*Caprimulgus carolinensis*
Whip-poor-will	*Caprimulgus vociferus*
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Acadian Flycatcher	*Empidonax virescens*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Gray Kingbird	*Tyrannus dominicensis*

Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Carolina Chickadee	*Parus carolinensis*
Tufted Titmouse	*Parus bicolor*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Brown-headed Nuthatch	*Sitta pusilla*
Brown Creeper	*Certhia americana*
Carolina Wren	*Thryothorus ludovicianus*
Bewick's Wren	*Thryomanes bewickii*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*

Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
Water Pipit	*Anthus spinoletta*
Cedar Waxwing	*Bombycilla cedrorum*
Loggerhead Shrike	*Lanius ludovicianus*
European Starling	*Sturnus vulgaris*
White-eyed Vireo	*Vireo griseus*
Solitary Vireo	*Vireo solitarius*
Yellow-throated Vireo	*Vireo flavifrons*
Philadelphia Vireo	*Vireo philadelphicus*
Red-eyed Vireo	*Vireo olivaceus*
Bachman's Warbler	*Vermivora bachmanii*
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrina*
Orange-crowned Warbler	*Vermivora celata*
Northern Parula	*Parula americana*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*

Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Yellow-throated Warbler	*Dendroica dominica*
Pine Warbler	*Dendroica pinus*
Kirtland's Warbler	*Dendroica kirtlandii*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Blackpoll Warbler	*Dendroica striata*
Cerulean Warbler	*Dendroica cerulea*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Protonotaria citrea*
Worm-eating Warbler	*Helmitheros vermivorus*
Swainson's Warbler	*Limnothlypis swainsonii*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Kentucky Warbler	*Oporornis formosus*
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Wilsonia citrina*
Wilson's Warbler	*Wilsonia pusilla*
Yellow-breasted Chat	*Icteria virens*
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*

Blue Grosbeak	*Guiraca caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza americana*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Bachman's Sparrow	*Aimophila aestivalis*
American Tree Sparrow	*Spizella arborea*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*Pooecetes gramineus*
Savannah Sparrow	*Passerculus sandwichensis*
Henslow's Sparrow	*Ammodramus henslowii*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Boat-tailed Grackle	*Quiscalus major*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Orchard Oriole	*Icterus spurius*
Northern Oriole	*Icterus galbula*

Purple Finch	*Carpodacus purpureus*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*

TABLE 4 - MAMMALS OF THE LOWER SAVANNAH RIVER FLOODPLAIN

Opossum	*Didelphis marsupialis*
Southeastern Shrew	*Sorex longirostris*
Shorttail Shrew	*Blarina brevicauda*
Least Shrew	*Cryptotis parva*
Starnose Mole	*Condylura crystata*
Eastern Mole	*Scalopus aquaticus*
Little Brown Myotis	*Myotis lucifugus*
Eastern Pipistrel	*Pipistrellus subflavus*
Big Brown Bat	*Eptesicus fuscus*
Red Bat	*Lasiurus borealis*
Seminole Bat	*Lasiurus seminolus*
Hoary Bat	*Lasiurus cinereus*
Southern Yellow Bat	*Lasiurus floridanus*
Evening Bat	*Nycticeius humeralis*
Rafinesque's Bat	*Plecotus rafinesquii*
Brazilian Free-tailed Bat	*Tadarida brasiliensis*
Marsh Rabbit	*Sylvilagus palustris*
Eastern Cottontail	*Sylvilagus floridanus*
Gray Squirrel	*Sciurus carolinensis*
Fox Squirrel	*Sciurus niger*
Southern Flying Squirrel	*Glaucomys volans*
Beaver	*Castor canadensis*
Rice Rat	*Oryzomys palustris*
Eastern Havest Mouse	*Reithrodontomys humulis*
Cotton Mouse	*Peromyscus gossypinus*
Cotton Rat	*Sigmodon hispidus*

Eastern Woodrat	*Neotoma floridana*
Muskrat	*Ondatra zibethica*
Black Rat	*Rattus rattus*
Norway Rat	*Rattus norvegicus*
House Mouse	*Mus musculus*
Coyote	*Canis latrans*
Gray Fox	*Urocyon cinereoargenteus*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
River Otter	*Lutra canadensis*
Bobcat	*Lynx rufus*
White-tailed Deer	*Odocoileus virginianus*

TABLE 5 - Importance Values[1] for Tree Species in Bottomland Hardwood Forest in Lower Savannah River

Species	Habitats: Bar Habitat[2]	Old Bar/Cut-Off[3] #4	Over-flow[4] Banks
Fraxinus pennsylvanica		81	
53 27			
Green Ash			
Salix nigra Black Willow	55	-	-
Acer saccharinum Silver Maple	36	9	3
Betula nigra River Birch	29	-	17
Platanus occidentalis Sycamore	28	-	31
Carya aquatica Water Hickory	21	46	30
Ulmus americana American Elm	14	10	13
Quercus lyrata Overcup Oak	11	20	6
Acer rubrum Red Maple	8	51	14
Taxodium distichum Bald Cypress	8	-	-
Quercus laurifolia Swamp Laurel Oak	5	50	34
Planera aquatica Water Elm	4	-	-
Nyssa aquatica Water Tupelo	-	45	-
Liquidambar styraciflua Sweetgum	-	16	79
Carpinus caroliniana Ironwood	-	-	25
Populus heterophylla Swamp Cotton-wood	-	-	8
Ilex opaca American Holly	-	-	3
Nyssa biflora Swamp Blackgum	-	-	3
Persea palustris Swamp Red Bay	-	-	3
Quercus michauxii Swamp Chestnut Oak	-	-	3

1. Importance values are sum total of relative dominance (basic area), relative density, and relative frequency. Tree species are stem diameters greater than 4 inches dbh. Importance values add up to 300 in each series of plots.

2. Includes 3 each 0.1 ac plots in transects 36 & 68 N.

3. Includes 3 each 0.1 ac plots in transect 68 N.

4. Includes 3 each 0.1 ac plots in transects 35, 39, & 55.

TABLE 6. Relative Density[1] of Seedlings, Shrubs, and Woody Vines in Bottomland Hardwood Forest in Lower Savannah River

Species Overflow[4]	Bar Habitat[2]	Habitats: Old Bar/Cut-Off[3] #4	Banks
Smilax rotundifolia		40.2	14.0
3.7			
Common Green-briar			
Platanus occidentalis	21.5	-	-
Sycamore			
Forestiera accuminata	15.3	2.2	01
Swamp Privet			
Toxicodendron radicans	4.6	27.7	41
Poison Ivy			
Fraxinus pennsylvanica	4.6	-	-
Green Ash			
Acer rubrum	3.4	1.7	03
Red Maple			
Brunnichia cirrhosa	2.5	3.9	-
Redvine			
Carya aquatica	1.8	2.0	34
Water Hickory			
Ulmus americana	1.2	-	08
American Elm			
Campsis radicans	0.9	17.4	121
Trumpet-creeper			
Bignonia capreolata	0.6	8.1	15
Cross-vine			
Vitis rotundifolia	0.6	2.8	17
Muscadine Grape			
Acer saccharinum	0.6	-	-
Silver Maple			
Taxodium distichum	0.3	-	-
Bald Cypress			
Betula nigra	0.3	-	-
River Birch			
Quercus laurifolia	-	18.2	05
Swamp Laurel Oak			
Wisteria frutescens	-	1.1	-
American Wisteria			
Arundinaria gigantea	-	0.8	80

Giant Cane			
Rubus sp.	-	-	--
Blackberry			
Carpinus caroliniana	-	-	07
Ironwood			
Parthenodissus quinquefolia	-	-	07
Virginia Creeper			
Ilex decidua	-	-	06
Deciduous Holly			

TABLE 4, continued

Liquidambar styraciflua	-	-	02
Sweetgum			
Sabal minor	-	-	01
Dwarf Palmetto			
Persea palustris	-	-	01
Red Bay			
Itea virginica	-	-	01
Virginia Willow			

1. Relative density is the ratio of the number of individuals of a particular species to the total number of individuals of all species. Occurrence is based upon number of individuals less that 4 inches dbh. Plot size is 10x10 ft^2 centered in each 0.1 ac canopy plot.

2. Includes 3 each 100 ft^2 plots in transects 36 & 68 N.

3. Includes 3 each 100 ft^2 plots in transect 68.

4. Includes 3 each 100 ft^2 plots in transects 35, 39, & 55.

TABLE 7. Important Herbs, Lower Savannah River

BAR HABITAT

Spilanthes americana
Onoclea sensibilis
Boehmerica cylindrica
Pilea pumila
Commelina caroliniana
Lobelia ssp.
Apocynum cannabinum
Leersia ssp.
Solanum carolinense
Heterotheca subaxillaris
Polygonum ssp.

OLD BAR/CUTOFF HABITAT

Carex ssp.
Boehmeria cylindrica
Apocynum cannabinum
Heterotheca subaxillaris
Diodia virginiana
Saururus cernuus
Polygonum ssp.

OVERFLOW BANK HABITAT

Pilea pumila
Boehmeria cylindrica
Leersea virginica
Cyperus ssp.
Apocynum cannabinum
Lobelia ssp.
Woodwardia virginica
Matalea ssp.
Lobelia caerulea
Carex ssp.

ENCLOSURE 8

COMMENTS RECEIVED FROM PUBLIC REVIEW OF THE DRAFT EA AND DISTRICT RESPONSES TO THOSE COMMENTS

TABLE OF CONTENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

JAN

District Engineer
Savannah District, Corps of Engineers
P. O. Box 889
Savannah, GA 31402
Attn: Mr. M.J. Yuschishin/Ms. Ana Vergara

Subject: Environmental Assessment (EA) and Finding Of No Significant Impact (FONSI) for Restoration of Cutoff Bends Numbers 3 and 4, Savannah River at Mile 41 Georgia and South Carolina

Dear Sir:

Pursuant to Section 309 of the Clean Air Act, EPA, Region 4 has reviewed the subject document which assesses the consequences of restoring the original flow regime in bends #3 and #4. This modification would increase the water quantity in associated feeder creeks and via overbank flow into surrounding wetlands. The closure of the navigation cuts along with restored flows to the entrance of Mill and Bear Creeks should benefit the biota in the Savannah National Wildlife Refuge and the quality/quantity of water being withdrawn by the City of Savannah on Abercorn Creek.

On the basis of cost Alternative #22 was selected by the local sponsor. This is unfortunate since Alternative #36 appears to more completely achieve environmental restoration and navigation potential while minimizing adverse impacts. This notwithstanding, we are sensitive to the cost differential associated with the latter option and hope that at some future time funding can be secured to complete the more comprehensive alternative.

On the basis of the information provided in the document we have no significant objections to implementation of this proposal. Thank you for the opportunity to comment. If we can be of further assistance in this matter, Dr. Gerald Miller (404-347-3776) will serve as initial point of contact.

Sincerely yours,

Heinz Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activity Branch

46-054 98 - 12

RESPONSE -- Environmental Protection Agency;
Environmental Policy Section,
Federal Activities Branch,
January 11, 1996.

1. **SELECTED ENVIRONMENTAL RESTORATION PLAN FOR THE LOWER SAVANNAH RIVER. Concur. Alternative 36 is the alternative that best meets the District's study objective of maximizing environmental restoration outputs, but in the absence of a local cost sharing support, the District has selected Alternative 22 as the recommended restoration alternative.**

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
P.O. Box 12559
217 Fort Johnson Road
Charleston, South Carolina 29422-2559

February 8, 1996

Colonel Grant M. Smith
District Engineer
U.S. Army Corps of Engineers
Post Office Box 889
Savannah, Georgia 31402-0889

Dear Colonel Smith:

The enclosed Final Fish and Wildlife Coordination Act (FWCA) Report evaluating the Lower Savannah River Restoration Study, Effingham County, Georgia, and Jasper County, South Carolina, is submitted in fulfillment of the FWCA [48 Stat. 401, as amended; 16 U. S. C. 661 et seq.; Section 2(b)]. In January 1996, a draft of this report was coordinated with the National Marine Fisheries Service, the Georgia Department of Natural Resources and the South Carolina Department of Natural Resources. All of these agencies concurred with the report and supported its recommendations. In accordance with the FWCA, this report should be attached to and made an integral part of the Corps' Final Feasibility Report.

Discussions between the Corps and the city of Savannah, the cost-sharing partner for the study indicate that the city would like to support alternative plan 36 and believes it would provide ideal restoration of the study area. However, because of the high cost of plan 36, the city, as the sole cost-sharing partner, cannot support that alternative. The city is in favor of alternative plan 22, which would provide substantial restoration benefits at a significantly lower cost.

Alternative 22 consists of constructing a large diversion structure in the Savannah River to divert water into Bear Creek, plugging cutoff bend three below the Bear Creek entrance and restoring the connection of Mill Creek to the Savannah River. This alternative would provide substantial restoration of the Bear Creek zone (2,367 acres) and the Mill Creek zone (708 acres) identified in the revised habitat evaluation, but would not restore the Raccoon Creek zone (1,633 acres). Plan 22 would provide a net increase of 1,067 average annual habitat units of fish habitat and a net increase of 1,960 average annual habitat units of bottomland hardwood functional value.

Plan 36 includes the actions provided by plan 22 plus the restoration of the Savannah River to its original channel at cutoff bend four. Of all the plans evaluated, plan 36 provides the highest restoration benefits while minimizing potential adverse impacts. This plan restores all three restoration zones, including the Bear Creek, Raccoon Creek and Mill Creek zones. The proposed restoration action at cutoff bend four would not only restore the Raccoon Creek zone but also, because of flow connections to the Bear Creek zone and the Mill Creek zone, would benefit those zones. Plan 36 would provide a net increase of 1,848 average annual habitat units of fish habitat and a net increase of 3,498 average annual habitat units of bottomland hardwood functional value.

The Service recommends that the Corps implement plan 22 to restore wetlands in the study area if the city of Savannah remains the sole cost-sharing partner or implement plan 36 to restore wetlands in the study area if additional cost-sharing partners can be located.

We appreciate the cooperation of you and your staff during the course of the Lower Savannah River Restoration Study. We request that you continue close coordination with the Service throughout development of detailed restoration and construction plans, contracting, and construction.

Sincerely yours,

Edwin M. EuDaly

Edwin M. EuDaly
Acting Field Supervisor

RECOMMENDATIONS

The Service recommends that the Corps perform the following actions to address the problems associated with the Lower Savannah River project.

1. Do not conduct any maintenance activities on the Savannah to Augusta navigation project, and seek deauthorization of this navigation project.

2. In conjunction with fish and wildlife agencies, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat.

3. Implement Plan 22 to restore wetlands in the study area if the city of Savannah remains the sole cost-sharing partner.

4. Implement Plan 36 to restore wetlands in the study area if additional cost-sharing partners can be located.

5. If Plan 22 is selected, expedite construction by completing this project under authority of Section 1135 of the Water Resources Development Act of 1986.

6. Continue close coordination with the Service throughout development of detailed restoration and construction plans, contracting and construction.

RESPONSE - - United States Department of the Interior
Fish and Wildlife Service
February 8, 1996.

1. DO NOT CONDUCT ANY MAINTENANCE ACTIVITIES ON THE SAVANNAH TO AUGUSTA NAVIGATION PROJECT TO SEEK DEAUTHORIZATION OF THIS NAVIGATION PROJECT. The original study objective included maintaining navigation as a purpose for this project. The District briefly looked at the impact of deauthorizing navigation, but due to continued use of the channel for navigation based on our survey of local towing companies and subsequent discussions at the District Project Review Board, the District concluded that some minimal provision for navigation was still appropriate at this time. The navigation project is currently an inactive, Federally authorized navigation project. Due to the amount of water that moves through the river channel, the river has remained navigable approximately 60 percent of the year. The District has documented yearly freight traffic which continues to occur on the river. All shipments are large, heavy, oversize items which cannot be moved by any other method. The difference in providing for a minimal level of navigation as proposed in the recommended plan, and not providing for navigation as recommended by USF&WS, is $138,000, or an average annual cost of $10,200.

2. IN CONJUNCTION WITH FISH AND WILDLIFE AGENCIES, DETERMINE AND IMPLEMENT A SAVANNAH RIVER FLOW REGIME THAT PROVIDES FOR DIVERSE AND PRODUCTIVE FISH AND WILDLIFE HABITAT. This action is outside the scope of this study. There are more acreage outside the cuts and cutoff bends 3 & 4 along the Savannah River that would be affected by changes in the river flow regime.

3. IMPLEMENT PLAN 22 TO RESTORE WETLANDS IN THE SUTUDY AREA IF THE CITY OF SAVANNAH REMAINS THE SOLE COST-SHARING PARTNER. Concur. Alternative 22 is the final selected restoration plan.

4. IMPLEMENT PLAN 36 TO RESTORE WETLANDS IN THE STUDY AREA IF ADDITIONAL COST-SHARING PARTNERS CAN BE LOCATED. Concur.

5. IF PLAN 22 IS SELECTED, EXPEDITE CONSTRUCTION BY COMPLETING THIS PROJECT UNDER AUTHORITY OF SECTION 1135 OF THE WATER RESOURCES DEVELOPMENT ACT OF 1986. Congressional authorization will be sought for the project because insufficient Section 1135 funds are available to implement this project.

6. CONTINUE CLOSE COORDINATION WITH THE SERVICE THROUGHOUT DEVELOPMENT OF DETAILED RESTORATION AND CONSTRUCTION PLANS, CONTRACTING AND CONSTRUCTION. Coordination with these agencies will be maintained to ensure the less possible impact to fishery resources and wetlands during construction.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

January 19, 1996

Colonel Grant M. Smith
District Engineer, Savannah District
Department of the Army, Corps of Engineers
P.O. Box 889
Savannah, Georgia 31402-0889

Dear Colonel Smith:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Assessment (DEA) of Navigation Channels and Cutoff Bends 3 and 4, Lower Savannah River Restoration Project, Effingham County, Georgia and Jasper County, South Carolina. The DEA was provided as an attachment to Mr. M.J. Yuschishin's letter of December 27, 1995, and is advertised in a Public Notice also issued on December 27, 1995. The selected Alternative, Number 22, involves realignment and constriction at cutoff bend 3 at the mouth of Bear Creek; restoration of Mill Creek; and no action at cutoff bend 4. Alternative 36 encompasses work prescribed in Alternative 22 as well as improvements at cutoff bend 4, but is unsupported due to substantially increased costs and lack of a local sponsor.

The study site is located near River Mile 41 of the Savannah River. The selected alternative is supported by, and would be partially funded by the City of Savannah. It is expected to provide substantial restoration of hydrologic conditions in riparian wetlands of Bear Creek (2,367 acres) and Mill Creek (708 acres). It is also expected to enhance water quality at the City of Savannah's Abercorn Creek municipal water treatment facility.

The NMFS concurs with findings contained in the DEA and we strongly endorse project implementation with inclusion of recommendations prescribed in the U.S. Fish and Wildlife Service's (FWS) January 1996, Fish and Wildlife Coordination Act Report. Those recommendations are as follows:

1. Terminate and deauthorize maintenance activities on the Savannah to Augusta Navigation Project;

2. In conjunction with fish and wildlife agencies, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat;

3. Implement Alternative 22 to restore wetlands in the study area if the City of Savannah remains the sole cost-sharing partner;

4. Implement Alternative 36, which would include wetland enhancement measures at cutoff bend 4, if additional cost-sharing partners can be located;

5. Expedite plan construction through use of authority contained in Section 1135 of the Water Resources Development Act of 1986; and

6. Maintain close coordination with the FWS, NMFS, and Georgia Department of Natural Resources throughout development of detailed restoration and construction plans, contracting, and construction.

With regard to recommendation 6, major excavation and filling within aquatic zones should be restricted to periods of low biological activity including migration of anadromous fish. This would generally limit such activities to mid October through mid January of most years.

Finally, in accordance with the Endangered Species Act of 1973, as amended, it is the responsibility of the appropriate Federal regulatory agency to review its activities and programs and to identify any activity or programs that may affect endangered or threatened species or their habitat. If it is determined that these activities may adversely affect any species listed as endangered or threatened, formal consultation with our Protected Species Management Branch must be initiated. The appropriate contact person for matters pertaining to protected species is Mr. Charles Oravetz who may be contacted at the letterhead address or at (813) 570-5312. Mr. David Rackley of our Charleston Branch Office should be contacted regarding technical aspects of the comments we have provided. He may be reached at P.O. Box 12607, Charleston, South Carolina 29412, or at (803) 762-8574.

We appreciate the opportunity to provide these comments.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

RESPONSE -- United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
January 19, 1996.

Note: These comments are the same comments received from US Fish and Wildlife. Please refer to previous responses to comments 1 to 6 in the Fish and Wildlife Service recommmedations.

1. TERMINATE AND DEAUTHORIZE MAINTENANCE ACTIVITIES ON THE SAVANNAH TO AUGUSTA NAVIGATION PROJECT.

2. DETERMINE AND IMPLEMENT A SAVANNAH RIVER FLOW REGIME THAT PROVIDES FOR DIVERSE AND PRODUCTIVE FISH AND WILDLIFE HABITAT.

3. IMPLEMENT ALTERNATIVE 22 TO RESTORE WETLANDS IN THE STUDY AREA IF THE CITY OF SAVANNAH REMAINS THE SOLE COST-SHARING PARTNER.

4. IMPLEMENT ALTERNATIVE 36, WHICH WOULD INCLUDE WETLAND ENHANCEMENT MEASURES AT CUTOFF BEND 4, IF ADDITIONAL COST-SHARING PARTNERS CAN BE LOCATED.

5. EXPEDITE PLAN CONSTRUCTION THROUGH USE OF AUTHORITY CONTAINED IN SECTION 1135 OF THE WATER RESOURCES DEVELOPMENT ACT OF 1986.

6. MAINTAIN CLOSE COORDINATION WITH THE FWS, NMFR, AND GEORGIA DEPARTMENT OF NATURAL RESOURCES THROUGHOUT DEVELOPMENT OF DETAILED RESTORATION AND CONSTRUCTION PLANS, CONTRACTING, AND CONSTRUCTION.

7. ENDANGERED SPECIES ACT OF 1973. It has been determined that the proposed environmental restoration project would not adversely affect any threatened or endangered species or their habitat. A Biological Assessment of Threatened and Endangered Species is included as an Enclosure in the EA prepared for this project. Consultation with the National Marine Fisheries Service, Protected Species Management Branch, was done during the public review period of the draft EA.

BEAUFORT - JASPER WATER & SEWER AUTHORITY

POST OFFICE BOX 2149 / BEAUFORT, SOUTH CAROLINA [illegible]
[illegible] [illegible] Engineering & Operations FAX [illegible]

DEAN MOSS, General Manager

January 22, 1996

District Engineer
U.S. Army Engineer District, Savannah
Attn: Ana Vergara PD-EI
P.O. Box 889
Savannah, Georgia 31402-0889

Re: Comments EA & FONSI - Cutoff Bends 3 & 4 Lower Savannah River Restoration Project

Dear Ms. Vergara:

Thanks for the copy of the referenced documents. The Authority is very interested in this project due to its proximity to our raw water supply intake located at river mile 39.2. This intake is the drinking water supply for 50,000 residents of Beaufort and Jasper Counties. Our concerns are:

- Water Quantity:
  The reports do not quantify the reduction of water quantity at our intake due to the diversion of main river channel flow to Bear, Raccoon and Mill Creeks. Please revise the EA to include this calculation.

- Water Quality:
  Sections 6.04 & 6.06 of the EA indicates that an increase in river turbidity will occur as a result of the dredging activities associated with this project and states that only minimal and temporary impacts are expected. Please revise the EA to quantify the specific turbidity impacts (including expected duration) at our intake. In addition, the Authority is concerned over the quality of the dredged sediments. Paragraph g. on page 11 of Enclosure 6 refers to uncertainties concerning possible environmental effects associated with the incomplete project sediment data. We strongly recommend that measures should be taken to minimize potential environmental impacts from possible contaminants entrained in the sediment. These measures include confined upland disposal, isolated open water disposal where the disposed sediments are raised to high ground elevation, and use of a silt curtain for open water disposal. These construction techniques must be applied to the selected project Alternative # 22. Also, more sediment sampling specific to Alternative #22 should be completed to eliminate the uncertainties mentioned previously.

Our concerns must be addressed prior to obtaining the Water Quality Certification from the South Carolina Department of Health and Environmental Control. If you have any questions or would like to discuss these issues further, please give me a call.

Sincerely,

Ed Saxon, P.E.
Chief Engineer

c. William D. Moss, Jr., General Manager
Mark Giffin, SCDHEC

POST OFFICE BOX 2149 / BEAUFORT, SOUTH CAROLINA 29901-2149
803/521/9600 803/521/2006 Engineering & Operations FAX 803/521/9600

BEAUFORT - JASPER WATER & SEWER AUTHORITY

DEAN MOSS, General Manager

February 19, 1996

District Engineer
U.S. Army Engineer District, Savannah
Attn: Ana Vergara PD-EI
P.O. Box 889
Savannah, Georgia 31402-0889

Re: Lower Savannah River Restoration Project - COE Response

Dear Ms. Vergara:

Thanks for allowing the Authority to preview the District's proposed response to our comments and concerns on the referenced project. As indicated in your response, there will be no dredging of the main channel and no open water disposal associated with selected Alternative #22 and the fill material for the Cutoff Bend 3 work will be obtained from an adjacent sand bar. Based upon this explanation of the project, the Authority has no objection to Alternative #22 as proposed. However, if the project scope changes to include any dredging of the river channel or open water disposal, our specific concerns listed in our letter to you dated 1/22/96 must be addressed.

If you have any questions, please do not hesitate to give me a call.

Sincerely,

Ed Saxon, P.E.
Chief Engineer

c. William D. Moss, Jr., General Manager
Mark Giffin, SCDHEC

RESPONSE - - Beaufort - Jasper
Water & Sewer Authority
Beaufort, SC
January 22, 1996

1. WATER QUANTITY. Section 6.11 of the EA prepared for this project describes the potential water flow increase for each of the proposed final alternatives. Flow int he Savannah River, below River Mile 41, would be reduced by the additional volumes expected to flow in the creeks. The potential for water flow increase into Bear Creek and Mill Creek for the selected restoration plan would be 66 percent over the existing conditions or an increase of 70.99 cfs. Average water flow in the main channel during low flow conditions is 6,600 cfs in the project area. The water flow increase into Bear Creek and Mill Creek is not expected to impact water quantity at the raw water supply intake located at River Mile 39.2.

2. WATER QUALITY. The selected restoration plan does not include open water disposal of dredged material or dredging activities associated with construction of a navigation channel and slackwater channel in the cutoff bends. An increase in turbidity will occur as a result of the realignment and constriction of the mouth of cutoff bend 3 to the mouth of Bear Creek, filling behind the sheet pile wall and plug, and construction of the new entrance to Mill Creek. The estimated construction time is 140 days. Water quality impacts would be limited to the construction period and would consist of increases in suspended solids and turbidity in the vicinity of the construction. These impacts would be localized and temporary. To minimize these impacts, the following measures would be taken during construction:

- The specifications would include provisions for erosion control measures in the vicinity of the project, including the use of silt fences and slope protection, as necessary.

- The material excavated for construction of the plug and constriction of the mouth of the cutoff bend would be primarily sand with approximatelly 10 percent fine-grianed soil material. It would settle out quickly in the area immediately adjacent to the project.

- The project site would be located in the bend where existing velocities are low and not in the main river channel, where velocities are much higher. Since the sheet piling would be placed prior to placement of any fill for the closure structure, velocities would be further reduced in this area, allowing sedimentation of the fine-grained material within the bend.

- It is anticipated that the material would be excavated by mechanical means (i.e. clamshell, dragline), which would greatly reduce the potential for suspension of material.

- The Beaufort-Jasper County water intake is located approximately 2 miles below the construction site. Any turbidity or suspended solids leaving the immediate project area would be rapidly diluted when mixed with swift moving flows in the main river channel.

Conclusion: Based on the above information, it is our position that no measurable increases in turbidity and suspended solids over the existing concentrations will occur at the Beaufort-Jasper County Water Authority intake.

3. SEDIMENT QUALITY. It has been estimated that approximately 15,100 cubic yards of soil material are required to fill the area between the existing bank and the sheet pile wall and for the plug in Cutoff bend 3. This will require dredging approximately 19,000 cubic yards of fill material from the adjacent sand bars in the cutoff bend. The material consists of approximately 90 percent sand and 10 percent fines (silt and clay). Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material (Federal Register, 40 CFR Part 230.60 (a)). Sediment samples were taken in cutoff bend 3 where construction is going to take place. The sediment analysis revealed no hazardous or toxic materials at the project site. The data revealed no concern for heavy metals, as all observed levels were within the range for uncultivated soils in Georgia. The levels of radionuclides in the sediments were similar to levels in soils in other areas. The lack of detection of other PAHs at levels of concern indicates that it is unlikely that the five PAHs where detection limits were above ERM levels are present at levels that would impact the aquatic environment.

There are no known sources of possible contamination in the vicinity of the proposed project and the fill material is composed primarily of sand. Under these conditions, EPA regulations 230.60 (b) allow for a determination of no concern for contaminants without further testing. However, the District conducted further testing which confirmed this determination.

Given this information, we have determined that there are no concerns for contaminants in the project area and further sediment sampling is not necessary.

Georgia Department of Natural Resources

Lonice C. Barrett, Commissioner

Historic Preservation Division

Mark R. Edwards, Division Director and State Historic Preservation Officer
500 The Healey Building, 57 Forsyth Street, N. W., Atlanta, Georgia 30303
Telephone (404) 656-2840 Fax (404) 651-8739

January 24, 1996

Mr. M.J. Yuschishin
Chief, Planning Division
Department of the Army
Savannah District, Corps of Engineers
P.O. Box 889
Savannah, GA 31402-0889

RE: Restore Cutoff Bends 3 and 4, Savannah River
Effingham County, Georgia
HP940722-072

Dear Mr. Yuschishin:

The Historic Preservation Division (HPD) has reviewed the Joint Public Notice and Effects Assessment for the proposed restoration of cutoff bends 3 and 4 in the Savannah River, Effingham County, Georgia. As previously stated, HPD has no concerns regarding the proposed undertaking, based on the results of a previous survey which indicated that no historic structural or archaeological resources listed in or eligible for listing in the National Register of Historic Places are located within the project's area of potential effects.

It is important to remember that any future changes to this project as it is currently proposed may require additional steps for compliance with Section 106 of the National Historic Preservation Act. HPD encourages federal agencies and project applicants to discuss such changes with our office to ensure that potential effects to historic resources are adequately considered in project planning.

If we may be of further assistance, please contact David R. Morris, Environmental Review Specialist, at (404) 656-2840.

Sincerely,

Jeffrey L. Durbin
Environmental Review Coordinator

JLD:drm

cc: Dr. George Vogt, South Carolina SHPO
Ellen Andrews, Coastal Georgia RDC

RESPONSE - - Georgia Department of Natural Resources
Historic Preservation Division
January 24, 1996.

1. NO HISTORIC STRUCTURAL OR ARCHAEOLOGICAL RESOURCES LISTED IN OR ELIGIBLE FOR LISTING IN THE NATIONAL REGISTER OF HISTORIC PLACES ARE LOCATED WITHIN THE PROJECT'S AREA OF POTENTIAL EFFECTS. Concur. **Determination is made based on the results of the cultural resource survey.**

2. FUTURE CHANGES TO THIS PROJECT, AS PROPOSED, MAY REQUIRE ADDITIONAL STEPS FOR COMPLIANCE WITH SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT. Cooncur. **Any future changes will be discussed with the Historic Preservation Office.**

Georgia Department of Natural Resources
205 Butler St. S.E., East Floyd Tower, Atlanta, Georgia 30334
Lonice C. Barrett, Commissioner
404/656-6328

January 26, 1996

Ms. Ana Vergara
Corps of Engineers
Savannah District
P.O. Box 889
Savannah, Georgia 31402-0889

RE: Lower Savannah Environmental Restoration Draft Feasibility Report

Dear Ms. Vergara:

The Georgia Department of Natural Resources appreciates the opportunity to have participated in the development of the referenced Draft Feasibility Report for the Lower Savannah Environmental Restoration Study. We encourage finalization of the report and implementation of alternative number 22. This alternative provides significant environmental benefits, minimal environmental impacts, and is relatively affordable. We understand that the City of Savannah supports alternative number 22, and will be the local sponsor for this very important project.

Sincerely,

Lonice C. Barrett
Commissioner

LCB:njb

cc: Harold Reheis
David Waller
Harry Jue
Keith Parsons

RESPONSE - - Georgia Department of Natural Resources
Commissioner
January 26, 1996.

1. FINALIZATION OF THE REPORT AND IMPLEMENTATION OF ALTERNATIVE NUMBER 22. Concur. Alternative 22 is the selected alternative.

Georgia Department of Natural Resources

205 Butler Street, S.E., Suite 1152 East Floyd Tower, Atlanta, Georgia 30334
Lonice C. Barrett, Commissioner
Harold F. Reheis, Director
David Word, Assistant Director
Environmental Protection Division
404/656-4713

February 9, 1996

Colonel Grant M. Smith
District Engineer
U.S. Army Corps of Engineers
P. O. Box 889
Savannah, Georgia 31402-0889
ATTN: Mr. M. J. Yuschishin

RE: Water Quality Certification
Public Notice Draft EA
Lower Savannah River Basin Environmental
Restoration Feasibility Report
Effingham County

Dear Colonel Smith:

Pursuant to Section 401 of the Federal Clean Water Act, the State of Georgia issues this certification to the Savannah District, U.S. Army Corps of Engineers, an applicant for a Federal permit or license to conduct an activity in, on or adjacent to the waters of the State of Georgia.

The State of Georgia certifies that there is no applicable provision of Section 301; no limitation under Section 302; no standard under Section 306; and no standard under Section 307, for the applicant's activity. The State of Georgia certifies that the applicant's activity will comply with all applicable provisions of Section 303.

This certification is contingent upon the following conditions:

1. All work performed during construction will be done in a manner so as not to violate applicable water quality standards.

2. No oils, grease, materials or other pollutants will be discharged from the construction activities which reach public waters.

It is your responsibility to submit this certification to the appropriate Federal Agency.

Sincerely,

Harold F. Reheis

Harold F. Reheis
Director

HFR:kpr

cc: Mr. Nick Ogden
Mr. Mike Gennings
Mr. Tom Welborn

RESPONSE - - Georgia Department of Natural Resources
Environmental Protection Division
February 9, 1996.

WATER QUALITY CERTIFICATION IS CONTINGENT UPON THE FOLLOWING CONDITIONS:

1. ALL WORK PERFORMED DURING CONSTRUCTION WILL BE DONE IN A MANNER SO AS NOT TO VIOLATE APPLICABLE WATER QUALITY STANDARDS. Concur. **Construction activities would have only temporary and localized impacts on water quality. Appropriate measures have been incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the construction project. Erosion control measures would be used during construction to minimize impacts to water quality.**

2. NO OILS, GREASE, MATERIALS OR OTHER POLLUTANTS WILL BE DISCHARGES FROM THE CONSTRUCTION ACTIVITIES WHICH REACH PUBLIC WATERS. Concur. **All necessary precautions will be taken during construction activities to avoid discharges of pollutants into the water.**

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Mr. Nicholas Ogden
Chief Regulatory Branch
Savanah District, Corp. of Engineering
P.O. Box 889
Savanah, GA 31402

FROM: Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

DATE: 1/9/96

SUBJECT: Executive Order 12372 Review

APPLICANT: Georgia DNR & South Carolina DHEC

PROJECT: EA/FONSI: Lower Savannah River Basin

FEDERAL ID:

STATE ID: GA960109003

A copy of the Public Notice Permit Request, Environmental Information, or Direct Federal Development project was received by the Georgia State Clearinghouse on 1/9/96. The review has been initiated and every effort is being made to ensure prompt action. The review will focus on the projects compatibility with those state or regional goals, policies, plans, criteria for Developments of Regional Impact (DRI), environmental impacts, or inconsistencies with federal executive orders, acts and/or rules and regulations administered by the state and local units of government. The initial review process should be completed by (date 28 days later).

If the Clearinghouse has not contacted you by that date your proposal may be considered consistent. In that event, make this receipt part of the federal record for this project.

In future correspondence regarding this project, please include the State Application Identifier shown above. If you have questions regarding this project, please contact us at (404) 656-3855.

OFFICE OF PLANNING AND BUDGET

ZELL MILLER
GOVERNOR

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TIM BURGESS
DIRECTOR

TO: Nicholas Ogden
Department of the Army/USCOE
P.O. Box 889
Savannah, GA 31402-0889

FROM: Tripp Reid, Administrator/Barbara L. Melvin
Georgia State Clearinghouse

DATE: 2/2/96

SUBJECT: Executive Order 12372 Review

PROJECT: EA/FONSI: Lower Savannah River Basin

STATE ID: GA960109003

FEDERAL ID:

The State level review of the above referenced Public Notice/Permit Request has been completed. This request has been found to be consistent with State goals, policies, plans, objectives, and programs, with which the State is concerned.

Additional Comments:

None.

TR/blm

RESPONSE - - Office of Planning and Budget
Georgia State Clearinghouse
February 2, 1996.

1. PROJECT IS CONSISTENT WITH STATE GOALS, POLICIES, PLANS, OBJECTIVES, AND PROGRAMS. Concur.

The Georgia Conservancy

COASTAL OFFICE: 711 Sandtown Road, Savannah, Georgia 31410 • 912-897-6462 • Fax: 912-4 70

January 26, 1996

Col. Grant M. Smith
Distrist Engineer
Attn: Ana Vergara PD-E1
U.S. Army Corps of Engineers
P.O. Box 889
Savannah, GA 31402

Re: Lower Savannah River Basin Environmental Restoration Study and Draft Feasibility Report.

Dear Col. Smith:

The Georgia Conservancy is a nonprofit organization of almost 10,000 people dedicated to the responsible stewardship of Georgia's vital natural resources. We strive to balance the demands of social and economic progress with our commitment to protect the environment. We appreciate the opportunity to provide the following comments on the proposed restoration of the Lower Savannah River Basin.

We strongly support the progressive efforts of the Corps of Engineers (COE) Savannah District in seeking environmental restoration projects in the Lower Savannah River Basin and elsewhere. The thorough work of the Planning Division on this and other projects, resulting in benefits to the natural and economic resources of Georgia, must be applauded.

After a long-term and lengthy evaluation of alternatives, the COE has submitted two specific alternatives (#22 and #36) for consideration regarding restoration in the study area. The study area, a large portion of which is located within the boundaries of the Savannah National Wildlife Refuge, includes cutoff bends #4 and #3 in the Savannah River, as well as three smaller watersheds (Mill Creek, Raccoon Creek and Bear Creek).

Alternative #36 would result in the maximum benefits in fish habitat and bottomland hardwood functional values by addressing restoration of the entire study area. Certain losses in value would result from dredging of the old channel affected by cutoff bend #4. Alternative #22 would result in little more than half of the environmental benefits, and does not include changes to the hydraulics of cutoff bend #4.

The document states (page A-12) that:

> "It was determined that any project in this area should provide for navigation."

The higher cost for alternative #36 is due to dredging for navigation interests. While actual and potential needs for navigation above the Savannah Harbor were solicited from various organizations (Appendix J), no economic analysis is included to justify public subsidies for such dredging activities. The principle reason given for #22 as the preferred alternative is the lower cost, and the lack of a local sponsor willing to take responsibility for the cost of dredging.

Clearly, without the cost of dredging for navigation, alternative #36 would be feasible, thus reaping the maximum benefits to the natural resources that were damaged when cuts were constructed in the river. <u>Navigation needs should be continually assessed as the project moves forward. Navigation interests should also be considered for a local sponsor to fund the dredging if dredging is justified</u>.

Until an economic analysis is performed that adequately justifies publicly funding dredging for private navigation purposes, the adoption of Alternative #36 - as set forth in the report and study - is unwarranted. <u>In conclusion, the Conservancy supports Alternative #36, excluding dredging for navigation at this time, and urges that restoration move forward</u>. Thank you for your consideration of these comments. Should you have any questions, please do not hesitate to contact me in the coastal office.

Sincerely,

Rebecca R. Shortland
Vice President for Coastal Programs

c: Mr. Ed Eudaly, U.S. Fish & Wildlife Service
Mr. Sam Drake, U.S. Fish & Wildlife Service
Mr. Carl Hall, GA Dept. of Natural Resources, Wildlife Resources Division
Carolyn Boyd Hatcher, Pres. & CEO
S. Wesley Woolf, VP Environmental Policy

RESPONSE - - The Georgia Conservancy
Coastal Programs
January 26, 1996.

Paragraph 7: IN CONCLUSION, THE CONSERVANCY SUPPORTS ALTERNATIVE #36, EXCLUDING DREDGING FOR NAVIGATION AT THIS TIME... Restoration of the cutoff bends, without providing a minimum level of navigation, was considered early in the planning process. Dredging would be needed even if navigation is not considered. When addressing full closure of cut 4 without dredging a channel through the old bend, the hydraulic modeling yielded high velocities and an unstable water surface. Future conditions of the adjacent wetland areas were unpredictable. There was a strong possibility of a meandering channel in the bend which could cut its way across the cutoff island. To avoid this situation, a restoration channel was then considered for the cutoff bend. The initial design proposed a restoration channel using the existing configuration of the bend. In order to accomodate all the flow from the main river into the already filled bend and to avoid possible unstable hydraulic conditions and uncontrolled erosion, the dimensions for this channel would have to be similar in width and depth as the main channel. Cutoff bend 4 is a long bend with large amounts of sediments accumulated. This represented a significant amount of material to be dredged. In the specific case of cutoff bend 4, the channel would be following the existing configuration of the bend providing the expected environmental restoration of the adjacent wetlands and creeks and, at the same time, it would provide for a minimum level of navigation. The higher cost for alternative 36 is due to the dredging activity that would be needed in order to accommodate all the flow from the main river into the cutoff bend, the construction of an upland disposal site, and the closure structure on cut 4. These actions would be needed even without providing for navigation.

Fort Howard

Fort Howard Corporation • P.O. Box 19130 • Green Bay, WI 54307-9130 • 414-435-8821

January 24, 1996

District Engineer
Department of the Army
Savannah District Corps of Engineers
P. O. Box 889
Savannah, GA 31402-0889
ATTN: Ms. Ana Vergara (PD-EI)

RE: Comments to the Draft Environmental Assessment for the proposed Environmental Restoration of Cutoff Bends 3 & 4 and Mill Creek.

Dear Ms. Vergara:

Fort Howard Corporation ("Fort Howard or the "Company") appreciates the opportunity to comment on the November 1995 Draft Environmental Assessment (the "Assessment") for the proposed environmental restoration of Cutoff Bends 3 and 4 of the Lower Savannah River (the "Savannah Restoration Project") as prepared by the Environmental Resources Branch of the U.S. Army Corps of Engineers for the Savannah District (the "COE").

Fort Howard is a major manufacturer and converter of sanitary paper products such as toilet tissue, napkins, and paper towels. The Company's basic raw material, pulp, is produced on-site using a proprietary process which recycles thousands of tons of wastepaper per day. Fort Howard believes it is the largest producer of tissue products sold into the commercial (away-from-home) market. It has three domestic facilities: one each located in Green Bay, Wisconsin; Muskogee, Oklahoma; and, Rincon, Georgia. The Rincon, Georgia mill represents an investment of over $750,000,000 and is a workplace to over 1,100 employees. That mill consists of four state-of-the-art paper machines, converting equipment and an on-site power generation facility. In addition, an outfall/intake structure and dock servicing the mill is located at River Mile 42, approximately one mile upstream of Cutoff Bend 4. The following is the Company's comments to the Assessment.

Fort Howard Supports Alternative 22

The COE identified 36 alternatives with respect to the Savannah Restoration Project. The COE then narrowed this list to alternatives nos. 16, 22, 24, 32, 36, and "no-action" for a more detailed analysis. Based on that, the COE tentatively selected Alternative No. 22 as the preferred alternative for the Savannah Restoration Project. If the COE concludes there is need for any restoration project, Alternative 22 is certainly the preferred project. Based upon the discussion in the Assessment, Alternative 22 meets all of the goals of the restoration project in the most cost-effective manner. That alternative does not require any upland disposal of dredge materials. It would increase the flow of fresh water to the Savannah's municipal and industrial fresh water intake facility and it would help restore environmentally significant areas.

Continued Navigation of the Savannah River is Important to the Future Viability of Fort Howard's Rincon Mill and Must Be Maintained

As we stated in prior comments, it is Fort Howard's position that the Savannah River remain navigable to the fullest extent possible. Paper machines at the Company's Rincon mill contain huge parts that can be transported economically by barge. In addition, coal and other petroleum-based fuels are burned in large quantities at the Rincon mill. Any activity that could hinder the ability to ship these materials by barge to the mill could increase the cost of these critical raw materials. The Company is pleased that the COE has maintained throughout the Savannah Restoration Project that continued navigability is of utmost importance. The implementation and effect of any restoration project must maintain that goal.

Reduction of DO Concentration in the Savannah River Must Be Temporary, Minimized and Not Lead to Reductions in Permitted BOD Discharge Levels.

The Environmental Assessment makes reference to possible reductions in dissolved oxygen ("DO") concentrations in the Savannah River during the construction of the Savannah Restoration Project. Any reductions below the applicable instream DO standard must be short term and minimized to the fullest extent possible. Any prolonged reductions below standards should be critically analyzed and understood prior to construction. Fort Howard is concerned that any DO reductions not impact present NPDES permits. We have designed, built and operated the Rincon mill with the full expectation that the present BOD permitted discharge levels remain the same.

Many Questions Regarding an Upland Disposal Facility Remain Unanswered

Selection and implementation of Alternative No. 36 requires an upland disposal facility for dredged materials. According to the Assessment, the area tentatively identified for the upland facility is within the Rincon mill plant site. No specifics are provided in the Assessment with respect to the design, operation, impacts on the Rincon mill or cost of this facility. In the event the COE no longer views Alternative 22 as its preferred approach and decides to revisit Alternative No. 36, these types of critical questions must be carefully analyzed and considered.

In conclusion, if the COE ultimately decides that some restoration activity is necessary, it should implement Alternative 22. That alternative appears to be the most cost-effective one while still meeting the goals of the project. In addition, Fort Howard is pleased to see that the COE acknowledges that, whatever alternative is selected, the Savannah River must remain navigable and DO levels be maintained above standards to the maximum extent possible. If you have any questions with respect to these comments, please fee free to contact me at 414/435-8821, ext. 2406.

SINCERELY,
FORT HOWARD CORPORATION

Mark S. Reimer
Attorney

RESPONSE – Fort Howard Corporation
January 24, 1996.

1. REDUCTION OF DO CONCENTRATION IN THE SAVANNAH RIVER MUST BE TEMPORARY, MINIMIZED AND NOT LEAD TO REDUCTIONS IN PERMITTED BOD DISCHARGE LEVELS. Alternative 22 would have lees impact on DO concentrations than the other four alternatives. Dredging actions would be limited to the construction of the new entrance into Mill Creek, constriction and realignment of the mouth of cutoff bend 3, and excavation of fill material within the cutoff bend to fill behind the sheet pile wall and plug. No confined upland disposal areas would be needed. Reduction of DO concentration in the Savannah River are expected to be temporary and minimal during project construction.

2. PROPOSED UPLAND DISPOSAL AREA FOR ALTERNATIVE 36. Environmental impacts of the proposed upland disposal area for alternative 36 are discussed in Sections 6.08-6.10, 6.24, 6.30, and 6.34. of the EA prepared for this project. Specifics about the design and operation of the proposed disposal area for this alternative are discussed in the Engineering Appendix. The selected plan would not require an upland disposal site.

ENCLOSURE 9

WATER QUALITY CERTIFICATIONS

Georgia Department of Natural Resources
205 Butler Street, S.E., Suite 1152 East Floyd Tower, Atlanta, Georgia 30334
Lonice C. Barrett, Commissioner
Harold F. Reheis, Director
David Word, Assistant Director
Environmental Protection Division
404/656-4713

February 9, 1996

Colonel Grant M. Smith
District Engineer
U.S. Army Corps of Engineers
P. O. Box 889
Savannah, Georgia 31402-0889
ATTN: Mr. M. J. Yuschishin

RE: Water Quality Certification
Public Notice Draft EA
Lower Savannah River Basin Environmental
Restoration Feasibility Report
Effingham County

Dear Colonel Smith:

Pursuant to Section 401 of the Federal Clean Water Act, the State of Georgia issues this certification to the Savannah District, U.S. Army Corps of Engineers, an applicant for a Federal permit or license to conduct an activity in, on or adjacent to the waters of the State of Georgia.

The State of Georgia certifies that there is no applicable provision of Section 301; no limitation under Section 302; no standard under Section 306; and no standard under Section 307, for the applicant's activity. The State of Georgia certifies that the applicant's activity will comply with all applicable provisions of Section 303.

This certification is contingent upon the following conditions:

1. All work performed during construction will be done in a manner so as not to violate applicable water quality standards.

2. No oils, grease, materials or other pollutants will be discharged from the construction activities which reach public waters.

It is your responsibility to submit this certification to the appropriate Federal Agency.

Sincerely,

Harold F. Reheis
Director

HFR:kpr

cc: Mr. Nick Ogden
Mr. Mike Gennings
Mr. Tom Welborn

ENCLOSURE 10

FEDERAL CONSISTENCY DETERMINATION

South Carolina
DHEC
Department of Health and Environmental Control
4130 Faber Place, Suite 300
Charleston, SC 29405

Promoting Health, Promoting the Environment

Office of Ocean and Coastal Resource Management
H. Wayne Beam, Ph.D., Deputy Commissioner | *Christopher L. Brooks, Assistant Deputy Commissioner*

(803) 744-5838 | *(803) 744-5847 (fax)*

March 16, 1996

Ms. Anna Vergara
U. S. Army Corps of Engineers
Savannah District
Post Office Box 889
Savannah, Georgia 31402-0889

Re: Restoration of Cutoff Bends 3 and 4
Jasper County
Federal Consistency

Dear Ms. Vergara:

The staff of the Office of Ocean and Coastal Resource Management (OCRM) certifies that Alternative 22 is consistent with the Coastal Zone Management Program. This certification shall serve as the final approval by the OCRM.

Interested parties are provided ten days from receipt of this letter to appeal the action of the OCRM.

Sincerely,

Robert D. Mikell
Director of Planning and
Federal Certification

JM
JHA/23352/jk

cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Mr. H. Stephen Snyder

Federal Consistency Determination
for the
Lower Savannah River Basin Environmental Restoration Project

1. SUMMARY DETERMINATION

The Federal Coastal Management Act (CZMA), 16 U.S.C. §§ 1451 et seq., as amended, requires each Federal Agency activity within or outside the coastal zone to be carried out in a manner consistent to the maximum extent practicable with the enforceable policies of approved state management programs. A Federal activity is defined as any function, including planning and/or construction of facilities, that is performed on behalf of a Federal agency in the exercise of its statutory responsibilities.

The information contained in this consistency determination is derived largely from the December 1996 draft Environmental Assessment for the proposed Lower Savannah River Basin environmental restoration of cutoff bends 3 & 4 and Mill Creek, Effingham County, Georgia and Jasper County, South Carolina.

In accordance with the CZMA, 16 U.S.C. § 1456 (c), Savannah District U.S. Army Corps of Engineers has determined that the proposed environmental restoration project would be carried out in a manner which is, to the extent practicable, consistent with the enforceable policies of the South Carolina Coastal Management Program. Section 2 describes the proposed project, while Section 4 describes the evaluation factors which were consider prior to reaching this determination.

2. DESCRIPTION OF THE PROPOSED ACTIVITY

The proposed project is the environmental restoration of cutoff bends 3 and 4 on the Savannah River, located approximately at River Mile 41, to increase water flows in Bear Creek, Little Abercorn Creek, Mill Creek, and the surrounding wetlands. Average Annual Habitat Units which would be created by implementation of the proposed project were calculated. A functional index of wetland value was developed to estimate the impact of restoration activities on bottomland hardwoods.

Restoration will include the partial or full closure of the navigation cuts and restoration of flow to the entrance of Mill Creek and Bear Creek. The creeks that originate in the cutoff bends and Mill Creek flow in Georgia through the Savannah National Wildlife Refuge and eventually discharge into Abercorn Creek.

Two (2) Final Restoration-Alternatives (Alternatives #22 and #36) have been identified which best accomplish the environmental restoration of cutoff bends 3 and 4 and Mill Creek.

• Alternative #22 includes a large diversion structure and narrow approach channel to the mouth of Bear Creek in cutoff bend 3, with no dredging in the cutoff bend. It also includes realignment and restoration of the mouth of Mill Creek. This alternative does not include any restoration of cutoff bend 4 and, therefore, construction of an upland confined dredged material disposal site is not needed. It would provide a substantial increase in flows in Bear Creek and Mill Creek, although there would be no improvement of flows from cutoff bend 4 to Flat Ditch Creek and Raccoon Creek. Total flows in those creeks would increase from the current 45.8 cfs to 116.8 cfs, which is equal to 66 percent of the maximum attainable flows. This alternative would provide substantial restoration of the Bear Creek zone (2,367 acres) and Mill Creek zone (708 acres), but would not restore the Raccoon Creek zone (1,633 acres). Alternative #22 represents the optimum investment of Federal and non-Federal funds for environmental restoration, with a gain of 56 percent of maximum attainable restoration benefits at a cost of only 28 percent of the most expensive alternative.

• Alternative #36 includes a large diversion structure and narrow approach channel to the mouth of Bear Creek in cutoff bend 3, and a slackwater channel in the remainder of the bend. A full closure structure would be constructed at navigation cut 4 and a navigation channel dredged in cutoff bend 4. The mouth of Mill Creek would be realigned and restored. Confined upland disposal and placement of the dredged material behind the closure structure in cut 4 would be included. Approximately 468,000 cubic yards of material would be dredged for this alternative. It would provide a total of 176.9 cfs in the creeks, the maximum attainable flow, through restoration of cutoff bend 4 and creek flows from cutoff bend 4. Alternative #36 provides the maximum attainable restoration benefits, providing a net increase of 1,848 average annual habitat units of fish habitat and a net increase of 3,498 average annual units of bottomland hardwood functional value.

Tentatively Recommended Restoration Alternative: If an additional sponsor could be identified who would fund the incremental cost share between Alternatives #22 and #36, Savannah District would prefer to select Alternative #36 as the Recommended Alternative. However, in the absence of such local cost sharing support, the District has selected Alternative #22 as the Tentatively Recommended Restoration Alternative for the Lower Savannah River Basin.

Construction of Final Restoration Alternatives: Access to the construction site is limited to water transportation. All equipment, construction material, and personnel were assumed to mobilize/demobilize from the vicinity of the Ocean Terminal docking facility in Savannah, Georgia. Waterfront access in the project vicinity are extremely limited and would not be provided to the contractor, except at the construction sites where upland construction is required, such as at the closure structure tie-in. Land access to the construction sites would be limited to the areas immediately adjacent to the work areas. No staging areas would be provided, with the exception of construction of the relocation of the entrance to Mill Creek.

A barge-mounted clamshell would place the stone for construction of the partial and full closure structures at the cuts. After completion of the closure structures, the areas above water would be covered with topsoil and seeded. Sheetpiling would be installed by a barge-mounted pile driver. Concrete articulated mattresses would be used for streambank erosion control. The mattresses would be constructed on barges and lowered into place.

An 18" hydraulic pipeline dredge would remove the material for the dredging of the slackwater channel on cutoff bend 3 and the navigation channel on cutoff bend 4. Dredged material from the slackwater channel (Approx. 93,000 c.y.) would be placed behind the closure structure in cut 4 to partially fill the cut. A temporary sheet pile wall would be placed on the downstream end of the cut to contain the hydraulic fill. Effluent from this area would be released through a weir to the Savannah River.

Material dredged from construction of the navigation channel on cutoff bend 4 (468,000 c.y.) would be placed in a new upland confined disposal area which would be constructed for Alternative #36. The proposed upland disposal area would be located on Fort Howard Paper Company property. The proposed site for the confined upland disposal area is an 85-acre area located west of the dredging site. A 15-foot easement would be required along an existing dirt road between the disposal site and the front entrance of the Fort Howard property. Two additional easements, each 20-foot wide, would be required for pipeline access to the disposal site and pipeline discharge between the disposal area and Mill Creek. After settling time, effluent from this site would be released through a weir to Mill Creek.

3. CONSISTENCY EVALUATION

Savannah District performed an evaluation of the proposal's consistency with the South Carolina Coastal Management Program. This document addresses each of the major policy issue outlined in the manual titled, South Carolina Coastal Council Guidelines and Policies of the South Carolina Management Program which applies to this project. In the following paragraphs, the section from the South Carolina manual is indicated in quotes, followed by the District's response.

3.01 "DEFINITION: ACTIVITIES WITH A "DIRECT AND SIGNIFICANT IMPACT" (Chapter III. pg. III-12)

An activity is considered to have direct and significant impact on coastal waters and therefore is subject to management in the coastal zone if it entails one or more of the following criteria:

1) located in a critical area;

2) detrimental environmental impact upon a critical area (for example, water pollution upstream from an inland source which would then reach and result in degradation of the estuarine system);

3) adverse effects on the quality or quantity of coastal resources - natural, economic, social or historical;

4) disruption of access to a public coastal resource."

3.02 This project would have a direct but not significant impact on coastal waters, is not located in a critical area, and would not have an adverse effect upon a critical area or on the quality and quantity of coastal resources. This project would have a positive impact on wetlands and wildlife habitats. There would be no disruption of access to a public coastal resource from implementation of this project.

3.03 "GENERAL GUIDELINES FOR EVALUATION OF ALL PROJECTS (Permitting and Certification of Other Permits) (Chapter III.D.3. pg.III-14)

I. In review and certification of permit applications in the coastal zone, the Coastal Council will be guided by the following general considerations (apply to erosion control and energy facility projects, as well as activities covered under Activities subject to Management):

3) The extent to which the project will protect, maintain or improve water quality, particularly in coastal aquatic areas of special resource value, for example, spawning areas or productive oyster beds."

3.04 The proposed project would allow the natural flow regime to resume in the cutoff bends, creeks and wetland areas, thereby restoring the environmental and wildlife habitat and the wetland functional value of 4,708 acres of to conditions which existed similar to the pre-navigation project. The new flow regime would increase the diversity and productivity of fish and wildlife habitat in the Lower Savannah River. Modifications to the entrance of Mill Creek on the Savannah River would increase flow to wetland areas along that creek. Frequency and duration of overbank flooding along the creeks would increase with the restoration project. Restoration of flow to Bear Creek would provide an additional benefit of improving the quality and quantity of water used by the City of Savannah.

3.05 "4) The extent to which the project will meet existing State and Federal requirements for waste discharges, specially point sources of air and water discharge, and for protection of inland wetlands."

3.06 Dredging would occur with implementation of Alternative 36. An increase in turbidity due to the dredging operations would be expected to occur during construction. The turbidity plumes generated at the dredge sites during hydraulic dredging for any of the alternatives are expected to produce only minimal and temporary impacts to aquatic species. Water levels would be managed within the confined disposal facility to obtain the settling time necessary to produce an effluent with the minimum level of suspended solids. The weir effluent from the disposal site on cut 4 would have a higher turbidity during construction than from the upland disposal site. Turbidity level from the disposal site would be 1,000 mg/l. Impacts to fish would be expected from this operation. This impact would be temporary and diminish over time. Placement of baffles to maximize retention time and removal of most of the suspended solids for this disposal area would be considered if this alternative is finally selected.

3.07 Wetlands would be protected to the extent practicable. The proposed alternatives would result in minimal direct loss of wetland and associated values if compared to the average functional values that would be gained from the implementation of the restoration project.

3.08 "5) The extent to which the project includes consideration for the maintenance or improvement of the economic stability of coastal communities."

3.09 The proposed environmental restoration project will provide a minimum level of navigation in order to maintain a contiguous navigable channel within the authorized navigation project. Although dredging and snagging of the authorized project was discontinued in 1981, the river remains navigable about 60 percent of the time. The industries which still use the river for transportation essentially do not have feasible alternate modes of transportation. There are indications that commerce may increase as the cost of other transportation modes becomes excessive. Barging interests who use the Savannah River for commercial navigation have expressed concern that the river be maintained for navigation. Although the amount of barge traffic has gradually declined over the years, the remaining traffic considers the navigation channel to be critical for their present and future operations.

3.10 "7) The possible long-range, cumulative effects of the project, when reviewed in the context of other possible development and the general character of the area."

3.11 Modifications to the natural flow regime from construction of the navigation channels and reservoirs in the Piedmont during the past 50 years, have caused degradation and loss of the forested wetlands along the lower Savannah River. The cutoff bends have been impacted by heavy sedimentation since the navigation modifications in 1962. The fill rate of the cutoff bends is linear and most of the fish habitat in cutoff bends will be completely eliminated in less than 15 years.

3.12 The proposed project would provide significant habitat unit benefits due to the large amount of bottomland hardwood habitat restored in cutoff bends 3 & 4, Mill Creek and the substantial additional flow into the other creeks. Water quality and quantity at the Savannah water intake would improve gradually as a result of the proposed project. The increase in habitat units and benefits to the bottomland hardwoods, along with a more constant water quality, are expected to improve wildlife habitat in the area. This would provide more recreation opportunities for fishing, hunting, and wildlife observation in the future.

3.13 "8) The extent and significance of negative impacts on Geographic Areas of Particular Concern (GAPCs). The determination of negative impacts will be made by the Coastal Council in each case with reference to the priorities of use for the particular GAPC. Applications which would significantly impact a GAPC will not be approved or certified unless there are no feasible alternatives or an overriding public interest can be demonstrated, and a substantial environmental impact is minimized."

3.14 The proposed project would not significantly impact any Geographic Area of Particular Concern.

3.15 "9) The extent and significance of impact on the following aspects of quality or quantity of these valuable coastal resources:

i) unique natural areas - destruction of endangered wildlife or vegetation or of significant marine species, degradation of existing water quality standards;"

3.16 Dredging can adversely affect endangered species, such as the shortnose sturgeon, which occur in the Savannah River. Based on the information about the species' general pattern of seasonal movement and known feeding areas, the dredging operation at cutoff bends 3 and 4 is not likely to affect the shortnose sturgeon. This issue is addressed in detail in the draft EA (Enclosure 1 - Biological Assessment of Threatened and Endangered Species).

3.17 Savannah District has contacted the states of Georgia and South Carolina regarding water quality certification. The proposed project is not expected to have a significant adverse impact on water quality.

3.18 ii) public recreational lands - conversion of these lands to other uses without adequate replacement or compensation, interruption of existing public access, or degradation of environmental quality in these areas;"

3.19 The proposed project would not adversely affect public recreational lands.

3.20 iii) historic or archaeological resources - irretrievable loss of sites identified as significant by the S.C. Institute of Archaeology and Anthropology or the S.C. Department of Archives and History without reasonable opportunity for professional examination and/or excavation, or preservation."

3.21 Intensive shovel testing along the river banks and on the cutoff islands showed no artifacts or archaeological sites within the boundaries of the project. No impacts to cultural resources would occur from the disposal area construction and operation. Cultural resources discovered in the future within the area of operation and management of the Restoration Project would be addressed in conformance to existing laws.

3.22 "10) The extent to which the project is in the national interest."

3.23 Programs have been developed to restore and protect wetland resources at the local, state and Federal levels of government. At the Federal Level, the President of the United States established the goal of "no net loss of wetlands" adapted from the National Wetlands Policy Forum recommendations (1988). Most of the forested wetlands in the southern United States lie in the coastal plain. The study area is one of the largest blocks of palustrine forested wetlands in the State of Georgia. A portion of the ecosystem which would benefit from the environmental restoration project is within the Federal Savannah National Wildlife Refuge. Increasing flows through the creeks and adjacent bottomland hardwoods would benefit those resources and increase their environmental value. Therefore the proposed project fully supports the "no net loss" goal and provides an opportunity to restore and protect this valuable resource from further degradation and loss.

3.24 Specific South Carolina Management Program Policy Applicable to the review of these documents.

3.25 VII. WILDLIFE AND FISHERIES MANAGEMENT (Chapter III, Policy Section III, p. III-51)

A. Wildlife and Fisheries Management Policies:

(1) In the coastal zone, Council issuance or review and certification of permit applications which would impact wildlife and fisheries resources will be based on the following policies:

(b) Wildlife and fisheries stocks and populations should be maintained in a healthy and viable condition and these resources should be enhanced to the maximum extent possible."

(c) Critical wildlife and fisheries habitat should be protected and enhanced to the extent possible."

3.26 No significant adverse impacts are anticipated by the implementation of this project. Fisheries habitat will benefit from implementation of the proposed project, as demonstrated by the increase in Average Annual Habitat Units resulting from each final alternative. Wildlife species would benefit as the health of bottomland hardwood vegetation is improved.

3.27 "VIII. DREDGING (Chapter III, Policy Section VIII, pg. III-55)

A. Dredging Policies:

(1) In the coastal zone, Council review and certification of permit applications for dredging projects will be based on the following policies:

(b) Suspended sediments must be kept to a minimum. The use of structures such as weirs and silt curtains to minimize water quality degradation is encouraged. Where highly toxic sediments are encountered, dredging will be prohibited unless the activity is consistent with other dredging policies, as well as those for manufacturing or other industrial activities."

3.28 This issue was partially-addressed in Section 3.06. Chemical analysis of sediments to be dredged have been found to be free of chemicals in toxic amounts.

3.29 "(c) Dredging should not reduce water circulation, water currents, mixing, flushing or salinity in the immediate area;"

3.30 Construction of a partial and full closure structures on the navigation cuts and dredging operations related to the proposed navigation channel in cutoff bend 4 and slack water channel in cutoff bend 3, are not expected to impact these factors appreciably, although current velocities would theoretically decrease after the dredging event due to the increase in cross-sectional area of the channel. Increasing flows in the creeks leading off the cutoff bends would result in more flushing of those creeks, thereby increasing the quality of water found in these areas.

3.31 "(d) Dredging and excavation shall not create stagnant water conditions, lethal fish entrapments, or deposit sumps or otherwise contribute to water quality degradation;"

3.32 The proposed project would not create such problems, but would improve fish habitat in the area. Minor temporary impacts to dissolved oxygen are expected from the dredge plume.

3.33 "(e) Designs for dredging and excavation Projects shall, where feasible, include protective measures such as silt curtains, diapers and weirs to protect water quality in adjacent areas during construction by preventing the dispersal of silt materials;

(f) Dredged materials shall be deposited and contained in such a manner so as to prevent dispersal into adjacent wetland areas.

(I) Wetlands shall not be utilized as depositories for waste materials except as discussed in R. 30 - 12 (I)."

3.34 If Alternative 36 is finally selected, all dredged material from the navigation channel in cutoff bend 4 (375,00 c.y. approx.) would be placed in a confined upland disposal area. Dredged material from the slackwater channel in cutoff bend 3 (93,000 c.y.) would be placed behind the closure structure in cut 4 to partially fill the cut. This activity would not result in a permanent adverse impacts to adjacent vegetated wetlands. The 2.3 acres identified as wetlands in the proposed upland disposal area would be eliminated through the construction. These wetlands are isolated and have already been impacted by pine plantation activities. Construction of fire break roads and access to the area have modified the hydrology of the area over the years. These wetlands exhibit effects of a more drier regime and upland species succession and are therefore of reduced ecological value. The direct loss of these wetlands and associated values is considered minimal if compared to the average functional values that would be gained from the implementation of the restoration project. An estimated 420 c.y. would be excavated from the new entrance to Mill Creek. This material would be used to obstruct the adjacent portion of the existing creek channel. No significant impacts to adjacent wetlands are expected from this activity. Alternative 22 would not require an upland disposal area. Filling cut 4 behind the closure structure, as proposed in Alternative 36, would not impact adjacent wetlands.

3.35 "(j) In all cases, dredging activities shall not be approved until satisfactory disposal sites have been acquired. (R. 30 - 12 (G)."

3.36 The proposed upland disposal area would be located on Fort Howard Paper Company property in Effingham County, Georgia. A real estate contract with the paper company would be in place before construction if Alternative 36 is selected.

3.37 "B. Dredged Material Disposal Policies:

(b) Open water and deep water disposal should be considered as an alternative if highland alternatives are not feasible. However, open and deep water disposal sites should be seriously considered only after careful consultation with the Council and other relevant State and Federal agencies."

3.38 Only sediments removed from the slackwater channel (93,000 c.y.) in Alternative 36 are considered for placement in open water behind the closure structure to partially fill cut 4.

3.39 "(c) Dredged materials containing hazardous levels of toxic material must be disposed of with extraordinary caution. These materials should never be disposed of in wetland areas and only in highland areas which are lined and diked with impervious materials. These materials will only be disposed in open water ocean dumping sites when maximum safety has been demonstrated after thorough review by the Coastal Council and other appropriate state and Federal agencies."

3.40 The District has reviewed sediment testing data from cutoff bends and cuts 3 & 4. The findings of that evaluation are contained in Enclosure 6 in the draft EA. In summary, the dredged materials do not contain hazardous levels of any toxic material.

3.41 "D. Public Open Space Policies:

The Coastal Council will apply the following policies in review and certification of permit applications located in or which would directly affect open space areas:

(1) Project proposals which would restrict or limit the continued use of a recreational open area or disrupt the character of such a natural area (aesthetically or environmentally) will not be certified where other alternatives exist."

3.42 The proposed project would have no adverse impacts on the Savannah National Wildlife Refuge, but would instead benefit habitats within the Refuge. Implementation of this project would result in restoration of wetlands adjacent to the Lower Savannah River and would enhance fish and wildlife-habitat and water quality. The Refuge would be a direct and very important beneficiary from the proposed project. The expected increase in duration and depth of flooding in wetland tributaries that feed the Savannah National Wildlife Refuge would increase flushing of detritus and nutrients from the wetlands. Bottomland hardwoods and their accompanying wildlife habitat would be maintained and enhanced from this action.

3.43 Adverse impacts to recreation activities would be concentrated around the immediate project area during construction activities. After project implementation, extensive opportunities for fishing, boating, and hunting would be provided as fish and wildlife habitat improve as a result of this action.

4.00 DATE OF AGENCY'S FINAL DECISION. The Savannah District is scheduled to make its final decisions by March 4, 1996 concerning completion of Final Report and Environmental Assessment for the Environmental Restoration of Cutoff Bends 3 and 4 and Mill Creek.

APPENDIX B

FISH AND WILDLIFE COORDINATION REPORT
ON
LOWER SAVANNAH RIVER BASIN STUDY

Prepared by:
Edwin M. EuDaly

Under the Supervision of
Roger L. Banks, Field Supervisor
Division of Ecological Services
Charleston, South Carolina

February 1996

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. Box 12559
217 Fort Johnson Road
Charleston, South Carolina 29422-2559

February 8, 1996

Colonel Grant M. Smith
District Engineer
U.S. Army Corps of Engineers
Post Office Box 889
Savannah, Georgia 31402-0889

Dear Colonel Smith:

The enclosed Final Fish and Wildlife Coordination Act (FWCA) Report evaluating the Lower Savannah River Restoration Study, Effingham County, Georgia, and Jasper County, South Carolina, is submitted in fulfillment of the FWCA [48 Stat. 401, as amended; 16 U. S. C. 661 et seq.; Section 2(b)]. In January 1996, a draft of this report was coordinated with the National Marine Fisheries Service, the Georgia Department of Natural Resources and the South Carolina Department of Natural Resources. All of these agencies concurred with the report and supported its recommendations. In accordance with the FWCA, this report should be attached to and made an integral part of the Corps' Final Feasibility Report.

Discussions between the Corps and the city of Savannah, the cost-sharing partner for the study indicate that the city would like to support alternative plan 36 and believes it would provide ideal restoration of the study area. However, because of the high cost of plan 36, the city, as the sole cost-sharing partner, cannot support that alternative. The city is in favor of alternative plan 22, which would provide substantial restoration benefits at a significantly lower cost.

Alternative 22 consists of constructing a large diversion structure in the Savannah River to divert water into Bear Creek, plugging cutoff bend three below the Bear Creek entrance and restoring the connection of Mill Creek to the Savannah River. This alternative would provide substantial restoration of the Bear Creek zone (2,367 acres) and the Mill Creek zone (708 acres) identified in the revised habitat evaluation, but would not restore the Raccoon Creek zone (1,633 acres). Plan 22 would provide a net increase of 1,067 average annual habitat units of fish habitat and a net increase of 1,960 average annual habitat units of bottomland hardwood functional value.

Plan 36 includes the actions provided by plan 22 plus the restoration of the Savannah River to its original channel at cutoff bend four. Of all the plans evaluated, plan 36 provides the highest restoration benefits while minimizing potential adverse impacts. This plan restores all three restoration zones, including the Bear Creek, Raccoon Creek and Mill Creek zones. The proposed restoration action at cutoff bend four would not only restore the Raccoon Creek zone but also, because of flow connections to the Bear Creek zone and the Mill Creek zone, would benefit those zones. Plan 36 would provide a net increase of 1,848 average annual habitat units of fish habitat and a net increase of 3,498 average annual habitat units of bottomland hardwood functional value.

The Service recommends that the Corps implement plan 22 to restore wetlands in the study area if the city of Savannah remains the sole cost-sharing partner or implement plan 36 to restore wetlands in the study area if additional cost-sharing partners can be located.

We appreciate the cooperation of you and your staff during the course of the Lower Savannah River Restoration Study. We request that you continue close coordination with the Service throughout development of detailed restoration and construction plans, contracting, and construction.

Sincerely yours,

Edwin M. EuDaly

Edwin M. EuDaly
Acting Field Supervisor

Georgia Department of Natural Resources

Lonice C. Barrett, Commissioner

2070 U. S. Highway 278, S.E., Social Circle, Georgia 30279
David Waller, Director, Wildlife Resources Division
770/918-6400

January 29, 1996

RECEIVED FEB 0 5 1996

Mr. Edwin M. Eudaly
Acting Field Supervisor
U. S. Fish and Wildlife Service
Post Office Box 12559
Charleston, South Carolina 29422-2559

RE: Lower Savannah River Restoration Study

Dear Mr. Eudaly:

Thank you for the opportunity to review the January 1996 Fish and Wildlife Coordination Report on the Lower Savannah River Basin Study. The report accurately describes fish and wildlife resources in the study area, identifies potential effects on those resources, and provides recommendations for improving habitat values by restoring portions of the Savannah River in lower Effingham County to its original channel.

The Department of Natural Resources concurs with all the recommendations contained in the final report, which lists alternative Plan 22 for restoring Mill and Bear creeks and 3,075 acres of associated forested wetlands in the study area if the City of Savannah remains the sole cost-sharing partner. If additional cost-sharing partners could be identified, we agree that the preferred restoration alternative (Plan 36) should be implemented. This plan would also accomplish restoration of Racoon Creek, its 1,633 acres of forested wetlands, and 1.3 miles of mainstream river habitat at cutoff bend number four with additional benefits to Mill and Bear creeks. It is unfortunate that the issue of barge navigation through the old oxbow bends escalated the costs of preferred study alternatives to a level that forced local support to select a more affordable plan.

Since it has not been maintained beyond 1979, we agree that the Corps of Engineers should continue to explore deauthorization of the old navigational channel to Augusta. The past practice of depositing dredged materials in the channel would be environmentally unacceptable in future navigational project maintenance. The Corps should implement a Savannah River flow regime that provides for more diverse and productive fish and wildlife habitats.

We commend the Fish and Wildlife Service on the thorough evaluation presented in the final coordination report. Please continue to keep us informed throughout development of detailed restoration and construction plans, contracting, and construction.

Sincerely,

David Waller

David Waller

South Carolina Department of
Natural Resources

James A. Timmerman, Jr., Ph.D.
Director

February 6, 1996

Mr. Edwin M. Eudaly
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, S.C. 29422-2559

RE: Lower Savannah River Restoration Study Fish and Wildlife Coordination Report

Dear Ed:

Personnel of the S.C. Department of Natural Resources have reviewed the above referenced Report and concur with its findings and recommendations for the implementation of alternative Plan 22.

Sincerely,

Robert E. Duncan
Director for Environmental Programs

cc: Steve Snyder, SCDHEC-OCRM
Sally Knowles, SCDHEC
David Rackley, NMFS
Bob Riggs, USACOE

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

January 29, 1996

Mr. Roger Banks
Supervisor
Charleston Field Office
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, South Carolina 29412

RECEIVED JAN 31 1996

Dear Mr. Banks:

The National Marine Fisheries Service has reviewed the Final Fish and Wildlife Coordination Act Report on the Lower Savannah River Restoration Study. The report describes fish and wildlife resources in the study area, identifies potential effects on those resources, and provides recommendations for improving habitat values by restoring portions of the Savannah River to its original channel.

We concur with the findings made in your agency's report. Endorsement of your recommendations was given to the Savannah District, Corps of Engineers, in comments on the Draft Environmental Assessment and associated Public Notice. A copy of that letter is enclosed.

We appreciate the opportunity to review the subject document and we request that our comments be compiled into your final report to the Charleston District. Related questions should be directed to the attention of David Rackley at (803) 762-8574.

Sincerely,

David H. Rackley

for Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

EXECUTIVE SUMMARY

The purpose of this study is to determine if any modifications should be made to the Savannah River Below Augusta Navigation Project, especially cutoffs three and four. This Fish and Wildlife Coordination Act Report evaluates existing fish and wildlife resources within the lower Savannah River study area and identifies problems, opportunities, and planning objectives for these resources. It also provides the results of habitat evaluation studies that quantify fish and wildlife benefits of alternative modifications to the cutoffs and cutoff bends.

The original study area included the Savannah River and surrounding wetlands from the vicinity of Augusta, Georgia to the upper end of Savannah Harbor. The 1991 reconnaissance study identified a number of cutoff bends that could benefit from various restoration measures. However, a critical need and state/local cost sharing funds were identified only for bends three and four. Therefore, the current study area includes the Savannah River and surrounding wetlands from the vicinity of Old Wood Landing (river mile 43), to the junction of Abercorn Creek (river mile 29). The study area is located in the lower Coastal Plain physiographic province in Effingham County, Georgia and Jasper County, South Carolina. The extensive forested wetlands of the study area are important habitat to many significant commercial and recreational fish and wildlife species.

By modifying the natural flow regime, reservoir construction in the Piedmont has caused loss and degradation of forested wetlands along the lower Savannah River. Reservoir construction also has blocked passage of anadromous fish to historic spawning grounds. The Corp's actions in the lower river, dredging and placement of pile dikes associated with maintenance of the navigation channel to Augusta, are also affecting the hydrological conditions in the forested wetlands.

Currently, the forested wetlands in the study area appear to be healthy. Up until now some flow has been available to wetland tributaries arising on cutoff bends three and four. Mature forested wetland communities can be maintained after a change in flooding regime until further disturbance (IE. timber cutting, storm damage) leads to regeneration. In this case, because of reduced wetland flooding, regeneration of a less desirable forest type would be expected.

The future without restoration will result in virtual (>97 percent) filling of cutoff bend three with sediment in less than 10 years and virtual filling of cutoff bend four in less than 15 years. Filling of the cutoff bends will result in loss of all flow into wetland tributaries in the upstream study area and will result in long term degradation of the wetland community.

Restoration components considered for cutoff bends three and four included: (1) restoration of the river to the pre-project channel, (2) diversion of river water into the cutoff bend, (3) diversion of river water into the tributaries of the cutoff bends, and (4) no action. These restoration components and the restoration of Mill Creek were combined into 36 different restoration plans.

Discussions between the Corps and the city of Savannah, the cost-sharing partner for the study indicate that the city would like to support alternative plan 36 and believes it would provide ideal restoration of the study area. However, because of the high cost of plan 36, the city, as the sole cost-sharing partner, cannot support that alternative. The city is in favor of alternative plan 22, which would provide substantial restoration benefits at a significantly lower cost.

Alternative 22 consists of constructing a large diversion structure in the Savannah River to divert water into Bear Creek, plugging cutoff bend three below the Bear Creek entrance and restoring the connection of Mill Creek to the Savannah River. This alternative would provide substantial restoration of the Bear Creek zone (2,367 acres) and the Mill Creek zone (708 acres) identified in the revised habitat evaluation, but would not restore the Raccoon Creek zone (1,633 acres). Plan 22 would provide a net increase of 1,067 average annual habitat units of fish habitat and a net increase of 1,960 average annual habitat units of bottomland hardwood functional value.

Plan 36 includes the actions provided by plan 22 plus the restoration of the Savannah River to its original channel at cutoff bend four. Of all the plans evaluated, plan 36 provides the highest restoration benefits while minimizing potential adverse impacts. This plan restores all three restoration zones, including the Bear Creek, Raccoon Creek and Mill Creek zones. The proposed restoration action at cutoff bend four would not only restore the Raccoon Creek zone but also, because of flow connections to the Bear Creek zone and the Mill Creek zone, would benefit those zones. Plan 36 would provide a net increase of 1,848 average annual habitat units of fish habitat and a net increase of 3,498 average annual habitat units of bottomland hardwood functional value.

The Service recommends that the Corps perform the following actions to address the problems associated with the Lower Savannah River project.

1. Do not conduct any maintenance activities on the Savannah to Augusta navigation project, and seek deauthorization of this navigation project.

2. In conjunction with fish and wildlife agencies, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat.

3. Implement Plan 22 to restore wetlands in the study area if the city of Savannah remains the sole cost-sharing partner.

4. Implement Plan 36 to restore wetlands in the study area if additional cost-sharing partners can be located.

5. If Plan 22 is selected, expedite construction by completing this project under authority of Section 1135 of the Water Resources Development Act of 1986.

6. Continue close coordination with the Service throughout development of detailed restoration and construction plans, contracting and construction.

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INTRODUCTION

A resolution of the Committee on Public Works and Transportation of the United States House of Representatives dated August 1, 1990 authorized this Corps of Engineers (Corps) study. The Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) (FWCA) authorized the U.S. Fish and Wildlife Service's (Service) involvement in this study. The Service prepared this report with funds transferred from the Corps under the National Letter of Agreement between our agencies for funding of FWCA activities.

The purpose of this study is to determine if any modifications should be made to the Savannah River Below Augusta Navigation Project, especially cutoffs three and four. This FWCA report evaluates existing fish and wildlife resources within the lower Savannah River study area and identifies problems, opportunities, and planning objectives for these resources. It also provides the results of habitat evaluation procedure studies that quantify fish and wildlife benefits of alternative modifications to the cutoffs and cutoff bends. This report recommends measures to restore fish and wildlife habitat in the study area.

The Service provided a reconnaissance level Planning Aid Report (PAR) in August 1985 which provided fish and wildlife resource information on the Savannah River Basin and identified problems, opportunities and planning objectives relative to these resources. In December 1989 the Service provided another reconnaissance level PAR addressing water allocation and new water supply requests in the Savannah River Basin. In November 1991, the Service provided a reconnaissance Planning Aid Report that surveyed fish and wildlife conditions in the river from Augusta to Savannah and discussed potential restoration measures. The Service provided a Draft Fish and Wildlife Coordination Act report on the Lower Savannah River Environmental Restoration study in May 1995 and a revised Habitat Evaluation Report in November 1995.

DESCRIPTION OF THE STUDY AREA

The 1991 reconnaissance study identified a number of cutoff bends that could benefit from various restoration measures. However, a critical need and state/local cost sharing funds were identified only for bends three and four. Therefore, the current detailed study area includes the Savannah River and surrounding wetlands from the vicinity of Old Wood Landing (river mile 43), to the junction of Abercorn Creek (river mile 29) (Figure 1). The study area is located in the lower Coastal Plain physiographic province in Effingham County, Georgia and Jasper County, South Carolina.

The Fish and Wildlife Service manages, as part of Savannah National Wildlife Refuge, 6,819 acres (61 percent) of the 11,176 acres in the study area. The Service is planning to acquire up to an additional 4,000 acres in the study area when studies are completed, funds become available, and land owners are willing to sell. Therefore the Service may eventually own and manage virtually the entire study area.

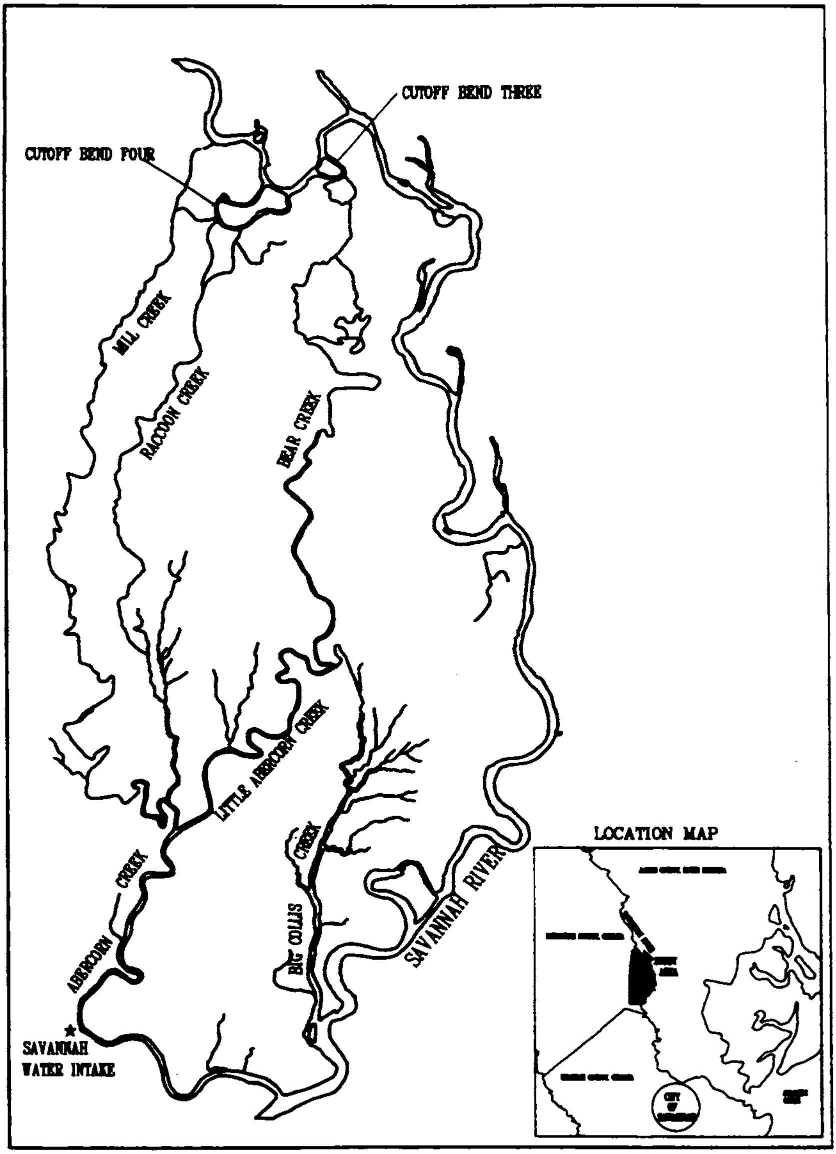

FIGURE 1. LOWER SAVANNAH RIVER STUDY AREA.

Analysis of the "Landcover of Georgia 1988-1990" a map product published by the Georgia Department of Natural Resources, indicates that the study area is the largest contiguous block of palustrine forested wetlands on the Georgia side of the Savannah River. The study area also appears to be one of the largest blocks of palustrine forested wetlands in the State of Georgia and is comparable in size to the highly significant swamps of the lower Altamaha River near Darien, Georgia.

Elevation in the study area ranges from about 70 feet on the ridges to about 5 feet on the Savannah River. Soils in the study area consist primarily of well drained sands on the higher elevations and poorly drained loams and loamy sands on lower elevations. Throughout the study area there is little development on the Savannah River and the flood plain ranges up to more than two miles in width. Palustrine forested wetlands (swamps/bottomland hardwoods) cover most of the flood plain.

Water discharge in the lower Savannah River varies considerably both seasonally and annually, even though it is largely controlled by releases from the Corps' J. Strom Thurmond Dam located upstream of the study area, about 20 miles northwest of Augusta, Georgia. Discharge is typically high in winter and early spring and low in summer and fall, but regulation by upstream reservoirs has reduced natural flow variations. Average discharge at Clyo (Effingham County, Georgia) is 11,720 cfs with a range for water year 1990 of about 6,000 cfs to 39,000 cfs (Bennett et al. 1990). Tidal effects extend upstream to approximately river mile 45.

The authorized project for the Savannah River between Augusta and Savannah, Georgia, provides for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (mile 21.3) to the head of navigation just below the 13th Street bridge (mile 202.2), a distance of 180.9 miles. The project also includes a lock and dam at New Savannah Bluff, located about 12 miles downstream from Augusta. Channel modifications, including deepening, widening, snagging, construction of bend cutoffs, and construction of pile dikes, have been made on the river to provide the 9-foot depth. However, by 1979, shipping on the river had virtually ceased, and channel maintenance was discontinued.

FISH AND WILDLIFE RESOURCES

FISH

A comprehensive five year fishery survey concluded that the lower Savannah River supports an abundant, diversified fish community, but has a low to moderately utilized fishery (Schmitt and Hornsby 1985). Based on number and weight collected the most abundant game fish were largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, redear sunfish, warmouth, flier, and pumpkinseed. Important non-game fish include longnose gar, bowfin, white catfish, channel catfish, common carp, spotted sucker, silver redhorse, striped mullet, and brown bullhead. The most important forage fish are gizzard shad and a number of minnow species. Anadromous fish found in the lower Savannah River are striped bass, striped bass x white bass hybrids, American shad, hickory shad, blueback herring, shortnose sturgeon, and Atlantic sturgeon.

During the early part of the 19th century, anadromous fish annually migrated to the headwaters of the Savannah River, through the Tugaloo River and up the Tallulah River to Tallulah Falls, Georgia, approximately 384 river miles from the ocean. After 1846 the Augusta Diversion Dam acted as a barrier to inland migration of anadromous species. Completion of the New Savannah Bluff Lock and Dam (NSBLD) in 1937 further restricted spawning migrations to below river mile 187.3.

Anadromous fish are an important component of the River's sport and commercial fisheries. Large numbers of American shad, blueback herring, striped bass, and sturgeon migrate to the NSBLD facility which is the first major obstruction to passage on the river. However, some fish have continued to migrate to historical spawning grounds above the facility. The means of passage appear to be swimming through fully opened dam gates at flows of 16,000 cfs or higher, and using the navigation lock when it is operated in a manner suitable for fish passage.

The lower Savannah River provides extremely important striped bass habitat. Prior to initiation of tide gate operation in 1977, the primary spawning area for striped bass in the Savannah River system was the tidal fresh water zone approximately 18-25 miles from the river mouth, specifically the Little Back River (McBay 1968; Rees 1974). Operation of the tide gate caused significant declines in numbers of striped bass eggs and larvae in the lower Savannah River system. These declines were related to increased salinity and modified transport patterns caused by the tide gate and associated hydrologic modifications (Van Den Avyle et al. 1990, Winger and Lasier 1990). The tide gate was taken out of operation in 1992.

WETLANDS

Palustrine forested wetlands dominate the extensive alluvial plain of the Savannah River (Figure 2). A 1994 vegetation survey was conducted in the vicinity of cutoff bends three and four (Bozeman, personal communication). Overflow areas in the vicinity of cutoff bends three and four are palustrine broad-leaved deciduous forests that are seasonally flooded (PFO1C). Dominant species are green ash, red maple, swamp laurel (diamondleaf) oak, water hickory, tupelo gum, overcup oak, sweetgum, ironwood, and American elm. Understory shrubs, seedlings, and vines include green-briar, sycamore, swamp privet, poison ivy, green ash, red maple, and several other vines including cross-vine and trumpet-creeper. Giant cane is also common in patches. Slightly higher terraces are temporarily flooded and are dominated by sweetgum, swamp laurel oak, sycamore, water hickory, green ash, ironwood, river birch, red maple, American elm, poplar, and overcup oak. Old sandbars are classed as palustrine broad-leaved deciduous scrub-shrub, temporarily flooded (PSS1A), and are dominated by green ash, black willow, silver maple, river birch, sycamore, water hickory, and American elm. These old sandbars are areas in the cutoff bends that have accumulated sediments and become vegetated.

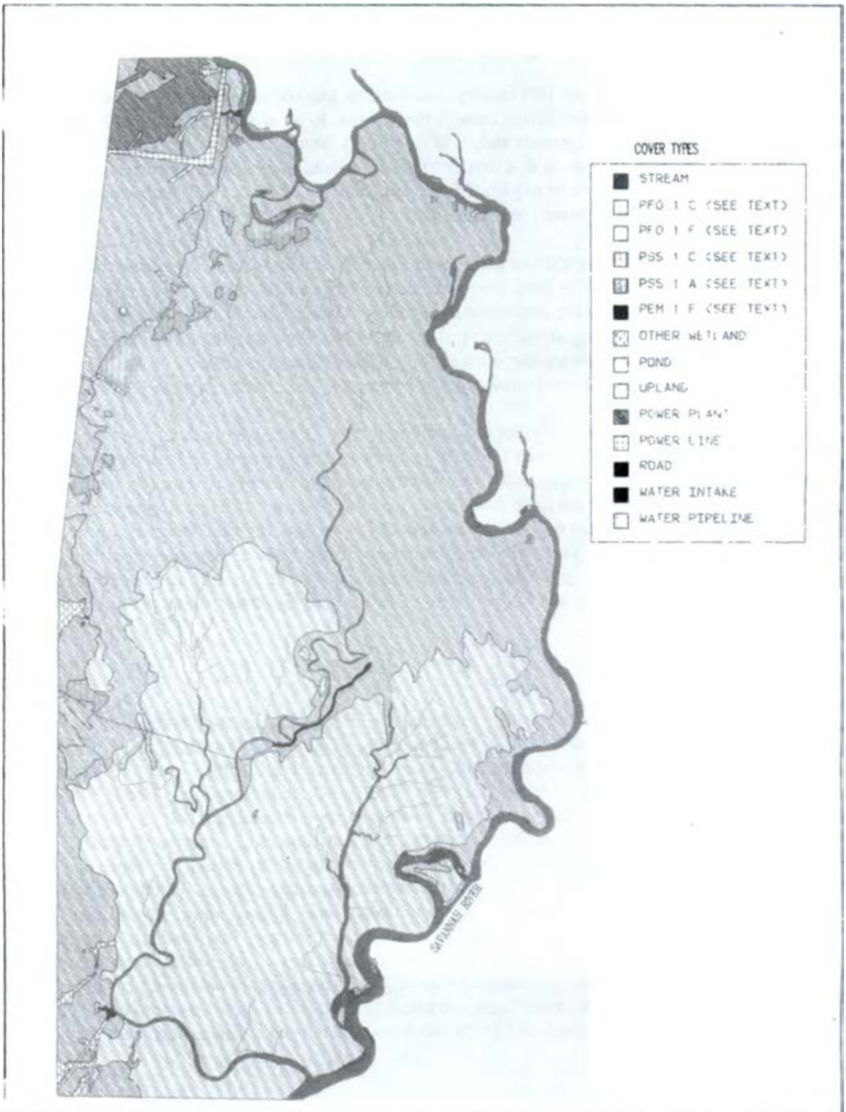

FIGURE 2. LOWER SAVANNAH RIVER STUDY AREA COVER TYPES FROM 1993 AERIAL PHOTOGRAPHS

Wharton (1982) described the floodplain flats on Bear Island in the northern part of the study area as a rare, nearly virgin, sweetgum-diamondleaf oak-green ash forest. Bear Island was recently acquired by the Fish and Wildlife Service and became part of the Savannah NWR. The remainder of the study area consists of mature forest with high species diversity and good interspersion of floodplain flats and sloughs vegetated with cypress and gum. Mast production in the study area is high due to the abundance of diamondleaf oaks and overcup oaks. The east facing bluff along the western edge of the floodplain and Mill Creek, is covered with a diverse upland hardwood forest. This area and other floodplain edge habitats are important nesting areas for the rare swallowtail kite and Mississippi kite.

Some areas south of cutoff bend four and between Raccoon Creek and Mill Creek were previously palustrine forested wetlands but timber has been harvested in the recent past. These areas are in various stages of regeneration and are now classified as palustrine broad-leaved deciduous scrub-shrub, seasonally flooded (PSS1C). These areas are expected to eventually return to the seasonally flooded palustrine broad-leaved deciduous forest category as the vegetation continues to grow.

The southern half of the study area is under tidal influence and is classed as palustrine deciduous forest, semipermanently flooded (PFO1/2F). Dominant species are tupelo gum, swamp blackgum, bald cypress, and sweetgum. The riverine habitat is lower perennial, unconsolidated bottom, and permanently flooded. This area includes all flowing streams and sloughs. Some marginal areas along the tidally influenced streams have freshwater marsh habitat classed as palustrine, persistent emergent, and semipermanently flooded (PEM1F). The dominant species are giant cutgrass, wild rice, tidemarsh amaranth, arrow-heads, false-nettle, and pickerelweed.

WILDLIFE

Wildlife associated with forested wetlands is numerous and diverse. The furbearers are an important component of these wetlands and include beaver, mink, otter, bobcat, gray fox, raccoon, and opossum. Deer, and turkey are important game species that use the bottomlands. The study area is part of the Atlantic Flyway and forested wetlands provide important wintering habitat for many waterfowl species and nesting habitat for wood ducks. Many species of woodpeckers, hawks, and owls use the bottomlands and swamps.

Neotropical migratory birds, many of which are decreasing in abundance, depend upon contiguous tracts of forested swamps for breeding and as corridors during migration. Robbins et al. 1989 found that the most area-sensitive bird species required at least 2,800 acres of contiguous forest to be present. The extensive forested wetlands of the Savannah River flood plain provide very valuable habitat for these birds. The American swallow-tailed kite, a state (SC) listed endangered species, can be observed on the study area. Swallow-tailed kites nest near or in palustrine wetlands and are closely associated with them.

The study area provides excellent habitat for a large number of reptiles and amphibians. Wetland habitats support many kinds of frogs including bullfrog, bronze frog, southern leopard frog, and several species of tree frogs, cricket frogs, and chorus frogs. Turtles found in the wetlands include river cooter, Florida cooter, pond slider, eastern chicken turtle, snapping turtle, mud turtle, and stinkpot. Snakes found in the wetlands include red-bellied water snake, banded water snake, brown water snake, eastern mud snake, rainbow snake, and eastern cottonmouth. The American alligator can be observed on streams and ponds of the study area.

ENDANGERED SPECIES

Federal Endangered (E), Threatened (T), and Candidate (C2) species that could occur in the Lower Savannah River Study Area include:

Eastern cougar (Felis concolor cougar) - E
American peregrine falcon (Falco peregrinus anatum) - E
Bald eagle (Haliaeetus leucocephalus) - E
Red-cockaded woodpecker (Picoides borealis) - E
Wood stork (Mycteria americana) - E
Kirtland's warbler (Dendroica kirtlandii) - E
Eastern indigo snake (Drymarchon corais couperi) - T
Shortnose sturgeon (Acipenser brevirostrum) - E
Canby's dropwort (Oxypolis canbyi) - E
Chaff-seed (Schwalbea americana) - E
Loggerhead shrike (Lanius ludovicianus) - C2
Flatwoods salamander (Ambystoma cingulatum) - C2
Gopher frog (Rana areolata capito) - C2
Gopher tortoise (Gopherus polyphemus) - C2
Florida pine snake (Pituophis melanoleucus mugitus) - C2
Creeping St. Johns'-wort (Hypericum adpressum) - C2
Pondspice (Litsea aestivalis) - C2
Pineland plantain (Plantago sparsiflora) - C2
Eulophia (Pteroglossaspis ecristata) - C2

Maintenance and enhancement of habitat for endangered and threatened species is an important Service goal. The species listed above should be taken into consideration in any future federal projects.

PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

The extensive forested wetlands of the Savannah River below Augusta are important habitat to many significant commercial and recreational fish and wildlife species, as well as to endangered and threatened plants and animals. These wetlands are also important for flood water storage, water purification, soil enrichment, erosion control and support for downstream fishing.

By modifying the natural flow regime, reservoir construction in the Piedmont has caused loss and degradation of forested wetlands along the lower Savannah River. The character of southeastern forested wetlands is determined by many factors including: (1) duration and periodicity of flooding; (2) depth of flooding; (3) intensity of stream flow; (4) quantity, nature and deposition rates of sediment carried by the stream, and (5) chemical aspects of the water (Bozeman and Darrell 1975). Regulation of river flow at the reservoirs has severely modified all these factors.

The result has been the succession of many of the remaining forested wetland communities to drier habitat types. This has reduced the richness and diversity of the river swamp and eliminated and degraded wetland habitats and associated values and functions that are important for fish and wildlife. Reduced river flow to the seasonally flooded wetland has made it possible for landowners to convert hundreds of acres of this habitat type to agriculture and pine plantations which are less productive for wildlife.

Natural mechanisms that enhance the riverine fish populations have also been modified due to reduced flooding resulting from upstream dams and the construction of cutoffs. It is likely that fish populations in some portions of the river and flood plain have been reduced. Riverine fish communities benefit from natural winter and spring floods. Over bank flooding allows for inundation of extensive flood plain spawning habitat including natural oxbow lakes. Flood water slowly recedes allowing the larval and juvenile fish to contribute to the rivers population. Temporary connection of the natural oxbow lakes also allows for the movement of adult fish into the frequently isolated oxbows. The carbon cycle of rivers is also closely tied to over bank flooding and productivity suffers with the loss of flood episodes.

The navigation cuts have effectively removed large channel segments from the river at low flow periods. The cutoff bends have accumulated sediment and organic matter since they were constructed in the late 1950's and early 1960's. Most of the cutoff bends have been substantially reduced in volume and surface area and many have become completely filled with sediment. Therefore available fish habitat has been reduced during normal summer flow conditions. Based on past trends, most of the fish habitat in cut off bends will be completely eliminated within 20 years. Fish habitat is adversely affected under these conditions and fish recruitment may be reduced.

The City of Savannah has experienced declining water quality (pH) at its pump station on Little Abercorn Creek. City officials believe that this problem is caused by reduced flow and wetland flushing from tributaries of the Savannah River. The tributaries that flow into Abercorn Creek include Bear Creek, Mill Creek, and Raccoon Creek (Figure 3).

The entrance to Bear Creek is located on Savannah River cutoff bend three. Reduced flow in the cutoff bend resulting from construction of the cutoff has reduced flows into Bear Creek. Reduced flow into cutoff bend four resulting from construction of cutoff four has reduced flows into Mill Creek and two channels that feed into Raccoon Creek. We also observed sheet flow from channels arising on cutoff bend four to Bear Creek during a March 1994 (high river flow) helicopter survey.

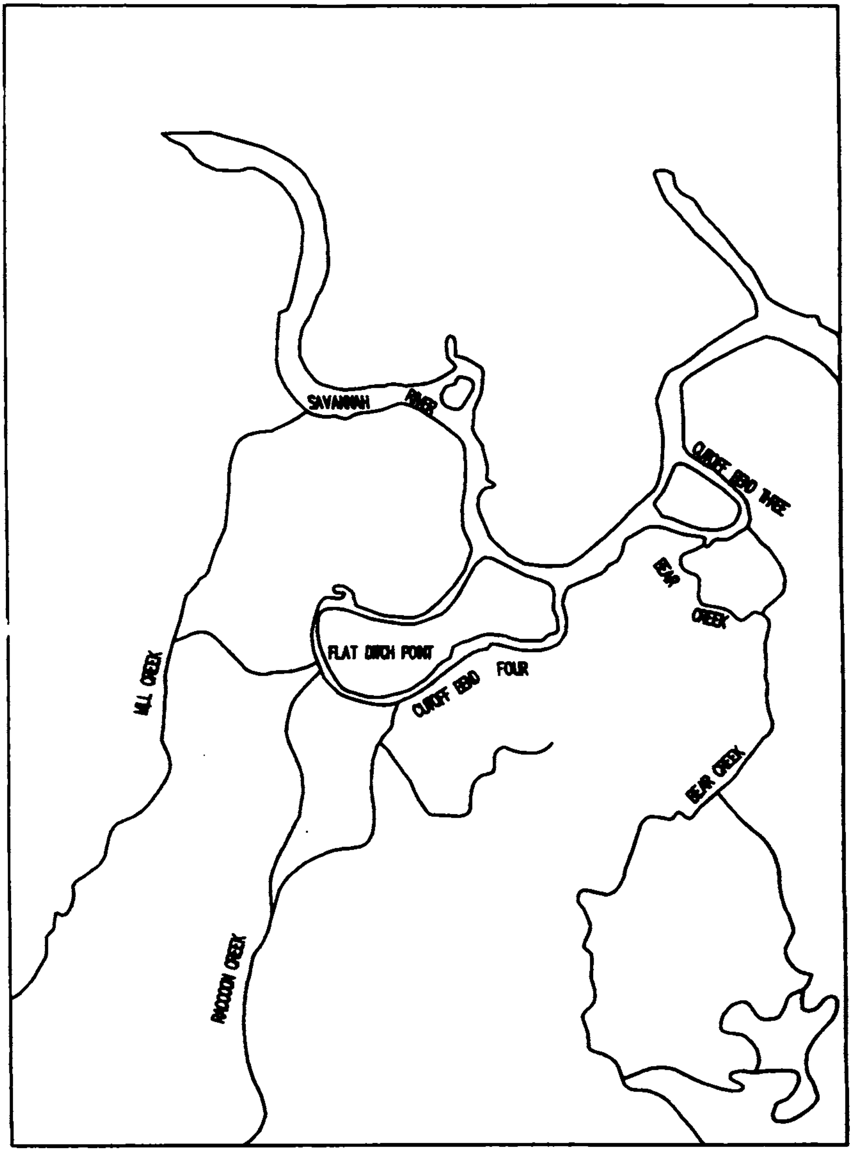

FIGURE 3. SAVANNAH RIVER IN THE VICINITY OF CUTOFF BENDS THREE AND FOUR.

The Savannah River entrance and other areas of Mill Creek have been blocked by logging debris and sedimentation resulting from logging operations carried out in the mid-1970's. Flow to Mill Creek has also been reduced because of river regulation from upstream reservoirs and the Savannah River navigation project. The sole existing source of Savannah River water for Mill Creek is a channel off of cutoff bend four at Flat Ditch Point.

In addition to affecting the city water supply these flow conditions reduce the quality and quantity of fish habitat. Some of the channels currently contain little or no water during river low flow conditions. Many areas that do contain water are stagnant and exhibit low pH and low dissolved oxygen, adverse fish habitat conditions.

The decrease in duration and depth of flooding in wetland tributaries that feed adjacent Savannah National Wildlife Refuge and privately owned wetlands has reduced flushing of detritus and nutrients from the wetlands.

The following planning objectives were developed considering the above problems.

1. Implement a Savannah River flow regime that will provide diverse and productive fish and wildlife habitat in the lower Savannah River.

2. Allow the Savannah River to establish a new hydraulic equilibrium by no longer maintaining the navigation channel and associated structures.

3. Restore Savannah River wetlands affected by cutoff bends where fish and wildlife and/or other benefits can be demonstrated.

EVALUATION OF ALTERNATIVES

Table 1 provides a list of the restoration actions considered for the project and Table 2 provides a list of restoration plans developed from the restoration actions. Plans 25, 26, 27, and 28 were eliminated after preliminary field evaluations because significant adverse wetland impacts were associated with relocating Bear Creek. Two methods were selected to evaluate the effects of the restoration alternatives on fish and wildlife habitat. First, a bottomland hardwood functional evaluation was developed for this study and was used to evaluate the effects of the project alternatives on forested wetlands and wildlife habitat. The habitat evaluation procedures were used to evaluate the effects of the project alternatives on fish habitat.

Table 1. Restoration components developed for the lower Savannah River restoration project.

RESTORATION COMPONENT	DESCRIPTION
BEND #3	
No Action	No Action
Partial Closure w/P/C Restoration Channel	Construct partial cut closure structure, increase flow through bend, dredge partial closure restoration channel in bend 76' top width x 10' deep, 1:3 side slopes
Full Closure w/Navigation Channel	Construct full cut closure structure, restore bend to accommodate navigation, dredge navigation channel in bend 229-259' top width x 9' deep @ 6,300 cfs, 1:3 side slopes
Full Closure w/F/C Restoration Channel	Construct full cut closure structure, dredge full closure restoration channel in bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Small Diversion	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek
Bear Creek/Large Diversion	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek
Relocate Mouth of Bear Creek	Relocate mouth of Bear Creek to bend #4, new channel from mouth to existing channel
Bear Creek/Small Diversion/ Slackwater	Construct small diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes
Bear Creek/Large Diversion/ Slackwater	Construct large diversion structure, narrow approach channel to Bear Creek, plug bend below Bear Creek, dredge slackwater channel in remainder of bend 182' top width x 13' deep, 1:3 side slopes
BEND #4	
No Action	No Action
Full Closure w/Navigation Channel	Construct full cut closure, dredge navigation channel in bend 204-254' top width x 9' deep, 1:3 side slopes
MILL CREEK	
No Action	No Action
Restore	Reorient mouth alignment, deepen entrance channel

Table 2. Alternative restoration plans developed for the lower Savannah River restoration project.

ALT	CUT AND BEND #3	CUT AND BEND #4	MILL CREEK
1	No Action	No Action	No Action
2	No Action	No Action	Restore
3	No Action	Full Closure w/Navigation Channel	No Action
4	No Action	Full Closure w/Navigation Channel	Restore
5	Partial Closure w/P/C Restoration Channel	No Action	No Action
6	Partial Closure w/P/C Restoration Channel	No Action	Restore
7	Partial Closure w/P/C Restoration Channel	Full Closure w/Navigation Channel	No Action
8	Partial Closure w/P/C Restoration Channel	Full Closure w/Navigation Channel	Restore
9	Full Closure w/Navigation	No Action	No Action
10	Full Closure w/Navigation	No Action	Restore
11	Full Closure w/Navigation	Full Closure w/Navigation Channel	No Action
12	Full Closure w/Navigation	Full Closure w/Navigation Channel	Restore
13	Full Closure w/F/C Restoration Channel	No Action	No Action
14	Full Closure w/F/C Restoration Channel	No Action	Restore
15	Full Closure w/F/C Restoration Channel	Full Closure w/Navigation Channel	No Action
16	Full Closure w/F/C Restoration Channel	Full Closure w/Navigation Channel	Restore
17	Bear Creek/Small Diversion	No Action	No Action
18	Bear Creek/Small Diversion	No Action	Restore
19	Bear Creek/Small Diversion	Full Closure w/Navigation Channel	No Action
20	Bear Creek/Small Diversion	Full Closure w/Navigation Channel	Restore
21	Bear Creek/Large Diversion	No Action	No Action
22	Bear Creek/Large Diversion	No Action	Restore
23	Bear Creek/Large Diversion	Full Closure w/Navigation Channel	No Action
24	Bear Creek/Large Diversion	Full Closure w/Navigation Channel	Restore
25	Relocate Mouth Bear Creek	No Action	No Action
26	Relocate Mouth Bear Creek	No Action	Restore
27	Relocate Mouth Bear Creek	Full Closure w/Navigation Channel	No Action
28	Relocate Mouth Bear Creek	Full Closure w/Navigation Channel	Restore
29	Bear Creek/Small Diversion/Slackwater	No Action	No Action
30	Bear Creek/Small Diversion/Slackwater	No Action	Restore
31	Bear Creek/Small Diversion/Slackwater	Full Closure w/Navigation Channel	No Action
32	Bear Creek/Small Diversion/Slackwater	Full Closure w/Navigation Channel	Restore
33	Bear Creek/Large Diversion/Slackwater	No Action	No Action
34	Bear Creek/Large Diversion/Slackwater	No Action	Restore
35	Bear Creek/Large Diversion/Slackwater	Full Closure w/Navigation Channel	No Action
36	Bear Creek/Large Diversion/Slackwater	Full Closure w/Navigation Channel	Restore

BOTTOMLAND HARDWOOD EVALUATION METHODS

Cover types were mapped from 1993, 1:34,000 scale color infrared photography (CIR), supplemented by 1989, 1:40,000 scale CIR. The Florida Land Use and Classification System was used to classify cover types. Mapped data was digitized on a digitizing tablet in ARC/INFO format. Additional information on the location of channels arising on cutoff bend four was obtained by ground survey using a Trimble global positioning system (GPS). Data obtained on the GPS were differentially corrected on a base station in Columbia, SC. Data were combined and edited using ARC/INFO geographic information system (GIS) software. Baseline areas of cover types were determined by querying the ARC/INFO database in conjunction with on-site observations.

Information for the bottomland hardwood evaluation was obtained from the following five biologists familiar with the study area. John Bozeman, Georgia Department of Natural Resources, has conducted vegetation surveys in the study area and has conducted other studies of bottomland hardwood systems in the southeast. Ed EuDaly, U.S. Fish and Wildlife Service, has conducted cover type mapping and fish and wildlife evaluations in the study area. John Robinette, U.S. Fish and Wildlife Service, is the refuge biologist for Savannah Coastal Refuges and is familiar with the geography and wildlife populations in the study area. Dennis Schmitt, Georgia Department of Natural Resources, has conducted fishery surveys in the study area and the Savannah River below Augusta. Ana Vergara, U.S. Army Corps of Engineers, is the project biologist for the lower Savannah environmental restoration study.

We divided the study area into three restoration zones based on landscape position and location of stream channels (Figure 4). All three zones extend downstream to the zone of dominant tidal influence, where tidal effects control the vegetative community. The Bear Creek zone consists of 2,367 acres and water flow to the zone is controlled primarily from cutoff bend three and Bear Creek. The Bear Creek zone is also affected during high river discharge conditions by a network of sloughs and overland flow carrying water from cutoff bend four to Bear Creek. Water flow to the area to the east of the Bear Creek zone is controlled primarily by the Savannah River. The Raccoon Creek zone consists of 1,633 acres and water flow is controlled from cutoff bend four. The Mill Creek zone consists of 708 acres and water flow is currently controlled by flows from Flat Ditch which arises on cutoff bend four and runs west to Mill Creek. Before the upper reaches of Mill Creek were impacted by logging operations about 25 years ago, major water flow to the Mill Creek zone was provided by flow from the mouth of Mill Creek on the Savannah River.

To estimate impact of restoration activities, we developed a functional index of wetland value. This functional index was based of the estimated amount of base flow in the tributary system and the estimated amount of flood water provided to the wetland system. The functional index was multiplied by acres to provide functional value. A functional value of one is equivalent to one acre of fully functioning (optimum) bottomland hardwood.

Impacts of each alternative on the functional index were based on the expected water flow that resulted from the alternative. The expected water flow was provided by results of the Corps'

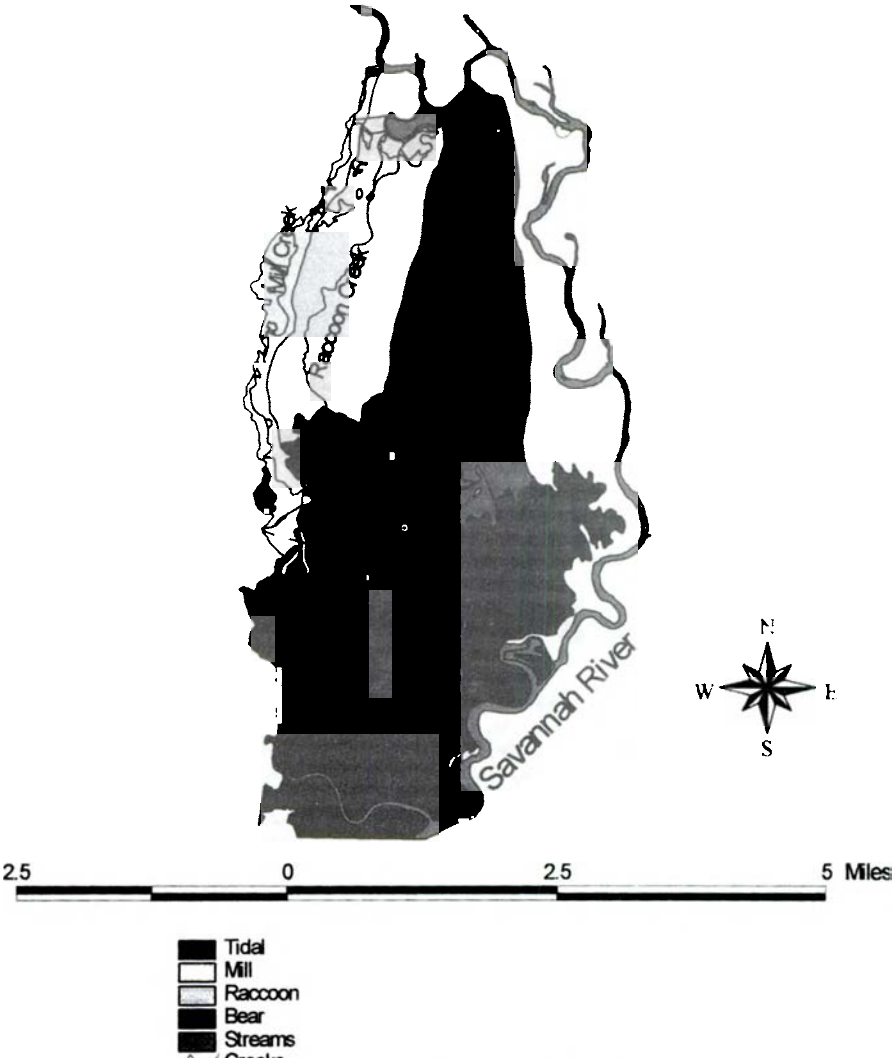

Figure 4. Lower Savannah River restoration zones.

hydraulic model in most cases and extrapolated from the model results in other cases. The future without project condition was estimated based on the projected closure rate of the cutoff bends. The projected rate of closure was determined by the Corps, based on statistical analysis of historical cross section data and sedimentation rate data.

Functional indices were estimated for the baseline (current) condition and various target years over the life of the project. The bottomland hardwood area at each target year was multiplied by the corresponding functional index to determine the functional value for the baseline condition and for various target years over the 50 year life of the project. The average annual functional values were then determined for the various project alternatives.

FISH HABITAT EVALUATION METHODS

The habitat evaluation procedures were initiated by using the GIS to classify the study area into cover types and measure area of each cover type. Representative fish species were then selected and habitat quality was determined by measuring habitat characteristics and applying them to suitability index models. The habitat quantity was multiplied by the habitat quality to determine habitat units. The habitat units were determined for the baseline (current) condition and for various target years over the 50 year life of the project. The average annual habitat units were then determined for the various project alternatives. The habitat evaluation study was carried out by a team consisting of one representative from the Service, one from the Corps, and two from the Georgia Department of Natural Resources.

Fish models used were simplified community fish models developed by combining species habitat suitability index models developed by the Service (Killgore and Miller 1987). The four models used were for: (1) sunfish, Lepomis, (2) crappie, Pomoxis, (3) bass, Micropterus, and (4) catfish, Ictalurus. The models were modified slightly to more accurately represent local conditions.

Water quality conditions were measured using a Hydrolab Surveyor II, biweekly from July 1993 through August 1994 at various locations in the study area (Figure 5). Percent cover was estimated using a tape transect at a number of locations in the stream system. Current velocities were measured using a Gurley current meter. All habitat measurements used were made at typical summer conditions (low flow).

Future flow estimates for the cutoffs and bends were provided by the Corps from the TABS hydraulic model. Future habitat conditions were estimated using the results from this model. In addition cutoff bend surface area and volume was estimated by the Corps using results of surveys (1950-1993) and regression equations.

The following assumptions were used in projecting future habitat conditions:

1. The fish habitat value of cutoff bends will be lost when remaining volume is three percent or less of original (1950 survey) volume.

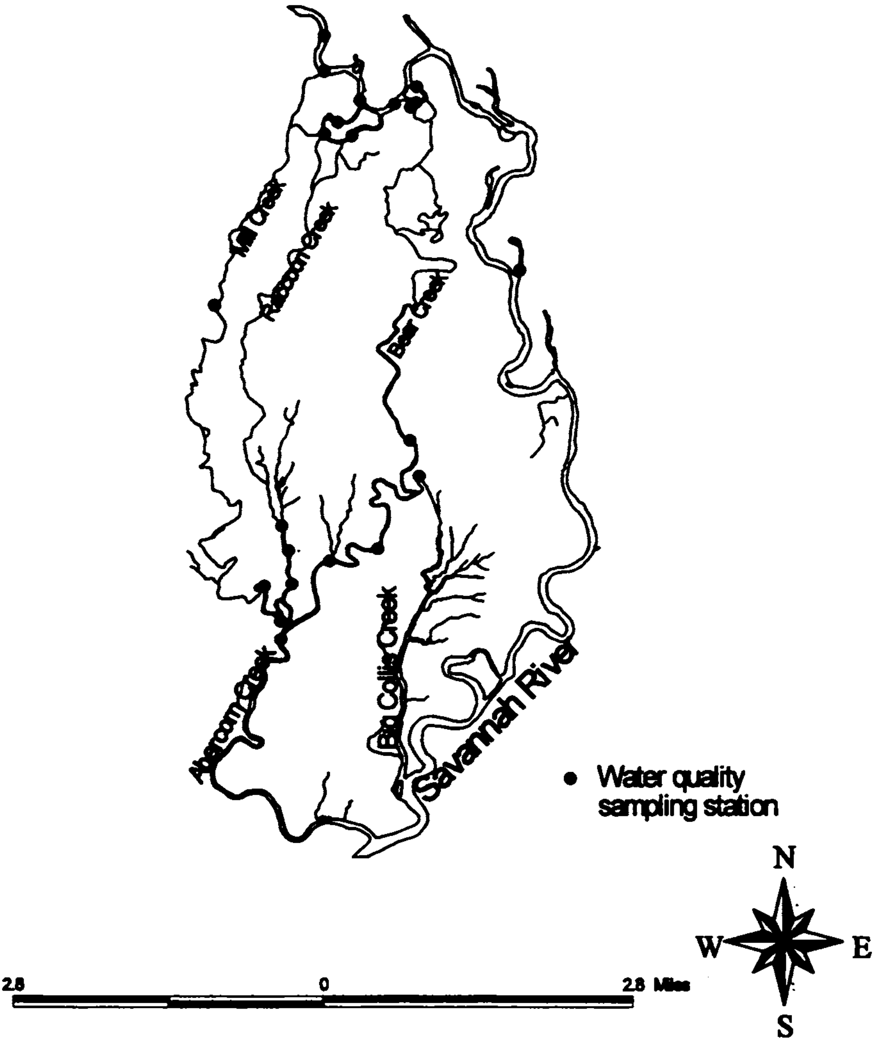

Figure 5. Water quality sampling sites, lower Savannah River.

2. When cutoff bends are filled to three percent or less, flow to tributaries will be eliminated at typical summer flows.

3. With full channel restoration physical conditions will return to conditions similar to the 1950 survey.

4. With full channel restoration water quality in the tributaries and Mill Creek will be the same as water quality in the river.

5. Restoration effects will extend downstream on the tributaries and Mill Creek to the point of dominant tidal influence (interface between tidal wetlands and non-tidal wetlands).

6. Fill rate of cutoff bends with partial restoration can be estimated from hydraulic regression models.

7. With partial restoration water quality effects will be proportional to the amount of flow diverted.

BOTTOMLAND HARDWOOD RESULTS

Table 3 provides a summary of the impacts of restoration actions in the lower Savannah River bottomland hardwood restoration zones. Table 4 provides the acreage, functional index and functional value for various target years over the life of the project and the average annual functional value for plan 1, the no action plan. Tables 5 through 35 provide the acreage, functional index and functional value for various target years over the life of the project and the average annual functional value for the restoration plans under consideration.

Table 36 provides a summary of the average annual bottomland hardwood functional value (AAFV) with each plan, the average annual functional value without the plan and the net average annual functional value of each plan. Plans 7, 8, 11, 12, 15, 16, 19, 20, 23, 24, 31, 32, 35 and 36 would result in a high amount of bottomland hardwood habitat restoration (net AAFV 2500-3498). Plans 3, 4, 13, 14, 22, and 34 would result in a moderate amount of bottomland hardwood habitat restoration (net AAFV 1500-2499). All of the other plans would result in a low amount of bottomland hardwood habitat restoration (net AAFV 518-1499). Table 37 provides the direct construction related loss or gain of bottomland hardwood acres and average annual functional value for major construction activities.

TABLE 3. Lower Savannah River bottomland hardwood restoration zones affected and impacts of actions for the various restoration alternatives.

PLAN	RESTORATION ZONE(S)	IMPACT OF ACTION
1	MILL, RACCOON, BEAR	ALL FLOW TO MILL CREEK AND RACCOON CREEK WILL BE LOST WHEN COB4 CLOSES AT YEAR 15. ALL FLOW TO BEAR CREEK WILL BE LOST WHEN COB3 CLOSES AT YEAR 10.
2	MILL	FLOW TO MILL CREEK WILL BE FULLY RESTORED.
3	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF FLOW FROM COB4.
4	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF FLOW FROM COB4.
5	BEAR	NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE. FLOW TO BEAR CREEK VARIES OVER TIME BECAUSE OF SEDIMENTATION IN COB3.
6	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE. FLOW TO BEAR CREEK VARIES OVER TIME BECAUSE OF SEDIMENTATION IN COB3.
7	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS OF DIVERSION AT COB3 AND FLOW FROM COB4.
8	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS OF DIVERSION AT COB3 AND FLOW FROM COB4.
9	BEAR	NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.

PLAN	RESTORATION ZONE(S)	IMPACT OF ACTION
10	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.
11	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM FLOW AT COB3 AND FLOW FROM COB4.
12	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM FLOW AT COB3 AND FLOW FROM COB4.
13	BEAR	FLOW TO BEAR CREEK WILL BE FULLY RESTORED.
14	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED.
15	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED.
16	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED.
17	BEAR	NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.
18	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.
19	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.

PLAN	RESTORATION ZONE(S)	IMPACT OF ACTION
20	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.
21	BEAR	NINETY PERCENT RESTORATION OF FLOW TO BEAR CREEK.
22	BEAR, MILL	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NINETY PERCENT RESTORATION OF FLOW TO BEAR CREEK.
23	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.
24	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.
25	PLAN DELETED	
26	PLAN DELETED	
27	PLAN DELETED	
28	PLAN DELETED	
29	BEAR	NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.
30	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NO FURTHER DEGRADATION OF BEAR CREEK BECAUSE OF BASELINE FLOW MAINTENANCE.
31	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.

PLAN	RESTORATION ZONE(S)	IMPACT OF ACTION
32	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.
33	BEAR	NINETY PERCENT RESTORATION OF FLOW TO BEAR CREEK.
34	MILL, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. NINETY PERCENT RESTORATION OF FLOW TO BEAR CREEK.
35	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE MAINTAINED THROUGH FLAT DITCH. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.
36	MILL, RACCOON, BEAR	FLOW TO MILL CREEK WILL BE FULLY RESTORED. FLOW TO RACCOON CREEK WILL BE FULLY RESTORED. FLOW TO BEAR CREEK WILL BE FULLY RESTORED BECAUSE OF COMBINED EFFECTS FROM EXTENSION AT COB3 AND FLOW FROM COB4.

Table 4. Plan 1 (No Action) acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.3	1412
20	4708	.2	942
50	4708	.2	942

AAFV = 1186

Table 5. Plan 2 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.57	2684
10	4708	.4	1883
20	4708	.32	1507
50	4708	.32	1507

AAFV = 1704

Table 6. Plan 3 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.67	3154
10	4708	.67	3154
20	4708	.67	3154
50	4708	.67	3154

AAFV = 3146

Table 7. Plan 4 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.75	3531
10	4708	.75	3531
20	4708	.75	3531
50	4708	.75	3531

AAFV = 3519

Table 8. Plan 5 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.4	1883
20	4708	.35	1648
50	4708	.35	1648

AAFV = 1770

Table 9. Plan 6 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.5	2354
20	4708	.4	1883
50	4708	.4	1883

AAFV = 2024

Table 10. Plan 7 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.8	3766
10	4708	.8	3766
20	4708	.8	3766
50	4708	.8	3766

AAFV = 3752

Table 11. Plan 8 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.87	4096
10	4708	.87	4096
20	4708	.87	4096
50	4708	.87	4096

AAFV = 4079

Table 12. Plan 9 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.4	1883
20	4708	.35	1648
50	4708	.35	1648

AAFV = 1770

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Table 13. Plan 10 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.5	2354
20	4708	.4	1883
50	4708	.4	1883

AAFV = 2024

Table 14. Plan 11 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.8	3766
10	4708	.8	3766
20	4708	.8	3766
50	4708	.8	3766

AAFV = 3752

Table 15. Plan 12 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.87	4096
10	4708	.87	4096
20	4708	.87	4096
50	4708	.87	4096

AAFV = 4079

Table 16. Plan 13 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.75	3531
10	4708	.65	3060
20	4708	.6	2825
50	4708	.6	2825

AAFV = 2935

Table 17. Plan 14 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.83	3908
10	4708	.76	3578
20	4708	.72	3390
50	4708	.72	3390

AAFV = 3467

Table 18. Plan 15 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.92	4331
10	4708	.9	4237
20	4708	.9	4237
50	4708	.9	4237

AAFV = 4228

Table 19. Plan 16 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	1.0	4708
10	4708	1.0	4708
20	4708	1.0	4708
50	4708	1.0	4708

AAFV = 4079

Table 20. Plan 17 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.4	1883
20	4708	.35	1648
50	4708	.35	1648

AAFV = 1770

Table 21. Plan 18 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.5	2354
20	4708	.4	1883
50	4708	.4	1883

AAFV = 2024

Table 22. Plan 19 acreage, functional index and functional value at various Table target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.8	3766
10	4708	.8	3766
20	4708	.8	3766
50	4708	.8	3766

AAFV = 3752

Table 23. Plan 20 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.87	4096
10	4708	.87	4096
20	4708	.87	4096
50	4708	.87	4096

AAFV = 4079

Table 24. Plan 21 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.53	2495
20	4708	.55	2589
50	4708	.55	2589

AAFV = 2546

Table 25. Plan 22 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.67	3154
10	4708	.67	3154
20	4708	.67	3154
50	4708	.67	3154

AAFV = 3146

Table 26. Plan 23 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.92	4331
10	4708	.92	4331
20	4708	.92	4331
50	4708	.92	4331

AAFV = 4312

Table 27. Plan 24 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	1.0	4708
10	4708	1.0	4708
20	4708	1.0	4708
50	4708	1.0	4708

AAFV = 4684

Table 28. Plan 29 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.4	1883
20	4708	.35	1648
50	4708	.35	1648

AAFV = 1770

Table 29. Plan 30 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.5	2354
20	4708	.4	1883
50	4708	.4	1883

AAFV = 2024

Table 30. Plan 31 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.8	3766
10	4708	.8	3766
20	4708	.8	3766
50	4708	.8	3766

AAFV = 3752

Table 31. Plan 32 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.87	4096
10	4708	.87	4096
20	4708	.87	4096
50	4708	.87	4096

AAFV = 4079

Table 32. Plan 33 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.5	2354
10	4708	.53	2495
20	4708	.55	2589
50	4708	.55	2589

AAFV = 2546

Table 33. Plan 34 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.67	3154
10	4708	.67	3154
20	4708	.67	3154
50	4708	.67	3154

AAFV = 3146

Table 34. Plan 35 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	.92	4331
10	4708	.92	4331
20	4708	.92	4331
50	4708	.92	4331

AAFV = 4312

Table 35. Plan 36 acreage, functional index and functional value at various target years and average annual functional value.

TARGET YEAR	ACRES	FUNCTIONAL INDEX	FUNCTIONAL VALUE
0	4708	.5	2354
1	4708	1.0	4708
10	4708	1.0	4708
20	4708	1.0	4708
50	4708	1.0	4708

AAFV = 4684

Table 36. Annual average annual bottomland hardwood functional value with each plan, the average annual functional value without the plan and the net average annual functional value of each plan.

PLAN	AVERAGE ANNUAL FUNCTIONAL VALUE WITH PLAN	AVERAGE ANNUAL FUNCTIONAL VALUE WITHOUT PLAN	AVERAGE ANNUAL NET FUNCTIONAL VALUE
1	1186	1186	0
2	1704	1186	518
3	3146	1186	1960
4	3519	1186	2333
5	1770	1186	584
6	2024	1186	838
7	3752	1186	2566
8	4079	1186	2893
9	1770	1186	584
10	2024	1186	838
11	3752	1186	2566
12	4079	1186	2893
13	2935	1186	1749
14	3467	1186	2281
15	4228	1186	3042
16	4684	1186	3498
17	1770	1186	584
18	2024	1186	838
19	3752	1186	2566
20	4079	1186	2893
21	2546	1186	1360
22	3146	1186	1960
23	4312	1186	3126
24	4684	1186	3498
25	PLAN DELETED	1186	PLAN DELETED

PLAN	AVERAGE ANNUAL FUNCTIONAL VALUE WITH PLAN	AVERAGE ANNUAL FUNCTIONAL VALUE WITHOUT PLAN	AVERAGE ANNUAL NET FUNCTIONAL VALUE
26	PLAN DELETED	1186	PLAN DELETED
27	PLAN DELETED	1186	PLAN DELETED
28	PLAN DELETED	1186	PLAN DELETED
29	1770	1186	584
30	2228	1186	1042
31	3752	1186	2566
32	4079	1186	2893
33	2546	1186	1360
34	3146	1186	1960
35	4312	1186	3126
36	4684	1186	3498

Table 37. Impact areas, acres, average annual functional index and average annual functional value of direct construction related loss or gain resulting from restoration components.

COMPONENT	IMPACT AREA	ACRES	AVERAGE ANNUAL FUNCTIONAL INDEX	AVERAGE ANNUAL FUNCTIONAL VALUE
NAVIGATION COB3	COB3	-8	1	-8
NAVIGATION COB3	COB3	-2	0.3	-0.6
NAVIGATION COB4	COB4	-1	1	-1
NAVIGATION COB4	COB4	-13	0.3	-3.9
NO NAVIGATION COB3	COB3	-5	0.3	-1.5
NO NAVIGATION COB4	COB4	-13	0.3	-3.9
CHANNEL DREDGING	DISPOSAL AREA	-2	0.5	-1
RELOCATE BEAR CREEK	COB4 TO BEAR CREEK	-2	1	-2
DREDGE LOWER END OF COB3	COB3	-5	0.3	-1.5
FILL/PLANT CUT 3	CUT 3	2.4	0.5	1.2
FILL/PLANT CUT 4	CUT 4	5.3	0.5	2.7

FISH HABITAT RESULTS

Table 38 provides the Lepomis (sunfish) acres of available habitat, habitat suitability index, habitat units and average annual habitat units (AAHU) for plan 1, the no action plan. Table 39 provides the Pomoxis (crappie) acres of available habitat, habitat suitability index, habitat units and average annual habitat units for plan 1, the no action plan. Table 40 provides the Micropterus (largemouth bass) acres of available habitat, habitat suitability index, habitat units and average annual habitat units for plan 1, the no action plan. Table 41 provides the Ictalurus (catfish) acres of available habitat, habitat suitability index, habitat units and average annual habitat units for plan 1, the no action plan. Table 42 provides the total baseline fish habitat value, which was determined by multiplying species group average annual habitat units by the number of species in that group found in the study area.

Tables 43 through 61 provide the acreage of available habitat, habitat suitability index at various target years and the average annual habitat units for the fish species groups. The average annual habitat units for each group were multiplied by the number of species of that group in the study area and all groups were summed to determine the total average annual habitat units. Table 62 provides a summary of the average annual habitat units with each plan, the average annual habitat units without the plan and the net average annual habitat value of each plan.

Plans 7, 8, 12, 16, 19, 20, 23, 24, 31, 32, 35 and 36 would result in a high amount of fish habitat improvement (net AAHU 1408-1922). Plans 3, 4, 6, 10, 14, 18, 22, 23, 24, 30 and 34 would result in a moderate amount of fish habitat improvement (net AAHU 890-1407). All of the other plans would result in a low amount of fish habitat improvement (net AAHU 372-889).

Table 38. Plan 1 (No Action) acreage, habitat suitability index (HSI) and habitat units (HU) at various target years and average annual habitat units (AAHU) for Lepomis group.

TARGET YEAR	ACRES	HSI	HU	AAHU
0	142	0.69	98	
1	142	0.69	98	
15	53	0.45	24	
50	53	0.45	24	
PROJECT LIFE				35

Table 39. Plan 1 (No Action) acreage, habitat suitability index (HSI) and habitat units (HU) at various target years and average annual habitat units (AAHU) for Pomoxis group.

TARGET YEAR	ACRES	HSI	HU	AAHU
0	142	0.74	105	
1	142	0.74	105	
15	53	0.45	24	
50	53	0.45	24	
PROJECT LIFE				35

Table 40. Plan 1 (No Action) acreage, habitat suitability index (HSI) and habitat units (HU) at various target years and average annual habitat units (AAHU) for Micropterus group.

TARGET YEAR	ACRES	HSI	HU	AAHU
0	142	0.63	89	
1	142	0.63	89	
15	53	0.42	22	
50	53	0.42	22	
PROJECT LIFE				32

Table 41. Plan 1 (No Action) acreage, habitat suitability index (HSI) and habitat units (HU) at various target years and average annual habitat units (AAHU) for Ictalurus group.

TARGET YEAR	ACRES	HSI	HU	AAHU
0	142	0.63	89	
1	142	0.63	89	
15	53	0.42	22	
50	53	0.42	22	
PROJECT LIFE				32

Table 42. Total baseline fish habitat value determined by multiplying species group average annual habitat units (AAHU) by the number of species in that group found in the study area.

SPECIES GROUP	AAHU	SPECIES IN GROUP	TOTAL HABITAT UNITS
LEPOMIS	35	8	280
POMOXIS	35	2	70
MICROPTERUS	32	1	32
ICTALURUS	32	6	192
TOTAL			574

Table 43. Plan 2 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR/ AAHU	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	144	.75	.83	.66	.69
15 AND 50	78	.60	.67	.57	.58
PROJECT LIFE		56	62	52	53

Table 44. Plan 3 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	178	.79	.85	.70	.73
15 AND 50	128	.71	.78	.64	.67
PROJECT LIFE		98	107	88	92

Table 45. Plan 4 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	180	.79	.85	.70	.73
15 AND 50	130	.71	.78	.64	.67
PROJECT LIFE		100	109	90	94

Table 46. Plan 5 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	143	.75	.86	.66	.68
15	110	.61	.68	.57	.59
16	120	.75	.86	.66	.68
30	110	.61	.68	.57	.59
31	120	.75	.86	.66	.68
50	110	.61	.68	.57	.59
PROJECT LIFE		81	92	73	76

Table 47. Plan 6 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	143	.75	.86	.66	.68
15	133	.61	.68	.57	.59
16	143	.75	.86	.66	.68
30	133	.61	0.68	0.57	0.59
31	143	.75	.86	.66	.68
50	133	.61	.68	.57	.59
PROJECT LIFE		94	107	85	88

Table 48. Plan 7 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	178	.81	.92	.72	.75
15	168	.75	.86	.66	.70
16	178	.81	.92	.72	.75
30	168	.75	.86	.66	.70
31	178	.81	.92	.72	.75
50	168	.75	.86	.66	.70
PROJECT LIFE		135	154	119	125

Table 49. Plan 8 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	180	.81	.92	.72	.75
15	170	.75	.86	.66	.70
16	180	.81	.92	.72	.75
30	170	.75	.86	.66	.70
31	180	.81	.92	.72	.75
50	170	.75	.86	.66	.70
PROJECT LIFE		136	155	121	127

Table 50. Plan 9 or 13 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	150	.77	.88	.68	.70
15 AND 50	108	.75	.88	.67	.68
PROJECT LIFE		86	101	77	78

Table 51. Plan 10 or 14 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	152	.77	.88	.68	.70
15 AND 50	133	.78	.90	.69	.71
PROJECT LIFE		106	122	93	96

Table 52. Plan 11 and 15 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	183	.81	.92	.72	.75
15 AND 50	173	.81	.92	.72	.75
PROJECT LIFE		141	160	125	130

Table 53. Plan 12 or 16 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	185	.81	.92	.72	.75
15 AND 50	185	.81	.92	.72	.75
PROJECT LIFE		149	170	133	138

Table 54. Plan 17 or 21 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	145	.77	.88	.68	.70
15 AND 50	98	.75	.88	.67	.68
PROJECT LIFE		79	93	71	72

Table 55. Plan 18 or 22 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	147	.77	.88	.68	.70
15 AND 50	123	.78	.90	.69	.71
PROJECT LIFE		99	113	87	90

Table 56. Plan 19 or 23 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for _Lepomis_, _Pomoxis_, _Micropterus_ and _Ictalurus_ groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	173	.81	.92	.72	.75
15 AND 50	163	.81	.92	.72	.75
PROJECT LIFE		133	151	118	123

Table 57. Plan 20 or 24 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for _Lepomis_, _Pomoxis_, _Micropterus_ and _Ictalurus_ groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	175	.81	.92	.72	.75
15 AND 50	175	.81	.92	.72	.75
PROJECT LIFE		141	160	126	131

Table 58. Plan 29 or 33 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for _Lepomis_, _Pomoxis_, _Micropterus_ and _Ictalurus_ groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	153	.77	.88	.68	.70
15 AND 50	106	.75	.88	.67	.68
PROJECT LIFE		85	100	76	77

Table 59. Plan 30 or 34 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	155	.77	.88	.68	.70
15 AND 50	131	.78	.90	.69	.71
PROJECT LIFE		104	121	92	94

Table 60. Plan 31 or 35 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	181	.81	.92	.72	.75
15 AND 50	171	.81	.92	.72	.75
PROJECT LIFE		139	158	124	129

Table 61. Plan 32 or 36 acreage and habitat suitability index (HSI) at various target years and average annual habitat units (AAHU) for Lepomis, Pomoxis, Micropterus and Ictalurus groups.

TARGET YEAR	AREA	LEPOMIS HSI/AAHU	POMOXIS HSI/AAHU	MICROPT. HSI/AAHU	ICTALURUS HSI/AAHU
1	183	.81	.92	.72	.75
15 AND 50	173	.81	.92	.72	.75
PROJECT LIFE		145	164	129	134

Table 62. Fish habitat average annual habitat units (AAHU) with each plan, the average annual habitat units without the plan and the net average annual habitat unit value of each plan.

PLAN	AAHU WITH PLAN	AAHU WITHOUT PLAN	NET AAHU
1	574	574	0
2	946	574	372
3	1643	574	1067
4	1666	574	1092
5	1359	574	785
6	1578	574	1004
7	2255	574	1681
8	2281	574	1707
9	1439	574	865
10	1760	574	1186
11	2074	574	1500
12	2496	574	1922
13	1439	574	865
14	1760	574	1186
15	2074	574	1500
16	2496	574	1922
17	1324	574	750
18	1641	574	1067
19	2221	574	1647
20	2362	574	1788
21	1324	574	750
22	1641	574	1067
23	2221	574	1647
24	2248	574	1788
25	PLAN DELETED	574	PLAN DELETED
26	PLAN DELETED	574	PLAN DELETED
27	PLAN DELETED	574	PLAN DELETED
28	PLAN DELETED	574	PLAN DELETED

PLAN	AAHU WITH PLAN	AAHU WITHOUT PLAN	NET AAHU
29	1423	574	849
30	1727	574	1153
31	2328	574	1754
32	2422	574	1848
33	1423	574	849
34	1727	574	1153
35	2328	574	1754
36	2422	574	1848

DISCUSSION

Based on Corps' analysis, only five percent of the original volume remained in cutoff bend three and eleven percent of the original volume remained in cutoff bend four in 1993. By the year 2000, only three percent of the original volume of cutoff bend three and six percent of the original volume of cutoff bend four are expected to remain. Field observations in 1993 indicated that at normal summer flows very little fish habitat remained in cutoff bend three. A large sand bar filled most of the bend. Flow into tributaries arising on the cutoff bends will also be lost. This loss of flow will result in reduction of habitat quantity in Mill Creek, Raccoon Creek and Bear Creek. The only existing major flow to Mill Creek is from a channel at Flat Ditch Point on cutoff bend four. Loss of this flow would cause a severe reduction of available habitat in Mill Creek. Water quality in the tributaries is also expected to decline as the high quality flow from the river is eliminated.

Currently, the forested wetlands in the study area appear to be healthy. Up until now some flow has been available to wetland tributaries arising on cutoff bends three and four. Mature forested wetland communities can be maintained after a change in flooding regime until further disturbance (IE. timber cutting, storm damage) leads to regeneration. In this case, because of reduced wetland flooding, regeneration of a less desirable forest type would be expected.

The future without restoration will result in virtual (>97 percent) filling of cutoff bend three with sediment in less than 10 years and virtual filling of cutoff bend four in less than 15 years. Filling of the cutoff bends will result in loss of all flow into wetland tributaries in the upstream study area and will result in long term degradation of the wetland community.

The fish habitat models used in this study are very simple and are based on basic physical and chemical habitat variables. The fish models do not account for some beneficial wetland values, such as increased fish spawning and nursery habitat on the flood plain, that would result from increased wetland flooding duration and frequency. Therefore restoration plans that provide a sufficient base flow to maintain cover and water quality in the streams will result in the same model results as plans that result in increased floodplain flooding. This limitation is a disadvantage of relying totally on the fish models. This limitation also resulted in a high amount of habitat improvement for a large number of the restoration plans because the models are not sensitive to changes in amount of water flow.

The bottomland hardwood evaluation was designed to be more sensitive to changes in the amount of wetland flooding. Because of the high significance and the scarcity of the bottomland hardwood resource in the study area, the bottomland hardwood evaluation should be given significant consideration in the selection of restoration plans.

Plans 16, 24 and 36 would maximize bottomland hardwood restoration by producing a net average annual functional value of 3498. Plan 16 includes a restoration channel in cutoff bend 3 rather than a navigation channel. Therefore conflicts with barge navigation in the Savannah River could arise if the Savannah River navigation project is not deauthorized. Because plans 24 and 36 provide the same amount of restoration and avoid potential conflicts with navigation, these plans would provide ideal restoration of the study area. Plan 36 would provide an increase of 1848 average annual habitat units of fish habitat and plan 24 would provide an increase of 1788 average annual habitat units of fish habitat.

Discussions between the Corps and the city of Savannah, the cost-sharing partner for the study indicate that the city would like to support alternative 36 and believes it would provide ideal restoration of the study area. However, because of the high cost of alternative 36, the city, as the sole cost-sharing partner, cannot support that alternative. The city is in favor of alternative 22, which would provide substantial restoration benefits at a significantly lower cost.

Alternative 22 consists of constructing a large diversion structure in the Savannah River to divert water into Bear Creek, plugging cutoff bend three below the Bear Creek entrance and restoring the connection of Mill Creek to the Savannah River. This alternative would provide substantial restoration of the Bear Creek zone (2,367 acres) and the Mill Creek zone (708 acres) identified in the revised habitat evaluation, but would not restore the Raccoon Creek zone (1,633 acres). Plan 22 would provide a net increase of 1,067 average annual habitat units of fish habitat and a net increase of 1,960 average annual habitat units of bottomland hardwood functional value.

Plan 36 includes the actions provided by plan 22 plus the restoration of the Savannah River to its original channel at cutoff bend four. Of all the plans evaluated, plan 36 provides the highest restoration benefits while minimizing potential adverse impacts. This plan restores all three restoration zones, including the Bear Creek, Raccoon Creek and Mill Creek zones. The proposed restoration action at cutoff bend four would not only restore the Raccoon Creek zone but also, because of flow connections to the Bear Creek zone and the Mill Creek zone, would benefit those zones.

Based on the habitat evaluation, we believe that plan 36 is the best plan to restore the study area. However, plan 22, which would cost about one quarter as much as plan 36, would provide about 56 percent of the benefits provided by plan 36. We understand the city's need, in representing the citizens of Savannah, to select a cost effective plan. Therefore, we will support plan 22 if additional cost-sharing partners cannot be located. We would still prefer to have plan 36 implemented if additional cost-sharing partners can be located.

RECOMMENDATIONS

The Service recommends that the Corps perform the following actions to address the problems associated with the Lower Savannah River project.

1. Do not conduct any maintenance activities on the Savannah to Augusta navigation project, and seek deauthorization of this navigation project.

2. In conjunction with fish and wildlife agencies, determine and implement a Savannah River flow regime that provides for diverse and productive fish and wildlife habitat.

3. Implement Plan 22 to restore wetlands in the study area if the city of Savannah remains the sole cost-sharing partner.

4. Implement Plan 36 to restore wetlands in the study area if additional cost-sharing partners can be located.

5. If Plan 22 is selected, expedite construction by completing this project under authority of Section 1135 of the Water Resources Development Act of 1986.

6. Continue close coordination with the Service throughout development of detailed restoration and construction plans, contracting and construction.

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APPENDIX C

CITY OF SAVANNAH - Office of the City Manager
P.O. Box 1027 • Savannah, Georgia 31402
912-651-6415 • FAX 912-238-0872

March 13, 1996

Ms. Monica Simon Dodd (PD-P)
U.S. Army Corps of Engineers
P.O. Box 889
Savannah, GA 31402-0889

Re: Lower Savannah River Study - Construction Financing

Dear Ms. Dodd:

As requested, the following statement is offered concerning financing.

We understand that upon congressional approval of this feasibility study, the Corps of Engineers will commence the planning, engineering, and design (PED) phase of the project. We also understand that the PED phase will be funded by the Corps of Engineers until such time as a separate implementation agreement is executed.

At this time, it is our intent to continue participation in and provide our share of the required funds for this project to completion.

However, this statement does not constitute a commitment on the part of the City of Savannah, nor is the City of Savannah under any obligation to enter into any agreement or expend any monies until such time as a separate agreement is negotiated and executed.

Sincerely,

Michael B. Brown

Michael B. Brown
City Manager

CITY OF SAVANNAH - Water and Sewer Bureau
P.O. Box 1027 • Savannah, Georgia 31402 • 912-651-4240 • FAX 912-651-6808

March 18, 1996

Ms. Monica Simon Dodd
Corps of Engineers
P.O. Box 889
Savannah, Georgia 31402-0889

Dear Monica:

This letter is in response to the comments made by the Chief of Engineers office at the feasibility review conference in August, 1995, which this writer and John Sawyer attended on behalf of the City of Savannah.

The purpose of this is to specifically address the comment requesting the City to state its legal capability to perform the items of local cooperation for the project. The project boundaries extend beyond the limits of the City of Savannah and into the State of South Carolina.

The City has the legal capability to perform the items of local cooperation, as listed on the enclosure to this letter for this project.

Items of performance outside the City's jurisdiction i.e. condemnation will be performed by the federal government on behalf of the City. This is done by a federal agreement known as a memorandum of agreement between the sponsor and the federal government at the sponsor's expense.

Should you require additional information, please advise.

Very respectfully,

Harry Jue
Water and Sewer Director

HJ/hc

cc: J.B. Blackburn, City Attorney
Michael Brown, City Manager

Items of Local Cooperation

The Water Resources Development Act of 1986, Public Law 99-662, specifies cost sharing for water resource projects. Under the provisions of Public Law 99-662, the city of Savannah will sponsor the continuation of the Lower Savannah River Basin through a new Project Cooperation Agreement. The new PCA must include the following non-Federal responsibilities in addition to the responsibility for fulfilling the requirements of Engineering Regulation 1165-2-130:

(1) Provide 25 percent of total project costs assigned to environmental restoration, as further specified below:

   a. Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project.

   b. Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

   c. Provide any additional amounts as are necessary to make its total contribution equal to 25 percent of total project costs assigned to environmental restoration.

(2) Provide 100 percent of total project costs assigned to municipal and industrial water supply.

(3) For so long as the project remains authorized, operate and maintain the physical construction features and excavated channels associated with the project and the hydraulic integrity of the distributary streams in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

(4) Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(5) Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project, any betterments, except for damages due to the fault or negligence of the United States or its contractors.

(6) Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20.

(7) Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

(8) Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

(9) To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

(10) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(11) Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

(12) Provide 25 percent of that portion of total historic preservation, mitigation and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration.

(13) Provide 100 percent of that portion of total historic preservation, mitigation and data recovery costs attributable to municipal and industrial water supply that are in excess of 1 percent of the total amount authorized to be appropriated for municipal and industrial water supply.