Document Overview
Water Allocation for the Alabama-Coosa-Tallapoosa (ACT) River Basin
Alabama and Georgia
Draft Environmental Impact Statement

This Environmental Impact Statement (EIS) presents a framework to evaluate the proposed water allocation formula for the ACT River Basin currently being developed by the ACT Basin Compact Commission. This draft EIS is organized as follows:

Main Report

Executive Summary: brief summary of the document

Section 1 – Purpose, Need, and Scope: background and history that led to the need for this EIS, as well as the evaluations completed for this EIS

Section 2 – Description of the Proposed Action: overview of the Federal decision required by the water allocation compact

Section 3 – Alternatives Considered: description of the no action and the action alternative flow scenarios

Section 4 – Affected Environment, Environmental Consequences, and Potential Mitigation Measures: description of existing conditions in the basin, as well as possible environmental impacts and mitigation remedies

Section 5 – List of Preparers: individuals who wrote and prepared this document

Section 6 – Coordination: Federal agencies, State agencies, Native American tribes, and other organizations, and individuals that will receive this draft EIS

Section 7 – Literature Cited: list of references used in preparing this document

Section 8 – Index: list of key terms by page number

Appendices

Supplementary technical information

Appendix Volume 1

Appendix A – Letters and Memorandums of Agreement and ACF Basin Compact
Appendix B – Agency Responsibilities
Appendix C – Public Involvement
Appendix D – Water Resources

Appendix Volume 2

Appendix E – Biological Resources
Appendix F – Socioeconomic Resources
Appendix G – Cultural Resources
Appendix H – Relevant Statutes and Executive Orders

A list of acronyms and abbreviations and a table summarizing the alternatives are provided immediately following the index. Note that the CD-ROM at the back of this document provides an electronic version of the report and Volumes 1 and 2 of the appendices.

Foreword

This Environmental Impact Statement (EIS) is being prepared by the Corps of Engineers and ten cooperating agencies to assist in a decision critical to the success of the Compact and the equitable allocation of surface water among the States of Alabama and Georgia. The Federal Commissioner is charged by the President of the United States to approve the water allocation formula now being considered by the ACT Compact Commissioners. The responsibility of the Federal Commissioner is to assure that a formula, once agreed upon by the State Commissioners, is in compliance with Federal laws and national policies. This foreword will provide an overview of how this EIS relates to the process of approving an allocation formula.

One of the major questions and concerns you may have is why preparation of this draft EIS has begun before the ACT Compact Commissioners have agreed upon a formula. The ACT Compact contains specific procedures and mandated milestones by which certain actions must be accomplished, which were approved by the States and the U.S. Congress, and have now been incorporated into Federal law. The Compact specifies that the States must reach consensus on a water allocation formula by December 31, 1998. Provisions of the Compact also require the Federal Commissioner to reach a concurrence decision on the formula within 255 days following the States' proposed formula. Because the Federal Commissioner's decision represents a major Federal action, the procedures stipulated by the National Environmental Policy Act (NEPA) must be followed, to include the preparation of this draft EIS to evaluate the effects of the formula. The benefits of this process are that it addresses all of the relevant issues and involves the public in Federal decision-making. However, to accommodate the required technical evaluations and include adequate opportunity for public involvement, this process normally requires 18 to 24 months to complete. Therefore, this draft EIS process had to begin well before an allocation formula was proposed by the State Commissioners. A notice of intent to prepare an EIS was published in October 1997, at which time planning meetings with the interagency team of cooperating Federal agencies began. Technical studies and data gathering efforts also were initiated. In addition, a newsletter and scoping questionnaire were distributed to the public.

The mandated timeline generated the problem of beginning an evaluation process when the water allocation formula was not yet developed. This dilemma generated much discussion among the cooperating Federal agencies and the Federal legal community. The eventual conclusion on an approach, and the only one that could practically be implemented under these conditions, was to develop an evaluation framework against which an eventual formula could be evaluated. The framework developed, as presented in this draft EIS, is a range of possible flow conditions likely to "bracket" the flow conditions defined by the future allocation formula. The framework was designed with the understanding that the basin has only a certain amount of water available, and there are structural and practicable constraints within the basin that define a range of low to high flows that can be applied to that amount of water. Once the evaluation framework was established, the hydrologic, environmental and socioeconomic impacts of the range of flow conditions—low, moderate, and high—could be measured and compared to baseline conditions (also known as the no

action alternative). The future allocation formula can then also be evaluated using this same evaluation framework.

It is important to emphasize that development of an allocation formula and evaluation of the effects of the formula is a continuous process. The States are striving diligently to develop an allocation formula that will equitably allocate water resources within the basin to meet future needs. Because the specific details of the allocation formula are unknown at this time, the first phase of evaluation can only be completed at a planning level of detail, predicting the types and ranges of potential impacts that may occur within the basin if an allocation formula is implemented.

The second phase of evaluation is to develop plans for implementing actions related to the allocation formula. When the formula is approved by the State Compact Commissioners and the Federal Commissioner, decisions must be made by Federal and non-Federal project managers on how reservoir projects will be regulated to provide for allocation formula flow. Resource management programs within the basin that might be impacted by a change in water allocation within the basin must also be addressed.

This continuous process to refine the evaluation of impacts of the water resource management program as additional details of implementation plans are developed is referred to as *programmatic*. Programmatic EISs allow for evaluation of a project early in the planning stages so changes can be made in the implementing actions to avoid, minimize, or mitigate potential impacts. Programmatic EISs also serve as a baseline document for future management decisions within a study area. Once more defined implementation plans are identified, such as proposed changes in project authorizations or revisions to specific project operation or management plans, follow-on EISs or environmental assessments may be necessary and would include additional coordination with the public.

Many formal opportunities are provided for public participation throughout the EIS process. Many of you have responded to the scoping questionnaire and web page. This draft EIS has been distributed for public review and comment, and public meetings to discuss this draft EIS will be held in each State. Details announcing the times and locations of these meetings will be included in the newsletter and the local news media. Your participation is welcome at these meetings, as are your comments at any time.

Water Allocation for the Alabama-Coosa-Tallapoosa River Basin
Alabama and Georgia
Draft Environmental Impact Statement

Lead Agency:
U.S. Army Corps of Engineers,
Mobile District

Cooperating Agencies:
Environmental Protection Agency
Forest Service
Natural Resources Conservation Service
Maritime Administration
Fish and Wildlife Service
U.S. Geological Survey
National Park Service
National Marine Fisheries Service
National Ocean Service
Southeastern Power Administration

Abstract:

The Alabama-Coosa-Tallapoosa (ACT) River Basin Compact Commission is developing a water allocation formula for the ACT River basin to provide an equitable sharing of water within the basin among the States of Alabama and Georgia. Compact Commissioners include the Governors of each State and a Federal Commissioner appointed by the President of the United States as a non-voting member. Under the ACT River Basin Compact, the two State Commissioners must negotiate and agree on a proposed allocation formula and present the formula to the Federal Commissioner for concurrence before the allocation formula can be implemented. This environmental impact statement (EIS) uses a programmatic framework for evaluating a range of flow and reservoir conditions were selected to bracket the flow conditions that may result from the allocation formula. The objectives of the that EIS are to address the potential environmental impacts across the entire basin, serve as a baseline document for future implementing actions, and meet the schedule for completion of agency and public review prior to a Federal Commissioner decision in late summer 1999. Alternative flow conditions in the high, moderate, and low range were compared to the flow conditions for the no action alternative (existing operating conditions within the basin). Flow conditions were modeled by using a historic flow data record that represents 55 years of recorded stream flows. Hydrologic models and water demands used in the hydrologic models were developed as part of the ACT/ACF Comprehensive Study. Project conditions were for a planning period extending through the year 2050. Evaluations of potential impacts of the no action alternative and action alternative flow scenarios were based on studies completed during the Comprehensive Study and additional investigations completed by the U.S. Army Corps of Engineers and cooperating Federal agencies. With the no action alternative, river flows and reservoirs would be maintained similar to existing conditions, with reservoir drawdowns under dry conditions. As demands increase into the future, reservoir elevations would drop significantly, while river flows could be maintained close to flows that were present under 1995 demands. The greatest effect would occur in the summer and fall, when inflows are naturally lower. With the low flow scenario river flows would be substantially reduced compared with river flows under the no action alternative. Reservoir levels would be maintained near full pool, except under drought conditions. The moderate flow scenario produces river flows that are high in the winter, responding to reservoir seasonal drawdowns, and elevated in the summer, as upstream reservoirs augment river flows during the dry summer months. The high flow scenario would maintain river flows higher in the spring, summer, and fall. Follow-on National Environmental Policy Act (NEPA) documentation (tiered environmental assessments or EISs) may be necessary to document specific impacts of the future implementing actions.

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Send your comments to the above address by **December 18, 1998.**

Water Allocation for the Alabama-Coosa-Tallapoosa (ACT) River Basin

Alabama and Georgia

Main Report

Lead Agency

U.S. Army Corps of Engineers, Mobile District

Cooperating Agencies

Environmental Protection Agency
Fish and Wildlife Service
Forest Service
Maritime Administration
National Marine Fisheries Service
National Ocean Service
National Park Service
Natural Resources Conservation Service
Southeastern Power Administration
U.S. Geological Survey

September 1998

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Appendices, Volume 1

Appendix A: Letters and Memorandums of Agreement and ACT Basin Compact

- Letters of Agreement
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- ACT Basin Compact

Appendix B: Agency Responsibilities

Lead Agency
- U.S. Army Corps of Engineers

Cooperating Agencies
- Environmental Protection Agency
- Fish and Wildlife Service
- U.S. Geological Survey
- National Park Service
- Natural Resources Conservation Service
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- NOAA, National Marine Fisheries Service
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- Southeastern Power Administration
- Department of Transportation, Maritime Administration

States of Alabama, Florida, and Georgia

Appendix C: Public Involvement

- Notice of Intent
- Summary of Scoping Questionnaire Responses

Appendix D: Water Resources

- Current Operation Model and 1977 Conditions Model *
- Flow Matrix Models: ACT and ACF Flow Allocation Formula Assessment *
- Hydrologic Flood Control Investigation: West Point, Allatoona, and Buford Projects
- Tailwater and Downstream Hydrographs
- Nonpoint Source Pollutant Loading Evaluation, ACT & ACF Water Allocation Formula Environmental Impact Statements *
- HEC-5Q Simulation of Water Quality in the ACT River Basin *

Appendices, Volume 2

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- Working Draft Fish and Wildlife Coordination Act (FWCA) Report for the ACT River Basin Water Allocation Formula
- Reservoir Fisheries Assessment for the ACT and ACF Water Allocation Formula Environmental Impact Statements

Appendix F: Socioeconomic Resources

- Draft Economic Analysis
- Environmental Impact Statement
  - Section 1: Municipal and Industrial Water Supply
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Appendix G: Cultural Resources *
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Archaeological Resources Protection Act of 1976 (16 U.S.C. § 470 et seq.)
Clean Air Act (42 U.S.C. § 7401-7671g)
Clean Water Act (33 U.S.C. § 1251 et seq.)
Endangered Species Act (16 U.S.C. § 1531 et seq.)
Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)
Magnuson Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq.)
Marine Protection, Research, and Sanctuaries Act of 1972
(33 U.S.C. § 1401- 1445; 16 U.S.C. § 1431 et seq.; also 33 U.S.C. § 1271)
National Environmental Policy Act of 1969 (42 U.S.C. § 4321-4347)
National Historic Preservation Act of 1966 (NHPA), as amended
(16 U.S.C. § 470 et seq.)
North American Wetlands Conservation Act (16 U.S.C. § 4401 et seq.)
Resource Conservation and Recovery Act (43 U.S.C. § 2101-2106)
Safe Drinking Water Act (42 U.S.C. § 300f et seq., 6939b; 15 U.S.C. § 1261 et seq.)
Watershed Protection and Flood Prevention Act (16 U.S.C. § 1001 et seq.;
33 U.S.C. § 701b)
Executive Order 12898, "Federal Actions to Address Environmental
Justice in Minority Populations and Low Income Populations," February 11, 1994
Executive Order 12088, "Federal Compliance with Pollution Control Standards,"
October 13, 1978
Executive Order 11988, "Floodplain Management," May 24, 1977
Executive Order 11990, "Protection of Wetlands," May 24, 1977
Executive Order 13045, "Protection of Children from Environmental
Health Risks and Safety Risks," April 21, 1997

* These appendix sections contain figures which are best viewed in color, but which have been reproduced in black and white in the hard copy version of the report. To view the figure in color, see the CD-ROM version of the report, a copy of which is included with each hard copy. Additional copies of the CD-ROM are available upon request from the Mobile District of the U.S. Army Corps of Engineers

Glossary

Action alternative: A flow condition that may result from the water allocation formula developed by the State Commissioners (see *bracket, alternative flow conditions,* and *range of flows*).

Alternative flow conditions: Alternative flow conditions include a range of flows (high, moderate, and low) for evaluation, which will serve as a surrogate for the flows that may result from the water allocation formula (see *surrogate, water allocation formula,* and *range of flows*).

Bankfull capacity: The stage at which a stream first overflows its natural banks.

Bracket: Range of flow conditions associated with the water allocation formula that will be negotiated by the states (see *water allocation formula*).

Brackish: Water with a salt concentration greater than freshwater and less than seawater.

Canopy: Tallest vegetation in a community, usually trees more than 30 feet tall or 3 inches in diameter; the tallest grasses or other herbaceous species.

Ceremonial mound: Large mound of earth used prehistorically for many different purposes including rituals.

Component: Any significant portion of an archaeological site or historic resource.

Comprehensive Study: Consensus-based study that determined the capabilities of the water resources of the basin, described the water resource demands of the basin, and evaluated alternatives that would use the water resources to benefit all user groups within the basin (see *action alternative* and *no action alternative*).

Confluence: Point of juncture of two or more streams.

Conservation pool: The portion of reservoir storage generally reserved for power production and water supply.

Consumptive uses: Activities that withdraw water from the basin and return only some or none back to the basin.

Control point: A defined point of interest included in the HEC-5 modeling effort for which HEC-5 computes hydrologic information.

Critical drought: The most severe drought for a region, either recorded or constructed.

Critical period: The time period containing the critical drought. Usually the time starts as the drought begins and reservoirs are full. The time ends after the reservoirs have been returned to full condition.

Daily time-step: The division of hydrologic information into a 24-hour period.

Detritus: Fresh to partly decomposed plant and animal matter.

Draft Environmental Impact Statement (EIS): Publication that documents the environmental conditions, issues, and effects associated with an action affecting the environment and on which the public is invited to review and comment. Comments received from regulatory agencies, organizations, and individuals are addressed in the final EIS (see *final EIS*).

Drainage area: Area measured in a horizontal plane which is enclosed by a location on the stream to the boundaries of the drainage divide.

Drawdown: The action of lowering a reservoir water level by beginning or increasing reservoir releases.

Emergent: Referring to plants that are entirely above water or mostly above water, with only the base remaining submerged.

Endemic: Characteristic of, or prevalent in, a particular area or environment.

Estuarine: Referring to deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Euryhaline: An organism that is able to tolerate wide fluctuations in salinity.

Final EIS: The final product of the environmental impact statement process, which responds to comments received on the draft EIS (see *draft EIS*).

Flood control pool: The portion of reservoir storage generally reserved for storing peak flood flows.

HEC-5: The computer program, "Simulation of Flood Control and Conservation System" developed by HEC. Performs sequential reservoir operations based on specific project demands and constraints.

HEC-5Q: The computer program, *Simulation of Flood Control and Conservations Systems Water Quality Analysis*, including simulations for water temperature, several conservative and non-conservative constituents, dissolved oxygen, and phytoplankton.

Herbaceous: Nonwoody plant species, such as grasses.

Inactive pool: The portion of reservoir storage below the conservation pool that contains *dead storage*. No reservoir releases are made from the inactive pool.

Indicator of Hydrologic Alteration: A program developed by the Nature Conservancy to analyze complex hydrologic data using simple patterns relevant to ecological interests for each year of record.

Letter of Agreement (LOA): LOAs were used to formalize commitments, agreements, and cooperation between states.

Memorandum of agreement (MOA): An MOA was signed by the affected states (Alabama, Florida, and Georgia) and the United States in June 1983, committing to work together as partners through a Section 308 comprehensive study process to seek resolution of water resource issues and to develop a water management system for the basin. The MOA

identified short-term study efforts and long-range studies. These long-range studies were never completed due to inadequate funds. Subsequent to litigation filed by the State of Alabama, a second MOA was signed by Alabama, Florida, and Georgia in 1992 (see *Section 1.1.4* and *Comprehensive Study*). Several supplements to this MOA were signed during the course of the Comprehensive Study.

Mesic: Area with a moderate amount of moisture.

Minimum stream flow: A low river flow at a specified point in a river. The minimum flow may be a regulated minimum flow or a specific level needed for water supply or other purposes.

Mitigation: The Council on Environmental Quality (CEQ) requires federal agencies, in preparing an EIS, to address appropriate mitigation measures not already included in the proposed action or alternatives. Mitigation measures may avoid, minimize, rectify, reduce, eliminate, or compensate for impacts.

Navigation window: Typically, a 10-day period in which stored water is released to the river and held at specified levels so that shippers have a predetermined depth and adequate lead time to move into the system. The window is used in the summer and fall months when water conditions are too dry for continuous periods of adequate depth.

No action alternative: The no action alternative is the baseline or current operation condition against which the action alternatives are compared. The no action alternative provides the baseline flows for comparing the impacts of the potential allocation formula or future implementing actions.

Nodes: Physical locations or critical modeling points, such as environmental points of interest, USGS stream gauge locations, reservoirs, or other model-related control points.

Offlap: The progressive offshore regression of the updip terminations of the sedimentary units within a conformable sequence of rocks, in which each successively younger unit leaves exposed a portion of the older unit on which it lies. Also, the successive contraction in the lateral extent of strata (as seen in an upward sequence) due to their being deposited in a shrinking sea or on the margin of a rising land mass.

Overload capacity: The maximum amount of electric power delivered by a generating station (all units) under specific conditions. This capacity will equal or exceed the nameplate capacity specified by the manufacturer.

Palustrine: Generally, refers to nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand (ppt).

Peaking project: A project in which hydropower is generated several hours a day, typically on weekdays, in response to system demands. Flows below a peaking project can fluctuate rapidly.

Period of record: Typically, the period for which there are published records for a station. Typically, for the HEC-5 hydrologic modeling, the period of record has been limited to the 55 years included from January 1, 1939 to December 31, 1993.

Plan of Study (POS): A POS was completed in January 1992 to include scopes of work for completion of the Comprehensive Study.

Programmatic Environmental Impact Statement: A programmatic EIS covers general issues in a broad, program-oriented analysis, and provides the reference basis for future tiered evaluations of specific actions when an allocation formula is implemented.

Projectile point: Generic term for spear or arrowheads.

Range of flows: The action alternatives are represented by high, moderate, and low flow conditions that are intended to bracket the flow conditions that may result from the water allocation formula developed by the State Commissioners or future implementing actions (see *action alternative* and *alternative flow conditions*).

Record of Decision (ROD): The ROD will state the Federal Commissioner's decision to concur or not to concur with the water allocation formula developed by the State Commissioners (see *water allocation formula*). Requirement for Federal agencies to prepare a public decision document that demonstrates consideration of environmental impacts described in the EIS before a decision or a major Federal action. The ROD may also outline additional actions or conditions that may be required prior to implementation of the allocation formula or other management actions in the basin.

River basin compact (compact): The compact is an interstate agreement to equitably apportion the surface waters of the river basin.

River reach: The stream length between control points.

Rock outcrop: Area of exposed bedrock.

Run-of-river project: A project in which the reservoir does not fluctuate on a seasonal basis, or that does not seasonally redistribute flows.

Salinity: Measure of the salt concentration in water.

Settlement pattern: The way in which habitation areas are distributed across the landscape.

Stakeholders: Members of the public and representatives of various interest groups who have differing values and who have a "stake" in the outcome of a project.

Storage project: A reservoir designed to re-regulate natural streamflow, providing more dependable yield during the low-flow season. This involves redistributing flow volumes on a seasonal basis. In general, reservoirs are filled in high-flow seasons (winter and spring), and lowered during low-flow seasons (summer and fall).

Streamflow gauge: Location on a river at which water levels and streamflows are measured.

Subcanopy: Vegetation less than 30 feet tall or 3 inches in diameter in a vegetative community.

Submersed: Plants that are adapted to and normally occur entirely below water.

Surcharge storage: The portion of reservoir storage above the flood control pool that stores water above the emergency spillway.

Tailwater rating: The unique relationship between flow (cfs) and water surface elevation (feet), which exists immediately downstream of a dam.

Tiering: Multi-level approach to preparing National Environmental Policy Act documents. The first tier, or programmatic EIS, covers general issues in a broad, program-oriented analysis. Subsequent tiers incorporate by reference the general discussions from the broader EIS, while concentrating on issues specific to the action being evaluated. Agencies are encouraged to tier EISs to avoid repeating issues and to focus on the issues required for decision at each level of review.

Time step: The division of hydrologic information into incremental units of time for use in HEC-5 modeling.

Trophic level: Classification of organisms in an ecosystem according to feeding relationships.

Unimpaired flow: Historically observed flows adjusted to account for the construction of large surface water reservoirs, withdrawals and returns for municipal and industrial water uses, and withdrawals for crop irrigation.

Unregulated flow: Flows that would be present in a stream, at a specific location, if no reservoirs existed. Also, this definition applies to flows once the effects of a reservoir have been removed by some computational method.

Water allocation formula (allocation formula): As defined by the river basin compact, a means of equitably apportioning the surface waters of the basin while protecting water quality, ecology, and biodiversity.

Water demand scenario (scenario): The water demand scenarios represent assumptions of water consumption. Agreed to by a consensus of the Comprehensive Study partners, the scenarios reflect different levels of water demand and conservation in the basin and are used for purposes of analysis. Estimate of future consumption.

Withdrawal site: Facility that withdraws water from the river system.

Executive Summary

Introduction

This draft environmental impact statement (EIS) was prepared in response to the negotiated interstate agreement among Alabama, Georgia, and the United States under the Alabama-Coosa-Tallapoosa (ACT) River Basin Compact (Compact). This agreement may result in changes in the allocation of surface water within the basin, changes that could have significant impacts on the human and natural environment. As a result, the decision to implement a change in water allocation is considered a significant action and warrants the preparation of this EIS. This EIS, therefore, was developed to provide the information to be used by an appointed Federal Commissioner to either concur or not concur with the water allocation formula that will be developed by the ACT Compact Commission as required under the Compact.

Because the area where these changes may take place is very large and represents multiple reservoirs and basins, this EIS follows a *programmatic* or broad view of these potential impacts. Under the National Environmental Policy Act (NEPA), which provides the guidelines and regulations that define how an EIS is conducted, a *programmatic* EIS is appropriate where the proposed action may result in broad, regional impacts, or if the actual implementing actions are unknown but are likely to result in several predictable actions that could result in cumulative impacts within a study area. Once the decision has been made regarding surface water allocation, specific actions that must be taken to implement the decision must be identified and may require follow-on site-specific environmental assessments (EAs) or EISs tailored to these individual implementing actions.

The allocation formula to be presented to the Federal Commissioner for his decision was not finalized at the time this draft EIS was produced. To provide an evaluation of potential impacts that might arise from the formula when it is finalized, an analytical framework was used in this draft EIS to "bracket" a range of flow scenarios that is expected to include the flow conditions that will result from the final formula adopted by the ACT Compact Commission. These impact analyses will be updated as necessary for the final EIS when the allocation formula has been completed.

This document has been prepared by the U.S. Army Corps of Engineers (Corps) Mobile District in cooperation with 10 other Federal agencies. These other agencies are:

- Environmental Protection Agency
- Fish and Wildlife Service
- Forest Service
- Maritime Administration
- National Marine Fisheries Service
- National Ocean Service
- National Park Service
- Natural Resources Conservation Service

- Southeastern Power Administration
- U.S. Geological Survey

The States of Alabama and Georgia also provided review and comments during preparation of this EIS.

Background

The ACT basin originates in north Georgia and Alabama and terminates in Mobile Bay. It extends approximately 320 miles and encompasses an area of approximately 22,800 square miles. During the last 160 years, the water resources in the basin have been developed to meet various demands for municipal and industrial water supply, flood control, hydropower, navigation, fish and wildlife conservation, recreation, and agricultural water supply. There are hundreds of reservoirs in the basin, but 18 (6 Federal and 12 non-Federal) are located on the three principal rivers: the Alabama, Coosa, and Tallapoosa Rivers or their major tributaries. These reservoirs provide for regional uses of the basin water resources for navigation, hydropower, flood control, water supply, recreation, and fish and wildlife.

Rapid growth in the metropolitan Atlanta area and north Georgia since 1950 has caused large increases in water demands. As a result, the Corps received requests from several local municipalities in the 1980s to reallocate water in its north Georgia reservoirs. Droughts that occurred in 1981, 1986, and 1988 heightened the public's concern and awareness of water management in the basin. In the late 1980s water supply reallocations were being studied by the Corps for Lake Allatoona, Carters Lake, and Lake Lanier. In November 1989, Alabama requested suspension of the reallocation studies pending completion of comprehensive economic and environmental impact analyses. In 1990, the Corps completed the Carters Lake report and recommended reallocation of reservoir storage to water supply for the City of Chatsworth, and the State of Georgia submitted plans for a water supply reservoir on the Tallapoosa River. Subsequently, the State of Alabama filed litigation challenging the proposed water reallocations in north Georgia. The States of Alabama, Georgia, and Florida and the Corps met to resolve this conflict outside the legal system. The initial meetings of the States and the Corps led to initiation of the Comprehensive Study of resources in the ACT basin and in the Apalachicola-Chattahoochee-Flint River Basin (ACF basin) in 1992.

Comprehensive Study

The Comprehensive Study was undertaken by Alabama, Florida, Georgia, and the Corps for both the ACT and ACF basins, as directed by a memorandum of agreement (MOA) among the three States and the U.S. Department of the Army. The study was consensus based, requiring the approval of all participants on all of the elements. The purpose of the Comprehensive Study was:

> *. . . to determine the capabilities of the Water Resources of the basins, to describe the water resource demands of the basins, and to evaluate alternatives which utilize the Water Resources to benefit all user groups within the basins.*

The Comprehensive Study has provided technical understanding of the water resources in both river basins and basin-specific tools to evaluate water management alternatives.

Table ES-1 presents the various elements of the Comprehensive Study that were approved and funded.

TABLE ES-1
Elements of the ACT/ACF Comprehensive Study

Process Support Elements	Water Resources Availability	Water Demand Elements	Comprehensive Management Strategy
Population and employment forecasts	Surface water	Agriculture water demand	Basinwide management
Database	Groundwater	Environmental water demand	Coordination mechanism
Public involvement		Power resources water demand	
		Municipal and industrial water demand	
		Navigation water demand	
		Recreation water demand	
		Water quality water demand	
		Apalachicola River and Bay water demand	

Source: Comprehensive Water Resource Study Partners, September 1995

ACT River Basin Compact

In 1996, Alabama and Georgia agreed to develop and implement an interstate water compact for the ACT basin with the purposes stated above. State negotiations for the compact began in September 1996, with a series of negotiating sessions held through January 1997. On January 13, 1997, each of the States and the Federal government, represented by the Department of Justice, reached agreement on the compact language.

The ACT River Basin Compact was passed by the Georgia legislature in January 1997 and by the Alabama legislature in February 1997. In a joint letter dated May 14, 1997, the three governors submitted the ACT Compact to the three States' Congressional delegations, which introduced the Compact into Congress on June 27, 1997. On November 7, 1997, Congress passed the Compact and sent the bill to the President, who signed it into law (Public Law [PL] 105-105) on November 20, 1997.

The Compact creates an interstate administrative agency, the ACT Basin Commission, which is composed of the Governors of Alabama and Georgia (who make up the State Commissioners), and a Federal Commissioner appointed by the President of the United States.

The Compact directs the parties to the Compact to:

> *. . . develop an allocation formula for equitably apportioning the surface waters of the ACT Basin among the States while protecting the water quality, ecology, and biodiversity of the ACT, as provided in the Clean Water Act, 33 U.S. Code (U.S.C.) section 1251 et seq., the Endangered Species Act, 16 U.S.C. Sections 1532 et seq., the National Environmental Policy Act, 42 U.S.C. Sections 4321 et seq., the Rivers and Harbors Action of 1899, 33 U.S.C. Sections 401 et seq., and other applicable Federal laws.*

After the water allocation formula is developed and unanimously approved by the State Commissioners, it becomes binding:

> *. . . upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner. If, however, the Federal Commissioner fails to submit a letter of concurrence to the Commission within 210 days after the allocation formula is agreed upon by the State Commissioners, the Federal Commissioner shall within 45 days thereafter submit to the ACT Basin Commission a letter of nonconcurrence with the allocation formula setting forth therein specifically and in detail the reasons for nonconcurrence; provided, however, the reasons for nonconcurrence as contained in the letter of nonconcurrence shall be based solely upon Federal law. The allocation formula shall also become effective and binding upon the parties to this Compact if the Federal Commissioner fails to submit to the ACT Basin Commission a letter of nonconcurrence.*

In ratifying the Compact, Congress clarified that:

> *. . . the Federal Commissioner may submit a letter of concurrence with the allocation formula unanimously adopted by the State Commissioners within 255 days of such adoption.*

Purpose and Need

Article VII of the Compact requires the Federal Commissioner to the ACT Basin Commission to concur or not concur with the water allocation formula as developed by the State Commissioners. This EIS evaluates the environmental and socioeconomic impacts of the proposed water allocation formula, including information and analyses provided by the cooperating Federal resource agencies. The EIS will be available to the public, the Federal Commissioner, Federal agencies, and the States to assist them in reviewing or developing an allocation formula. The EIS will form the basis for the Federal Commissioner's decision on the allocation formula approved by the State Commissioners. The EIS will also serve as a baseline document to assist the Corps in making future reservoir management decisions in the basin, and as an information base to assist Federal agencies in managing their programs in the basin.

Scope of the EIS

This EIS focuses on the potential impacts of surface water allocation within the watersheds of the Alabama, Coosa, and Tallapoosa Rivers. The EIS must address the potential impacts of water allocation and future basin management decisions on a very large basin that extends approximately 320 miles from northwest Georgia across Alabama to the mouth of the Mobile River and the Gulf of Mexico. The Alabama, Coosa, and Tallapoosa Rivers, which form this basin, encompass approximately 22,800 square miles. In addition, this EIS evaluates the effects of water allocation on a broad range of resources, including water resources, biological resources, socioeconomic resources, and cultural resources. Potential changes in stream flows associated with the water allocation are evaluated over a long planning period (1995 to 2050) to address incremental changes in water management and future changes that may be required to implement the final water allocation formula, taking into account future demands on water resources in the basin.

To address this wide geographic area and lengthy planning period, this EIS has been prepared as a *programmatic* document. Programmatic EISs are prepared when a proposed action will affect a large geographic area or will be composed of a series of smaller actions that will have similar and potentially cumulative effects, or to allow evaluation of a project early in the planning stages so that changes can be made, if needed, to minimize the potential impacts. Programmatic EISs focus on planning-level and conceptual impacts; they identify the resource areas that will require additional focus in the documents that tier from them. This is done because, when a programmatic EIS is prepared, all of the details associated with the proposed action are often unknown, but it is accepted that a number of smaller actions or projects will be required to complete the proposed action.

For the ACT water allocation, the actual water allocation formula was not available at the time this draft EIS was prepared, but it is assumed that operational changes at some of the reservoirs and lakes within the basin may be required to implement the formula. However, the types of changes that may be required and the reservoirs and lakes that will be affected will not be known until the final water allocation formula is known and the implementation strategy has been prepared. As a result, this EIS focuses on identifying environmental and socioeconomic resources that could potentially be affected by implementing the water allocation formula and describes them in a way that allows a planning-level review of the water allocation formula. Once the details of the water allocation formula are known and the implementation strategy has been prepared, project-specific National Environmental Policy Act (NEPA) documents will be prepared that focus on the environmental and socioeconomic impacts expected to occur once the water allocation formula is implemented at a specific reservoir or lake. The programmatic EIS can also be used as a baseline document for other Federal management actions or programs in the basin. A separate EIS is also being prepared to address impacts of allocation of surface water resources within the ACF basin.

Proposed Action

At the time this draft EIS was prepared, Alabama and Georgia were in negotiations to develop an allocation formula for the equitable allocation of water resources within the ACT basin. Under the ACT Compact between these States, a Federal Commissioner must approve the proposed allocation formula before it can be implemented. The Federal Commissioner's decision to concur or not concur with implementation of the allocation formula represents the proposed Federal action.

Potential Water Allocation Mechanisms

A number of approaches have been used by other states to develop water allocation formulas. The approaches that have been used vary with the type of hydrologic standards used, the time scales over which the hydrologic variables are measured, and the need to determine water availability. Water allocation formulas based on hydrologic standards are typically easier to monitor because they rely on fixed flows or quantities of water at specific locations. The final formula, as stated in the Compact, *"may be represented by a table, chart, mathematical calculation, or any other expression of the Commission's apportionment of water"* (PL 105-105). The final EIS will contain a detailed description of the final negotiated water

allocation formula and the approaches that will be used to allocate the surface water resources in the basin.

Process and Status for Developing the Allocation Formula

The difficult negotiation process to develop an allocation formula for the ACT basin has begun. State Allocation Formula Committee representatives have been appointed by the Governors of the States. A Federal Commissioner has also been appointed by the President as a non-voting member. The committee is holding meetings, which are open to the public, on a regular basis. Initial meetings discussed guiding principles and concepts that will form the basis of a negotiated allocation formula. Draft proposals for an allocation formula have also been presented by State Commissioners for consideration by the Compact Commission.

Proposed Implementation Approach

The approach that the ACT Compact Commissioner will adopt for the final water allocation formula may include a variety of hydrologic, time scale, and water availability allocation approaches. If implementing the water allocation formula requires changes in project authorizations or in how the Corps operates its reservoirs in the ACT basin, new water control manuals and additional NEPA documentation may be necessary to evaluate the site-specific impacts that could result from these specific changes in operation. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as Alabama Power Company, the ACT Commission will work with those entities and the appropriate regulatory agencies to make the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

Alternatives Considered

The alternatives considered for this draft EIS are the no action alternative (existing operating conditions) and a range of alternative flow conditions selected to bracket the water allocation formula to be developed by the State Commissioners. This EIS also presents a review of the historical changes in operations and demands that have occurred since approximately 1977. Operation of the Federal projects in the basin have changed incrementally since the late 1970s, when the last NEPA evaluation of water management in the basin was performed. The analysis of historical operations provides a perspective for evaluating impacts of the existing operating condition (no action alternative).

To provide a basis for evaluating potential flows that could be included in the final water allocation formula and to meet a schedule for completing the final EIS by late summer 1999, this draft EIS uses a *programmatic evaluation framework.* Alternative flow scenarios in this framework provide a range of reservoir operations during critical low flow periods for evaluation. The range of flows resulting from these operations "brackets" or encompasses the flows that may result from the final water allocation formula. To evaluate the potential environmental and socioeconomic impacts associated with different flows, hydrologic modeling of each of the alternative flow scenarios within the high, moderate, and low reservoir release range was compared with operations for the no action alternative. The environmental and socioeconomic impacts associated with this range of operations are expected to bracket or encompass the potential impacts associated with the flows that will

result from the final water allocation formula developed by the States and approved by the Compact.

Continue Existing Operations: The No Action Alternative

As required by NEPA, the no action alternative is the baseline condition against which the action alternative flow scenarios are compared. The no action alternative provides the baseline flows for comparing the impacts of the potential range of alternative flow conditions. The baseline represents the conditions in the ACT basin at the time the Comprehensive Study elements were prepared. In this EIS, the no action alternative assumes that existing project operations will continue unchanged into the future.

Baseline conditions for the no action alternative were also addressed for future water supply demand conditions. There are other approaches that could be considered, such as capping withdrawals at present permitted levels. However, the water supply demands used for the no action alternative were selected from the Comprehensive Study and provide the best current estimates of future water use. The no action alternative is based on current water use patterns, taking into account baseline water supply demands (1995 demand year) and increasing water supply demands in the future (2020 and 2050, future demand years targeted by the Comprehensive Study). ***Table ES-2*** summarizes the demand assumptions used for the no action and action alternative flow scenarios.

The last major evaluations of the environmental consequences of the individual operating reservoirs in the ACT basin were included in the EISs completed in the mid-to late 1970s. Since then, incremental changes have occurred in the project operations and water resource demands that have affected hydropower contracts and operating schedules, navigation flow requirements, and requirements for water quality and environmental demands or other uses of the system. Historical records maintained by the Corps illustrate the impacts of changes in operations or seasonal variations over time on pool levels and flow releases. Comparing historic operations with existing conditions provides a complete picture of the impacts related to changes in water demand and water resource management in the basin, as well as a perspective on existing flows to plan for future changes.

Action Alternative Flow Scenarios

A range of alternative flow conditions was evaluated in this draft EIS using a combination of projected water supply demands, and reservoir releases and operations that would represent the upper (high flow) and lower (low flow) boundaries during the time of year when minimum stream flows normally occur. The current and projected water supply demands were selected from the Comprehensive Study and are presented in ***Table ES-2.*** The range of reservoir operations and releases was varied in the action alternative to provide a wide range of potential stream flows during critical low flow conditions.

Table ES-2 summarizes the three flow conditions evaluated for the action alternative flow scenarios: high, moderate, and low flows. These flow conditions represent the range of foreseeable options for municipal, industrial, and agricultural demand and reservoir operations that could result from the water allocation formula being developed by Alabama and Georgia. The flow conditions using current day demands (1995 demand scenario) were used to evaluate the immediate to short-term environmental and socioeconomic effects that could occur when the water allocation formula is implemented and to provide a baseline for

comparison of future impacts due to increased demand through time. The predicted flows for the years 2020 and 2050 served as the basis for evaluating environmental consequences for future time periods.

TABLE ES-2
Alternatives Considered Applicable to the ACT Basin EIS

		Action Alternative Flow Scenarios		
Year	**No Action Alternative**	**High Flow Conditions**	**Moderate Flow Conditions**	**Low Flow Conditions**
1995	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Note: Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995).

Reservoir releases refers to the operation of reservoirs to maintain or enhance flows in the rivers during critical low flow periods.

High reservoir releases means that the reservoirs will be operated to maintain the highest practicable minimum flows in the rivers during critical low flow periods.

Low reservoir releases means that the reservoirs will be operated to maximize storage within the reservoirs and to provide the lowest reasonable releases or minimum flows in the rivers during critical low flow periods.

A combination of high reservoir releases and low water supply demand comprise the highest flow conditions. The low flow conditions are represented by a combination of low reservoir releases and high water supply demand. Reservoir releases for the moderate flow condition represent reservoir releases between the high and low flow conditions, combined with moderate water supply demands. These combinations of reservoir releases and water supply demands are expected to bracket any water allocation formula developed by the State Commissioners.

Potential Impacts Associated with the No Action and Action Alternatives

The following section provides a summary of the potential impacts on each major resource area.

Geology and Soils

Within the ACT basin are the Cumberland Plateau, Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain physiographic provinces. Geologic features determine both surface topography and groundwater aquifers. Impacts to geological resources under either the no action alternative or the alternative flow scenarios would be insignificant. No direct or cumulative impacts would influence geological features.

Soils are transported through erosion and sedimentation; therefore, variations in stream flow and reservoir elevations would potentially affect soil transport. Under the no action alternative, future water demand would cause minor decreases in stream flow and reservoir elevations through the year 2050. Some increases in sedimentation may result from the reduced stream velocity. These impacts would be similar to those found with the moderate flow scenario.

In the lowest flow scenario, stream releases would be reduced, particularly during dry conditions. Because the energy of stream currents affects movement of sediments in streams, these low flows could result in increased sediment deposition in some stream segments. In the low flow scenario, reservoirs would be maintained at higher, more stable levels. Some additional erosion along shorelines with erodible soils may be expected in some areas in which winds produce wave action affecting these soils.

With the highest flow scenario, stream flows would be higher in summer and lower in winter as compared with other scenarios. The higher summer flows would benefit stream segments with high sediment deposits by transporting these materials downstream. In the reservoirs, water levels would be lower in summer and fall, thereby potentially reducing shoreline erosion problems.

Water Resources

Water Quantity

There are three main rivers in the ACT basin—the Alabama, Coosa, and Tallapoosa Rivers. The Coosa and Tallapoosa join to form the Alabama River about two-thirds of the way downstream in the basin. The Coosa and Tallapoosa Rivers have numerous smaller tributary rivers.

There are 18 dams in the ACT basin, which form 16 major reservoirs (Jordan and Bouldin share a common reservoir and Carters Dam and Carters Reregulation Dam function as a single system). Six dams are Federally owned by the Corps and 12 are privately owned projects. Of the 18 dams, there are 2 on the Coosawattee River, 1 on the Etowah River, 7 on the Coosa River, 4 on the Tallapoosa River, 1 on the Cahaba River, and 3 on the Alabama River.

Water resources in this basin are used to meet a variety of demands, including municipal and industrial, agricultural, hydropower generation, and navigation.

The Corps modeled the no action and action alternative scenarios over a 55-year period of record during which there were low, average, and high precipitation conditions. During average and high flow years, these models indicate that a water allocation formula is not likely to be a significant issue because water quantities should be sufficient to meet demands. During dry periods, allocating flows may have more substantive effects on human and environmental resources. Therefore, the modeling focused on critical low flow periods. Impacts were evaluated for each of four subbasins in the ACT basin to assess potential effects on flowing rivers, reservoirs in each subbasin, groundwater, and flood control. Potential impacts on municipal and industrial water demand, thermal power generation, and agricultural demand were also examined.

With the no action alternative, river flows and reservoirs would be maintained similar to existing conditions, with reservoir drawdowns under dry conditions to augment downstream flows. As demands increase into the future (2020 and 2050), modeling indicated that reservoir elevations would drop significantly, while river flows could be maintained close to flows that were present under 1995 demands. The greatest effect of increased demands on river flows and reservoir levels under the no action alternative would occur in the summer, when inflows are naturally lower.

With the low flow scenario, river flows would be substantially reduced compared with river flows under the moderate flow scenario. Reservoir levels would be maintained near full pool, except under drought conditions. The low flow scenario would affect riverine resources by severely reducing the availability of water to meet municipal and industrial, thermal, and agricultural water demands that use these streams. The availability of navigation flows would be reduced slightly in the low flow scenario.

The moderate flow scenario was established to maintain target flows between the low flow and high flow scenario target flows. The moderate flow scenario produces river flows that are high in the winter, responding to reservoir seasonal drawdowns, and elevated in the summer (compared to natural inflow conditions), as upstream reservoirs augment river flows during the dry summer months.

The high flow scenario would maintain river flows higher in the spring, summer, and fall, but would produce lower flows in the winter compared to flows under the moderate flow scenario. In the high flow scenario, seasonal drawdown of the reservoirs was not included. Seasonal drawdowns under the low and moderate flow scenarios provided an additional source of water to augment flows during the late fall and winter. Without the seasonal drawdown, the modeling of the high flow scenario indicates lower river flows would occur in the late fall and winter. The high flow scenario would provide beneficial impacts on meeting water demands by increasing the amount of water available in rivers compared to the moderate or low flow scenarios. Navigation availability is slightly higher in the summer under the high flow scenario compared to the low and moderate flow scenarios; however, it is dramatically less in the fall. The high flow scenario has less water available for navigation in the fall under the high flow scenario because there is no seasonal drawdown under this scenario. The seasonal drawdown currently provides important augmentation flows for navigation during the fall.

A flood control analysis compared the impacts of reducing current flood control storage in Lake Allatoona by half and the impacts of eliminating it all together. Eliminating half the flood control storage would double flows in the Etowah River just below Allatoona Dam for floods with a 2-year to 500-year recurrence interval. In the Coosa River, flows would increase by about 20 percent. Eliminating all flood control storage in Lake Allatoona would increase downstream flows in the Etowah River by three to four times. In the Coosa River, flows would increase by 50 to 60 percent. Overall, reducing flood control storage in Lake Allatoona would have significant impacts on downstream flows in the Etowah and Coosa Rivers. There are many other reservoirs within the ACT basin that also provide flood control storage. While an analysis of reducing flood control storage was not performed on reservoirs other than Lake Allatoona, it is expected that reducing or eliminating flood control storage at any of these reservoirs would have significant impacts downstream during flood events.

Water Quality

Water quality in the ACT basin varies from generally good in the headwaters to gradually deteriorating water quality as the water flows through urban and agricultural areas toward the coastal zone. Specific river reaches and reservoirs in the basin reflect these changes through local fish advisories, based on nutrient loadings, and State and Federal designations that they do not meet all of their designated uses.

Potential impacts on rivers, reservoirs, and groundwater quality were evaluated for the ACT basin. A direct impact on rivers under the low flow scenario was lower dissolved oxygen. Under the high flow scenario, there would be substantial improvement in river water quality during critical dry periods.

In the reservoirs, the water quality model predicted modest increases in chlorophyll *a* concentrations and nutrient loadings to the reservoirs between 1995 and 2050 under the no action alternative. The model also predicted little difference in reservoir water quality between the action and no action alternative flow scenarios overall. Of the three action alternative flow scenarios, the high flow scenario would produce the highest chlorophyll *a* concentrations and phosphorus loadings and the low flow scenario would produce the lowest reservoir chlorophyll *a* concentrations and phosphorus loadings.

In terms of wastewater discharges, there would be substantial adverse effects on water quality in rivers under the low flow scenario and generally improved water quality under high flow releases because of dilution. Thermal discharges into surface waters would have only localized impacts under any of the flow scenarios; however, for certain existing facilities, the thermal mixing zone requirements in their National Pollutant Discharge Elimination System (NPDES) permits might be exceeded during periods of reduced river flow. Under the low flow scenario, more emphasis could be placed on groundwater resources during extreme drought conditions. These periodic, temporary increases in reliance on groundwater supplies could accelerate the formation of sinkholes. These subsidence features could potentially act as conduits to introduce nonpoint source runoff into the groundwater.

Biological Resources

Vegetation Resources

The vegetation in the ACT basin with potential to be affected by an allocation formula includes primarily bottomland, riparian, and wetland communities associated with riverine systems. The largest percentages of these important habitats in the basin are found along the Alabama River.

Potential impacts on terrestrial communities, freshwater wetlands, and estuarine wetlands were evaluated for the ACT basin. Expected impacts on terrestrial vegetation would be minimal under all alternatives as these habitats are not directly affected by stream flows or water levels. The possible exemption would be the construction of new reservoirs that may be required to meet additional water storage capacity.

A study of representative floodplain freshwater wetlands found that adverse impacts would not be likely to occur on riparian forest systems from any of the alternatives studied. Studies of wetland vegetation adjacent to two representative reservoirs, however, provided evidence that these systems would be affected by changes in reservoir water levels, although the changes in freshwater wetland vegetation communities would stabilize over time. Estuarine wetlands within Mobile Bay would experience the least alteration in community structure under the moderate to high flow scenarios.

Wildlife Resources

The wildlife of interest in the ACT basin relative to potential effects of a particular alternative are primarily those associated with riparian habitats. Terrestrial species that do not depend on reservoir or riverine systems would not be directly affected by any alternative related to the allocation formula. Wildlife that are dependent on these resources are also not expected to be adversely affected by any of the alternatives, since there is expected to be only limited habitat loss for very brief periods of time during critical low flow periods. The ability of many of these species, such as river otter and wood duck, to locate other habitats also reduces the severity of any effects on these species.

Fish and Aquatic Resources

Aquatic systems in the ACT basin provide a wide range of freshwater and estuarine habitats. These habitats support important fish and shellfish resources of recreational and commercial value. Existing uses of the rivers and reservoirs in the basin, such as for flood control and hydropower, affect the distribution and abundance of these aquatic resources.

Potential impacts were evaluated for riverine, reservoir, and estuarine habitat responses to the no action and action alternative flow scenarios. For the riverine habitat assessment, performance measures were developed to evaluate habitat-value functions using the Riverine Community Habitat Assessment and Restoration Concept. Flow scenarios for eight sites in the ACT basin were compared with river depth and velocity conditions that would be expected under unregulated, natural flow conditions. On an annual basis, the moderate flow scenario provides optimal flow conditions for maintenance of riverine habitat, with high flow conditions benefiting aquatic habitat during periods of drought in summer to early fall. In contrast, the no action alternative, on an annual basis, had the lowest scores for riverine habitat.

Performance measures were evaluated for ten mainstem reservoirs to examine differences in potential aquatic resource response for no action and for each of the three alternative flow scenarios. The performance measures were lowest in acceptability for the no action alternative, due to greater water level fluctuations. The low flow scenario would maintain the most stable reservoir levels on an annual basis, and therefore provides the most acceptable conditions for reservoir fisheries. Potential impacts during critical low flow periods were examined to evaluate the magnitude of effects resulting from implementation of the high flow scenario on basin reservoirs. For representative headwater storage reservoirs (Allatoona Lake and Lake Harris), the high flow scenario would substantially affect two consecutive spawning and rearing seasons for largemouth bass, spotted bass, and crappie during years when precipitation was similar to conditions experienced from 1954 through 1960 (critical low flow years of record).

Impacts of a flow allocation formula on the Mobile Bay estuary are expected to be insignificant because any reduction in flow to the Alabama River would be attenuated by additional flow from the Tombigbee River before both rivers converge to enter Mobile Bay.

Protected Species

There are 23 Federally listed threatened or endangered species of animals (including 10 protected species of mussels) and an additional 6 species of Federally protected plants. Most of these species would not be adversely affected by a water allocation formula because their preferred habitats would be unaffected. Protected species habitats in the upper Coosa and Tallapoosa River subbasins would be especially sensitive to adverse effects. If an allocation formula is developed that requires construction of additional water reservoirs, potential impacts to specific reaches of stream are possible. Once the selected water allocation formula has been developed by the States and new reservoir operational conditions determined, additional NEPA documentation will address these site-specific protected species issues. Implementation of a water allocation that requires additional reservoir construction could result in site-specific, indirect, or cumulative impacts on some species. Consultation with FWS under the Endangered Species Act will be addressed in the final EIS.

Fish and Wildlife Management Facilities

The ACT basin includes at least six facilities where water allocation changes could potentially have an effect. These include the William "Bill" Dannelly Lake in Camden, Alabama, Arrowhead Game Management Office and Public Fishing Area in Armuchee, Georgia, and fish hatcheries at Eastaboga and Marion, Alabama, and Summerville, Georgia. Although their water demands are 3.1 mgd, almost 90 percent is obtained from groundwater. Future needs of the Arrowhead Fishing Area and the Summerville Fish Hatchery may not be easily met using surface water under either the no action alternative or action alternative flow scenarios, but options for using additional groundwater resources would mitigate these effects. Therefore, no significant impacts on these resources are likely.

Land Use

The major land uses in the ACT basin are developed land, agricultural land, forests and timber, and water. Future land use conditions were extrapolated using population forecasts developed as part of the Comprehensive Study. From these data, the U.S. Environmental

Protection Agency (EPA) developed a land use forecast for future years. It may be expected that water availability would have an influence on population growth and land use change. However, the effects of water availability were not modeled in this EIS.

The ACT basin includes almost 14.5 million acres, of which approximately 3 percent is residential and 1 percent is classified commercial and industrial. Regardless of the water allocation formula developed for the basin, residential land use is expected to increase by more than 50 percent between 1995 and 2050. Similarly, commercial and industrial land uses are expected to increase during this time period by about 30 percent. Within the ACT basin, therefore, developed land would increase from 4 percent of total area to 5 percent of the total area under any of the alternative water allocation options.

Agricultural lands presently comprise approximately 16 percent of the basin. Most of this acreage is cropland and pasture land. Beef and dairy cattle grazing primarily are practiced in the southern portions of the ACT basin, and there are large rural areas with mixed agricultural uses. Agricultural production land is expected to increase by 11 percent by 2050. This increase represents less than a 1 percent change in the amount of land devoted to agricultural operations.

Forest land in the ACT basin accounts for approximately 78 percent of total land use and includes land within several national forests. The Georgia portion of the Coosa River basin falls within the Cohutta and Armuchee Ranger districts of the Chattahoochee National Forest. In Alabama, the Cahaba River runs through a unit of the Talladega National Forest, and south of Auburn-Opelika, a tributary to the Tallapoosa River runs through Tuskegee National Forest. In addition, Georgia has more privately owned forest land than any other State in the basin. This land use is expected to decline by 4 percent between 1995 and 2050 regardless of changes in water allocation.

Public lands in the ACT basin include state and national parks, state and national forests, wildlife management areas, and Corps lakes that together make up about 705,000 acres. No changes are expected in public lands from any of the alternative flow scenarios.

Contaminated sites and military installations were evaluated for the possibility that they might be affected by the alternatives considered. Based on information from the EPA Superfund database, one of the 11 Superfund sites in the ACT basin is located near the confluence of the Coosa River, Tallasseehatchee River, and Talladega Creek at the U.S. Army Alabama Ammunition Plant in Childersburg, Alabama. EPA records do not indicate that this site is situated within the direct influence of either of these water bodies; therefore, no anticipated environmental consequences to surface water quality are expected from the presence of any of the Superfund sites in the basin. Site-specific evaluation may be required once the water allocation formula has been developed. There are three major military installations in the ACT basin; all are located in Alabama. No impacts are anticipated that would affect military land uses as a result of the water allocation scenarios.

Socioeconomic Resources

Socioeconomic resources evaluated in this report include human population/ demographics, recreation, and economics. General population patterns in the ACT basin were developed from studies completed for the Comprehensive Study. Recreational opportunities from river and reservoir facilities were evaluated for the water allocation flow scenarios. Economic impacts are addressed by study and modeling completed by the Corps.

Population/Demographics

The ACT basin includes 42 counties with a total 1995 estimated population of 2,658,000. Approximately 73 percent of the population resides in the Alabama portion of the basin, and 27 percent is in the Georgia portion. The 1995 population estimates from the Comprehensive Study were used to develop the municipal and industrial water demands for projection of future water needs. The estimated 1995 population differs from the actual 1995 population because it underestimates the rapidly growing bedroom communities, particularly around Atlanta.

Growth in the ACT basin is projected to continue to increase at an average of about 1 percent per year through 2050. At this projected growth rate, by 2050 the basin, will include 4,236,000 people, with 75.5 percent of the people residing in the Alabama portion of the basin and 24.5 percent in the Georgia portion. It would be expected that population growth and demography in the basins will follow water availability. However, since alternative measures for water conservation and supply are feasible for any allocation formula that might be developed, it is not practical at this planning phase to predict a specific change in population distribution, other than projected growth rates.

Therefore, the analyses provided by the Corps assume that projected population growth would not be affected by water allocation and no differences are anticipated from the no action or action alternatives.

No disproportionate adverse effects on children, minority, or low-income populations are expected to occur.

Recreation

Twenty-five recreational study areas were evaluated in the ACT basin to estimate current and future use for boating, canoeing, fishing, and other water-related recreational uses. Five recreational areas are reservoirs operated by the Corps (Carters Lake on the Coosawatee, Lake Allatoona on the Etowah, and three facilities on the Alabama River), nine are reservoirs operated by Alabama Power Company, and six are other representative study sites. Lake Martin is the most heavily used reservoir in the ACT basin, with approximately 2.7 million visitor-days annually.

The effects of each of the alternative flow scenarios on reservoirs were evaluated by comparing the likely number of boat trips visitors might take at different water elevations in the reservoirs for each scenario. Alternative flow scenarios were evaluated for 1995, 2020, and 2050, taking into consideration water consumptive demand projections and population increases. In general, under the no action alternative, visitor use would be expected to increase 50 to 60 percent from 1995 to 2050. Under the low flow scenario, reservoir recreational opportunities would be optimal for most of the year, and less so for moderate and high flow scenarios.

Riverine recreation, such as wade fishing, canoeing, and rafting, depend on optimal stream and river depth and flow velocity. Because most of these activities take place in summer, the high flow scenario would provide the best riverine conditions by releasing water from reservoirs at this season, as compared to less desirable conditions that might result from either the moderate or low flow scenario.

Economics

Potential economic effects of implementing a water allocation formula were evaluated using the Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Construction Engineering Research Laboratory. The EIS focuses on the economic impacts of the no action as compared to the action alternative flow scenarios on municipal and industrial water supply, navigation, hydropower generation, agricultural water supply, recreation, and employment.

Municipal and industrial facilities in the basin depend on water supplies from reservoirs and rivers for water supplies, cooling water, irrigation, and in-production processes. These water uses have significant economic effects on the operation and continued growth of these areas. Although the low flow scenario has the most adverse impact, with an Average Annual Equivalent impact of $1.3 million, and the high flow scenario provides a benefit of approximately $2.4 million, these effects are considered insignificant and reflect only small, seasonal effects for either of the action alternatives.

Barge traffic for waterborne commerce in the ACT basin has been decreasing since the late 1980s when severe droughts adversely affected navigation channel conditions and competitive rates became available for other modes of transportation. Alabama River traffic is almost entirely related to forest products and pulp (85 percent of commerce). Annual transportation costs did not differ significantly for no action and the flow scenarios that ranged from low flow to high flow; therefore, no significant impacts are expected for any of the alternative flow conditions.

The ACT rivers are heavily developed for hydropower generation, with 15 facilities providing a total power capacity of 1,819.5 megawatts (MW). Thermal (steam) generation accounts for 77 percent of the basin's electrical power resource; hydropower and pumped storage make up the remaining 23 percent. The analyses for this draft EIS indicated that the high flow scenario produced greater benefits to hydropower production than no action or either of the other flow scenarios because it did not have a seasonal drawdown for flood control; consequently, the net available head was greater during high flows for future energy production.

Potential economic impacts on the agricultural water supply were evaluated by the Natural Resources Conservation Service (NRCS). Surface water and groundwater are used almost equally to meet agricultural irrigation demands for crops (particularly corn and peanuts) and orchards in the Alabama portion of the basin. The NRCS study indicated that irrigation is not heavily used in the Alabama portion of the ACT basin; consequently, the limited amount of surface water used for agriculture is sufficient for either no action or any of the alternative flow scenarios considered, and no economic impacts would occur.

The Corps includes flood control as a major focus for operating its reservoirs. Both the no action alternative and the action alternative flow scenarios hold flood control storage constant, so the potential impacts are zero when the alternative flow scenarios and the no action alternatives are compared. In a separate analysis, the Corps evaluated the impacts of reducing flood control storage at Lake Allatona in half as well as completely eliminating the storage. If flood storage were eliminated at Lake Allatoona, the potential property damage downstream of the dam would be over $4.8 million.

A survey of registered boaters was conducted to estimate per-trip spending at each of the study projects in the ACT basin. Logan Martin Lake accounted for the highest total annual spending, and Lake Allatoona's recreational use had the greatest total annual National Economic Development benefit. The low flow scenario had higher reservoir pool levels with less seasonal drawdown and provided the greatest recreation value.

A similar economic evaluation has not been made for recreational fisheries. However, because comparison of the alternative flow scenarios with the no action alternative indicates only minor direct effects that are likely for these resources, it would be expected that there also would be minimal impacts on economic impacts related to recreational fisheries.

Income and employment in the ACT basin have shown steady growth from 1975 to 1995. The greatest increases occurred from 1975 to 1985, with slower growth in the last decade. Per capita income is somewhat higher in the Alabama portion of the basin than in the Georgia portion of the basin. More than 80 percent of all jobs in the ACT basin are provided by the private sector. To evaluate regional economic impacts from the alternatives, the EIFS model was implemented. According to this study, none of the flow scenarios modified the expected business volume, personal income, or employment by as much as 0.1 of a percentage point; therefore, no significant impacts are anticipated from the modeled alternative scenarios.

Air Quality and Noise

Potential impacts of a water allocation formula on air quality and noise were evaluated for the ACT basin based on existing conditions and information available from EPA on national air quality standards and typical noise levels for different land uses. Air quality is generally good throughout most of the basin. The water allocation formula is not expected to result in any direct adverse effects on regional air quality, although indirect impacts are possible where demographics or land use changes occur as a result of an allocation formula, or if power generation sources change from hydropower to thermal generating plants utilizing fossil fuels.

The existing noise levels in the ACT basin were estimated by evaluating the percentage of the population residing in areas in which outdoor day/night average sound levels typically exceed 60 decibels (dB). The majority of people living in urban areas were found to have outdoor sound levels less than 60dB. Because population growth and increased urbanization were assumed to be independent of a water allocation formula, no impacts on noise are anticipated from either the no action alternative or the action alternative flow scenarios.

Cultural Resources

To evaluate potential impacts on cultural resources in the ACT basin, the Mobile District Corps summarized existing data on known cultural resources and estimated potential impacts on the resources from a change in water management. The period of evaluation of possible impacts for this study is 1995 through 2050; therefore, some standing structures that are relatively new today may be considered of historical importance near the end of this study period. The evaluation of impacts focused on three potential effects of changes in water level management: erosion, deposition of sediment, and access.

The primary characteristics affecting potential negative impacts on cultural resources is erosion around reservoir edges and in waterways or increased access to sites. The no action alternative was estimated to have the least adverse effect on existing cultural resources. Of the action alternative flow scenarios, the low flow scenario reservoir levels would remain more stable and downstream flows would have lower velocity, hence less opportunity to cause erosion of archeological sites.

Potential Mitigation Measures

The Council on Environmental Quality (CEQ) requires Federal agencies, in preparing an EIS, to address appropriate mitigation measures that are not included specifically as part of the proposed action or alternatives evaluated in the EIS (Title 40 of the *Code of Federal Regulations,* Part 1502.12 and 1502.16 [40 CFR 1502.14 and 1502.16]). Mitigation measures can include actions taken to avoid, offset, reduce, or compensate for adverse effects on the environment that may potentially result from implementation of a proposed action.

Proper consideration of mitigation requires that a full range of measures be identified (including, where appropriate, alternative means to mitigate a single impact), along with the cost of the measures, and their effectiveness in reducing the level of impact. The draft EIS includes the process that will be followed to identify appropriate mitigation options and the types or categories of mitigation that might be appropriate for certain types of expected impacts. The Corps, the cooperating agencies, and the States will evaluate the potential mitigation options presented in the final EIS once a proposed allocation formula is known. The justification of recommended mitigation measures will be based on the environmental and socioeconomic analyses presented in the final EIS and regulatory agency requirements. Mitigation measures may be the responsibility of the government or nongovernment agents, the Corps, private interests, or State or local governments. For example, the Corps may initiate habitat enhancement projects at Federal facilities to offset impacts on spawning areas adversely affected by changes in lake levels; or, more stringent State-imposed regulatory programs may be implemented to control point source or nonpoint source discharges to stream segments.

Regulatory Compliance

Compliance with environmental regulations is important in considering concurrence with or implementation of a water allocation formula. Changes in project authorizations may be required before the final water allocation formula can be implemented. It is expected that any changes required in the authorizations or operations at Corps facilities in the ACT basin will be in compliance with Federal laws and regulations. If additional NEPA documents are required to support changes in project authorizations or changes in operations at Corps facilities in the ACT basin, the status of regulatory compliance will be addressed in those documents.

1. Purpose, Need, and Scope

1.1 Introduction

This environmental impact statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps) Mobile District in cooperation with 10 other Federal agencies because Alabama, Georgia, and the United States, represented by the Department of Justice (DOJ), have negotiated an interstate water Compact for the Alabama-Coosa-Tallapoosa (ACT) river basin, which may result in changes in the allocation of water resources within the river basin. The stated purposes of the Compact, entered into by Alabama and Georgia, are:

> *. . . promoting interstate comity, removing causes of present and future controversies, equitably apportioning the surface waters of the ACT, engaging in water planning, and developing and sharing common databases*

This EIS has been developed to provide information that will serve as a basis for concurrence or nonconcurrence of a Federal Commissioner with a water allocation formula for allocation of water resources to be developed jointly by the States, as required by the interstate water Compact. At the time this EIS was prepared, there was no identified preferred action or alternative for an allocation formula. As a result, this EIS evaluates a range of alternative flow conditions projected to "bracket" a future allocation formula condition. Impacts for the range of flow conditions are addressed in this EIS. It is expected that impacts resulting from the final water allocation formula will fall within the range of impacts presented in this EIS.

The States of Alabama, Florida, and Georgia are also developing a water allocation formula for the Apalachicola, Chattahoochee, and Flint (ACF) River Basin, which is adjacent to the ACT basin. Simultaneously, the Corps is preparing an EIS to support the Federal Commissioner's decision on the water allocation formula being developed by the States for the ACF basin.

The following Federal agencies have agreed to act as cooperating agencies in preparing the EIS:

- Environmental Protection Agency
- Fish and Wildlife Service
- Forest Service
- Maritime Administration
- National Marine Fisheries Service
- National Ocean Service
- National Park Service
- Natural Resources Conservation Service
- Southeastern Power Administration
- U.S. Geological Survey

The States of Alabama and Georgia also provided input, review, and comments during the preparation of this EIS. The following sections summarize the events that led to developing the interstate water Compact.

1.1.1 Background

Historically, there has been adequate water to meet the needs of most users in the ACT basin. However, with increased growth and development, the droughts of 1981, 1986, and 1988 created greater competition among users than had been experienced before.

During the 1981 drought, hydropower production was reduced and municipalities and industries were required to implement water conservation measures. Recreational use of reservoirs was also limited. Although Birmingham, Alabama, received 70 percent of the normal rainfall expected for the year, flows in the Alabama River below Claiborne, Alabama, were below normal, and navigation was adversely affected.

During the 1986 drought, water quantities entering Carters Lake and Lake Allatoona were only one-third of what would typically be expected. Streamflows in the Etowah River during July and August of 1986 were the lowest observed in 58 years. The Governor of Alabama formed a Drought Task Force consisting of Federal and State agencies, as well as industry and other interests. This task force was responsible for organizing and coordinating drought response actions in the ACT basin. The most significant action taken by the task force was to reduce the minimum flows at 11 Alabama Power Company dams by 25 percent.

During the 1988 drought, the quantity of water entering Lake Allatoona and Carters Lake was 41 percent and 35 percent, respectively, of what would typically be expected. Beginning in May 1988, only minimum releases for navigation were made from the Alabama Power Company reservoirs. By July, releases from Alabama Power Company hydroelectric facilities were reduced to levels necessary to maintain water quality and water supply needs. As a result, flows were insufficient to maintain a 7-foot navigation channel in the Alabama River until September 1988, when precipitation returned to near-normal levels. The Governor of Alabama again created an Alabama Drought Task Force to coordinate response to the drought.

The periods of drought experienced in the 1980s directly demonstrated the competing demands for water in the region. These droughts resulted in numerous adverse effects, including those to industrial water supply, navigation, power production, agricultural production, water quality, and fish and wildlife maintenance. During these drought periods, recreational interests and fish and wildlife habitat suffered adverse impacts as lakes in the ACT basin experienced substantial drawdowns. For example, Lake Allatoona recorded lowest lake levels (821 feet), as compared with normal summer elevations (840 feet). Restrictive measures were instituted on water use to conserve it for drinking water; inland navigation was curtailed because of protracted low-flow conditions; agricultural crops were heavily damaged or lost completely in some areas; and almost all of the residents in the region experienced some level of hardship and inconvenience.

1.1.2 Competing Water Interests

Considerable growth has occurred in the Atlanta-metropolitan area, located in the upper part of the ACT basin since 1950. The population in this area increased from less than 500,000 in 1950 to almost 3 million by 1990. This increase in population has resulted in a commensurately increased demand for water resources.

As early as 1982, the Corps received water supply withdrawal requests from the City of Chatsworth to withdraw water from Carters Lake, from the City of Cartersville to withdraw water from Lake Allatoona, and from the Cobb County-Marietta Water Authority to

withdraw water from Lake Allatoona. In response to these requests, the Corps began preparing water supply reallocation reports to address the effects of the reallocation of existing storage in each reservoir from hydropower to water supply.

Public meetings were held in August, October, and November of 1989 to solicit input on the proposed water reallocations at Lake Allatoona and Carters Lake. The public and reviewing agencies identified the following issues:

- Cumulative environmental and economic impacts from the reallocations
- Impacts on downstream water supply, hydropower, navigation, water quality, recreation, and fish and wildlife resources
- Impacts and amount of interbasin transfer
- Need for comprehensive baseline studies of the ACT basin
- Need for environmental impact statements to evaluate the proposed reallocations

In November 1989, the Governor of Alabama wrote to the Corps' South Atlantic Division Engineer, requesting a suspension of the reallocation activities. The State of Alabama also requested that its Congressional delegation intercede to prevent the Corps from moving forward with the reallocation of water from Carters Lake and Lake Allatoona until a comprehensive economic and environmental impact analysis was completed. Alabama was equally opposed to the proposed reallocation at Lake Lanier. The Chair of the House Appropriation Subcommittee for Energy and Water Development then requested that the Corps develop a conceptual plan to accomplish the study requested by Alabama.

The Corps provided the requested conceptual study plan to the House subcommittee in February 1990. The plan was subsequently provided to Congressional and other interests in Alabama and Georgia for review. The plan called for a two-phase approach: (1) a short-term management plan to address immediate water supply needs, and (2) a long-term or comprehensive management plan to address the long-term water needs.

In May 1990, the Corps completed the Carters Lake water supply reallocation report that recommended the reallocation of reservoir storage to provide water supply for Chatsworth, Georgia. In June 1990, the State of Georgia filed a Section 404 permit application with the Corps to construct the West Georgia Regional Reservoir on the Tallapoosa River, approximately 5 miles upstream from the Alabama-Georgia State line. Three days after Georgia filed the application for the new reservoir, Alabama filed litigation against the Corps, challenging the adequacy of its application of the National Environmental Policy Act (NEPA) process with respect to proposed water supply reallocations at Carters Lake, Lake Allatoona, and Lake Lanier. The lawsuit also alleged that the Corps violated its duty to operate these reservoirs in a neutral and objective manner consistent with Congressional mandates.

Shortly after Alabama filed litigation against the Corps, representatives from Alabama and Georgia, later joined by the Corps, began discussions that sought to resolve the conflicts between the two States. Because similar problems were occurring in the neighboring Apalachicola-Chattahoochee-Flint (ACF) basin, Florida joined the discussions in September 1990. During the discussions, the parties agreed that litigation was the least desirable option for resolving the water resource conflicts. The States agreed that the best approach would be a Federally funded Comprehensive Study to address issues in both the ACT and ACF

river basins, to provide factual information on water availability, to forecast water needs, and to explore options to meet the identified needs, provided that concerns about objectivity and impartiality, as well as other state-specific needs, could be met. Subsequent to this tentative agreement, Alabama requested that the U.S. District Court defer the litigation while settlement negotiations continued.

1.1.3 Letters of Agreement

Two letters of agreement (LOAs) have been completed since Alabama and Georgia began developing cooperative approaches to resolve their water resource conflicts. These LOAs are summarized in the following discussion, and copies of the documents are provided in *Appendix A*.

In April 1991, an LOA was completed between Alabama and Georgia to formalize cooperation between the States. It included commitments to allow Cartersville and Chatsworth to expand water withdrawals to meet immediate needs; agreements on objectives and participation by Alabama and Georgia in the Comprehensive Study for the ACT and ACF basins; and agreements to stay further actions of the civil suit by Alabama. The LOA also superseded reallocation proposals that were underway for Lake Allatoona and Carters Lake, and included an agreement that Georgia would withdraw its request for permits to construct the West Georgia Regional Reservoir. A second LOA was completed between these two States in November 1996, providing for additional water withdrawals by Cartersville to accommodate the water demands of an existing industry. This agreement also extended the time before which Georgia could submit permit applications for the West Georgia Regional Reservoir until various aspects of the Comprehensive Study were completed. Subsequently, the West Georgia Regional Water Authority Chairman issued a public notice of intent to postpone filing for a Section 404 Permit Application for the West Georgia Regional Reservoir until agreement by the States was reached for an ACT basin water allocation, or December 31, 1998, whichever comes first.

1.1.4 Memorandum of Agreement

On January 3, 1992, the governors of Alabama, Florida, and Georgia, and the Assistant Secretary of the Army for Civil Works (ASA(CW)) signed a memorandum of agreement (MOA), committing to work together as partners through the Comprehensive Study process to seek resolution of water resource issues. The MOA was developed to formalize the partnership between the States and the U.S. Army Corps of Engineers to work together to develop technical information related to water resources in the ACT and ACF basins, and to recommend a coordination mechanism. Including specific study elements that would be required in the Comprehensive Study, the MOA also contained provisions governing the operations of the reservoirs, water allocations, and the litigation filed by Alabama during the preparation of the Comprehensive Study. Partners were required to develop a mechanism or mechanisms to implement the findings or recommendations of the Comprehensive Study. The MOA culminated 18 months of intense negotiations. *Appendix A* provides the full text of the MOA.

Before signing the MOA, the States and the Corps jointly prepared a plan of study (POS) to determine the scope for the Comprehensive Study. The draft POS was prepared and furnished to the public for review and comment. Using the draft POS as a starting point, a series of 11 public meetings were conducted in the two basins. The draft POS was revised, based on comments received at the public meetings, and was approved by the States and the Corps as the official guidance document for completing the Comprehensive Study.

This document was followed by five supplemental MOAs. The first was executed on January 18, 1994, and modified the agreement by agreeing to complete the Comprehensive Study by September 30, 1995, rather than 3 years after the Comprehensive Study Plan was completed. The next supplemental MOA, issued on April 7, 1995, extended the date for completing the Comprehensive Study by one year, to September 30, 1996. The September 24, 1996, supplement to this MOA recognized that all parties agreed that it was in their best interest to pursue interstate Compacts between Alabama and Georgia for the ACT basin and between Alabama, Florida, and Georgia for the ACF basin. The September 30, 1996, supplement made minor modifications to the MOA and extended the time to complete the Comprehensive Study to December 31, 1997. The latest supplemental MOA, dated November 20, 1997, reaffirmed the binding of the States to the agreements of the MOA until the Comprehensive Study was completed, and extended the date for completing the study to September 30, 1998. These supplemental MOAs are also included in *Appendix A*.

1.1.5 Comprehensive Study

The Comprehensive Study was undertaken by Alabama, Florida, Georgia, and the Corps for both the ACT and the ACF basins, as directed by the MOA described in Section 1.1.4. The study was consensus-based and, as a result, a number of extensions were required and approved to complete the technical investigations needed to support the development of a water allocation formula. As expressed in the POS, the purpose of the Comprehensive Study is to:

> *. . . determine the capabilities of the Water Resources of the basins, to describe the water resource demands of the basins, and to evaluate alternatives which utilize the Water Resources to benefit all user groups within the basins.*

The Comprehensive Study has provided technical understanding of the water resources in both river basins and basin-specific tools to evaluate the water management alternatives. The goal of the Comprehensive Study is to:

> *. . . develop relevant technical information, strategies, and plans, and recommend a formal coordination mechanism for the long-term, basinwide management and use of the water resources to meet the environmental, public health, and economic needs of the basins.*

Table 1-1 presents the various elements of the Comprehensive Study that were approved to be evaluated and funded by the study partners. Brief descriptions of each of the elements follow the table.

1.1.5.1 Process Support Elements

1.1.5.1.1 Population and Employment Forecasts

This element developed an economic model to provide forecasts of key economic and population variables. Based on the forecasts, the estimated demand for municipal, industrial, and recreational use of water was calculated.

1.1.5.1.2 Database

The database development element created a common database for the Comprehensive Study. The database consists of historical and forecasted water flow and water quality data, tables, reports and other text documents, and Geographic Information System (GIS) data.

TABLE 1-1
Elements of the Comprehensive Study

Process Support Elements	Water Resources Availability	Water Demand Elements	Comprehensive Management Strategy
Population and employment forecasts	Surface water	Agriculture water demand	Basinwide management
Database	Groundwater	Environmental water demand	Coordination mechanism
Public involvement		Power resources water demand	
		Municipal and industrial water demand	
		Navigation water demand	
		Recreation water demand	
		Water quality water demand	
		Apalachicola River and Bay water demand	

Source: Comprehensive Water Resource Study Partners, September 1995

Database management standards were developed to ensure that the data is easily accessible and usable by all of the members of the Comprehensive Study team.

1.1.5.1.3 Public Involvement for the Comprehensive Study

An extensive public involvement program was developed for the Comprehensive Study. The objectives of the program have been to:

- Involve interested persons within each State and basin in the development of the POS and the comprehensive basin planning process.
- Obtain views and concerns from interest groups and the general public by holding public meetings and workshops to receive comments and identify issues during the study.
- Provide reports, share study outputs, and solicit comments from interested persons regarding the results of technical investigations and other aspects of the study.
- Prepare and distribute news releases and secure media coverage during the study.

Each of the Federal and State study participants was responsible for identifying and soliciting participation from individuals and groups throughout the Comprehensive Study process. This was accomplished in a number of ways, including task forces and work groups that reviewed and commented on scopes of work for specific study elements, as well as reviewed and provided comments on draft reports for those study elements. A series of 11 joint-basin meetings were held throughout the States to discuss the various elements of the Comprehensive Study. The States also held a series of other meetings and conferences to solicit input on specific study elements and to allow opposing stakeholder groups to interact and better understand each other.

1.1.5.2 Water Resources Availability

1.1.5.2.1 Surface Water

The surface water availability study quantified the amount of water in the streams and reservoirs in the ACT and ACF basins. Specifically, the study determined the existing and future availability of surface water within the ACT and ACF basins; conceptually determined how the ACT and ACF basins respond to variations in weather, river management, and water use; and provided simulated flow data for use in other study elements.

1.1.5.2.2 Groundwater

The groundwater availability study quantified how changes in surface and groundwater quantities in one part of the basin affect the quantity of surface and groundwater available in other parts of the basin. The study also identified where groundwater resources are being under- or overused, identified where groundwater could be used in place of surface water, and established water budgets for eight sub-areas in the ACT and ACF basins that show the amount of water that enters and leaves each basin and the sources of water inputs and withdrawals or other losses.

1.1.5.3 Water Demand Elements

1.1.5.3.1 Agricultural Water Demand

The agricultural water demand study forecast the quantities of water that would be needed to support agricultural activities from 1995 to 2050 in a normal year. The study element evaluated water needs for six basic agricultural categories: crops and orchards, turf farms, nurseries, aquaculture, livestock, and poultry.

1.1.5.3.2 Apalachicola River and Bay Water Demand

Although not directly related to the ACT basin, this element of the Comprehensive Study provided information to determine how much fresh water is needed to support the biota of the Apalachicola River and Bay ecosystems. Five separate studies were completed to determine how much water would be required. A three-dimensional model was developed for Apalachicola Bay, which predicts changes in the physical characteristics of the bay, such as salinity and circulation, that result from changes in the amount of freshwater flowing into the bay.

1.1.5.3.3 Environmental Water Demand

The environmental water demand study identified significant environmental water needs and described the environmental effects of potential changes in water management on resources. The study evaluated the effects of changes in water management on riverine resources (including anadromous fish), riparian wetlands habitat, reservoir fisheries habitat, protected species, and fish and wildlife management facilities (refuges, hatcheries, etc.).

1.1.5.3.4 Municipal and Industrial Water Demand

The municipal and industrial water demand study forecast the demand for water by municipalities and industries in the ACT and ACF basins through the year 2050. For the purposes of the study, municipal and industrial water use included all water uses, both public and self-supplied, described as residential, commercial, governmental, institutional, industrial, manufacturing, and other unaccounted-for uses. No agricultural demands were included in this study.

1.1.5.3.5 Navigation Water Demand

The navigation water demand study determined the amount of water required to support Congressionally authorized navigation projects in both the ACT and ACF basins. This was accomplished by developing an inventory of physical characteristics and navigation facilities in the basins; defining and describing the historic and current relationships between the availability of a navigation channel and river flows; determining how frequently the navigation channel has been used for barge traffic and predicting future use through the year 2050; examining the effect of various flow conditions on commercial barge traffic through the year 2050; forecasting water needs to support authorized navigation projects; and determining the economic relationships to navigation associated with various alternative modifications to the water resources in the two basins.

1.1.5.3.6 Power Resources Water Demand

The power resources water demand study described and quantified the existing power plant operating conditions in the basins for both the hydropower generating units and the coal, gas, and nuclear power facilities that rely on the rivers in the basin for cooling water. The study also estimated the electric load and resource needs for 1995, 2000, 2010, 2020, and 2050, as well as the need for and potential location of additional generating capacity. The potential effects of alternative flow conditions in the basin on power generation were also evaluated in the study.

1.1.5.3.7 Recreation Water Demand

The recreation water demand study used registered boat owners in the basin as a surrogate for recreational users of the reservoirs and lakes. The purpose of the study was to determine if there was a statistically significant relationship between reservoir levels and recreational use. The study also included an impact assessment, showing how recreational boaters would alter their recreational use of a specific lake based on changes in water level resulting from different management scenarios.

1.1.5.3.8 Water Quality Water Demand

The water quality water demand study described and quantified the existing and projected water quality conditions. The study also evaluated the effects of different water management alternatives on water quality in the basin. This study also included an inventory of water quality data from 1980 to 1993, compilation of existing point source water quality data, and projection of wastewater loading through the year 2050. Water quality modeling included development of a one-dimensional basinwide water quality model and more detailed two-dimensional models for Walter F. George, Weiss, and Neely Henry Lakes.

1.1.5.4 Comprehensive Management Strategy

1.1.5.4.1 Basinwide Management

The basinwide management study had a number of objectives, including addressing the water resource problems in the basin through 2050 for a wide range of hydrologic conditions; developing potential solutions for the projected problems and predicting the outcomes of implementing combinations of alternatives; measuring the effectiveness of the alternatives; analyzing the cumulative effects of a reasonable number of alternatives; and describing basinwide management strategies that can be used to address the water demands within the basin.

1.1.5.4.2 Coordination Mechanism

The coordination mechanism study addressed the requirement of the 1992 MOA for an appropriate coordination mechanism or mechanisms to implement the findings of the Comprehensive Study. A coordination mechanism is an arrangement, agreement, or response that governs how managers interact in the process of managing natural resources, such as water. The first phase of this study collected information on past coordination mechanisms and evaluated them for their applicability to the ACT and ACF basins. Through facilitated workshops, the States agreed to pursue interstate water compacts for both the ACT and ACF basins.

1.1.6 ACT River Basin Compact

In 1996, Alabama and Georgia agreed to develop and implement an interstate water Compact for the ACT river basin. The purposes of the Compact are to:

> *. . . promote interstate comity, removing causes of present and future controversies, equitably apportioning the surface waters of the ACT, engaging in water planning, and developing and sharing common data bases.*

State negotiations regarding the Compact began with a series of negotiation sessions held from September 1996 to January 1997. On January 13, 1997, each of the States and the Federal government, represented by the Department of Justice, reached agreement on the Compact language. The ACT River Basin Compact was passed by the Georgia legislature in January 1997 and by the Alabama legislature in February 1997. In a joint letter dated May 14, 1997, the two governors submitted the ACT Compact to the two States congressional delegations, who introduced the Compact into Congress on June 27, 1997. The Congress passed the Compact and sent the bill to the President on November 7, 1997. The President signed the ACT River Basin Compact into law (PL 105-105) on November 20, 1997 (***Appendix A***).

The Compact states that:

> *This Compact shall extend to all of the waters arising within the drainage basin of the ACT in the States of Alabama and Georgia. The parties to this Compact are the States of Alabama and Georgia and the United States of America.*

The Compact creates an interstate administrative agency, the ACT Basin Commission, composed of the Governors of Alabama and Georgia (who make up the State Commissioners), and a Federal Commissioner appointed by the President of the United States.

> *Each State shall have one vote on the ACT Basin Commission and the Commission shall make all decisions and exercise all powers by unanimous vote of the two State Commissioners. The Federal Commissioner shall not have a vote but shall attend and participate in all meetings of the ACT Basin Commission to the same extent as the State Commissioners.*

The ACT River Basin Compact directs the parties to the Compact to:

> *. . . develop an allocation formula for equitably apportioning the surface waters of the ACT Basin among the States while protecting the water quality, ecology, and biodiversity of the ACT, as provided in the Clean Water Act, 33 U.S. Code (U.S.C.) Sections 1251 et seq., the Endangered Species Act, 16 U.S.C. Sections 1532 et seq., the National Environmental Policy*

> *Act, 42 U.S.C. Sections 4321 et seq., the Rivers and Harbors Act of 1899, 33 U.S.C. Sections 401 et seq., and other applicable Federal laws.*

After the water allocation formula is developed and unanimously approved by the State Commissioners, it becomes binding:

> *. . . upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner. If, however, the Federal Commissioner fails to submit a letter of concurrence to the Commission within 210 days after the allocation formula is agreed upon by the State Commissioners, the Federal Commissioner shall within 45 days thereafter submit to the ACT Basin Commission a letter of nonconcurrence with the allocation formula setting forth therein specifically and in detail the reasons for nonconcurrence; provided, however, the reasons for nonconcurrence as contained in the letter of nonconcurrence shall be based solely upon Federal law. The allocation formula shall also become effective and binding upon the parties to this Compact if the Federal Commissioner fails to submit to the ACT Basin Commission a letter of nonconcurrence.*

In ratifying the Compact, Congress clarified that:

> *. . . the Federal Commissioner may submit a letter of concurrence with the allocation formula unanimously adopted by the State Commissioners within 255 days of such adoption.*

1.2 Purpose and Need

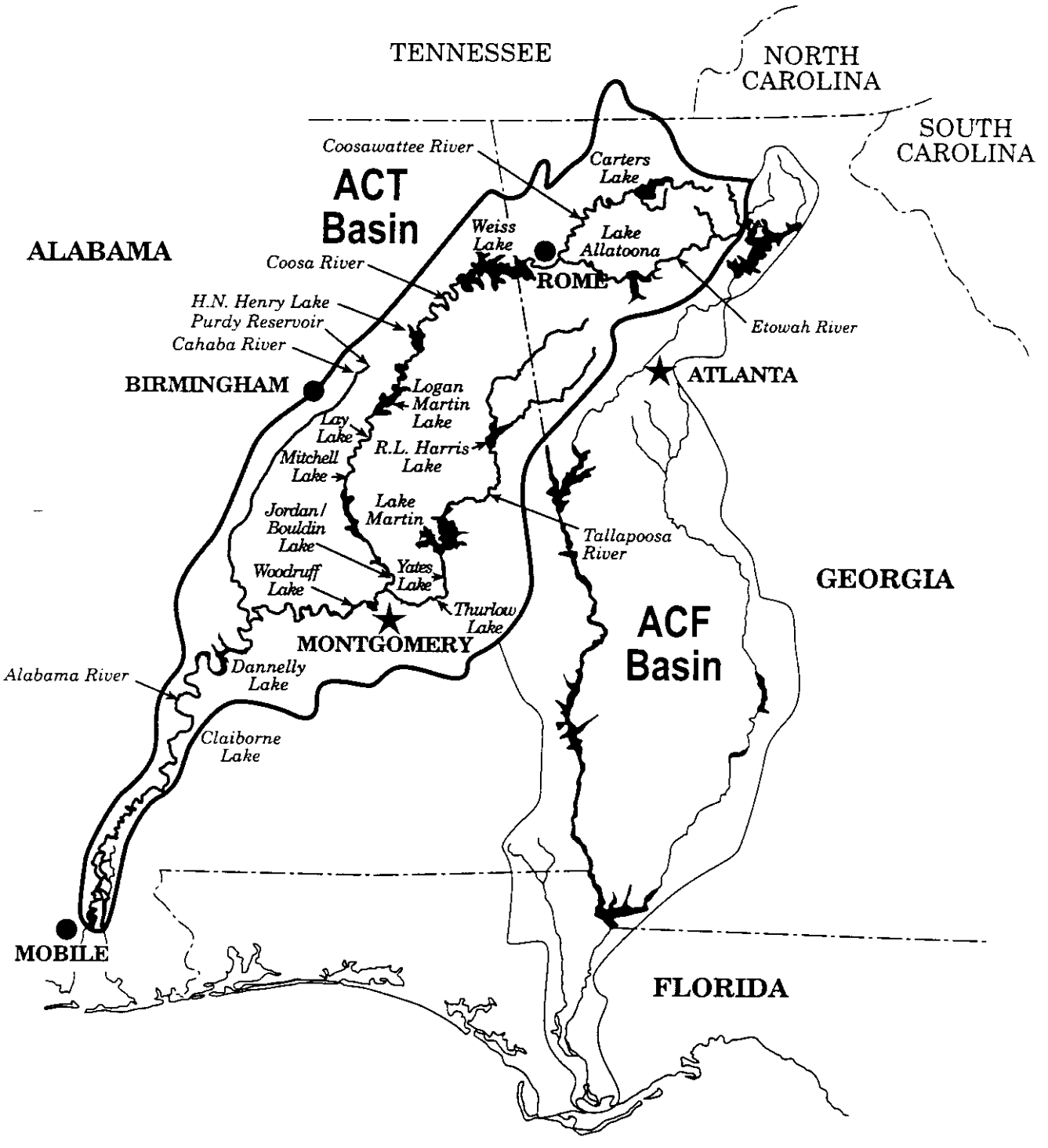
Article VII of the ACT River Basin Compact requires the Federal Commissioner to concur or not concur with the water allocation formula as developed by the State Commissioners. The overall purpose of the allocation formula is to fulfill multi-purpose water resource needs while balancing environmental interests.

This EIS will evaluate the environmental and socioeconomic impacts of the proposed water allocation formula, including information and analyses provided by the cooperating Federal agencies. The EIS will be available to the public, the Federal Commissioner, Federal agencies, and the States to assist them in reviewing or developing an allocation formula. The EIS will form the basis for the Federal Commissioner's decision on the allocation formula approved by the State Commissioners. The EIS will also serve as a baseline document to assist the Corps in making future reservoir management decisions in the basin, and as an information base to assist Federal agencies in managing their programs in the basin.

1.3 Scope of EIS

This EIS will focus on the potential impacts of surface water allocation within the watersheds of the Alabama, Coosa, and Tallapoosa Rivers, including Mobile Bay (***Figure 1-1***). The EIS must address the potential impacts of water allocation formula and future basin management decisions on a very large basin that extends approximately 320 miles from northwest Georgia across Alabama to the mouth of the Mobile River and the Gulf of Mexico. The watershed of the Alabama, Coosa, and Tallapoosa Rivers, which form this basin, encompasses approximately 22,800 square miles. In addition, the EIS evaluates the effects of the water allocation formula on a broad range of resources, including water resources, biological resources, socioeconomic resources, and cultural resources. Potential changes in stream flows associated with the water allocation formula will be evaluated over

FIGURE 1-1
Site Map of the ACT Basin



a long planning period (1995 to 2050) to address incremental changes in water resource management and future changes that may be required to implement the final water allocation formula, taking into account future demands on water resources in the basin. To address this wide geographic area and lengthy planning period, a *programmatic* EIS will be completed. A separate EIS is being prepared to address impacts of the allocation of water resources in the ACF basin.

1.3.1 Programmatic Environmental Impact Statements

A programmatic EIS approach was selected to allow an evaluation of a broad range of alternative operating conditions on human and environmental resources across the entire basin. This programmatic framework for analysis permits an overall assessment of impacts on the basin and provides the basis for future assessments of prospective operational plans as they are identified and/or developed.

Programmatic EISs provide a broader look at alternatives than project-specific EISs and identify long-range effects (Title 40 of the *Code of Federal Regulations* Subpart 1502.4(b)) [40 CFR 1502.4(b)]. When preparing an EIS for a "broad Federal action," the lead agency may evaluate the proposal based on common geographic locations, similarities of impacts, or stages of development. Preparing a programmatic EIS is an opportunity for a Federal agency to evaluate the potential cumulative impacts of the reasonably foreseeable actions under that program or within that geographical area (40 CFR 1502.4(c); Forty Questions No 24(b)).

The preparation of a programmatic EIS facilitates and expedites the preparation of subsequent project-specific NEPA documents through the use of tiering. Tiering refers to the concept of a multi-level approach to preparing NEPA documents. The first tier, or programmatic EIS, covers general issues in a broad program-oriented analysis. Subsequent tiers incorporate by reference the general discussions from the broader EIS, while concentrating on issues specific to the action being evaluated. Agencies are encouraged to tier EISs to avoid repeating issues and to focus on the issues required for decision at each level of review.

Programmatic EISs are prepared when a proposed action will affect a large geographic area or be composed of a series of smaller actions that will have similar and potentially cumulative effects, or to allow evaluation of a project early in the planning stages so that changes can be made, if needed, to minimize the potential impacts. Programmatic EISs focus on planning-level and conceptual impacts; they identify the resource areas that will require additional focus in the documents that tier from them. This is done because, when a programmatic EIS is prepared, often all of the details associated with the proposed action are unknown, but it is accepted that a number of smaller actions or projects will be required to complete it. For the ACT water allocation, the actual water allocation formula was not available at the time this draft EIS was prepared, but it is assumed that there will be operational changes at some of the reservoirs and lakes within the basin in order to implement the formula. However, the types of changes that may be required and the reservoirs and lakes that will be affected will not be known until the final water allocation formula is known and the implementation strategy has been prepared. As a result, this EIS focuses on identifying environmental and socioeconomic resources that could potentially be affected by the implementation of the water allocation formula and describes them in a way that allows a planning-level review of the water allocation formula. Once the details of the water allocation formula are known and the implementation strategy has been prepared, project-specific NEPA documents will be prepared that focus on the environmental and

socioeconomic impacts that are expected to occur once the water allocation formula is implemented at a specific reservoir or lake.

The proposed action for this EIS is the Federal Commissioner's decision to concur or not concur with the water allocation formula developed by the State Commissioners. Subsequent EISs or environmental assessments tiered to this EIS may be necessary if implementation of the water allocation formula requires a specific change in operation and/or project authorization at Corps or other Federal facilities in the ACT basin. Other Federal agencies could use this EIS as a base document for their implementing actions or other resource management actions within the basin. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as the Alabama Power Company or the Birmingham Water Works Board, the ACT River Basin Commission will work with those entities and the appropriate regulatory agencies to facilitate the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

1.3.1.1 Schedule

The completion schedule for this programmatic EIS is controlled by the timelines legislated by the ACT River Basin Compact. Alabama and Georgia must agree on a proposed water allocation formula by December 31, 1998, unless there is an unanimous vote to extend the deadline. After unanimous approval of the water allocation formula by the State Commissioners, the Federal Commissioner must submit a letter of concurrence or non-concurrence within 255 days to the ACT Basin Commission. Because this EIS is intended to inform the Federal agencies, the Federal Commissioner, the States, and the public on the impacts of the proposed allocation formula and alternatives, it must be completed well before this period elapses. An EIS typically takes between 18 months and 2 years to prepare. If the EIS were not initiated until after the water allocation formula were approved, there would be insufficient time to complete the EIS and make it available to assist in the review of a proposed water allocation formula. Therefore, this EIS was initiated in the fall of 1997, using a programmatic evaluation framework to assist in assessing future allocation formulas to be developed by the States.

1.3.1.2 Cooperating Agencies

The Corps, as the lead agency with assistance from 10 cooperating Federal agencies, is responsible for preparing the draft EIS, receiving comments from the public, and then preparing a final EIS in time to assist in the review of a proposed allocation formula prior to the Federal Commissioner's decision. The role of the cooperating agencies is to provide baseline environmental information, to assist in preparing impact analyses for some resource areas, and to review technical documentation and assist in responding to public comments of the draft EIS. ***Appendix B*** provides details on the roles that each of the agencies played in preparing this programmatic EIS.

1.3.2 Public Involvement

1.3.2.1 NEPA Public Involvement Process

The Corps invites full public participation in the NEPA process to promote open communication and better decision-making. All persons and organizations that have a potential interest in the proposed action, including minority, low-income, disadvantaged,

and Native American groups, are urged to participate in this NEPA environmental analysis process.

Public comments are invited at any time in the process. Formal opportunities for public participation began with the scoping meetings held in conjunction with the Comprehensive Study. In addition, this programmatic EIS process provides a series of opportunities to provide input, including a web site for electronic receipt of public comment, newsletters, review copies of the draft and final EISs, and public meetings on the draft EIS. Each of these steps in the process is briefly discussed below.

If you would like assistance or more specific information on how to participate, please contact Pat Robbins in the Mobile District Public Affairs Office, (334) 690-2505.

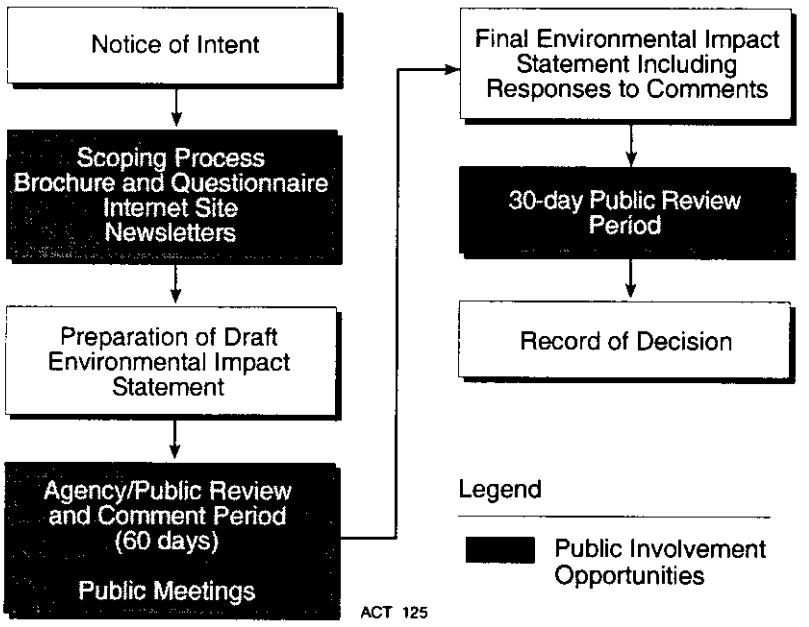
1.3.2.1.1 Notice of Intent

The public was notified of the Corps' intent to prepare this programmatic EIS and opportunities for public involvement by publication of a Notice of Intent (NOI) (***Appendix C***) in the *Federal Register* on October 31, 1997. The NOI identified the Corps as the lead agency and the cooperating agencies that will assist in preparation of the EIS.

1.3.2.1.2 Public Review of the EIS

The EIS process is designed to involve the public in Federal decision-making. During the preparation of this EIS, comments from concerned individuals, agencies, and organizations are welcome at any time. Formal opportunities to comment and participate, such as during scoping and public review of the EIS, are outlined in ***Figure 1-2***. Comments received throughout this process will be included in the final EIS.

FIGURE 1-2
Public Involvement Opportunities in the EIS Process



1.3.2.1.3 Public Mailing List

A public mailing list was developed by the Corps and the cooperating agencies for over 5,300 individuals, agencies, government entities, and special interest groups in the ACT and ACF basins and surrounding areas. The public mailing lists have been updated throughout

the preparation of the EIS based on information received by the Corps and the cooperating agencies during the scoping process and the public review process.

1.3.2.1.4 Brochure and Questionnaire

A scoping brochure and questionnaire were mailed to more than 4,870 individuals, agencies, and groups included on the public mailing list in October 1997. The purpose of the brochure was to inform the public about the project and to solicit scoping comments from the recipients. The questionnaire invited input on specific issues to be addressed, and requested information from respondents on how they would like to be contacted in the future to receive information. Issues identified by the public, interest groups, and agencies are summarized in Section 1.3.2.2.

1.3.2.1.5 Newsletters

Four newsletters mailed to individuals, groups, and agencies on the mailing list for this EIS are a part of the public involvement process. The first newsletter, composed of the scoping brochure and questionnaire, is discussed in the section above. The second newsletter was distributed in early June 1998 and described the relationship of the EIS process to the Compact Commission efforts to develop an allocation formula and the EIS evaluation framework. The third newsletter was mailed concurrently with filing of this draft EIS, and the newsletter announced availability of the document and the schedule for the public meetings. The fourth newsletter will be mailed immediately prior to or concurrent with the filing of the final EIS. In addition to announcing meetings and availability of the EIS documents, the newsletters provided updates on the progress of the project to the public and other interested parties.

1.3.2.1.6 Internet Web Page

A web page was established to allow the public to obtain information on the project over the Internet. The web page includes a home page for the EIS, a page for each of the ACT and ACF river basins, a page summarizing the EIS process as well as links to the newsletters and scoping questionnaire, the annotated bibliography, and the NOI. The web page also will include information on the public meetings held during the draft EIS review process. The address for the web page is **www.sam.usace.army.mil/sam/pd/actacfeis**.

1.3.2.1.7 Draft EIS

The public is invited to review and comment on this draft EIS. A notice of availability was published in the *Federal Register*, public notices were mailed to those on the mailing list, and press releases were furnished to the local news media. A public comment period of 60 days begins with the publication of a notice of availability in the *Federal Register*. The comment period provides an opportunity for the public to review the issues addressed in the impact analysis and to comment on any aspect of the process. Comments on the draft EIS received from regulatory agencies, organizations, and individuals will be addressed in the final EIS.

1.3.2.1.8 Public Meetings

Public meetings will be held in each State to accept comments on this draft EIS. These meetings will follow an open house format rather than have formal presentations. A court reporter will be present at each meeting to record a transcript of statements presented at each meeting. As part of the public involvement program for the EIS, individuals, agencies, and groups are invited to provide written or oral comments on the draft EIS. Comments received during the meetings will be evaluated, and detailed responses will be included in the final EIS. Written comments on the draft EIS will be accepted for about 30 days after the public meetings are held. Public Notices and newsletters are being sent to individuals, groups, and agencies on the mailing list for the draft EIS, announcing the meeting dates,

locations, and times. News releases will also announce the meeting dates and times to the media in the project area.

1.3.2.1.9 Final EIS

The final EIS will evaluate and respond to comments received on the draft EIS. Copies of the final EIS will be furnished to all who comment on the draft EIS and to others requesting it. A notice of availability of the final EIS will be published in the *Federal Register* and in local newspapers, and will be mailed to individuals, agencies, and groups on the mailing list.

1.3.2.1.10 Record of Decision

There will be a 30-day waiting period following filing of the EIS, after which a Record of Decision (ROD) will be prepared. The ROD will state the Federal Commissioner's decision to concur or not to concur with the water allocation formula developed by Alabama and Georgia, considering the impacts addressed in the EIS, any mitigation measures that will be implemented, and an overview of the impacts associated with the allocation formula. The ROD will also reiterate the need for additional NEPA documents to address the impacts resulting from any changes in project operations or authorizations required to implement the water allocation formula alternatives at Corps-operated reservoirs if not adequately addressed in this programmatic EIS.

1.3.2.2 Scoping Issues

The first step in preparing an EIS is to scope, or identify, the issues to be addressed in the analysis and documentation. Often, at the beginning of the analysis, little is known about the potential impacts of a proposed action, so public and agency participation are solicited as early as possible to assist in identifying the critical issues to be analyzed in the document. The public, agencies, and various groups identified issues of concern during the public meetings and comprehensive evaluations conducted during the Comprehensive Study during workshops, and in response to the scoping brochure and questionnaire. ***Table 1-2*** summarizes the issues identified. A more comprehensive list of questions and issues raised by the public can be found in Appendix C.

TABLE 1-2
Summary of Key Issues to be Addressed in the EIS

Water Resources: Quantity
Availability of water to meet future water supply needs for municipal, industrial, and agricultural uses
Potential effects of allocation on reservoir/lake levels and stream flows
Potential effects of allocation on availability of groundwater
Availability of adequate flows to support navigation
Potential changes in flood frequency as a result of the water allocations
Water Resources: Water Quality
Potential effects of changes in stream flows on assimilative capacity (for wastewater discharges)
Potential impacts on reservoir/lake water quality
Potential effects of erosion and sedimentation on water quality
Potential effects of nonpoint source pollution (all types) on water quality
Biological Resources
Potential effects of changes in hydrologic regime on riverine habitat for native fish, mussels, and other aquatic organisms, and managed game fisheries

(CONTINUED)

TABLE 1-2 (CONTINUED)
Summary of Key Issues to be Addressed in the EIS

Potential effects of changes in reservoir levels on reservoir fisheries and other aquatic organisms
Potential effects of changes in hydrologic regime on anadromous fish habitat, including spawning and rearing habitat, summer thermal refugia, and upstream passage
Potential effects of changes in flow regime on estuarine habitats for finfish and shellfish [oysters were evaluated]
Potential effects of changes in hydrologic regime on riparian wetland habitat values
Potential effects of changes in reservoir levels on reservoir wetland structure and function
Potential effects of changes in hydrologic regime on estuarine wetland habitats, submerged aquatic vegetation, and primary productivity
Availability and timing of freshwater inflows to Mobile Bay
Potential effects of changes in hydrologic regime on wetland habitat value for terrestrial wildlife
Potential effects of changes in hydrologic regime on habitat for protected species of riparian plants, fish, mussels, and other aquatic species
Potential effects of changes in hydrologic regime on ability of State and Federal wildlife management facilities to withdraw surface waters for propagating fish and wildlife
Economics
Potential effects of altered stream flows on power generation
Potential effects of altered flows, erosion, and sedimentation on navigation and the shipping industry
Potential effects of reduced stream flows on the agriculture industry
Potential effects of altered lake /reservoir levels on the recreation industry
Potential effects of altered flows on commercial fisheries
Land Use: Recreation
Potential effects of altered lake /reservoir levels on water-based recreation users, including impacts on seasonal shoreline access, and boat access and launching

1.3.3 Impact Analyses Process

1.3.3.1 Framework for the Proposed Action

This draft EIS evaluates an anticipated range of reasonable flows that could result from the final ACT basin water allocation formula. This programmatic approach was necessary because the proposed water allocation formula was not developed when the EIS was started. Presenting a range of realistic potential flows that could result from the final water allocation formula allows evaluation of a wide range of potential environmental and socioeconomic impacts. It is expected that the environmental and socioeconomic effects that result from the final water allocation formula will fall within the range of effects presented in the EIS. The basic framework for the analyses is based on the data collected and analyses completed for the Comprehensive Study to the maximum extent practicable. These data and analyses were used because they have been rigorously reviewed by the States, the cooperating agencies, and the public. The baseline data and the analytical models and techniques used to develop and understand the impacts that could result from implementing the water allocation formula are described below.

1.3.3.2 Baseline Data

The baseline data, presented in Section 4 of this EIS, were derived from the various elements of the Comprehensive Study being completed by the Corps, the cooperating agencies, Alabama and Georgia, as well as other State and Federal agencies. The study

elements that comprise the Comprehensive Study as it applies to the ACT basin are described in Section 1.1.5.

Current operations depict how the water management system is operating today, under existing conditions and with no allocation formula. A summary of current operations conditions has been incorporated into an existing operations model. Output from this model will provide baseline data on the impacts of the existing water management system.

The last major NEPA evaluations of water management operations in the ACT basin were completed in the mid- to late-1970s (Corps, 1973a, 1973b, 1974a, 1974b, 1974c, 1974d, 1976; 1987; FPC, 1973). Since the 1970s, several incremental changes in water management operations have been implemented in the ACT system. Operations in the basin in the mid-1970s differed in several respects from current operations due to changes in hydropower contracts and operating schedules, changes in navigation flow requirements, and other changes related to water quality, environmental, or other users of the system. Historical records maintained by the Corps depict the observed impacts of changes in operations or seasonal variation over time on pool levels and flow releases from the Corps reservoirs. For purposes of this document, the observed baseline for relevant hydrologic statistics is available in ***Appendix D***. A review of historic project operations indicates that the operations conditions of 1977 represent the conditions of the basin projects at the time the last NEPA documents were prepared. This operational scenario has been incorporated into an historic operations (1977) HEC-5 model. Output data from this historical operations model can be used to evaluate impacts of the existing water management operations within the basin. Details of the differences in operations conditions for the historical operations model and the existing operations model are included in ***Appendix D***.

The Federal agencies cooperating in the EIS provided additional baseline information and assisted in evaluating potential impacts on their respective resource areas of responsibility. ***Table 1-3*** summarizes the areas of support/responsibility for each of the cooperating agencies.

TABLE 1-3
Baseline Data and Support Provided by Cooperating Agencies

Agency	Baseline Data/Responsibility
Environmental Protection Agency	Water quality data and land use data/evaluation of nonpoint source loadings and water quality impacts
Fish and Wildlife Service	Protected species, wetlands, and aquatic resources data/evaluation of impacts on these resources
U.S. Geological Survey	Geology and agricultural water use information/review of impacts on groundwater
National Park Service	Recreation information/review evaluation of recreation impacts
Natural Resources Conservation Service	Soils and groundwater use data/evaluation of economic impacts on agriculture
Forest Service	National forest information/review impacts on national forests
National Marine Fisheries Service	Baseline data from existing records on fisheries in Mobile Bay
National Ocean Service	No baseline data/review of potential impacts on coastal zone
Maritime Administration	Navigation activities/review of potential impacts on navigation and shipping industry
Southeastern Power Administration	Federal hydropower facilities/evaluation of economic impacts on hydropower generation

1.3.3.3 Water Demand Scenarios

Water consumption assumptions for three municipal and industrial water demand scenarios were developed by the Corps, the Institute for Water Resources, the States, and the cooperating Federal agencies as part of the Comprehensive Study. All of the demand scenarios were agreed to by a consensus of the Comprehensive Study partners. Thesedemand scenarios reflect differing levels of water conservation in the basin. Scenario 1 and Scenario 3 from the Comprehensive Study were selected for use in hydrologic models for this EIS as representative of realistic water demands in the ACT basin (and are shown in bold type in ***Table 1-4***). These demands are averages of water needs over a wide range of climatic conditions and do not represent the worst case demands that may occur during drought periods.

TABLE 1-4
Assumptions for the Municipal and Industrial Water Demand Scenarios

Water Demand Scenario	Assumptions
Municipal and industrial scenario 1 with no conservation (extreme demand) (Moderate and Low Flows)	**Water use projections based on residential and non-residential water use patterns and not considering water conservation (other than that measured in the water use modeling survey). Water demand projections were driven by projected changes in employment and housing characteristics in the basin for 1995, 2020, and 2050.**
Municipal and industrial scenario 2 with passive conservation	Water use projections based on residential and non-residential use patterns considering water use efficiency resulting from recently implemented plumbing codes, the natural replacement of water fixtures, and known increases in water and wastewater rates.
Municipal and industrial scenario 3 with aggressive conservation (extreme conservation) (High Flow)	**Water use projections based on residential and non-residential water use patterns plus passive increases in water use efficiency resulting from recently implemented plumbing codes, the natural replacement of water fixtures, known increases in residential water and wastewater rates, basinwide implementation of selected active demand management programs, summer surcharge for residential customers, and a basinwide increase in residential water and wastewater rates. The active demand management programs factored into the demand projections are a residential rebate program for ultra-low-flow toilets, residential indoor-outdoor home water audit and retrofit, and commercial water audits.**

Note: Bold indicates scenario selected for modeling.

Source: Planning and Management Consultants, Ltd., 1996

The Natural Resources Conservation Service (NRCS was responsible for developing the agricultural water demand estimates used in this EIS. The data generated by the NRCS study were approved by the States and the cooperating State and Federal agencies as part of the Comprehensive Study. Six demand scenarios were developed, three with conservation and three without. The three scenarios selected for use in this EIS reflect the highest,

moderate, and lowest water demand rates for agriculture (and are shown in bold type in *Table 1-5*).

TABLE 1-5
Assumptions for the Agricultural Water Demand Scenarios

Water Demand Scenario	Assumptions
Agricultural scenario 1 (high demand with no conservation, extreme demand) (Low Flow)	**Assumes an optimistic agricultural market growth rate, a strengthened international position, an increase in agricultural exports, strong economic growth, and an improved standard of living.**
Agricultural scenario 2 (moderate demand with no conservation, moderate demand) (Moderate Flow)	**Assumes the continuation of the current rate of economic and technological growth and no substantial change in national agricultural policy, price supports, or agricultural exports.**
Agricultural scenario 3 (low demand with no conservation)	Assumes a reduction in agricultural price support programs, a gradual shift to the world market price structure, increased international competition for agricultural trade, and a reduction in agricultural exports.
Agricultural scenario 1 (high demand with conservation)	Assumes an optimistic agricultural market growth rate, a strengthened international position, an increase in agricultural exports, strong economic growth, and an improved standard of living. The following conservation measures are factored into the assessment: irrigation scheduling, moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.
Agricultural scenario 2 (expected demand with conservation)	Assumes the continuation of the current rate of economic and technological growth and no substantial change in national agricultural policy, price supports, or agricultural exports. The following conservation measures are factored into the assessment: irrigation scheduling, moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.

(CONTINUED)

TABLE 1-5 (CONTINUED)
Assumptions for the Agricultural Water Demand Scenarios

Water Demand Scenario	Assumptions
Agricultural scenario 3 (low demand with conservation, lowest demand) (High Flow)	**Assumes a reduction in agricultural price support programs, a gradual shift to the world market price structure, increased international competition for agricultural trade, and a reduction in agricultural exports. The following conservation measures are factored into the assessment: irrigation scheduling; moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.**

Note: Bold indicates scenario selected for modeling.
Source: Natural Resources Conservation Service, 1995

1.3.3.4 Hydrologic Modeling

Hydrologic modeling tools were developed to achieve the goal of the Comprehensive Study to assess existing water resources needs in the basin and to evaluate the ability of the system to meet these needs, as well as to develop long-term, basinwide management alternatives. A modeling approach was needed to simulate the complex interrelationships between the competing water uses and to allow evaluation of the effects of various management strategies on environmental resources and other competing demands. Hydrologic modeling was conducted with continuous support and input from the stakeholders involved in the Comprehensive Study process.

HEC-5 and a number of water quality models were used to predict and analyze hydrologic data in the basin under existing and alternative management scenarios. These models are briefly described in the following text.

The HEC-5 model, developed by the Corps' Hydrologic Engineering Center (HEC), was used to define impacts of alternative flow scenarios for this EIS. HEC-5 works on a *daily* average flow basis. The HEC-5 model uses 55 years of historic streamflow data, including local inflows between gaged inflows and also including the physical and operational characteristics of reservoirs (***Appendix D***). The HEC-5 modeling completed for this EIS was used to simulate the conditions that would exist in the rivers and reservoirs of the ACT basin under the alternatives evaluated. The data generated by the models enabled the interdisciplinary team to adequately assess the potential environmental and socioeconomic effects associated with each alternative.

The output from the HEC-5 model is voluminous. HEC-5 predicts the average stream flow and reservoir elevations at 45 nodes (see Section 1.3.3.6) in the basin on a daily basis for 55 years of the historical record under each simulated operating scenario. While this is useful information, allowing a comprehensive analysis of how the alternatives would affect basin resources under conditions that existed over a 55-year period, the volume of data is so large that analysis is difficult and time-consuming. The Corps used the Indicators of

Hydrologic Alteration (IHA) data processing program, developed by the Nature Conservancy, to summarize output from the HEC-5 models in order to provide meaningful statistics on the large number of output parameters. The output from IHA included monthly frequency data at each node. These data formed an additional foundation for impacts analyses by the various resource agencies for this EIS.

1.3.3.5 Water Quality

The water quality modeling completed for this EIS was used to simulate the conditions that would exist in the rivers and reservoirs of the ACT basin under the alternatives evaluated. The data generated by the models enabled the interdisciplinary team to adequately assess the potential environmental and socioeconomic effects associated with each alternative.

Water reallocation in the ACT basin could have substantial effects on water quality in both streams and reservoirs. Impacts due to increased or decreased streamflows, increased wastewater discharges, and changing land uses within the basin are evaluated in this EIS. To do so, it was necessary to first assess existing water quality in the basin and, second, to predict the effect of various water management alternatives on basin water quality conditions.

A basin-wide water quality inventory was completed by the Corps' Waterways Experiment Station (WES). Existing water quality, water quality standards, and main stem cross-sectional stream geometry data were collected for the entire basin. The data were analyzed to characterize water quality, and to identify water quality trends, areas of water quality concerns, and data gaps (Ashby et al., 1996).

Once the existing water quality in the basin was documented, predictive modeling was developed to assess the impacts of various alternatives. Three models were developed to assess water quality impacts: (1) a nonpoint source projection model, Better Assessment Science Integrating Point and Nonpoint Source (BASINS), which predicts the nonpoint source loadings for input to the HEC-5Q and CE-QUAL-W2 models; (2) a basin-wide one-dimensional water quality model (HEC-5Q) to evaluate stream and reservoir water quality throughout the basin; and (3) a two-dimensional reservoir water quality model (CE-QUAL-W2) to evaluate both longitudinal and vertical effects of various alternatives on Lake Allatoona, Lake Weiss, and H.N. Henry Lake. The HEC-5Q was built for the ACT and ACF basins by the Corps' Mobile District staff and adopted under the Comprehensive Study for the ACT and ACF basins.

The U.S. Environmental Protection Agency (EPA) developed point source loadings for the HEC-5Q and CE-QUAL-W2 water quality models as part of the Comprehensive Study. EPA used Comprehensive Study-approved population and wastewater load projections for a number of target years, including 1995, 2020, and 2050. Formulas were developed to convert wastewater volume into water quality constituent loads (e.g., pounds of phosphorus, nitrogen, and BOD), based on the type of point source (municipal wastewater treatment plants and industrial treatment plants). Spreadsheets were developed to present the point source loading projections on a county-level basis for use in the water quality models. Preliminary final versions of the spreadsheets were used for the models in this draft EIS.

Pollutant loads from nonpoint sources can have as significant an impact as point source wastewater discharges on basin water quality. Population growth into the year 2050 will change land uses significantly, with resulting changes in nonpoint source pollutant loadings. The nonpoint source pollutant loadings for the years 1995, 2020, and 2050 were predicted by the EPA BASINS program. The results from the BASINS program were fed

back into the HEC-5Q and CE-QUAL-W2 programs to analyze the overall impacts on streams and reservoirs. The CE-QUAL-W2 analysis was not completed for the draft EIS, but will be included in the final EIS.

One-dimensional modeling with the HEC-5Q model was conducted by the Corps' HEC, with field data collection support from the U.S. Geological Survey (USGS) and EPA. Flow output data predicted by the HEC-5 model provided direct input into the HEC-5Q model. HEC-5Q simulates streamflow and water quality within the basin's network of streams and reservoirs. Impacts from changes in streamflows and increases in wastewater discharges were assessed with this model. The model was calibrated with data compiled by WES and supplemented by data collected by the USGS and EPA in 1994 and 1995.

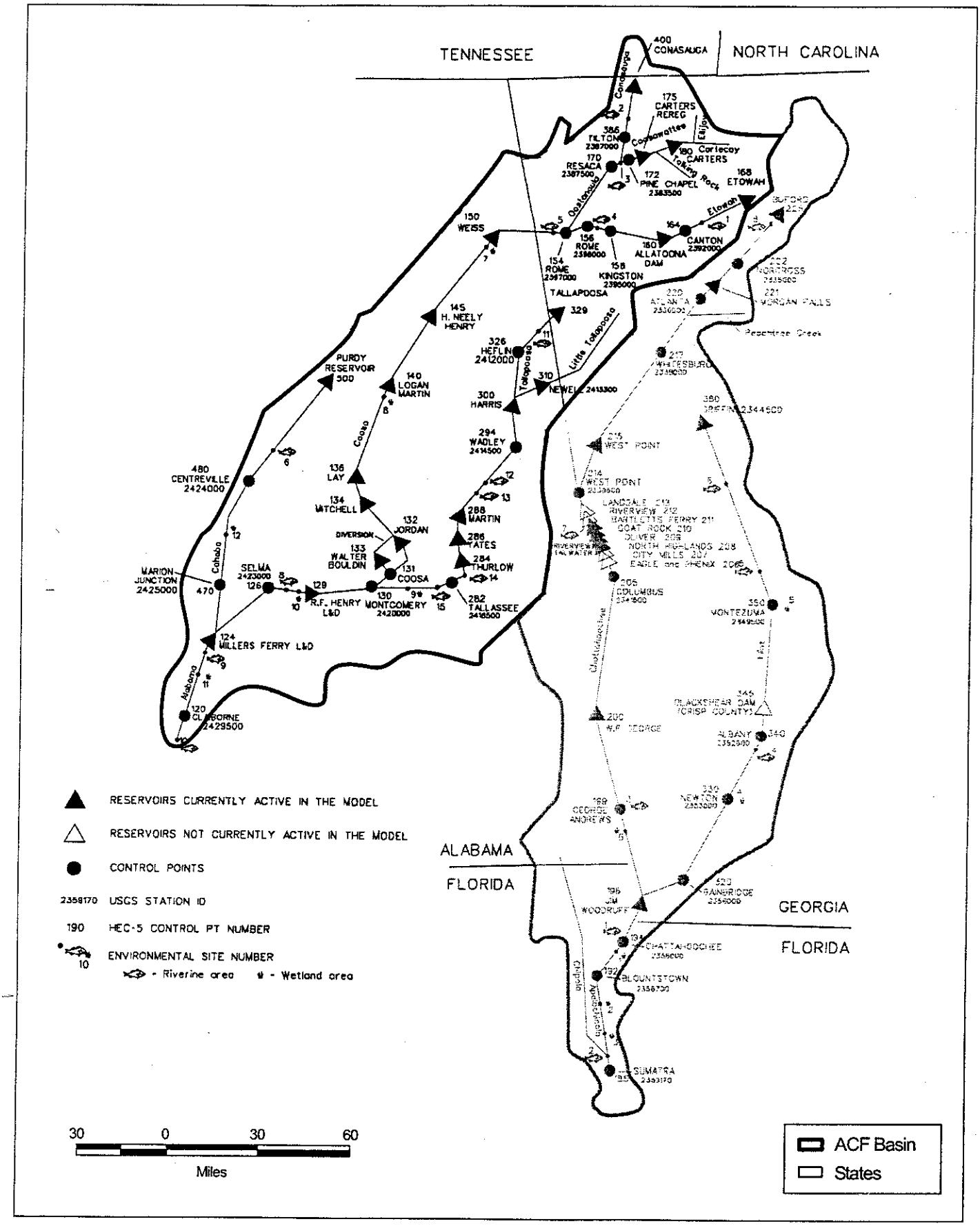
The HEC-5Q model provided limited data on reservoir impacts of alternative water management scenarios. Therefore, a two-dimensional reservoir water quality model will be used on three reservoirs in the ACT basin to produce detailed data. Weiss and Neely-Henry models were developed by WES as part of the Comprehensive Study and the Lake Allatoona model developed by WES for the Georgia Department of Natural Resources (GDNR). The hydrodynamic and water quality model, CE-QUAL-W2, was run for the ACT basin by the Corps' WES. Output data from HEC-5Q were used as input to this model to maintain consistency. These models were calibrated with data collected by EPA-supported Clean Lakes Studies, and data collected in 1994 by the Comprehensive Study and the Alabama Department of Environmental Management (ADEM). Data from CE-QUAL-W2 for all three reservoirs modeled (Lake Allatoona, Weiss Lake, and H.N. Henry Lake) will be included in the final EIS.

1.3.3.6 Node Analyses

Building a model using HEC-5 requires the identification of specific locations (called *nodes*) in which to input data such as demands on reservoir releases, and to provide output such as stream flows or reservoir levels. In the ACF basin model, there are 37 nodes (***Figure 1-3***). Fourteen nodes represent reservoirs such as Lake Allatoona and Mitchell Lake. Twenty-three nodes represent other locations on the three main rivers. The river nodes were generally selected to correspond to locations in which there are existing stream gages since the stream gage data could then be used to calibrate the model.

Inputs at each node consist of items such as water withdrawals to meet consumptive demands and water discharges from treatment facilities. In reality, all withdrawals and discharges do not occur at just 37 locations in the basin; however, the model would become too complex if every withdrawal and discharge location were included in the model. Therefore, withdrawal and demands have been grouped at the various nodes.The HEC-5 model output consists of daily flows or reservoir elevations at each node for each management alternative modeled. The node analysis forms the basis of all impact assessments. By predicting flows and reservoir levels at multiple locations across the basin, the impacts can be assessed on a variety of stream and/or reservoir characteristics (e.g., a 25 percent reduction in stream flow would have a much different impact on the headwaters of the Tallapoosa River than on the mainstem Alabama River). Because the ACT basin is so large and physically diverse, it was critical to assess the impacts of different management alternatives on a representative selection of stream and reservoir characteristics. Section 4.4 provides detailed discussion of the nodes used for these representative sections.

FIGURE 1-3
Location of the Nodes for the ACT Basin



ATL\Scarlett\Graphics\144282.AO.PP\7-21-98\ACF\ACT101

Predicted streamflows and/or reservoir levels were provided by HEC-5at each node for the existing (no action) alternative and for each of the demand and allocation alternative scenarios. The impacts for all resources were then assessed based on the changes predicted by HEC-5 at each node for a particular alternative compared to the no action alternative. The analysis of impacts in this EIS is based on this nodal analysis of the HEC-5 predictions.

1.3.3.7 Ecological Analyses

Ecological impacts resulting from implementing the water allocation formula were evaluated using direct output from the HEC-5 model and also using the summary statistic output from the range of variability approach (RVA), which is based on the IHA statistical program developed by The Nature Conservancy (Richter, et al., 1996, and Richter, et al., 1997). The IHA program summarizes the volume of data generated at each node into more manageable statistics applicable to the evaluations of aquatic resources. For the purposes of this EIS, model-generated data and environmental performance measures were used to evaluate potential impacts on riverine aquatic resources, reservoir fisheries, and wetlands at specific locations in the basin, which were established in the Comprehensive Study. The performance measures were modified for this EIS analysis from a monthly to a daily time-step.

1.3.3.7.1 Riverine Aquatic Resources Analyses

The environmental performance measure for riverine aquatic resources was developed during the Comprehensive Study and is based on a comparison of the unimpaired flows with the no action and range of alternative flow scenarios using the RVA approach. Details on these measures are included in *Appendix E*.

1.3.3.7.2 Riparian Wetland Analyses

A similar performance measure was used to evaluate impacts on riparian wetland communities. This measure, called the Riparian Wetland Unit, is an index of potential change between a reference condition (unimpaired flows) and both no action and the range of alternative flow scenarios. Details on these measures are included in *Appendix E*.

1.3.3.7.3 Reservoir Fisheries Analyses

Fisheries in the various reservoirs in the ACT basin were evaluated using a modified performance measured developed by the FWS that is based on developing acceptability ratings for different lake levels. Acceptability ratings were developed using an iterative survey of regional fishery experts (Ryder, et al., 1995). The ratings provided a score for the critical spawning and rearing periods (March through October), and then are weighted based on how lake levels change over this same period. When lake levels increase or stay the same, these average scores are multiplied by two; they remain unchanged if the lake levels stay the same or decrease. *Appendix E* includes the reservoir fisheries report.

Additional information on the environmental performance measures, the range of variability approach, the indicators of hydrologic alteration methodology, and how they were applied to this project can also be found in *Appendix E*.

1.3.3.8 Protected Species Surveys

Site-specific field surveys were conducted to supplement the protected species inventory developed during the Comprehensive Study. The USGS, through the Biological Resources Division, conducted surveys and mapped protected invertebrate and fish species in the upper Coosa River Basin. The Fish and Wildlife Service (FWS) conducted a survey for protected fish and invertebrate species in the Upper Tallapoosa River system. The inventory

and identification of both State and Federal protected species within the ACT basin was completed by the FWS as part of the Comprehensive Study to identify the species that could potentially be affected by changes in water management and to provide life history information on those species to help develop and evaluate the water allocation formula. (Ziewitz et al., 1997) ***Appendix E*** provides the results of the protected species evaluations.

1.3.3.9 Economic Analyses

The regional economic effects of implementing the water allocation formula have been estimated using the Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Construction Engineering Research Laboratory (CERL). Direct impacts, the outputs generated by the EIFS model, are discussed in terms of changes in employment and income directly related to implementing the water allocation formula. Inputs for the EIFS model were generated by evaluating the direct impacts on inland navigation, reservoir recreation, agricultural water supply, municipal and industrial water supply, electric power generation, and flood control, as described below:

- Impacts on inland navigation were estimated by changes in the shipping costs per ton of commerce moved by railroad, truck, or barge.
- Impacts on reservoir recreation were calculated as the difference between the gross value of recreation use and the value of diminished reservoir recreation use. Only boater recreation was evaluated. A qualitative assessment of impacts on riverine recreation was also conducted.
- Impacts on agricultural production and income were estimated through an agricultural water supply analysis conducted by NRCS. The Corps completed an analysis of potential shortages in meeting agricultural demands for surface water based on the results of the HEC-5 modeling. This information was used by NRCS to evaluate the potential economic impacts on the agriculture industry.
- Municipal and industrial water supply impacts were estimated using the results of the HEC-5 model and an probability-based risk analysis to determine water supply shortages at locations within the basin. A qualitative evaluation of the predicted shortages was used to determine impacts in terms of their direct impacts on income and employment.
- Impacts on power generation operations were assessed using the Proprietary Hourly Power System Evaluation Model (PROSYM) power simulation software. The modeling evaluated the worst-case flow alternative first, followed by more moderately impacting flow alternatives. This step-wise manner of analysis helped in determining which flow alternatives contributed significant beneficial or adverse effects. PROSYM is the model used to determine energy values for projects that are owned and operated by the Corps. It provides a simulation of hour-by-hour operations of power plant operations to evaluate operating costs to meet power loads. The model can be run to give the most economic means for meeting demands and can be provided by region.
- The direct economic impacts on residential, commercial, and public structures in the 500-year floodplains downstream of Lakes Lanier, Allatoona, and West Point were calculated based on computer modeling of the inundation of these structures and their contents with varying river levels and flows. Model output was provided in the form of induced monetary damages for the alternative water levels and flows simulated.

Impacts associated with changes in flood control storage were not evaluated as part of the alternatives, but are provided in *Appendix F*.

Impacts were allocated by regions of influence that consisted of one or more counties. EIFS then compared these impacts to a rational threshold value (RTV) for that region of influence to determine if a significant impact had occurred. The RTV was calculated on the basis of yearly historical fluctuations in employment, sales volume, and income within the affected region. For an impact to be significant, it must exceed the RTV. *Appendix F* includes the socioeconomic reports prepared by the Corps.

1.3.3.10 Cultural Resource Predictive Model

The Corps developed a predictive model to identify sites in the ACT basin that could contain cultural resources. The predictive model uses Geographic Information System (GIS) topography, distance from a permanent water supply, historic land use information, and level of development or disturbance data to predict if an area has a high, moderate, or low probability of containing unknown archeological sites (*Appendix G*).

1.3.4 Relevant Statutes and Executive Orders

Table 1-6 lists statutes and executive orders relevant to decisions regarding water allocation formula alternatives. *Appendix H* summarizes the requirements for the relevant statutes and executive orders.

TABLE 1-6
Federal Environmental Statutes and Executive Orders Applicable to the ACT Basin EIS

Acts
Alabama-Coosa-Tallapoosa River Basin Compact (PL 105-105, 111 Stat. 2234)
Archaeological and Historic Preservation Act of 1974 (16 U.S. Code [USC] 470 et seq.)
Clean Air Act, as amended (42 USC 7401-7671g))
Clean Water Act, as amended (33 USC 1251, et seq.)
Endangered Species Act of 1973, as amended (16 USC 1531, et seq.)
Fish and Wildlife Coordination Act, as amended (16 USC 661, et seq.)
Magnuson-Stevens Fishery Conservation Management Act (16 USC 1801, et seq.)
Marine Protection, Research, and Sanctuaries Act of 1972 (33 USC 1401-1445, 16 USC 1431, et seq., and 33 USC 1271)
National Environmental Policy Act of 1969 (42 USC 4321-4347)
National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.)
North American Wetlands Conservation Act (16 USC 4401 et seq.)
Resource Conservation and Recovery Act (43 USC 2101-2106)
Federal Environmental Statutes and Executive Orders Applicable to the ACT Basin EIS

(CONTINUED)

TABLE 1-6 (CONTINUED)
Federal Environmental Statutes and Executive Orders Applicable to the ACT Basin EIS

Safe Drinking Water Act, as amended (42 USC 300f et seq, 6939b; 15 USC 1261 et seq.)
Watershed Protection and Flood Prevention Act of 1954 (16 USC 1101, et seq.; 33 USC 701b)
Executive Orders
American Heritage Rivers (Executive Order 13061)
Environmental Justice in Minority Populations and Low-Income Populations (Executive Order 12898
Federal Environmental Statutes and Executive Orders Applicable to the ACT Basin EIS
Acts
Federal Compliance with Pollution Standards (Executive Order 12088)
Flood Plain Management (Executive Order 11988
Protection of Wetlands (Executive Order 11990)
Protection of Children from Environmental Health Risks and Safety Risks (Executive Order 13045)

2. Description of the Proposed Action

2.1 Introduction

2.1.1 Proposed Action

The ACT Compact Commissioners are currently in negotiations to develop an allocation formula for the equitable allocation of water resources within the ACT basin. Under the ACT River Basin Compact between these States (PL 105-105, November 20, 1997), the proposed allocation formula must be approved by a Federal Commissioner before it can go into effect. It has been determined that the Commissioner's decision of concurrence or nonconcurrence represents a major Federal action that could result in significant impacts to the environment within the ACT basin. The draft EIS has been prepared to provide the information needed by the Federal Commissioner to make an informed decision of concurrence or nonconcurrence.

Under the Compact, the allocation formula is required to be completed by December 31, 1998, unless State Commissioners vote unanimously to extend this date. The Compact also requires the Federal Commissioner to reach a concurrence decision within 255 days of receipt of the State's proposed allocation formula. Because an EIS normally requires 18 to 24 months to complete documentation and coordination and must allow sufficient time for a review of potential impacts by the public and the decisionmakers, this EIS was initiated before the identification of a water allocation formula by the States. A programmatic evaluation framework was developed to assess the impacts that would likely result from a range of flow conditions that would likely "bracket" the flow conditions of the allocation formula that will be negotiated by Alabama and Georgia.

This programmatic approach meets the requirements of the Compact and NEPA by providing sufficient information to assist in review of the impacts of a proposed allocation formula prior to the Commissioner's decision, and also allows the document to be carried forward and used in the future to address the broad areas of water resources that could be affected by implementing an allocation formula. This evaluation framework could also be used to evaluate future modifications that could be made to the allocation formula. As a programmatic EIS, the environmental framework used for the analyses in this document will also facilitate the tiering of additional EAs and EISs, as necessary, to support future site-specific changes in water management strategies and water resource projects that may be required to implement the water allocation formula or for other basin management actions or programs.

2.1.2 Summary of Available Water Allocation Mechanisms for the ACT Basin

The water allocation management formula developed by Alabama and Georgia for the ACT basin may include a combination of approaches to meet the desired objectives of the Compact. Because the water allocation formula was not available at the time this draft EIS was prepared, the following text reviews the various options that may be used by these States to develop the formula. The final expression of the formula, as stated in the Compact,

"may be represented by a table, chart, mathematical calculation, or any other expression of the Commission's apportionment of water" (PL 105-105). It is intended that the final EIS will contain a detailed description of the final negotiated water allocation formula and the approaches that will be used to allocate surface water resources in the basin.

The approaches that may be used in the water allocation formula could vary in their treatment of the type of hydrologic standards used, the time scales over which the hydrologic variables are measured, and the need to determine water availability. The most common ways these variables have been treated in other water allocation formulas are as described in the following text.

2.1.2.1 Hydrologic Standards

Hydrologic standards generally use minimum flow standards, storage limitations, consumption or diversion limits, and delivery requirements, or combinations thereof.

Minimum flow approaches can be used in a number of situations and are useful when an allocation formula includes instream uses. This approach is easy to monitor because existing stream gaging stations can often be used. An example would be a formula that requires a State to regulate daily water use to meet some minimum flow at a specific gage during certain periods.

Reservoir storage approaches limit the volume of water that can be stored by a party to the water allocation formula. For example, an upper limit could be placed on how much water could be stored upstream.

Rights of consumption or diversion approaches are more complex than either minimum flow or reservoir storage because they usually rely on a percentage of the water available or specify fixed quantities that can be used. Water allocation formulas that use this approach typically require more monitoring than the other approaches.

Delivery requirement approaches are similar to those for minimum flow except that delivery requirements are volume, or quantity-based, instead of flow-based. For example, Georgia could be asked to deliver a minimum volume of water over a specific number of months or years.

2.1.2.2 Time Scale

Some hydrologic standards, such as flow minimums and storage maximums, are in effect at all times of the year. A water allocation formula that includes an approach based on consumption or delivery of water from other parts of a river basin often features long time periods with annual or multi-year monitoring requirements. In areas in which withdrawals and subsequent shortages result from agricultural demands, monitoring could be limited to the growing season.

2.1.2.3 Water Availability

Two water availability approaches may be used for a water allocation formula. One approach would specify a fixed quantity to be allocated for each user, while the other would rely on a percentage of the total water available. Water availability approaches also often include operational and allocation changes that become effective if there are

significant changes that affect water availability, such as drought (short-term temporary effects) or additional water development (long-term permanent effects).

2.1.2.4 Process and Status for Developing the Allocation Formula

The ACT Compact Committees, composed of State members appointed by the Governors of Alabama and Georgia, and the Federal Commissioner appointed by the President as a non-voting member, have adopted a protocol to facilitate the development of an allocation formula. Regular meetings have been scheduled, rotating among the States, and have been attended by the Committee Members and their Alternates, along with appropriate technical resources, other agencies, and representatives from public organizations. These meetings have provided opportunities for formal and informal presentations of ideas and approaches, technical evaluations, and public interests that could be considered in each State's proposal.

The ACT Compact requires the Commission to involve the public during the development, review, and approval of the water allocation formula. It states that:

> *All meetings of the Commission shall be open to the public. The signatory parties recognize the importance and necessity of public participation in activities of the Commission, including the development and adoption of the initial allocation formula and any modification thereto. Prior to the adoption of the initial allocation formula, the Commission shall adopt procedures ensuring public participation in the development, review, and approval of the initial allocation formula and any subsequent modification thereto. At a minimum, public notice to interested parties and a comment period shall be provided. The Commission shall respond in writing to relevant comments.*

In accordance with the requirements of the ACT Compact, each State provides appropriate notification to public stakeholders and the respective media, as well as an opportunity for public hearings, presentations by interested parties, and written comments to be considered during the allocation formula development.

Before the water allocation formula can be forwarded to the Federal Commissioner for review, it must be approved by the State Commissioners. The Compact requires that *"each state shall have one vote on the ACT Basin Commission and the Commission shall make all decisions and exercise all powers by unanimous vote of the two State Commissioners."* As a result, the water allocation formula must be approved by all of the State Commissioners before it can be forwarded to the Federal Commissioner. The water allocation formula will become effective and binding on all parties *"upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner."*

2.2 Proposed Implementation

The approach that the ACT Compact Commission will adopt for the final water allocation formula may include a variety of hydrologic, time scale, and water availability approaches. If implementing the water allocation formula requires changes in project authorization or in how the Corps operates its reservoirs in the ACT basin, new water control manuals and additional NEPA documentation may be necessary to evaluate the site-specific impacts that could result from the changes in operations. As required by the ACT River Basin Compact:

> *The parties to this Compact recognize that the United States operates certain projects within the ACT Basin that may influence the water resources within the ACT Basin. The parties to this Compact further acknowledge and recognize that various agencies of the United States have responsibilities for administering certain federal laws and exercising certain federal powers that may influence the water resources within the ACT Basin. It is the intent of the parties to this Compact, including the United States, to achieve compliance with the allocation formula adopted in Accordance with this Article. Accordingly, once an allocation formula is adopted, each and every officer, agency, and instrumentality of the United States shall have an obligation and duty, to the maximum extent practicable, to exercise their powers, authority, and discretion in a manner consistent with the allocation formula so long as the exercise of such powers, authority, and discretion is not in conflict with federal law.*

For example, if implementing the water allocation formula requires changes in project authorizations or how the Corps operates its reservoirs in the ACT basin, to the extent practicable and within the limits of existing federal laws, new water control manuals and separate NEPA documentation will be prepared to evaluate the site-specific impacts that could result from the required change in operations. In some cases, Congressional action, i.e., implementing legislation (33 CFR 2 Section 216), may be required to change how some Corps-operated reservoirs are managed. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as Alabama Power Company or the Birmingham Water Works Board, the ACT River Basin Commission will work with those entities and the appropriate regulatory agencies to facilitate the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

3. Alternatives Considered

The alternatives considered for this draft EIS include the no action alternative and a range of alternative flow conditions selected to bracket the water allocation formula to be developed by the State Commissioners. The no action alternative is defined by the existing operations conditions within the ACT basin. In addition, a review of historical operations is provided as part of this EIS to document incremental changes in operations and demands that have occurred since the last comprehensive environmental studies were conducted, approximately 20 years ago. This review provides a realistic perspective of current conditions that comprise the baseline, or the no action alternative.

To provide a basis for evaluating the allocation formula, and to meet a schedule for completing the final EIS by late summer 1999, this draft EIS uses a programmatic evaluation framework. This framework provides a range of alternative flow conditions that would encompass or "bracket" the flows that are likely to result from the water allocation formula. To evaluate the potential environmental impacts associated with different flow conditions, alternative flow conditions comprising the high, moderate, and low range can be compared to the flow conditions for the no action alternative and the historical operating conditions scenario. The environmental impacts associated with the range of flow conditions are expected to bracket the potential impacts associated with the flow conditions resulting from the final water allocation formula.

The above alternative flow conditions, including those produced by the no action alternative, were hydrologically modeled by using a historic flow record that represents 55 years of recorded stream flows. The evaluations in the draft EIS compare the effects of the range of flows for the years 1995, 2020, and 2050, accounting for water demand changes affecting stream flows during each time period. The water demands used in the models were developed as part of the Comprehensive Study and have been reviewed and approved by the Corps and by the States of Alabama and Georgia. The assumptions associated with the water demands from municipal, industrial, and agricultural uses remain the same for each year. Specific elements of each of these alternatives are described in the following sections. ***Appendix D*** includes the relevant water demand estimates used to develop the range of alternative flow conditions.

3.1 Continue Existing Operations, the No Action Alternative

As required by NEPA, the no action alternative is the baseline condition against which the action alternatives are compared. The no action alternative provides the baseline flows for comparing the impacts of potential alternative allocation formulas. This baseline represents the conditions in the ACT basin at the time the Comprehensive Study elements were prepared. In this EIS, the no action alternative assumes that existing project operations will continue unchanged into the future, and demonstrates those impacts that would occur without implementation of an alternative allocation formula.

The action alternative flow scenarios will be compared, to the extent practicable, with the no action alternative to evaluate the environmental effects of the water allocation formula

developed by Alabama and Georgia. This evaluation will assist in identifying the direct, indirect, and cumulative impacts expected to result from implementation of the allocation formula. This information will be used to support the Federal Commissioner's decision to concur or not to concur with the water allocation formula.

3.1.1 Existing Operations Model

As discussed in Section 1.3.3.4, a HEC-5 model was constructed to predict stream flows resulting from existing operations (no action) and potential future operations. The existing operations model was developed by using management and operations strategies currently in place at the various reservoir projects. These strategies prescribe reservoir operations for minimum flow releases, power generation rules, and storage management (i.e., to meet competing water uses, such as navigation, power generation, recreation, water supply, wastewater assimilation, fish and wildlife conservation, and flood control). ***Appendix D*** provides details on model development and current conditions.

3.1.2 No Action Alternative

The no action alternative assumes that current reservoir operations will continue, and that water supply demand will continue to increase through the year 2050. There are other approaches that could be considered, such as capping withdrawals at present permitted levels. However, the water supply demands used for the no action alternative were selected from the Comprehensive Study and provide the best current estimates of future water use. The no action alternative is based on current water use patterns and demands (1995), taking into account increasing water supply demands in the future (2020 and 2050).

The demands for the no action alternative are best reflected by the water demand scenarios, which include municipal and industrial demand (scenario 1) and agricultural demand (scenario 2) with no conservation, as defined by the Comprehensive Study (see ***Tables 1-4*** and ***1-5*** for descriptions of these demand scenarios). These demands were selected because they were comparable and consistent for both Alabama and Georgia (Planning and Management Consultants, 1996; NRCS, 1995). Based on these demand scenarios, water supply demands for the years 1995, 2020, and 2050 were modeled for comparison with the alternative flow scenarios. The detailed assumptions for each of these demand scenarios are provided in Section 1.3.3.3. ***Table 3-1*** summarizes the assumptions for the no action alternative.

3.1.3 Historical Operating Conditions

The last major evaluations of the environmental consequences of the individual operating reservoirs in the ACT basin were included in EISs completed in the 1970s. Since then, incremental changes have occurred in project operations due to changes in hydropower contracts and operating schedules, changes in navigation flow requirements, and other changes related to water quality, environment, or other uses of the system. Historical records maintained by the Corps illustrate the observed impacts of changes in operations or seasonal variations over time on pool levels and flow releases from Corps reservoirs. Comparing historic operations conditions with existing operations conditions provides a complete picture of the impacts related to changes in water demand and water resources

TABLE 3-1
Alternatives Considered Applicable to the ACT Basin EIS

Demand Year	No Action Alternative	Action Alternative Flow Scenarios		
		High Flow Conditions	Moderate Flow Conditions	Low Flow Conditions
1995	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995). Consumptive demands associated with thermal power generation were modeled and included in the calculation of total demands. One set of thermal power demands was used for all the alternatives.

Reservoir releases in this table refers to the operation of reservoirs to maintain or enhance flows in the river during critical low periods.

Note: This table is available as a foldout at the end of this report.

management in the basin, as well as a perspective on existing flows to plan for future changes. ***Appendix D*** reviews the differences in operating conditions for the historical operations model and the existing operations model.

The historical operating conditions can be evaluated using the same modeling approach and 55 years of historic flow data used for modeling of the other alternatives. The flow data set has been translated into the historic operating conditions model, represented by operations in effect in the year 1977. This model incorporates water demands hindcast for the 1970s. This information was used to provide a comparative analysis of hydrologic conditions in 1977 with current conditions. The historic data set could be used to facilitate future evaluations related to implementing revised water control plans or other implementing actions.

3.2 Action Alternatives Considered and Potential Mitigation Options

The action alternatives considered for this draft EIS include a range of alternative flow conditions, also referred to as alternative flow scenarios, that would bracket the flow conditions that may result from any potential water allocation formula developed by the State Commissioners. A programmatic evaluation framework has been constructed because the allocation formula is not yet available for evaluation in the draft EIS. A proposed allocation formula may not be presented by the States until late 1998. If the EIS were not initiated until a proposed formula was known, there would not be sufficient time to complete the environmental evaluations for the EIS and make the EIS available to assist in the environmental review of the effects of this formula at that time and to complete the environmental review in time to meet the scheduled date for the Federal Commissioner's decision in late summer of 1999. However, evaluating the environmental effects and potential mitigation for a range of flow conditions can provide sufficient information on the expected environmental impacts of flows that may result from an alternative allocation formula to support a Federal Commissioner decision.

The evaluation of the action alternatives follows a programmatic approach (described in Section 1.3.1) that will allow consideration of a range of possible allocation formulas. The modeled flow conditions evaluated in this EIS do not represent actual alternatives plans for implementing an allocation formula. Rather, the range of flow conditions represents a framework to bracket the potential environmental consequences associated with possible water allocation formulas. The objective of this programmatic approach is to evaluate a range of flow conditions that is broad enough to encompass whatever flow conditions may result from the allocation formula to be developed by the State Commissioners. This programmatic evaluation framework is consistent with NEPA guidance requiring an evaluation of the full spectrum of possible alternatives.

3.2.1 Range of Alternative Flow Conditions

The range of flow conditions was developed based on combinations of projected water supply demands, as well as reservoir releases and operations that would result in the upper (high reservoir releases) and lower (low reservoir releases) boundaries of flow conditions during the time of the year when minimum stream flows normally occur (critical periods). The water supply demands for the years 1995, 2020, and 2050 are represented by projected

demands that were selected from the Comprehensive Study. The selected demand scenarios provide the realistic estimates of potential demand (low to high) that may occur. It should be noted that these demands do not reflect inter-annual changes in demands that may occur during critical drought periods. Peak water supply demands may be greater in some cases; however, the deficiencies in demands during drought years could not be determined. The reservoir releases and operations were varied in the alternative flow scenarios to provide the widest practicable range of potential stream flows during critical low flow periods.

Table 3-1 summarizes the no action alternative and the range of flow conditions evaluated for the action alternative. The various alternative flow conditions represent the range of foreseeable options for municipal, industrial, thermal, and agricultural demand and reservoir operations that could result from the water allocation formula being developed jointly by Alabama and Georgia. The modeled flow conditions that incorporate 1995 water demands are used to evaluate the immediate to short-term environmental effects that could occur when the water allocation formula is implemented. The predicted flows for the years 2020 and 2050 serve as the basis for evaluating environmental consequences for future time periods. The effects of the alternative flow scenarios can then be compared to one another and to the no action alternative.

The term *reservoir releases* in ***Table 3-1*** refers to the operation of reservoirs to maintain or enhance flows in the rivers. *High reservoir releases* means that the reservoirs will be operated to maintain the highest practicable minimum flows in the rivers during critical low-flow periods. *Low reservoir releases* means that the reservoirs will be operated to maximize storage within the reservoirs and to provide the lowest reasonable releases or minimum flows in the river during critical low flow periods. During low reservoir releases, the least possible flow augmentation would occur. During periods when flow augmentation is not required, water would be released from the reservoir at the same rate it flows into the reservoir. *Moderate reservoir releases* means that the reservoirs would be operated at some reasonable intermediate condition between the high-release and low-release conditions.

A combination of high reservoir releases during critical periods and low water supply demand comprise the high-flow conditions scenario. The low-flow conditions scenario is represented by a combination of low reservoir releases during critical periods and high water supply demands. Reservoir releases for all of the flow scenarios would be balanced over the year. For example, if high releases were required during certain periods, low releases could occur during other less critical periods. Reservoir releases for the moderate-flow condition would represent reservoir releases between the high- and low-flow conditions, combined with moderate water supply demands. These combinations of reservoir releases and water supply demands are expected to provide a range of operation conditions and are expected to provide flow conditions that would bracket any water allocation formula developed by the State Commissioners.

3.2.2 Mitigation

3.2.2.1 Council on Environmental Quality Mitigation Guidance

The Council on Environmental Quality (CEQ) requires Federal agencies, in preparing an EIS, to address appropriate mitigation measures not already included in the proposed action or alternatives (40 CFR 1502.14 and 1502.16). Mitigation can include options that would:

- Avoid the impact altogether by not taking a certain action or parts of an action
- Minimize impacts by limiting the degree or magnitude of the action and implementation
- Rectify the impact by repairing, rehabilitating, or restoring the affected environment
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action
- Compensate for the impact by replacing or providing substitute resources or environments

For any proposed action that would result in a significant adverse effect on the environment, appropriate mitigation measures must be considered. All reasonable mitigation measures, even if they are outside the jurisdiction of lead or cooperating agencies, must be identified. To ensure that environmental effects of a proposed action are fairly assessed, the potential mitigation measures must also be discussed. This draft EIS includes a description of the process that will be followed to identify appropriate mitigation options, and the types or categories of mitigation that might be appropriate for certain types of expected impacts. Once an allocation formula is known, the final EIS will provide information regarding the likelihood that mitigation will be required, implementation plans, and responsible agencies.

3.2.2.2 Potential Mitigation Options

Potential mitigation of the impacts associated with the range of alternative flow conditions is addressed in this EIS. General mitigation measures to address impacts are summarized for each natural resource area (in Section 4). The measures identified are potential options that could be used to mitigate impacts. Proper consideration of mitigation requires that a full range of measures be identified (including, where appropriate, alternative means to mitigate a single impact), along with the relative cost of the measures and their effectiveness in reducing the level of impact. The Corps, the cooperating Federal agencies, and the States will evaluate the potential mitigation options presented in the final EIS. The justification of recommended mitigation measures will be based on the environmental and economic analyses presented in the EIS and regulatory agency requirements.

Mitigation measures to address unavoidable impacts associated with the final water allocation may be implemented by the Corps at existing Federal facilities, by private reservoir operators (e.g., FERC licensing conditions), or by State agencies, depending on the location of the area of impact. The specific details of the mitigation required at Federal facilities may be presented in the other site-specific NEPA documents that tier from this EIS (e.g., revisions to the water control manuals and their supporting NEPA documents), which may be required to bring about a change in current operations. For example, the Corps may initiate a program for habitat enhancement in Federal reservoirs to address loss of fish spawning habitat due to increased water level changes. Mitigation of impacts due to increased stream flows downstream of Corps facilities may require stream bank protection or restoration. Mitigation of impacts on stream flows may also require implementation of drought management plans by the States to reduce water usage during these critical periods. More stringent regulatory criteria may be implemented by States for point source or nonpoint source discharges to particular stream segments. Restrictions on lawn watering,

car washing, or surface or groundwater withdrawals for irrigation are typical conservation measures that may be implemented.

4. Affected Environment, Environmental Consequences, and Potential Mitigation Measures

This chapter of the document describes the affected environment, environmental consequences, and potential mitigation measures in one chapter so that the reader can more easily evaluate existing conditions and environmental impacts on individual resource categories. Only those environmental parameters that may be affected are included.

4.1 Baseline for Analyses

The Comprehensive Study provided the primary resource documents for describing the baseline conditions for the affected environment in the ACT basin. These Comprehensive Study documents were developed and approved by the various resource and/or cooperating agencies and the States of Alabama and Georgia with the objective that they would provide the relevant technical data and analyses necessary to evaluate current conditions in the EIS. As appropriate, these study elements have been supplemented with other information when necessary to meet the needs of this programmatic EIS. The cooperating Federal agencies (see Section 1.1.1) provided substantial information on existing or baseline conditions in the river basin. Additional information sources included specific Internet web sites, recent mapping data, Corps hydrologic modeling studies and water quantity and quality modeling, protected species surveys, biological impact evaluations by the FWS, recreation and economics impact evaluations conducted by the Corps, and cultural resource impact modeling under contract to the Corps. Overviews of each information source used to describe the affected environment and support impact analyses are included in the main body of this EIS. More detailed technical sections of these Comprehensive Study elements and other additional data collection and analyses that support these discussions are provided in the appendices referenced in the appropriate section of this EIS.

The environmental consequences associated with each evaluated alternative are also discussed for each resource heading in the following sections. The hydrology analyses conducted by the Corps form the basis for evaluating the consequences of each alternative. The results of these analyses are used in the appropriate sections to determine if (1) there could be an effect or impact to a resource area, (2) what the magnitude of that effect might be relative to direct, indirect, or cumulative impacts, (3) the significance of those effects, and (4) whether these effects are likely to be mitigated. The hydrologic analyses, discussed in detail in Section 4.4.1, include evaluations of the no action alternative as well as a range of alternative minimum flow options (high, moderate, and low) within which it is anticipated the allocation formula developed by the States will fall (see Section 3.3.1). This range of

alternative minimum flow conditions form the basis for evaluating the action alternative; i.e., the Federal Commissioner's concurrence with the States' proposed water allocation formula.

The approach used for impact evaluation is to compare the likely effects of the action alternative flow scenarios to the no action alternative (existing operations conditions) for each resource area for each of the modeled study years (i.e., 1995, 2020, and 2050). The approaches used to actually make these comparisons vary by technical resource area. Some resource area baseline descriptions include modeled data in addition to qualitative descriptions of existing conditions. When that is the case, current conditions may reflect modeled rather than actual data (see Section 4.7.1). The specific details for the impact analyses used are described under Environmental Consequences for each of the resource areas.

The application of these analyses to the types of impacts projected and the significance levels of these impacts are discussed in the following sections.

4.1.1 Direct, Indirect, and Cumulative Impacts

An EIS considers direct, indirect, and/or cumulative impacts that are likely to result from each alternative evaluated. The guidance used for determining the category into which impacts might occur is as follows:

- *Direct impact* is the direct effect that results from a particular action. An example could be an action that produces a flow regime that decreases habitat for an aquatic species.
- *Indirect impact* is an effect caused by the action that may occur later in time or farther removed in distance from the location of the effect, but is reasonably foreseeable. For example, the impact of an action that reduces hydropower generation could result in demand for nonrenewable resource power generation (coal or oil-fueled) and therefore have indirect effects on air quality.
- *Cumulative impact* is an effect on the environment that results from the impact of an action that is added to the impacts of past, other present, or reasonably foreseeable future actions. These effects might occur through a series of actions that are connected in some way. For example, the effects of flow diversions from a series of upstream reservoirs within a single drainage system might produce cumulative negative effects on water quality or quantity necessary to support commercial fisheries habitat in downstream reaches of the basin.

Direct and indirect impacts are addressed by resource area in Sections 4.3 to 4.9. Cumulative impacts are discussed separately and are summarized in Section 4.10.

4.1.2 Mitigation

Some or all of an alternative's negative effects on a particular resource area may be reduced or balanced by other actions or activities, i.e., mitigative actions. In developing this EIS, mitigative measures have been defined for each resource area to the extent that mitigation is believed feasible and practical, and would result in meaningful reductions in the projected negative impacts.
Potential mitigation options or actions are discussed in Section 4.11.

4.1.3 Significance Criteria

The final element in evaluating impacts to each resource is significance assessment. Significance criteria provide an objective measure of the degree of impact on each resource area that can be used in the significance assessment. For a programmatic EIS, this assessment must be based on broader interpretation and data evaluation than project-specific EISs. Three categories of impacts have been defined for this EIS—insignificant, significant, or beneficial. Some of these significance evaluations may be linked to a regulatory standard. For example, a violation of a water quality standard would be considered significant; no violation would be considered insignificant; and a change that provided even greater protection for the standard than currently exists would be considered beneficial. Other impacts may be evaluated on the weight of evidence and professional judgment. For example, a non-regulatory standard could include a change in reservoir levels or fluctuations. Fluctuations that result in increased erosion could be considered *significant*; minor changes in level or timing of fluctuations that would not produce observable increases in erosion could be considered *insignificant*; and changes or attenuation of rate of drawdown that would reduce the rate of erosion would be considered *beneficial*. In general, these categories of significance may be summarized as follows:

- *Significant impact* is defined as a violation of a regulation, standard, or published criterion, or an effect that would result in an unacceptable loss of a resource.
- *Insignificant impact* is the result of an alternative whereby no regulation, standard, or criterion is likely to be violated, and no meaningful loss of a resource occurs.
- *Beneficial impact* is the result of an alternative that may be expected to enhance or otherwise increase the value of a resource, as perceived by the resource agency and/or the public.

The significance criteria used in this EIS to evaluate impacts are based on recommendations provided by each of the resources and/or cooperating agencies during the preparation of this document. These criteria are summarized in ***Table 4-1***.

TABLE 4-1
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Geology and Soils					
Geology	Karst environments – sinkholes	Indirect effects on water quantity	Water quantity losses to groundwater	Groundwater losses that prevent meeting agricultural and municipal and industrial (M&I) demands	None
		Indirect effects on stability of surface environment	Surface environment stability affected by potential sinkhole formation/collapse	Flow changes could increase flow into or from karst environments, enhancing the conditions favorable for sinkhole formation (i.e., dissolution in vulnerable areas)	None
				Changes that result in dewatering aquifer in karst environment could increase the potential for sinkhole collapse	None
Hydrogeology	Surface water contribution to groundwater recharge; effects on spring discharge; impacts on flow in the river and wetlands habitat	Effects on water quality	Surface water flows affected by groundwater interaction, effects on wetlands	Effects on surface water flows that impact water quality standards, or reduction in wetlands habitat for protected species or important game species	Restored hydrology and reconnection of floodplain

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Soils	Erosion impacts on channel degradation and isolation of small tributaries	Indirect effects on wetlands, water quality, and aquatic and cultural resources; sedimentation into streams and reservoirs from NPS sites	Indirect effects on recreational uses and aesthetics; sedimentation and siltation of reservoirs and/or stream channels	Effects that increase water-related movement of erodible soils	Effects that reduce the areas of erodible soils affected or reduce sedimentation
Water Resources					
Water quantity	Surface water flows	Indirect effects on water quality, wetlands, and protected species	Indirect effects on other resources	Reduction in flows that produce impacts to regulated resources; impacts that result in exceeding established water control structure operations	Flow augmentation that enhances regulated resources
	Flood flows	Changes in flood hazard areas as defined by FEMA	Increased frequency or extent of flooding	Any increase in flooding extent or frequency affecting human health, property, or safety	Flood management that reduces impacts to human health, property, or safety; restored floodplain hydrology
	Navigation	None	Meet navigation requirements	Reduction in frequency of meeting navigation requirements; undue navigation delays	Enhance frequency of meeting navigation requirements

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
	Reservoir levels and fluctuation	Effects on cultural and protected biological resources	Effects on recreational, biological, or other uses; losses due to erosion	Increased impacts to regulated resources; increased erosion or loss of recreational or biological resources	Enhance protection of regulated resources; enhanced habitat or access to recreational facilities
	Water supply demands	None	Ability to meet agricultural and M&I demands	Reduction in ability to meet water supply demand requirements	Enhanced ability to meet water supply demand requirements
Water quality	Water quality requirements to meet resource uses	Water quality standards and impacts to protected species	Water quality impacts to non-regulated uses[b], including aquatic resources and human contact uses	Reduction in water quality that violates standards or causes loss in other resource uses	Enhanced water quality
	Protect existing uses	Maintain anti-degradation standards	Water quality impacts to non-regulated uses, including aquatic resources and human contact uses	Change in water quality degrades stream quality below current conditions	Enhanced ability to meet or exceed current water quality and uses
Biological Resources					
Vegetation resources					
Terrestrial communities	Impacts from changes in elevations, flows, or durations or construction of new reservoirs	Losses of protected species	Losses related to increased flooding or erosion	Impacts to important or protected terrestrial populations	Changes in elevations, flows, or duration that decrease erosion or flooding of terrestrial communities

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Wetlands	Loss of wetlands	Impacts to jurisdictional wetlands	Indirect effects on other resources that may be affected by wetland losses	Changes that result in substantive wetland losses or reduction in habitat value	Water quantity changes that enhance wetlands areas and/or functions
Fish and aquatic resources					
Riverine	Frequency, timing, and duration of flows	Losses of protected species or critical habitat	Losses of native biodiversity and impacts to recreational or commercial fishery resources, anadromous species, or their habitats	Impacts to regulated resources or substantive losses of other aquatic resources	Enhanced habitat or riverine values to support protected species, native riverine species, anadromous species, or other game fish species
Reservoir	Frequency, timing, and duration of reservoir level fluctuations	FERC license requirements for non-Federal projects; losses of protected species or critical habitat; authorized purposes for Federal projects	Losses to recreational or commercial fishery resources or their habitats	Impacts that conflict with FERC licenses affect protected species or other fishery resources, or affect ability to meet authorized project purposes	Enhanced habitat or reservoir values to support protected species, game fish species, or anadromous species; improved ability to meet authorized purposes or FERC requirements
Estuarine	Change in salinity concentration, salinity variability, and water circulation	Protected species, essential fish habitat	Losses to recreational or commercial fishery resources and/or their habitats	Impacts to managed resources, anadromous species, or losses of other estuarine resources and habitats	Enhanced estuarine habitat values to support protected species, anadromous species, or essential fish habitat

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Land Use					
General land use patterns	Relationship of land use and impervious surfaces and impacts to water quality	Water quality standards and approved stormwater plans	Indirect effects on aesthetics, and water quality uses	Induced changes in land use increasing nonpoint source loadings	Changes in land use or implementation of nonpoint source best management plans that reduce nonpoint source loadings
Agricultural uses	Effects of water supplies in meeting agricultural demands, flooding, or erosion of prairie farmlands	None	Inadequate supplies reducing available farmlands and increasing flooding	Losses of crops or farmlands related to inadequate supplies or increased flooding or erosion	Enhanced ability to meet expanded agricultural demands, decreased flooding or erosion
Socioeconomic Resources					
Population/ demographics	Impacts on population growth and quality of life	Local land use plans or policies	Growth or shift in population characteristics that affect approved plans	Substantial growth inducement or concentration of population that is inconsistent with local plans or policies	
Environmental Justice/ protection of children	Disproportionate risks and potential impacts to minority, low income, and child populations related to water quality and flooding	EO 12898 and EO 13045	Disproportionate risks and potential impacts to low income, minority, and child populations	Disproportionate impacts that affect low-income, minority, and child populations	Changes that result in reduced impacts to low income, minority, or child populations

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area		Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Recreation						
	Reservoir	Recreational access and uses of reservoirs	None	Losses of recreational uses or land values	Increased fluctuations or reductions in levels during major recreational use periods that affect uses	Reduced fluctuations or changes in levels that result in enhancement of uses, or values, or access to recreational facilities
	Riverine	Recreational uses	None	Losses of recreational uses or values	Reductions or increases in flows at times that cause reductions in recreational uses, access, or safety	Enhancement of recreational uses, access or improved safety
Regional economics						
		Effects on income and employment	None	Changes in rational threshold values[c] or NED benefits	Exceedance below rational threshold values generated by EIFS modeling; changes that decrease NED benefits	Exceedance above rational threshold values generated by EIFS modeling; changes that increase NED benefits
Hydropower		Reduction in hydropower generation due to changes in water availability	None	Reduced income from power generation	Substantial loss in income from hydropower generation below projections	Significant gain in income from hydropower generation

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACT Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Air Quality and Noise	Increased dependence on non-renewable fuels and related air impacts due to reduction in hydropower generation	Air quality standards, potential local noise ordinances	Indirect effects on energy production that might induce additional power development	Effects that violate air quality or noise regulations	Changes that result in decreased air emissions or reduced noise levels
Cultural Resources					
Historic and archaeologic al resources	Erosion, sediment deposition, or change in access to resources	National Register of Historic Places (NRHP)	Potential effects on other areas of importance not eligible for listing on NRHP	Changes in surface water flows or reservoir levels that result in losses of NRHP sites, or have a high potential to impact areas with high probability to contain these sites	Reduced erosion and reduced access to cultural resource sites that would reduce potential losses of important resources

[a] Professional standard is a judgment made by an appropriate technical resource professional of the significance on an environmental or socioeconomic effect on that resource.

[b] Nonregulated uses include resources that may not be protected under State or Federal regulations, but may be subject to negative environmental effects.

[c] Rational threshold values indicators of deviation from historic regional economic trends.

EIFS Economic Impact Forecast System
EO Executive Order
FEMA Federal Emergency Management Agency
FERC Federal Energy Regulatory Commission
NED National Economic Development

4.2 Description of Basin

The ACT basin drains about 22,820 square miles in parts of southeastern Tennessee, northwest Georgia, and a diagonal area across Alabama, from the northeast to the southwest corner of the State (see ***Figures 4-1*** and ***4-2***). About 77 percent of the ACT basin lies in Alabama. The majority of the remaining 23 percent lies in Georgia, with a very small portion in southeast Tennessee. The basin extends approximately 320 miles from the Blue Ridge Mountains to the Gulf of Mexico and has an average width of approximately 75 miles. The basin covers 32 counties in Alabama, 18 counties in Georgia, and 2 counties in Tennessee.

The main rivers of the ACT basin are the Alabama, Coosa, and Tallapoosa Rivers. The Cahaba River is also a major river in the basin. The Alabama River joins the Tombigbee River and forms the Mobile River, which subsequently flows into the Gulf of Mexico at Mobile Bay. The scope of this EIS covers the ACT basin and Mobile Bay.

The ACT basin is a dynamic hydrologic system containing interactions between aquifers, streams, reservoirs, floodplains, estuaries, and adjacent river basins. Water resources in the ACT basin have been managed to serve a variety of purposes, including navigation, hydroelectric power, flood control, water supply, water quality, and recreation. These water resources also provide important habitat for fish and wildlife. There are 18 dams in the basin (6 Federal and 12 non-Federal projects) that have altered the natural streamflow and provided significant improvements and opportunities for the public in these resource areas. The interrelationship between dam operations and downstream river flows has resulted in a highly regulated system over much of the basin, with the exception of the Cahaba River, which remains naturally free-flowing.

The ACT basin is characterized by a warm and humid, temperate climate due to its latitude, altitude, and proximity to the Gulf of Mexico. Average annual temperature ranges from about 60° Fahrenheit (F) in the north to 70°F in the south. Average daily temperatures in the ACT basin range from about 40 to 55°F in January to 75 to 80°F in July. Summer temperatures are typically in the 70s to the 90s. Freezing temperatures in winter occur for only short periods (Couch et al., 1996).

Precipitation is highest at the northern end of the basin in the mountains and at the southern end of the basin near the Gulf of Mexico. Average annual precipitation is about 65 inches per year at both the northern and southern ends of the basin. The central part of the basin receives less precipitation, with an annual average of 55 inches (see ***Figure 4-3***). Precipitation varies substantially on an annual basis. For example, in Montgomery, Alabama, annual precipitation varied from 27 to 75 inches from 1948 to 1996, with an annual average of 52 inches over this period. Precipitation is generally highest in late winter and early spring, and then again in mid-to late summer, when tropical depressions and tropical storms from the Gulf of Mexico occasionally track up the basin.

About half the water that falls as precipitation in the ACT basin is returned to the atmosphere as evapotranspiration (direct evaporation plus transpiration by plants). Evapotranspiration ranges from about 30 to 42 inches of water per year in the ACT basin, generally increasing from north to south. Average annual runoff basinwide ranges from 20 to 40 inches (or about 40 to 65 percent of average annual precipitation). Runoff is greatest in the Blue Ridge Mountains and near the Gulf coast (USGS, 1996).

FIGURE 4-1
Map of the ACT Basin

ATL\Scarlett\Graphics\144284.AO.PP\7-21-98\ACT\ACT102

FIGURE 4-2
Map of the ACT Basin Counties

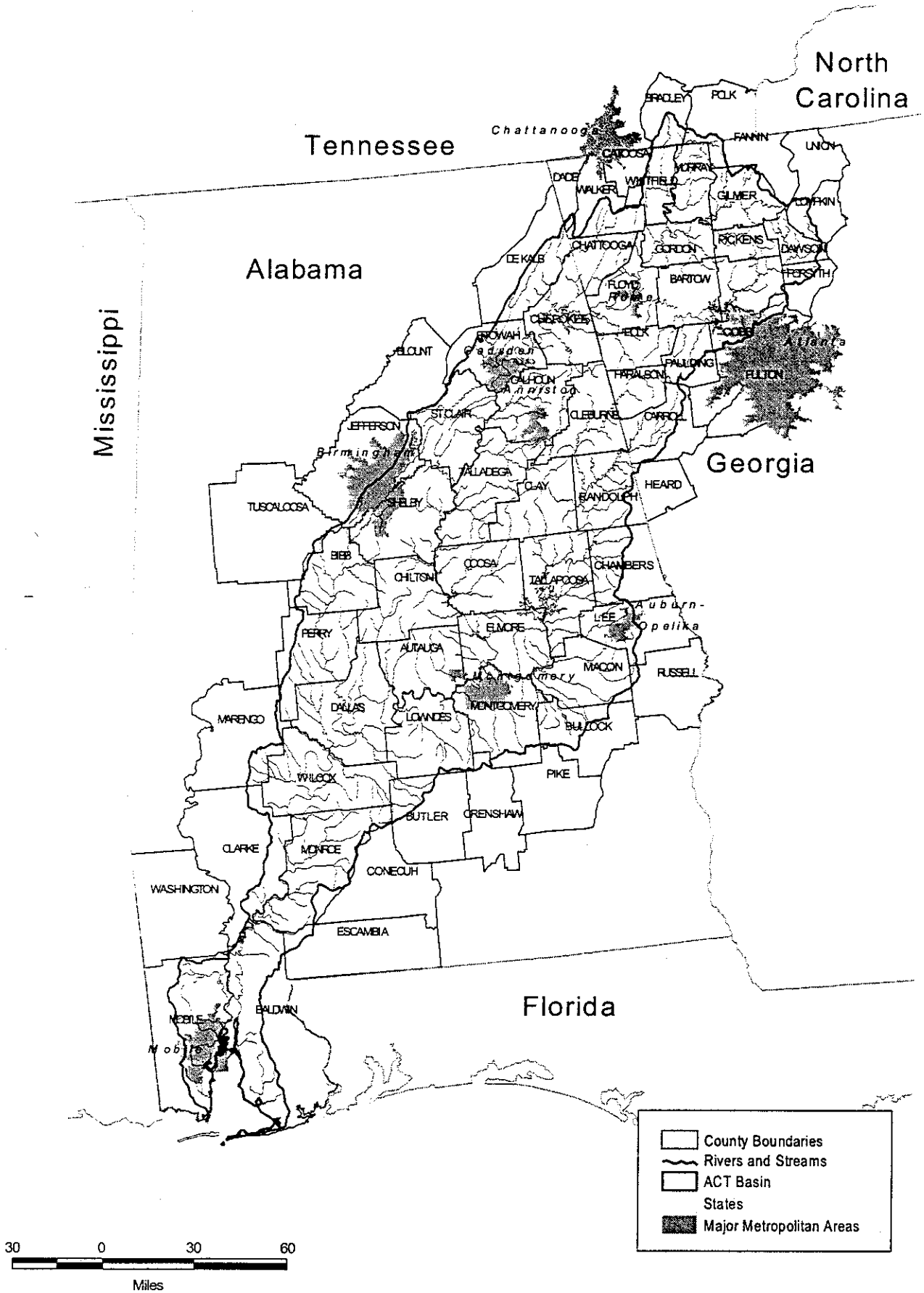
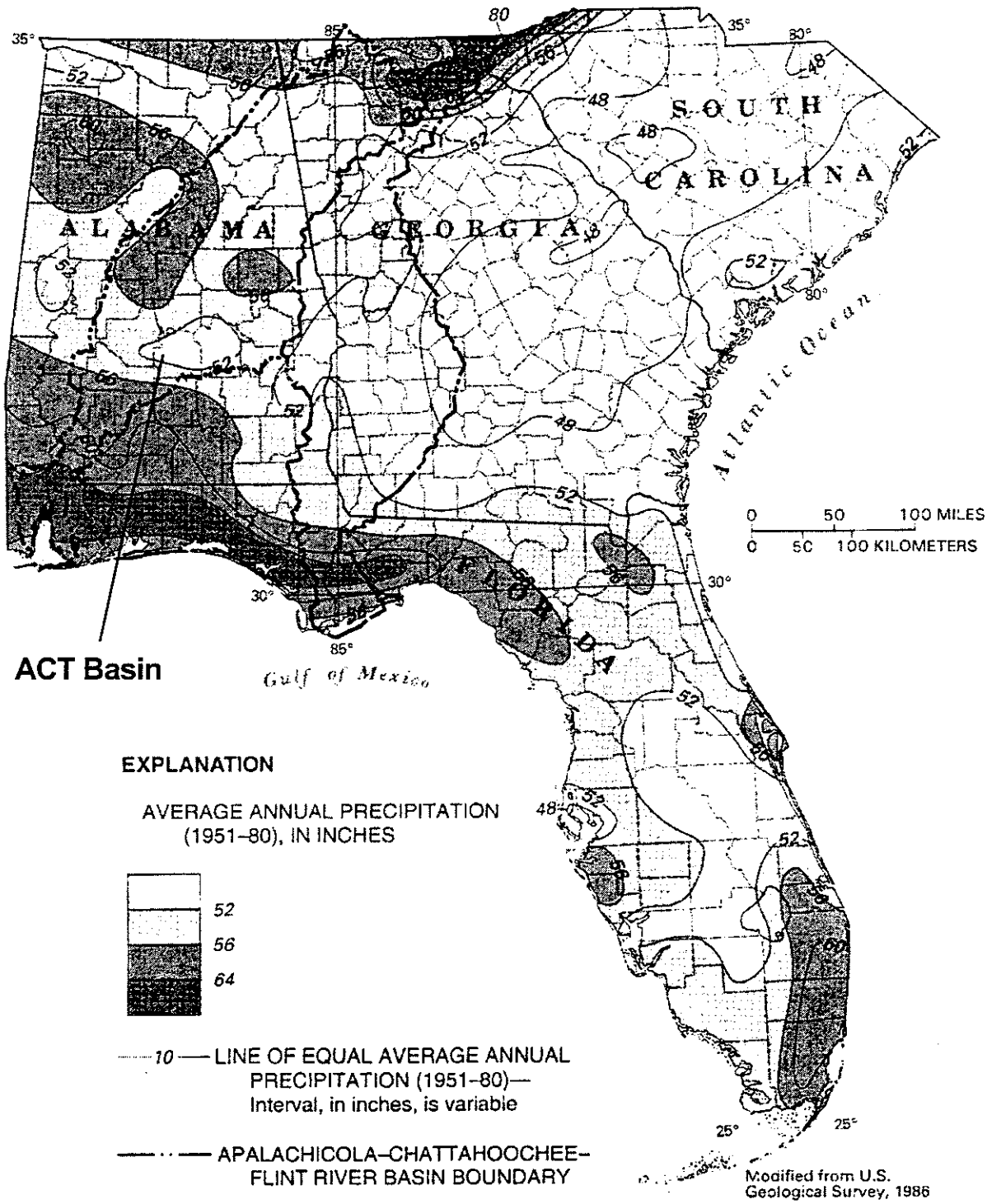


FIGURE 4-3
Average Annual Precipitation in the ACT Basin
Couch, et al., 1996



Historically, there has been adequate water to meet the needs of most users in the ACT basin. However, during the droughts in the 1980s, hydropower production had to be reduced, navigation was significantly curtailed, municipalities and industries were required to implement water conservation measures, and recreational use of reservoirs was limited. Agricultural crops were also heavily damaged. This drought period demonstrated the competing demands for water in the basin and prompted the States of Alabama and Georgia to initiate a process for regional water resource planning (see Section 1.1).

4.3 Geology and Soils

This section addresses the geologic and soil environment in the ACT basin. For purposes of discussion, the boundaries and descriptions of the four subareas of the basin are consistent with those used by the USGS in evaluating the groundwater resources during the Comprehensive Study. The description and evaluation of geology and soils is based on studies conducted by the USGS as part of the National Water Quality Assessment (NAWQA) Program. Impact evaluations were completed by the Corp's contractor based on the results of the HEC-5 modeling of potential changes in stream flows (see Section 4.4). The USGS provided review and input on the impact analyses as a cooperating Federal agency.

4.3.1 Geology

The following section focuses on the geologic setting in the ACT basin that influences surface and groundwater availability and the potential impacts associated with changes in water management.

4.3.1.1 Affected Environment

The physiography of the ACT basin reflects a geologic history of mountain-building in the Appalachian Mountains and long periods when the land was submerged beneath the oceans in the Coastal Plain province.

The physiographic provinces located within the ACT basin include the Cumberland Plateau, Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain physiographic provinces (*Figure 4-4*). A generalized map of the major aquifers in the ACT subareas (subareas 5, 6, 7, and 8) is presented in *Figure 4-5*.

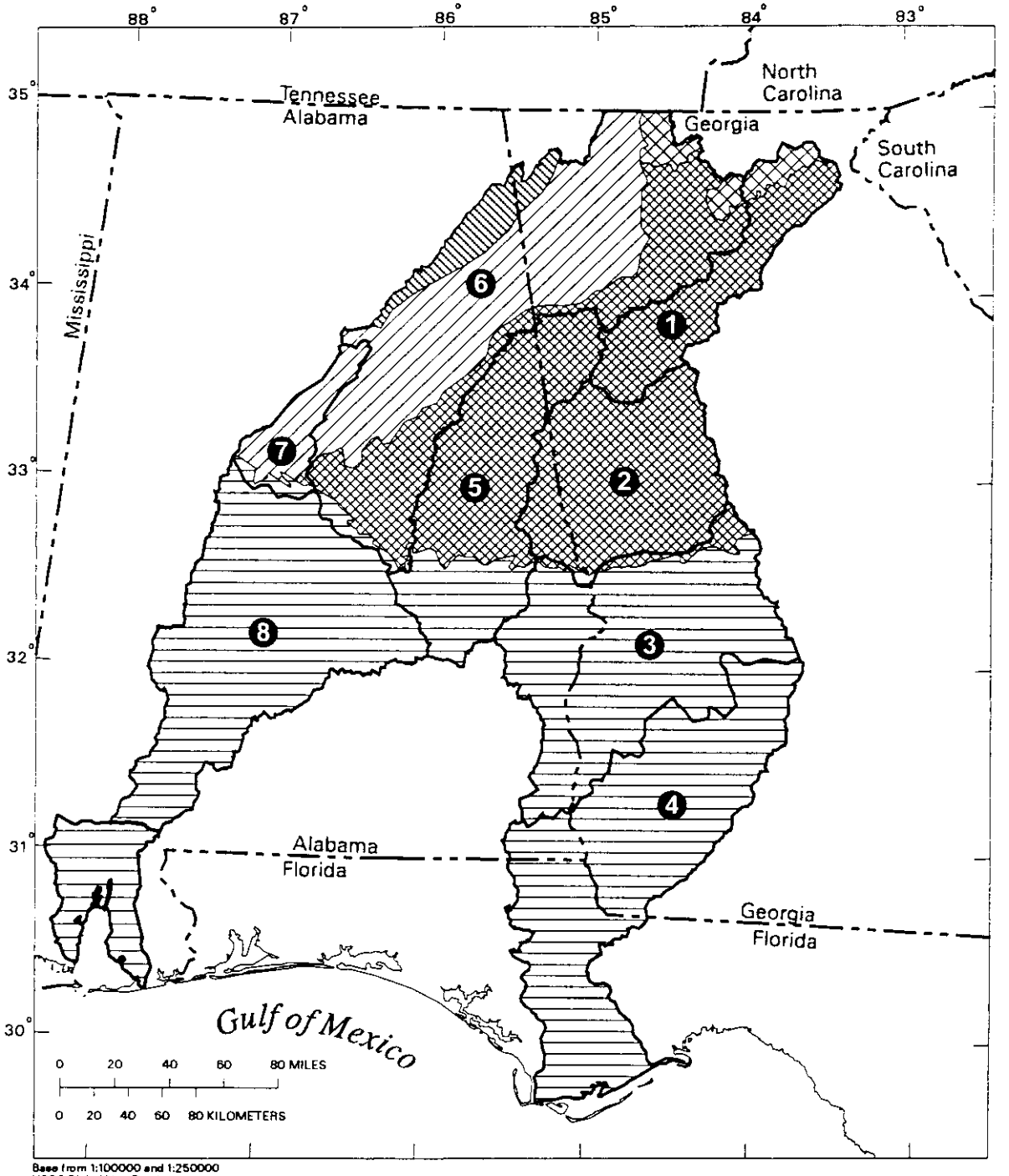
4.3.1.1.1 Cumberland Plateau and Valley and Ridge Physiographic Provinces

In the ACT basin, the Cumberland Plateau is limited to subarea 6, where it comprises 8 percent of the land area. The Cumberland Plateau is dominated by relatively flat plateaus ranging in altitude from 1,500 to 1,800 feet. These plateaus bound narrow, northeast-southwest-trending linear valleys.

The Valley and Ridge province covers 34 and 84 percent of subareas 6 and 7, respectively. This province predominantly has relatively narrow, northeast-trending ridges at altitudes ranging from 600 to 1,600 feet. In this area, streams drain wide valleys (Scott, Cobb, and Castleberry, 1987; Cressler et al., 1976). In both the Cumberland Plateau and Valley and Ridge provinces, the stream patterns are predominantly trellis-like or rectangular.

These two provinces are characterized by rocks of Paleozoic age. These rocks are folded, faulted, and thrusted clastic and carbonate rocks of stream or marine origin that have been only locally metamorphosed. Typical rock types include shale, siltstone, sandstone, limestone, and dolostone. Lens-shaped discontinuous quartz sand and gravel beds of Cenozoic age have been deposited on the valley floor of the Coosa River, particularly in the areas of Calhoun, Cherokee, Elmore, Etowah, and St. Clair counties in Alabama. A generalized geologic and hydrogeologic profile representative of subareas 6 and 7 is

FIGURE 4-4
Physiographic Provinces and Subareas in the ACT and ACF Basins
Source: Modified from Journey and Atkins, 1997

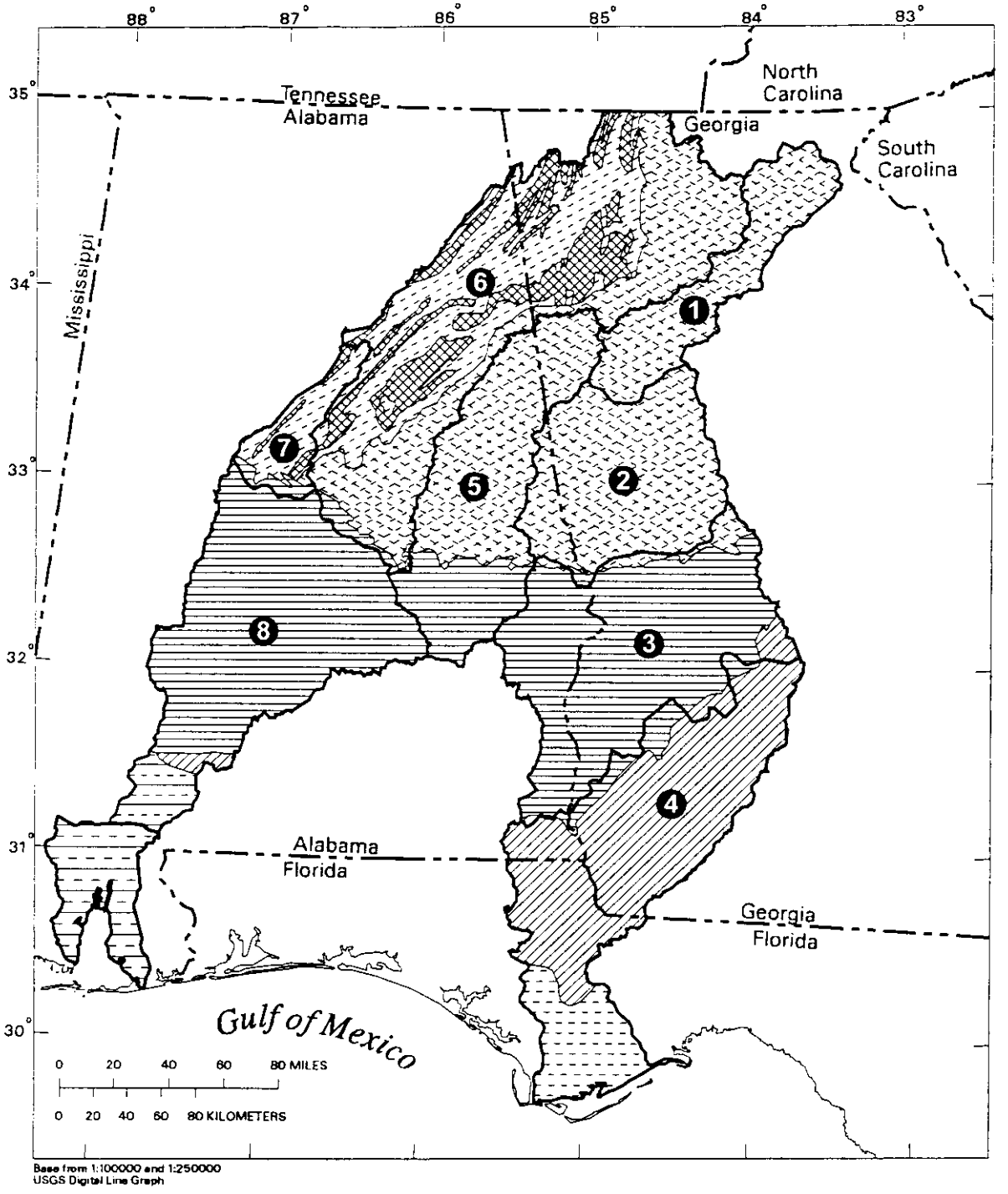


EXPLANATION

PHYSIOGRAPHIC PROVINCES

Coastal Plain
Piedmont
Cumberland Plateau
Valley and Ridge
Blue Ridge
Subarea 1
Boundaries

FIGURE 4-5
Major Aquifers and Subareas in the ACF and ACT Basins
Source: Modified from Chapman and Peck, 1997a



EXPLANATION
AQUIFERS

- Surficial aquifer system
- Coastal lowlands aquifer system
- Southeastern Coastal Plain aquifer system
- Floridan aquifer system
- Valley and Ridge and Cumberland Plateau aquifers: carbonate
- Subarea 1
- Valley and Ridge and Cumberland Plateau aquifers: sandstone
- Piedmont and Blue Ridge (crystalline–rock) aquifers
- Boundaries

presented in *Tables 4-2* and *4-3*. These profiles include descriptions relevant to the Cumberland Plateau and the Valley and Ridge provinces.

TABLE 4-2
Generalized Geologic Units in Subarea 6, Water-Bearing Properties, Chemical Characteristics, and Well Yields

Physiographic Province	Geologic Age and Lithology	Aquifer Type	Water-Bearing Properties and Chemical Characteristics	Well Yield
Valley and Ridge	Cenozoic–sand and gravel	Porous-media	Generally adequate only for domestic use. May have high iron concentrations.	10 gallons per minute typical
Coastal Plain	Cretaceous–sand and gravel beds of the Coker and Gordo Formations	Porous-media	Used for limited public water supply in Chilton and Elmore Counties, Alabama.	100 to 200 gallons per minute (Scott, Cobb, and Castleberry, 1987)
Valley and Ridge and Cumberland Plateau	Paleozoic–sandstone, shale, and siltstone	Fracture-conduit	Yield highly variable, may have high iron content. In limited use for public water supply.	10 to 200 gallons per minute (Bossong, 1989)
	Paleozoic–limestone, dolostone, and chert	Solution-conduit	Widely used for public water supply. Water may have high concentrations of calcium and bicarbonate.	10 to 2,000 gallons per minute (Bossong, 1989)
Piedmont and Blue Ridge	Regolith, soil, alluvium, colluvium, and saprolite derived from various aged rocks	Porous-media, preferential flow	Generally suitable for domestic use only.	No available data
	Precambrian to Paleozoic–quartzite, slate, gneiss, schist, marble, phyllite, and granite	Fracture-conduit	Local, discontinuous properties, well yields variable. Water quality generally good.	1 to 25 gallons per minute typical; may exceed 500 gallons per minute (Kidd, 1989; Guthrie et al., 1994)

Source: Robinson, et al., 1997

The geology in these provinces generally controls the types of aquifers present, as well as the natural quality and quantity of groundwater. Due to the wide variation of lithologic and water-bearing characteristics, the aquifers in both subareas 6 and 7 vary widely. These areas are dominated by three main types of aquifers, based on their ability to store and yield water: 1) porous-media, 2) solution-conduit, and 3) fracture-conduit aquifers. These aquifers differ in how they were formed and in their water-supply potential. In the Cumberland Plateau and the Valley and Ridge provinces, the dominant aquifers include the Surficial aquifer system and the Valley and Ridge and Cumberland Plateau aquifers, which are well-cemented carbonate rocks in which water flows through channels formed as a result of solutioning. There is little primary porosity or permeability, and the water moves through features such as enlarged fractures and bedding planes. The weathered zone above many of

TABLE 4-3
Generalized Geologic Units in Subarea 7, Water-Bearing Properties, Chemical Characteristics, and Well Yields

Physiographic Province	Geologic Age and Lithology	Aquifer Type	Water-Bearing Properties and Chemical Characteristics	Well Yield
Valley and Ridge	Cenozoic–sand and gravel	Porous-media	Generally adequate only for domestic use. May have high iron concentrations.	10 gallons per minute typical
Coastal Plain	Cretaceous–sand and gravel beds of the Coker and Gordo Formations	Porous-media	Used for limited public water supply in Chilton and Elmore Counties, Alabama.	100 to 200 gallons per minute (Scott et al., 1987)
Valley and Ridge	Paleozoic–sandstone, shale, and siltstone	Fracture-conduit	Yield highly variable. May have high iron concentrations. In limited use for public water supply.	10 to 200 gallons per minute (Bossong, 1989)
	Paleozoic–limestone, dolostone, and chert	Solution-conduit	Widely used for public water supply. Water may have high concentrations of calcium and bicarbonate.	10 to 2,000 gallons per minute (Bossong, 1989)
Piedmont	Regolith, soil, alluvium, colluvium, and saprolite derived from various aged rocks	Porous-media, preferential flow	Generally suitable for domestic use only.	No available data
	Precambrian to Paleozoic–quartzite, slate, gneiss, schist, marble, phyllite, and granite	Fracture-conduit	Local, discontinuous properties. Well yields variable. Water quality generally good.	1 to 25 gallons per minute typical; may exceed 500 gallons per minute (Kidd, 1989; Guthrie et al., 1994)

Source: Mooty and Kidd, 1997

the carbonate-rock aquifers contains a layer of chert rubble that stores and transmits water to the underlying fracture-rock aquifer. Wells completed in these aquifers may supply several thousands of gallons of water per minute.

Folding and faulting disrupted local geologic features so that the same aquifer may occur in adjacent valleys but may still not be hydraulically connected (Planert and Pritchett, 1989). In this type of environment, groundwater withdrawal and resulting water-level declines could lead to development of sinkholes, depending on the amount of water withdrawn, the resulting water-level decline, the proximity of solution conduits to the land surface, and the land-surface loading.

Aquifers in which water travels through fractures in the rock are present in the shales, siltstones, and sandstones of the Valley and Ridge and Cumberland Plateau provinces. These aquifers are generally composed of two water bearing zones: shallow unconsolidated soils and rock, and deeper, fractured bedrock. These aquifers may yield quantities of water suitable for public or industrial supplies.

Along the Coosa River, aquifers typically receive recharge from the upland areas and discharges to the surface water environment.

4.3.1.1.2 Blue Ridge and Piedmont Physiographic Provinces

In the ACT basin, the Blue Ridge province is limited to the northernmost portion of subarea 6, and makes up about 4 percent of that subarea (***Figure 4-4***). The Blue Ridge province has mountain ridges that reach altitudes of 4,100 feet (Robinson et al., 1997). In this area, most streams have rectangular or trellis drainage patterns. The Blue Ridge differs from the Piedmont province primarily in its higher topographic relief.

Thirty-four percent of subarea 6 and most of subarea 5 (71 percent) are located within the Piedmont Physiographic province. Both the Blue Ridge and Piedmont provinces are underlain by Precambrian and Paleozoic crystalline rocks, which include slate, phyllite, schist, gneiss, quartzite, and granite. Less extensive outcrops of quartzites are also present. The area is highly folded and faulted.

Groundwater characteristics are largely controlled by geology in the Blue Ridge and Piedmont provinces, where bedrock is generally covered by a layer of weathered rock and soil that can range in thickness from a few feet to more than 150 feet. From the land surface, the regolith zone consists of a porous and permeable zone that grades downward into a clay-rich, relatively impermeable zone that overlies or grades into a porous and permeable saprolite known as a transition zone (Heath, 1989). This transition zone grades downward into unweathered bedrock. Groundwater found in the regolith or in areas of alluvial and colluvial deposits usually have low yields and are limited to domestic uses (Robinson et al., 1997).

The principal aquifers in the Blue Ridge and Piedmont provinces are bedrock aquifers in which the groundwater flows along fractures (***Figure 4-5***). These aquifers can discharge to the surface waters. Due to the intense metamorphic history of the bedrock aquifers in this area, there is little or no primary porosity and poor permeability (Chapman et al., 1993).

4.3.1.1.3 Coastal Plain Physiographic Province

The northern boundary of the Coastal Plain is marked by the Fall Line, which generally follows the contact between the crystalline rocks of the Piedmont and the unconsolidated sediments of the Coastal Plain. The Coastal Plain makes up about 2 percent of subareas 6 and 14 percent of subarea 7, the southernmost 29 percent of subarea 5, and the entire extent of subarea 8. Land elevations range from 50 to 850 feet, but are generally less than 300 feet and decrease toward the coast. The geology in the Coastal Plain consists of sediments, which are predominantly sands of the Pliocene to recent age. Across the fall line, streams undergo abrupt changes in gradient, marked by rapids and shoals. In the Coastal Plain, streams typically lack the riffles and shoals common to streams in the Piedmont, and exhibit greater flood plain development and increasing sinuosity (Couch et al., 1996).

Coastal Plain sediments in Alabama form a thick wedge of unconsolidated or poorly consolidated clastic and carbonate rocks, which dips south to southwestward from the Fall Line toward the Gulf of Mexico (Kidd, et al., 1997). The sediments range in thickness from a feather edge at the Fall Line to as much as an estimated 21,000 feet near the coast. They are underlain in places by metamorphic and igneous rocks of Precambrian and Paleozoic age and in other places by sedimentary rocks of Paleozoic and early Mesozoic age. The rocks underlying the Coastal Plain sediments are, in part, a southern and southwestern extension

of the Piedmont province, and in part, a southwestern extension of the Valley and Ridge province. These rocks of Precambrian to early Mesozoic age, combined, constitute the pre-Cretaceous Coastal Plain floor or base of the aquifer system (Kidd et al., 1997).

Coastal Plain sediments in the basin are parts of three regional aquifer systems: the Southeastern Coastal Plain, Floridan, and Coastal lowlands aquifer systems. The principal part of the Southeastern Coastal Plain aquifer system consists of clastic deposits of Early and Late Cretaceous, Paleocene, and Early and Middle Eocene age. The Floridan aquifer system consist of calcareous deposits of Oligocene and Eocene age. The Coastal lowlands aquifer system is an off-lapping sequence of fluvial, deltaic, and marine deposits of the Miocene age and younger (Kidd et al., 1997).

The Coastal Plain aquifers in subareas 6 and 7 consist of Cenozoic sand and gravel (Journey and Atkins, 1997; Robinson et al., 1997; Mooty and Kidd, 1997) (***Tables 4-2*** and ***4-3***, respectively). In subarea 5, the Coastal Plain aquifers consists of Cenozoic sand and gravel and the Cretaceous sand and gravel beds of the Coker and Gordo Formations (***Table 4-4***).

TABLE 4-4
Generalized Geologic Units in Subarea 5, Water-Bearing Properties, Chemical Characteristics, and Well Yields

Physiographic Province	Geologic Age and Lithology	Aquifer Type	Water-Bearing Properties and Chemical Characteristics	Well Yield
Coastal Plain	Cenozoic–sand and gravel	Porous-media	Generally adequate only for domestic use. May have high iron concentrations.	10 gallons per minute typical
Coastal Plain	Cretaceous–sand and gravel beds of the Coker and Gordo Formations	Porous-media	Used for limited public water supply in Bullock, Macon, and Lee Counties, Alabama.	100 to 200 gallons per minute (Kidd, 1987)
Piedmont	Regolith, soil, alluvium, colluvium, and saprolite derived from various aged rocks	Porous-media, preferential flow	Generally suitable for domestic use only.	No available data
	Precambrian to Paleozoic–quartzite, slate, gneiss, schist, marble, phyllite, and granite	Fracture-conduit	Local, discontinuous properties; well yields, variable. Water quality generally good.	1 to 25 gallons per minute typical; may exceed 500 gallons per minute (Kidd, 1989; Guthrie et al., 1994)

Source: Journey and Atkins, 1997

Aquifers in subarea 8 vary in lithology and water-bearing characteristics (***Table 4-5***), and are characterized as either porous media or solution conduit aquifers. The porous media aquifers occur in sand and gravel deposits in the alluvial plain of the Alabama River and in clastic deposits in the southeastern Coastal Plain, which include sands and gravels of the Citronelle Formation and undifferentiated deposits of Miocene age. The solution conduit aquifers, as described above, include the Floridan aquifer. Well yields from the Floridan aquifer are relatively low in subarea 8. In southeastern Alabama, the Floridan aquifer is part of the high-yielding Ocala Limestone, but the Ocala Limestone grades westward into the Yazoo Clay, which is a confining unit. In the Alabama River basin, the Floridan aquifer

system is separated from the underlying Lisbon aquifer by the Moodys Branch Formation and the Yazoo Clay.

TABLE 4-5
Generalized Hydrogeologic Units in Subarea 8, Water-Bearing Properties, Chemical Characteristics, and Well Yields

Physiographic Province	Geologic Age and Lithology	Hydrogeologic Unit and Type	Water-Bearing Properties and Chemical Characteristics	Well Yield
Coastal Plain	Pliocene and Miocene–sands, gravels, clays of the Pliocene age Citronelle Formation and undifferentiated deposits of Miocene age	Coastal lowlands aquifer system, porous-media	Used for public water supply in Monroe and Escambia Counties. Water soft. Locally may contain high concentrations of iron and may be corrosive.	100 to 500 gallons per minute (Davis, 1987)
Coastal Plain	Oligocene and Eocene–limestone, sandy clay of the Oligocene age Vicksburg Group and the Eocene age Ocala Limestone	Floridan aquifer system, solution-conduit	Source of domestic supply. Water soft to very hard. Locally may contain high concentrations of iron.	Generally less than 50 gallons per minute
Coastal Plain	Eocene–limestone, marl, and sandy clay of the Yazoo Clay and Moodys Branch Formation	Yazoo confining unit	No available data	No available data
Coastal Plain	Eocene–sand, gravel, clays of the Lisbon, Tallahatta, and Hatchetigbee Formations and the upper part of the Tuscahoma Sand	Lisbon aquifer, porous-media	Extensive domestic supply source in Clarke and Monroe Counties. Water soft to very hard. Locally may contain high concentrations of iron.	Generally less than 100 gallons per minute (DeJarnette, 1989)
Coastal Plain	Eocene–clay of the lower part of the Tuscahoma Sand	Tuscahoma confining unit	No available data	No available data
Coastal Plain	Paleocene–sand in lower part of Tuscahoma Sand, sand, clay, and gravelly-sand in Nanafalia Formation	Nanafalia-Clayton aquifer, porous-media	Public supply source in Monroe and Clarke Counties. Water generally soft. Locally hard and may contain high concentrations of iron.	75-900 gallons per minute (Barksdale and Moore, 1976)
Coastal Plain	Paleocene–chalky marl, limestone and clay of the Porters Creek Formation and the Clayton Formation	Prairie Bluff confining unit	No available data	No available data
Coastal Plain	Upper Cretaceous–chalk and clay of the Prairie Bluff Chalk	Prairie Bluff confining unit	No available data	No available data
Coastal Plain	Upper Cretaceous–calcareous sandstone, sandy chalk, clay of the Ripley Formation	Ripley aquifer, porous-media	Public supply in Lowndes and Wilcox Counties. Water soft to moderately hard. Locally, may contain high concentrations of iron.	75-200 gallons per minute (Barksdale and Moore, 1976)
Coastal Plain	Upper Cretaceous–chalk of the Demopolis Chalk and Mooreville Chalk	Selma confining unit	No available data	No available data
Coastal Plain	Upper Cretaceous–sand and gravel of the Eutaw Formation	Eutaw aquifer, porous-media	Extensive use as public supply in northern and central parts of basin. Water soft to moderately hard. Locally, may contain high concentrations of chloride and iron.	Up to 700 gallons per minute (Scott et al., 1987)

(CONTINUED)

TABLE 4-5 (CONTINUED)
Generalized Hydrogeologic Units in Subarea 8, Water-Bearing Properties, Chemical Characteristics, and Well Yields

Physiographic Province	Geologic Age and Lithology	Hydrogeologic Unit and Type	Water-Bearing Properties and Chemical Characteristics	Well Yield
Coastal Plain	Upper Cretaceous–clay of the upper part of the Gordo Formation	Gordo confining unit	No available data	No available data
Coastal Plain	Upper Cretaceous–sand and gravel of the Gordo and Coker Formations	Tuscaloosa aquifer, porous-media	Major source of public water supply in northern and central parts of the basin. Water soft to hard. Locally, may contain high concentrations of iron.	200 to 500 gallons per minute (Scott et al., 1987)

Source: Kidd et al., 1997

The Southeastern Coastal Plain aquifer system is subdivided into five major aquifers. From shallowest to deepest, these include the Lisbon aquifer, the Nanfalia-Clayton aquifer, the Ripley aquifer, the Eutaw aquifer, and the Tuscaloosa aquifer.

As with similar environments, where calcareous aquifers are present in the Cumberland Plateau and Valley and Ridge provinces, groundwater withdrawal and resulting water-level declines could lead to the development of sinkholes, depending on the amount of water withdrawn, the resulting water-level decline, the proximity of solution conduits to the land surface, and the land-surface loading.

4.3.1.2 Environmental Consequences

Impacts on geological resources as a result of the no action and action alternative flow scenarios would be insignificant. Other than the potential for potential sinkhole formation that might occur in subareas 6 and 7 as a result of a greater dependence on groundwater in these areas, there would be no effects on geological formations in the basin as a result of the allocation formula. Water that is being stored and transported throughout the basin under various management schemes is not expected to significantly influence major geological structures, and therefore there would be no foreseeable impacts on the resource. However, localized erosive and depositional effects will continue under the no action and action alternatives and are discussed in more detail in Section 4.3.2.2.

4.3.2 Soils

This section describes the existing soil conditions in the ACT basin and the potential environmental consequences of each alternative on soils.

4.3.2.1 Affected Environment

The following discussions are based on research into the characteristics of the soils in the ACT basin obtained from the U.S. Department of Agriculture and the Natural Resources Conservation Service (NRCS) STATSGO database.

4.3.2.1.1 Soil Types

There are six soil orders in the ACT basin, three of which comprise the majority of soils—ultisols, inceptisols, and entisols. More than 110 soil series are present in the ACT basin.

Ultisols are characterized by sandy or loamy surface horizons and loamy or clayey subsurface horizons. These deeply weathered soils occur as residual products of in-place weathering of the parent acid crystalline and metamorphic bedrock.

Entisols are young soils with little or no change from the parent material and with poorly developed subhorizons. These soils are frequently infertile and droughty because they are deep, sandy, well-drained, and subject to active erosion.

Inceptisols are soils with one or more horizons in which mineral materials other than carbonates or amorphous silica have been altered or removed but not accumulated to a significant degree. These soils are composed primarily of weathered material and typically do not contain components such as clays or hydrated iron or aluminum oxides.

4.3.2.1.2 Major Land Resource Areas

Soils of the ACT basin are divided into seven Major Land Resource Areas (MLRAs), formerly called soil provinces: Southern Piedmont, Southern Coastal Plain, Southern Appalachian Ridges and Valleys, Sand Mountain, Blue Ridge, Alabama Blackland Prairies, and Eastern Gulf Coast Flatwoods (***Figure 4-6***).

The Southern Coastal Plain comprises the majority of the soils in the Coastal Physiographic province in the basin, while the Southern Piedmont MLRA comprises the majority of the Piedmont Physiographic province. The Southern Appalachian Ridges and Valleys and the Sand Mountain MLRA dominate the Cumberland Plateau and Valley and Ridge Physiographic provinces.

4.3.2.1.3 Prime Farmland

As designated by the U.S. Department of Agriculture (USDA), prime farmland has the best combination of physical and chemical characteristics for producing beneficial crops, and is also available for this use. Prime farmland can be cropland, pastureland, range land, forest land, or other land, but not urban built-up land or water. In general, prime farmlands have an adequate and dependable water supply, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, few or no rocks, and soils that are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Based on information from the NRCS State Soil Geographic Database (STATSGO) database, approximately 30 percent of the ACT basin has been designated as prime farmland. Most prime farmland is concentrated in the southern third of the ACT basin along stream channels and in areas in which groundwater resources are more readily available (***Figure 4-7***). The presence of actively cultivated prime farmlands creates greater local demands on surface water and/or groundwater supplies for irrigation during the growing seasons from April through September for this region.

4.3.2.1.4 Erosion and Sedimentation

Erosion and sedimentation are two of the major processes that can impact the stability of soils in the area of the ACT basin. The effects of erosion occur as a result of the ability of environmental media, such as water and wind, to pick up and move soil and rock particles. In the context of this programmatic EIS, the main erosional medium of concern is water in the form of runoff, surface water flow, and groundwater flow. There is also erosion by wind

FIGURE 4-6
Major Land-Resource Areas in the ACT Basin
Source: STATSGO, 1998

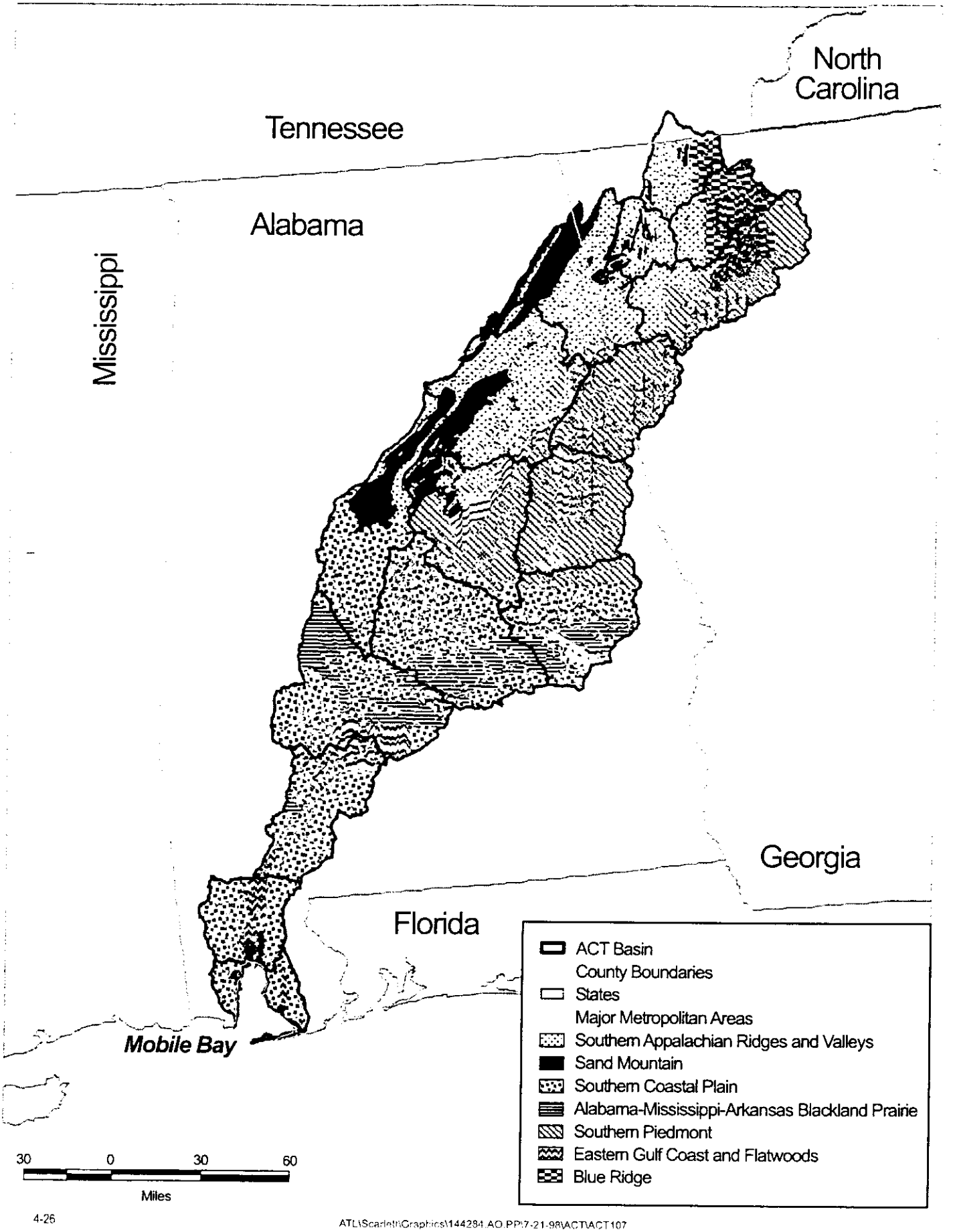


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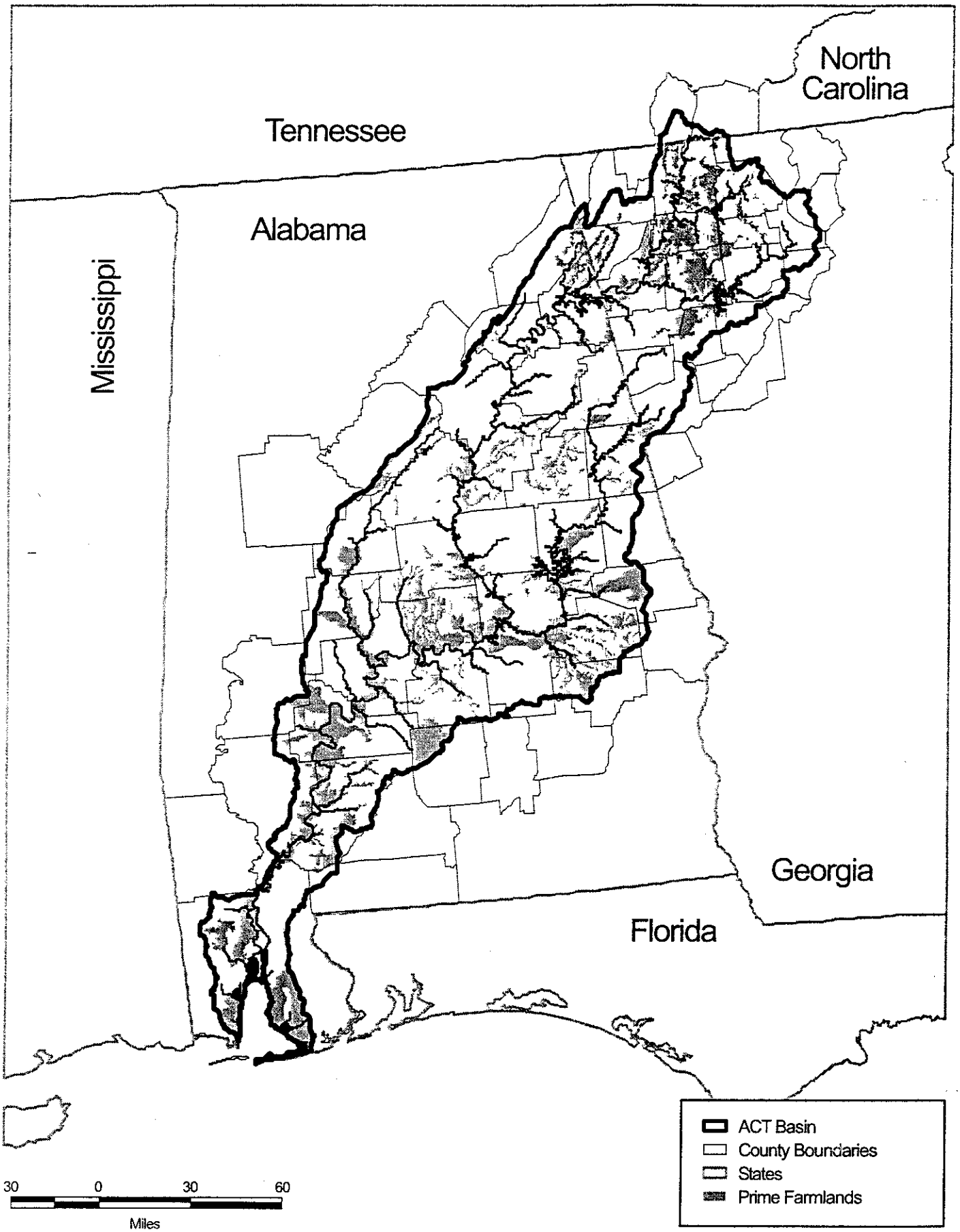
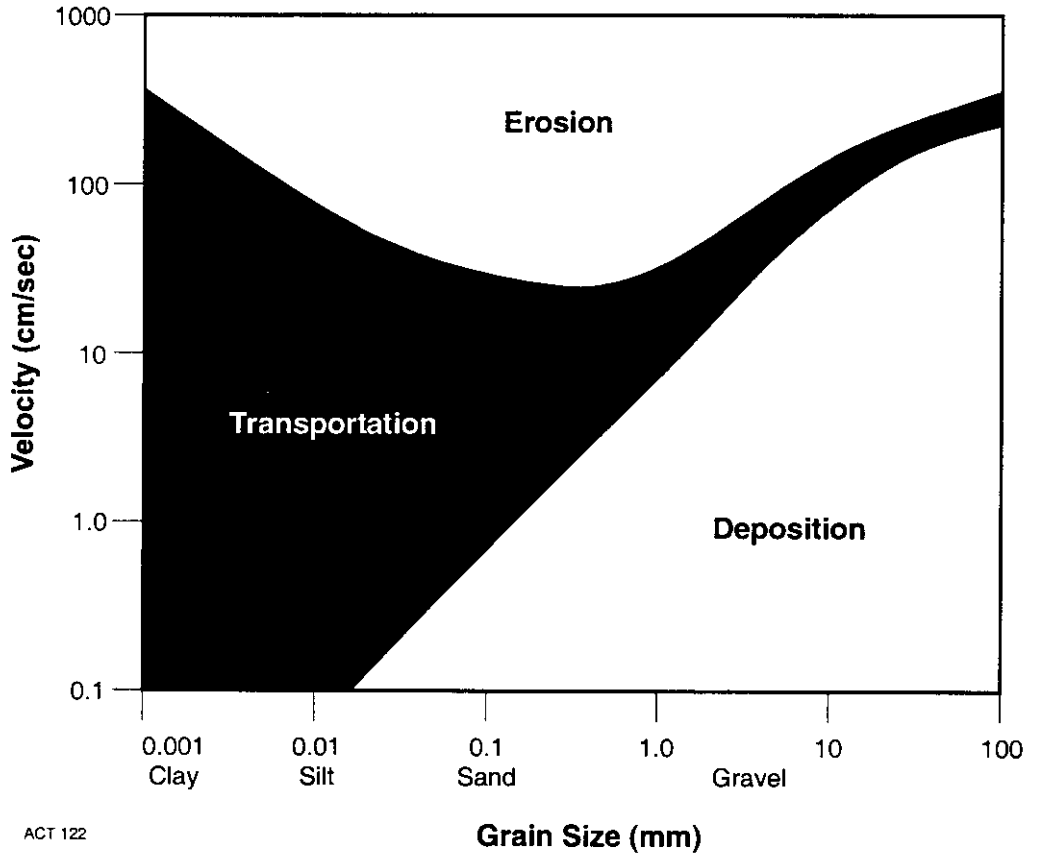
FIGURE 4-7
Prime Farmlands in the ACT Basin
Source: STATSGO Database, NRCS, 1998



transport in exposed areas. In river environments, erosional areas occur along unstable slopes, on the cut banks in stream bends, along reservoir banks, and in other areas in which water travels at high enough velocities to pick up the soil or rocks. While erosion is a natural process, variations in flow rates can seriously affect localized areas in which stream banks are cut further back, structural features are undermined, or slopes become unstable and dangerous. Similar patterns of induced erosion are also associated with increased fluctuations on reservoir levels.

In contrast, deposition, sedimentation, or siltation occurs when the velocities of flowing water are reduced and can no longer carry the suspended load of soil and rock. This results under a variety of conditions, such as when a stream enters a larger water body or shallower environment, or floods onto a broader flood plain; or when flows are reduced as a result of surface water withdrawal from the channel or through surface water losses to groundwater. The complex relationships of water flow velocity and grain size to erosion, sedimentation, and transport are presented in ***Figure 4-8***.

FIGURE 4-8
Relationship of Stream Velocity to Erosion, Transport, and Deposition of Various Sizes (ACT Basin)



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The sediment sizes of the streams and water courses of the ACT basin vary greatly, from cobbles and even boulders in the headwater streams to fine clays and silts in the lower reaches. This pattern is typical for the ACT and ACF basins because the channel slope is greatest in the headwaters of the basin and decreases in the downstream direction. Sediment sizes are generally inversely related to slope and drainage area.

At the Fall Line, just above Montgomery, Alabama, the slope of the Alabama River is very steep, at approximately 5 feet per mile, and transitions gradually to a slope of approximately 0.82 foot per mile. Below the Fall Line, the slope of the Alabama River is approximately 0.34 foot per mile. Generally, the stream bed above the Fall Line is more controlled by less erodible outcrops in the bed and banks. Below the Fall Line, the bed is more sandy, and below Cedar Creek and RM 59, the Alabama River is characterized as a meandering alluvial river, with reverse curves and sandy point bars. The bed material trend of fining in the downstream direction is locally interrupted by changes in the type of material through which the water flows as well as the manmade structures on the system. The bed material median grain size (d_{50}) on the Alabama River below Montgomery is approximately 0.25 millimeters (mm).

Retention structures in the system generally trap the heavier material in the pool and result in erosion below the structure. This shoaling is to be expected, since the dam slows the velocity of the water and allows much of the heavier sediment to shoal, and there is much less heavy sediment passed downstream to take the place of the ongoing erosion below the dam. The heavier and larger material falls out near the upstream end of the pool, and the finer material settles in the pool farther downstream. Sediment ranges are used to monitor changes in the lakes in the system.

Lake Martin accounts for 31 percent of the storage volume in the basin. Lake Allatoona is next largest, with 13 percent, followed by Carters Lake and Harris, each with 8 percent. Shoaling in Lake Martin is not considered to be a problem because of the huge volume of storage available. Typical shoaling in the Allatoona, Carters Reregulation, William "Bill" Dannelly, and "Bob" Woodruff Lake pools is shown in ***Figures 4-9*** through ***4-12***. The cross-sectional data presented in these figures are from the following locations:

- ***Figure 4-9:*** On the Little River arm, approximately 2.5 river miles upstream from the mouth in Allatoona Lake
- ***Figure 4-10:*** Approximately 1.2 river miles upstream from the Carters Reregulation Dam on the Talking Rock Creek arm
- ***Figure 4-11:*** Approximately 102 river miles upstream from Millers Ferry Lock and Dam on the Alabama River
- ***Figure 4-12:*** Approximately 48 river miles upstream from the R.F. Henry Lock and Dam on the Alabama River

Effects of erosion at Neely Henry have been found to be especially noticeable following a period of prolonged drawdown of this impoundment. At Logan-Martin Reservoir, major problems occur with siltation of the reservoir and the periodic dredging operations necessary to maintain seawalls, piers, and boat access slips. The siltation appears to be primarily related to development of the land upstream and around the reservoir (Miller, 1998). Similar siltation issues are reported at the Bells Landing Park at Claiborne Lake and associated feeder streams, such as Talatchee Creek, Maiben Creek, and Black Creek, all of which are located adjacent to areas affected by clear-cut timber harvesting in the early 1990s. In contrast, erosion is also occurring at Claiborne Lake, where banks are being undercut due to the periodic fluctuations in the reservoir water levels (Ellis, 1998).

FIGURE 4-9
Lake Allatoona Shoaling

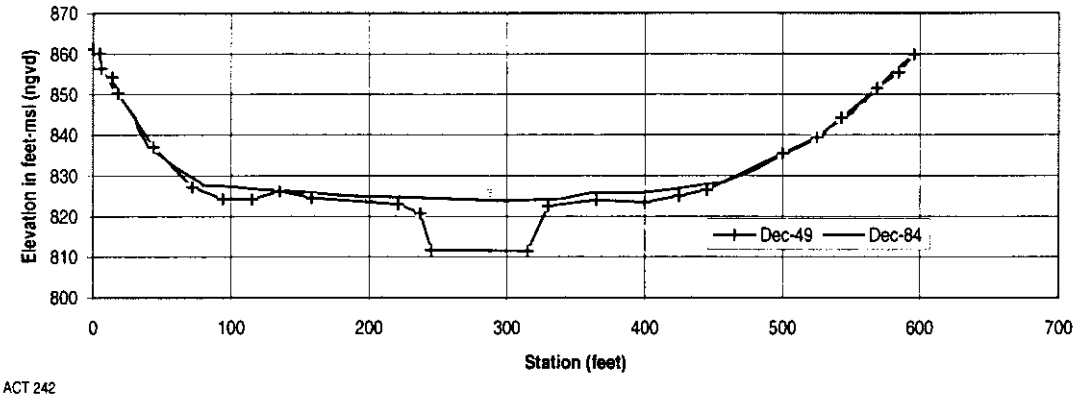

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FIGURE 4-10
Carters Reregulation Lake Shoaling

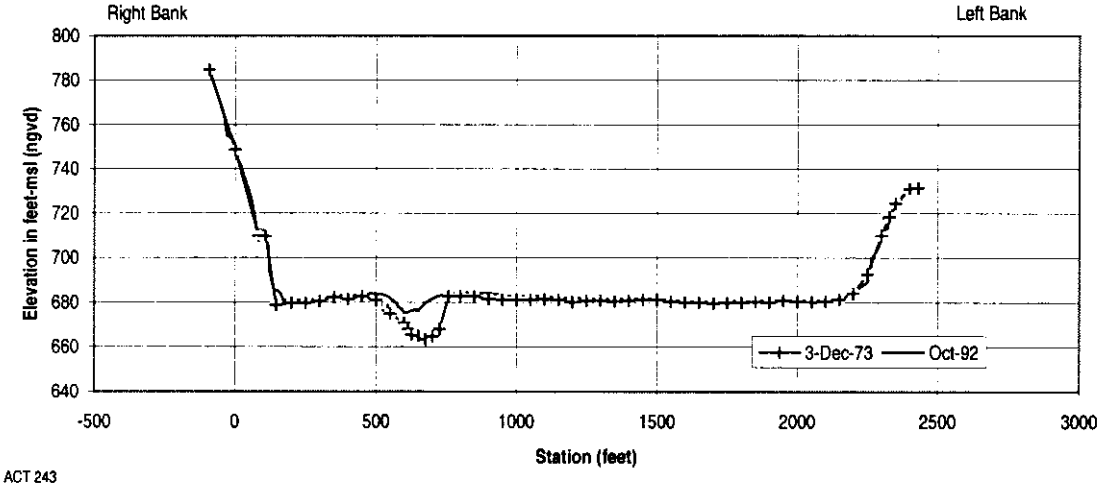

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FIGURE 4-11
William "Bill" Dannelly Lake Shoaling

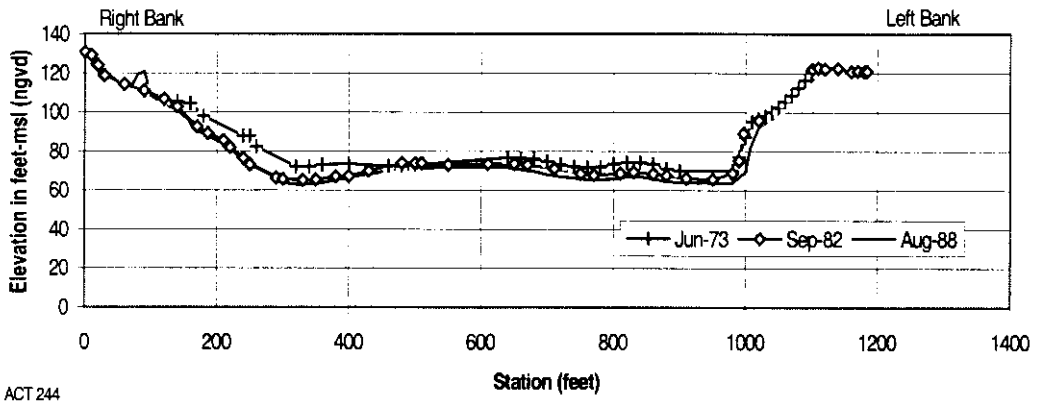

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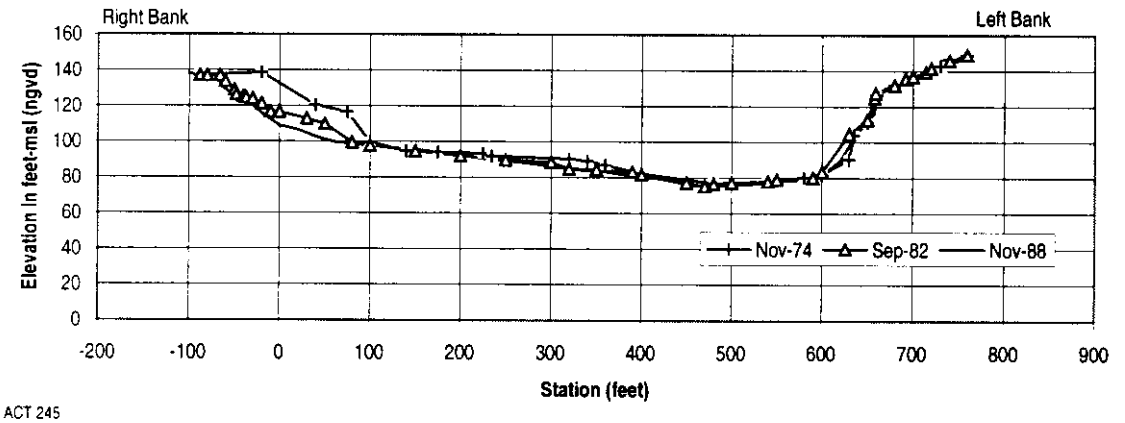
FIGURE 4-12
"Bob" Woodruff Lake Shoaling



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Shoaling also occurs in the streams at point bars, or convex bends in the river. Secondary currents in these bends in the river sweep bottom sediment toward the point creating these bars. Shoaling also occurs in areas of increased cross-sectional flow area, where flow velocity slows, or where erodible material occurs. Ms. Grays Bar, at RM 59 on the Alabama River, is the location of the greatest shoaling problem on the lower river. The river is controlled by hard outcrops of material forcing the river to make a sharp bend to the left.

Immediately below the bend, the top width of the river at low water expands approximately 100 percent as the banks transition from erosion-resistant to nonerosion-resistant material. Old training dikes on the right side of the river force the current into a reverse course and an associated crossing that tends to shoal. The high banks contribute a considerable amount of coarse sand and gravel to the channel.

Downward degradation of the river below dams in the upper and middle reaches of the system is attenuated to some degree by the downstream dams. However, below the most downstream dam on the system, Claiborne, there is no controlled tailwater, and erosion occurs. The erosion continues for miles unless stopped by exposure of hard material in the river bed, or until the river attains a relative equilibrium in slope, sediment size and quantity, and flow.

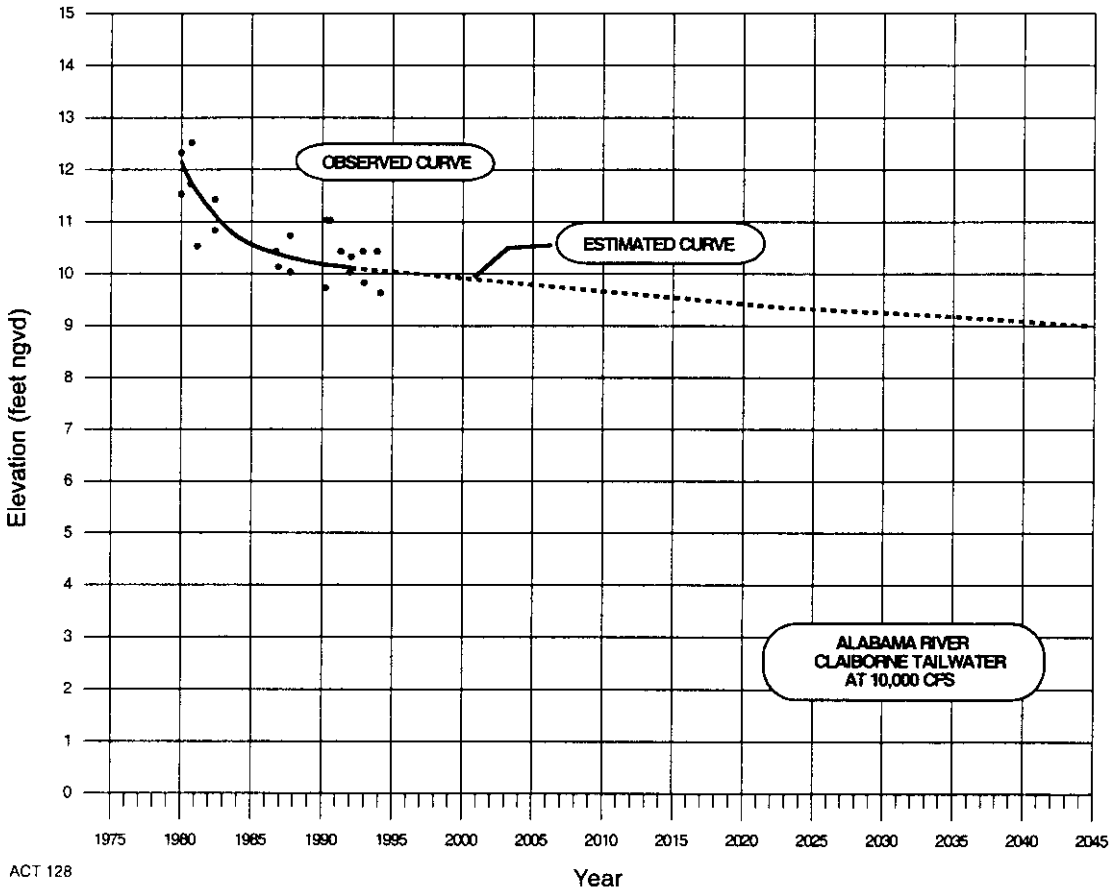
The tailwater degradation curve at Claiborne for 10,000 cfs is shown in ***Figure 4-13***. The curve indicates the low water elevations below the dam through time. A projection of the future degradation of the tailwater over the life of the project was made and is shown on the drawing. The data were plotted at several scales, and curve fits were attempted by several methods using several ranges of data. The best fit was by eye. The projection was made using all available data from 1980 through 1994. This rate is approximately 1 foot in 40 years, or 0.025 foot per year. The data since 1985 might indicate stabilization of the rate of degradation, but, considering the episodic nature of geomorphic events, a short-term data record could be misleading. The entire record indicates that continued erosion could occur, and plans should be made for this contingency. It is expected that the degradation would not continue linearly, but would either be attenuated by outcrops of rock or gradually decrease as the slope of the river continues to decrease. It was estimated that the rate of erosion would gradually decrease as the slope of the river decreases. The observed and estimated parts are noted in the drawing.

4.3.2.2 Environmental Consequences

Under the no action alternative, future demand for water is expected to cause minor decreases in stream flow and reservoir elevations through the year 2050. This would increase sedimentation in rivers as river velocities decrease and provide more opportunity for deposition. These effects are expected to be minimal, however.

Under the low flow scenario, river flows would be significantly reduced under critical dry conditions (see Section 4.4.1.2). Low river flows and the resulting low velocities would cause deposition of sediment that would otherwise remain in suspension. The low flow scenario would maintain relatively high and stable reservoir levels. This scenario may increase problems associated with shoreline erosion where it is currently a concern at several lakes. Higher water levels, particularly under high wind conditions, can cause greater shoreline erosion.

FIGURE 4-13
Claiborne Lake Tailwater Degradation, 1980 to 1994



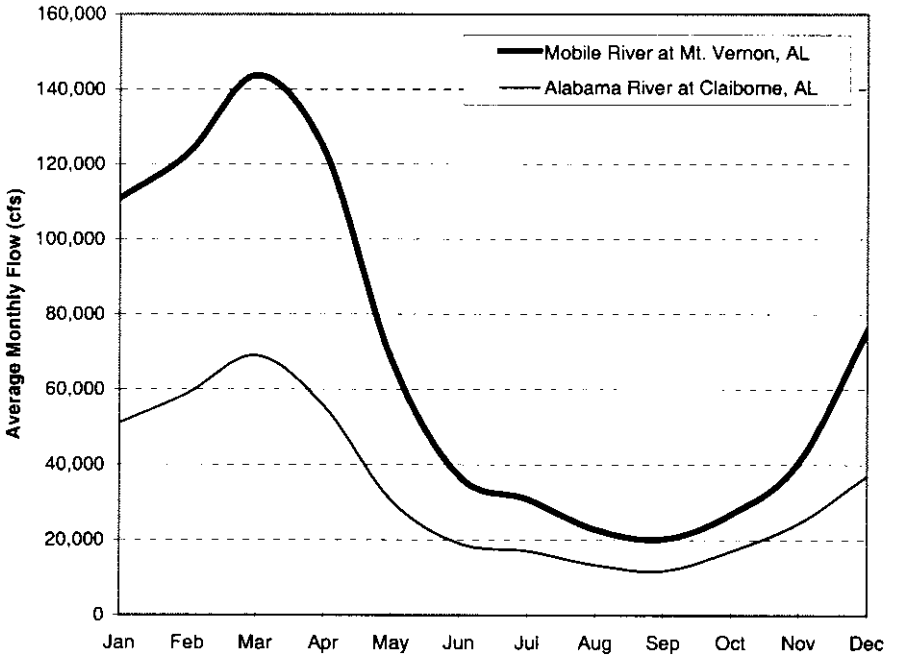
Under the low flow scenario, river flows are generally maintained higher in the summer and lower during the winter. The higher summer flows would improve stream segments where silt and sediment have built up over time, by providing regular scouring flows. The high flow scenario does not generally increase high flows, so no stream erosion concerns are expected. The high flow scenario may reduce shoreline erosion problems around the reservoirs because it produces lower reservoir levels in the summer and fall. However, new erosional problems could be uncovered or could develop as reservoirs are drawn to regularly lower levels than they currently experience.

4.4 Water Resources

This section examines the complex interrelationships between among water groundwater, and the numerous competing demands on water resources in the ACT basin. A significant amount of information that is used in this section was developed and approved during the Comprehensive Study by the States of Alabama, Florida, and Georgia, and the Corps, which were partners in the study. The Corps, using tools developed during the Comprehensive Study, applied a hydrologic model to the allocation scenarios for this EIS. Data analysis and technical expertise on water quality issues addressed in this EIS were provided by EPA (surface water quality) and USGS (groundwater quality).

This ACT basin EIS includes the Alabama, Coosa, and Tallapoosa Rivers. The Comprehensive Study addressed the resources within the basin boundaries from the headwaters downstream to Claiborne Lock and Dam. This EIS also addresses the area downstream, including Mobile River and Mobile Bay. The ACT basin (22,820 square miles) has approximately the same drainage area size as the Tombigbee River basin (20,200 square miles). Thus, flows from the ACT basin are diluted roughly in half by the time the Alabama River joins the Tombigbee River to form the Mobile River. ***Figure 4-14*** shows the monthly average flows for the years 1954 to 1997 for the Mobile River at Mt. Vernon, Alabama, compared to the monthly average flows for the same period for the Alabama River at Claiborne, Alabama. The monthly average flows at Mt. Vernon, Alabama, are estimated using the flows at Coffeeville and Claiborne, Alabama, plus a factor to account for ungaged inflows between these gage locations and Mt. Vernon. This EIS includes the Mobile River resources, but not to the level of detail of other resources in the ACT basin due to the limited effect of an allocation formula on Mobile River and Bay resources.

FIGURE 4-14
Comparison of Flows in Alabama and Mobile Rivers (ACT Basin)



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The hydrologic modeling that the Corps performed on the reservoirs and rivers in the ACT basin is discussed first. This modeling provides the framework for evaluating environmental consequences in this EIS. Next, this section addresses water quantity, followed by water quality. The water quantity and water quality sections first describe the affected environment, presenting an overview of the resource in the ACT basin, and then the environmental consequences of the no action alternative and the action alternative flow scenarios.

The water quantity modeling completed by the Corps provided the basis for evaluating the impacts on water availability, instream flows, and reservoir water level elevations. This information was also used by the cooperating agencies to evaluate the potential impacts on each of the other resource areas (e.g., biological communities, economics). Water quality modeling was completed by the Corps Waterways Experiment Station (WES) and the Hydrologic Engineering Center (HEC). EPA participated in the water quality modeling effort and provided input on point and nonpoint source loadings for the water quality model. In addition, EPA assisted in reviewing and analyzing the results of the water quality modeling.

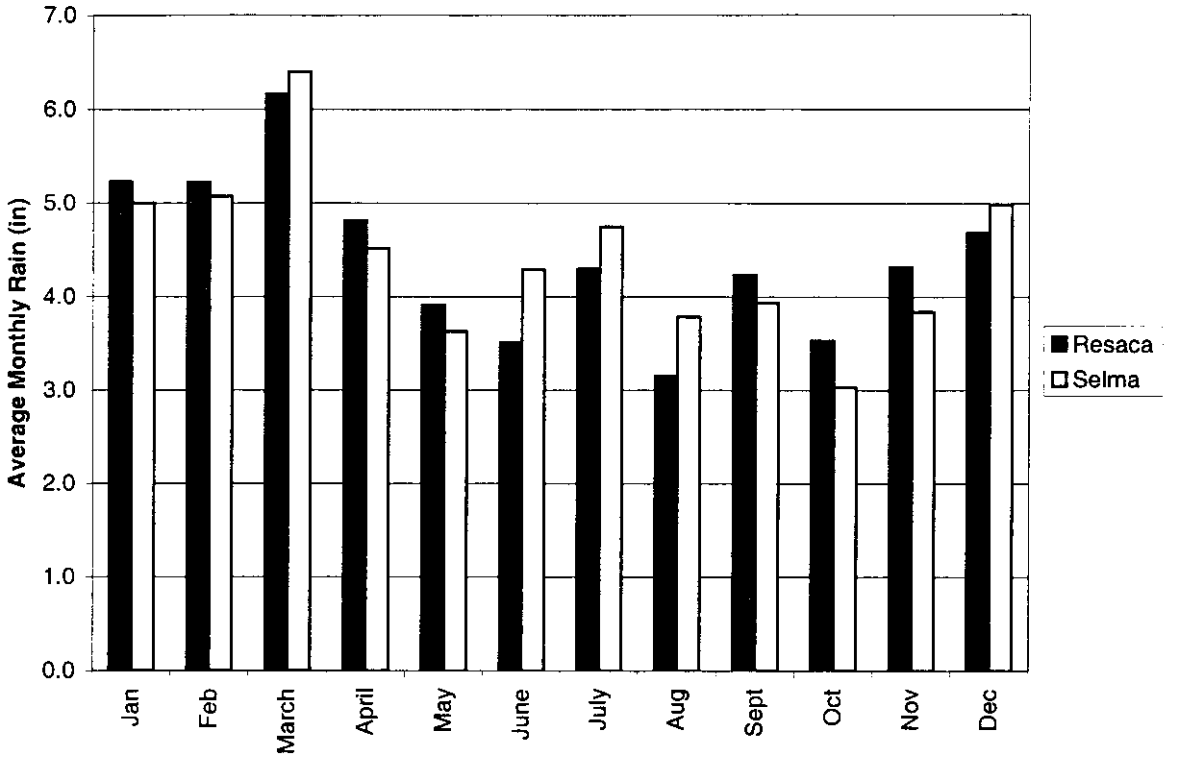
4.4.1 Water Quantity

This water quantity discussion addresses the amount of water in the ACT basin by examining flow rates, flow durations, reservoir water levels, and groundwater quantities. There are many factors that can affect water quantity, including weather, municipal and industrial (M&I) consumption, agricultural use for irrigation, the operation of hydro- and thermal power plants, and flood control dams.

In the southeast United States, rain falls nearly every month (***Figure 4-15***). However, the need for water in the summer and fall often is greater than the supply of water in the river basin. An important function of the many reservoirs in the ACT basin is to store water when there is an abundance of rain and to release water when there is less rain, ensuring that all water needs can be met throughout the year. This management of water is a complex process that must consider the many competing demands for water in the basin, take past and future hydrologic conditions into consideration, and determine the most appropriate operating conditions for all the reservoirs in the basin to optimize the use of water. The Corps takes an active role in water management in the ACT basin to supply water to meet the various competing demands.

The various uses of water in the ACT basin include hydropower, navigation, water quality (such as assimilative capacity for wastewater discharges) and water supply, flood control, fish and wildlife habitat, and recreation. Water demands can be consumptive or nonconsumptive. *Consumptive* demands withdraw water from the basin for some purpose and return only a portion or none of it back to the basin. An example of consumptive uses are municipal, industrial, and some forms of steam generation water supplies, which return only a portion of the water back to the basin. For purposes of this analysis, agricultural water supply withdrawals are assumed to provide no return flow to the surface water streams. In contrast, hydropower demand is a *nonconsumptive* use of water. It uses the flow in the river to drive turbines to generate electricity, but no water is withdrawn or lost from the system.

FIGURE 4-15
Monthly Precipitation at Resaca, Georgia, and Selma, Alabama, Based on 1956 to 1997 Data



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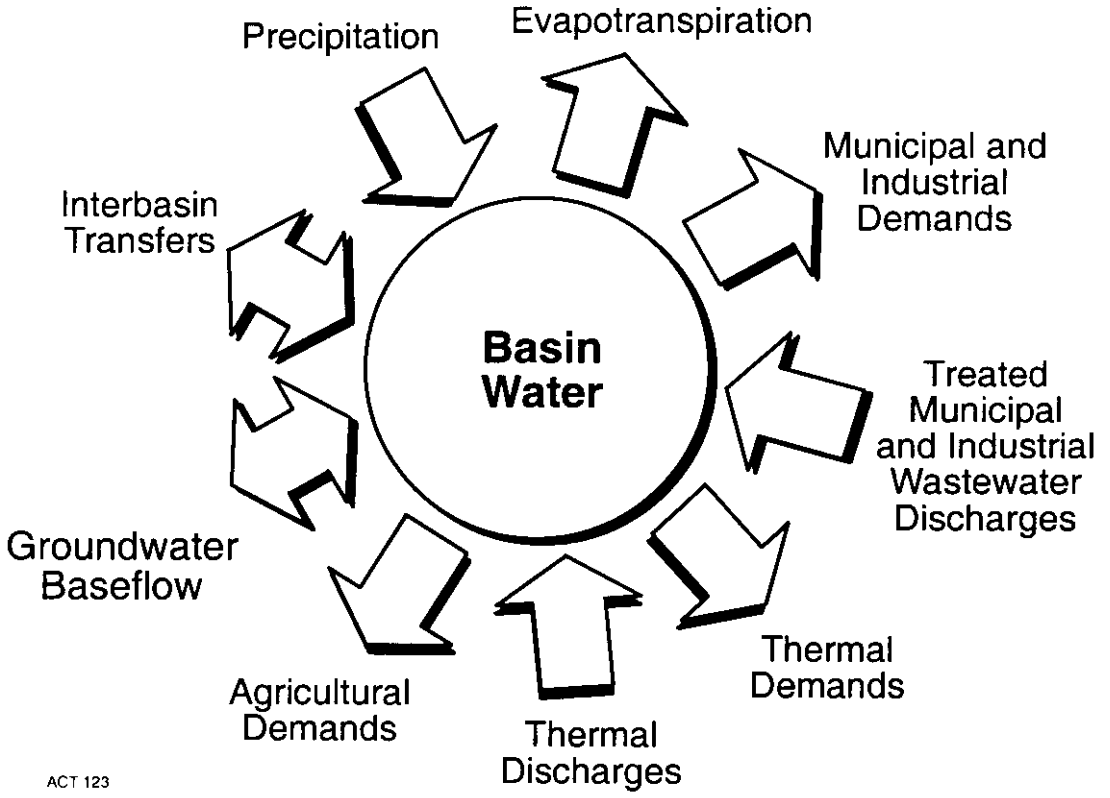
In considering basin water management, it is critical to account for the various withdrawals/losses and returns/gains to the system. Water is lost through evapotranspiration (total of evaporation and plant transpiration), M&I water withdrawals, thermal power withdrawals, agricultural water withdrawals, groundwater transfers, and interbasin transfers. Water is returned, or added, to the basin through precipitation, treated M&I and thermal power plant discharges, groundwater baseflow contribution, and interbasin transfers. ***Figure 4-16*** illustrates schematically the gains and losses of water to the basin.

Water resources in the ACT basin include both surface water (carried in rivers and reservoirs) and groundwater. There is significant interaction in the basin between the surface water and groundwater with groundwater providing substantial base flow for some streams. Surface water hydrology in the ACT basin is also greatly influenced by various management activities among its 18 reservoirs. These reservoirs attenuate high river flows during wet periods and augment low flows during dry weather periods.

FIGURE 4-16
Basin Water Gains and Losses



4.4.1.1 Affected Environment

The following sections review the water resources for the ACT basin, and include discussions of the major rivers and their tributaries, constructed reservoirs that are within the river basin, and groundwater resources that may interact with these surface water systems. *Figure 4-17* illustrates the subbasins used for discussion of water quality and quantity issues. A longitudinal view of the basin and locations of locks and dams is included in *Figure 4-18*. The last part of this section reviews the relationships between these water resources and their capabilities to meet the water supply demands for the ACT basin.

4.4.1.1.1 Rivers

There are three main rivers in the ACT basin—the Alabama, Coosa, and Tallapoosa Rivers. The Coosa and Tallapoosa join to form the Alabama River about two-thirds of the way downstream in the basin. The Coosa and Tallapoosa Rivers have numerous smaller tributary rivers. Relevant characteristics of the main rivers are described below. *Figure 4-18* presents a longitudinal profile of the Alabama, Coosa, Etowah, and Tallapoosa Rivers.

Rivers in the ACT basin include both natural (unregulated) and regulated rivers. Natural rivers exhibit a more consistent pattern, responding to precipitation and drought periods as expected with short periods of high flows and prolonged periods of low flows, respectively. Regulated streams exhibit a variable pattern, with daily variations due to hydropower operations (most prominent below peaking projects), and lower flood peaks and higher

FIGURE 4-17
Water Resources Subbasin Map of the ACT Basin

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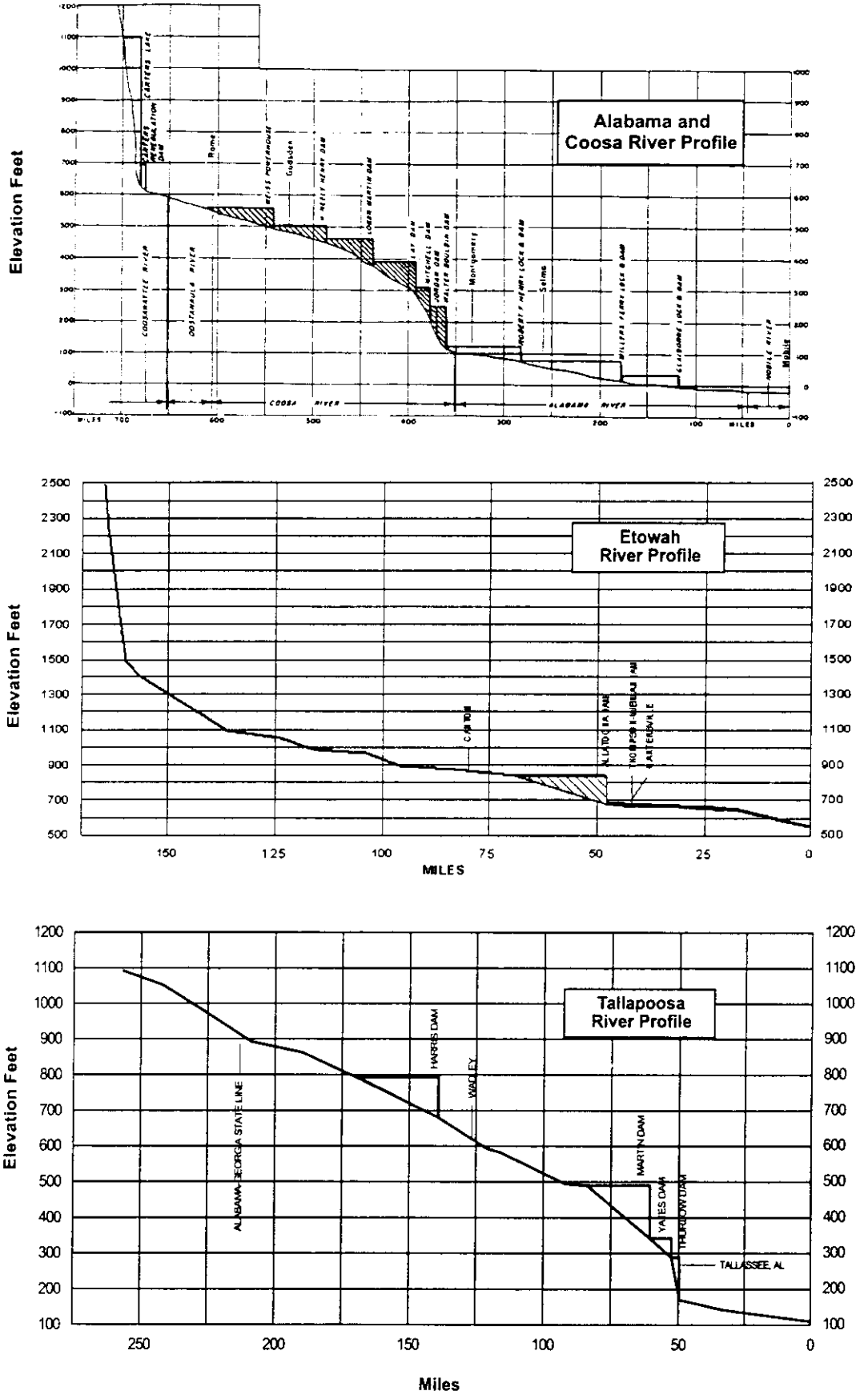
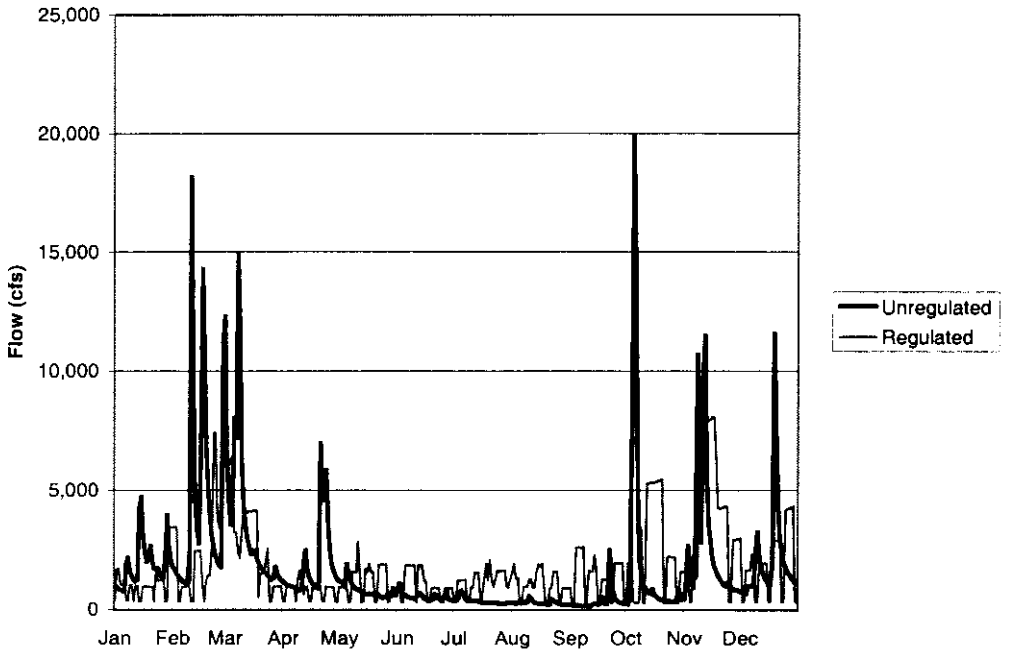
FIGURE 4-18
Longitudinal Profile of the Alabama, Coosa, Etowah and Tallapoosa Rivers
(ACT Basin)



sustained minimum flows through dry periods as the upstream reservoirs augment low flows. A typical natural and regulated stream pattern over a year is illustrated in *Figure 4-19*. Although the two riversshown are different rivers, with slightly different drainage areas and total water yield, the distinct patterns of flow variability in a regulated river, as compared to the more stable flows of an unregulated river, is apparent.

FIGURE 4-19
Comparison of Natural and Regulated Flows



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The highest monthly average flows for these rivers occur in the later winter/early spring months of February to April, which is typically the rainy season. Through late spring and summer, low precipitation and high evapotranspiration combine to reduce river flows. The lowest average monthly flow typically occurs at the end of the summer in September.

4.4.1.1.1.1 Coosa River

The Coosa River basin originates in the Blue Ridge Mountains and extends to Wetumpka, Alabama, north of Montgomery, Alabama. The basin has a drainage area of 10,200 square miles. The Coosa River has several main tributary streams that significantly affect flows in the river.

The Coosa River basin begins in southeast Tennessee with the Conasauga River. The Conasauga River drains an area of 727 square miles, about 20 percent of which is in Tennessee and 80 percent in Georgia. The Conasauga River has a fairly steep slope of 35.5 feet per mile for the upper 41 miles through the mountains, then falls at a more gentle slope of 3 feet per mile for the 47 miles to its mouth. The Conasauga River joins the Coosawattee River (865 square miles) to form the Oostanaula River (2,150 square miles), which is a primary tributary to the Coosa River. The Coosawattee River initially falls at a steep rate of 29 feet per mile for 19 miles, then falls at a more gently slope of 2 feet per mile for the 27 miles to its mouth. There are two dams on the Coosawattee River: Carters Dam and Carters Reregulation Dam. Carters Dam, located about 27 miles upstream of the

Coosawattee/Conasauga River confluence, is a peaking hydroelectric power facility that causes a regular pulsing of downstream flows and is the only hydroelectric facility in the basin with pumpback capabilities. Carters Reregulation Dam was constructed to return the stream flow to a more normal pattern, removing the pulsing caused by the peaking facility. The dam also serves as the lower reservoir for the pumpback operation. With the upper reservoir (Carters Lake) and the lower reservoir (Carters Reregulation Reservoir), water is released from Carters Dam during peak electrical demands and pumped back up to from the reregulation reservoir to Carters Lake during off-peak time. The Cartecay and Elijay Rivers are two primary tributaries to the Coosawattee River (Corps, 1997).

The Oostanaula River is formed by the confluence of the Conasauga and Coosawattee Rivers near Resaca, Georgia. The Oostanaula River flows in a southerly direction for 47 miles to join the Etowah River at Rome, where the two rivers form the Coosa River. The Oostanaula River has a drainage area of 2,150 square miles. The slope of the Conasauga River is relatively flat with a fall averaging 1 foot per mile. The Etowah River begins in the Blue Ridge Mountains near Dahlonega, Georgia, and flows about 150 miles in a southwesterly direction to its confluence with the Oostanaula River at Rome, Georgia. The Etowah River basin drains an area of 1,860 square miles, all in Georgia. The Etowah River has a very steep slope initially, falling at a rate of 45 feet per mile, then becomes more gently with a slope of 4.5 feet per mile for 93 miles to Allatoona Dam. Downstream of the Dam, the slope is 3.2 feet per mile to its mouth. There is one dam on the Etowah River—Allatoona Dam, which is about 48 miles above Rome near Cartersville, Georgia (Corps, 1997).

The Oostanaula and Etowah Rivers converge near Rome, Georgia, to form the Coosa River. The Coosa River flows 286 miles from Rome, Georgia, to north of Montgomery, Alabama, where it joins the Tallapoosa River to form the Alabama River. The Coosa River drains an area of 10,200 square miles. The river falls approximately 420 feet in 267 miles, or 1.6 feet per mile, in a series of six successive pools, from its source to Jordan Dam. Seven Alabama Power Company dams form continuous, impoundments over nearly the entire length of the Coosa River, with each dam discharging into the upper end of the next downstream impoundment. These seven dams are Weiss, H. Neely Henry, Logan Martin, Lay, Mitchell, Jordan, and Bouldin. The upper three Alabama Power Company projects operate as hydropower peaking facilities, with releases occurring several hours each weekday and with no releases on the weekends. The lower four Alabama Power Company projects operate generally as run-of-river projects for hydropower production and to maintain stable flows from Jordan Dam over the weekends when the upstream peaking facilities do not operate. Because the reservoirs provide continuous inundation from one dam to the next, the effects of the peaking operation are tempered and attenuated.

The first of these seven dams is located 60 miles below Rome and the last one 19 miles above the confluence with the Tallapoosa River. As required by their FERC license (Corps, 1997), the Alabama Power Company projects on the Coosa River are operated to maintain a continuous minimum flow at Jordan Dam of 4,000 cfs in April and May. The flows are reduced during June to 2,000 cfs by July 1 and remain at 2,000 cfs from July through March. The Coosa River channel varies from 300 to 500 feet wide, with banks 25 feet high along the flood plain. Numerous tributaries enter the Coosa River below Rome, Georgia. The largest of these is the Chattooga River, which has a drainage area of 675 square miles.

The capacity of the Coosa River within its banks varies substantially throughout the river's length. Capacity is about 15,000 cfs at Rome, Georgia, and about 50,000 cfs near Gadsden, Alabama (Corps, 1997). Historically, average daily flows at the USGS gage on the Coosa

River at Rome, Georgia have been as low as 907 cfs (in October 1988) and as high as 64,600 cfs (in January 1947) and 64,200 cfs in more recent years (March 1990).

Average annual flows at several gages in the Coosa River basin are summarized in *Table 4-6*.

TABLE 4-6
Historical Gage Data (in cfs) for the Coosa River Basin[a]

Month	Coosawattee River at Carters, GA (Gage No. 02382500)	Etowah River at Allatoona Dam, GA (Gage No. 02394000)	Coosa River at Rome, GA (Gage No. 02397000)
January	1,313	2,364	9,657
February	1,529	2,228	10,508
March	1,895	2,637	13,080
April	1,766	2,611	10,565
May	1,227	2,270	6,891
June	958	1,518	4,696
July	823	1,542	4,182
August	683	1,415	3,462
September	580	1,240	3,030
October	675	1,705	4,172
November	850	2,122	5,583
December	1,036	2,293	7,244

[a] USGS average annual flow data for water years 1976 through 1996 were used. This period represents the time after the final dam in the Coosa River basin was completed (Carters Dam, operational in 1975).

4.4.1.1.1.2 Tallapoosa River

The Tallapoosa River begins in northwest Georgia, 40 miles west of Atlanta, at an elevation of 1,145 feet. The river flows 235 miles into Alabama to join the Coosa River north of Montgomery. The basin drains a total area of 4,680 square miles, of which 15 percent are in Georgia and 85 percent in Alabama. From its source, the river falls at a rate of 12 feet per mile for the first 15 miles, then descends at a more gradual rate of 3.4 feet per mile. In the lower reach from Thurlow Dam to its mouth, the river falls at a rate of 1.6 feet per mile.

Alabama Power Company constructed four dams across the Tallapoosa River. The upper two projects (Harris and Martin) are hydroelectric peaking facilities that generally operate several hours each weekday and do not generate power on the weekends. The two downstream projects (Yates and Thurlow) operate as run-of-river facilities, slightly reregulating peak releases and maintaining downstream minimum flows over the weekends when the upstream projects do not operate.

The river's width varies from 250 feet to 700 feet and has banks that are 20 feet high along the flood plain. The principal tributary streams are the Little Tallapoosa River and Sougahatchee, South Sandy, Uphapee, and Hillabee Creeks (Corps, 1997).

The river has a capacity of 2,500 cfs in the upper reaches, 22,000 cfs near Wadley, Alabama, and 60,000 just below Thurlow Dam (Corps, 1997). Historically, flows at the USGS gage on the Tallapoosa River at Wadley, Alabama, have been as low as 41 cfs (in August 1987) and as high as 67,900 cfs (in April 1979).

Average annual flow at two gages in the Tallapoosa River basin are summarized in *Table 4-7*.

TABLE 4-7
Historical Gage Data (in cfs) for the Tallapoosa River Basin[a]

Month	Tallapoosa River at Wadley, AL (Gage No. 02414500)	Tallapoosa River at Tallassee, AL (Gage No. 024185000)
January	3,412	5,544
February	4,800	7,811
March	5,105	6,740
April	2,281	3,620
May	2,229	3,404
June	1,762	3,382
July	1,737	3,223
August	1,472	3,143
September	1,031	2,409
October	1,429	3,127
November	2,383	4,950
December	2,754	6,215

[a] USGS average annual flow data for water years 1984 through 1996 were used. This period represents the time after the final dam in the Tallapoosa River basin was completed (Harris Dam, operational in 1983).

4.4.1.1.1.3 Alabama River

The confluence of the Coosa and Tallapoosa Rivers forms the Alabama River near Wetumpka, Alabama, north of Montgomery. The Alabama River, excluding the Coosa and Tallapoosa River tributary areas, drains an area of 7,940 square miles, all of which is in Alabama. Montgomery, the largest city located on the stream, is about 14 miles downstream from the source of the Alabama River. The river meanders generally in a westerly direction for 100 miles to Selma and then southwesterly 210 miles to join the Tombigbee River. The Alabama and Tombigbee Rivers merge to form the Mobile River near Calvert, Alabama. The Alabama River has a relatively flat slope, averaging 0.3 foot per mile. The channel varies in width from 400 to 600 feet with banks 10 feet high (Corps, 1997).

The Cahaba River is a major tributary of the Alabama River. The Cahaba River originates on the southern slope of Cahaba Mountain northeast of Birmingham, Alabama, at an elevation of approximately 1,200 feet. The river drains an area of 1,825 square miles. It flows southwesterly and southerly for 196 miles where it joins the Alabama River 17 miles downstream from Selma, Alabama, within Dannelly Lake. Purdy Dam, a water supply project owned by the Birmingham Water Works Board, is on the headwaters of the Cahaba River. The Cahaba River has an average slope of 15 feet per mile for the first 25 to 30 miles, then drops to a slope of 2.5 feet per mile for 44 miles, and finally flattens to a slope of 0.6 feet per mile to its mouth.

The Corps constructed three multi-purpose dams on the Alabama River. R. F. Henry, located 30 miles above Selma and 245 miles above the mouth, and Millers Ferry, located 73 miles downstream of Selma and 142 miles above the mouth; each has a navigation lock and a hydroelectric powerhouse. Claiborne, located 82 miles above the mouth, only has a navigation lock. The Alabama River has a carrying capacity that varies from 100,000 to 150,000 cfs (Corps, 1997). Historically, flows at the USGS gage on the Alabama River at

Claiborne Lock and Dam have been as low as 3,890 cfs (in September 1986) and as high as 255,000 cfs (in March 1990).

Average annual flow at two gages on the Alabama River and one gage on the Cahaba River are summarized in *Table 4-8*.

TABLE 4-8
Historical Gage Data in cfs for the Alabama and Cahaba River Basins[a]

Month	Alabama River at Montgomery, AL (Gage No. 02420000)	Alabama River at Claiborne Dam (Gage No. 02428400)	Cahaba River at Marion Junction (Gage No. 02425000)
January	35,659	50,334	4,423
February	39,753	58,865	5,253
March	50,022	68,943	6,414
April	42,957	55,091	5,376
May	22,293	30,552	2,714
June	15,441	19,080	1,489
July	12,430	17,125	1,330
August	9,871	13,361	902
September	9,125	11,742	910
October	12,556	17,212	1,170
November	17,519	24,692	1,759
December	25,668	36,903	2,944

[a] USGS average annual flow data for water years 1976 through 1996 were used. Data for the Montgomery gage were available only through 1990.

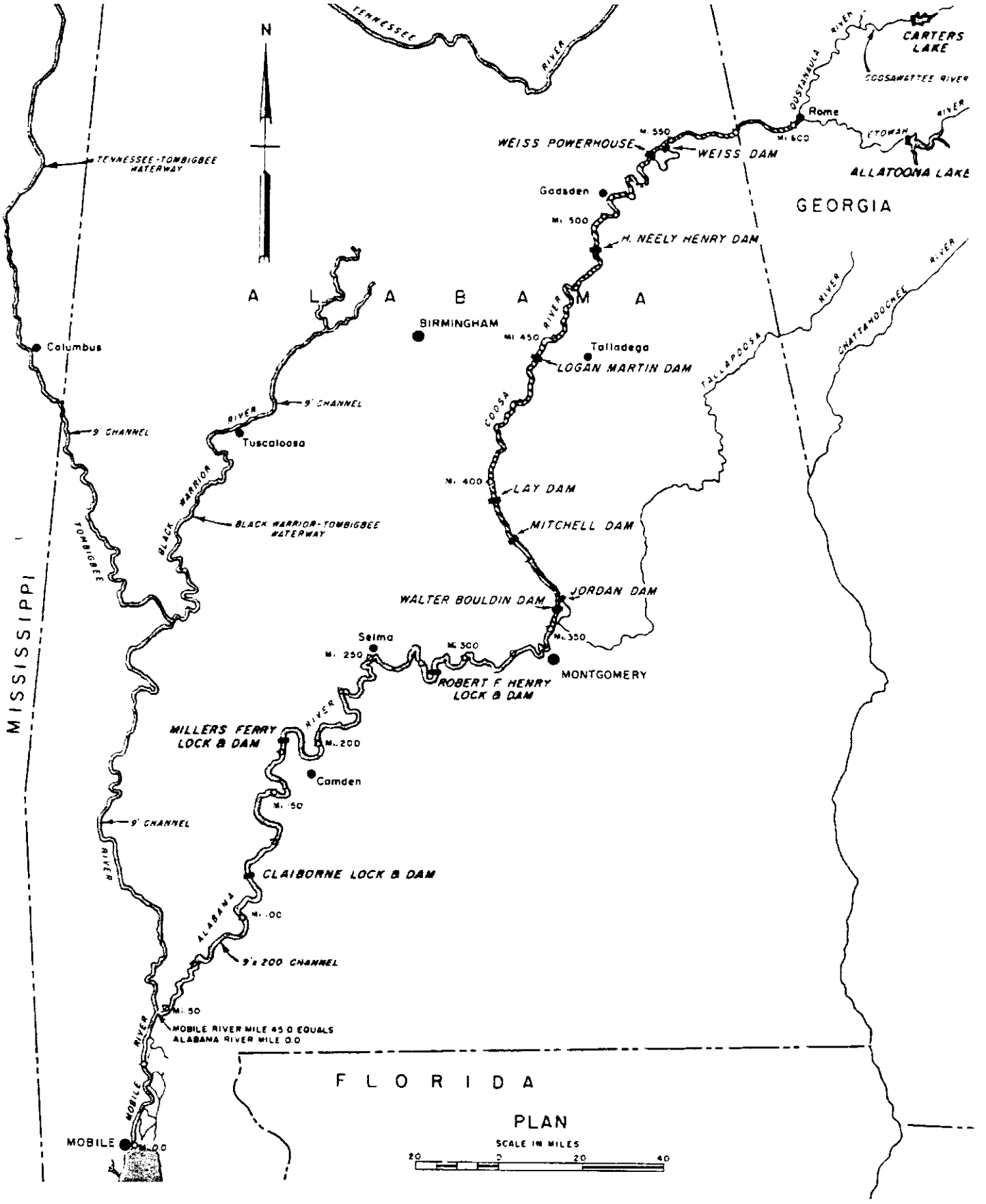
4.4.1.1.1.4 Navigation

Navigation is an important use of water resources in the ACT basin. Keeping the rivers clear for navigation was one of the first missions for the Corps of Engineers. Today's commercial barge lines still use rivers to move significant quantities of bulk materials by barge.

The Alabama River downstream to the Mobile area provides a critical navigation route for commercial barge traffic, which is an important regional economic resource (see Section 4.7.3.1) (*Figure 4-20*). A minimum flow is required to ensure usable water depths to support navigation. Congress has authorized continuous navigation on the river, when sufficient water is available. There are three locks and dams on the Alabama River, and a combination of dredging, river training works, and flow augmentation, which together support navigation depths on the river.

A 9-foot-deep by 200-foot-wide navigation depth is needed to provide the full authorized navigation channel on the Alabama River to Montgomery, Alabama. A minimum depth of 7.5 feet can provide a limited amount of navigation. Under low flow conditions, even the 7.5-foot depth has not been available at all times. Over the period from 1976 to 1993, the 7.5-foot navigation channel was available 79 percent of the time and the 9-foot navigation channel was available 72 percent of the time.

FIGURE 4-20
Navigation Projects in the ACT Basin



4.4.1.1.2 Reservoirs

Modern dam construction in the ACT basin dates from the middle to the latter part of the 1800s. Navigation locks and small dams provided sufficient depths for slack-water river traffic on the Coosa River in the early 1900s. These dams are no longer in service. By 1930, two dams on the Coosa River and three on the Tallapoosa River were built to take advantage of the natural stream gradients for power production. During the middle 1900s, large, multi-purpose reservoirs were built throughout the basin for hydropower, navigation, recreation, and water supply (Corps, 1997). The last dam (Harris Dam on the Tallapoosa River) was completed in 1983.

There are 18 dams in the ACT basin, which form 16 major reservoirs (Jordan and Bouldin share a common reservoir and Carters Dam and Carters Reregulation function as a single system). Six dams are Federally owned by the Corps and 12 are privately owned projects. Of the 18 dams, there are 2 on the Coosawattee River, 1 on the Etowah River, 7 on the Coosa River, 4 on the Tallapoosa River, 1 on the Cahaba River, and 3 on the Alabama River. The 18 projects and their key characteristics are listed in ***Table 4-9***. Smaller impoundments that currently occur in the basin but are not on mainstem rivers, or are planned, are listed in ***Table 4-10.***

TABLE 4-9
Existing Mainstem Dams/Reservoirs in the ACT Basin

Basin/River/ Project Name	Owner/ Year Completed	Drainage Area (square miles)	Reservoir Size (ac)	Total Reservoir Storage (ac-ft)	Conservation Storage[b] (ac-ft)	Total Capacity (MW)	Normal (Summer) Lake Elevation (ft)
			Coosa River Basin				
Coosawattee River		875					
Carters Dam and Lake	Corps/1974	376	3,220	383,565	141,402	575[c]	1,074
Carters Reregulation Dam	Corps/1974	154	870	19,300	17,210	None	700
Etowah River		1,860					
Allatoona Dam and Lake	Corps/1949	1,110	11,860	670,050	284,582	80[c]	840
Coosa River		10,270					
Weiss Dam and Lake	APCO/1961	5,273	30,200	305,815	199,838	98[d]	564
H. Neely Henry Dam and Lake	APCO/1966	6,600	11,200	120,639	86,992	98[d]	508
Logan Martin Dam and Lake	APCO/1964	7,743	15,263	273,300	133,502	143[d]	465
Lay Dam and Lake	APCO/1914	9,087	12,000	262,306	51,991	164[d]	396
Mitchell Dam and Lake	APCO/1923	9,827	5,850	170,422	47,201	156[d]	312
Jordan Dam and Lake [a]	APCO/1928	10,165	6,807	235,780	19,062	116[d]	252
Bouldin Dam and Lake [a]	APCO/1967	10,165	6,807	235,780	NA	226[d]	252
			Tallapoosa River Basin				
Tallapoosa River		4,660					
Harris Dam and Lake	APCO/1983	1,453	10,661	425,503	141,401	126[d]	793

(CONTINUED)

TABLE 4-9 (CONTINUED)
Existing Mainstem Dams/Reservoirs in the ACT Basin

Basin/River/ Project Name	Owner/ Year Completed	Drainage Area (square miles)	Reservoir Size (ac)	Total Reservoir Storage (ac-ft)	Conservation Storage[b] (ac-ft)	Total Capacity (MW)	Normal (Summer) Lake Elevation (ft)
Martin Dam and Lake	APCO/1926	3,000	40,000	1,623,000	638,912	150 [d]	490
Yates Dam and Lake	APCO/1928	3,250	2,000	53,770	5,002	33 [d]	344
Thurlow Dam and Lake	APCO/1930	3,300	574	18,461	NA	54 [d]	289
			Alabama River Basin				
Alabama River		22,800					
Robert F. Henry Lock and Dam/R.E. "Bob" Woodruff Lake	Corps/1972	16,300	12,510	234,200	12,110	68 [d]	125
Millers Ferry Lock and Dam/William "Bill" Dannelly Lake	Corps/1969	20,700	18,500	331,800	46,704	75 [d]	80
Claiborne Lock and Dam and Lake	Corps/1969	21,473	5,930	96,360	NA	None	35
Cahaba River		1,890					
Purdy Dam and Lake	BWWB/NA	43	990	24,000	NA	None	550

[a] Share a common reservoir

[b] Top of conservation pool (maximum) – top of inactive pool

[c] Overload capacity: represents maximum power generation capability of units.

[d] Nameplate capacity: represents full-load continuous rating of generators

ac	Acre	ft	Feet
ac-ft	Acre feet	kW	Kilowatts
APCO	Alabama Power Company	MW	Megawatts
BWWB	Birmingham Water Works Board	NA	Not applicable

Source: ***Appendix D***; Slater, 1990

TABLE 4-10
Planned or Existing Reservoirs Not on Mainstem Water Bodies in the ACT Basin

County	Stream	Project Status
Bibb	Town Creek	Unknown
Calhoun	Choccolocco Creek	Completed
Clay	Cheaha Creek	Completed
Clay	Crooked Creek	Completed
Cleburne	Coleman Creek	Completed

(CONTINUED)

TABLE 4-10 (CONTINUED)
Planned or Existing Reservoirs Not on Mainstem Water Bodies in the ACT Basin

County	Stream	Project Status
Cleburne	Cahulga Creek	Completed
Cleburne	Shoal Creek	Completed
Cleburne	Shoal Creek	Completed
Fannin	Rock Creek	Unknown
Haralson	Tallapoosa River	Planned
Murray	Mill Creek	Completed
Randolph	High Pine Creek	Completed
Talladega	Tallaseehatchie Creek	Completed
Talladega	Tallaseehatchie Creek	Completed
Union	Cooper Creek	Completed
Whitfield	Conasauga River	Unknown
Whitfield	Haig Mill Creek	Completed

Most of the dams in the ACT basin function to generate electricity by hydropower. Hydropower dams convert the force of falling water into electrical power. Although no longer the primary source of energy in the U.S., hydropower is still a very important source of electricity because it can be started quickly to provide immediate needs.

Much of the hydropower generation is *peaking* power. The generators are turned on when there is the most, or *peak,* demand for power. Air conditioning and heating are the power uses that often cause the peak demand for power so the hydropower releases are usually made when temperatures are extreme. Peaking hydropower projects typically generate power during the peak electrical demand hours (generally from 2 to 8 hours per day) on the weekdays and then do not generate on the weekends. In contrast, the run-of-river hydropower projects in the ACT basin typically generate power by passing the available inflows from upstream peaking projects. However, run-of-river projects do normally operate for a portion of the day, thus significantly influencing daily flows in the tailrace and downstream water courses. Unlike storage projects, run-of-river hydropower facilities do not follow a rule curve, nor do they fluctuate or redistribute flows seasonally.

This paragraph describes in very simplified terms the general process by which reservoir release decisions are made. For HEC-5 modeling purposes, each reservoir is typically subdivided into separate storage levels, as shown in ***Figure 4-21.*** The lowest level is the top of the inactive pool. No reservoir releases are made when the pool level is below this level. Level 2 is usually associated with the top of the conservation pool. The conservation pool can be subdivided into multiple action zones, as illustrated in ***Figure 4-22*** (see ***Appendix D*** for more information on storage levels for all reservoirs in the basin). Each action zone triggers a different operating schedule. Level 3 is the top of the flood control pool. Typically, the area between the top of conservation and flood control is active flood storage. Water is stored in this area when it cannot be safely passed through the downstream channel system. Usually, the top of the flood control level is not the maximum level.

FIGURE 4-21
Schematic of Reservoir Storage (ACT Basin)
Source: ***Appendix D***

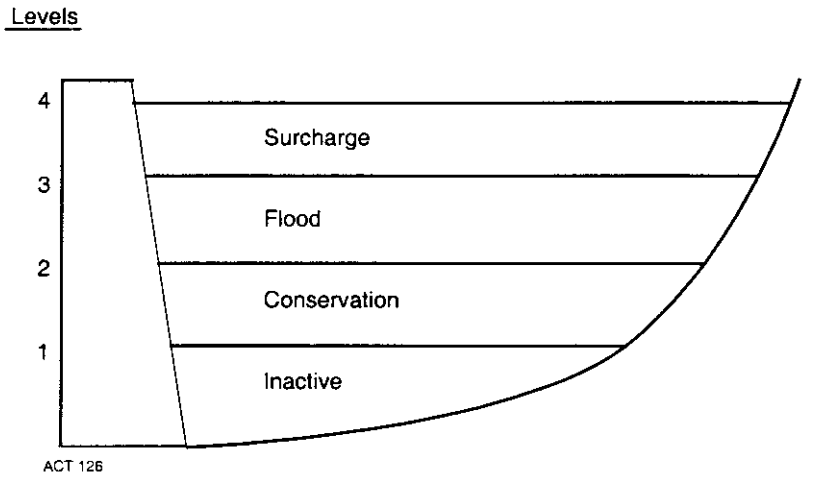
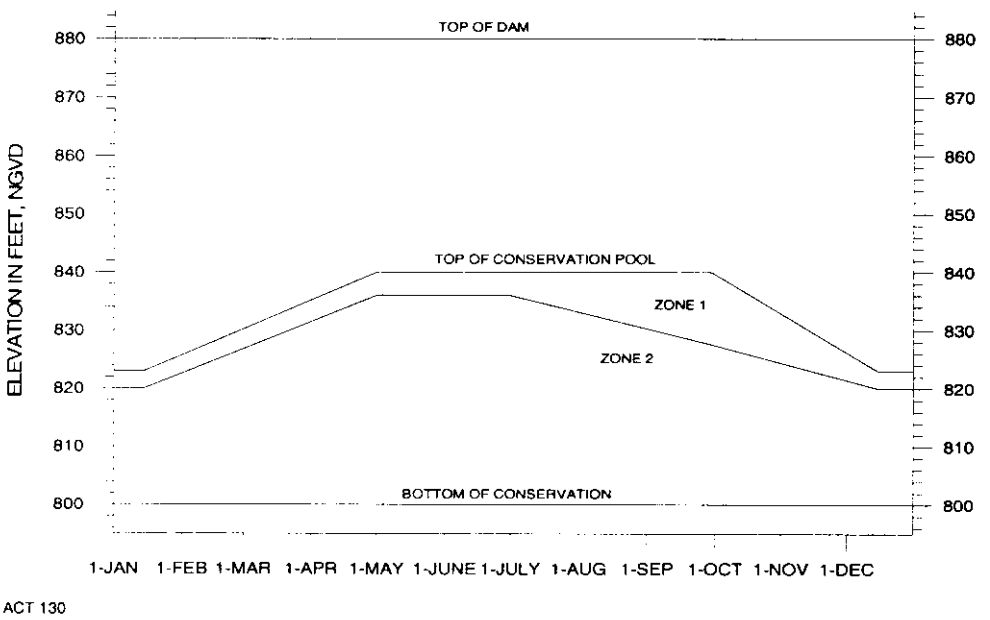


FIGURE 4-22
Lake Allatoona Action Zones Within Conservation Pool



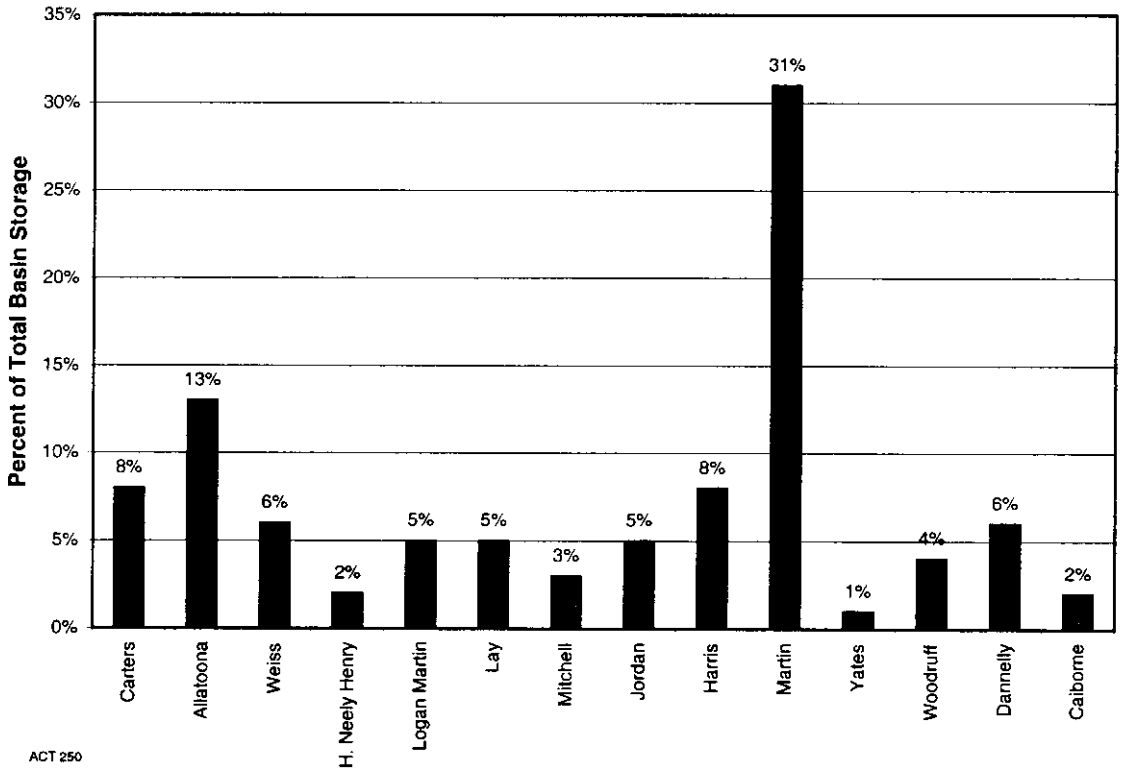
Typically, a reservoir has surcharge storage to accommodate water above the emergency spillway. In surcharge storage, the outflow is determined by the spillway capacity and cannot be controlled by the operators. Unlike western reservoirs, the reservoirs in the ACT Basin do not maintain high levels of reserve storage. It has been reported that all major reservoirs in the ACF basin provide only a few months of available stream flow (Rose, 1998) and similar low flow to storage ratios would be expected for the ACT basin as well. For example, the ACT reservoirs that are operated as storage projects can provide approximately 28 days of flow at Claiborne based on the mean annual flow, and approximately 85 days based on the mean October flow, the lowest average flow month.

4.4.1.1.2.1 Carters Lake

The Corps' Carters Dam and Carters Reregulation Dam on the Coosawattee River is a multipurpose project for flood control, hydropower, navigation, water quality, fish and wildlife enhancement, and recreation. The Carters project is a pumped-storage peaking facility. Water is released from Carters Dam, flows through the penstock, and generates power as it is discharged to the reregulation dam pool. The Corps generates power at Carters Dam only a few hours each weekday, when demand for electricity is greatest. When demand for electricity is low, usually during the night or on weekends, the turbines reverse and pump water back up from the reregulation pool to Carters Lake. Water is available again for hydropower generation in the next peak use period, and Carters Lake is maintained at its optimal power generation level.

Although there are 18 dams in the ACT basin, 2 dams share a reservoir (Bouldin and Jordan Dam both form the Jordan Lake) and 2 other dams (the Carters Dam and Carters Reregulation Dam) have interrelated operations. Thus, the 18 dams essentially form 16 major reservoirs. Of the 16 reservoirs, Martin Lake on the Tallapoosa River has the greatest amount of storage, containing over 30 percent of the entire storage in the ACT basin. Allatoona, Harris, Weiss, and Carters are the next four largest reservoirs in terms of storage (see ***Figure 4-23***). Thurlow and Purdy Lakes are not included in ***Figure 4-19*** because of their small storage capacity. Each reservoir is discussed individually below.

FIGURE 4-23
Water Storage in the ACT Basin



The Reregulation Dam serves two purposes: as a lower pool for the pumped storage operation and to reregulate peaking flows from Carters Dam to provide a more stable downstream flow.

Carters Lake has a total storage capacity of 472,800 acre-feet at elevation 1,099 feet. Of this, 134,900 acre-feet is usable for power generation, 95,700 acre-feet is reserved for flood control, and 242,200 acre-feet is dead storage. The minimum power pool elevation is 1,022 feet and the maximum power pool (maximum conservation pool) elevation is 1,074 feet in the summer and 1,072 feet in the winter. Carters Lake has a surface area of 3,220 acres at elevation 1,072 feet. The normal year-round operating range for the reregulation dam is 677 to 696 feet. The Carters Reregulation Dam provides a minimum continuous flow of 240 cfs to the Coosa River.

As expected with a peaking/pumped storage operation, both Carters Lake and the reregulation pool experience frequent elevation changes. Typically, water levels in Carters Lake vary no more than 1 to 2 feet per day. Levels can rise more than this during flooding events, however, as the lake captures and retains flood flows.

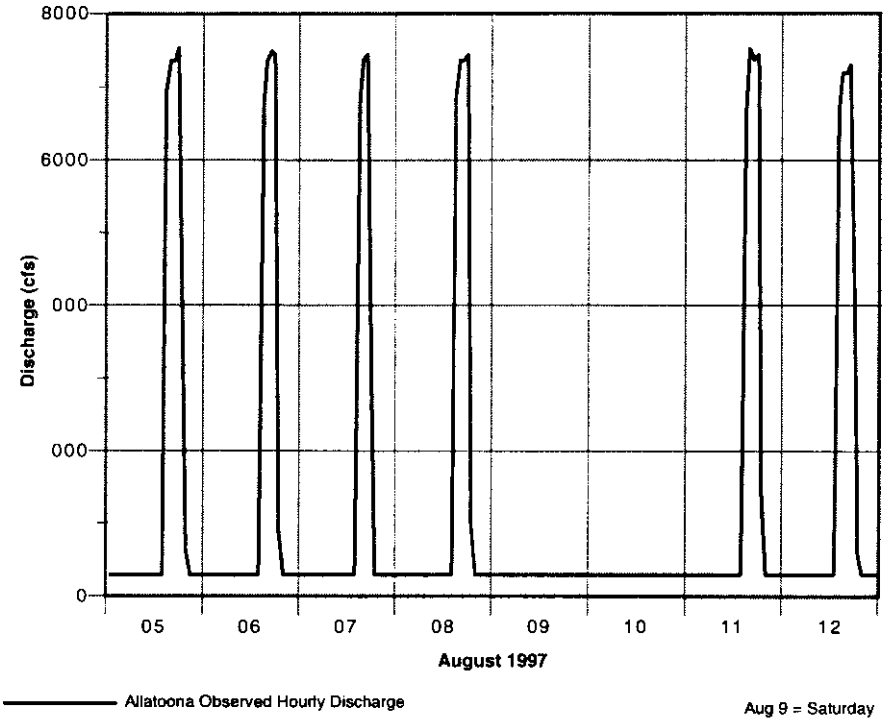
4.4.1.1.2.2 Lake Allatoona

The Corps' Allatoona Dam on the Etowah River creates the 19,200-acre Allatoona Lake. The project was built for flood control, regulation of streamflow for navigation, hydroelectric power, and recreation. Other purposes of the project are water supply, water quality, and fish and wildlife enhancement. Major withdrawals from, and releases to, this reservoir are made by the Cartersville and Cobb County-Marietta water systems. The Northwest Cobb water pollution control plant also discharges into this lake. The lake has a flood control storage capacity of 265,300 acre-feet and a conservation storage of 284,580 acre-feet.

A minimum flow of about 250 cfs is continuously released through a service unit, which generates power while providing a constant flow to the Etowah River downstream. Allatoona Dam operates in a peaking mode, generating power between 2 and 6 hours during normal operations each weekday. Weekend generation may occur if required to meet customer needs. The period of power generation is related to the stage of Conservation pool drawdown. Generally, only the 250 cfs minimum flow is released on the weekends. ***Figure 4-24*** shows a typical weekly pattern of flows downstream of the dam. The total generating capacity of the project is 80 megawatts (MW). ***Appendix D*** contains this information for other reservoirs in the basin.

Water levels in Lake Allatoona remain fairly stable during normal operating conditions. Lake levels vary only several inches except during high inflows to the basin and during flood storage drawdown in the winter, which reduces the pool from 840 feet to 823 feet. Flood flows that are captured in the reservoir are generally released slowly over the subsequent weeks, unless additional flood flows are anticipated. Power releases during the low flow season augment flows at the Alabama Power Company's projects along the Coosa River. The releases also provide water for municipal and industrial needs in the Rome, Georgia, area and for navigation on the Alabama River below Montgomery during the dry season.

FIGURE 4-24
Typical Daily Variation in Allatoona Dam Discharge



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4.4.1.1.2.3 Weiss Lake

Weiss Lake is the first of seven Alabama Power Company reservoirs on the Coosa River. Weiss Lake has a surface area of 30,200 acres and a storage capacity of 305,800 acre-feet. The project is operated for peaking power production, with typical operation for power generation of 1 to 6 hours per day during the week but with no generation on the weekend. The dam's operation is coordinated with releases from the downstream reservoir (H. Neely Henry Lake) to keep the pool levels in balance and fairly stable. The H. Neely Henry Lake affects the Weiss Dam tailwater at the power plant, inundating the tailwater. The issue of minimum flows or leakage flows is not critical where the tailwater is inundated with a downstream reservoir because there is no free-flowing stretch of river that could dry up.

Weiss Dam also operates as a flood control facility. Flood control storage is 10 feet in the summer and between 10 and 16 feet in the fall, winter, and early spring. Between 3 and 5 feet is allowed for conservation storage, depending on the season. Conservation storage is used for hydropower and water supply. The generating capacity of the project is 88 MW.

4.4.1.1.2.4 H. Neely Henry Lake

H. Neely Henry Dam is a multi-purpose project on the Coosa River owned by Alabama Power Company. The reservoir's purposes include hydropower, navigation, water quality, water supply, and recreation. There is no flood control storage in the reservoir, although Alabama Power Company lowers the pool elevation to minimize flood damages in the Gadsden area in advance of an impending flood.

The reservoir has a surface area of 11,200 acres and a storage area of 120,600 acre-feet. Normal lake elevation is 508 feet. Alabama Power Company typically operates the project with a fairly stable pool, although reservoir levels can fluctuate a foot or more if necessary to meet high power demands. The dam is operated as a peaking facility, with no generation on the weekends and several hours of generation each weekday, as power needs require. The generating capacity of the project is 72.9 MW. Logan Martin Lake inundates the tailwater of the H. Neely Henry Dam.

4.4.1.1.2.5 Logan Martin Lake

Logan Martin Lake is the third in a series of seven Alabama Power Company reservoirs on the Coosa River. The reservoir is created by the Logan Martin Dam, which is a peaking hydropower facility. There is no flood control storage in the reservoir; all inflow is passed through the project when the reservoir reaches the top of the conservation pool. Although Logan Martin Lake has no flood control storage, Alabama Power Company coordinates the operation with other projects on the Coosa River to minimize flooding. When inflow exceeds the power plant's capacity (32,700 cfs), the excess is released through the spillway. Another 640 cfs is lost through under seepage.

Logan Martin Lake has a surface area of 15,300 acres and a storage capacity of 273,300 acre-feet. The peaking facility operates several hours each weekday, depending on electrical power demand. The generating capacity of the project is 128 MW.

4.4.1.1.2.6 Lay Lake

Lay Lake, a 12,000-acre reservoir on the Coosa River downstream of the Logan Martin Dam, is a hydropower facility owned by Alabama Power Company. The project's primary purpose is hydropower production, but the reservoir also provides storage for water quality, water supply, and recreation. A major paper products company also releases treated wastewater into Lay Lake. The reservoir is typically maintained near the top of the conservation pool (465 feet), but can be drawn down a foot to meet high power demands. The power plant operates as necessary to keep the lake from exceeding the top of the conservation pool. Generally, the project is operated in a run-of-river mode, releasing outflows that approximate reservoir inflows on a daily basis. The generating capacity of the Lay Lake project is 142 MW.

Although Lay Lake has no flood control storage, Alabama Power Company coordinates the operation with other projects on the Coosa River to minimize flooding. The Lay Dam is also operated together with the Mitchell and Jordan Dams to maintain downstream flow requirements on weekends, since the upper storage projects do not normally operate on weekends. Lay Dam contributes its run-of-river flows in meeting the downstream requirements at Jordan Dam.

4.4.1.1.2.7 Mitchell Lake

Mitchell Dam is operated by Alabama Power Company primarily for hydropower production; however, the 5,850-acre reservoir also provides storage for water quality, water supply, and recreation. Alabama Power Company maintains the reservoir as close to the top of the conservation pool as possible (312 feet). If necessary, the reservoir can be drawn down 1 foot to meet power demands. The project has a generating capacity of 170 MW. There is no flood control storage at the Mitchell project.

The Mitchell Dam is also operated together with the Lay and Jordan Dams to maintain downstream flow requirements on weekends, since the upper storage projects do not normally operate on weekends. Mitchell Dam contributes its run-of-river flows in meeting the downstream requirements at Jordan Dam.

4.4.1.1.2.8 Jordan Lake

The Jordan and Bouldin Dams are both Alabama Power Company facilities on the Coosa River. Jordan Lake, which is a 6,800-acre reservoir, is maintained at 252 feet under most circumstances; however, the level is frequently lowered by 1 foot to meet power or minimm flow demands.

Lay, Mitchell, and Jordan Dams operate as necessary to maintain downstream flow requirements on weekends since the upper storage projects normally do not operate on weekends. The minimum flow at Jordan Dam is 2,000 cfs from July through March, 5,000 cfs during April and May, and 3,438 cfs during June. Jordan Dam contributes its run-of-river flows in meeting this downstream requirement. Jordan Dam has a leakage flow of 187 cfs.

Water from Lake Jordan supplies both Jordan and Bouldin Dams for hydropower peaking generation. All flows in excess of the minimum flow requirement at Jordan Dam pass through a canal to Bouldin Dam. Flows greater than the 30,000 cfs penstock capacity at Bouldin Dam pass through the Jordan Dam's turbines or spillway (Bouldin Dam has no minimum flow requirements and no spillway). Jordan and Bouldin facilities have generating capacities of 100 and 225 MW, respectively.

4.4.1.1.2.9 R.L. Harris Lake

The R.L. Harris Dam is an Alabama Power Company facility on the Tallapoosa River, creating the 10,700-acre Harris Lake. Harris Dam is the most upstream of a series of four dams on the Tallapoosa River. The two most upstream projects (Harris and Martin) are peaking facilities and the two most downstream (Yates and Thurlow) are run-of-river projects, passing inflow as it enters each reservoir. Harris operates to maintain a continuous minimum flow of 45 cfs at the Wadley gage, which is about 15 miles downstream of the dam.

Alabama Power Company operates the Harris project in a peaking mode, generating power as demands dictate, typically on a Monday through Friday schedule. The generating capacity of the project is 135 MW. The penstock capacity is 16,000 cfs.

The project maintains between 2 and 10 feet of flood control storage, depending on the season, and a conservation pool of between 17 and 25 feet, depending again on the time of year. Generally, Alabama Power Company operates the project to keep the reservoir from exceeding the top of the conservation pool.

4.4.1.1.2.10 Lake Martin

The Martin Dam and Lake is the second in a series of four Alabama Power Company projects on the Tallapoosa River. Martin Lake has a surface area of 40,000 acres and a storage capacity of 1,623,000 acre-feet. The primary purpose of the Martin project is hydropower production, but the reservoir also provides storage for water quality, water supply, and recreation. Alexander City is a major user of water from this project, and it also releases treated wastewater into the reservoir. The Martin project is a peaking facility that normally operates on a Monday through Friday schedule to meet peak power demands. The generating capacity of the project is 154 MW. The penstock capacity is 16,700 cfs.

Alabama Power Company operates the Harris and Martin Dams to provide a minimum flow of 1,200 cfs at the Thurlow Dam. Alabama Power Company also operates the project as necessary to keep the reservoir level from exceeding the top of the conservation pool. Martin Lake has no storage reserved for flood control, although seasonal winter drawdowns are used to prepare for spring inflows and may provide incidental flood control benefits. Alabama Power Company also coordinates the operation of Martin with other projects on the Tallapoosa River in the interest of flood control to the extent possible.

4.4.1.1.2.11 Yates Lake

The Yates project is the third in a series of four Alabama Power Company projects on the Tallapoosa River. Alabama Power Company operates the Yates facility together with the Thurlow facility downstream to meet the 1,200 cfs minimum flow requirement at Thurlow on weekends, since the upper two storage projects normally do not operate on weekends.

Yates Lake has a surface area of 2,000 acres and a storage capacity of 53,800 acre-feet. The Yates Dam has an open-crest spillway with an elevation of 344 feet. Flows in excess of turbine capacity flow over the spillway. The generating capacity of the project is 37 MW. The penstock capacity is 9,755 cfs.

4.4.1.1.2.12 Thurlow Lake

The Thurlow Dam is the fourth Alabama Power Company dam on the Tallapoosa River. Alabama Power Company operates the Thurlow project together with the Yates project to meet downstream flow requirements on weekends, when the upper two storage projects (Harris and Martin) are typically not operating. The Thurlow project's primary purpose is hydropower, but the reservoir also provides storage for water quality, water supply, and recreation. Alabama Power Company also operates the project to provide a continuous minimum release of 1,200 cfs. Together with the minimum flow requirements of the Jordan and Bouldin Dams, this provides a continuous minimum flow of 4,640 cfs to the Alabama River at Montgomery.

The Thurlow reservoir has no flood control storage. Alabama Power Company coordinates the Thurlow operation with the other Tallapoosa River projects to minimize flooding.

Thurlow Lake is by far the smallest of the four Tallapoosa River reservoirs. The surface area of the lake is 574 acres, and the storage capacity is 18,500 acre-feet. Alabama Power Company typically operates the project at 289 feet with little fluctuation. Generating capacity at the project is 58 MW.

4.4.1.1.2.13 Purdy Lake

Purdy Lake is a small, 990-acre reservoir at the headwaters of the Cahaba River. It has a drainage area of only 43 square miles. The primary purpose of the lake is to provide water supply for the City of Birmingham. The dam and reservoir are owned by the Birmingham Water Works Board. There are no hydropower generating facilities at the project.

4.4.1.1.2.14 R.E. "Bob" Woodruff Lake

The R.E. "Bob" Woodruff Lake is created by the Robert F. Henry Lock and Dam, located 281 miles upstream of Mobile Bay. This is the first of three Corps projects on the Alabama River, also known as the Alabama River Lakes. Woodruff Lake extends from the Robert F. Henry Lock and Dam upstream to the Walter Bouldin Dam. The City of Montgomery, Alabama, is located on the lake. In addition to hydropower and navigation, Woodruff Lake provides recreation and fish and wildlife enhancement.

Woodruff Lake is 77 miles long and averages 1,300 feet wide. It has a surface area of 12,500 acres and a storage capacity of 234,200 acre-feet at a normal pool elevation of 125 feet. There is a 9-foot-deep by 200-foot-wide navigation channel over the entire length of the lake. The Corps operates the project for navigation and hydropower generation. The facility has a generation capacity of 68 MW. The R.F. Henry Dam is operated in tandem with the downstream Millers Ferry Dam to provide an average daily outflow of 6,600 cfs from the Millers Ferry Dam for navigation and waste assimilation needs on the Alabama River.

Lake levels are typically fairly stable with minimal fluctuation. The lake is a popular recreation destination, receiving up to 2 million visitors annually.

4.4.1.1.2.15 William "Bill" Dannelly Lake

The William "Bill" Dannelly Lake is created by the Millers Ferry Lock and Dam on the Alabama River, 178 miles upstream of Mobile Bay. Dannelly Lake is 103 miles long and averages almost 1,400 feet wide. The reservoir partially inundates several tributary streams. The Cahaba River flows into the upper reaches of Dannelly Lake.

Dannelly Lake has a storage capacity of 331,800 acre-feet at a normal pool elevation of 80 feet. It has a surface area of 18,500 acres. There is a 9-foot-deep by 200-foot-wide navigation channel extending the entire length of the reservoir. The facility is a multi-purpose reservoir constructed by the Corps for both navigation and hydropower. The reservoir also provides recreational benefits and has lands managed for wildlife mitigation. The hydropower generating capacity of the project is 75 MW. An average daily outflow of 6,600 cfs is provided from the Millers Ferry Dam for navigation and assimilative flow needs on the Alabama River.

Lake levels remain fairly stable on a day-to-day basis, but rise slightly, up to 0.5 feet, in wet weather. The reservoir provides ample recreation opportunities. Recreation visitors number 3 million annually.

4.4.1.1.2.16 Claiborne Lake

Claiborne Lake is created by the Claiborne Lock and Dam on the Alabama River about 118 miles upstream of Mobile Bay. The lake is similar to a wide river, averaging about 800 feet wide, with a surface area of 5,850 acres. Claiborne Lake extends 60 miles upstream to the Millers Ferry Lock and Dam. Storage capacity in the lake is 96,360 acre-feet at a normal pool elevation of 35 feet. The lake has a 9-foot-deep, 200-foot-wide navigation channel extending its entire length. The primary purpose of this Corps project is navigation. There is no hydropower generating capability at the project. The lake also provides recreation benefits and has lands managed for wildlife mitigation.

Claiborne Lake is the most primitive of the three Alabama River Lakes. The lake remains mostly within its original river banks and is surrounded by a rustic atmosphere. The Corps is allowing the shoreline to revert to its natural state, providing important wildlife habitat. Recreation visitors number over one million annually.

4.4.1.1.2.17 Potential Future Lakes

Future reservoir projects have been considered for the ACT basin to meet expanding or projected needs in the region for additional water supply and recreation (***Table 4-10***). The development of these projects will depend on future decisions that affect water allocation for the ACT basin. Individual tiered environmental assessments (EAs) and/or EISs, which

are outside the consideration of this programmatic EIS, will be completed for these specific projects as they reach the appropriate stage of planning.

4.4.1.1.3 Groundwater

The groundwater aquifers underlying the ACT basin vary widely in their lithologic and water-bearing characteristics. The types of aquifers present include porous-media, fracture-conduit, and solution-conduit aquifers. Specifically, these are the surficial aquifer systems, Cenozoic deposits, Cretaceous deposits, Paleozoic deposits, the Coastal lowlands aquifer system, the Upper Floridan aquifer system, the crystalline-rock aquifer, and the five major aquifers of the Southeastern Coastal Plain aquifer system (the Lisbon aquifer, the Nanafalia-Clayton aquifer, the Ripley aquifer, the Eutaw aquifer, and the Tuscaloosa aquifer. Throughout the ACT basin, it appears that shallow groundwater contributes to base flow of the Alabama, Coosa, and Tallapoosa Rivers and their major tributaries, although the degree of contribution varies widely and must be evaluated on a localized basis.

The groundwater system underlying the ACT basin was delineated in the Comprehensive Study. Eight subareas were delineated; subareas 5, 6, 7, and 8 underlie the ACT basin (see *Figure 4-4*). In subarea 5, the dominant aquifers consist of crystalline rock aquifers toward the northern portion of the basin and Cenozoic and Cretaceous deposits toward the southern portion of the basin. In this subarea, the Tallapoosa River receives groundwater from the Cretaceous and crystalline rock aquifers. Well yields from the Cretaceous aquifer typically range from between 100 and 200 gallons per minute (gpm), and are used for limited public water supplies in portions of Alabama. The Cenozoic deposits have relatively low yields—in the range of 10 gpm—and are generally only used only for domestic wells.

Portions of subareas 5 and 6 that are located within the Blue Ridge and Piedmont provinces have the crystalline-rock aquifer as the primary aquifer. This aquifer is commonly overlain by the surficial (porous-media) aquifer. Yields from wells in the fractured crystalline aquifer are highly variable. Typical well yields range from 1 to 25 gpm. High yielding wells, however, can produce 100 gpm or greater (yields as high as 700 gpm have been reported). Only 9 percent of wells inventoried by the USGS had yields greater than 50 gpm (Journey and Atkins, 1997). Although recent studies by the USGS have concluded that groundwater resources can be developed in this area, the complex nature of the fractured rock produces production zones of limited extent. In addition, quantitative estimates of aquifer properties are difficult to assess.

In the Blue Ridge and Piedmont provinces, groundwater storage is primarily in the overlying weathered bedrock (regolith or saprolite) that forms the porous-media aquifer. Wells completed in the regolith are more susceptible to reduced yields during drought conditions, whereas wells completed in the bedrock are often capable of sustaining yield during drought conditions. The volume of water in storage in the regolith is controlled by porosity and thickness. To a lesser degree, the volume of water in storage in the crystalline-rock aquifer is controlled by the degree of fracturing. Because of the limited storage in fractures, water levels in fracture-conduit aquifers typically respond rapidly to pumping.

The aquifers in subareas 6 and 7 that are located within the Valley and Ridge province and a portion of the Cumberland Plateau province are typically found in Cenozoic sand and gravel deposits, Paleozoic sandstones, and Paleozoic limestones. The Cenozoic sand and gravel deposits are typically found in the valley floor of the Coosa River and only form

localized aquifers that discharge to the Coosa River. This type of aquifer can generally maintain yields of only about 10 gpm, and is used only for domestic water supply wells.

The Paleozoic limestones and sandstones have highly variable yields, ranging from 10 gpm to 2,000 gpm and 10 gpm to 200 gpm, respectively. As with other areas, these aquifers are generally composed of two water-bearing zones: the shallow regolith/saprolite and the deeper fractured bedrock. In the regolith, groundwater flows through pore spaces, and porosity can range from 20 to 30 percent. In the fracture-conduit and solution-conduit rock portion of the aquifer, groundwater flow is generally along routes of secondary porosity. As with the crystalline rock aquifers, groundwater storage is primarily in the overlying regolith or saprolite. The volume of water in storage is controlled by porosity and the thickness of the regolith. In the sandstones of the Valley and Ridge and Cumberland Plateau provinces, groundwater yields may be sufficient to sustain public or industrial supplies. In this area, most of the public wells yield less than 100 gpm, but otherwise are similar in yields to the crystalline rock aquifer. In this area, the groundwater receives recharge from upland areas and generally discharges to the Coosa River.

The majority of subarea 8 and a small section of subarea 5 are composed of the Southeastern Coastal Plain aquifer system, which is a complex sequence of water-bearing zones and confining units. The recharge areas generally coincide with the outcrop areas of their respective geologic units in Baldwin, Escambia, Clarke, Monroe, Marengo, Wilcox, Dallas Lowndes, Perry, Dallas, Autauga, Bibb, Chilton, Autauga and Elmore Counties, Alabama. Yields and water-bearing properties for each of the five aquifers of the Southeastern Coastal Plain are as follows:

Lisbon aquifer	Less than 100 gpm	Domestic uses
Nanafalia-Clayton aquifer	75 to 900 gpm	Public water supplies
Ripley aquifer	75 to 200 gpm	Public water supplies
Eutaw aquifer	up to 700 gpm	Public water supplies
Tuscaloosa aquifer	200 to 500 gpm	Public water supplies

The Upper Floridan aquifer is found in the southern portion of subarea 8. Well yields from the Upper Floridan aquifer are relatively small. Yields are generally less than 50 gpm, but yields between 75 to 175 gpm were obtained from public water supply wells used by the City of Monroeville, Alabama, until the 1950s. Currently, the Upper Floridan aquifer of the ACT basin is generally used for domestic wells.

The southernmost aquifer of the ACT basin is the Coastal Lowland aquifer system, which consists of sand and gravely sand beds. These water-bearing units have good well yields—typically between 100 and 500 gpm—and are used as a source of public water supplies.

The Comprehensive Study found that the ration was 1 to 1; i.e., every gallon of groundwater withdrawal was equivalent to 1 gallon of surface withdrawal in areas of the basin north of the fall line. In the Coastal Plain (the area below the fall line), the ratio was found to be 0 + .1, i.e., that groundwater withdrawal had no effect on surface water flows (Corps, 1997).

4.4.1.1.4 Water Supply Withdrawals

Fresh water is withdrawn from both surface water and groundwater sources in the ACT basin to meet regional water supply purposes. ***Figure 4-25*** shows the major surface water withdrawals in the ACT basin (EPA, 1996a). About 80 percent of withdrawn water is eventually returned to the surface or groundwater system.

Water use follows a seasonal pattern. The peak water demand months are June through September, when irrigation and residential water demands peak with the warm temperatures (Davis et al., 1996). The seasonal demands on surface water affect how decisions are made to manage project operations in the ACT basin. For example, the Lay, Mitchell, and Jordan Dams on the Coosa River are operated on the weekends to maintain minimum flow requirements at Montgomery, ensuring that the City has sufficient water to meet its demands and navigation needs. In addition, project operations during drought periods must take water demands into consideration to provide minimum flows to meet navigation, water supply, and water quality demands.

Interbasin transfers result when water is withdrawn from one basin and eventually discharged to another basin. Interbasin transfers of surface water were investigated as part of the Comprehensive Study. These investigations focused on surface water interbasin transfers and did not address groundwater and surface water relationships. For the ACT, transfers of surface water out of the basin included 43 million gallons per day (mgd) to the ACF basin and 12 mgd out of the study area (***Figure 4-26***). Transfers into the ACT basin included 9 mgd from the ACF basin and 52 mgd from outside the study area. This produced a net transfer of 6 mgd into the ACT basin (PMCL, 1996). (Water withdrawals, discharges, and transfers are typically quantified in mgd. Streamflows and reservoir releases are typically quantified in cubic feet per second (cfs). The conversion factor is 1.55 cfs = 1 mgd.)

4.4.1.1.4.1 Municipal and Industrial Demands

Municipal and industrial water demand includes all water uses, both publicly supplied and self-supplied, including residential, commercial, governmental/institutional, industrial, manufacturing, and other demands such as unaccounted for water use (e.g., system losses and fire-fighting). In water resource management, a portion of municipal and industrial uses are considered consumptive uses. That is, at least some portion of the study area's municipal and industrial water demand is permanently removed from the system.

The water demands presented in this section are from Scenario 1 of the Planning and Management Consultants, Limited (PMCL) study (1996) completed for the Comprehensive Study. This scenario develops water use projections based on current water use patterns, but does not include additional water conservation beyond that measured in the water use modeling data. The scenario is primarily driven by projected changes in population, employment, and housing characteristics in the study area. Since the accuracy of the estimated 1995 water demands is closely linked to the 1995 population estimates described in Section 4.7.1.1, differences between the actual and estimated population would translate into an over- or under-estimation of water demand. These water demands are annual averages of water needs over a wide range of climatic conditions and do not represent the worst case demands that may occur during drought periods. These water demands are annual averages of water needs over a wide range of climatic conditions and do not

FIGURE 4-25
Surface Water Withdrawals from Thermal Power Plants and Municipalities Serving Populations of Greater than 10,000 (ACT Basin)

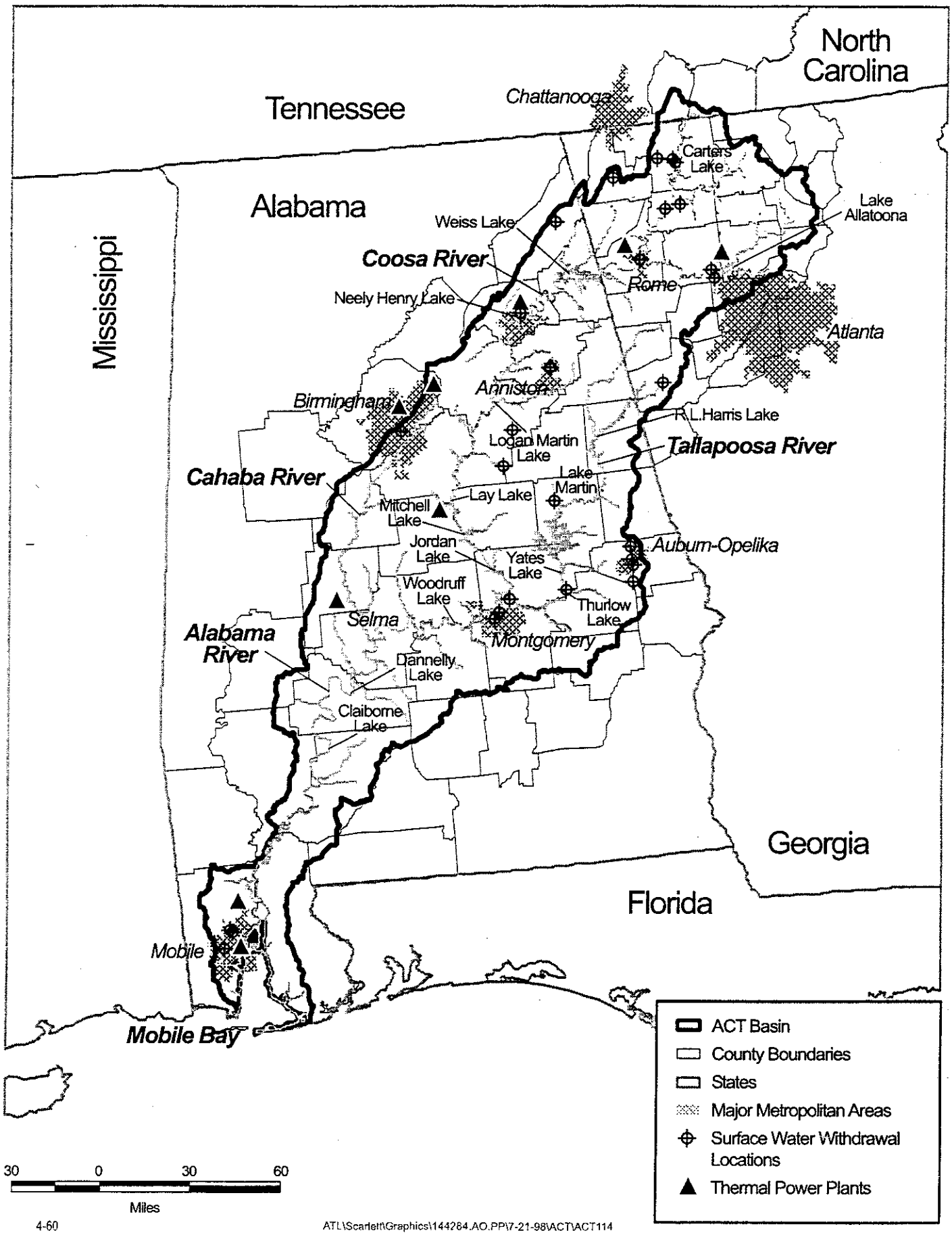

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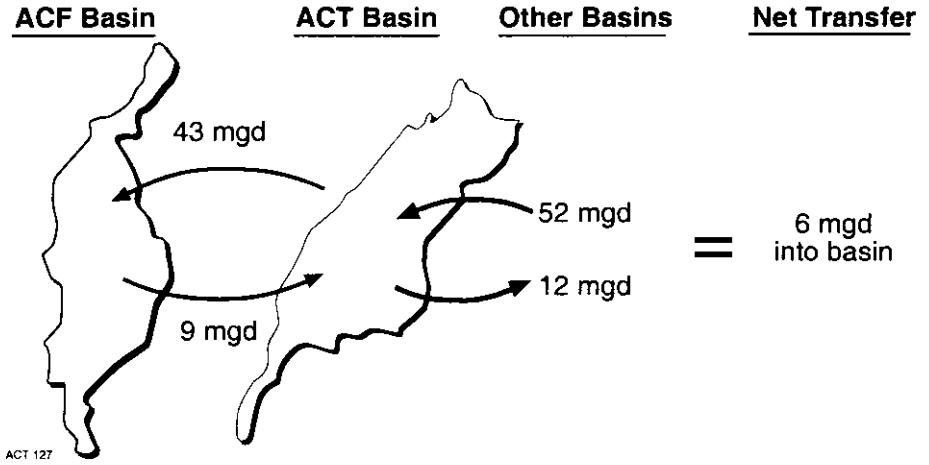
FIGURE 4-26
Interbasin Transfer Schematic (ACT Basin)



represent the worst-case demands that may occur during drought periods. These water demands are annual averages of water needs over a wide range of climatic conditions and do not represent the worst case demands that may occur during drought periods.

In areas in which population growth is not directly linked to employment growth (i.e., bedroom communities), water demands may be significantly under-estimated. For this reason, county-level and subbasin-level data, which are used in the HEC-5 modeling, are not presented here. The States have approved the basinwide figures that are shown in this section through the Comprehensive Study.

Table 4-11 displays estimated municipal and industrial water demand for the ACT basin. These figures represent gross, unconstrained demand figures as presented in the Comprehensive Study, Municipal and Industrial Water Demands (PMCL, 1996). Alabama's 1995 estimated municipal and industrial water demands were 683 mgd of the 886 mgd of total demand in the ACT basin (77 percent). Demand in Georgia is estimated to have been approximately 203 mgd (23 percent). The majority of that demand came from manufacturing (64 percent), with residential (22 percent), commercial (4 percent), and other demands (10 percent) making up the balance. The strong demand for water in the manufacturing sector is driven by the pulp and paper industry in Alabama and the textile industry, especially the carpet industry, in Georgia.

TABLE 4-11
Estimated 1995 Municipal and Industrial Water Demand (mgd), by State and ACT Basin Total

Area	1995	2020	2050
Alabama portion	683	902	979
Georgia portion	203	210	221
ACT basin total	886	1,112	1,200

Source: PMCL, 1996

The majority of municipal and industrial demands come from the Coosa River basin (52 percent), with the Alabama River basin next (27 percent), followed by the Cahaba River (15 percent), and the Tallapoosa River (6 percent).

4.4.1.1.4.2 Agricultural Demand

As part of the Comprehensive Study, the Natural Resources Conservation Service (NRCS) evaluated historic and existing agricultural activities and water demand in the ACT basin. The study prepared by NRCS developed projections of agricultural water demands for 1995 and future years (NRCS, 1996). These projections included demands by the agricultural sector, including irrigation of crops/orchards, turf grasses and plant nurseries, and water demands for aquaculture, livestock, and poultry.

The annual average agricultural water use in the Alabama portion of the ACT basin was estimated to total 75.1 mgd in 1995 (***Table 4-12***). Two planning areas, the Coosa and the Alabama-Cahaba, account for a significant portion of the total water use. The Coosa planning area contains the counties of Calhoun, Cherokee, Chilton, Coosa, DeKalb, Elmore, Etowah, St. Clair, Shelby, and Talledega. The Alabama-Cahaba planning area contains the counties of Autauga, Bibb, Dallas, Lowndes, Perry, and Jefferson.

Surface water and groundwater are used almost equally to meet agricultural irrigation demands in the Alabama portion of the basin. Natural runoff is used extensively for aquaculture purposes. Irrigation of crops and orchards and aquaculture accounted for the majority of the existing agricultural water demand. The NRCS study (1995) indicated, however, that irrigation is not heavily used in the Alabama portion of the ACT basin.

The average annual water demands in the Georgia portion of the ACT basin were estimated to be 21.9 mgd in 1995. Livestock and poultry demands accounted for 11.7 mgd of the total demand. Aquaculture (6.5 mgd) and crops and orchards (2.2 mgd) represent other significant water demands in the area. The Georgia Geological Survey found that the majority of agricultural water demands are met through surface collection. Of the other agricultural sectors inventoried, only nurseries obtain water primarily from groundwater.

Seasonal water needs are critical to the production and quality of certain crops, particularly corn and peanuts. Lack of water during key growth stages can essentially destroy the crop. Agricultural water demands in May through August account for the large majority of the annual demand. These months reflect the heart of the growing season for crop and orchards.

After completing the Agricultural Water Demand Technical Report and Appendix A, NRCS prepared the Basinwide Management Shared Vision Appendix (Appendix B) at the request of the Basinwide Management Work Group (NRCS, 1996). The study completed for Appendix B used more detailed data for modeling than had been developed previously and includes revised agricultural demand data. For this appendix, the 17 subbasins used in the original analysis (discussed above) were further subdivided into 25 subbasins.

Table 4-12 presents the estimated 1995 annual average agricultural water demands in the ACT basin based on this study.

TABLE 4-12
Estimated 1995 Annual Average Agricultural Water Demands, by State and Basin Total (mgd), ACT Basin

Area	Crops and Orchards	Turf	Nursery	Aquaculture	Livestock/ Poultry	Total
Alabama portion	17.5	10.0	2.2	34.0	11.4	75.1
Georgia portion	2.2	0.9	0.6	6.5	11.7	21.9
ACT basin total	19.7	10.9	2.8	40.5	23.1	97.0

Source: NRCS, 1996

4.4.1.1.4.3 Thermal Demand

Thermal power generation demands were evaluated in the Comprehensive Study and the withdrawals included in the HEC-5 model for the basin (*Appendix D*). As noted earlier in this section, surface water withdrawals for power generation are significant in the ACT basin. The thermal plants included in the model were the Alabama Power Company's Gadsden Steam and Gaston Steam Plants and Georgia Power Company's Hammond and Bowen Plants. The location of these and other powerplant withdrawals is shown in *Figure 4-25*.

4.4.1.2 Environmental Consequences

The HEC-5 model was used to evaluate surface water quality impacts of the no action and alternative flow scenarios on the major rivers and reservoirs in the ACT basin. The no action model of the ACT basin was built by the Corps in concurrence with the States during the Comprehensive Study. The Corps adapted and used the no action model during development of this draft EIS to compare the action alternative flow scenarios to the no action alternative. Details on model development and assumptions for the existing conditions (no action) model are found in *Appendix D*.

The no action and action alternatives were simulated under 1995, 2020, and 2050 projected water demands, which are shown in *Appendix F*, Section 1. The action alternative for the purpose of this draft EIS is a range of minimum instream flows that would likely bracket any allocation formula that will be submitted by the States. Each of the three scenarios (low, moderate, and high release scenarios) was also modeled using 1995, 2020, and 2050 projected water demands (see Section 1.3.3.3). Water demands are discussed in Section 4.4.1.1. Thus, a matrix of model runs was set up for evaluation in this draft EIS. The details of matrix model development and execution are also documented in *Appendix D*.

The last major NEPA evaluations of water management operations at the various reservoir projects in the ACT basin were included in the EISs completed in the 1970s. To assess the impact of operational changes since that time, the HEC-5 model was also used to simulate conditions in the ACT basin under 1977 operations, which was selected as a representative year for historic operating conditions. The methods and assumptions that the Corps used in developing the 1977 model are detailed in *Appendix D*.

4.4.1.2.1 Basinwide Hydrologic Modeling

To simulate the effects of the allocation formula on water resources, the Corps Mobile District constructed, with the assistance of the Corps Hydrologic Engineering Center (HEC), a hydrologic model of all the major streams and reservoirs in the basin using a computer

modeling program called HEC-5. Originally developed by HEC, the HEC-5 computer program, Simulation of Flood Control and Conservation Systems, allows simulation of the sequential operation of any reservoir system configuration during a specified period of time. The Corps constructed the HEC-5 model of the ACT and ACF basins in consultation and cooperation with the States in the Surface Water Availability study element of the Comprehensive Study. The model of the ACT basin, a tool to evaluate alternative water management scenarios, was constructed to simulate operation of the reservoirs and streams in the basin. The HEC-5 model uses 55 years of daily historic streamflow data (1939 to 1993), the physical and operational characteristics of reservoirs and river reaches, and the net consumptive water demands in the basin to determine basinwide surface water impacts for various operational scenarios.

The HEC-5 model was set up in a "node" framework representing the ACT basin (***Figure 1-3***). The nodes were selected to represent physical locations or critical modeling points, such as environmental points of interest, USGS stream gage locations, reservoirs, or other model-related control points. This node framework is discussed in more detail in Section 1.3.3.6. HEC-5 model output in terms of predicted streamflows and reservoir elevations were used to assess the impacts of operating the system under various management scenarios. The Corps documented the HEC-5 model of the ACT and ACF basins in two reports prepared under the Comprehensive Study (Corps, 1997, 1998b). ***Appendix D*** of this EIS contains an overview of the model setup and assumptions.

4.4.1.2.1.1 1977 Operating Conditions Evaluation

Operations of the Federal projects in the ACT basin have changed incrementally since the last major NEPA evaluations of water management in the basin were completed. The primary differences between operations in 1977 and 1995 are changes in minimum dam releases and changes in the Federal projects' hydropower marketing contracts (see ***Appendix D*** for details). Required minimum flow releases increased from the Allatoona, Jordan, and Thurlow dams from 1977 to 1995. In addition, there have been other operational changes due to modification of Federal hydropower marketing agreements that have changed since 1977. The overall effect of the changes in hydropower marketing is that the 1977 condition provided less energy than the 1995 operations. These changes generally affect how much and when energy is produced to meet the contract conditions.

Two 1977 HEC-5 models were developed for historic (1977) operating conditions: one with 1977 water demands and one with 1995 water demands. The first run was established to calibrate the model against actual 1977 flow gage data, and the second run was used to compare to the no action alternative with 1995 demands to assess the impact of the changed operations on water resources in the ACT basin.

The HEC-5 model results show that reservoir levels in the ACT basin would not differ greatly under 1977 operations compared to 1995 operations. In general, HEC-5 reservoir level results run for 1995 water demands show only minor differences between the 1977 and 1995 operations. For example, fall water levels at Lake Allatoona are slightly lower (up to 0.5 foot) under 1995 operations compared to 1977 operations, early summer levels in Weiss Lake are slightly lower (up to 0.2 foot) for the 1995 operations compared to 1977 operations, Martin Lake has higher predicted summer levels and lower predicted spring levels in 1995 compared to 1977, and Dannelly Lake has slightly higher late summer elevations (0.2 to 0.3 foot) under 1995 operations compared to 1977. Overall, however, these differences are

fairly slight and would not be expected to cause significant environmental consequences, either adverse or beneficial.

A comparison of river flows at several key locations in the ACT basin under 1995 and 1977 operating conditions shows much more substantial differences between the two operating scenarios. At the upper end of the basin at the Rome gage on the Coosa River, no significant differences were observed in the modeling results between operating scenarios. However, at the Coosa gage on the Coosa River (just upstream of the confluence with the Tallapoosa River), there is a substantial difference between summer low flows for the two operating conditions. The 1995 operations provides low flows (i.e., 90 percent exceedance flows) two to three times greater than the low flows under 1977 operations in the summer. This is likely the result of the increased minimum flow requirement from Jordan Dam since the late 1970s, which supports waste assimilation and navigation on the Alabama River.

A similar pattern is seen on the Tallapoosa River at Tallassee (downstream of Thurlow Dam). Under low flow conditions (95 percent exceedance flows), summer flows are about 4 times higher and fall flows are up to 6 times higher for the 1995 operating conditions than for the 1977 operating conditions. The HEC-5 model predicts that flows would decrease to less than 100 cfs on the Tallapoosa River under very dry conditions under the 1977 operating conditions, whereas the flow is maintained in the 1,150 cfs range under 1995 operating conditions. This illustrates the dramatic positive effect of the addition of the 1,200 cfs minimum flow requirement from the Thurlow Dam. In 1977, there was no minimum flow requirement from Thurlow Dam.

The differences between the 1977 and 1995 operating conditions model runs was not as pronounced on the Alabama River because the combined minimum flow requirement from the Jordan, Bouldin, and Thurlow Dams to the Alabama River was put in place in 1972. Thus, the model predicted no significant differences in Alabama River flows between the 1977 and 1995 operating conditions.

The differences in low flows on the lower Coosa and lower Tallapoosa Rivers under 1977 and 1995 operating conditions illustrate the dramatic improvements in water management due to the changes that have been implemented since the late 1970s. The HEC-5 modeling analysis illustrates that minimum low flows that are necessary to meet water supply, water quality, navigation, and hydropower operation demands are similar under the 1995 operations, but not as consistently under the 1977 operations. The above summary information provides a perspective for evaluating impacts of the existing operating condition no action alternative.

4.4.1.2.1.2 Development of the Low, Moderate, and High Scenarios

For the action alternative in this draft EIS, a range of reasonable, forseeable minimum flows—low, moderate, and high—was developed to form a framework to evaluate the allocation formula now being negotiated between the States of Alabama and Georgia. These flow scenarios do not represent a specific operational alternative. Instead, they are intended to bracket a range of flows that will include a flow represented by the final allocation formula. By analyzing this range of flows, it is reasonable to assume that the range of potential impacts of the actual allocation formula will be addressed as appropriate for a programmatic EIS. This EIS identifies and analyzes the range of impacts associated with this range of minimum flows.

The HEC-5 model was used to simulate conditions in the rivers and reservoirs of the ACT basin under three flow scenarios: low, moderate, and high. The three scenario models were optimized for reservoir releases during critical low flow periods. The optimization determined whether to release the highest flow rate and draw the reservoir to the lowest allowable elevation, to release the lowest flow rate and maintain the pool near the top the conservation pool, or to release a moderate flow between the low and high release rates.

The descriptions selected to name the three flow scenarios describe conditions in the river under low flow/dry weather conditions in the basin. That is, under critical dry conditions, the low release scenario will provide lower river flows than the moderate or the high release scenarios. However, each scenario was modeled for the full 55-year period of record, with the same amount of water to be managed under each of the three scenarios. Considering that the mass of water must be conserved within the model, if flows are lower during the dry weather periods for a given scenario, the flows for that scenario may be higher than the other two scenarios at other times of the year, such as under wet spring conditions. To appreciate the full effect of each scenario, the impacts must be viewed and evaluated on a monthly or seasonal basis.

Each flow scenario was modeled using 1995, 2020, and 2050 projected demands. The 1995 demands were included to illustrate the immediate impact of implementing an alternative flow scenario. The 2020 and 2050 demands were modeled to show the mid-term and long-term impacts expected from implementing the water allocation formula, taking into account future projected water demands. Water demands were held constant in the HEC-5 model for each year of the 55-year period of record, even though in reality, water demand will fluctuate around a mean depending on the amount of rainfall in a given year. The water demands used in the HEC-5 models were developed during the Comprehensive Study. *Appendix D* includes details on the development and modeling of this matrix of flow and demand scenarios. Each scenario is discussed individually below.

Low Flow Scenario. The low flow scenario focused on providing the lowest reservoir releases (during low flow periods of the year) that maintain reservoirs at or near the top of the conservation pool. This scenario incorporated the highest projected consumptive water demands, which varied monthly. Seasonal drawdown for flood control as defined in the regulation manuals is included in this scenario. The reservoirs do not augment navigation or existing downstream flow targets (see Section 4.4.1.2.1.3, below), nor do they explicitly provide for peaking hydropower operations. However, hydropower is still generated because some water is always being released from the dams. This scenario establishes the lowest reasonable flow rate that could occur during dry periods as a result of the flow allocation formula. The low flow scenario generally maintains reservoir elevations near full pool, even during critical low flow periods. Some slight drawdowns are necessary during very dry periods, but overall elevations remain high and stable. River flows under the low flow scenario are very low in the late summer/early fall, and generally lower during dry periods throughout the year, a consequence of maintaining higher reservoir levels

Moderate Flow Scenario. The moderate flow scenario was established as an intermediate condition between the high and low flow scenarios. This scenario assumes moderate water demands. As with the other scenarios, the reservoirs were not modeled to augment navigation or existing downstream flow targets, nor do they explicitly provide for peaking hydropower operations. Seasonal drawdown was included in the model, but reservoirs were not drawn down as much as existing operation. The moderate flow scenario is most

similar to the existing operation, with the notable exception that daily hydropower peaking operations were not simulated.

High Flow Scenario. Under the high flow scenario, reservoir releases are at their highest, allowing each reservoir to deplete its storage and recover within a critical period. This scenario was run iteratively to determine the maximum reservoir release that still allowed the reservoir to recover its lost storage. Seasonal drawdown eliminated in this scenario to preserve as much water in the reservoirs to maintain the high reservoir releases throughout the drier parts of the year. Because no flood control storage was available, this scenario produced higher flows during the wet months and lower flows in the fall when seasonal drawdowns augment downstream rivers. As with the other two scenarios, the reservoirs do not augment navigation or existing downstream flow targets, nor do they explicitly provide for peaking hydropower operations. However, as with the other two scenarios, hydropower is still generated because some water is always being released from the dams. The response in river flows to the high flow scenario is higher, sustained low flows in the dry months and lower flows in the winter months (because there is no seasonal drawdown). In the reservoirs, the levels are much lower in the summer and early fall, as reservoirs are depleted to sustain higher stream flows, and higher in the winter due to the elimination of winter drawdown to conserve water for the high flow releases the remainder of the year.

4.4.1.2.1.3 Downstream Flow Targets

The matrix models were developed around downstream minimum flow targets. Each storage reservoir operates to maintain a minimum flow (flow target) at the dam and/or a downstream location. The current downstream flow targets, such as FERC-mandated minimum flows, are included in the no action scenario. These targets, however, were changed in the matrix models to provide a range of minimum flows. This allowed for the optimization of reservoir releases to supply the range of flow targets. It is acknowledged that no changes in the individual project operations can occur until they are re-evaluated and potentially re-licensed once the allocation formula is finalized. The Corps will re-evaluate Federal projects. Non-Federal projects will be re-evaluated during FERC relicensing.

Reservoirs are currently operated to support a variety of uses, including hydropower generation, flood control, minimum downstream flows, water quality, and water supply. Under the matrix model analysis, all three modeled scenarios (low, moderate, and high) were optimized for reservoir releases. Because it is possible that the flow allocation would be manifested through instream flow targets, the action alternative models were designed to optimize reservoir releases. In this process, each reservoir was optimized to operate for the highest reservoir release (for the high flow scenario), the lowest reasonable flow releases (for the low flow scenario), and a reasonable reservoir release between the low and high releases (for the moderate flow scenario). The optimized releases were then established as "flow targets." The flow targets were used in the HEC-5 models of the three action alternative flow scenarios (see ***Appendix D***). Each reservoir was operated to maintain a minimum flow (flow target) at the dam or downstream location.

The flow targets used in the matrix models of the ACT basin are shown in ***Table 4-13***. These minimum flow targets do not represent recommended minimum flow targets for an allocation formula; they were selected only to provide a range of flow conditions broad enough to bracket any combination of minimum flows that may occur from the allocation formula. It should be recognized that changes in current minimum instream flows could

affect existing wastewater discharge permit limits because the assimilative capacity of the river would be reduced. Therefore, changes in existing minimum flows would likely require changes in permit criteria or other regulatory action to address wastewater discharges in the affected stream segments.

TABLE 4-13
Downstream Flow Targets Used in the HEC-5 Model (in cfs)

	Action Alternative Flow Scenarios									
	1995 Demand Year			2020 Demand Year			2050 Demand Year			No Action[a]
Location	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	1995, 2020, 2050 Demands
Allatoona	170	530	892	170	520	875	170	520	871	240
Carters Rereg.	190	310	425	190	310	425	190	310	425	240
Weiss	900	1,780	2,655	900	1,760	2,620	900	1,730	2,560	
H.N.Henry	940	1,910	2,880	940	1,890	2,835	940	1,850	2,755	
Logan Martin	1,190	2,300	3,420	1,190	2,280	3,365	1,190	2,240	3,285	
Jordan	1,340	2,420	3,500	1,340	2,380	3,425	1,340	2,320	3,300	2,000-5,000
Harris	45	410	785	45	400	775	45	390	745	45 (at Wadley)
Martin	290	1,230	2,175	290	1,230	2,175	290	1,220	2,150	
Thurlow	160	1,330	2,500	160	1,330	2,500	160	1,330	2,500	1,200
R.F. Henry	1,630	3,550	5,440	1,630	3,520	5,400	1,630	3,460	5,300	
Millers Ferry	2,520	4,690	6,865	2,520	4,680	6,850	2,520	4,610	6,700	

[a] Only the mandated minimum flows were modeled in the no action alternative.

4.4.1.2.1.4 Critical Period Analysis

The no action and action alternative flow scenarios were modeled over a 55-year period of record. Within those 55 years, there were low, average, and high precipitation conditions. Some of the analysis in this draft EIS focuses on the critical periods, as defined by observed conditions in the basin. Analysis of the full period of record is also included throughout this section.

The following timeframes represent critical drought periods in the ACT basin:

- June 6, 1954 to January 6, 1957
- July 1, 1980 to February 6, 1982
- May 15, 1985 to June 15, 1989

To focus the analysis on times when an allocation formula will have the greatest effect, the impacts were evaluated not only on the entire 55-year period of record, but also on the critical periods, as defined above. This allows a closer examination of low flow impacts, when allocation of water and the associated impacts are of critical concern. There are over 3,000 days within the defined critical periods. This represents over 15 percent of the entire 55-year period of record.

Model output data are produced by HEC-5 in the form of daily flows and reservoir elevations. The Indicators of Hydrologic Alteration (IHA) program was then used to statistically analyze the entire 55-year model output, to provide summaries of annual low and high flows and frequency distributions of the data (see ***Appendix D***). In addition, a frequency analysis of the flows and reservoir levels at key locations in the basin was conducted on only the critical periods, to evaluate impacts under dry/drought conditions when the allocation formula will be most essential.

4.4.1.2.1.5 General Model Assumptions

Reservoir operations covers the full array of hydrologic conditions from flood to drought. However, in the modeling more emphasis was placed on water supply operation since this study focuses on water availability in the basins. In addition, flood control operations are controlled on an hourly basis. Although high flow conditions were modeled within the 55-year period of record, true flood control operation of the reservoirs could not be duplicated using the daily time step that HEC-5 uses. Therefore, the model approximates the flood control operation at the daily time step. As a result, the model may predict higher flows than would actually occur under true operating conditions because the model cannot account for the hourly changes in operations that reduce peak flows. The Corps prepared a separate flood control analysis to evaluate the impacts of reduced flood control storage in the basin in the event that the allocation formula includes a requirement for reduced flood control storage (see ***Appendix D***).

In developing the three flow scenarios, several modeling decisions were made to attempt to bracket the potential minimum instream flows in the allocation formula that is being developed by the States, with no intent to influence the States' decision in any way. Therefore, several complex management techniques that are currently in place in the basin were not modeled under the three scenarios because that would have presumed knowledge of how the reservoirs would be operated to meet the States' allocation formula.

For example, the peaking hydropower projects in the basin operate under a complex rule curve system, whereby the number of hours that the project can operate each day depends on the amount of storage in the reservoir, the amount of storage in the basin, weather conditions and forecasts, and downstream needs. To incorporate this complex operation into the matrix models would have required the model to establish how each individual reservoir would be operated under each flow scenario. Because it is anticipated that the allocation formula will be manifested through instream flow targets, the model was designed to optimize reservoir releases. The daily fluctuating nature of peaking operations, which generally operate Monday through Friday and shut down on weekends, was modeled as a week-long constant release. Thus, the model results do capture hydropower operations on a weekly basis, but do not fully capture the daily variability in flows and reservoir levels that result from hydropower operations.

The operation of the low and moderate scenarios solely to meet target flows rather than to support hydropower or other uses resulted in less seasonal drawdown than under the no action alternative. For these reasons, absolute elevations and flows predicted by HEC-5 for the three action scenarios cannot be precisely compared to absolute elevations and flows for the no action scenario. The no action alternative will naturally exhibit more daily variability in flows and levels because it has captured the true nature of peaking operations.

In the analysis in this draft EIS, the impacts of the action alternative flow scenarios were compared with the no action alternative under 1995, 2020, and 2050 water demands. The high flow scenario was compared to the moderate flow scenario, and the low flow scenario to the moderate flow scenario. When considering that the moderate flow scenario most closely resembles the current operations with respect to minimum flows and demands, this relative comparison allows a general assessment of the impacts of the high flow scenario against current conditions. In addition, a general comparison can be made between low flows in the action alternative and the no action alternative. Although this is not a precise comparison, it does allow for general trends and ranges of impacts to be analyzed. This is adequate for the purposes of the draft EIS, which is to provide hydrologic information on a programmatic level of detail to the interdisciplinary team to assess the range of potential environmental and socioeconomic impacts of the allocation formula. In the final EIS, the impacts of the actual allocation formula will be evaluated and a more precise comparison can be made to the no action alternative.

4.4.1.2.2 Impact Analysis Approach

This section describes the direct impacts on water quantity associated with the action alternative scenarios of high, moderate, and low flow compared to the no action alternative. There is an evaluation of the impacts for current (1995) demands as well as a review of the mid- and long-range impacts by analyzing the same scenarios under 2020 and 2050 year water demands.

Impacts on water resources in the ACT basin under the no action and alternative flow scenarios will vary depending on where they occur in the basin. Because this is a programmatic EIS, impacts were analyzed on a basinwide basis rather than by specific projects. However, because impacts vary over the basin, the basin was subdivided into four subbasins: the upper Coosa, lower Coosa, Tallapoosa, and Alabama River subbasin (*Figure 4-17*). The rivers and reservoirs within each subbasin were then analyzed as a group. For this programmatic analysis, representative reservoirs and river flow locations were selected to summarize the analysis of the subbasin. The locations selected are described in the following paragraphs.

Subbasins were delineated according to hydrologic features within the ACT basin. The Coosa River basin was subdivided into an upper Coosa River subbasin and a lower Coosa River subbasin. The upper subbasin is characterized by steep rivers with more variable flows in response to precipitation events. The upper subbasin extends from the headwaters of the Conasauga and Coosawattee Rivers to the joining of the Oostanaula and Etowah Rivers at Rome, Georgia. The Rome gage is located where the Oostanaula and Etowah Rivers join to form the Coosa River. River flows within the upper Coosa River subbasin were evaluated at Rome. There are two reservoirs—Carters Lake and Lake Allatoona—in this subbasin.

The lower Coosa River subbasin does not contain as steep a slope as the upper Coosa River subbasin; however, it still lies above the Fall Line. The lower Coosa River subbasin extends from Rome, Georgia, to the intersection of the Coosa River with the Tallapoosa River near Montgomery, Alabama. A series of seven Alabama Power Company dams form continuous impoundments over the entire lower Coosa River. Operations at these dams collectively affect flows in the lower Coosa River. River flows in the lower subbasin were analyzed at the Coosa, Alabama, model node just below Jordan and Bouldin Dams.

The Tallapoosa River subbasin begins at the headwaters of the river in Georgia and continues to its confluence with the Coosa River near Montgomery, Alabama. The upper reaches of the Tallapoosa River are characterized by steeper slopes until it reaches the Fall Line at Tallassee, Alabama. Below the Fall Line the river has a much lower gradient. River flows in the Tallapoosa River subbasin were analyzed at the Tallassee gage. The Tallapoosa River subbasin also contains the Harris, Martin, Yates, and Thurlow Dams.

The fourth subbasin evaluated is the Alabama River subbasin. This subbasin was also delineated based on hydrology. The Alabama River is the flattest river in the ACT basin and extends from the confluence of the Coosa and Tallapoosa Rivers to Mobile Bay. The R.F. Henry and Millers Ferry Dams are located in the subbasin. Flows in this subbasin were evaluated on the Alabama River at Claiborne, Alabama.

Direct impacts are the effects that a particular action has on the river flows and reservoir elevations in the basin. These effects occur as a direct result of the action. As discussed above, caution must be used in comparing the HEC-5 model results for the low, moderate, and high flow scenarios directly to the no action model results because of the modeling assumption differences between the two sets of model runs. The low flow scenario and the high flow scenario can each be compared directly to the moderate flow scenario to assess impacts. Direct impacts of the no action alternative can also be displayed. However, only general comparisons between the no action alternative and the alternative flow scenario can be made. Although this approach does not allow a value-by-value comparison, it is more than adequate to assess general impacts to water resources in the ACT basin for this programmatic draft EIS.

This analysis focuses on river flows and reservoir elevation that would occur as a result of the no action and alternative flow scenarios during critical periods, as defined by the Corps and described earlier in this section. The HEC-5 modeling focused on the critical periods, because the target flows were established to ensure maintenance of the minimum flows throughout the critical drought periods. The critical periods also show the greatest impact of the alternative flow scenarios. Environmental consequences would also occur during noncritical periods as reservoirs and rivers are operated to maintain the different target minimum flows of each scenario. Impacts under average flow conditions over the full period of record are presented within each subbasin.

In the following sections, impacts are presented as a comparison of 50 percent exceedance flows and elevations and 90 percent exceedance flows and elevations. The 50 percent exceedance flows represent the flows that are exceeded 50 percent of the time. This can be considered close to average flow conditions. The 90 percent exceedance flow, or the flow that is exceeded 90 percent of the time, represents flow under low flow, or very dry, conditions.

4.4.1.2.3 River Impacts

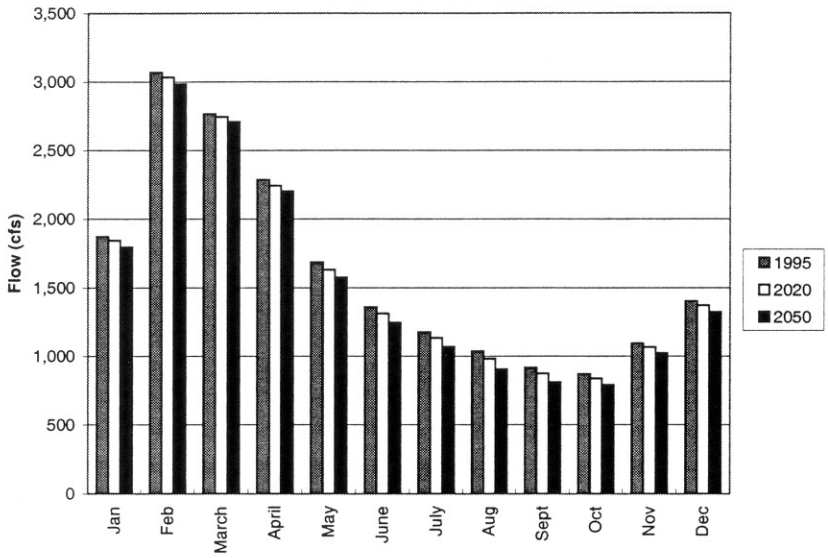
4.4.1.2.3.1 Upper Coosa River Subbasin

The Rome gage on the Coosa River was selected as the representative location to assess impacts to riverine water resources in the Upper Coosa River subbasin. This gage marks the beginning of the Coosa River, where the Etowah and Oostanaula Rivers join. The drainage area to this point is just over 4,000 square miles. Two hydropower dams and reservoirs are located within this subbasin: Allatoona Dam on the Etowah River and the Carters Dam/

Reregulation Dam on the Coosawattee River. These projects alter flows in the upper Coosa River basin.

Under the no action alternative, the model predicted that low flows in the Coosa River at Rome would decrease only slightly from 1995 to 2050, although water demands increase considerably during this period (***Figure 4-27***). The HEC-5 modeling indicates that although

FIGURE 4-27
Coosa River at Rome. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



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the river flows do not change significantly due to increased demands, there are substantial effects on reservoir levels (as discussed in the reservoirs impacts section).

A comparison of the action alternative flow scenarios to the no action alternative (***Figure 4-28***) shows that during dry periods (illustrated using the lowest flows that were observed for 7, 30, and 90 consecutive days) the low flow scenario would result in flows similar to those of the no action alternative. These flows range between 500 and 700 cfs. The moderate and high flow scenarios would have substantially higher flows (300 to 500 cfs higher) than the no action alternative.

The three action alternative scenarios were modeled to maintain target flows on the Upper Coosa River downstream from Allatoona Dam and the Carters Dam/Reregulation Dam, as shown in ***Table 4-13***. To investigate the effects of the three action alternative scenarios in greater detail, ***Figure 4-29*** presents a comparison of the 50 percent exceedance flow over the full period of record (this is close to average flows over the full period). This figure illustrates that there are seasonally varying differences among the three action alternative scenarios over the full period of record. Overall, the low flow scenario would produce higher fall and early winter flows than the moderate and high flow scenarios. Conversely, under the drier summer conditions, the low flow scenario produces flows lower than the moderate and high flow scenarios.

The differences among the three scenarios are much more pronounced when reviewing the effects under critical periods for the 90 percent exceedance flows. ***Figure 4-30*** illustrates that

the low flow scenario produces spring and summer flows that are generally half of those produced under the moderate scenario and one-third of those produced under the high flow scenario. These results are similar to those shown in *Figure 4-28.*

FIGURE 4-28
Coosa River at Rome. Low Flows. Full Period, Action Alternative. 2050 Demands

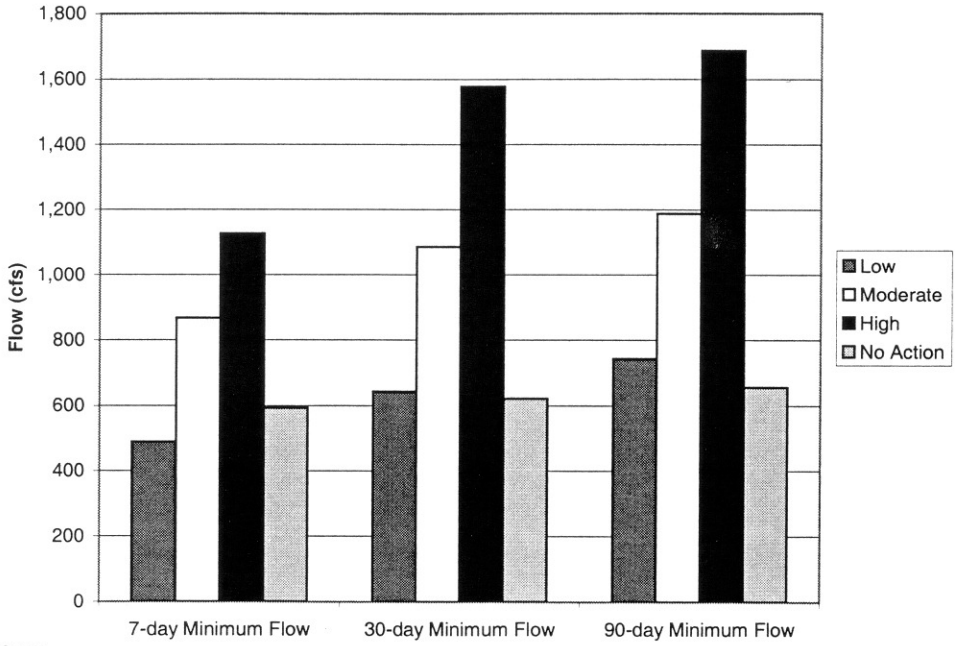

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FIGURE 4-29
Coosa River at Rome. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands

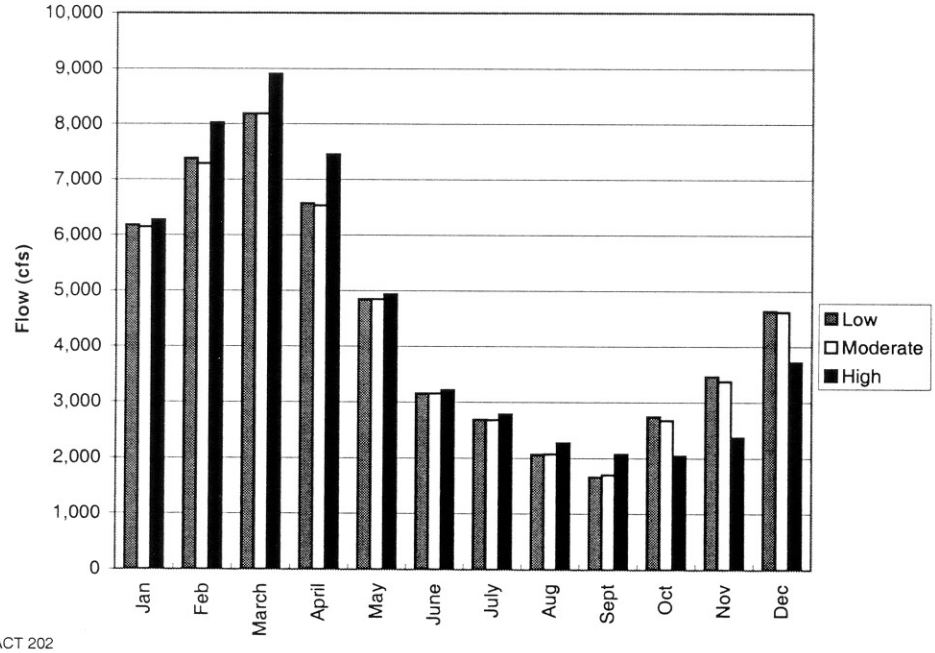

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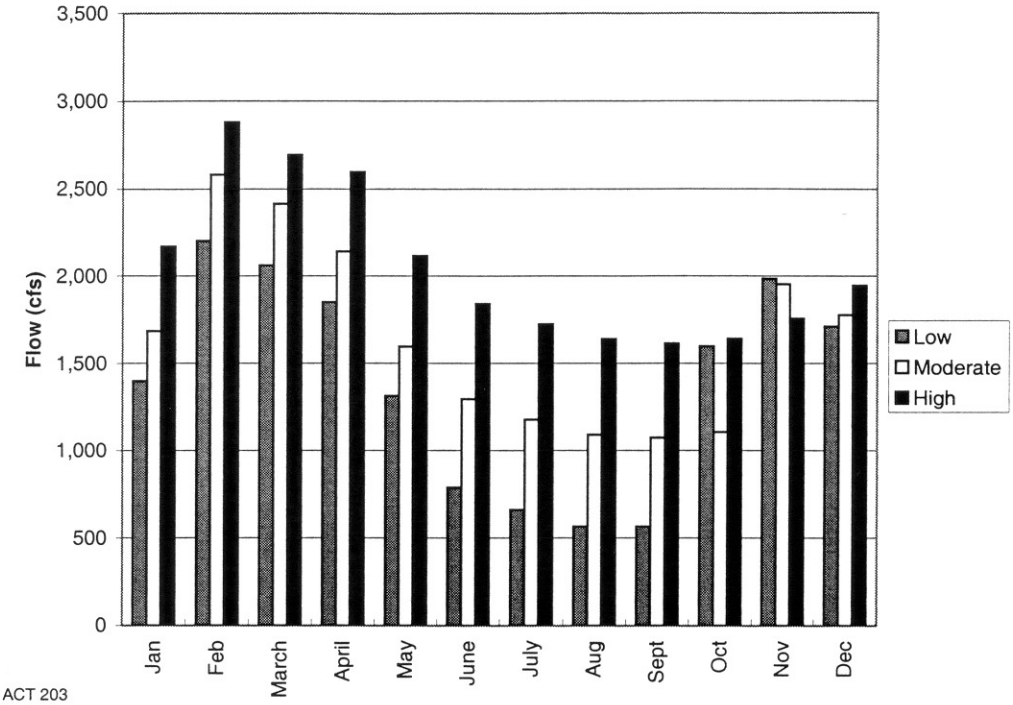
FIGURE 4-30
Coosa River at Rome. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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4.4.1.2.3.2 Lower Coosa River Subbasin

Water resource impacts on rivers in the Lower Coosa River subbasin were assessed at the Coosa River at Coosa, Georgia. This is just downstream of Jordan and Bouldin Dams, above the confluence with the Tallapoosa River. The drainage area to this point is over 10,000 square miles. There are a series of seven APCO dams on the mainstem Coosa River, all of which are in this subbasin. The upper three are peaking hydropower projects and the lower four operate generally in a run-of-river mode, with minimum releases for water supply, water quality, and navigation purposes. Assessment of flows at the Coosa gage allows evaluation of the cumulative effect of the seven projects.

Under the no action alternative, flows in the Coosa River at Coosa would not vary significantly from 1995 to 2050 (***Figure 4-31***). Seasonally, flows would be lowest in the summer and fall (July through January).

Comparing lows flows on the Coosa River at Coosa (using the 7-, 30-, and 90-day consecutive low flows) shows that the low flow scenario produces flows similar to those of the no action alternative (***Figure 4-32***). These flows range from approximately 1,000 cfs to 1,600 cfs. The moderate and high flow scenarios produce significantly higher flows during dry periods (up to 1,500 cfs more than the no action scenario). These low flow statistics represent conditions in the basin under the driest conditions of the 55-year period of record.

The three action alternative scenarios were modeled to maintain target flows on the lower Coosa River downstream from Weiss Dam, Neely Henry Dam, Logan Martin Dam, and Jordan Dam, as shown in ***Table 4-13***. To investigate the effects of the three action alternative flow scenarios in greater detail, ***Figure 4-33*** presents a comparison of the 50 percent

FIGURE 4-31
Coosa River at Coosa. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

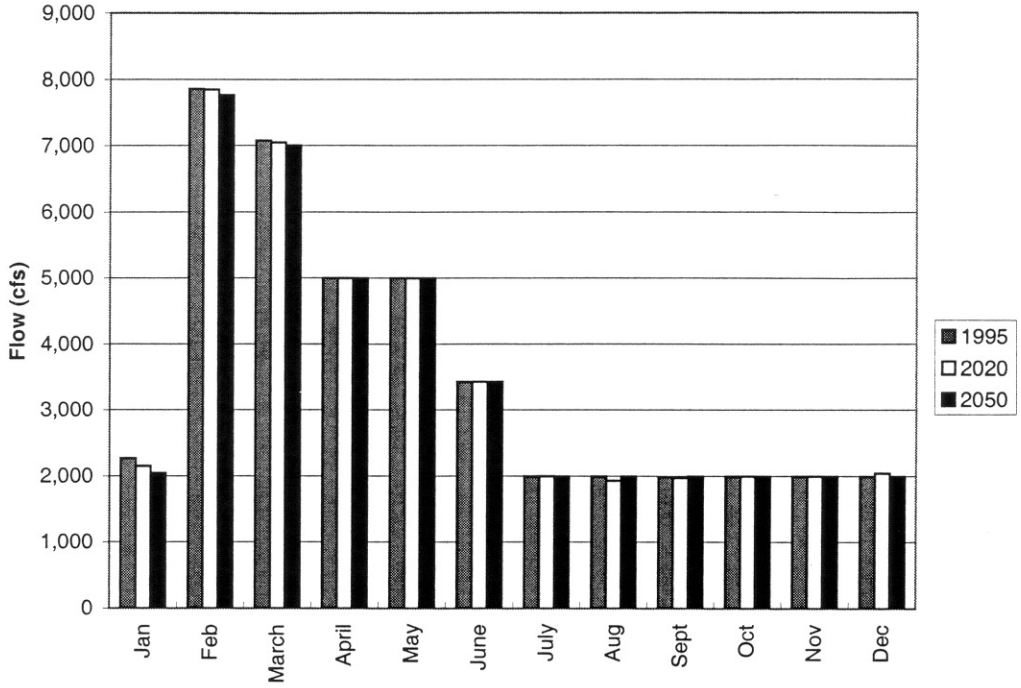

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FIGURE 4-32
Coosa River at Coosa. Low Flows. Full Period, Action Alternative. 2050 Demands

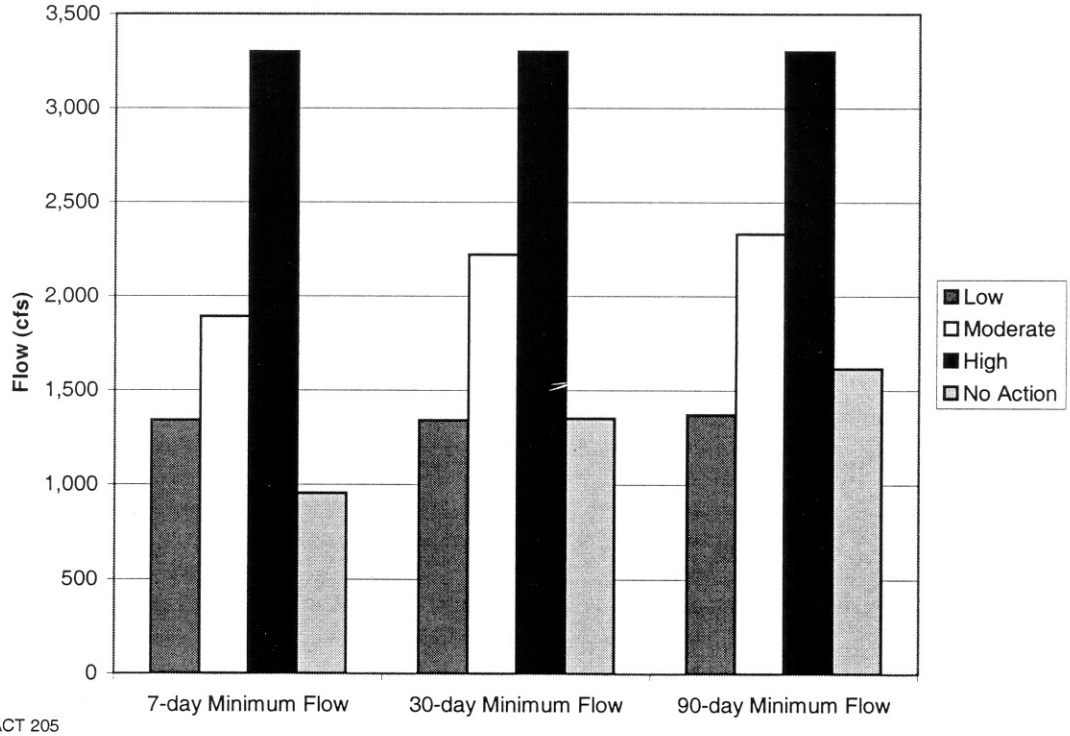

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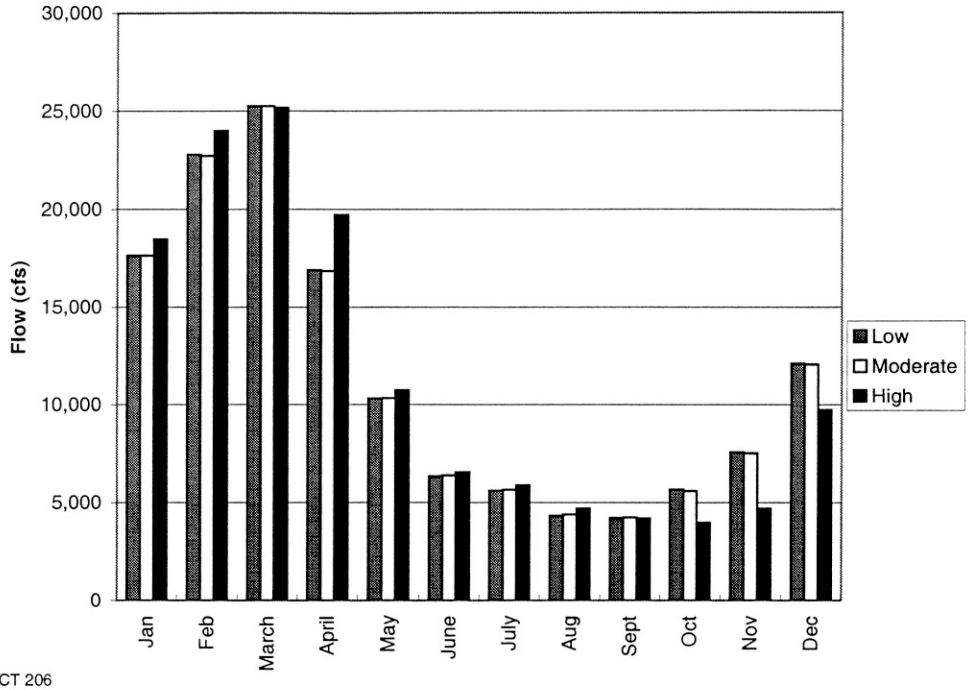
FIGURE 4-33
Coosa River at Coosa. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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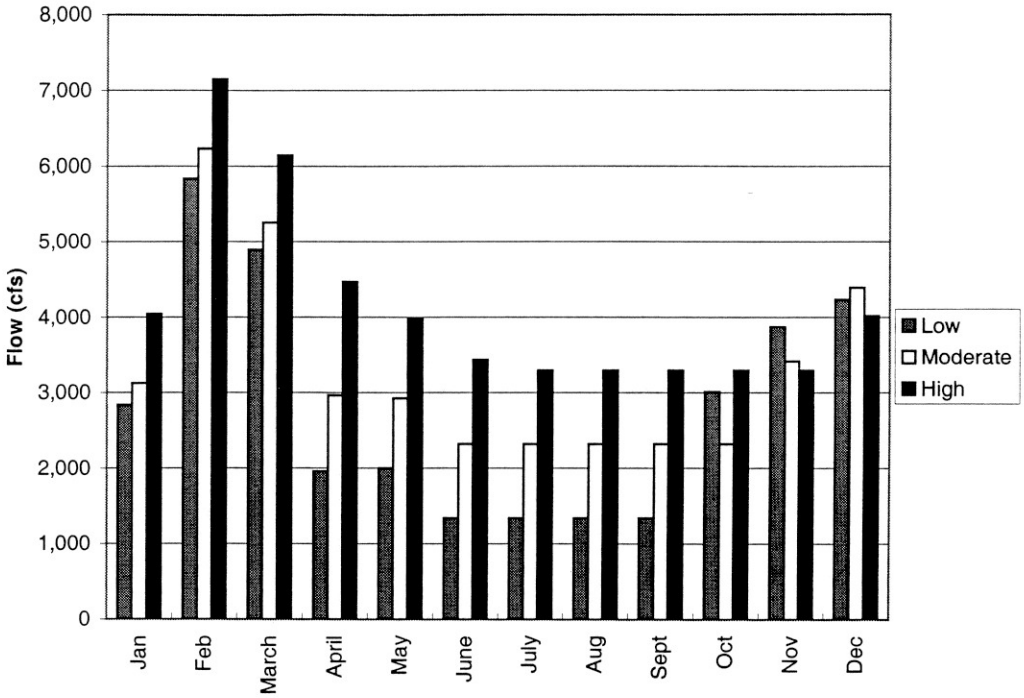
exceedance flow over the full period of record (this is close to average flows over the full period). This figure illustrates that there are seasonally varying differences among the three action alternative scenarios over the full period of record. Overall, the low flow scenario would produce higher fall and early winter flows than the moderate and high flow scenarios. Conversely, under the drier summer conditions, the low flow scenario produces flows lower than the moderate and high flow scenarios.

The differences among the three scenarios are much more pronounced when reviewing the effects under critical periods for the 90 percent exceedance flows. ***Figure 4-34*** illustrates that the low flow scenario produces spring and summer flows that are generally half of those produced under the moderate scenario and one-third of those produced under the high flow scenario. These results are similar to those shown in ***Figure 4-32***. The flow differences between among are directly attributable to the differences in target flow established in the HEC-5 modeling (***Table 4-13***).

4.4.1.2.3.3 Tallapoosa River Subbasin

The riverine water resources impacts in the Tallapoosa River subbasin in this draft EIS are assessed at the Tallassee and Heflin gages on the Tallapoosa River and the Newell gage on the Little Tallapoosa River. The Heflin and Newell gages are located along the Georgia-Alabama border and are on nonregulated reaches of the Tallapoosa River. The Tallassee gage is located in Alabama downstream from the four APCO projects on the Tallapoosa River. The upper two projects (Harris and Martin) are peaking hydropower projects and the lower two (Yates and Thurlow) operate as run-of-river facilities. Flows at the Tallassee gage incorporate the cumulative effects of the four projects.

FIGURE 4-34
Coosa River at Coosa. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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Under the no action alternative, flows in the Tallapoosa River at Tallassee would decrease only slightly from 1995 to 2050 due to increased water demands (***Figure 4-35***). Although future water demands appear to have only small effects on river flows, they have more substantial effects on reservoir levels, as discussed in the Reservoirs impacts section.

Comparing lows flows on the Tallapoosa River at Heflin and on the Little Tallapoosa River at Newell (using the 7-, 30-, and 90-day consecutive low flows) shows that there are no significant differences among the three action alternative scenarios and the no action alternative (***Figures 4-36*** and ***4-37***). Because the Heflin and Newell nodes are located on unregulated streams, the only difference between the flow scenarios are the demands that were used in the model (i.e., there were no instream flow targets modeled because there were no reservoirs to release flows to meet the targets). The moderate flow scenario and the no action alternative would have the same flows because they have the same demands. The low flow scenario has slightly lower flows than the other scenarios because it assumed higher demands (i.e., no conservation). The high flow scenario, on the other hand, assumed lower demands (i.e., high conservation) and therefore shows slightly higher flows.

Seven-day low flows at Heflin would be approximately 5 cfs in 2050. At Newell the 7-day low flow goes to zero and the 30-day low flow is only 1 cfs for all alternatives in 2050.

At Tallassee, the moderate flow scenario produced low flows similar to the no action alternative (approximately 1,100 to 1,200 cfs) (***Figure 4-38***). The low flow scenario produced low flows that were one-quarter of those observed under the moderate scenario.

FIGURE 4-35
Tallapoosa River at Tallassee. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

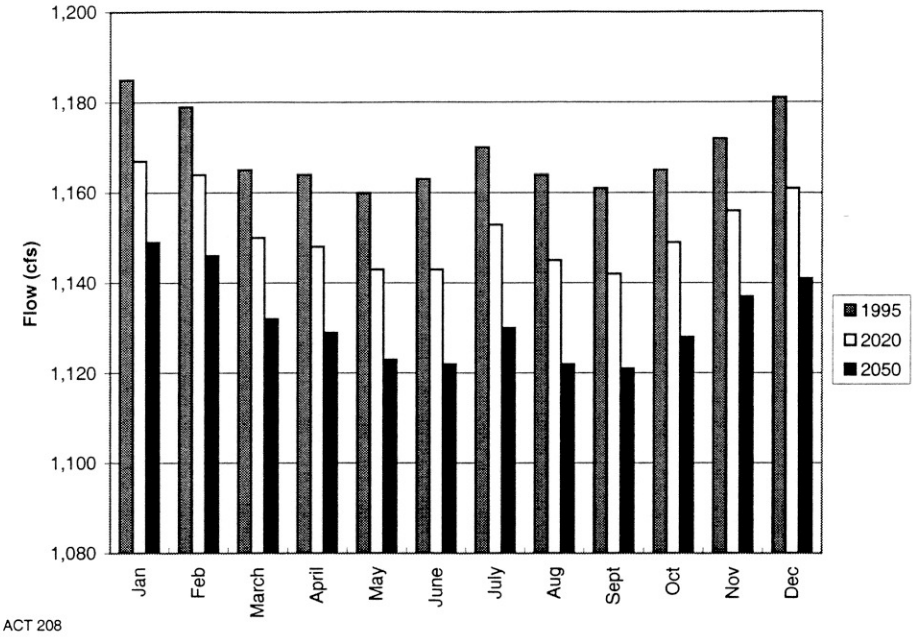

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FIGURE 4-36
Tallapoosa River at Heflin. Low Flows. Full Period, Action Alternative. 2050 Demands

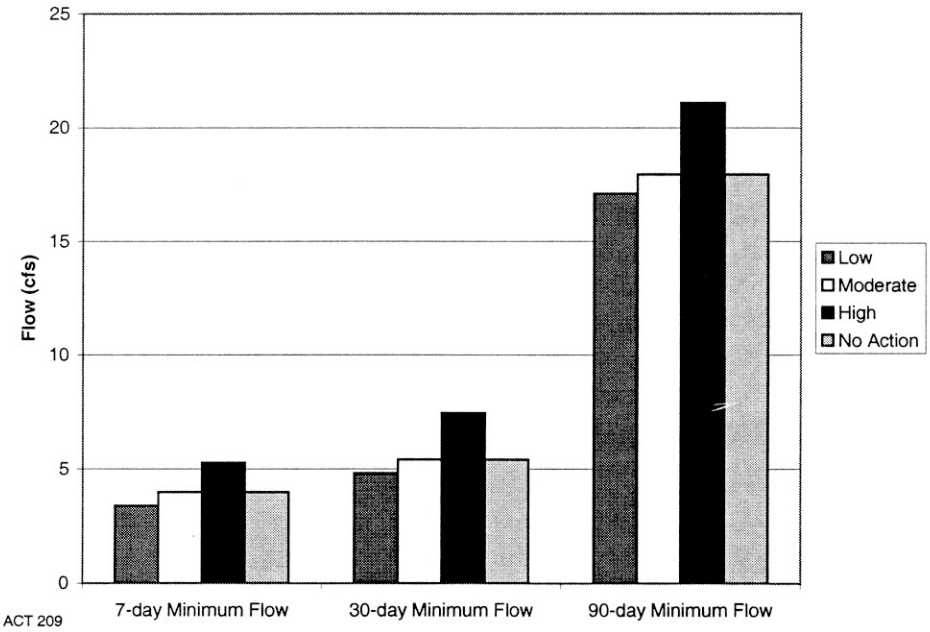

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FIGURE 4-37
Little Tallapoosa River at Newell. Low Flows. Full Period, Action Alternative. 2050 Demand

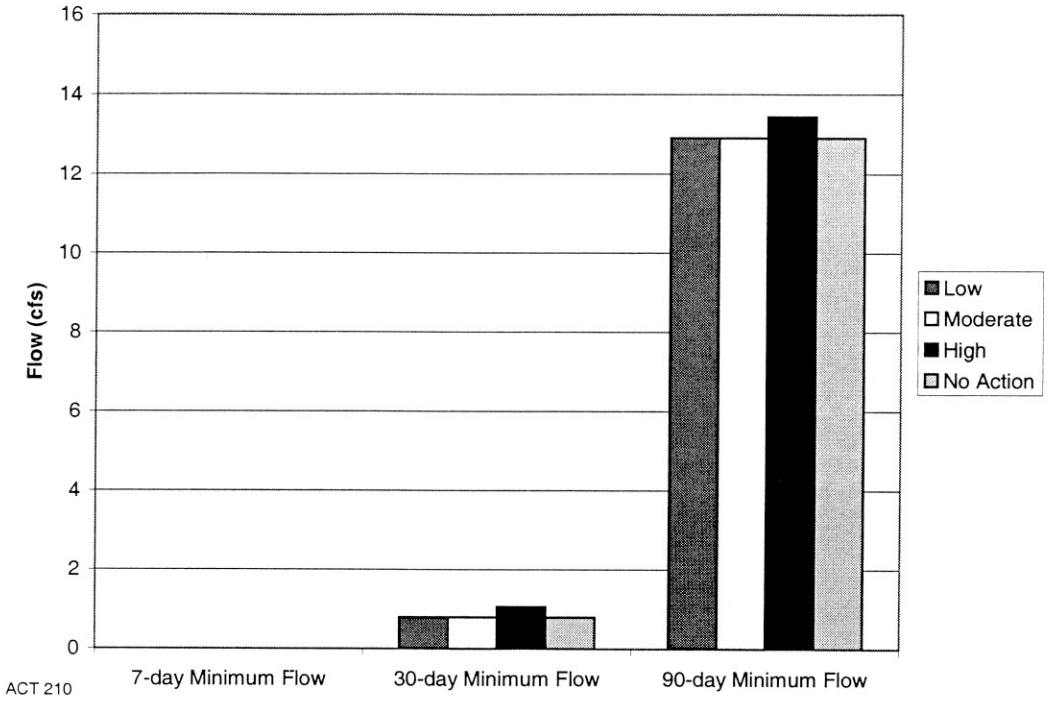

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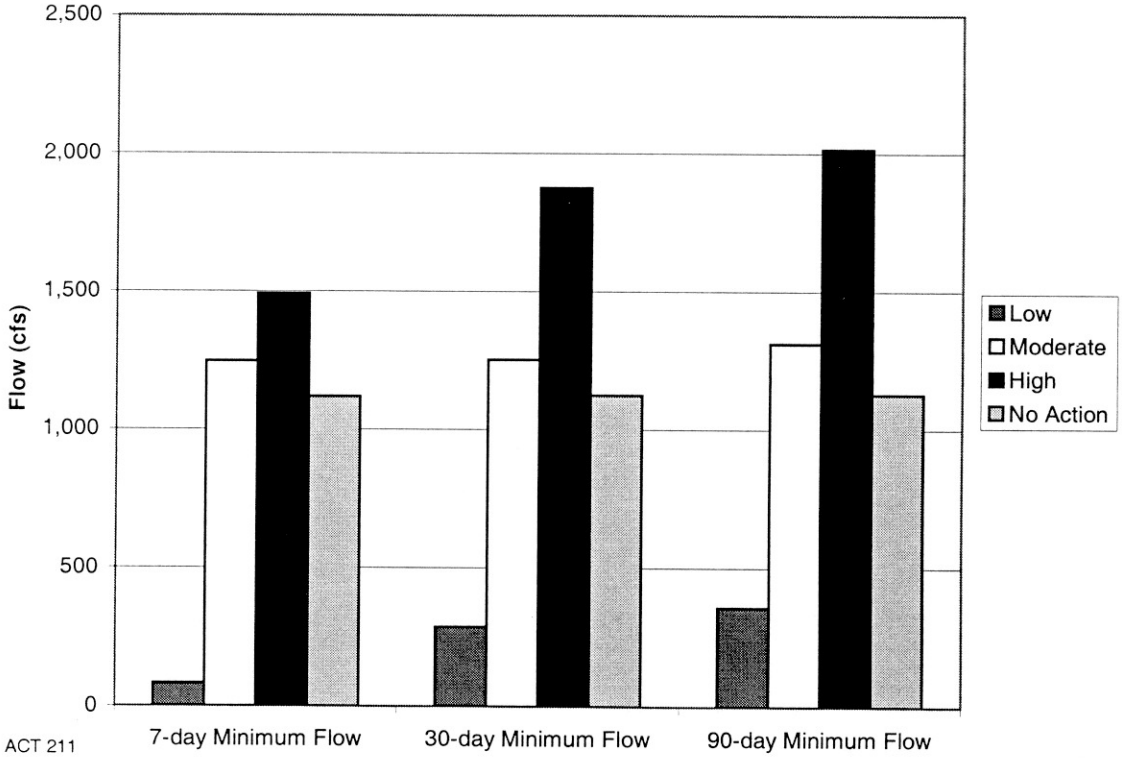
FIGURE 4-38
Tallapoosa River at Tallassee. Low Flows. Full Period, Action Alternative. 2050 Demands



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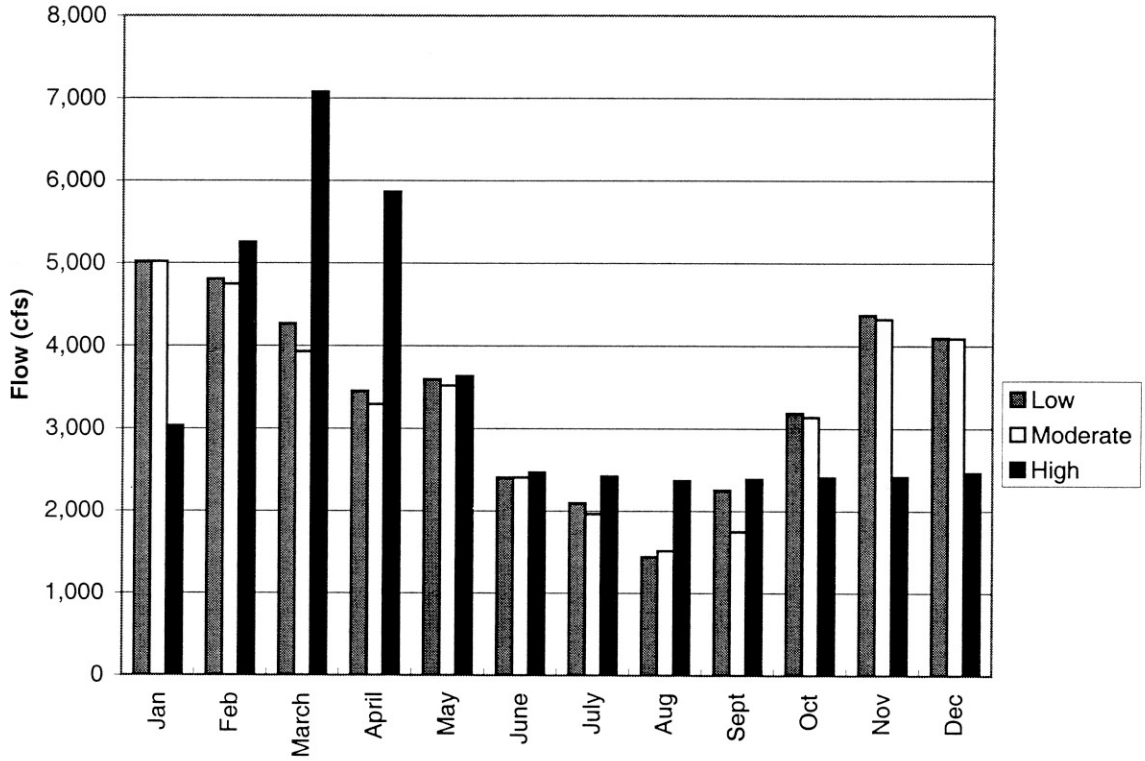
The three action alternative scenarios were modeled to maintain target flows on the Tallapoosa River below the Harris, Martin, and Thurlow Dams (***Table 4-13***). To investigate the effects of the three action alternative scenarios in greater detail, ***Figure 4-39*** presents a comparison of the 50 percent exceedance flow over the full period of record. This figure illustrates that there are seasonally varying differences among the three action alternative scenarios over the full period of record. Overall, the low flow scenario would produce higher fall and early winter flows than the moderate and high flow scenarios. Conversely, under the drier summer conditions, the low flow scenario produces flows lower than the moderate and high flow scenarios. The fact that the high scenario does not include seasonal drawdowns in the fall and winter is reflected in ***Figure 4-39,*** where the high scenario has significantly lower flows because the water is being held in the reservoirs and not released downstream.

FIGURE 4-39
Tallaposa River at Tallassee. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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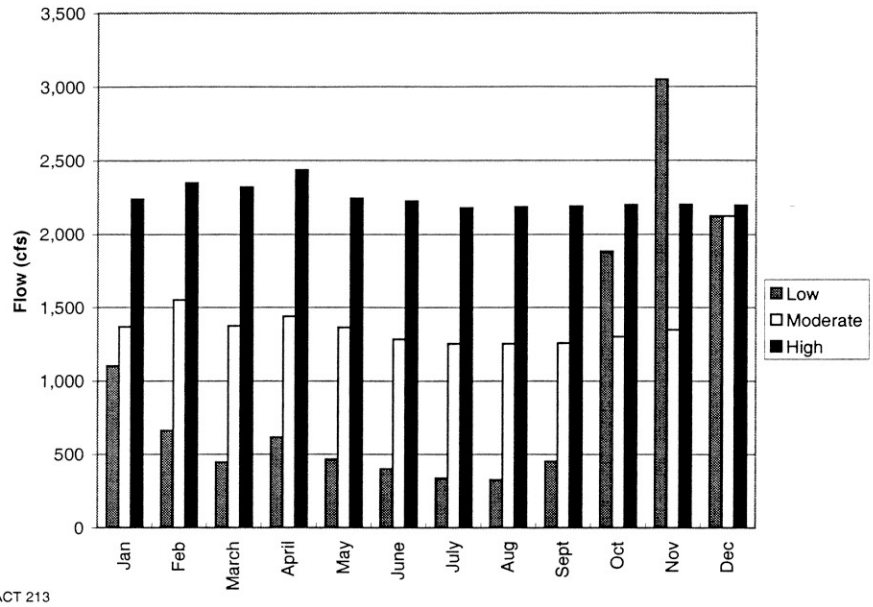
The differences among the three scenarios are much more pronounced when reviewing the effects under critical periods for the 90 percent exceedance flows. ***Figure 4-40*** illustrates that the low flow scenario produces spring and summer flows that are less than half of those produced under the moderate scenario and less than one-quarter of those produced under the high flow scenario. The flow differences among scenarios are directly attributable to the differences in target flow established in the HEC-5 modeling (***Table 4-13***).

FIGURE 4-40
Tallapoosa River at Tallassee. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2020 Demands



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4.4.1.2.3.4 Alabama River Subbasin

Water resources impacts on riverine resources in the Alabama River subbasin are assessed on the Alabama River at Claiborne, which is downstream of the Claiborne Lock and Dam. Downstream of the Claiborne Lock and Dam, the Alabama River joins the Tombigbee River to form the Mobile River. Water resources impacts of the allocation formula in the ACT basin below Claiborne are significantly diminished by the diluting effect of the Tombigbee River (see ***Figure 4-10***).

Under the no action alternative, flows in the Alabama River at Claiborne would decrease slightly from 1995 to 2050, due to increased water demands. Overall, 90 percent exceedance flows during the critical period were projected to decrease up to 7 percent between 1995 and 2050 in winter and spring, up to 5 percent in summer (***Figure 4-41***).

Figure 4-42 presents a direct comparison of the three action alternative scenarios to the no action alternative on the Alabama River at Claiborne. The figure illustrates that the low and moderate scenarios produce lower flows during dry periods than the no action alternative. Under the low flow scenario, flows are slightly more than half of the flow under the no action alternative during dry periods. The high flow scenario produces flows that are approximately 15 to 20 percent greater than the no action alternative during dry periods. These low flow statistics represent conditions in the basin under the driest conditions over the entire 55-year period of record.

The action alternative scenarios were modeled to meet target flows on the Alabama River at Claiborne as shown in ***Table 4-13.*** Providing a closer look at the differences among the three action alternative scenarios, ***Figure 4-43*** presents the 50 percent exceedance flows over the full period of record in the Alabama River at Claiborne. This figure illustrates that there are only minor differences among the three action alternative scenarios under the average conditions represented.

FIGURE 4-41
Alabama River at Claiborne. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

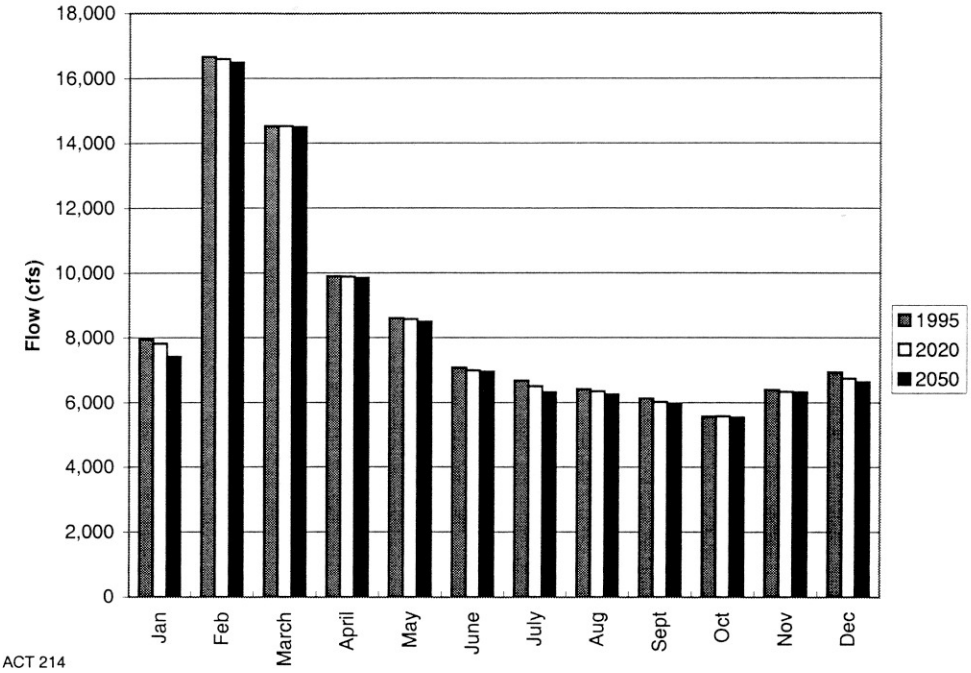

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FIGURE 4-42
Alabama River at Claiborne. Low Flows. Full Period. Action Alternative. 2050 Demands

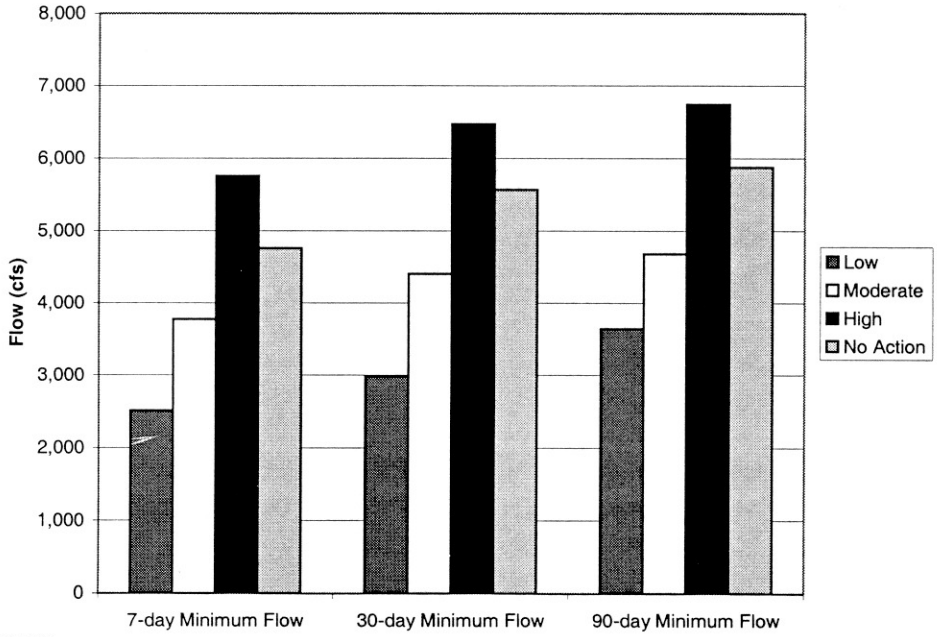

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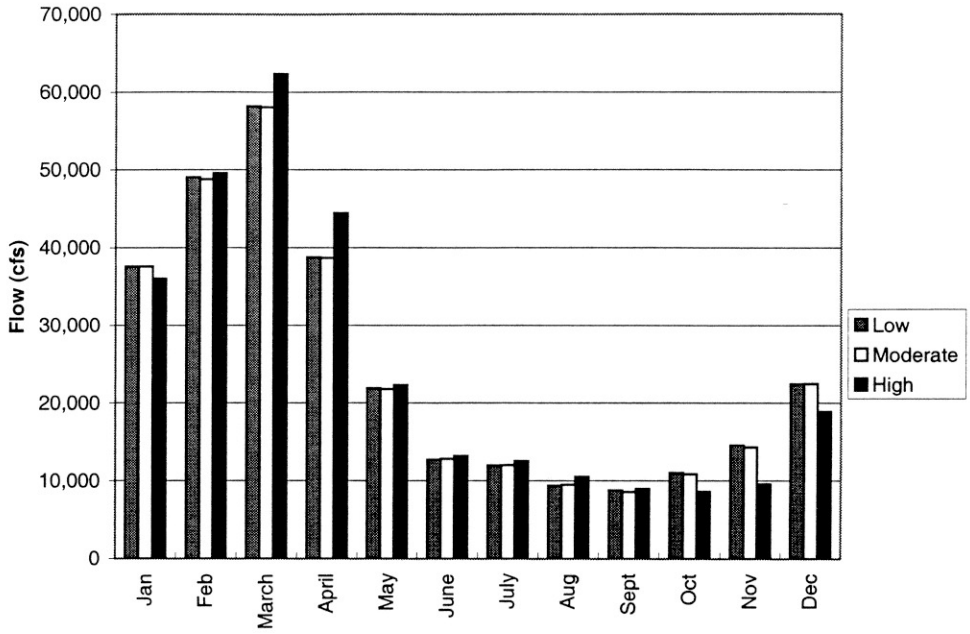
FIGURE 4-43
Alabama River at Claiborne. 50 Percent Exceedance. Full Period. Action Alternative. 2050 Demands



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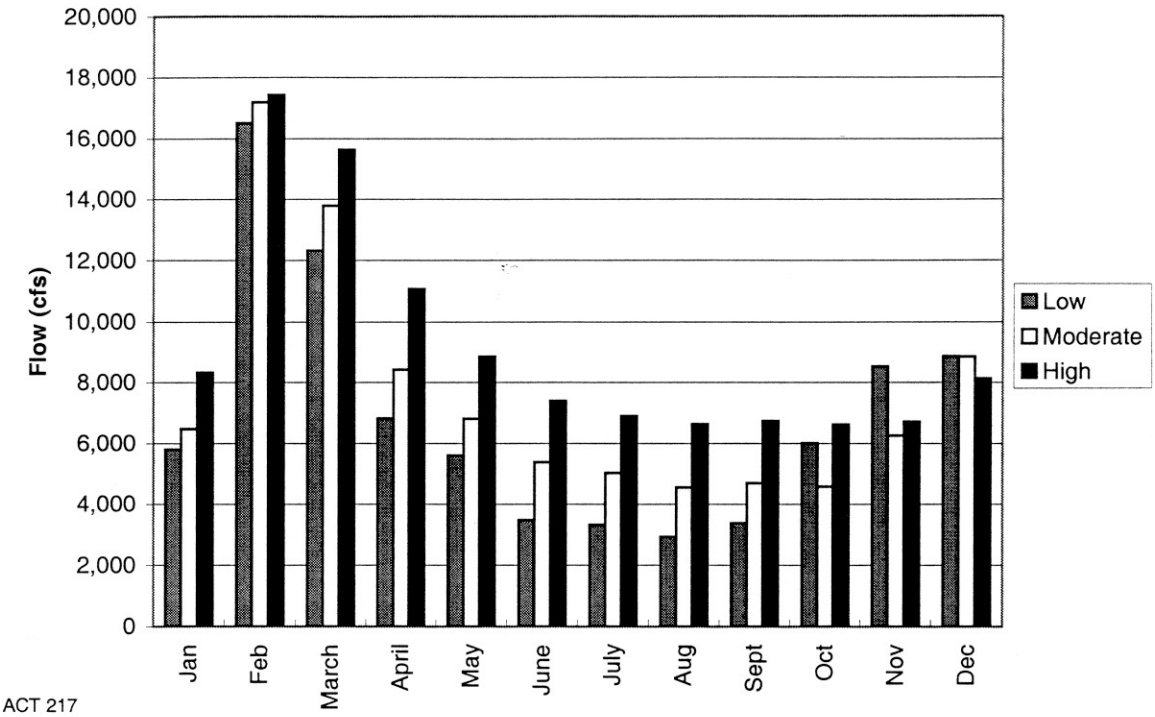
The differences among the three action alternative scenarios on the Alabama River are more pronounced when considering low flows during critical dry periods. The 90 percent exceedance flows under critical periods exhibit differences of about 20 to 40 percent between the low and moderate flow scenarios and the moderate and high scenarios (*Figure 4-44*).

On the Mobile River, the increases and decreases in flows as a result of the various scenarios would be about half of what the Alabama River experiences. Thus, in the summer months when the Alabama River under the high flow scenario would experience flows about 40 percent higher than the moderate scenario for the 90 percent exceedance flow, the Mobile River flows would be about 20 percent higher.

Overall, the impacts of the action alternative scenarios on river flows in the ACT basin would be minor when considering the typical or average conditions over the full period of record. Changes in 50 percent exceedance flows would be greatest in the summer, when demands for water are high and evapotranspiration is highest. Under low flows during critical periods, the three action alternative scenarios would differ significantly from the no action alternative. The differences would be greatest in the summer and fall. The low flow scenario would have substantially lower low flows, which could adversely affect riverine aquatic resources, including vegetative resources and protected species. It could also adversely affect riverine recreation that is flow-dependent, such as rafting and kayaking. The high flow scenario, in contrast, would provide substantially higher flows during critical drought periods, which could enhance riverine resources. Specific impacts to these resources are addressed elsewhere in this draft EIS under the individual resource areas.

FIGURE 4-44
Alabama River at Claiborne. 90 Percent Exceedance. Critical Drought Period. Action Alternative. 2050 Demands



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4.4.1.2.4 Reservoir Impacts

4.4.1.2.4.1 Upper Coosa River Subbasin

There are two reservoirs in the upper Coosa River subbasin: Allatoona Lake and Carters Lake. Both projects were evaluated in this section to assess the impacts of the allocation formula on reservoir levels.

Under the no action alternative, reservoir levels would decrease from 0.5 to 2.5 feet at Lake Allatoona from 1995 to 2050 during critical dry periods (***Figure 4-45***). The 90 percent exceedance elevation at Lake Allatoona would decrease by about 2 feet in the later summer and fall between 1995 and 2050. In contrast, there is no difference in the no action scenario between 1995 and 2050 at Carters Lake (***Figure 4-46***). This is due to the lack of substantial changes in water demands in this portion of the watershed.

The action alternative scenarios would have significant effects on 7-day, 30-day, and 90-day minimum reservoir elevations at Lake Allatoona compared to the no action alternative, as illustrated in ***Figure 4-47***. Both the low and moderate flow scenarios would maintain reservoir elevations approximately 9 to 10 feet above the no action alternative during dry periods. In contrast, the high flow scenario would produce reservoir elevations that are 10 to 15 feet lower than the no action alternative. At Carters Lake, there would be no significant difference between reservoir elevations for the low flow scenario and the no action alternative (***Figure 4-48***). The moderate flow scenario would produce minimum

FIGURE 4-45
Lake Allatoona. 90 Percent Exceedance. Critical Drought Period. No Action Alternative

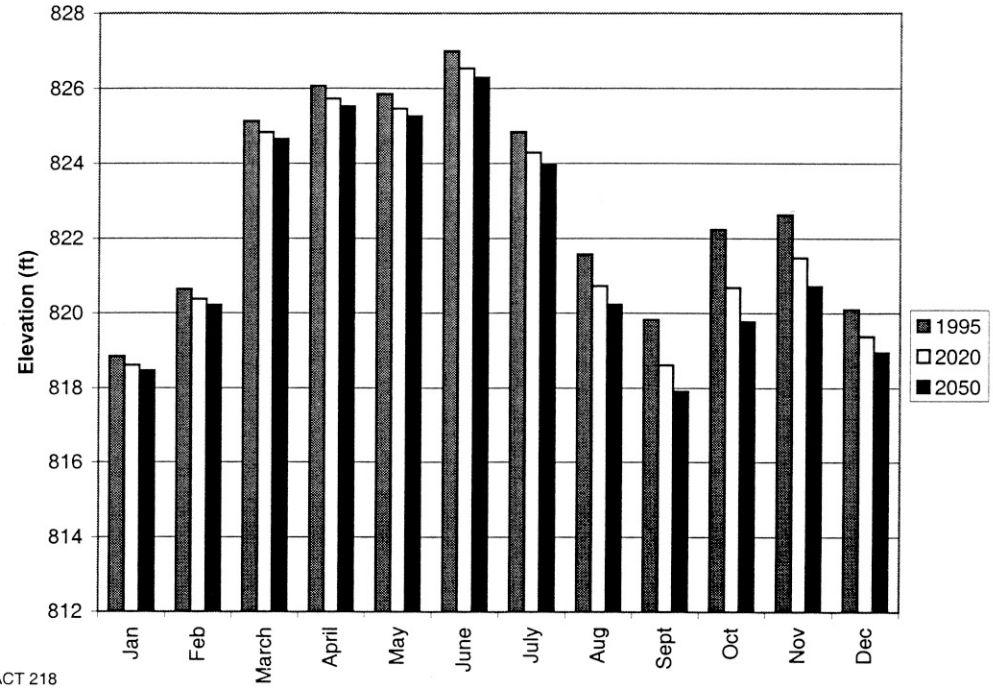

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FIGURE 4-46
Carters Lake. 90 Percent Exceedance. Critical Drought Period. No Action Alternative

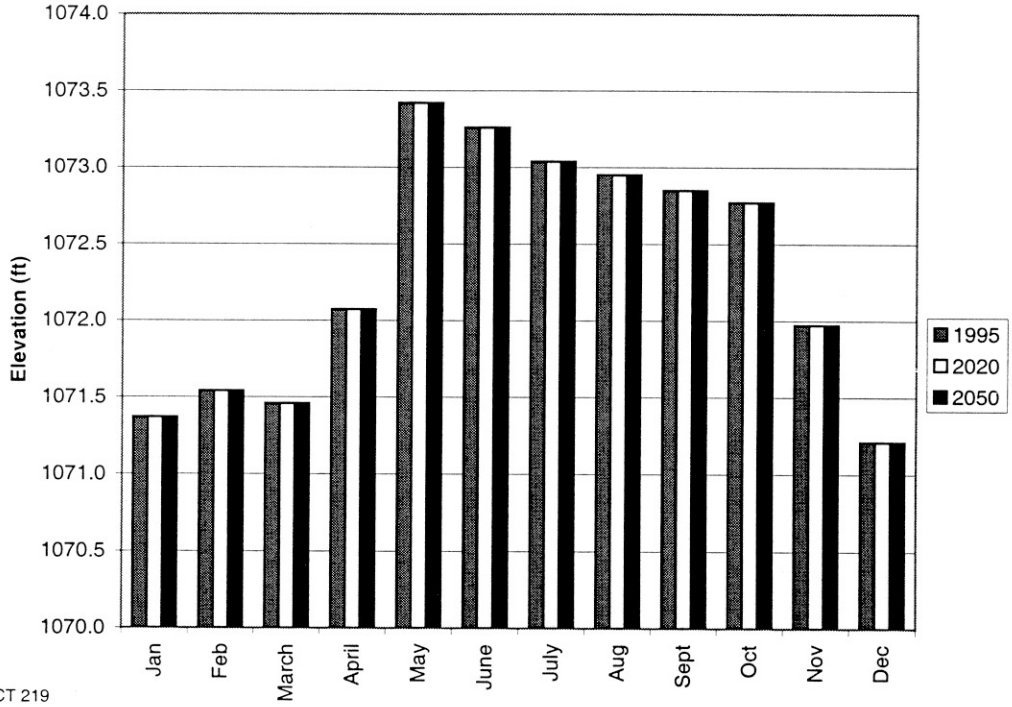

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FIGURE 4-47
Lake Allatoona. Low Elevations. Full Period. Action Alternative. 2050 Demands

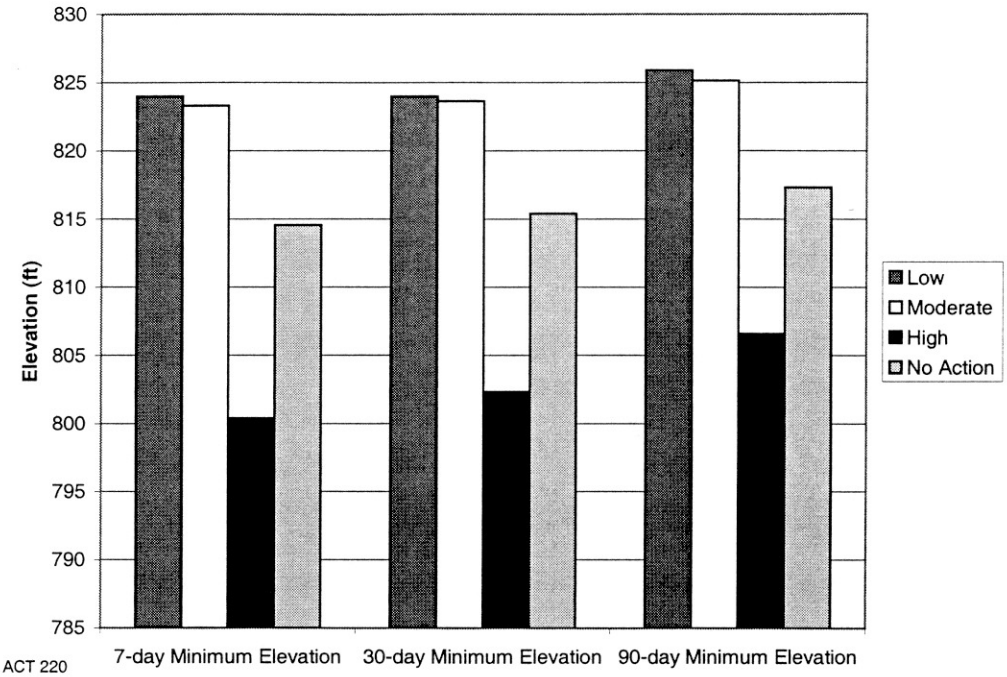

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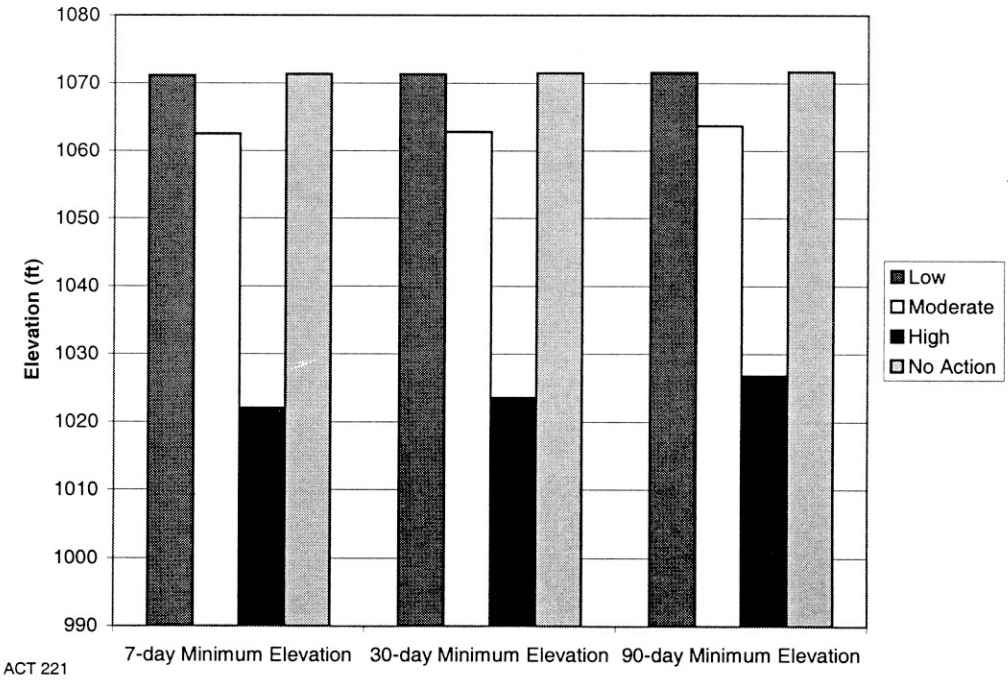
FIGURE 4-48
Carters Lake. Low Elevations. Full Period. Action Alternative. 2050 Demands



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reservoir elevations that are about 10 feet lower than under the no action alternative. The differences are much greater for the high flow scenario, where minimum reservoir elevations would be 45 to 50 feet lower than the no action alternative.

The action alternative scenarios were modeled to draw Lake Allatoona and Carters Lake down as necessary to meet the minimum flow targets shown in ***Table 4-13***. To assess the impacts of the action alternative scenarios in greater detail, ***Figures 4-49*** and ***4-50*** present 50 percent exceedance elevations for the three scenarios under the full period of record. These figures demonstrate that there is very little difference between the low flow and moderate flow scenario under these conditions, which approximate average flow conditions over the full period of record. The high flow scenario, in contrast, maintains higher lake levels in the winter (due to the lack of winter drawdown in the modeling assumptions of the high flow scenario). Overall, the differences among the three scenarios under average summer conditions are fairly minor.

Differences among the three scenarios become more apparent when viewing 90 percent exceedance elevations for critical periods only. ***Figures 4-51*** and ***4-52*** show substantial differences among the three scenarios in all months of the year, with the consistent trend of the low flow scenario producing the highest and most stable reservoir elevations and the high flow scenario producing substantial drawdowns compared to the other scenarios. These figures illustrate the substantial impacts that could result under critical conditions due to the three action alternative scenarios.

FIGURE 4-49
Lake Allatoona. 50 Percent Exceedance. Full Period. Action Alternative. 2050 Demands

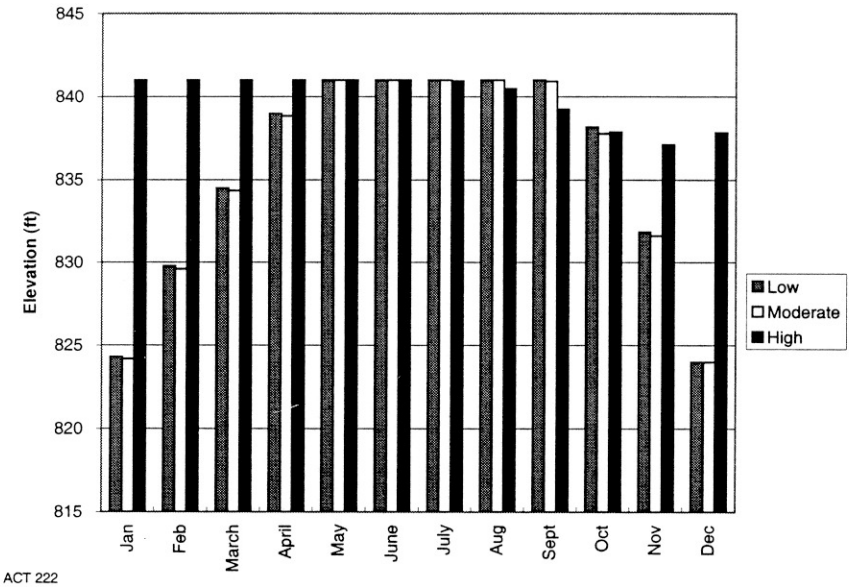

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FIGURE 4-50
Carters Lake. 50 Percent Exceedance. Full Period. Action Alternative. 2050 Demands

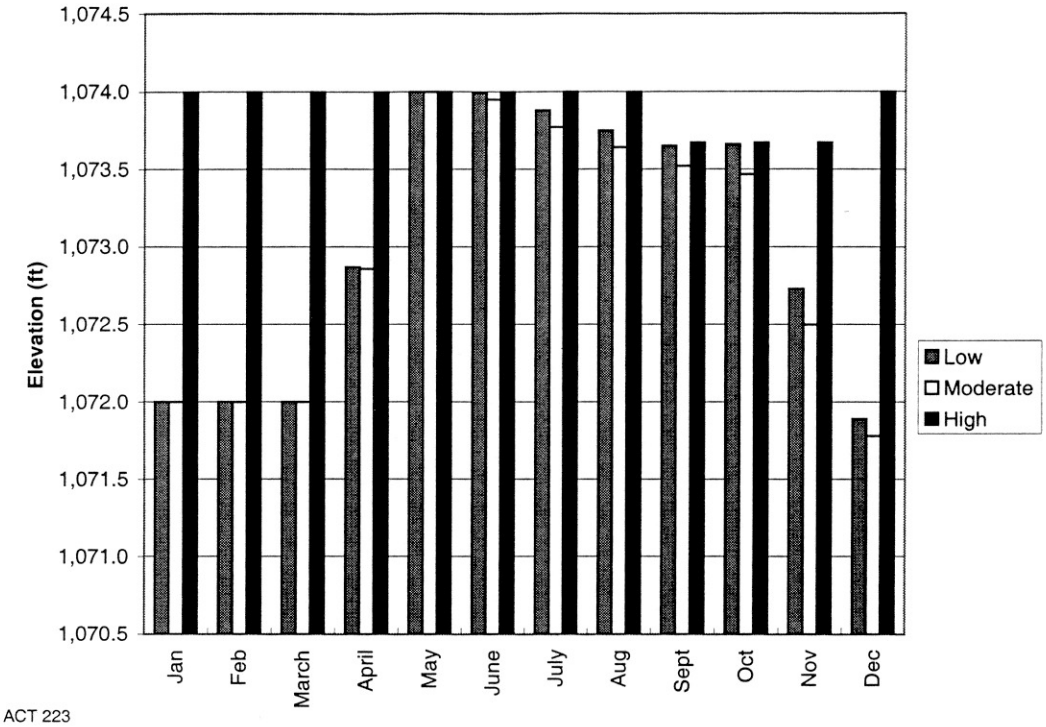

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FIGURE 4-51
Lake Allatoona. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands

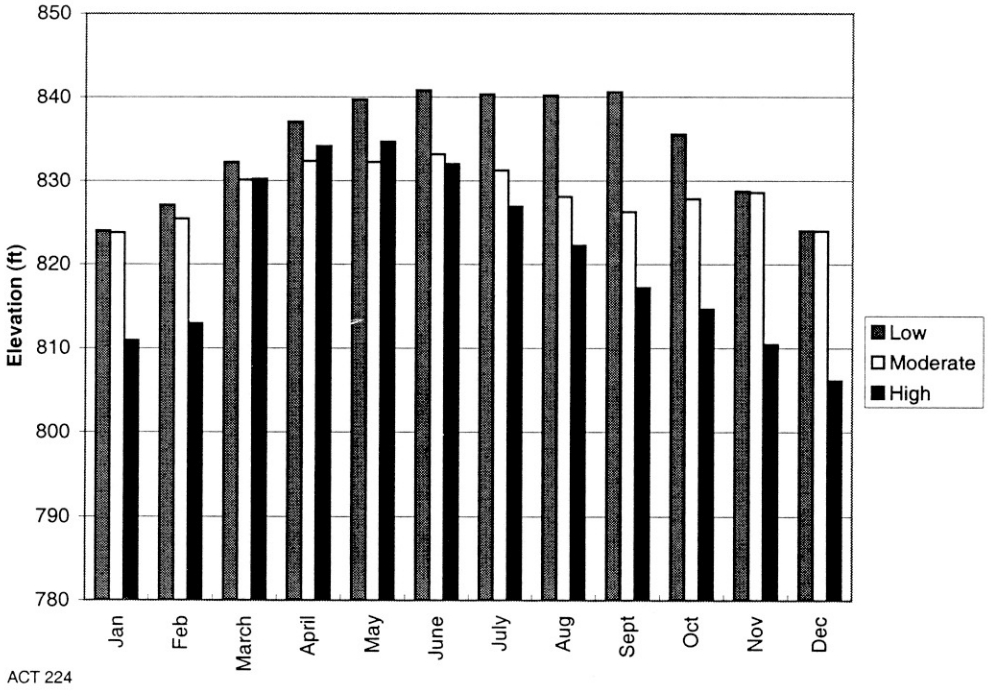

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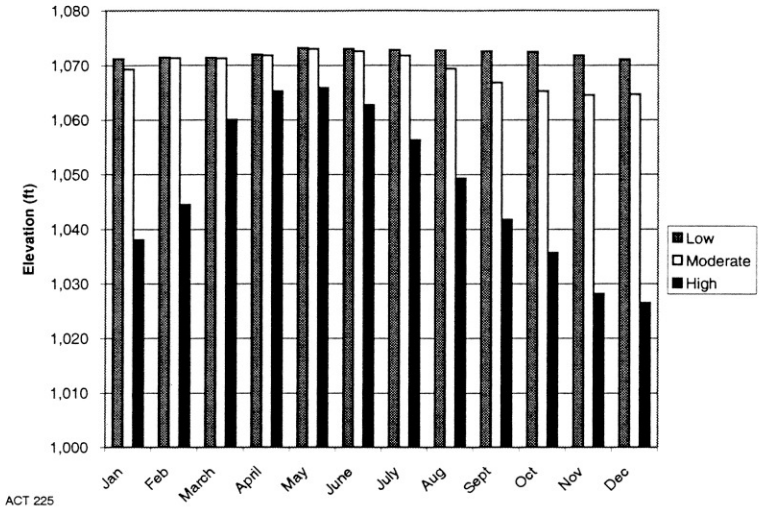
FIGURE 4-52
Carters Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands

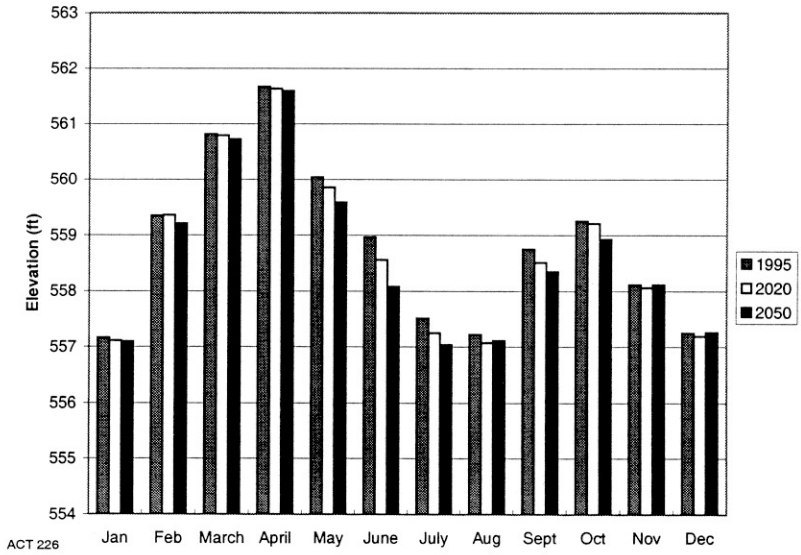


4.4.1.2.4.2 Lower Coosa River Subbasin

Seven APCO dams are built in series along the mainstem Coosa River. The largest is Weiss Lake, which is the most upstream reservoir. Impacts to reservoir levels at Weiss Lake were assessed in this section, to determine the effect of the allocation formula in the lower Coosa River subbasin.

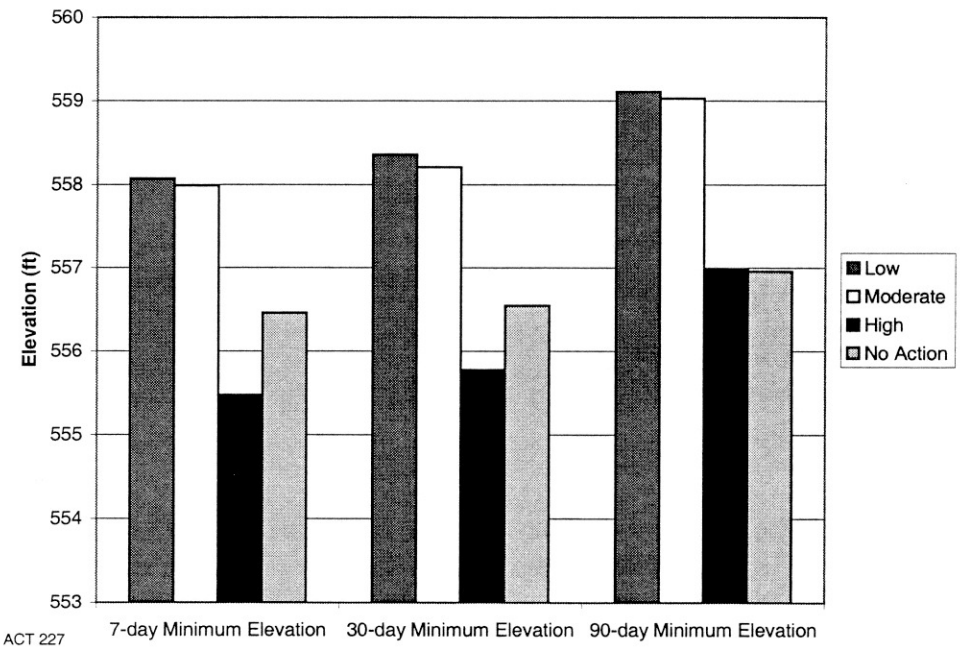
Under the no action alternative, 90 percent exceedance elevations in Weiss Lake are expected to decrease, on average, by about 0.3 foot during the critical dry period. This difference would vary on a monthly basis. For example, the 90 percent exceedance elevations would decrease up to 0.9 foot in the summer between 1995 and 2050 (*Figure 4-53*).

FIGURE 4-53
Weiss Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



The action alternative scenarios would have some effects on 7-day, 30-day, and 90-day minimum reservoir elevations at Weiss Lake compared to the no action alternative, as illustrated in ***Figure 4-54.*** Both the low and moderate flow scenarios would maintain reservoir elevations approximately 2 feet above the no action alternative during dry periods. In contrast, the high flow scenario would produce reservoir elevations that are 1 foot lower than the no action alternative.

FIGURE 4-54
Weiss Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands



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The action alternative scenarios were modeled to draw the reservoirs down as necessary to meet the minimum flow targets shown in ***Table 4-13***. To assess the impacts of the action alternative scenarios in greater detail, ***Figure 4-55*** presents 50 percent exceedance elevations for the three scenarios under the full period of record. This figure demonstrates that there is very little difference between the low flow and moderate flow scenario under these conditions, which approximate average flow conditions over the full period of record. The high flow scenario, in contrast, maintains higher lake levels in the winter (due to the lack of winter drawdown in the modeling assumptions of the high flow scenario). Overall, the differences among the three scenarios under average summer conditions are insignificant.

Differences among the three scenarios become more apparent when viewing 90 percent exceedance elevations for critical periods only. ***Figure 4-56*** shows greater differences among the three scenarios in all months of the year, with the consistent trend of the low flow scenario producing the highest and most stable reservoir elevations during the summer and the high flow scenario producing substantial drawdowns compared to the other scenarios. These figures illustrate the impacts that could result under critical conditions due to the three action alternative scenarios.

FIGURE 4-55
Weiss Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2060 Demands

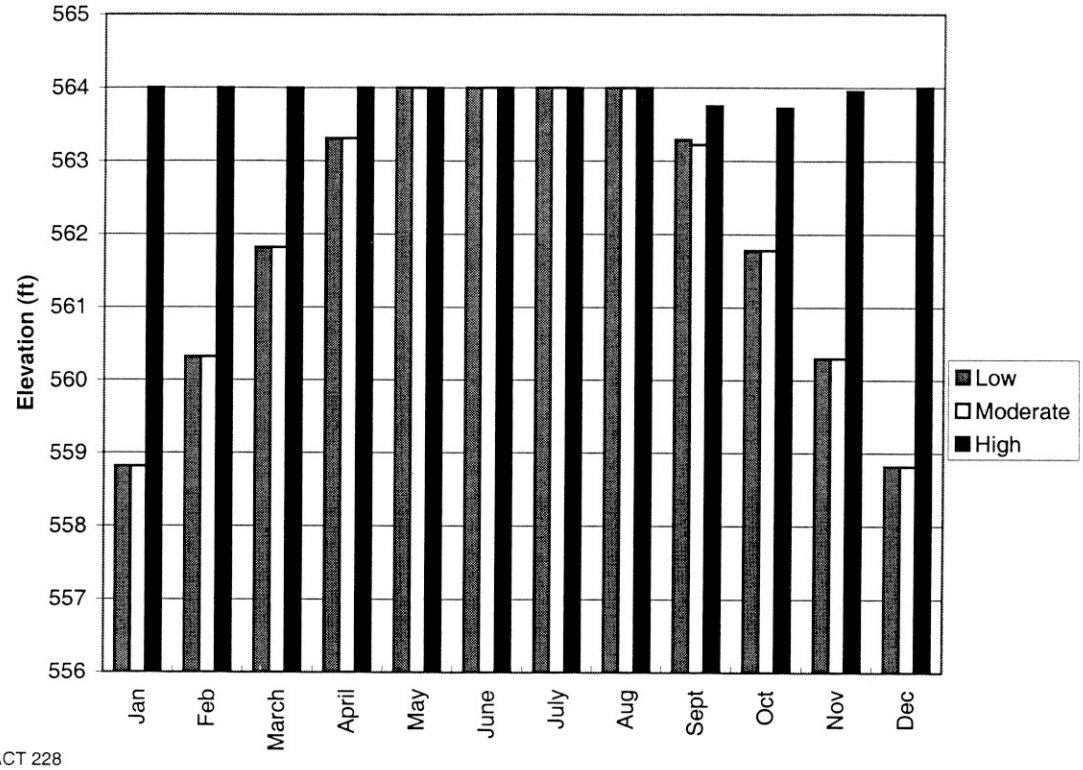

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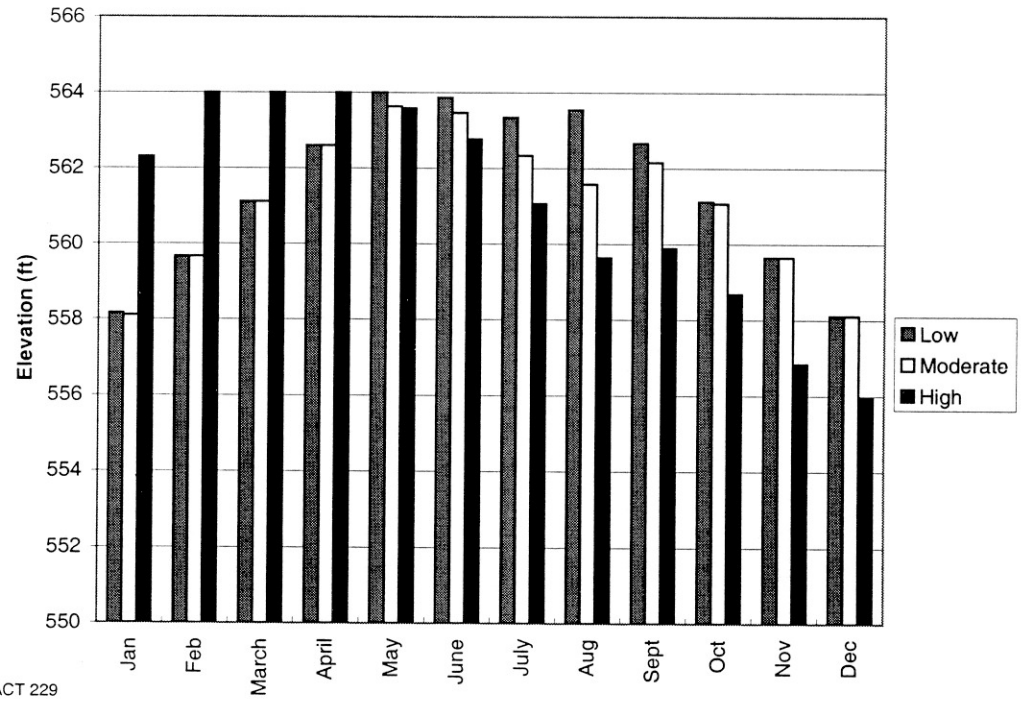
FIGURE 4-56
Weiss Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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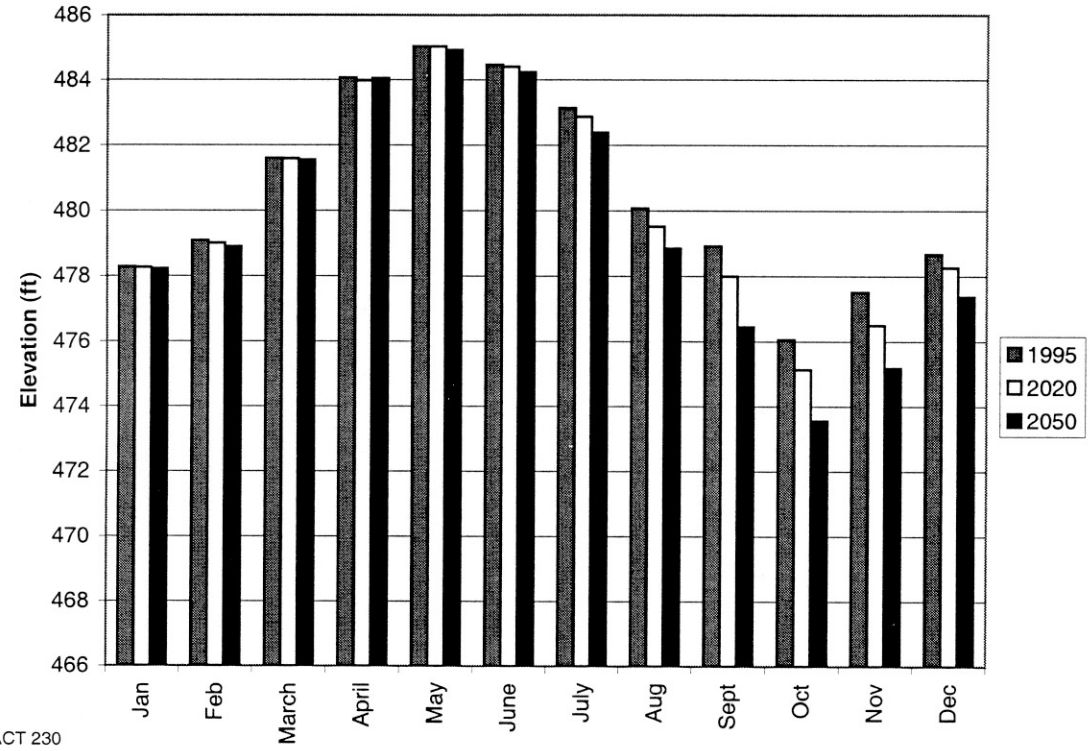
4.4.1.2.4.3 Tallapoosa River Subbasin

There are four reservoirs in the Tallapoosa River subbasin—Harris, Martin, Yates, and Thurlow Lakes. Harris and Martin Dams have peaking hydropower operations, whereas Yates and Thurlow operate generally as run of river. There would be no significant effect on Yates and Thurlow as a result of the no action alternative or the action alternative flow scenarios because of their run-of-river nature. Martin Lake was selected for analysis in the Tallapoosa River subbasin because it has by far the largest surface area of the four reservoirs and it is expected to have demonstrable effects due to the no action and action alternative flow scenarios.

Under the no action alternative, 90 percent exceedance levels in Lake Martin are expected to decrease from 1995 to 2050 by about 2 feet in the late summer and fall during the critical dry period. The 90 percent exceedance elevations for the no action alternative are illustrated in *Figure 4-57*.

FIGURE 4-57
Lake Martin. 90 Percent Exceedance. Critical Drought Period, No Action Alternative.



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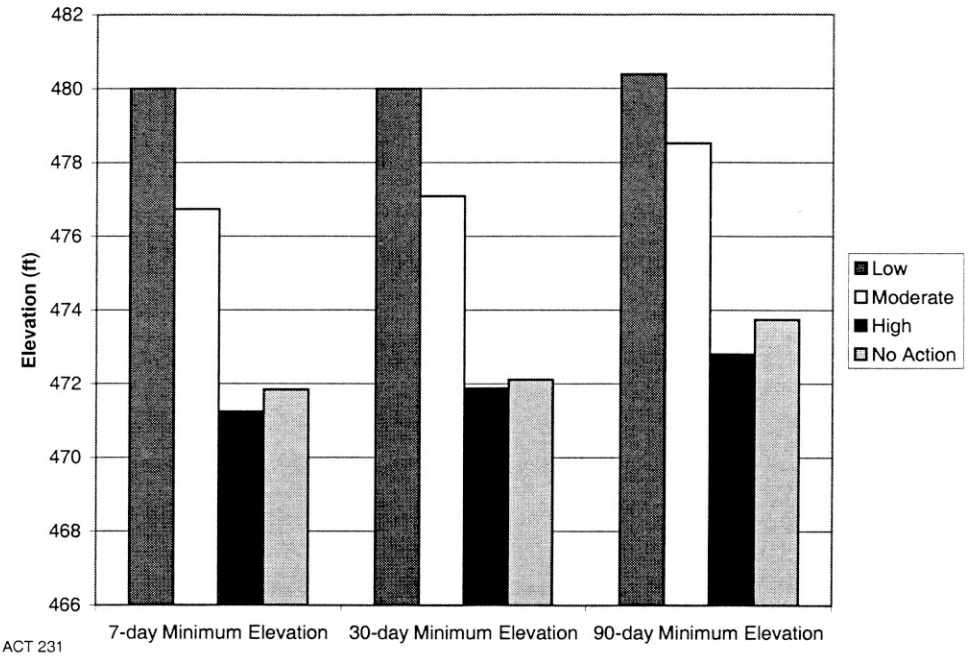
The action alternative scenarios would have substantial effects on 7-day, 30-day, and 90-day minimum reservoir elevations at Lake Martin compared to the no action alternative, as illustrated in *Figure 4-58*. The low flow scenario would maintain reservoir elevations approximately 6 to 8 feet above the no action alternative during dry periods. The moderate flow scenario would maintain elevations about 5 feet above the no action alternative. In contrast, the high flow scenario would produce reservoir elevations that are only 1 foot lower than the no action alternative.

FIGURE 4-58
Lake Martin. Low Elevations. Full Period, Action Alternative. 2050 Demands



The action alternative scenarios were modeled to draw the reservoirs down as necessary to meet the minimum flow targets shown in ***Table 4-13***. To assess the impacts of the action alternative scenarios in greater detail, ***Figure 4-59*** presents 50 percent exceedance elevations for the three scenarios under the full period of record. This figure demonstrates that there is very little difference between the low flow and moderate flow scenario under these conditions, which approximate average flow conditions over the full period of record. The high flow scenario, in contrast, maintains higher lake levels in the winter (due to the lack of winter drawdown in the modeling assumptions of the high flow scenario). Overall, the differences among the three scenarios under average summer conditions are insignificant.

Differences among the three scenarios become more apparent when viewing 90 percent exceedance elevations for critical periods only. ***Figure 4-60*** shows greater differences among the three scenarios in all months of the year, with the consistent trend of the low flow scenario producing the highest and most stable reservoir elevations during the summer and the high flow scenario producing substantial drawdowns compared to the other scenarios. The difference between the high and low scenarios is around 10 feet in the summer and fall. These figures illustrate the impacts that could result under critical conditions due to the three action alternative scenarios.

FIGURE 4-59
Lake Martin. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands

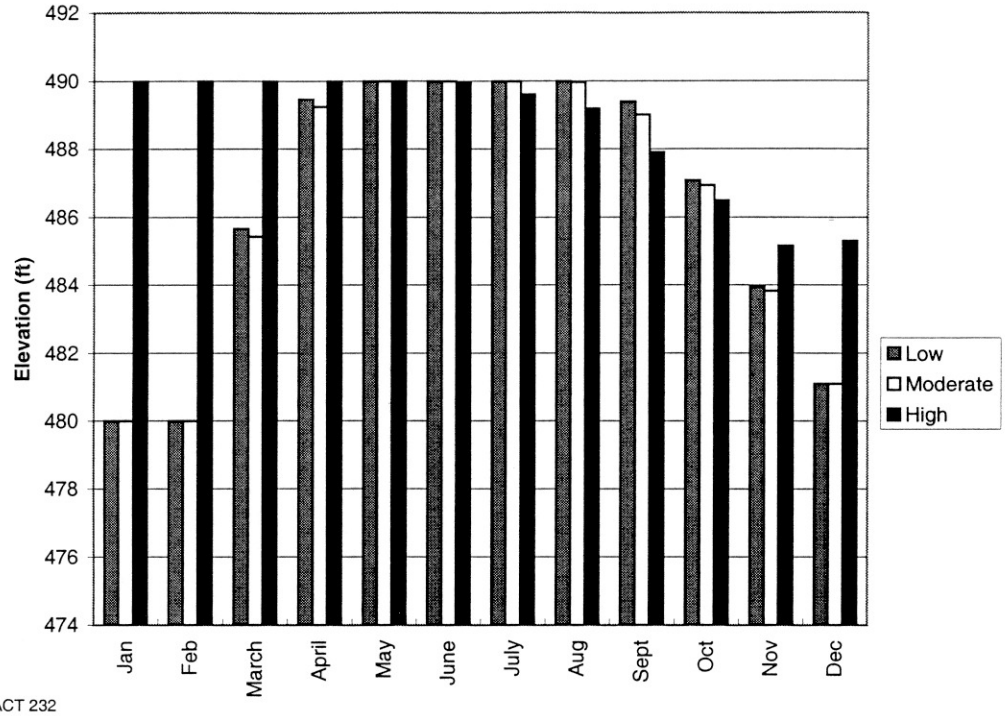


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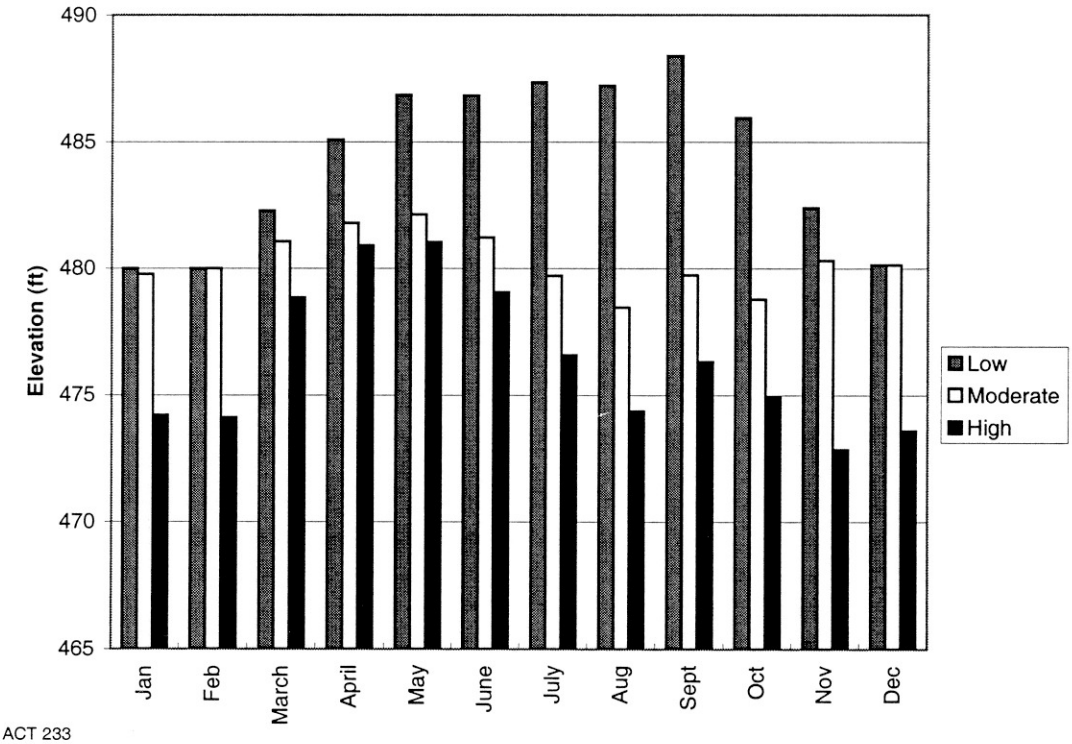
FIGURE 4-60
Lake Martin. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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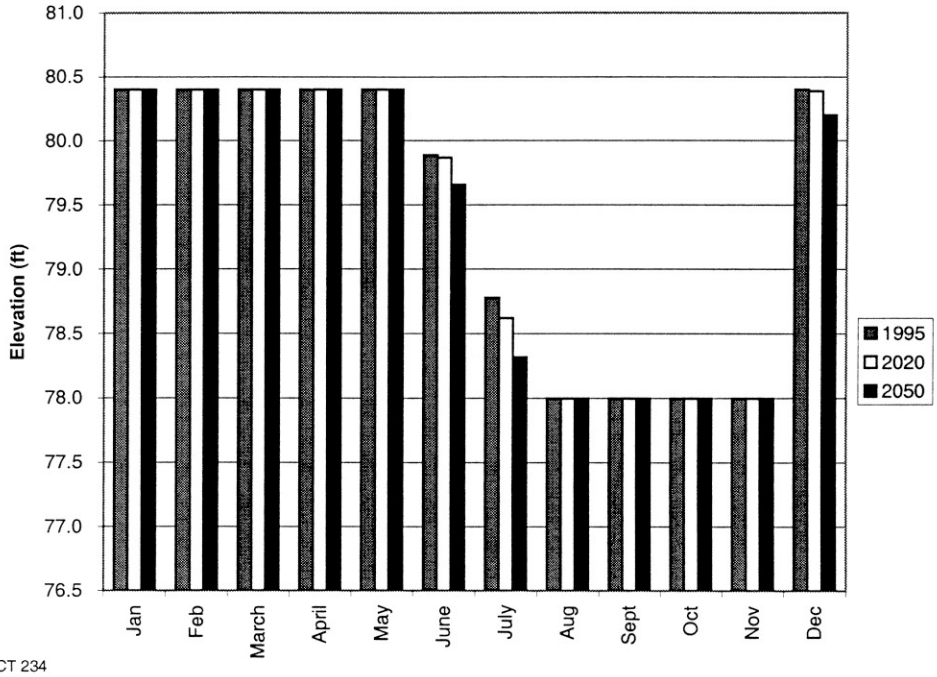
4.4.1.2.4.4 Alabama River Subbasin

There are three reservoirs on the Alabama River (the so-called "Alabama Lakes"). These reservoirs are riverine in physical appearance and do not generally experience much fluctuation. Dannelly Lake is the middle of the three reservoirs. Impacts to Dannelly Lake caused by the no action and action alternatives are discussed in this section.

Under the no action alternative, the model predicted that 90 percent exceedance reservoir levels would decrease slightly, by about 0.5 foot, from 1995 to 2050. The greatest difference would be in July (***Figure 4-61***).

FIGURE 4-61
Dannelly Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



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The action alternative scenarios would have some effects on 7-day, 30-day, and 90-day minimum reservoir elevations at Dannelly Lake compared to the no action alternative, as illustrated ***in Figure 4-62***. The low flow scenario would maintain reservoir elevations approximately 2 feet above the no action alternative during dry periods. The moderate flow scenario would maintain elevations about 1 foot above the no action alternative. The high flow scenario would produce reservoir elevations that are similar to the no action alternative.

The action alternative scenarios were modeled to draw the reservoirs down as necessary to meet the minimum flow targets shown in ***Table 4-13***. To assess the impacts of the action alternative scenarios in greater detail, ***Figure 4-63*** presents 50 percent exceedance elevations for the three scenarios under the full period of record. This figure demonstrates that there is no significant difference among any of the alternative flow scenarios under these conditions, which approximate average flow conditions over the full period of record.

FIGURE 4-62
Dannelly Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands

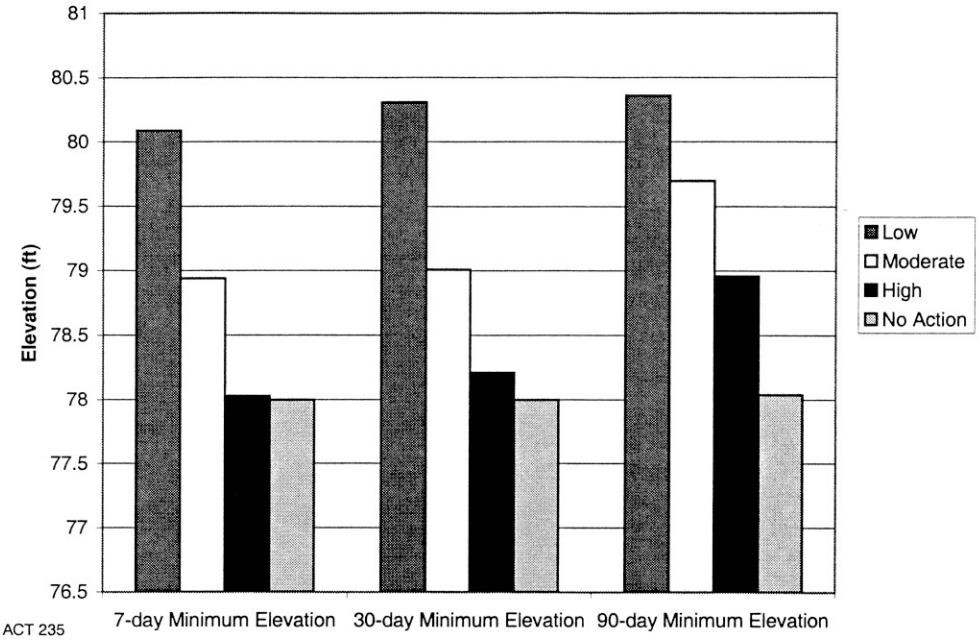

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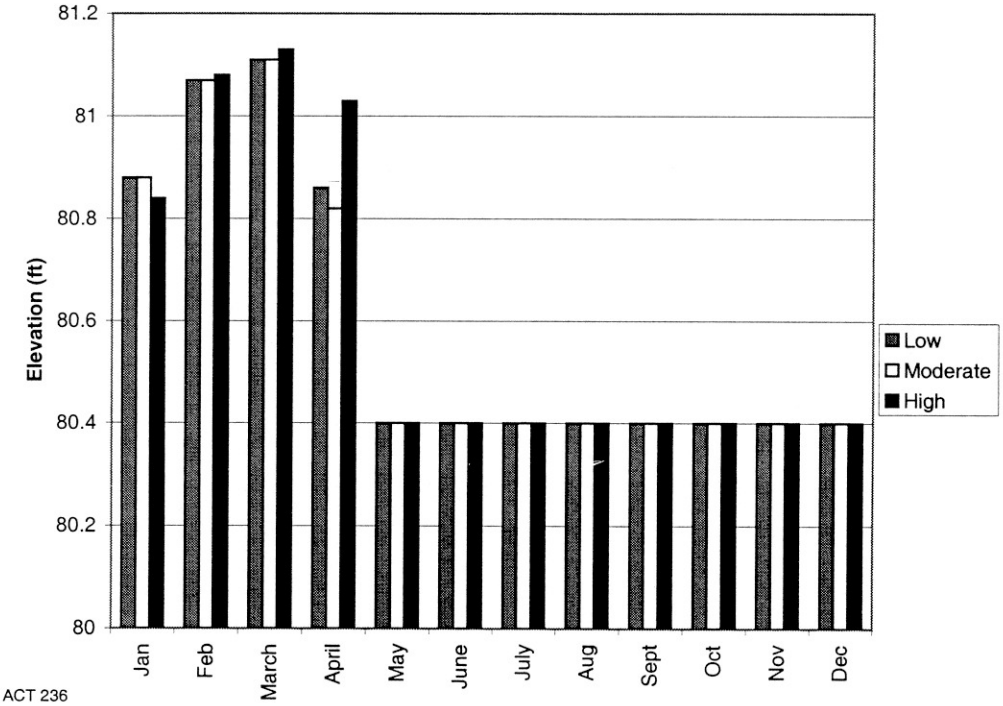
FIGURE 4-63
Dannelly Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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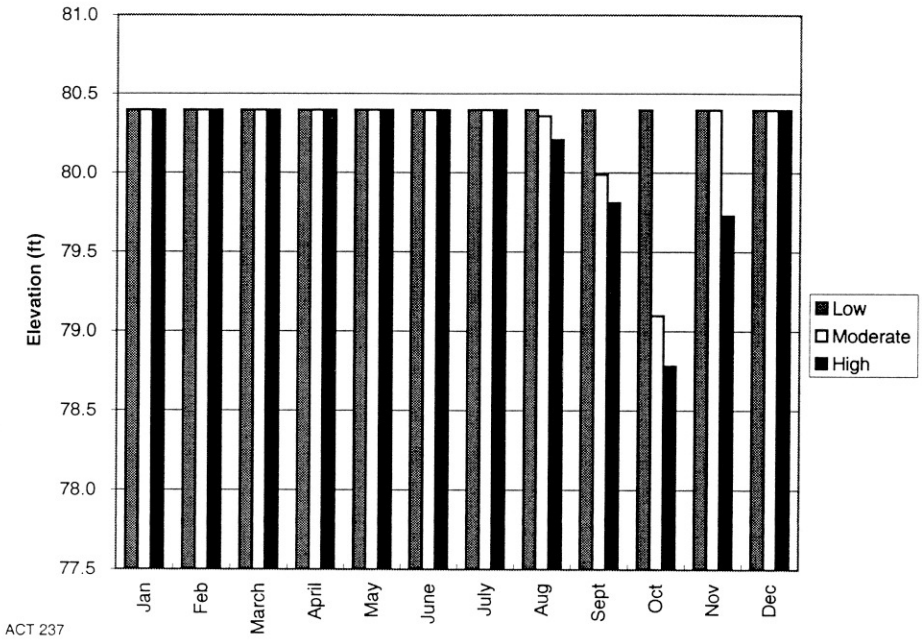
Differences among the three scenarios become apparent during the dry fall months when viewing 90 percent exceedance elevations for critical periods only. ***Figure 4-64*** shows greater differences among the three scenarios in September, October, and November, with the consistent trend of the low flow scenario producing the highest and most stable reservoir elevations and the high flow scenario producing drawdowns compared to the other scenarios. The difference between the high and low scenarios is less than 2 feet in the fall. These figures illustrate the impacts that could result under critical conditions due to the three action alternative scenarios.

FIGURE 4-64
Dannelly Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



Overall, impacts to reservoirs will be significant for the high flow scenario, which draws reservoirs down to augment downstream flows. These substantial drawdowns could adversely affect fisheries, vegetation, and recreation. Specific impacts to these resources are addressed within each resource section of this draft EIS. In contrast, the low flow scenario would offer substantial beneficial impacts by maintaining higher and more stable reservoirs. However, under precipitation events, the reservoirs and flows below the reservoirs could experience more rapidly changing water levels and flows under the low flow scenario, due to the reduced amount of storage in the reservoirs to attenuate peak inflows.

4.4.1.2.5 Groundwater Impacts

Groundwater resources support municipal, industrial, and agricultural demands in the basin. Under the no action alternative, groundwater resources would remain unchanged.

Under the low flow scenario, more pressure would be put on groundwater sources of water because the low river flows would be insufficient to support all the demands. Groundwater tables may be lowered due to the increased pumping in the basin.

Under the moderate flow scenario, there would be little change in groundwater resources because the moderate flow scenario is very similar to the current operating conditions. Thus, groundwater withdrawals would occur to the same degree as they currently do.

The high flow scenario provides substantially higher summer flows compared to the no action alternative. This scenario would have little impact on groundwater resources because water demands would generally be met by stream flows. There may be a reduction in the amount of groundwater pumping required, if more water can be withdrawn from surface water sources.

4.4.1.2.6 Navigation Impacts

The Corps used the HEC-5 results to assess navigation channel availability at Claiborne on the Alabama River. A 9-foot channel is needed to fully support navigation, while a 7.5-foot channel is acceptable to support limited navigation. A flow of 9,500 to 12,000 cfs is needed to support a 9-foot depth, and a flow of 8,500 to 10,000 cfs is needed for a 7.5-foot depth.

Overall, the percent of time that a 9-foot and 7.5-foot channel is available under the 2050 demands of the no action alternative ranges from 54 percent to 100 percent (***Figure 4-65***). This availability decreased only slightly (generally less than 5 percent) from 1995 to 2020 to 2050, due to increased consumptive demands in the basin.

The HEC-5 model predicts that the low flow scenario would maintain channel depths about the same amount of time as the moderate flow scenario. Availability of the 7.5- and 9-foot channel depths is high (95 to 100 percent) from January through May, then drops off through early fall (with a minimum in August/September), and increases throughout the fall (***Figure 4-66***). Both would maintain a 9-foot channel between 40 and 70 percent of the time in the summer and a 7.5-foot channel between 50 and 80 percent of the time in the summer.

The annual pattern of channel availability is somewhat different for the high flow scenario, because the modeling assumed no winter drawdown of the reservoirs. The winter drawdown through the fall helps augment downstream flows. The high flow scenario has the same pattern of channel availability in the winter and early summer as the moderate and low flow scenarios, with high availability (90 to 100 percent) from January through May, before gradually decreasing through the summer. Availability of the 9-foot channel ranges from 55 to 80 percent in June through August, but continues to decrease to a minimum (40 to 50 percent) in November (***Figure 4-67***).

FIGURE 4-65
Alabama River at Claiborne Navigation Channel Availability. No Action Model with 2050 Moderate Demands

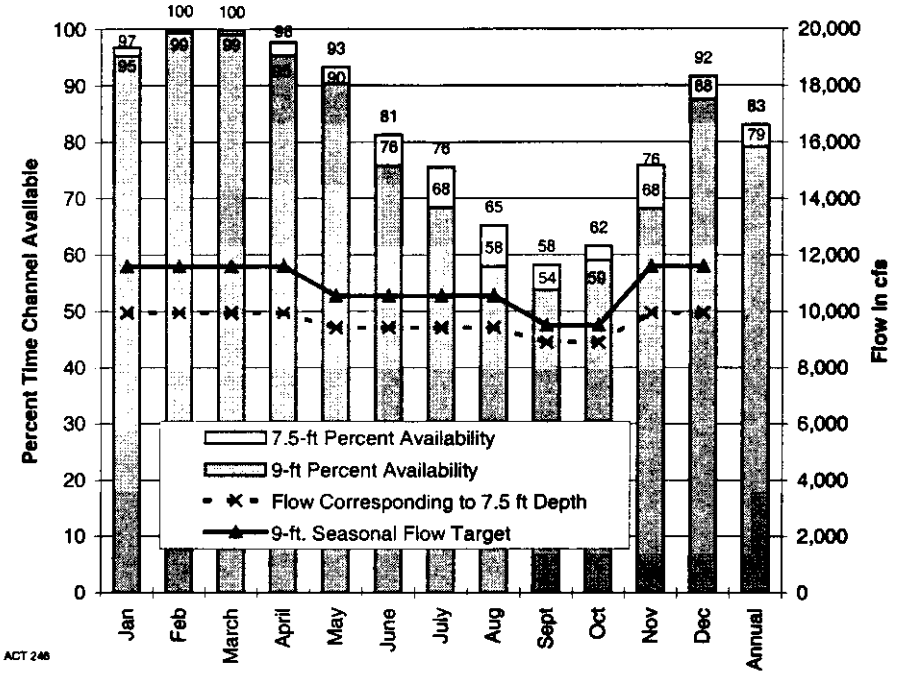


FIGURE 4-66
Alabama River at Claiborne Navigation Channel Availability. Low Flow Scenario. 2050 Demands

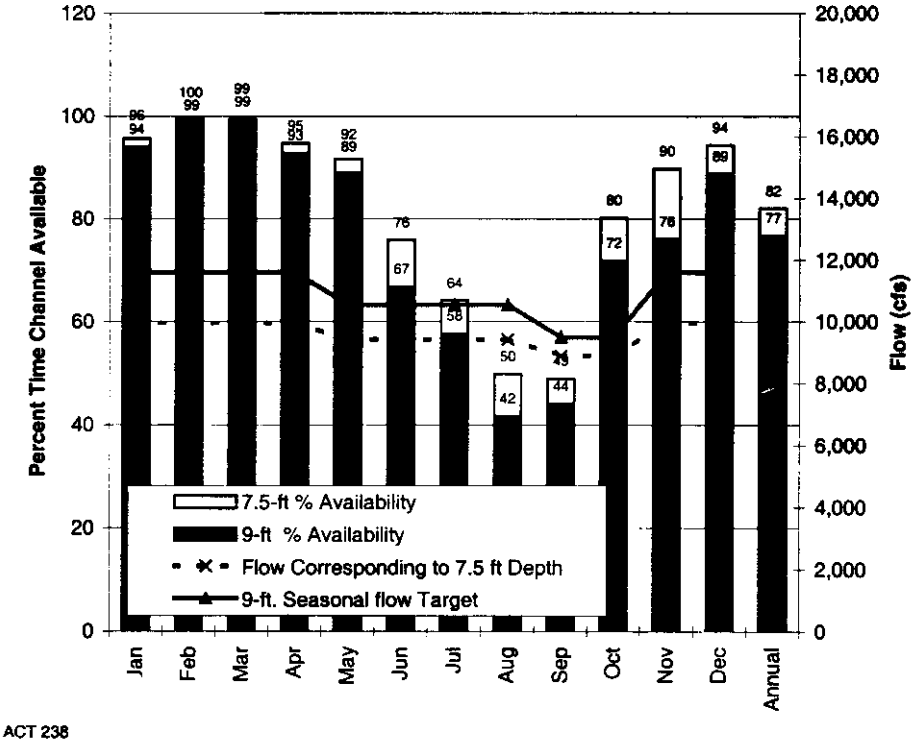
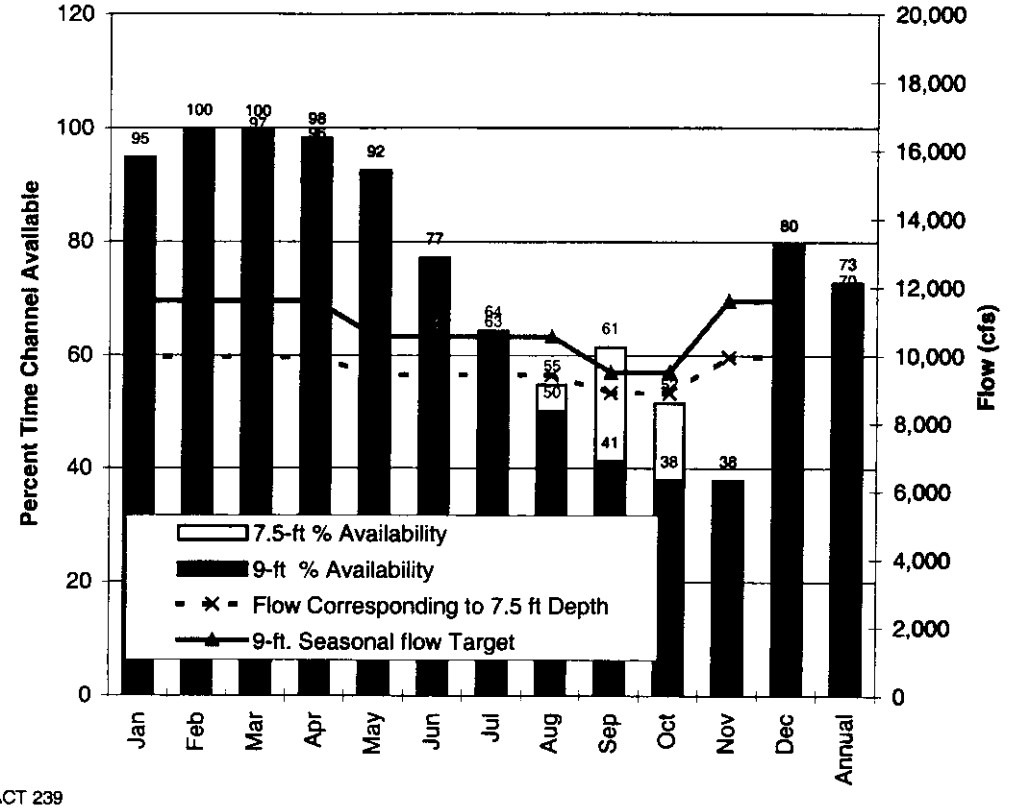


FIGURE 4-67
Alabama River at Claiborne Navigation Channel Availability. High Flow Scenario with 2050 Demands



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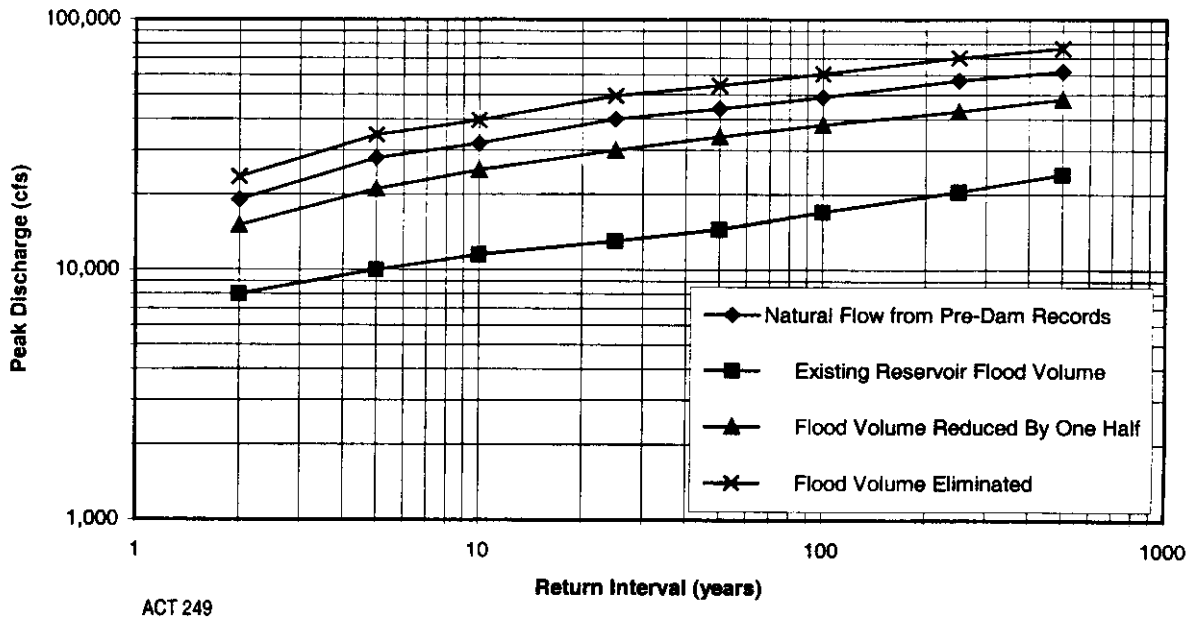
4.4.1.2.7 *Flood Control Impacts*

Because the HEC-5 modeling conducted for evaluation of hydrologic data in this EIS is a low flow evaluation, it is not appropriate to use it to assess impacts on flood flows and flood control. A separate analysis evaluates the downstream impacts of reallocating flood control on Lake Allatoona in the ACT basin. The analysis compared the effects of maintaining current flood control storage, eliminating one-half of current flood control storage, and eliminating all flood control storage in these reservoirs. The impacts of these three options on downstream flows were analyzed using flood routing analysis. The detailed report is included in *Appendix D*.

The analysis concluded that eliminating half of the flood control storage would increase downstream flows substantially. At Lake Allatoona, eliminating half of flood control storage would double downstream flows below the dam for all frequency floods from the 2-year to the 500-year flood (*Figure 4-68*). Flood flows in the Coosa would increase by about 20 percent if half the existing flood control storage in Lake Allatoona was eliminated. Eliminating all flood storage at Allatoona would increase downstream flows in the Etowah River by three to four times over flows with the current amount of flood control storage. Flood flows in the Coosa River would increase by 50 to 60 percent. As indicated by these values, reducing flood control storage at Lake Allatoona would have significant impacts on downstream flows in the Etowah and Coosa Rivers.

FIGURE 4-68
Peak Flood Frequency at Allatoona Dam



There are many other reservoirs within the ACT basin that also provide flood control storage. While an analysis of reducing flood control storage was not performed on reservoirs other than Lake Allatoona, it is expected that reducing or eliminating flood control storage at any of these reservoirs would have significant impacts downstream during flood events.

4.4.1.2.8 Water Supply Withdrawals

The analysis of potential effects of the alternative scenarios on water supply was based on the HEC-5 modeling described above and an additional analysis of potential shortages for each of the primary areas of demand: municipal and industrial, thermal power generation, and agriculture. The analysis of shortages was based on a statistical analysis of the HEC-5 model output that estimates the net flows at each of the nodes in the basin after all the consumptive uses have been accounted for (see *Appendix D*).

4.4.1.2.9 Municipal and Industrial Demand

Estimates of shortages in municipal and industrial water demands were identified using the HEC-5 model. HEC-5 produces output in *net flows,* which are flows remaining after all consumptive uses have been taken out of the system. These net flows are based on water demand, but reflect the effects of wastewater returns, interbasin transfers, groundwater use, and other basin losses. Monthly probability distributions were then used to construct an expected annual water budget consisting of mean net flow by month along with a standard deviation. With the mean and standard deviation known for each month, the probability of zero net flow was calculated. The probability of zero net flow indicates the likelihood of impacts to consumptive demand categories. *Appendix F* includes a detailed description of the approach use to determine shortages. It is important to note, however, that shortages do

not imply that water faucets are running dry. In reality, demands would naturally vary during wet and dry periods. However, at this programmatic level, these changes could not be estimated or modeled.

To model the effects of the shortages of the impacts to consumption demand categories, a hierarchy of demand priorities was developed by the Corps' EIS development team. In the model developed, agricultural water demands were determined to be the lowest priority and are affected first by any water shortages in the river systems. Thermal (steam) power generation is affected after agricultural water demands, when instream flows fall to zero during a water shortage. Since municipal and industrial water demands are assumed to be the highest priority consumptive use category, impacts to this demand category occur only after agricultural and thermal water usage can no longer be diverted to satisfy municipal and industrial water demands. Therefore, in addition to the shortages shown below in municipal and industrial water supplies under the no action alternative, there may be a shortage in agricultural and thermal water supplies that are in the same reach. ***Table 4-14*** shows modeled municipal and industrial demand shortages by State for the no action alternative. These shortages are based on the estimated 1995 demands shown in ***Table 4-11*** and the modeled flows described in Section 4.4.2.

TABLE 4-14
Modeled Annual Shortages in Municipal and Industrial Demands by State for the ACT Basin (mgd), No Action Alternative

Area	1995	2020	2050
Alabama portion	12	14	16
Georgia portion	4	4	3
ACT basin total	16	18	19

Source: ***Appendix F***

Municipal and industrial water supply demand shortages over the entire basin that were identified in the model for the no action alternative ranged from 16 mgd in 1995 to 19 mgd in 2050 (***Figure 4-69***). These are minor shortages that account for only 2 percent of total basin demands. These shortages are primarily in Alabama along the river segments near Centerville and Claiborne (***Appendix F***) and accounted for between 54 and 60 percent of the shortages between 1995 and 2050. These shortages are modeled shortages and do not mean that water withdrawals were curtailed or streams were actually dry.

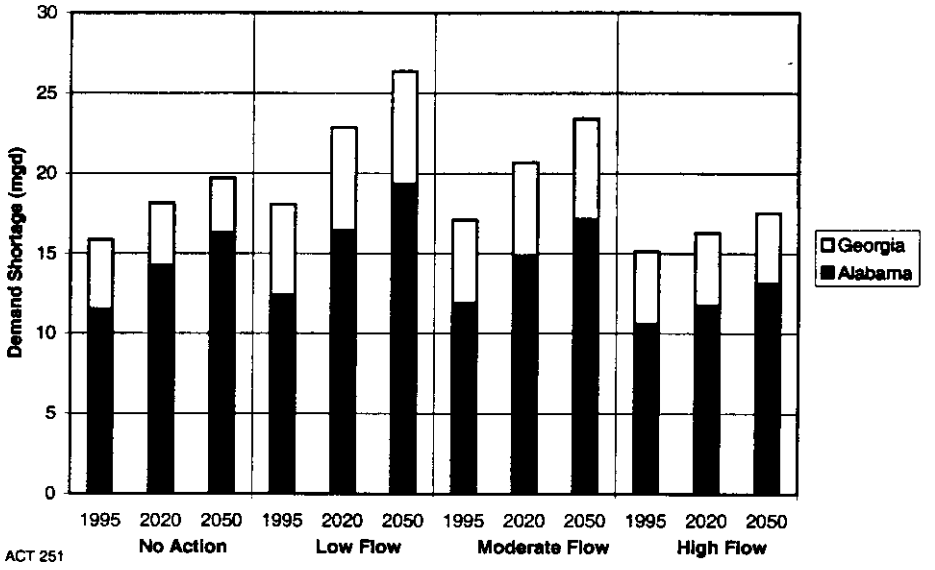
In the high flow scenario, the potential water shortages are the least severe (***Figure 4-69***) and ranged from 15 mgd in 1995 to 18 mgd in 2050. The high flow scenario calls for the maximum release of water from storage reservoirs to meet downstream flow needs, and, as a result, provides the greatest amount of flow to meet water supply demands.

Under the moderate flow scenario the municipal and industrial shortages are slightly higher than the high flow scenario. The shortages for 1995 and 2050 were 17 and 23 mgd, respectively. The moderate scenario included similar municipal and industrial water demands to the no action scenario (see Section 3); however, the differences in reservoir operations resulted in greater shortages for the moderate alternative than the no action alternative.

Municipal and industrial water supply shortages were expectedly highest for the low flow scenario, ranging from 18 mgd for 1995 to 26 mgd in 2050. This scenario included no

conservation measures. In this scenario, rivers have the least amount of available flows to meet demands (*Figure 4-69*).

FIGURE 4-69
Municipal and Industrial Demand Shortages



4.4.1.2.10 Thermal Demand

Steam generation power plants that have closed loop systems with cooling towers have a consumptive use impact. Cooling towers may remove substantial quantities of water through evaporative losses. In the ACT basin, these plants that have consumptive use (i.e., are not once-through facilities) are the Bowen and Gaston plants. However, the consumptive use at Gaston is never zero, and, therefore, was not modeled. In contrast, the once through cooling systems have less effect on consumptive uses, since effectively all the water is returned to the surface water source. Examples of some of these losses include values that are estimated to be as high as 35 to 40 mgd at the Bowen plant (Corps, 1995). The actual losses vary depending on climatic conditions and facility operations.

Thermal requirements were modeled in HEC-5 as a consumptive demand. If net flows, at a point at which thermal demands are present, fell below zero, one or more of the consumptive demands at the point would be affected.

The Hammond coal-fired steam plant uses once-through cooling, which categories it as an nonconsumptive-use plant. Therefore, given the assumptions stated above, there are no water resource shortages at this site (*Appendix F*).

Bowen has two coal-fired plants and one fuel-oil-fired thermal plant with flows measured at the Logan Martin modeling node. The HEC-5 model output data on net flows at that node reveal that for the period of record there were no flows below zero. Therefore, all demands were met for the period of record, with no direct impacts. However, extreme events that have not been recorded could cause net flows to drop below zero at some future time for some duration.

The modeling of water demand shortages indicated municipal and industrial shortages but no thermal shortages because the net stream flows remained above zero in the stream segments with thermal power withdrawals. Thermal power plants have had to curtail operations during low flows because they could not meet the discharge temperature limits.

4.4.1.2.11 Agricultural Demand

Under all alternative scenarios (no action and action alternative flow scenarios), no water supply shortages were identified for agricultural irrigation needs. Results of the modeling indicates that no significant water shortages occur at any of the nodes or planning areas (***Appendix F***). ***Table 4-15*** provides an example of the shortage analysis results from a flow-point in the Alabama-Cahaba subbasin. Assuming the high demand and drought conditions that occurred in 1962, the modeling results predict 1-day shortages of surface water for aquaculture during July and August in 2050 under the low flow scenario. These shortages would not result in damage because 99.96 percent of all agricultural water needs would still be satisfied.

TABLE 4-15
Agricultural Water Supply Shortage (in mgd) for the Low Flow Scenario in 2050

Flow Point	Subbasin	Period Short	No. of Days Shortage	Surface Agricultural Demand	Actual Shortage	Percent of Agricultural Demand Satisfied
480	AL-CAHA	Jul-62	1	10,401	4.28	99.96[a]
480	AL-CAHA	Aug-62	1	8,943	4.96	99.94
329	LWR-ACT	Nov-54	2	294	1.64	99.44

[a] Row 1 indicates that with low flow releases and conditions observed during the drought of 1962, a 1-day shortage in July could be expected in the Alabama-Cahaba subbasin using high agricultural water demands for 2050.

Surface water withdrawals from rivers and mainstream reservoirs account for only a small portion of total agricultural water withdrawals in the ACT/ACF Comprehensive Study area. Consequently, minor variations in historic river flows would not be expected to have a significant impact on agricultural production and income, even with increasing water demands. Corps HEC-5 hydrologic modeling studies show this to be the case.

Through normal flows and controlled releases from reservoirs, the HEC-5 model was able to satisfy all agricultural water needs in the ACT basins through 2050. The few minor shortfalls observed were of short duration and would not affect key plant growth stages. In addition, even where a shortage of a few days was observed, 80 to 100 percent of agricultural water demands were satisfied. Studies comparing yields to water availability show that, until plant water restriction reaches 20 percent or more for several successive days, there is little yield reduction and potential loss of income. Consequently, it appears that the agricultural economy of the ACT basins should suffer no measurable loss of income as a result of alternative flows associated with potential water allocation formulas.

The findings in this report are based on the assumption that groundwater supplies are stable and will provide the major share of agricultural water needs projected in the Comprehensive Study. Reductions in groundwater availability, forcing increased dependence on surface supplies, could substantially change the conclusions of the study.

It should be noted that the modeling of agricultural demand shortages may not fully assess potential seasonal irrigation demands that would occur during a drought. For example, the

State of Georgia has noted that the agricultural demand estimates may exceed the annual demands by a factor of 2 during a drought.

4.4.2 Water Quality

This discussion of water quality reviews the characteristics of the ACT basin that affect the ability of the water resources to meet the various regulatory standards and uses for which they are intended. The water quality of these resources is dependent on the natural characteristics of these basins (climate, precipitation, geology, vegetation, topography, etc.) as well as societally influenced effects (impoundments, point and nonpoint releases, development, etc.). The following sections relate these effects to water quality characteristics of each of the major river basins, along with an overview of the wastewater discharges that affect these resources in the ACT basin. A final section summarizes the water quality features of the groundwater in the ACT basin that may interact with these surface water systems.

4.4.2.1 Affected Environment

Water quality in the ACT basin is of interest to the many people who live in the basin and use its water resources. Surface water is a drinking water source and thus its quality is of utmost importance. The ACT basin has widely ranging land uses, which have significant effects on water quality. Water quality in the basin has been studied on a limited basis, and ***Figure 4-70*** provides a general description of water quality conditions in the ACT basin.

Although the quality of treated wastewater discharges in the basin has improved since the 1970s with the adoption of improved wastewater treatment processes, water quality continues to be a concern from both point sources and unregulated nonpoint sources. Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff.

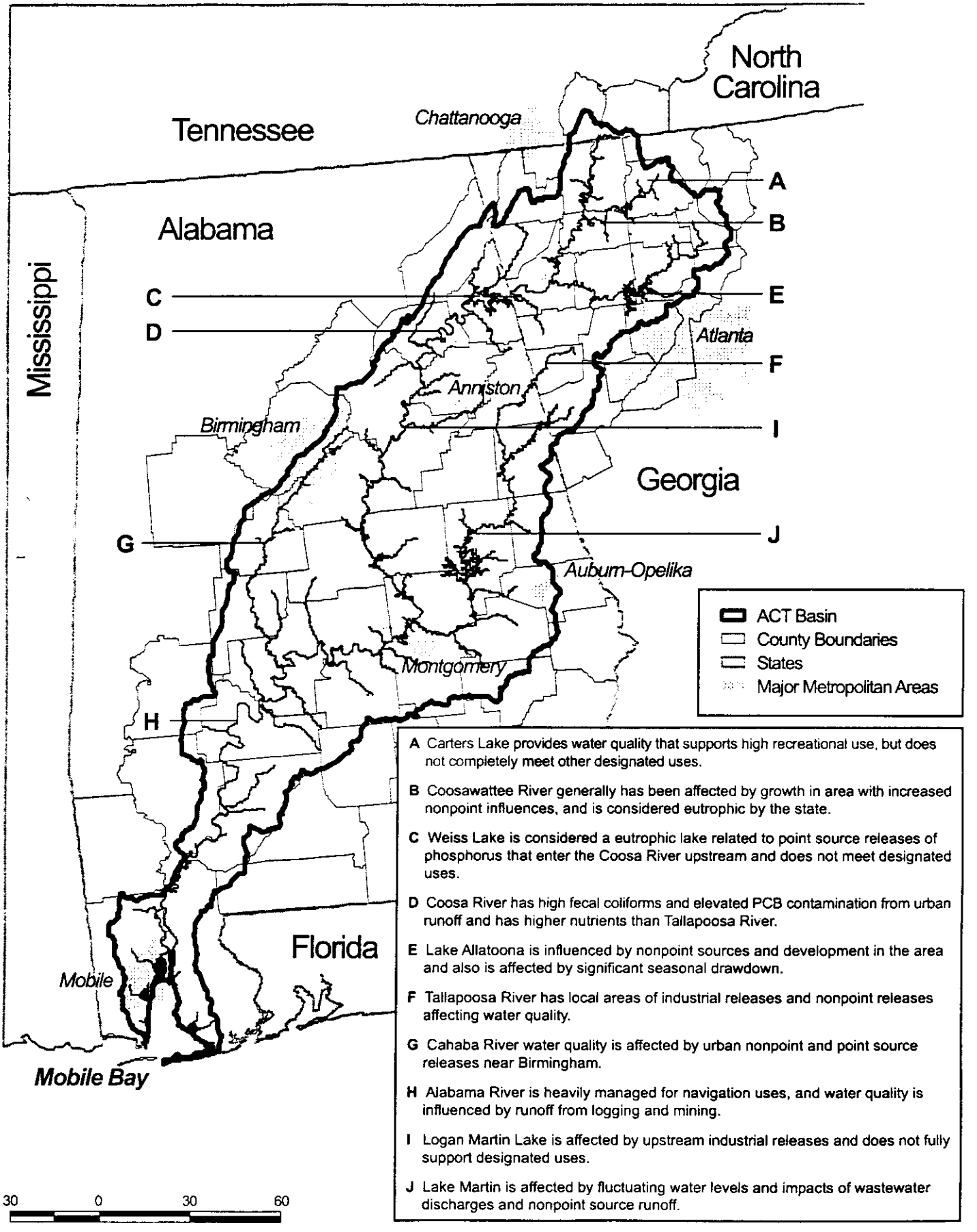
Because of these continued sources of pollution to the basin's surface waters, a substantial number of rivers and lakes in the basin are either not supporting or only partially supporting their designated uses. Georgia, for example, defines partially supporting as waters with (1) chemical data that exceed water quality standards 11 to 25 percent of the time or (2) fish consumption guidelines. Streams are listed as not supporting designated uses if (1) chemical data exceed water quality standards more than 25 percent of the time; (2) fish consumption bans are in place; or (3) acute or chronic tests predict toxicity at low streamflows (GDNR, 1996).

Federal law (the Federal Clean Water Act) and State laws (the State water quality regulations) regulate water quality in the ACT basin. State regulatory agencies establish water quality standards to protect the designated uses of the States' waters. Water quality standards consist of water use classifications, general narrative standards, and numeric standards for water quality parameters and toxic substances. Water use classifications for the rivers in the study area are shown in ***Table 4-16***.

4.4.2.1.1 Comprehensive Study Summary

As part of the Water Quality Element Scope of Work for the ACT/ACF Comprehensive Basin Study, data inventory, usability assessment, and summary analyses were conducted on water quality in both basins. The study included a compilation and assessment of water quality data for compliance with water quality standards (Ashby, et al., 1996). Water quality data were collected from electronic sources, published and unpublished sources, and

FIGURE 4-70
General Water Quality Conditions in the ACT Basin



A Carters Lake provides water quality that supports high recreational use, but does not completely meet other designated uses.

B Coosawattee River generally has been affected by growth in area with increased nonpoint influences, and is considered eutrophic by the state.

C Weiss Lake is considered a eutrophic lake related to point source releases of phosphorus that enter the Coosa River upstream and does not meet designated uses.

D Coosa River has high fecal coliforms and elevated PCB contamination from urban runoff and has higher nutrients than Tallapoosa River.

E Lake Allatoona is influenced by nonpoint sources and development in the area and also is affected by significant seasonal drawdown.

F Tallapoosa River has local areas of industrial releases and nonpoint releases affecting water quality.

G Cahaba River water quality is affected by urban nonpoint and point source releases near Birmingham.

H Alabama River is heavily managed for navigation uses, and water quality is influenced by runoff from logging and mining.

I Logan Martin Lake is affected by upstream industrial releases and does not fully support designated uses.

J Lake Martin is affected by fluctuating water levels and impacts of wastewater discharges and nonpoint source runoff.

TABLE 4-16
Water Use Classifications in the ACT Basin

State	Classification Description	Classification Code
Alabama	1. Public Water Supply	APWS
	2. Swimming and Other Whole Body Water-Contact Sports	AS
	3. Fishing and Wildlife	AFW (Default)
	4. Agricultural and Industrial Water Supply	AAIW
Georgia	5. Drinking Water Supply	GPWS
	6. Recreation	GR
	7. Fishing	GF (Default)
	8. Primary Trout Fishing	GPTF
	9. Secondary Trout Fishing	GSTF
	10. Wild River/Scenic River	GWS

Source: Ashby et al., 1996

data discovery meetings with local, state, federal, and private sources. Although the data were statistically analyzed, the primary goal of the study was to compile and assess the data for suitability for modeling and evaluation. Limited evaluations beyond these purposes were conducted.

Based on the Comprehensive Study, many of the surface waters in the study area were considered to have high or improved water quality. Water quality improvements, particularly in lower biochemical oxygen demand (BOD) and higher dissolved oxygen (DO) values, were noted in many key locations in the basin. General concerns included water quality degradation associated with eutrophication, watershed development, and impacts to fisheries in the study area. Specific areas considered to be markedly impaired in Georgia included the Coosawattee River from Elijay to Carters Lake (eutrophication), and reaches of the Coosa River (high fecal coliform bacteria counts). Major water quality impairments in Alabama were associated with low DO concentrations, organic and nutrient enrichment, siltation, and high fecal coliform bacteria counts in the Alabama, Cahaba, Coosa, and Tallapoosa River basins. Sources of these impairments included both point and nonpoint sources and urban runoff (Ashby et al., 1996).

In the Comprehensive Study analysis of water quality data, exceedances of standards for temperature, DO, and pH were generally associated with reservoirs. The report indicated that depth of sample was not noted, so some DO deviations, for example, could have been from bottom reservoir waters, where low DO is not unusual under thermal stratification conditions. Exceedances were found both in the reservoirs and in the rivers immediately downstream. Water clarity in the reservoir was only 3 feet on average. Median values of color in the reservoir waters were relatively high, indicating the presence of dissolved organic compounds (Ashby et al., 1996).

4.4.2.1.2 Coosa River Basin

The upper part of the Coosa River basin lies in Georgia and is impacted by growth from the metro Atlanta region. GDNR lists 121 miles of streams in the Coosa River basin as partially supporting their designated uses and 371 miles as not supporting their designated uses. Urban runoff and high PCB concentrations in fish are the most commonly cited problems

(GDNR, 1996). Alabama lists 39 miles of streams in the Coosa River basin that either do not support or only partially support their designated uses (ADEM, 1998).

GDNR states that both reservoirs in the ACT basin that are in Georgia (Carters Lake and Lake Allatoona) only partially support their designated uses. This includes nearly 12,000 acres in Lake Allatoona, where urban runoff is listed as the potential cause, and just under 4,000 acres on Carters Lake, where nonpoint source pollution is listed as the potential cause. Fecal coliform bacteria and metals are the principal parameters that are named for exceeding criteria (GDNR, 1996).

Further down the Coosa River basin, gravel mining, feedlots, cropland erosion, and hydroelectric power production are sources for organic enrichment and low DO concentrations in the basin. The Coosa River is generally more enriched in nutrients (nitrogen and phosphorus) than the Tallapoosa River (Ashby et al., 1996). In 1990 a statewide ban on high phosphate detergents in Georgia was implemented to aid the phosphorus reduction process for all water in Georgia and further downstream.

ADEM's 1998 Section 303(d) list indicates that Weiss Lake, Lake H. Neely Henry, Lake Logan Martin, Lay Lake, and Lake Mitchell either do not support or only partially support their designated uses. Priority organics, nutrients, pH, organic enrichment, DO, and flow alteration are listed as some of the causes for the impairment. The sources of these problems range from flow regulation to industrial discharges to urban and rural nonpoint source pollution (ADEM, 1998).

4.4.2.1.3 Tallapoosa River Basin

Gravel mining, feedlots, and cropland erosion were most frequently cited as nonpoint sources of impairments in the Tallapoosa River (Ashby et al., 1996). Alabama has identified only 11 miles of streams in the Tallapoosa River basin that either do not support or only partially support their designated uses (ADEM, 1998). ADEM's 1998 Section 303(d) list indicates that Yates Reservoir does not support or only partially supports its designated uses.

4.4.2.1.4 Alabama River Basin

In the Alabama River basin, logging and mining activities were cited as causes for impairments in the basin. Similar impairments, including high concentrations of metals and low pH values attributed to mining activities were described for the Cahaba River basin (Ashby et al., 1996). According to Alabama's 1998 Section 303(d) listing of impaired waters, 41 miles of streams in the Alabama River basin only partially support their designated use. The Cahaba River basin has 111 miles of streams that either do not support or only partially support their designated uses (ADEM, 1998).

On the Alabama River, water quality indicators such as dissolved oxygen (DO) and biochemical oxygen demand (BOD) have shown trends indicative of degrading conditions (Ashby et al., 1996).

4.4.2.1.5 Wastewater Discharges

Point source discharges of treated wastewater affect the quantity, as well as quality, of water in the ACT basin. Point source discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) and include both municipal and industrial discharges. Wastewater discharges in the ACT basin were identified for the HEC-5Q

modeling (***Appendix D***) and the major discharges from EPA's basins database used in this modeling are presented in ***Figure 4-71***.

Municipal wastewater discharges are a major source of potential nutrient loading in the basin. To address this concern, Georgia has implemented a ban on phosphate-based detergents and has included phosphorus limits on many dischargers. This program has greatly reduced phosphorus loadings in Georgia. Industrial wastewater discharges are also significant point sources regulated under the NPDES program. However, only a small number of the industrial discharges include significant amounts of flow. Industrial discharges can consist of organic heavy oxygen-demanding waste loads from facilities such as pulp and paper mills and large quantities of non-contact cooling water.

Storm sewer discharges, if they are contained in a separate system and not combined with the sanitary flow, typically are discharged directly to surface waters. Stormwater runoff discharges (from both municipalities and industrial sites) are now subject to NPDES permitting. Pollutants typically found in urban stormwater runoff include pathogens (bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons, and other compounds potentially toxic to aquatic life. In addition, runoff often contains sediment, excess organic material, fertilizers, herbicides, and pesticides, which can adversely affect water quality in the receiving stream. Stormwater runoff could also increase the temperature of the receiving stream, which is a particular concern in cold water trout streams. The quantity of urban runoff can also cause problems, contributing to flooding and erosion downstream (GDNR, 1997).

Table 4-17 summarizes municipal and industrial discharges to the ACT basin.

4.4.2.1.6 Nonpoint Source Pollution

Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff. The BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) Nonpoint Source Model was used to estimate current levels of nonpoint source pollution in the basin. The BASINS model was also used to predict loadings for 1995, 2020, and 2050 land uses, as further described in Section 4.4.2.2 and *Appendix D*.

Five key parameters were looked at in the BASINS modeling – flow, BOD, total nitrogen, total phosphorus, and fecal coliform bacteria. The estimated annual pollutant loadings for 1995 from nonpoint sources in the ACT basin are listed below:

- Average flow: 24,702 cfs
- BOD: 13,608 tons
- Total nitrogen: 8,330 tons
- Total phosphorus: 2,447 tons
- Fecal coliform: 2.6 E+17 counts

According to the BASINS model, the greatest contributions to nonpoint source loadings in the ACT basin came from the lower Coosa River basin and the Alabama River (*Appendix D*, 1998).

FIGURE 4-71
Major Wastewater Discharges in the ACT Basin

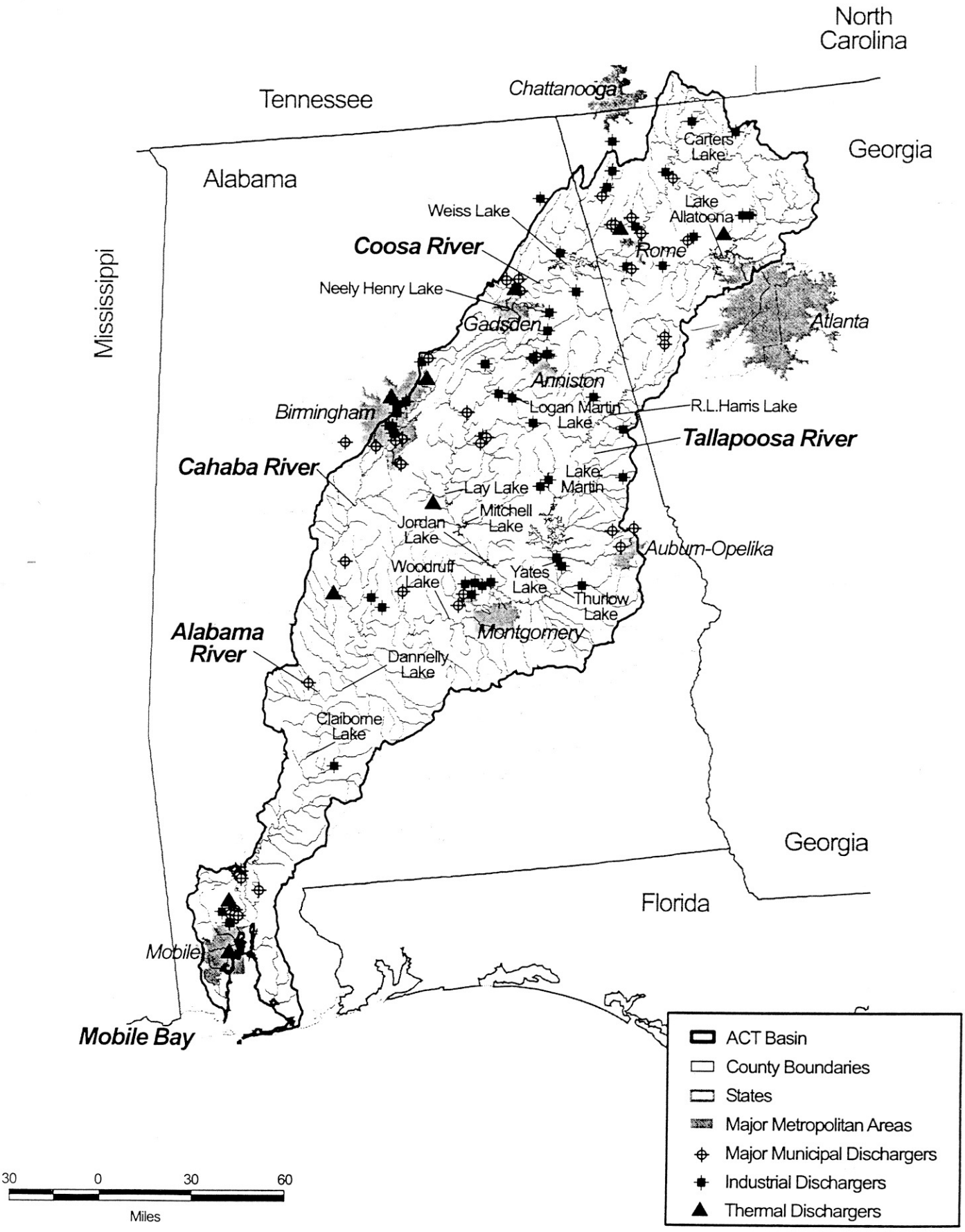


TABLE 4-17
Major Municipal and Industrial Discharges into the ACT Basin

Discharge Type[a]	Point Source Discharge Location[b]	Flow (mgd, 1995)	BOD_5 (mg/L)	NH_3-N (mg/L)	PO_4-P (mg/L)
Alabama River Tributaries					
I	Alabama R. Pulp Purdue Hill (1,2)	63	72	1	1
M	Monroeville, 2 plants (2)	3	30	10	5
I	MacMillan Bloedel (2,3)	18	58	6	3
M	Dallas Co. WWTP (1)	7	30	10	5
M	Selma Valley Cr. WWTP (1)	23	30	10	5
I	Union Camp – Prattville (1)	42	32	4	2
I	International Paper (1)	46	65	4	1
M	Prattville Pine Cr WWTP (2)	3	15	2	5
M	Prattville Autauga Cr WWTP (2)	1	15	2	5
M	Montgomery Econchate WWTP (1)	16	30	10	5
M	Montgomery Towassa WWTP (1)	2	30	10	5
M	Montgomery Catoma Cr WWTP (1)	17	30	10	5
I	General Electric (3)	2	30	2	2
Cahaba River Tributaries					
M	Upstream Cahaba R-Trussville (1,2,4)	9.5	5	1	5
M	Leeds WWTP (1,2,4)	3.2	5	1	5
M	Birmingham Riverview + Hoover Inverness (1,2,4)	5	4	1	5
M	Jefferson County (1,2,4)	50.9	5	1	5
M	Pelham + Alabaster + Helena (1,2,4)	9	4	1	5
M	Bibb + Perry Counties (1)	1.5	30	10	5
Coosa River Tributaries					
M	Wetumpka WWTP (2,4)	1.1	30	15	5
M	Clanton WC-Chilton+Coosa Co. (1)	1.2	30	15	5
I	Avondale Mills+Sylacausa (3,4)	4.0	15	3	5
M	Both Talladega WWTPs (2,3,4)	5.0	15	3	5
PP	Gaston Power Plant: Conversion of phytoplankton to BOD				
I	Kimberly Clark (3)	58.0	44	6	3
M	Choccolocco+Jacksonville (1)	7.3	15	3	5

(CONTINUED)

TABLE 4-17 (CONTINUED)
Major Municipal and Industrial Discharges into the ACT Basin

Discharge Type[a]	Point Source Discharge Location[b]	Flow (mgd, 1995)	BOD_5 (mg/L)	NH_3-N (mg/L)	PO_4-P (mg/L)
M	Pell City WWTP (2,3,4)	1.0	30	15	5
M	Anniston Ft. McClellen (1)	1.8	15	3	5
I	Tyson Foods (3)	0.9	30	14	3
M	Gadsden West (2,3,4)	10.0	30	15	5
M	Gadsden East + Attalla (2,3,4)	5.0	30	15	5
I	Gulf States Steel (3)	77.0	18	1	2
I	Goodyear Tire (3)	14.0	18	3	3
M	Centre Lagoon (1)	0.4	30	15	5
M	Fort Payne – Dekalb Co. (1)	4.0	15	2	5
Upper Coosa River Tributaries					
M	Northwest Cobb WWTP (1)	2.5	10	2	1
M	Cobb: Noonday Creek WWTP (1)	9.1	10	2	1
M	Canton WPCP (1)	2.4	20	10	5
M	Calhoun WWTP (1)	10.8	30	10	5
M	Catsworth WWTP (1)	1.5	30	15	5
P	PO_4 loading to tributaries (average rate of approximately 1000 lb/day)				
M	Cartersville (1)	6.6	25	10	5
M	Both Rome WWTP (1)	18.8	30	15	5
I	Inland Rome (1)	20.0	30	4	2
M	Chattooga (1)	3.2	25	10	5
M	Whitefield (1)	4.1	30	15	5
M	Gilmer (1)	1.5	30	15	5
M	Paulding (1)	0.3	15	3	5
M	Pickens (1)	1.1	30	15	5
M	Plok-Rockmart (1)	3.4	30	15	5
M	Walker (1)	2.8	10	2	5
Tallapoosa River Tributaries (Alabama)					
M	Tuskegee North (1,3)	1.8	30	15	5
M	Tuskegee South (1,3)	1.8	30	15	5
M	Tallassee Lagoon (1)	0.7	30	15	5
M	Alburn N. + Opelika (2,3,4)	4.0	5	1	5

(CONTINUED)

TABLE 4-17 (CONTINUED)
Major Municipal and Industrial Discharges into the ACT Basin

Discharge Type[a]	Point Source Discharge Location[b]	Flow (mgd, 1995)	BOD_5 (mg/L)	NH_3-N (mg/L)	PO_4-P (mg/L)
I	West Point Pepperell (3,4)	1.6	30	5	2
M	Alburn South (2,3,4)	4.0	5	1	5
M	Alexander City+WWTP (1,2)	7.7	23	5	5
M	Ashland WWTP (1)	0.9	30	15	5
I	Tyson Foods Heflin (3)	0.3	30	14	3
M	Haralson + Paulding + Co. (1)	1.0	30	15	5
M	Carrol Co. (1)	5.5	30	15	5
M	Bullock Co. (1)	0.7	30	15	5
M	Randolph Co. (1)	0.7	30	15	5

[a] Type of discharge: M = municipal, I = industrial, PP = power plant, P = phosphorus).

[b] The numbers in parentheses indicate source from which data were obtained:
(1) EPA spreadsheet data (July 1998); (2) Jim Greenfield, EPA, 1998; (3) 1984-88 pipes data
(4) Lott, ADEM, 1998

4.4.2.1.7 Groundwater

Overall, the natural quality of groundwater from all aquifers in the ACT basin is acceptable for public water supply. However, depending on the source aquifer, groundwater of the Valley and Ridge, Cumberland Plateau, and Coastal Plain provinces may have high iron concentrations, high calcium and bicarbonate, or locally elevated chlorine, whereas the groundwater in the Piedmont and Blue Ridge provinces appears to be of consistently good quality.

Overall, groundwater quality is very good for use as drinking water from wells. Since most wells used in public water systems draw from deeper aquifers, the number of contaminated wells is limited.

4.4.2.2 Environmental Consequences

Model results were used to assess the impacts of the no action and action alternative flow scenarios on water quality. Three water quality models were used in this analysis: BASINS, HEC-5Q, and CE-QUAL-W2. The BASINS modeling was conducted by Tetra Tech, Inc. under the direction of EPA and the Corps. The purpose of the BASINS modeling was to assess nonpoint sources and to provide nonpoint source flows and pollutants as inputs to the HEC-5Q and CE-QUAL-W2 models. BASINS used locations of tributary inflow points designated in the HEC-5Q model and major control points designated in the HEC-5 model. The BASINS model uses meteorological data, detailed land use data, and future growth projections to evaluate nonpoint source runoff in the basin. A CE-QUAL-W2 model is being developed by WES to verify and supplement the HEC-5Q results on a limited number of reservoirs in the basin. These results will be incorporated into the final EIS. HEC-5Q and BASINS model summary information are included in *Appendix D*.

The CE-QUAL-W2 studies will be conducted on three reservoirs in the Coosa River basin. GDNR is sponsoring the water quality model of Lake Allatoona, which was conducted by

WES. WES is also performing water quality modeling of Weiss Lake and H. Neely Henry Lake.

4.4.2.2.1 Basinwide Water Quality Modeling

The Corps HEC conducted one-dimensional modeling of the rivers and reservoirs in the ACT basin using the HEC-5Q model. HEC-5Q used data generated by the HEC-5 hydrologic model, point source load projection spreadsheets developed by EPA as part of the Comprehensive Study, and the BASINS model of nonpoint source runoff to predict average concentrations of critical parameters in streams and reservoirs. HEC selected a critical period of analysis to run the HEC-5Q model to determine water quality impacts of the no action and alternative flow scenarios. The years 1984 through 1988 were selected for the analysis. HEC calibrated the HEC-5Q model to water quality data for these periods. This 5-year period includes two major droughts (1986 and 1988). Under drought conditions, water quality is critically affected, with higher temperatures and lower flows causing decreases in dissolved oxygen concentrations and increases in concentrations of other pollutants. Thus, this analysis focuses on the impacts under worst-case conditions in the basin. Under typical or normal conditions, the impacts to water quality would be less pronounced. Unless it is stated otherwise, the values presented in this analysis are the average summer (May to October) values for the 5 years modeled (1984 to 1988).

The HEC-5Q analysis results are presented in ***Appendix D*** for select stream reaches in the basin. The stream reaches were chosen where impacts were most likely to occur, due to either natural or unnatural conditions (i.e., wastewater discharges or water withdrawals). One of the key parameters modeled on stream water quality in the ACT basin was dissolved oxygen (DO). Other parameters included BOD_5 and nutrients. Dissolved oxygen concentrations are especially important in determining the overall quality or health of a river. Dissolved oxygen concentrations above 5 mg/L are desirable. Water quality standards in Georgia, for example, require a daily average dissolved oxygen concentration of 5 mg/L for the Drinking water Recreation, and Fishing water use classification (GNDR, 1996). On the other end of the spectrum, dissolved oxygen concentrations below 3 mg/L are not desirable for aquatic life, and DO values of 1 mg/L or below indicate very low levels of oxygen in the water, too low to support aquatic life. This indicates very poor water quality. The HEC-5Q model predicted the number of days per year that the river at a given point would be below certain dissolved oxygen levels.

In the reservoirs in the basin, the modeling effort focused on chlorophyll *a* concentrations, nutrient loading in the reservoirs, reservoir retention time, and tailwater DO concentrations. The Corps and EPA chose these parameters in consultation with the Corps water quality modelers as being good indicators of water quality trends in the basin's reservoirs.

Although the initial development and calibration of the HEC-5Q model was accomplished for hydrologic conditions from 1984 to 1988, subsequent simulations for the 1995, 2020, and 2050 water demand levels were also performed using the 1984 to 1988 hydrologic data. The majority of impacts here are presented for the average summer period for the 5-year model simulation. For a detailed review of how the water quality results vary by year within the 5-year period, the complete model output is provided in ***Appendix D***. In general, 1986 conditions proved to be most critical within this time frame. During 1986, the southeast was facing a serious drought, which lowered stream flows and water quality in many parts of the basin.

4.4.2.2.2 Upper Coosa River Subbasin Impacts

The Upper Coosa River Subbasin extends from the river's headwaters in Tennessee and Georgia to the joining of the Oostanaula and Etowah Rivers at Rome, Georgia. There are two major reservoirs in the Upper Coosa River Subbasin: Lake Allatoona and Carters Lake. Under the no action alternative, the HEC-5Q model predicted low dissolved oxygen in the tailwaters of Allatoona Dam, but none below Carters Dam or Carters Reregulation Dam (*Table 4-18*). On the tributaries to the Coosa River (Coosawattee, Conasauga, Oostanaula, and Etowah Rivers), there were no significant occurrences of dissolved oxygen concentrations below 5 mg/L under the no action alternative.

TABLE 4-18
Upper Coosa River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
Carters	0	0	1
Carters Reregulation	0	0	0
Allatoona	172	199	209
River DO: Days Below 5 mg/L			
Coosawattee at Resaca (mile 693.1)	0	0	0
Conasauga at Resaca (mile 693.0)	0	0	0
Oostanaula at Hwy75 (mile 685.1)	0	0	0
Downstream of Oostanaula (mile 646.0)	0	0	0
Etowah at Allatoona (mile 717.0)	0	0	0
Etowah at Euharlee (mile 672.1)	0	1	1
Etowah at Rome (mile 648.0)	0	0	0
Coosa above Weiss (mile 638.9)	0	0	3

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

The HEC-5Q model was run for 5 years: 1984 through 1988. The results in *Table 4-18* are presented as the average results over the 5 years. However, it is also interesting to assess the impacts for each of the 5 years modeled to determine the variability in water quality that can occur under various hydrologic conditions. As an example of the variability, the Coosa River above Weiss Lake was selected as a representative location at the downstream point of the subbasin to illustrate stream dissolved oxygen concentration variability over the years 1984 to 1988 (*Figure 4-72*).

Another interesting evaluation, presented in *Table 4-19,* is a comparison of the average percent of the stream flow that is made up of wastewater (both municipal and industrial combined). For the no action alternative, these data illustrate that the percentage would increase in an upstream to downstream manner and also would increase from 1995 demands to 2050 demands.

FIGURE 4-72
Summer Dissolved Oxygen in Coosa River Above Weiss. No Action Alternative

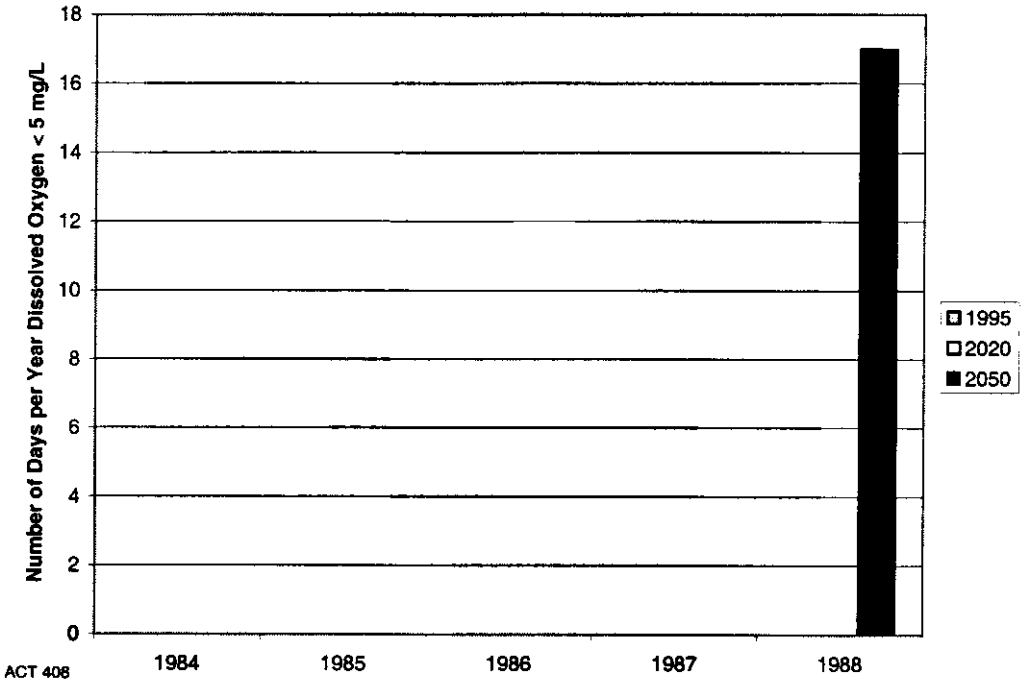


TABLE 4-19
Upper Coosa River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Coosawattee at Resaca (mile 693.1)	3.9	5.1	6.7
Conasauga at Resaca (mile 693.0)	2.3	2.9	3.8
Oostanaula at Hwy75 (mile 685.1)	3.2	4.1	5.5
Downstream of Oostanaula (mile 646.0)	2.6	3.4	4.5
Etowah at Allatoona (mile 717.0)	1.7	2.6	3.6
Etowah at Euharlee (mile 672.1)	3.9	5.8	8.3
Etowah at Rome (mile 648.0)	3.5	5.2	7.2
Coosa above Weiss (mile 638.9)	5.1	6.7	9.5

Average May to October values predicted by HEC-5Q model for the years 1984 to 1988

Reservoirs in the upper Coosa River subbasin include Lake Allatoona and Carters Lake. According to the HEC-5Q model, both would have moderate chlorophyll *a* concentrations under the no action alternative (***Table 4-20***). Lake Allatoona would have the greatest increase in chlorophyll *a* concentrations between 1995 and 2050, increasing from 12 µg/L to 23 µg/L. There would be no appreciable change in retention time for any of the reservoirs between 1995 and 2050. The model shows that phosphorus loadings are the greatest above the Carters Reregulation Dam and that these loadings are predicted to increase by 35 percent from 1995 to 2050.

TABLE 4-20
Upper Coosa River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
Carters	9.5	10.9	13.4
Carters Reregulation	5.0	4.9	4.7
Allatoona	12.1	17.8	23.5
Summer Retention Time (days)			
Carters	19.9	19.9	19.9
Carters Reregulation	0.6	0.6	0.6
Allatoona	38.9	37.0	35.8
Summer Phosphorus Loading (pounds/acre/month)			
Carters	5.0	5.9	7.2
Carters Reregulation	24.3	27.7	32.9
Allatoona	3.3	4.0	4.9

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

A comparison of the action alternative scenarios to the no action alternative in the upper Coosa River subbasin (*Table 4-21*) indicates that all three action alternative scenarios produce similar stream dissolved oxygen results compared to the no action alternative. The only exception is on the Coosa River above Weiss Lake, where the dissolved oxygen concentrations for the low flow scenario are predicted to be below 5 mg/L for 33 days compared to only 3 days for the no action alternative.

TABLE 4-21
Upper Coosa River Subbasin. River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Reservoir Tailwater DO: Days Below 5 mg/L				
Carters	1	1	0	0
Carters Reregulation	0	0	0	0
Allatoona	209	210	215	212
River DO: Days Below 5 mg/L				
Coosawattee at Resaca (mile 693.1)	0	0	0	0
Conasauga at Resaca (mile 693.0)	0	0	0	0
Oostanaula at Hwy75 (mile 685.1)	0	0	0	0
Downstream of Oostanaula (mile 646.0)	0	0	0	0
Etowah at Allatoona (mile 717.0)	0	0	0	0
Etowah at Euharlee (mile 672.1)	1	2	2	1
Etowah at Rome (mile 648.0)	0	0	0	0
Coosa above Weiss (mile 638.9)	3	33	0	4

Average summer predicted by HEC-5Q model for the years 1984 to 1988

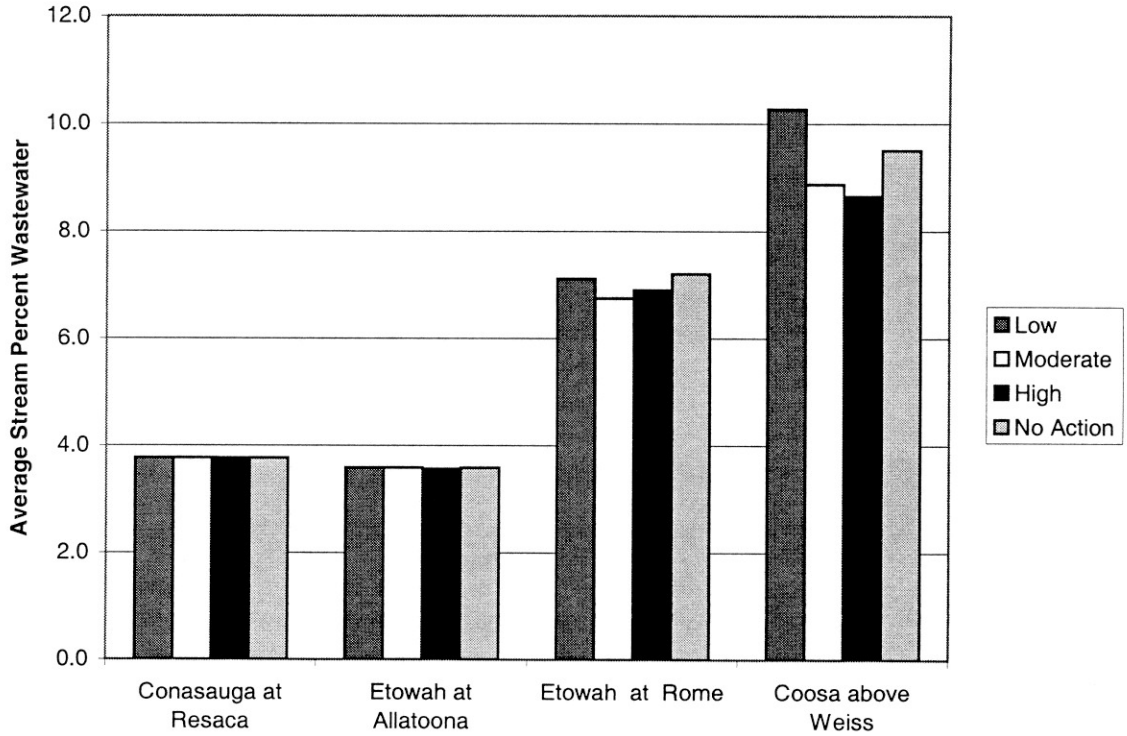
Table 4-22 illustrates the differences in percent wastewater component in stream flow under the action and no action alternatives. In general, the low flow scenario produced the highest percentage of wastewater in stream flow, followed by the moderate and then the high flow scenarios. The low flow scenario generally produced results greater than the no action alternative, whereas the moderate and high flow scenarios produced stream percentages that were generally less than the no action alternative (*Figure 4-73*).

TABLE 4-22
Upper Coosa River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Coosawattee at Resaca (mile 693.1)	6.7	7.3	5.6	5.8
Conasauga at Resaca (mile 693.0)	3.8	3.8	3.8	3.8
Oostanaula at Hwy75 (mile 685.1)	5.5	5.8	4.8	5.0
Downstream of Oostanaula (mile 646.0)	4.5	4.7	4.1	4.1
Etowah at Allatoona (mile 717.0)	3.6	3.6	3.6	3.6
Etowah at Euharlee (mile 672.1)	8.3	9.5	7.6	8.2
Etowah at Rome (mile 648.0)	7.2	7.1	6.8	6.9
Coosa above Weiss (mile 638.9)	9.5	10.3	8.9	8.7

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-73
Average Stream Percent Wastewater During Summer in Coosa River Subbasin. 2050 Demands



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The HEC-5Q model predicted that chlorophyll *a* concentrations and phosphorus loadings would be comparable under the action alternative flow scenarios and the no action alternative (***Table 4-23***). Lake Allatoona would have chlorophyll *a* concentrations in the low 20s, while Carters Lake would have chlorophyll *a* concentrations in the low teens. Summer retention times would be greatest under the low flow scenario and lowest under the high flow scenario. Some discrepancies between the action alternative scenarios and the no action alternative can be attributed to the decisions made in establishing the HEC-5 model runs for the three scenarios (see Section 4.4.1.2). The HEC-5Q model used flow data input

from HEC-5, so that the discussion in earlier sections regarding assumptions and the cautions concerning the analysis of the flow data are also applicable to the water quality data.

TABLE 4-23
Upper Coosa River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
Carters	13.4	12.9	13.1	14.1
Carters Reregulation	4.7	4.8	4.3	6.4
Allatoona	23.5	20.9	22.2	23.2
Summer Retention Time (days)				
Carters	19.9	19.2	17.5	12.4
Carters Reregulation	0.6	0.7	0.5	0.7
Allatoona	35.8	57.4	47.6	32.3
Summer Phosphorus Loading (pounds/acre/month)				
Carters	7.2	7.1	7.8	9.2
Carters Reregulation	32.9	29.8	34.6	31.0
Allatoona	4.9	3.6	4.1	5.5

Average summer predicted by HEC-5Q model for the years 1984 to 1988

Overall, the action alternative scenarios appear to have limited impacts on water quality in the Upper Coosa River Subbasin compared to the no action alternative. In general, the high flow scenario would slightly improve water quality in the streams in particular because of the increased amount of dilution. The high flow scenario produced fewer instances of low dissolved oxygen in the streams. In the reservoirs, the low flow scenario generally resulted in lower chlorophyll *a* concentrations and phosphorus loadings.

4.4.2.2.3 Lower Coosa River Subbasin Impacts

The lower Coosa River subbasin extends from the Georgia-Alabama border to the confluence of the Coosa River with the Tallapoosa River near Montgomery, Alabama. There are seven reservoirs in this subbasin, with no free-flowing river reaches between the reservoirs and dams. Dissolved oxygen concentrations in the Coosa River at Montgomery were usually above 5 mg/L. Over the 5-year modeling period (1984 to 1988) the occurrence of low dissolved oxygen concentrations in the Coosa River at Montgomery varied from a high of 50 days in one year to a low of zero days in a year (***Figure 4-74***). Below each of the seven dams on the lower Coosa River, the HEC-5Q model predicted dissolved oxygen concentrations below 5 mg/L under the no action alternative (***Table 4-24***). The model also predicted slight increases in the occurrence of low dissolved oxygen concentrations from 1995 to 2050 under the no action alternative (***Figure 4-75***).

FIGURE 4-74
Summer Dissolved Oxygen in Coosa River at Montgomery. No Action Alternative

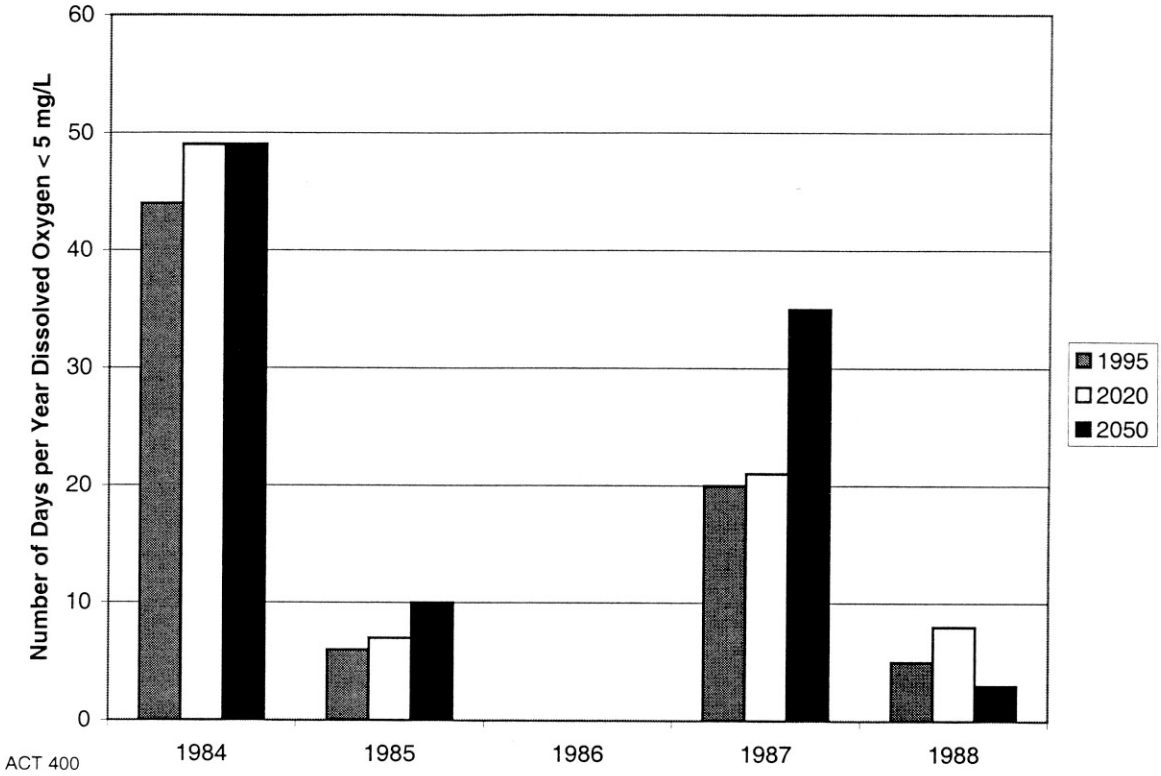

TABLE 4-24
Lower Coosa River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
Weiss	75	77	78
H. Neely Henry	14	16	15
Logan Martin	67	76	91
Lay	141	145	150
Mitchell	131	135	139
Bouldin	56	58	59
Jordan	99	101	113
River DO: Days Below 5 mg/L			
Coosa at Montgomery 364.1	15	17	19

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-75
Summer Dissolved Oxygen in Lower Coosa River Subbasin Reservoir Tailraces. No Action Alternative

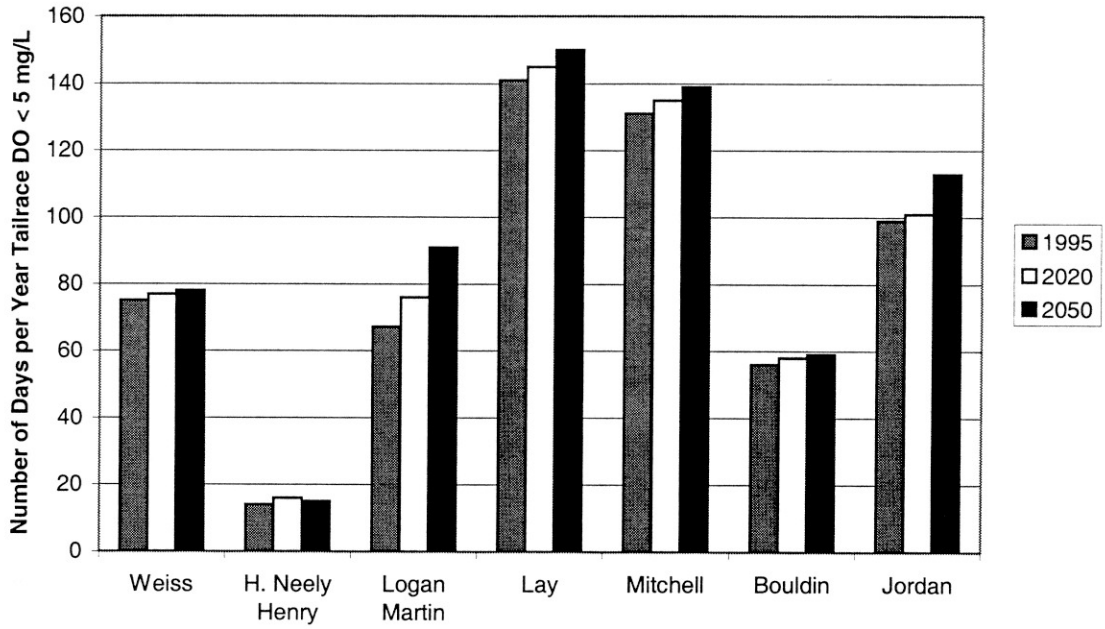

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Table 4-25 presents a comparison of the average percent of the stream flow that is made up of wastewater (both municipal and industrial combined). These data show that there is little contribution of wastewater to the Coosa River at Montgomery.

TABLE 4-25
Lower Coosa River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Coosa at Montgomery 364.1	4.6	5.0	5.9

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

At the seven reservoirs on the lower Coosa River, chlorophyll *a* concentrations generally decrease from upstream to downstream (***Figure 4-76***). The greatest chlorophyll *a* concentrations are predicted in Weiss Lake (28-35 µg/L) for the no action alternative (***Table 4-26***). For the no action alternative, chlorophyll *a* concentrations increased from 1995 to 2050. Retention times were generally low for all of the reservoirs on the lower Coosa River. Phosphorus loadings under the no action alternative ranged from a low of 5 pounds/acre/month at Weiss Lake to 16 pounds/acre/month at Lake Mitchell.

FIGURE 4-76
Reservoir Summer Chlorophyll *a* Concentrations in Lower Coosa River Subbasin. No Action Alternative

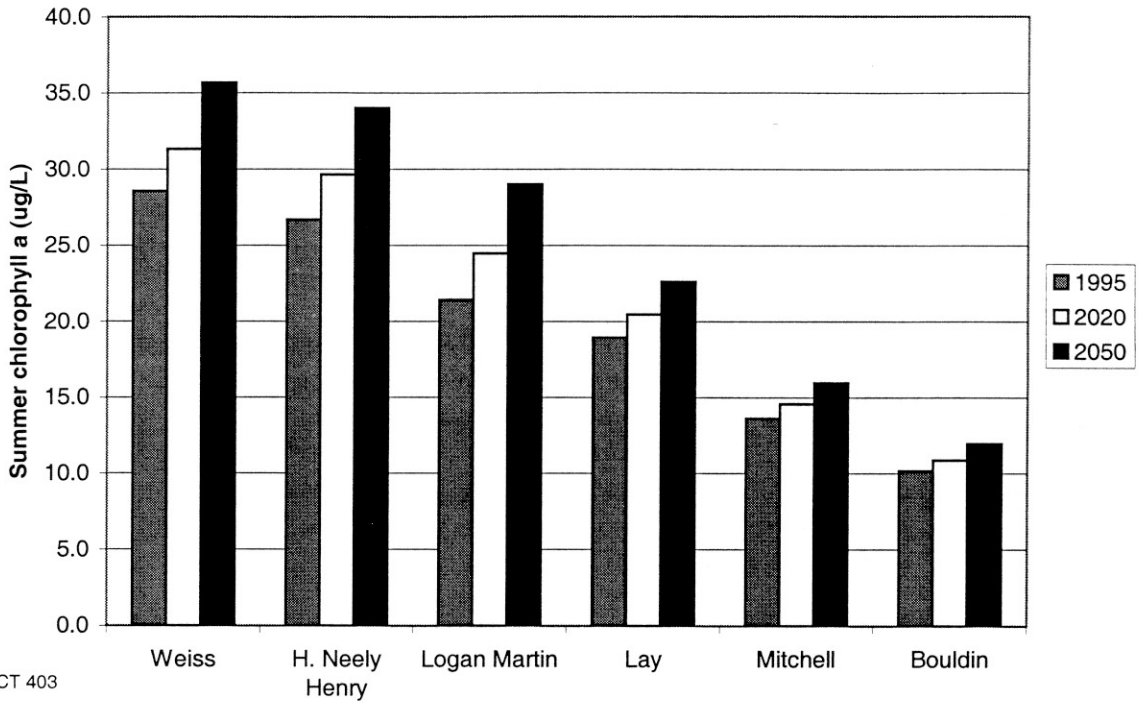

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TABLE 4-26
Lower Coosa River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
Weiss	28.6	31.3	35.7
H. Neely Henry	26.7	29.6	34.1
Logan Martin	21.4	24.5	29.0
Lay	18.9	20.5	22.6
Mitchell	13.6	14.6	15.9
Bouldin	10.2	10.9	12.0
Jordan	N/A	N/A	N/A
Summer Retention Time (days)			
Weiss	9.9	9.9	9.8
H. Neely Henry	3.3	3.3	3.1
Logan Martin	6.7	6.7	6.6
Lay	7.1	7.2	7.2
Mitchell	4.3	4.3	4.4
Bouldin	5.6	5.6	5.9
Jordan	N/A	N/A	N/A

(CONTINUED)

TABLE 4-26 (CONTINUED)
Lower Coosa River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Phosphorus Loading (pounds/acre/month)			
Weiss	5.5	6.3	7.9
H. Neely Henry	8.2	9.2	11.3
Logan Martin	7.2	8.1	9.7
Lay	7.5	8.6	10.4
Mitchell	13.5	14.8	16.6
Bouldin	9.6	10.4	11.6
Jordan	N/A	N/A	N/A

Average summer values predicted by HEC-5Q model for the years 1984 to 1988
N/A Not available

A comparison of the action alternative scenarios to the no action alternative in the lower Coosa River Subbasin (*Table 4-27*) indicates that the action alternative scenarios generally produce lower dissolved oxygen concentrations, with the exception of Jordan Lake (*Figure 4-77*). The high flow scenario generally produced better dissolved oxygen concentrations than the low flow scenario.

TABLE 4-27
Lower Coosa River Subbasin. River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Reservoir Tailwater DO: Days Below 5 mg/L				
Weiss	78	95	89	93
H. Neely Henry	15	27	24	20
Logan Martin	91	73	87	98
Lay	150	150	153	151
Mitchell	139	142	143	139
Bouldin	59	60	57	57
Jordan	113	74	62	57
River DO: Days Below 5 mg/L				
Coosa at Montgomery 364.1	19	21	14	13

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Table 4-28 shows that there is no significant difference between alternatives in the percent of wastewater in the lower Coosa River in the summer months.

The HEC-5Q model predicted no significant change in chlorophyll *a* concentrations between the action alternative flow scenarios and the no action alternative (*Table 4-29* and *Figure 4-78*). Within the action alternative flow scenarios, the chlorophyll *a* concentrations were higher for the high flow scenario than the low flow scenario. These differences were minor, however, and did not differ significantly from the no action alternative. Retention times in the reservoirs were lowest for the high flow scenario and highest for the low flow scenario. The retention times under the no action alternative generally fell between the high and low scenario. Summer phosphorus loadings in the Lower Coosa River Subbasin showed no significant difference between the action alternative scenarios and the no action alternative.

FIGURE 4-77
Summer Dissolved Oxygen in Lower Coosa River Subbasin Reservoirs. Action Alternative. 2050 Demands

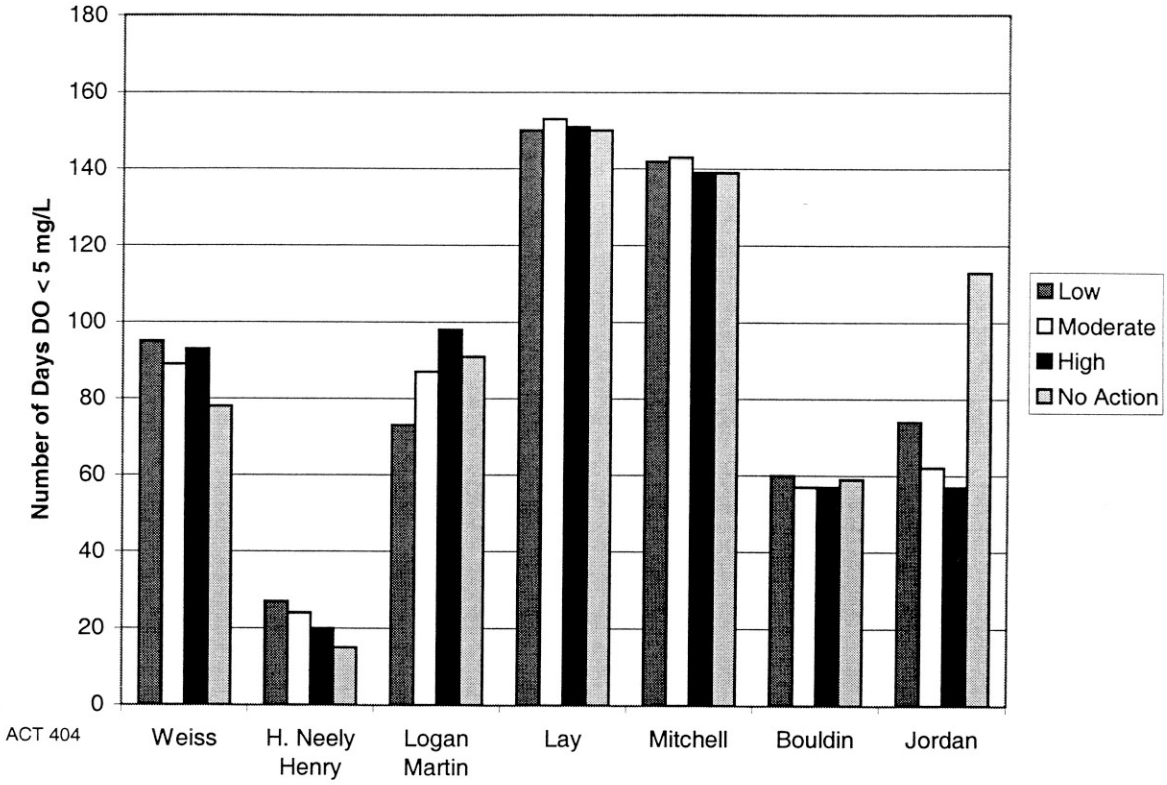


TABLE 4-28
Lower Coosa River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Coosa at Montgomery 364.1	5.9	5.6	5.8	6.1

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-78
Reservoir Summer Chlorophyll *a* Concentrations in Lower Coosa River Subbasin. Action Alternative. 2050 Demands.

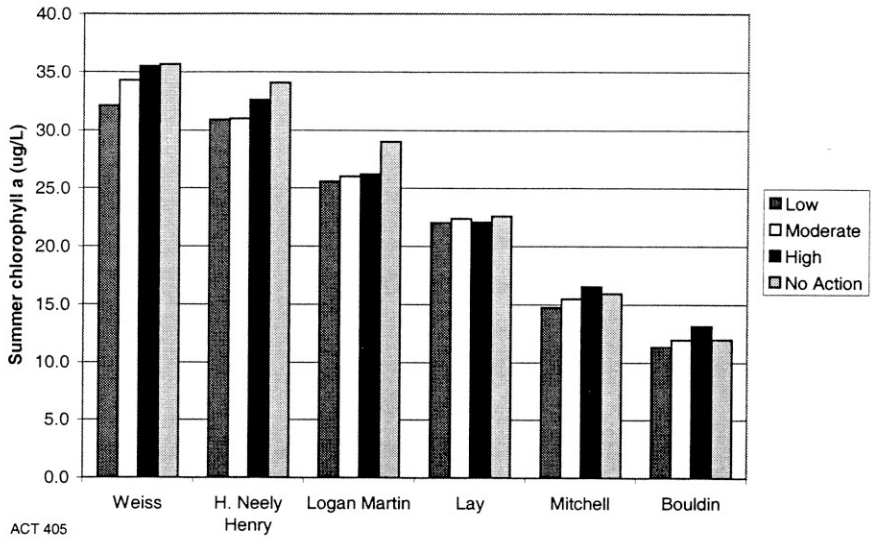


TABLE 4-29
Lower Coosa River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
Weiss	35.7	32.1	34.3	35.5
H. Neely Henry	34.1	30.9	31.0	32.6
Logan Martin	29.0	25.6	26.0	26.2
Lay	22.6	22.0	22.4	22.1
Mitchell	15.9	14.7	15.5	16.6
Bouldin	12.0	11.3	12.0	13.1
Jordan	N/A	N/A	N/A	N/A
Summer Retention Time (days)				
Weiss	9.8	12.5	11.2	9.2
H. Neely Henry	3.1	4.4	4.0	3.3
Logan Martin	6.6	8.4	7.5	6.6
Lay	7.2	7.6	7.3	6.2
Mitchell	4.4	4.6	4.5	3.8
Bouldin	5.9	6.1	5.9	5.1
Jordan	N/A	N/A	N/A	N/A
Summer Phosphorus Loading (pounds/acre/month)				
Weiss	7.9	7.0	7.3	7.9
H. Neely Henry	11.3	10.3	10.1	10.9
Logan Martin	9.7	9.2	9.2	9.6
Lay	10.4	10.4	10.4	10.8
Mitchell	16.6	16.6	16.6	17.3
Bouldin	11.6	11.7	11.7	12.0
Jordan	N/A	N/A	N/A	N/A

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Overall, there appeared to be no significant difference between the action alternative scenarios and the no action alternative in the lower Coosa River subbasin.

4.4.2.2.4 Tallapoosa River Subbasin Impacts

The Tallapoosa River Subbasin extends from the headwaters in Georgia to the confluence of the Tallapoosa River with the Coosa River near Montgomery, Alabama. There are four reservoirs on the Tallapoosa River. Under the no action alternative, the HEC-5Q model predicted that there would be a significant numbers of days when the dissolved oxygen would be below 5 mg/L below Harris Dam (***Table 4-30***). The model also predicted that there would be low dissolved oxygen concentrations below Martin Dam. On the Tallapoosa River itself, the model predicted that dissolved oxygen concentrations would almost always be above 5 mg/L.

TABLE 4-30
Tallapoosa River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
Harris	196	199	202
Martin	33	34	37
Yates	0	0	0
Thurlow	0	0	0
River DO: Days Below 5 mg/L			
Tallapoosa at Heflin 547.0	0	0	0
Tallapoosa above Harris 528.9	0	0	0
Little Tallapoosa at Hwy100 530.0	0	0	0
Tallapoosa at Wadley 485.7	1	1	1
Tallapoosa above Martin 445.9	0	0	0
Tallapoosa at Tallassee 407.8	0	0	0
Tallapoosa at Montgomery 365.1	0	0	0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Table 4-31 shows that very little of the water in the Tallapoosa River comes from wastewater discharges.

TABLE 4-31
Tallapoosa River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Tallapoosa at Heflin 547.0	0.6	0.9	1.3
Tallapoosa above Harris 528.9	0.5	0.7	0.9
Little Tallapoosa at Hwy100 530.0	3.0	3.9	5.2
Tallapoosa at Wadley 485.7	1.3	1.6	2.0
Tallapoosa above Martin 445.9	0.5	0.6	0.8
Tallapoosa at Tallassee 407.8	1.0	1.2	1.4
Tallapoosa at Montgomery 365.1	1.2	1.5	1.8

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Reservoirs on the Tallapoosa River had relatively low chlorophyll *a* concentrations under the no action alternative. These concentrations generally increased from 1995 to 2050 under the no action alternative (***Table 4-32***). Retention times were greatest at Lakes Harris and

Martin. These retention times did not vary significantly between 1995 and 2050 under the no action alternative. Summer phosphorus loadings were greatest at the Yates and Thurlow reservoirs. Phosphorus loadings at these locations increased about 20 percent between 1995 and 2050 under the no action alternative.

TABLE 4-32
Tallapoosa River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
Harris	11.6	13.4	15.6
Martin	5.4	5.7	6.1
Yates	7.7	7.9	8.3
Thurlow	7.4	7.5	7.7
Summer Retention Time (days)			
Harris	47.9	47.3	46.5
Martin	86.2	86.0	85.2
Yates	2.7	2.7	2.7
Thurlow	0.9	0.9	0.9
Summer Phosphorus Loading (pounds/acre/month)			
Harris	2.4	2.8	3.3
Martin	0.7	0.8	0.9
Yates	14.5	15.5	17.4
Thurlow	37.5	40.2	45.0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Under the action alternative scenarios, the HEC-5Q model predicts higher dissolved oxygen concentrations below Harris and Martin Dams compared to the no action alternative (*Table-4-33*). Dissolved oxygen concentrations had the fewest days below 5 mg/L for the high flow scenario. In the Tallapoosa River itself there were no significant days when the dissolved oxygen concentration was below 5 mg/L for either of the alternatives.

TABLE 4-33
Tallapoosa River Subbasin. River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Reservoir Tailwater DO: Days Below 5 mg/L				
Harris	202	152	144	143
Martin	37	33	32	5
Yates	0	0	0	0
Thurlow	0	0	0	0
River DO: Days Below 5 mg/L				
Tallapoosa at Heflin 547.0	0	0	0	0
Tallapoosa above Harris 528.9	0	0	0	0
Little Tallapoosa at Hwy100 530.0	0	0	0	0
Tallapoosa at Wadley 485.7	1	1	1	1
Tallapoosa above Martin 445.9	0	0	0	0
Tallapoosa at Tallassee 407.8	0	0	0	0
Tallapoosa at Montgomery 365.1	0	0	0	0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Table 4-34 shows that under the action alternative scenarios there would be no significant change in the percent of wastewater in the river compared to the no action alternative.

TABLE 4-34
Tallapoosa River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Tallapoosa at Heflin 547.0	1.3	1.2	1.3	1.3
Tallapoosa above Harris 528.9	0.9	0.9	0.9	0.9
Little Tallapoosa at Hwy100 530.0	5.2	5.2	5.2	5.2
Tallapoosa at Wadley 485.7	2.0	1.6	1.5	1.5
Tallapoosa above Martin 445.9	0.8	1.1	1.1	1.1
Tallapoosa at Tallassee 407.8	1.4	1.6	1.5	1.4
Tallapoosa at Montgomery 365.1	1.8	2.1	1.9	1.8

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Chlorophyll *a* concentrations predicted by the HEC-5Q model under the action alternative scenarios generally bracketed the concentrations under the no action alternative (*Table 4-35*). Retention times were greater under the low and moderate flow scenarios compared to the no action alternative. Retention times under the high flow scenario were similar to the no action alternative. Phosphorus loadings were generally similar under the action and no action alternatives.

TABLE 4-35
Tallapoosa River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
Harris	15.6	14.6	14.9	16.3
Martin	6.1	5.1	5.7	6.6
Yates	8.3	7.6	8.6	9.9
Thurlow	7.7	7.4	7.7	8.9
Summer Retention Time (days)				
Harris	46.5	58.7	56.5	47.0
Martin	85.2	108.2	98.2	83.0
Yates	2.7	3.2	3.1	2.5
Thurlow	0.9	1.0	1.0	0.8
Summer Phosphorus Loading (pounds/acre/month)				
Harris	3.3	3.2	3.2	3.3
Martin	0.9	1.0	1.0	1.0
Yates	17.4	18.5	17.9	19.6
Thurlow	45.0	48.5	45.4	49.4

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

4.4.2.2.5 Alabama River Subbasin Impacts

The Alabama River subbasin extends from the confluence of the Coosa and Tallapoosa Rivers to Mobile, Alabama. The subbasin also includes the Cahaba River. The HEC-5Q model predicted low dissolved oxygen concentrations below the R.F. Henry Dam and in the Cahaba River above Millers Ferry Dam under the no action alternative (*Table 4-36* and *Figure 4-79*). The number of days with dissolved oxygen concentrations below 5 mg/L increased at these locations between 1995 and 2050.

TABLE 4-36
Alabama River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
R. F. Henry	19	23	28
Lake Purdy	0	0	0
Millers Ferry	2	3	3
Claiborne	0	0	0
River DO: Days Below 5 mg/L			
Cahaba at Caldwell 387.9	0	0	0
Cahaba at Helena 65.1	0	0	0
Cahaba at Centerville 324.9	0	0	1
Cahaba at Harrisburg 307.8	1	2	2
Cahaba at Marion Junction 265.3	0	0	0
Cahaba above Millers Ferry 250.2	20	24	27
Alabama R. at Cutoff 64.9	0	0	0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-79
Summer Dissolved Oxygen in Alabama River Subbasin Reservoirs. No Action Alternative.

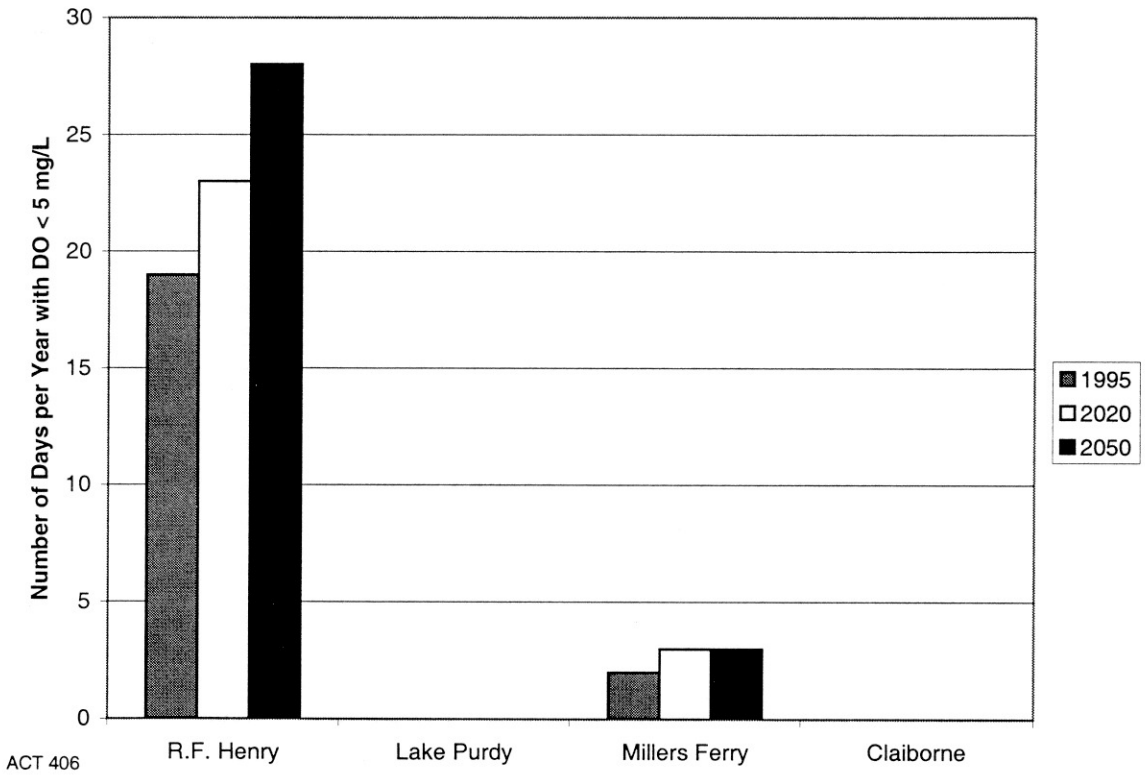


Table 4-37 shows that a significant portion of the flow in the upper Cahaba River is composed of wastewater. Farther down the Cahaba River and into the Alabama River, the percentage of wastewater significantly decreased.

TABLE 4-37
Alabama River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Cahaba at Caldwell 387.9	25.7	30.8	40.8
Cahaba at Helena 365.1	47.1	52.8	63.4
Cahaba at Centerville 324.9	3.1	2.8	3.5
Cahaba at Harrisburg 307.8	3.4	3.6	5.0
Cahaba at Marion Junction 265.3	2.1	2.1	2.6
Cahaba above Millers Ferry 250.2	2.2	2.1	2.7
Alabama R. at Cutoff 64.9	4.8	5.2	5.7

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Chlorophyll *a* concentrations in the reservoirs are high at Lake Purdy in the upper reaches of the Cahaba River (*Table 4-38*). From 1995 to 2050 the chlorophyll *a* concentrations in Lake Purdy were predicted to increase from 42 µg/L to 61 µg/L under the no action alternative. The retention time for Lake Purdy was also the highest of the reservoirs in this subbasin. Summer phosphorus loadings were predicted to be the greatest at Claiborne under the no action alternative.

TABLE 4-38
Alabama River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
R. F. Henry	11.3	12.0	13.0
Lake Purdy	42.7	48.6	61.0
Millers Ferry	21.0	23.0	25.0
Claiborne	25.0	26.6	28.2
Summer Retention Time (days)			
R. F. Henry	2.8	2.8	2.9
Lake Purdy	55.7	52.3	47.6
Millers Ferry	3.2	3.2	3.2
Claiborne	0.8	0.8	0.8
Summer Phosphorus Loading (pounds/acre/month)			
R. F. Henry	11.7	13.3	15.3
Lake Purdy	8.2	9.5	11.6
Millers Ferry	11.7	13.4	15.3
Claiborne	29.7	34.1	38.9

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

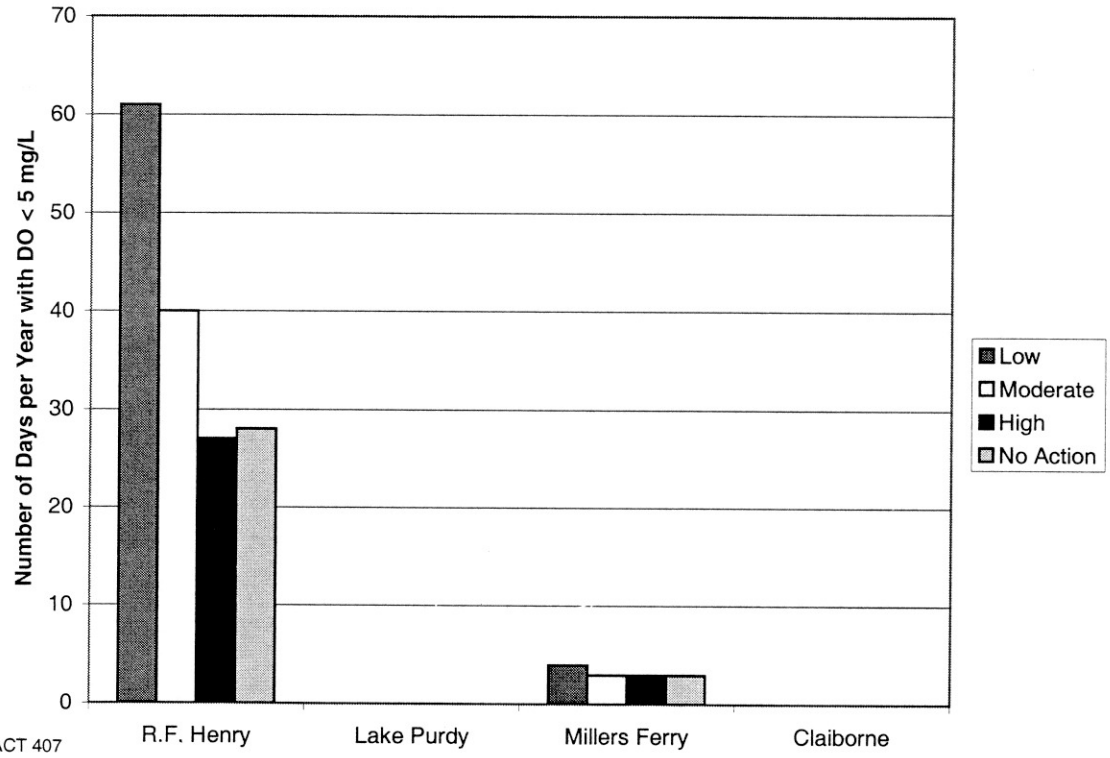
A comparison of the action alternative scenarios and the no action alternative shows that low dissolved oxygen conditions would increase under the low and moderate scenarios compared to the no action alternative below R.F. Henry Dam (*Table 4-39* and *Figure 4-80*). There was no significant difference between the action alternative scenarios and the no action alternative for the other locations.

TABLE 4-39
Alabama River Subbasin. River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Reservoir Tailwater DO Days Below 5 mg/L				
R. F. Henry	28	61	40	27
Lake Purdy	0	0	0	0
Millers Ferry	3	4	3	3
Claiborne	0	0	0	0
River DO: Days Below 5 mg/L				
Cahaba at Caldwell 387.9	0	0	0	0
Cahaba at Helena 365.1	0	0	0	0
Cahaba at Centerville 324.9	1	1	1	0
Cahaba at Harrisburg 307.8	2	3	2	2
Cahaba at Marion Junction 265.3	0	0	0	0
Cahaba above Millers Ferry 250.2	27	29	28	23
Alabama R. at Cutoff 64.9	0	0	0	0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-80
Dissolved Oxygen in Alabama River Subbasin Reservoirs. 2050 Demands. Action Alternative



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There is no difference between the percent of wastewater in the river for the action and no action alternatives (***Table 4-40***).

TABLE 4-40
Alabama River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Cahaba at Caldwell 387.9	40.8	41.2	40.8	40.1
Cahaba at Helena 365.1	63.4	63.1	63.4	63.5
Cahaba at Centerville 324.9	3.5	2.6	3.5	5.9
Cahaba at Harrisburg 307.8	5.0	4.5	5.0	6.6
Cahaba at Marion Junction 265.3	2.6	2.1	2.6	3.9
Cahaba above Millers Ferry 250.2	2.7	2.2	2.7	3.8
Alabama R. at Cutoff 64.9	5.7	5.9	5.8	5.7

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

The HEC-5Q model predicts no significant difference in reservoir water quality between the action and no action alternatives (***Table 4-41***).

TABLE 4-41
Alabama River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
R. F. Henry	13.0	14.5	13.7	14.2
Lake Purdy	61.0	61.0	61.0	61.0
Millers Ferry	25.0	25.1	24.9	24.5
Claiborne	28.2	27.3	27.9	27.8
Summer Retention Time (days)				
R. F. Henry	2.9	3.1	3.0	2.6
Lake Purdy	47.6	47.6	47.6	47.6
Millers Ferry	3.2	3.4	3.3	3.0
Claiborne	0.8	0.8	0.8	0.7
Summer Phosphorus Loading (pounds/acre/month)				
R. F. Henry	15.3	15.4	15.1	15.3
Lake Purdy	11.6	11.6	11.6	11.6
Millers Ferry	15.3	15.3	15.2	15.4
Claiborne	38.9	39.1	38.6	39.3

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

4.4.2.2.6 Wastewater Discharge Impacts

The low flow scenario could produce substantial adverse effects on water quality in the ACT basin due to the much lower stream flows. The numerous wastewater treatment plants (both industrial and municipal) that discharge to the rivers in the basin would potentially face tighter discharge limits in order to preserve water quality under the low flow scenario. Conversely, there would likely be no impact on permitted wastewater discharges as a result of the high flow scenario. The generally higher stream flows that are produced under the high flow scenario would enhance water quality in the streams and might allow new discharges to rivers where restrictions are currently in place due to degraded conditions. The high flow scenario would provide enhancements to onerous permitting requirements facing wastewater dischargers, although existing permit limits would not be revised due to antibacksliding rules.

4.4.2.2.7 Thermal Discharge Impacts

Thermal discharges into surface waters affect water quality by increasing rates of biological activities as well as reducing solubility of DO in water. Increased biological activity from thermal increases can increase rates of eutrophication, and reduce DO in areas where

nutrient loading is high from point or nonpoint sources. Effects of thermal additions on oxygen solubility and reduction in DO, are not likely to be significant, affecting only a limited zone near the discharge. Another potential impact is the possible killing of biota in the discharge zone due to high temperatures. This could produce an increased BOD in the river, further decreasing DO levels.

Plants that have once-through cooling systems add greater thermal load to receiving streams, which can further exaggerate these effects. Steam generation systems in the ACT basin that are once-through facilities include Georgia Power Plant Hammond, at Rome. Thermal effects directly related to changes in eutrophication rates or DO solubility, while locally important in the immediate area of a steam generation power plant, are not likely to significantly lower the levels of DO available for aquatic species within the basin. The effect of the no action alternative would depend on continued trends in water quality, in which nonpoint water quality issues combined with thermal additions in localized areas may continue the trend for eutrophication in these areas. Under conditions in which an allocation scenario of the action alternative resulted in reduced flows, there could be impacts to the current operating permits for these facilities. For example, under extreme low flow conditions, the thermal mixing zone requirements in the NPDES permits could be exceeded and the thermal power generation facility may be required to limit operations to meet NPDES permit limits on temperatures.

4.4.2.2.8 Groundwater Impacts

Groundwater quality in the ACT basin is generally good and water is suitable for consumption. Under the low flow scenario, when stream flows are significantly reduced, more emphasis could be placed periodically on groundwater resources during extreme drought conditions. These periodic, temporary increases in reliance on groundwater supplies could accelerate the formation of sinkholes or other subsidence features that could potentially act as conduits to directly introduce nonpoint source runoff into the groundwater regime. However, under the low flow scenario, the surface water shortfalls are not expected to be frequent or prolonged. As a result, the increased stresses on the aquifers are expected to be transitory in nature and only short term.

Under the high flow scenario, ample amounts of surface water supply should be available to meet current and future demands, so no impacts on groundwater quality are anticipated beyond the normal growth in demand for groundwater projected under the no action scenario.

4.5 Biological Resources

The following sections address the potential effects on vegetation resources (including wetlands), wildlife resources, fish and aquatic resources, protected species, and fish and wildlife management facilities. The evaluation of these resources is based primarily on information developed under the Environmental Water Demand element of the Comprehensive Study and analyses of the alternative range of flow scenarios completed by FWS and summarized in the Fish and Wildlife Coordination Act (FWCA) report (***Appendix E***). Additional literature and information sources were used, as needed, to support the evaluation of resources not addressed by the Comprehensive Study elements or FWS analyses. Environmental performance measures were developed by FWS to address potential impacts on riverine aquatic resources, riparian wetlands, and reservoir fisheries. Brief summaries of the environmental performance measures are included under the appropriate resource sections, and the detailed descriptions are included in ***Appendix E***.

4.5.1 Vegetation Resources

The following section addresses potential impacts on terrestrial vegetation communities within the basin as well as freshwater and estuarine wetland communities. Terrestrial vegetation was addressed in a qualitative manner based on existing literature.

4.5.1.1 Affected Environment

4.5.1.1.1 Terrestrial Communities

The ACT basin contains seven dominant native terrestrial vegetative communities: Appalachian oak forest, oak-hickory-pine forest, rock outcrop, grass-dominated, longleaf pine-turkey oak sandhill, maritime shrub, and evergreen maritime forest (FWS, 1998). This does not include areas modified for agricultural use. These communities include a mix of forests and grasslands, as well as cultivated areas. In areas not managed for timber production, the species present in plant communities are generally controlled by the soils, geology, and microclimate of the area. However, a number of species present in the basin are highly adaptable and are broadly distributed.

Appalachian oak forests in the ACT basin are limited to north central Georgia and the northern-most headwaters of the Coosa River. Dominant canopy species can be divided into two groups: dry slope and mesic slope communities. Drier slopes in the headwaters typically are dominated by oak species, including chestnut oak (*Quercus prinus*), northern red oak (*Quercus rubra*), and white oak (*Quercus alba*). Also present in the canopy are a number of pines, hickories, red maple (*Acer rubrum*), and tulip poplar (*Liriodendron tulipifera*). The subcanopy typically includes saplings of the canopy species, as well as mountain laurel (*Kalmia latifolia*), various azaleas (*Rhododendron* spp.), and blueberries (*Vaccinium* spp.).

More mesic sites typically are dominated by red maple, American beech (*Fagus grandifolia*), basswood (*Tilia herterophylla*), hickories, tulip poplar, white ash (*Fraxinus americana*), and hemlock (*Tsuga canadensis*). Subcanopy species may be similar to those on drier sites, but may also include buckeye (*Aesculus* spp.), spicebush (*Lindera benzoin*), and hobblebush (*Lyonia* spp.).

Oak-hickory-pine forests are the most abundant native vegetative community in the ACT Basin (Martin et al., 1993). This forest type can be found throughout most of central and northern Alabama as well as western Georgia. The dominant canopy species in the oak-hickory-pine forests of the uplands include loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinata*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), post oak (*Quercus stellata*), several hickories (*Carya* spp.), yellow poplar (*Liriodendron tulipifera*), persimmon (*Diospyros virginiana*) and easter red cedar (*Juniperus virginiana*). In areas managed primarily for forestry products, dominant canopy species are often limited to loblolly and short-leaf pine. Subcanopy species in the upland forests typically include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), eastern redbud (*Cercis canadensis*), shadbush (*Amelanchier canadensis*), black gum (*Nyssa sylvatica*), American holly (*Ilex opaca*), blackberry (*Rubus* spp.), viburnums (*Viburnum* spp.), sumacs (*Rhus* spp.), greenbriars (*Smilax* spp.), grapes (*Vitis* spp.), and Japanese honeysuckle (*Lonicera japonica*). These forested areas, especially if adjacent to bottomland hardwoods forests (see *Freshwater Wetlands* below), provide good habitat for game animals.

Rock outcrop communities are highly specialized plant communities associated with either granite or limestone outcrops. The ACT basin contains small areas of both communities. These plant communities are found in areas that lack sufficient soil to support large shrubs or trees, thus maintaining communities dominated by herbaceous species. Because of the temperature and moisture extremes associated with rock outcrop areas, a number of different vegetative communities have evolved to take advantage of the varying moisture and soil conditions. Each of these communities is composed of a unique assemblage of plants, although some species can be found in more than one community type. Many of these outcrop-adapted plant species are either officially protected or considered rare where they are found, and many are classified as endemic. Martin et al., (1993) identifies three limestone and eight granite outcrop communities in the ACT basin.

In the ACT basin, *grass-dominated communities* are limited to the lower Coosa, Tallapoosa, and Cahaba Rivers in an area called the Black Belt (Martin et al., 1993). Typically, dominated by little bluestem (*Andropogon scoparius*), 58 other herbaceous species have been documented in the remnant Black Belt grasslands in Alabama. Although occasionally invaded by sweet gum (*Liquidambar styraciflua*) and eastern red cedar, the remnant grass-dominated communities are maintained by periodic droughts and floods that prevent most tree and shrub species from becoming established. Periodic burns, resulting from lightening strikes or other sources, also minimize colonization by shrub and tree species in some areas.

The *longleaf pine-turkey oak sandhill* community is common in the lower portions of the Alabama River basin. Dominant plant species in this community are typically longleaf pine (*Pinus palustris*), turkey oak (*Quercus laevis*), bluejack oak (*Quercus incana*), mockernut hickory (*Carya tomentosa*), flowering dogwood, and wiregrass (*Aristida stricta*). This community is typically maintained by periodic burns. In areas in which longleaf pine has been selectively removed, turkey oak and mockernut hickory dominate the canopy. Fire-intolerant species, such as magnolia and holly, can invade areas that do not burn on regular intervals.

The *maritime shrub community* is limited to the coastal areas of Alabama. This community type is typically divided into two subcommunities that can be distinguished by their dominant canopy species and typical location along the coast: dune oak-buckthorn and oak

scrub. The dune oak-buckthorn community typically occurs on the tops and landward slopes of dunes. The canopy of this community is typically comprised of live oak (*Quercus virginiana*), tough buckthorn (*Bumelia tenax*), red bay, slash pine (*Pinus elliotii*), and loblolly pine. Understory species include saw palmetto (*Serenoa repens*), hercules club (*Zanthoxylum clava-herculis*), myrtle, yaupon (*Ilex vomitoria*), rusty lyonia (*Lyonia ferruginea*), muscadine grape (*Vitis rotundifolia*), bamboo briar (*Smilax laurifolia*), pepper-vine (*Ampelopsis arborea*0, and juveniles of the dominant canopy species.

Oak scrub forests occur in moderately drained areas of old dune complexes. The community is typically a dense, scrubby growth of broad-leaved evergreens and pines. The canopy of this community is characterized by live oak, slash pine, myrtle oak (*Quercus myrtifolia*), American olive (*Osmanthus americanus*), Chapman's oak (*Quercus chapmanii*) and red bay. Pond pine and longleaf pine are typically scattered throughout the community, but are not usually found in large numbers. The most common understory species in this community are saw palmetto, bayberry, rusty lyonia, myrtle oak, gallberry, huckleberry, and shiny blueberry (*Vaccinium myrsinites*).

Evergreen maritime forests are found along the coast in Alabama. These forest are dominated by magnolia (*Magnolia virginiana*), laurel oak, and live oak. Subcanopy species are often limited to juveniles of the dominant canopy species, red bay, cabbage palm, and slash pine.

4.5.1.1.2 Wetlands

Wetlands are transitional lands between terrestrial and deep-water habitats, in which the water table is at or near land surface or the land is covered by shallow water (FWS, 1998). *Palustrine* wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens, (e.g., freshwater marshes, swamps, bogs, fens, and wet prairies). Estuarine wetlands include deepwater tidal areas and adjacent tidal wetlands, which are usually semi-enclosed by land but have access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

The Comprehensive Study included a wetlands element, the findings of which were compiled in a three-volume final report. Volume I (FWS, 1998) developed relationships between flow rates and habitat values of riparian wetlands within the study area; Volume II (FWS, 1998) presents the results of a riparian wetland inventory conducted within the study area; and Volume III (FWS, 1998) presents the results of a study that located and characterized wetland resources around four mainstem reservoirs in the study area.

Most of the wetland area within the ACT basin is represented by forested palustrine wetlands located within the floodplains of rivers. These *riparian* (river-associated) forested systems are often referred to as *bottomland hardwoods*. Riparian palustrine systems within the ACT basin also include small areas of non-forested wetlands, such as marsh or shrub wetlands. Riparian systems depend on the natural flooding regime of rivers and, in turn, influence the water and habitat quality of riverine ecosystems. The remaining wetland area within the ACT basin consists of estuarine wetlands and palustrine wetlands that occur along reservoirs (reservoir-associated). Estuarine wetlands constitute a relatively small percentage of the total wetland area within the basin; however, because of the economic value of the estuarine ecosystem to coastal communities within the basin, the potential environmental impacts to estuarine wetlands associated with the water allocation alternatives are assessed in this EIS.

4.5.1.1.2.1 Freshwater Wetlands

The ACT basin contains approximately 52 percent (273,594 acres) of the palustrine floodplain wetland area in the ACT and ACF basins. The majority of this wetland area is located in the Alabama River subbasin (86 percent with the Coosa and Tallapoosa River subbasins having a nearly equal share of the remainder (FWS, 1998).

The palustrine wetland areas within the ACT basin consist primarily of bottomland hardwood forests. Dominant tree species within these systems include water tupelo (*Nyssa aquatica*), bald cypress (*Taxodium distichum*), Carolina ash (*Fraxinus caroliniana*), swamp tupelo (*Nyssa sylvatica*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), overcup oak (*Quercus lyrata*), planertree (*Planera aquatica*), green ash (*Fraxinus pennsylvanica*) and water hickory (*Carya aquatica*).

The coverage of river-associated (riparian) and reservoir-associated wetlands within each subbasin of the ACT basin (***Figure 4-81***) is presented below.

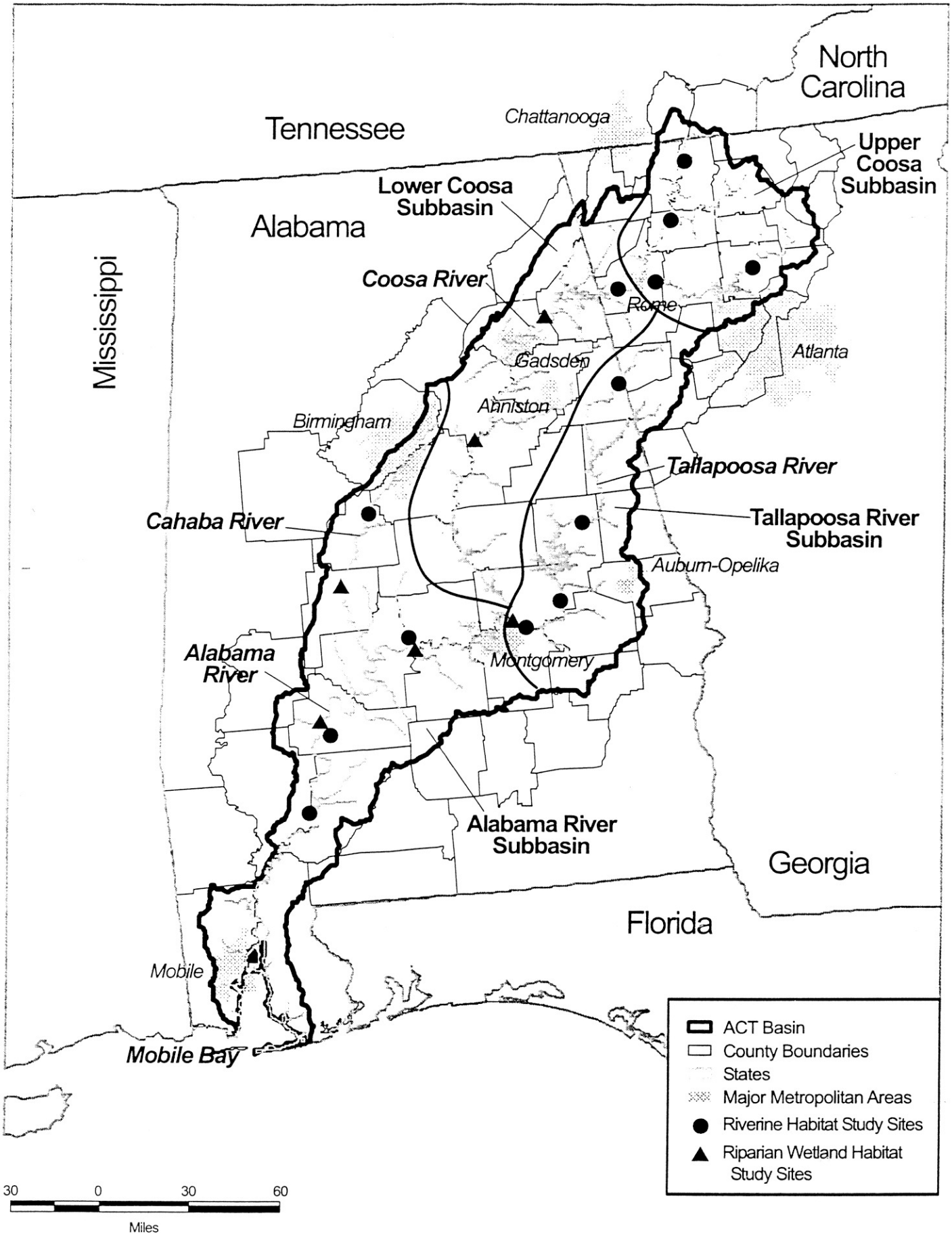
Alabama River Subbasin. Approximately 39 percent (187,339 acres) of the Alabama River subbasin consists of palustrine wetland habitat. Approximately 99 percent (186,626 acres) of the wetlands within this subbasin are riparian wetlands and less than 1 percent (714 acres) are reservoir-associated wetlands.

Coosa River Subbasin. Approximately 8 percent (21,069 acres) of the Coosa River subbasin consists of palustrine wetland habitat. Approximately 55 percent of this wetland area (11,688 acres) consists of riparian wetlands, and 45 percent consists of reservoir-associated wetlands that have been created as a result of extensive hydropower development (six reservoirs) along the Coosa River mainstem in Alabama (FWS, 1998).

Wetlands were located and characterized at the following two reservoirs in the Coosa River subbasin for the Comprehensive Study (FWS, 1998):

- H. Neely Henry Lake – There are approximately 7,344 acres of wetland associated with H. Neely Henry Lake (Dove and Kress, 1997). Approximately 1,542 acres of wetland are supported at or below the normal pool elevation. Within this elevation range, lacustrine littoral wetlands (lake edge) with unconsolidated bottom comprise approximately 97 percent of the total wetland acreage; emergent wetlands comprise 2 percent; and forested wetlands together with other types make up the remaining 1 percent. The normal pool elevation of this reservoir is 508 feet and the top-of-dam elevation is 540 feet, resulting in an elevation difference of 32 feet. An additional 5,288 acres of wetland occur between normal pool and top-of-dam elevations. Within this elevation range, lacustrine littoral wetlands with unconsolidated bottom comprise approximately 66 percent of the total wetland acreage; emergent wetlands comprise 10 percent; forested wetlands comprise 13 percent; and other types make up the remaining 11 percent.

FIGURE 4-81
Locations of Riverine Aquatic Resource and Riparian Wetland Study Sites in the ACT Basin



- Weiss Lake – There are approximately 4,218 acres of wetland at Weiss Lake (Dove and Kress, 1997). Approximately 625 acres of wetland is supported at or below the normal pool elevation. Within this elevation range, emergent wetlands comprise approximately 36 percent of the total wetland acreage; forested wetlands comprise 24 percent; scrub-shrub wetlands comprise 15 percent; and a variety of other types make up the remaining 25 percent. The normal pool elevation of this reservoir is 564 feet and the top-of-dam elevation is 590 feet, resulting in an elevation difference of 26 feet. An additional 2,081 acres of wetland occur between normal pool and top-of-dam elevations. Within this elevation range, forested wetlands comprise approximately 57 percent of the total wetland acreage; scrub-shrub wetlands comprise 18 percent; emergent wetlands comprise 13 percent; and a variety of other types make up the remaining 12 percent.

Etowah/Oostanaula/Conasauga River Subbasins. Approximately 3 percent (4,651 acres) of the Etowah/Oostanaula/Conasauga River subbasins contain palustrine wetlands, of which 84 percent (4,115 acres) is riparian wetland habitat and 12 percent (536 acres) is reservoir-associated wetland habitat (FWS, 1998). Most of this wetland area is restricted to narrow corridors in the upper reaches of the subbasins.

Tallapoosa River Subbasin. Approximately 7.5 percent (22,387 acres) of the Tallapoosa River subbasin contains palustrine wetlands, of which 97 percent (21,702 acres) is riparian wetland and 3 percent (684 acres) is reservoir-associated wetland (FWS, 1998).

4.5.1.1.2.2 Estuarine Wetlands

The only estuarine wetlands within the ACT basin are within the Mobile Bay estuary system, which lies between Mobile and Baldwin Counties in southwestern Alabama. The Mobile Bay estuary consists of Mobile Bay and the Mobile-Tensaw River Delta. Mobile Bay is a drowned river valley that extends approximately 31 miles from the Mobile-Tensaw River Delta at the northern end to the Gulf of Mexico at the southern end. It has an average width of approximately 10.8 miles and an average depth of about 9.7 feet, and receives drainage from a watershed area in excess of 43,000 square miles. Mobile Bay has approximately 6,224 acres of tidal marsh, 3,261 acres of bayous and rivers, 11,110 acres of connecting bays, 248,343 acres of open water, and a total shoreline length of 162 miles (FWS, 1998).

The Mobile-Tensaw River Delta extends southward from the confluence of the Tombigbee and Alabama Rivers to the northern end of Mobile Bay. It opens into the northern end of Mobile Bay through the Mobile, Tensaw, Apalachee, and Blakeley Rivers, and consists of approximately 20,323 acres of open water, 10,450 acres of fresh-mixed marsh, 69,348 acres of swamp, and 84,839 acres of mixed bottomland forest. The Mobile-Tensaw Delta is one of the most ecologically important areas in Alabama. It is on the National Register of Natural Landmarks, and is designated as a geographic area of particular concern by the State of Alabama (FWS, 1998).

The open water areas of the Mobile Bay estuary contain a high diversity of phytoplankton, benthic algae, and submersed aquatic vegetation. The species composition and abundance of these open water plant communities vary considerably within the estuary and are controlled by seasonal variations in water temperature and river flow conditions. Over 250 species of phytoplankton, and a total of 245 species of benthic algae and 33 species of submersed aquatic vegetation have been documented to occur within the Mobile Bay estuary system. Phytoplankton are recognized as the most important primary producers in

the open waters of the estuary while benthic algae and submersed vegetation provide important habitat for small aquatic organisms and produce substantial quantities of organic matter that enters the food chain.

Tidal marshes of coastal Alabama are most abundant in the Mobile-Tensaw River Delta and in the lower reaches of Mobile Bay, particularly along the northern shore of Mississippi Sound. Approximately 16,992 acres or 60 percent are saline and brackish marsh and 11,232 acres or 40 percent are freshwater marsh (FWS, 1998). Saline marshes are composed almost entirely of smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*). Most of the saline marsh area is typically covered by black needlerush while the seaward periphery is usually dominated by a zone of smooth (FWS, 1998). Brackish marshes generally occur further inland along the margins of rivers, streams, and bayous where salinity levels are reduced. Brackish marshes have less smooth cordgrass and needlerush, and more freshwater species such as sawgrass (*Cladium jamaicense*), club rush (*Eleocharis cellulosa*), and three-square bulrush (*Scripus americanus*) than saline marshes. Freshwater marshes occur beyond the influence of normal tidal action. A total of 85 species of plants have been identified in the freshwater marshes of coastal Alabama (FWS, 1998). Dominant freshwater marsh species include giant reed (*Phragmities australis*), cattail (*Typha latifolia*), bulrushes (*Scirpus* spp.), sedges (*Carex* spp., *Cyperus* spp.), and spikerushes (*Eleocharis* spp.).

Freshwater swamps within the Mobile Bay estuary occur primarily in the Mobile-Tensaw River Delta (over 69,000 acres). The plant species composition of the freshwater swamp community varies with the degree of flooding the community experiences (FWS, 1998). Extensively flooded areas are typically dominated by bald cypress and swamp tupelo. Moderately flooded areas are usually dominated by sweet bay (*Magnolia virginiana*), red maple, and Virginia willow (*Itea virginica*). Areas that experience little flooding are typically dominated by water oak (*Quercus nigra*), laurel oak (*Quercus laurifolia*), sweet gum (*Liquidambar styraciflua*), southern magnolia (*Magnolia grandiflora*), and devilwood (*Osmanthus americana*). A total of 62 species of trees, shrubs, vines, and herbaceous plants have been identified in the freshwater swamps of coastal Alabama (FWS, 1998).

Wet pinelands, pine savannahs, and bogs represent the remaining wetland communities that occur within the Mobile Bay estuary system. Wet pinelands and pine savannahs are pine-dominated communities characterized by low relief and poor drainage. The dominant pine species within these communities is typically slash pine (*Pinus elliottii*). Pine savannahs generally have less shrub species and more herbaceous species in the understory than wet pinelands. Bogs are scattered throughout some wetland and upland pine communities and support a unique flora, including pitcher plants (*Sarracenia* spp.), sundews (*Drosera* spp.), butterworts (*Pingiucula* spp.), milkworts (*Polygala* spp.), and several species of orchids. A total of 103 plant species has been identified from the pine woodlands, savannahs, and bogs of coastal Alabama (FWS, 1998).

4.5.1.2 Environmental Consequences

4.5.1.2.1 Terrestrial Communities

The ACT compact concerns surface water flow in the rivers of the basin. Modifications to Federal reservoir operations to comply with the formula and other such actions are unlikely to directly affect terrestrial habitats. An example of a possible exception may be a change in the operations of a hydropower facility to generate power for daily peak demand periods.

The current operations, which raise and lower the river substantially on weekdays at some facilities, may be responsible for fairly high rates of bank erosion, affecting riparian terrestrial as well as aquatic habitats (FWS, 1998). Changes in these operations that are necessitated by the allocation formula may affect terrestrial habitats if the area is subject to bank erosion changes.

4.5.1.2.2 Wetlands

4.5.1.2.2.1 Freshwater Wetlands

Analysis of potential effects on freshwater wetlands in the ACT basin included studies on riparian wetlands (Davis, 1997) and reservoir-associated wetlands (Dove and Kress, 1997b).

Riparian Wetlands. The riparian wetland study selected six sites to represent floodplain forests in three of the larger subbasins (*Figure 4-81*):

- Site 7: Coosa River, Weiss Dam tailwaters
- Site 8: Coosa River, Logan Martin Dam tailwaters
- Site 9: Tallapoosa River near mouth
- Site 10: Alabama River, R. F. Henry Lock and Dam tailwaters
- Site 11: Alabama River, Claiborne Lock and Dam tailwaters
- Site 12: Cahaba River

Hydrologic data from the Tallapoosa River (Site 9) were influenced by discharges from Bouldin and Jordan Dams on the Coosa River and backwaters from Woodruff Lake on the Alabama River. Because of resulting data interpretation problems, wetland analysis at this site was not performed (Davis, 1997). In addition, Site 9 was not included in this report's analysis because the potential for significant effects on wetlands in the basin would likely occur mainly in the Alabama and Coosa River subbasins. Consequently, only five wetland sites (Sites 7, 8, 10, 11, 12) were evaluated in the report.

In cooperation with FWS, the Corps developed a riparian wetlands performance measure for use in evaluating water management alternatives (Corps, 1997a). The measure, referred to as the Riparian Wetland Unit (RWU), provides an index of similarity between historic flows and water management alternative flows that can be used to rank the alternatives by the likelihood of affecting wildlife habitat at a specific site. The reference hydrologic condition is defined by a long-term record of river stages and a distribution of wetland acreage by elevation. The alternative condition is a flow regime that could occur under a hypothesized set of water demands and management rules, such as simulated by the Comprehensive Study's shared vision models.

The rationale for RWU is as follows:

- The frequency and timing of inundation in the floodplain are major factors regulating riparian wetlands ecology
- Greater changes in the frequency and timing of inundation are likely to have greater impacts than lesser changes
- Changes affecting larger acreage of riparian wetlands are likely to have greater impacts than changes affecting smaller acreage

Under this approach, the frequencies with which specific river stages (1-foot elevation intervals) are exceeded in the reference and alternative hydrology data sets are computed for each month of the year. These frequencies are compared for the entire range of stages in which riparian wetlands occur. The acreage of riparian wetlands occurring in each 1-foot elevation interval is used as a quantity for prorating the potential impact of changes in the monthly exceedance frequencies. For the purposes of the Comprehensive Study, reference-condition flows used for these impounded sites were historic flows observed since the time of impoundment.

The final index is a ratio of the acreage-prorated exceedance frequencies under the reference condition to those under the alternative condition. Complete similarity between a water management alternative and the reference condition flows yields an index of 1.0. An alternative for which an order-of-magnitude dissimilarity in exceedance frequencies (e.g., a reference condition exceedance value of 10 percent is altered to 0 or 20 percent) is computed at all elevations during all months yields an index of 0.0. Davis (1997) concluded that there was not a specific flow-wildlife habitat relationship for riparian forested wetlands within the ACT and ACF basins. The optimum flow regime for habitat value would be the hydrological conditions under which the bottomland hardwood communities developed and to which wildlife is adapted. Therefore, the historic flows provide the reference conditions against which all water management alternatives can be compared for effects on wildlife habitat. Water management alternatives that result in the highest performance measures (riparian wetland units) indicate the least potential for impact to riparian wetland wildlife habitat.

Table 4-42 summarizes the results of the RWU performance measure analysis for the five sites under the twelve operational flow scenarios. The performance measure scores for the sites ranged from 0.56 to 0.81. For each site, there was little variation in performance scores between demand years for a given scenario (i.e., 1995, 2020, and 2050) or generally between flow scenarios. Site 12 on the Cahaba River is not directly influenced by reservoir releases and would not be directly affected by an allocation formula; this site showed no variation in performance measure scores between any of the 12 scenarios.

The greatest range of RWU performance scores observed between scenarios (0.14) occurred at Site 8 on the Coosa River below Logan Martin Dam, which showed greater potential for riparian wetland impacts (i.e., lower scores) under the no action alternative compared to the action alternative flow scenarios (***Table 4-42***). For all other sites, the range of variation was less than or equal to 0.05 across all scenarios. These results indicate that historic flow conditions would be altered to a similar degree under the no action alternative (existing conditions) and the three action alternative flow scenarios in the range of elevations at which most of the wetland acreage occurs. Therefore, as presently modeled, a water allocation formula would be unlikely to significantly alter the quality of riparian wetland habitat, as defined by its value to floodplain-dependent wildlife and plant species.

Riparian wetlands located along riverine reaches downstream from existing mainstem reservoirs in the ACT basin would be the ones most likely to experience direct effects of alternative flow scenarios as evaluated using the RWU performance measure. However, wetlands located on other riverine segments could experience adverse effects from indirect actions related to allocation decisions, such as the construction of new reservoirs for additional storage capacity or increased surface water withdrawal to meet growing demand for consumptive uses. These indirect actions could occur under either the no action or

action alternatives. Riparian wetlands at new reservoir sites would be inundated and replaced by open-water habitats, and downstream riparian wetlands would be affected by altered flow regimes. Increased surface water pumping also could seasonally alter downstream flow regimes, particularly during low flow periods.

TABLE 4-42
Riparian Wetland Unit (RWU) Performance Measure Scores for the No Action and Action Alternatives

				Action Alternatives								
	No Action Alternative			High Flow			Moderate Flow			Low Flow		
Wetland	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**
Coosa River												
Site 7	0.58	0.58	0.57	0.58	0.58	0.58	0.59	0.59	0.59	0.59	0.59	0.59
Site 8	0.56	0.58	0.56	0.68	0.68	0.67	0.70	0.70	0.70	0.70	0.70	0.70
Alabama River												
Site 10	0.67	0.66	0.66	0.65	0.65	0.64	0.68	0.67	0.67	0.68	0.68	0.68
Site 11	0.60	0.59	0.59	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.63
Cahaba River												
Site 12	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81

Source: FWS, 1998; ***Appendix E***

Riparian wetlands with the greatest potential for significant adverse impacts resulting from new reservoir construction or other indirect actions of an allocation decision would be those occurring along the unregulated reaches of the Tallapoosa and Little Tallapoosa Rivers upstream from Harris Lake in Georgia and Alabama, and along unregulated portions of the Upper Coosa Subbasin, especially the Conasauga River and the Etowah River upstream of Allatoona Lake (*Figure 4-81*). While riparian wetlands along upland rivers such as these typically cover much smaller areas than those found in the lower ACT basin below the Fall Line, they help protect water quality and adjacent riverine habitats; provide seasonal breeding sites for many species of fish, waterfowls, and amphibians; and harbor protected species of plants and wildlife. These reaches of river harbor a large portion of the native riverine aquatic biodiversity remaining in the ACT basin, including many endemic species of fish and mussels and several species of Federally and state protected species (see Section 4.5.4).

Reservoir Wetlands. Potential impacts to reservoir wetlands in the ACT basin were evaluated by examining wetland distribution data collected for H. Neely Henry and Weiss Lakes during the Comprehensive Study (Dove and Kress, 1997) and by inspecting plots of daily water elevations for representative reservoirs (Allatoona, Weiss, and Harris) for the 55-year period of record, and selected critical low flow periods, under the no action and action alternative flow scenarios (CH2M HILL, 1998; see Appendix E). Comparisons of the magnitude and degree of seasonal fluctuation of reservoir levels under the different flow scenarios were then used to infer the potential for adverse impacts to adjacent wetland systems. Water level fluctuations would impact wetlands associated with reservoirs if the

magnitude, frequency, and duration of drawdown or inundation substantially differed between scenarios to result in alterations to wetland community structure.

Based on the water elevation data, the magnitude of water level fluctuations experienced by reservoirs in the ACT basin during normal rainfall years is relatively small and similar among the no action alternative and action alternative flow scenarios. However, during critical drought periods, significant drawdown of reservoir levels may occur in storage reservoirs under the high flow scenario and, to a lesser degree, under the moderate flow scenario. The least amount of drawdown would occur under the low flow scenario. Drawdown during critical drought periods under the moderate flow scenario of the action alternative is similar to that under the no action alternative. Of the three reservoirs examined for critical drought periods, Allatoona and Harris Lakes exhibited significant drawdown of water levels under the high flow scenario, with drawdowns of 15 feet or more extending for up to 6 months. Weiss Lake showed less pronounced differences between the action scenarios. Lay, Mitchell, Bouldin, and Yates Lakes would not be expected to show substantial differences in water level management between the action alternative flow scenarios, because they are operated more nearly in run-of-river modes, which tend to minimize reservoir level fluctuations.

During severe drought periods, wetlands associated with reservoirs that would experience significant sustained drawdown under the high flow scenario, such as Lake Allatoona and Lake Harris, could undergo shifts in plant community structure. Drawdown conditions persisting for several months could cause certain types of wetland communities, such as lacustrine or emergent wetlands to become severely stressed or to die off. Recruitment of wetland plant species more suited to drier conditions such as certain shrub and tree species may occur shortly after the onset of the drawdown. However, these shifts in wetland community structure would be temporary, lasting only the duration of the drought period. As water levels rise after the drought, there would be a gradual shift back to the original wetland conditions.

In summary, there is a potential for wetlands associated with certain reservoirs, primarily those in the headwaters region of the basin, to experience temporary impacts as a result of significant drawdown during critical drought periods under the high flow scenario. Such impacts would be less pronounced under the no action and moderate flow scenario, and insignificant under the low flow scenario. The extent and duration of such impacts would be dependent on the magnitude and duration of the drought experienced. The systems eventually would revert back to original wetland conditions over time following the end of drought. Based on the drought record, significant impacts to wetland-dependent wildlife and plant species would not be expected under any of the scenarios in the ACT basin during critical drought periods.

4.5.1.2.2.2 Estuarine Wetlands

The assessment of potential impacts to estuarine wetlands in the ACT basin is based on the scientific literature and focuses primarily on the salinity tolerances of wetland communities in the Mobile Bay estuary and how the structure of such communities may be affected by changes in salinity resulting from freshwater inflow alterations. Because no flow scenario model was developed for estuarine wetlands, the impact assessment in this EIS is limited to general assumptions of how this resource may be impacted under undefined alterations to the current inflow regime.

Significant changes in the seasonal salinity of the Mobile Bay estuary resulting from reduced freshwater inflow from the Mobile River could alter the species composition and structure of wetland communities within the estuary. For example, the coverage of brackish-water marshes in the lower Mobile-Tensaw River Delta could be reduced in response to generally higher salinity conditions, with replacement by more salinity-tolerant communities. Similarly, the coverage of freshwater marshes in the upper delta could change in response to significant inflow reductions, with freshwater marsh species being replaced by more brackish marsh species adapted to broader salinity regimes.

Many marsh species in the Mobile Bay estuary have broad salinity tolerances and can tolerate increased salinities resulting from decreased river flow. However, increases in salinity generally could result in overall growth reduction because plants expend energy in salt absorption to counteract increases in osmotic pressure rather than expending energy for growth (FWS, 1998). Although many marsh species can tolerate increased salinities, they will eventually be replaced by species that are better adapted to higher salinity regimes.

In addition to altering the salinity regime of the Mobile Bay estuary, reduced river inflow could alter nutrient loading. Changes in nutrient loading have the potential to affect the productivity of estuarine wetland communities. Reductions in inflow volume may also act to decrease the spatial extent of wetland communities by altering the hydrology of the systems.

The degree to which wetland communities within the Mobile Bay estuary ecosystem would be impacted by changes in freshwater inflow is directly dependent on the magnitude of the inflow reductions and the position of each wetland community within the Mobile Bay estuary system relative to the Mobile River.

The Alabama River joins the Tombigbee River (which is not part of the ACT basin), to form the Mobile River, which ultimately flows into Mobile Bay. Because the drainage areas of the Tombigbee and Alabama Rivers are similar in size, both rivers contribute roughly the same inflow volumes to the Mobile Bay estuary (see Section 4.4.1.1). Therefore, any reduction in flow volume of the Alabama River would result in an overall inflow reduction that is half of the original reduction volume. The potential impacts to wetland communities associated with inflow reductions in the ACT basin would thus be diminished downstream of the confluence of the Tombigbee and Alabama Rivers.

Although impacts to estuarine wetlands in Mobile Bay cannot be quantitatively assessed with existing information, HEC-5 modeling results indicate only minor differences in flow parameters between the no action alternative and action alternative flow scenarios at the downstream-most gage below Claiborne Lake (see Section 4.4.1.2). Substantial flow accretion from the Cahaba River, which would not be affected by an allocation formula, and other large tributary systems in the lower Alabama River basin would partly attenuate flow fluctuations associated with reservoir operations under the different flow scenarios. In addition, the major flow volume contributed by the Tombigbee River in joining the Alabama River to form the Mobile River would further attenuate any seasonal differences in flow characteristics between the action alternative flow scenarios. Therefore, no significant adverse impacts to estuarine wetlands are likely to occur in Mobile Bay or in the upstream delta and Mobile River.

4.5.2 Wildlife Resources

Potential impacts on wildlife resources within the basin address species that may be associated with terrestrial and riparian habitats. Due to the nature of the proposed water allocation formula, the evaluation focused on those species associated with riparian habitats. A component of the Comprehensive Study (Davis, 1997) developed by FWS, included a hydrology-driven riparian floodplain wetland model and an associated wildlife habitat suitability model. The evaluation of potential impacts on wildlife is based on these models and existing literature.

4.5.2.1 Affected Environment

The wildlife assemblages found in the ACT basin vary greatly depending on the vegetative community, although some species, such as white-tail deer, raccoon, Virginia opossum, and grey squirrel are found throughout the basin in a number of habitat types. Other species are more closely tied to the vegetative communities, such as muskrat, which are limited to freshwater emergent marshes. Appalachian oak forests can support between 79 and 165 species of terrestrial and semi-aquatic animals depending upon the successional stage of the forest compartment (FWS, 1998). The greatest species diversity has been documented in forests between 80 and 100 years of age. The number of species supported by a forest of this successional stage is typically twice as many as that supported by a forest less than 5 years old.

Oak-hickory forests in the ACT basin support between 18 and 26 common species and up to 9 Federally protected species and 30 State protected or rare species. Unlike the Appalachian oak forests, the shrub successional stage of this vegetation type supports the greatest number of species. Most of the rare or officially protected species, as well as species that typically have large home ranges, such as Cooper's hawk, require large tracks of mature forest.

Rock outcrops typically support animal communities that are a subset of that supported by the surrounding community. Except for Fowler's toads, amphibians are typically not found in large numbers because of the heat and low moisture associated with the outcrops. Even outcrops that contain pools of water in the spring rarely support breeding amphibians because the pools generally do not retain water long enough for tadpoles to reach maturity. Reptiles, especially lizards, are usually the most common species found on outcrops. Birds and mammals are usually transient visitors because most outcrop communities lack sufficient cover and food sources to support them in any numbers.

Because grasslands lack the structural diversity of forests, they typically support fewer species of wildlife. Many of the species typically found in grass-dominated areas are generalists that use the grassland and the forest edge as their home range, such as white-tail deer and red fox. Other species may include the grasslands as part of a foraging territory located a significant distance from breeding areas, such as red-tailed hawks. Other species, however, such as prairie deer mice (*Permyscus maniculatus bairdii*) and meadow voles (*Microtus pernnsylvanicus*) occur only in maintained grasslands or pastures. There are no endemic species of wildlife known from the Alabama portion of the Black Belt and no studies have been completed to document the more common species of wildlife that use the area, primarily because the remnant native grasslands are small and disjunct, typically surrounded by agricultural fields and pastures.

Longleaf pine-turkey oak sandhill communities typically support a number of mammal species, 11 of which are considered characteristic of the community. Up to 33 species of birds and more than 60 species of reptiles and amphibians can also be found in the longleaf pine-turkey oak sandhill community. A number of the species supported by this community are officially listed as threatened or endangered by FWS or Alabama. Of note are the two endemic mammals found in this community, the Florida mouse (*Podomys floridanus*) and the Big Cypress fox squirrel (*Sciurus niger avicennia*).

Maritime shrub communities and evergreen maritime forests support communities similar to those found in more inland locations: raccoon, cottontail rabbit, as well as a number of species of mice. White-tail deer is the largest mammal native to the coastal region. Maritime and coastal areas support large numbers of bird species, especially during migrations. Up to 300 species of birds have been documented in the coastal areas of Alabama during spring and fall migrations.

Because of the changing conditions associated with coastal areas, many of the small mammal, reptile, and amphibian species that use coastal areas, especially beaches, have been recognized by taxonomists and regulatory agencies as distinct subspecies. As a result, a large number of them are considered rare or are officially protected. Most of these species, however, are typically found on barrier islands, although some can be found in areas that are largely undeveloped.

Forested wetlands, typically called bottomland hardwood forests, provide valuable and diverse habitat for many animal species (FWS, 1998). Because they are transition areas between upland areas and pure aquatic habitats, they can be considered edge systems, and typically support a greater diversity of wildlife species than the two adjacent habitats. The enormous number of mammals, birds, reptiles, amphibians, and invertebrates that use forested wetlands prohibit a comprehensive listing of the species typically found in them (FWS, 1998).

Generally, the floodplain can be divided into a detritus-dominated aquatic area that graduates to drier, upland areas as elevation and distance from the aquatic community increases. The near-upland areas of floodplain forests typically support a greater diversity of animals than the wetter areas because they provide greater amounts of food for herbivorous and omnivorous species.

4.5.2.2 Environmental Consequences

The water allocation formula is not expected to have any significant adverse direct effects on terrestrial wildlife because no terrestrial habitats will be affected by changes in flows in the rivers. Minor losses of habitat could occur as a result the high flow scenario that calls for increased reservoir storage to supplement downstream flows.

Semi-aquatic and aquatic species, such as river otter and wood duck, are also not expected to be adversely effected by the water allocation formula. As discussed above in Section 4.5.1.2, none of the flow scenarios analyzed as part of the action alternative have a significant adverse effect on the floodplain habitats.

4.5.3 Fish and Aquatic Resources

The following sections address the potential impacts on riverine aquatic resources, reservoir fisheries, and estuarine resources. These resources have the greatest potential for effects as a result of the water allocation formula and, therefore, have been addressed in more detail than some of the other biological resources. Impacts were evaluated using environmental performance measures developed by FWS during the Comprehensive Study. Detailed results of FWS analyses of riverine aquatic resources and riparian wetlands are provided in *Appendix E*. The evaluation of reservoir fisheries was also based on a performance measure developed by FWS. Results of the reservoir fisheries analysis are summarized in a separate report prepared by CH2M HILL (1998) (*Appendix E*).

4.5.3.1 Affected Environment

4.5.3.1.1 Riverine

The ACT basin forms the eastern half of the Mobile basin and supports exceptional aquatic biodiversity, reflecting the wide range of habitats within its three major physiographic sections. The Mobile basin ranks third in the nation in freshwater fish diversity and contains almost 40 percent of North America's aquatic turtle species. A total of 173 freshwater fish species, including many endemic species, are known from the basin (FWS, 1998). Despite extensive habitat modification, many of these species persist in the basin. The ACT basin also contains at least 45 species of freshwater mussels, including nine endemic species, as well as a great diversity of snails (at least 78 species occur in the Coosa River, of which 60 are endemic) and crayfish (14 species are known from the Tallapoosa River) (FWS, 1998.). The Fall Line between the upland (Piedmont) and lowland (Coastal Plain) regions of the basin acts as a natural barrier or filter to the movement of fish and other aquatic organisms, and thus, is one of the most significant physical features affecting the distribution of fishes in the basin. Many fish species are limited to either above or below the Fall Line in this basin and elsewhere (FWS, 1998).

The following sections describe the existing environment in each of the major subbasins shown in *Figure 4-81*.

4.5.3.1.1.1 Alabama River Subbasin

The Alabama River is directly regulated by three Corps multi-purpose dams. Together, these three facilities impound 233 miles of the mainstem river (Freeman et al., 1997). In upstream to downstream order, they are R.F. Henry (Woodruff Lake), Millers Ferry (Dannelly Lake), and Claiborne (Claiborne Lake). All three dams contain navigation locks, and R. F. Henry and Millers Ferry dams also are operated for hydropower generation (see Section 4.4.2.1). A portion of the mainstem channel of the Alabama River is maintained by annual dredging for navigation purposes. In addition, flows entering the subbasin are regulated by upstream hydropower facilities in the Tallapoosa River and Coosa River drainages.

The only remaining unimpounded reach of the mainstem Alabama River is the 82-mile reach extending downstream from Claiborne Lock and Dam to the confluence of the Alabama and Tombigbee Rivers. This lower reach of the river historically has supported high species diversity and abundance of freshwater fishes and mussels. Although habitat alteration and flow regulation are prevalent along the Alabama River, the lower unimpounded reach has retained many riverine characteristics as a result of large inflows,

significant non-dredged areas, and limited storage capacity of the Corps' reservoirs (i.e., fairly stable water levels).

FWS (1998) compared pre-impoundment and post-impoundment hydrologic regimes downstream of Claiborne Lock and Dam using the Range of Variability Approach (RVA) (Richter et al., 1997) to further characterize existing riverine habitat conditions (***Appendix E***). The assessment showed significant post-impoundment hydrologic alterations, including increased frequency and duration of flows less than 12,400 cubic feet per second (cfs), and decreased frequency and duration of spring flows exceeding 80,000 cfs. Flows in excess of 80,000 cfs may be critical in permitting upstream passage of migratory species past Claiborne Lock and Dam (FWS, 1998).

Up to 144 species of fish have been documented from the Alabama River subbasin, excluding the Cahaba River drainage (FWS, 1998). However, total fish diversity has declined since the Corps' dams were constructed in the 1960s. Although the dams likely impede the movement of migratory and resident fishes, some species, including striped bass (*Morone saxatilis*) and blue sucker (*Cycleptus sp.cf. elongatus*) are able to move past these structures (FWS, 1998). This subbasin continues to support a diverse community, including paddlefish (*Polyodon spathula*), blue sucker, striped bass, southern walleye (*Stizostedion* sp.), Alabama shad (*Alosa alabamae*), mooneye (*Hiodon turgisus*), and Alabama sturgeon (*Scaphirhynchus suttkusi*) (FWS, 1998; Freeman et al., 1997). The Federally protected Gulf sturgeon (*Acipenser oxyrinchus desotoi*) may also occur in the lower reaches of the subbasin.

Native freshwater mussels also declined after dams were constructed; however, several species persist in the lower and middle reaches of the Alabama River subbasin, including commercially harvested species such as ebony mussel (*Fusconaia ebena)*, washboard mussel (*Megalonaias nervosa)*, and other species (*Quadrula* spp., *F. cerina*, and *Obliquaria reflexa*). Claiborne Lake and Dannelly Lake also contain two Federally endangered mussel species, the southern clubshell (*Pleurobema decisum*) and the only known population of the heavy pigtoe (*P. taitianum*).

The Cahaba River, a major tributary to the Alabama River in the subbasin, flows about 191 miles and drains an area of 1,872 square miles. The Cahaba River is one of the essentially free-flowing rivers in the southeastern U.S. and supports exceptional diversity of native fishes and aquatic invertebrates (Freeman et al., 1997; FWS, 1998). It provides habitat for up to 135 fish species and 50 mussel species, including 12 Federally protected aquatic species, such as goldline darter (*Percina aurolineata*), Cahaba shiner (*Notropis cahabae*), and fine-lined pocketbook mussel (*Lampsilis altilis*).

The upper Cahaba River also serves as an important source of water supply and as receiving waters for Birmingham, Alabama. As a result of water diversion and extensive point and nonpoint pollution in the watershed, notable faunal declines coincident with water quality degradation have been documented (Freeman et al., 1997; Mayden and Kuhajda, 1989; Pierson et al., 1989; Shepard et al., 1994).

4.5.3.1.1.2 Coosa River Subbasin

The mainstem Coosa River, from its origin at the confluence of the Etowah and Oostanaula Rivers to its confluence with the Tallapoosa River, is impounded and regulated by six dams, which are operated by Alabama Power Company (APCO) for hydropower generation. Four of these facilities generate hydropower in a peaking mode, and two operate in a run-of-river

mode, releasing outflows that approximate reservoir inflows (see Section 4.4.2.1). Together, these six dams impound 238 miles of the Coosa River (Freeman et al., 1997), fragmenting the few remaining reaches of free-flowing riverine habitat.

At least 147 fish species have been documented from the Coosa River drainage, including the Oostanaula-Conasauga-Coosawattee and Etowah subbasins (FWS, 1998). Historically, the Coosa River supported productive sport and commercial fisheries, including lake sturgeon (*Acipenser* sp. cf. *fulvescens*) in the upper reaches. However, as a result of riverine habitat loss, modification and fragmentation from impoundments, and water quality degradation, aquatic biodiversity has declined (Burkhead, 1993, Burkhead et al., 1992, Freeman, 1993, FWS, 1986 and 1993a). The remaining significant reaches of free-flowing riverine habitat on the mainstem Coosa River are described below:

- An 8-mile reach extends downstream from Jordan Dam in the lower Coosa River. This reach is substantially affected by highly fluctuating hydropower releases from Bouldin and Jordan Dams. The downstream effects of highly fluctuating flow releases are limited to a degree by the downstream minimum flow requirements on weekends (see Section 4.4.1.2). The Jordan Dam tailwaters provide habitat for two Federally protected species, the endangered tulotoma snail (*Tulotoma magnifica*) and the threatened fine-lined pocketbook mussel. The tailwaters also support a regionally important spotted bass fishery, as well as locally important fisheries for striped/white/hybrid bass, catfish, sunfish, and freshwater drum (*Aplodinotus grunniens*). Southern walleye also are occasionally caught in this reach (FWS, 1998). The shoal lily/Cahaba lily (*Hymenocallis* sp.) occurs occasionally on shoals in this reach. Paddlefish, a species of concern, is restricted in this subbasin to downstream of the Fall Line (i.e., downstream of Jordan Dam) (FWS, 1998).

- A 21-mile reach of bypassed river channel extends downstream from Weiss Dam, which results from diversion of flow at Weiss Dam for hydropower generation. Although few aquatic surveys have been reported from this reach, aquatic habitat is severely degraded by reduced flows and channel dewatering.

- A 9-mile free-flowing reach extends downstream from Rome, Georgia, to the headwaters of Weiss Lake. This reach provides potentially suitable habitat for striped bass migrating upstream from Weiss Lake and other game fishes. Flows are influenced by releases from Allatoona and Carters Dams, as well as point and nonpoint source discharges from upstream communities, which also degrade water quality in the reach. Georgia Department of Natural Resources (1996) has issued a fish consumption advisory in the Coosa River because of elevated polychlorinated biphenyl (PCB) levels in fish tissue. Based on preliminary mussel survey data, few mussel species persist in this reach (FWS, 1998), suggesting that poor water quality may be the principal limiting factor. The riverine habitat performance measure developed as part of the Comprehensive Study (Freeman, 1998a) showed relatively high habitat values for this reach (see Section 4.5.3.2), reflecting attenuation of upstream discharges from Carters and Allatoona Dams, as well as substantial addition of unregulated flow from the Conasauga River and other tributaries.

4.5.3.1.1.3 Etowah River Subbasin

The Etowah River originates as a high-gradient stream in the Blue Ridge province of the Southern Appalachian Mountains and flows about 69 miles westward through Piedmont upland to Allatoona Reservoir. These upper reaches of the system provide important refuge for riverine fauna native to the Coosa River drainage. Because of habitat loss and modification resulting from a variety of influences, including impoundment, timbering, agriculture, gold mining, and urban development, at least 35 mussel species and 7 fish species have been extirpated from the Etowah River subbasin. However, the upper mainstem river and tributaries continue to support the Federally endangered amber darter (*Percina antesella*), the Federally endangered Etowah darter (*Etheostoma etowahae*), the Federally threatened Cherokee darter (*E. scotti*), and four additional State protected species. Other native fishes include freckled darter (*P. lenticula*), rock darter (E. *rupestre*), frecklebelly madtom (*Noturus munitus*), southern walleye, redhorses, several undescribed minnow and darter species, and possibly lake sturgeon (Freeman, 1998a; Burkhead et al., 1997). Significant riverine fisheries exist for striped and white bass, catfishes, spotted bass, redeye bass, and other species (Freeman et al., 1997).

The lower Etowah River subbasin contains a potentially significant remnant of mid-sized riverine habitat within the Coosa and Etowah River subbasins. About 48 miles of mainstem riverine habitat remain from the tailwaters of Allatoona Dam to Rome, Georgia. Historically, this reach probably contained over 90 fish species, including lake sturgeon and at least 51 mussel species. It currently supports substantial fisheries for striped/white bass, spotted bass, and catfishes. However, cursory sampling efforts in 1993 indicate that the overall native fish assemblage is drastically reduced (e.g., extremely low abundances and species diversity). Of the 22 fish species collected from the Etowah River mainstem in 1993, only four species were collected immediately downstream from the dam. Fish species diversity does not reach a downstream maximum until 40 miles below the dam (Burkhead et al., 1997). The Federally threatened Cherokee darter occurs in two tributaries downstream from Allatoona Dam.

Substantial daily fluctuations in stage and discharge occur in the reach downstream of Allatoona Dam as a result of hydropeaking operations; releases may vary from 240 cfs to 8,900 cfs on a daily basis. Poor quality waters discharged from Allatoona Dam, industrial and municipal discharges from the Cartersville vicinity, and erosional silt loads have historically degraded water quality in the lower subbasin. Georgia has issued a fish consumption advisory in the lower subbasin because of high PCB levels in fish tissue (Freeman et al., 1997).

Based on RVA analysis comparing pre-impoundment and post-impoundment hydrologic regimes downstream of Allatoona Dam (FWS, 1998; ***Appendix E***), significant post-impoundment hydrologic alterations included shorter duration but increased frequency of low flow pulses, increased frequency of high flow pulses, and increased frequency of flow reversals. Hydropeaking at Allatoona Dam has resulted in extreme destabilization of downstream habitat, as reflected in low habitat values under existing conditions (Freeman, 1998a, 1998b; see Section 4.5.3.2).

In 1996, American Rivers' list of the top 10 most endangered river systems in the U.S. included the Etowah River. The diversity of fish and mussels in the Etowah River is equal to the Conasauga River, which was considered to have the highest biodiversity in the Coosa River drainage. However, current data suggest that this subbasin was the historic center of

aquatic biodiversity in the eastern Mobile River drainage (Burkhead et al., 1997). The Etowah River subbasin may have more imperiled fishes (17 species) and invertebrates (16 species) than any other river system of similar length in the southeast U.S. Seventeen imperiled fishes have been identified in the subbasin, and many are believed to be extirpated. Of an estimated 105 fish species that have been reported from this subbasin, 91 are native fishes of which 15 species have been eliminated. It has been estimated that up to 65 percent of the 51 mussel species reported from this subbasin have been extirpated (Burkhead et al., 1997). Preliminary study data show that unionid mussels were not found at any of the 10 sites in Allatoona Dam's tailwaters (FWS, 1998). Contracted studies by the USGS Biological Research Division (BRD) in Athens, Georgia, and Gainesville, Florida, are continuing, and additional information on protected, rare and endemic fish and mussel species is expected by fall 1998 and will be included in the final EIS.

4.5.3.1.1.4 Oostanaula-Conasauga-Coosawattee River Subbasins

The Oostanaula River extends about 47 miles from the junction of the Conasauga and Coosawattee Rivers to its confluence with the Coosa River at Rome, Georgia. As a result of habitat changes and degraded water quality, aquatic biodiversity has declined (Burkhead, 1993; Burkhead et al., 1992; Freeman, 1993; FWS, 1986, 1993a, 1993b). Nevertheless, the potential exists for a significantly enhanced fishery in this portion of the subbasin with improvements in water quality. Although no impoundments occur in the Oostanaula River mainstem, flows are affected by Carters Dam and Re-regulation Dam upstream on the Coosawattee River. However, based on RVA analysis of pre- and post-impoundment hydrologic regimes in the Oostanaual River, the frequency and duration of low and high flow pulses are not greatly affected (FWS, 1998; ***Appendix E***).

Preliminary mussel survey data from the Oostanaula River indicate that its extant mussel community, although less than historic, is relatively intact and healthy as compared to most of the Coosa River basin. One snail species (*Leptoxis formani*) has been recently collected here that was formerly thought to be extinct. In addition, a rare large-form of the endangered triangular kidneyshell mussel (*Ptychobranchus greeni*) has also been found in its lower reach (FWS, 1998). These initial data tend to support the above determination that this river's flow regime is relatively less altered compared to most of the Coosa River basin.

The Conasauga River is an unregulated stream that flows for about 91 miles from southeast Tennessee and north Georgia to its junction with the Coosawattee River. Historically, about 90 fish and 44 mussel species have been reported from this drainage. Today, mussel diversity has been reduced by about 50 percent; fish diversity has been similarly impacted. It is believed to be second only to the Etowah River in the number of imperiled fishes and invertebrates in any other river system of similar length in the southeast (Burkhead et al., 1997). Despite these declines, there are reaches of the Conasauga River upstream from Dalton that are considered high priority resource areas because they continue to support good native aquatic communities, including lake sturgeon (possibly) and holiday darter (*Etheostoma sp.* cf. *E. brevirostrum*), which may be an undescribed endemic species. Runs of striped bass and walleye have been reported in this drainage (FWS, 1998). The drainage also provides habitat for Federally protected aquatic species (six mussel and three fish species) and seven State protected fish species (Georgia and Tennessee) whose continued existence and recovery are largely dependent on the improvement of water quality in the watershed.

The regulated reach of the Coosawattee River extends about 25 miles downstream from Carters Dam and Re-regulation Dam to its confluence with the Conasauga River. Minimum

continuous flows of 240 cfs are released from the dam. This tailwater reach supports sport fisheries, including catfishes, spotted bass, redeye bass, southern walleye and striped bass. This reach may also contain some imperiled fishes, such as the trispot darter (*Etheostoma trisella*) and river redhorse (*Moxostoma carinatum*). As a result of habitat changes and water quality degradation, aquatic biodiversity has declined in this portion of the subbasin. About 9 miles of unregulated mainstem habitat occur in the headwaters upstream from Carters Reservoir, which are isolated from other mainstem riverine habitats in the subbasin (Freeman et al., 1997).

Based on RVA analysis conducted by FWS (1998) for the Coosawattee River 16 miles downstream of Carters Dam, significant post-impoundment alterations in hydrologic regime included increased high pulse length and decreased rise rate, with minimal overall effects on frequency and duration of low flow pulses in spring and summer (***Appendix E***). Relatively high habitat values for this reach (Freeman, 1998a; see Section 4.5.3.2) indicate that reregulated discharges from Carters Re-regulation Dam help to moderate stream flow fluctuations.

Preliminary mussel survey data suggest that the lower portion of the Coosawattee River supports a fairly good mussel fauna, including two Federally protected species (*Pleurobema georgianum* and *P. greeni*). However, the mussel fauna is much reduced in the middle and upper reaches of Carters Dam tailwaters (FWS, 1998). These data suggest that the aquatic community, particularly mussels in the upper three-quarters of this reach, are being affected by flow regulation and/or degraded water quality at or downstream from Carters Dam and Re-regulation Dam.

Although Alabama and Georgia have not recently stocked striped bass in this subbasin between Carters/Allatoona Reservoirs and Weiss Reservoir, varying age classes of this species are frequently caught by recreational anglers in this subbasin (FWS, 1998). In addition, white bass, as well as subadult and adult striped bass, including males in spawning condition, have been collected in the subbasin (FWS, 1998). These are compelling observations that suggest that white and striped bass from Weiss Reservoir are successfully reproducing somewhere in this subbasin, particularly since potential spawning habitat is present in the Conasauga River and the tailwaters of Allatoona Dam (83 miles) and Carters Dams (109 miles) to Weiss Reservoir. If further studies demonstrate that striped bass in Weiss Reservoir are self-sustaining, it would be a regionally important resource because only two other self-sustaining reservoir populations of striped bass are known in the eastern United States, i.e., Santee-Cooper (South Carolina) and Kerr (Virginia and North Carolina) Reservoirs.

Studies by the USGS-BRD in Athens, Georgia, and Gainesville, Florida, have been initiated in this subbasin to provide additional information on protected, rare, and endemic fish and mussel species. Preliminary freshwater mussel data indicate that the unusual, large river form of the endangered triangular kidneyshell mussel (*Ptychobranchus greeni*) continues to persist in the lower Oostanaula and Coosawattee Rivers (FWS, 1998). In addition, a freshwater mussel species tentatively identified as the endangered southern pigtoe mussel (*Pleurobema georgianum*) was collected in the lower Coosawattee River during this study. A previously believed extinct species of freshwater snail (*Leptoxis formani*) was collected in the Oostanaula River as well (FWS, 1998).

4.5.3.1.1.5 Tallapoosa River Subbasin

This subbasin originates in the Piedmont Upland physiographic section. Downstream of the Fall Line, the subbasin enters the Coastal Plain region and is characterized by low gradient relief and sedimentary rock substrates (FWS, 1998). Because of the nature of the subbasin's metamorphic and igneous rocks in the subbasin's middle to upper reaches, the dissolved mineral content and resulting fertility of its waters are relatively low compared to the rest of the ACT basin.

Historically, the Tallapoosa River supported diverse and productive fisheries. At least 134 fish species have been reported from this subbasin (FWS, 1998). Riverine fisheries presently include striped/white/hybrid basses, paddlefish (season closed since 1987), black basses, sunfishes, catfishes, and crappie. Although there are four hydroelectric facilities in this subbasin, about 70 percent (168 miles) of the mainstem channel remains free-flowing (Freeman et al., 1997). About 95 miles of this mainstem riverine habitat is regulated by the Harris Dam (50-mile tailwater) and Thurlow Dam (45-mile tailwater). The remaining riverine habitat (about 170 miles), located in the upper mainstem and Little Tallapoosa River above Harris Reservoir, is unregulated. The upper unregulated portion and the Harris and Thurlow Dam tailwaters are effectively isolated from other riverine reaches in the subbasin by impoundments.

Upper Reach. The unregulated portion of this subbasin upstream from Harris Reservoir supports at least 50 fish species, four of which are endemic to the subbasin: Tallapoosa shiner (*Cyprinella gibbsi*), lipstick darter (*Etheostoma chuckwachatte*),Tallapoosa darter (*E. tallapoosae*), and mottled sculpin (*Cottus* sp. cf. *C. bairdi*). Eight native fish species are protected by Georgia State law. In addition, secondary trout habitat, which is capable of supporting stocked trout, occurs in the uppermost portions of the system. Two crayfish species of concern (*Cambarus englishi* and *Orconectes holti*) also occur in the subbasin (FWS, 1998). The proposed West Georgia Regional Reservoir near the Georgia/Alabama State line would partially impound and fragment this remaining unregulated riverine habitat, and could alter flow regimes and stream habitat conditions downstream to Harris Reservoir (Freeman et al., 1997).

Contracted studies through the USGS-BRD at Auburn University are being conducted in the upper reach to fill in data gaps on protected, rare and endemic fish, crayfish, and mussel species. Preliminary data from one of these studies suggest that the Federally protected fine-lined pocketbook mussel (*L. altilis*) and three species of concern (Alabama pimpleback mussel [*Quadrula archeri*], lipstick darter, and crayfish [*Cambarus englishi*]) occur in the upper mainstem of the Tallapoosa River (FWS, 1998).

Middle Reach. The middle 50-mile reach of the Tallapoosa River reach from Harris Dam downstream to the head of Martin Reservoir is the only remaining Piedmont large-river habitat in this subbasin. Before the construction of Harris Dam in 1983, this reach supported productive fisheries, particularly spotted bass, redeye bass and flathead catfish, which are now much reduced or eliminated. Today, over 60 fish species are known from the tailwaters and tributaries in this reach, including four endemic species mentioned in the preceding paragraph. Shoals in the lower portion of this reach (e.g., Griffin Shoals) contain a few stands of the Cahaba lily. Aquatic resources in this reach are adversely affected by highly fluctuating discharges that occur almost daily from Harris Dam, which is operated as a peaking hydroelectric facility by Alabama Power Company.

Hydropeaking operation of Harris Dam causes flows to fluctuate from leakage (200 cfs) to 7,000 to 12,000 and more cfs depending on generation levels. As a result, hourly fluctuations in habitat type and location, which normally occur at least 5 days per week, prevent stable habitat for foraging and reproduction of fishes longer than 24 hours at a time. Exceptions occur only when generation releases are constant over several days or are restricted to small pulses to maintain minimum flows at Wadley. These exceptions in the operation of Harris Dam provide rare opportunities for fish to grow and reproduce in this reach of the Tallapoosa River (FWS, 1998).

RVA analysis revealed that the greatest changes in annual flow regime are in low flow pulse frequency (increased 450 percent) and duration (decreased 70 percent), high flow pulse frequency (increased 108 percent), and frequency of flow reversals (increased 81 percent). Significant changes from the pre-dam flow regime also occur in fall rate (increased 58 percent) and 1-day and 3-day minimum flows (increased 63 percent and 47 percent). Under existing conditions, low flow pulses (July to September) with a duration of $\geq$ 10 days occur on average every 2.6 years compared to 1.2 years in the pre-dam record. During the 1986 to 1988 drought, spring (April to June) low flow pulses $\geq$ 10 days had a recurrence interval of 4.3 years under existing conditions, whereas the post-dam recurrence interval was 9.5 years. Therefore, the frequency of low flow pulses ($\geq$ 10 days) has been reduced by half during the summer and increased twice during the winter (Freeman, 1998a, 1998b).

Riverine habitat values (existing conditions, 1995 demands) are low to moderate (0.37 to 0.48) in the lower tailwaters near Horseshoe Bend National Military Park based on average daily flow data. When these values are adjusted for *hourly* fluctuations resulting from hydropeaking, riverine habitat values decline (about 0.21) (Freeman, 1998a, 1998b).

Past biological studies in the Harris Dam tailwaters have reflected the generally poor riverine habitat values shown in the above analysis. Significant degradation of the downstream fisheries has been documented since its construction in 1983 (FWS, 1998).

Lower Reach. The lower 45-mile riverine reach of the lower Tallapoosa River downstream from Thurlow Dam is characterized by numerous rocky shoals at the Fall Line for about two miles downstream from the dam, after which it is a typical low gradient Coastal Plain river down to its confluence with the Coosa River. This reach historically supported a rich fish fauna of over 120 species, including native Gulf Coast striped bass, Gulf sturgeon, and southern walleye. These fisheries have declined drastically since the construction of upstream hydropower dams and downstream navigation dams on the Alabama River. Nevertheless, a diverse fish community (60 or more species) persists in the lower Tallapoosa River including paddlefish, freckled darter (*Percina lenticula*), and at least one State protected species, crystal darter (*Crystallaria asprella*). It also contains potential habitat for Alabama sturgeon, a Federal candidate species (Freeman et al., 1997). The April 1991 implementation of a minimum continuous flow (1,200 cfs) by Alabama Power Company, which reduced the severity of daily flow fluctuations downstream from Thurlow Dam, significantly increased fish abundance and diversity in this reach (Kinsolving, 1989; Kinsolving and Bain, 1993; Scheidegger and Bain, 1995; Travnicek and Maceina, 1994; Travnicek et al., 1995).

Because river flows in the lower Tallapoosa River have been altered by upstream dams throughout the period of record, RVA analysis was used instead to evaluate the effects of

continuous minimum flows at Thurlow Dam, which began in 1991. As expected, the greatest change occurred in 1-day, 3-day and 7-day minimum flows which increased between 175 percent and 1,500+ percent. Significant beneficial changes also occurred in median winter flows (increased 38 to 59 percent) and rise/fall flow rates (decreased 47 to 49 percent) (Freeman, 1998a, 1998b).

Spring high flow pulses greater than generation capacity (>8,000 cfs) with a minimum 20-day duration are not uncommon, occurring on average every 3.4 years with a mean duration of 9.5 days. Continuous high discharges provide stable high flow habitats (e.g., floodplain inundation and instream channel conditions) which can result in reproductive opportunities for migratory and spring-spawning fishes (e.g., paddlefish, striped bass). This analysis likely underestimates the actual duration of high flow periods because turbine generation during high reservoir inflows can also create extended periods of high stable discharges. However, without hourly discharge data, this condition cannot be examined with confidence (Freeman, 1998a, 1998b).

The results of riverine habitat value analysis in the lower Tallapoosa show somewhat lower values (0.37 to 0.38) near Doziers Bar as compared to near Thurlow Dam (0.31 to 0.50). However, this analysis is based on daily average flows and does not consider the effects of hourly flow fluctuations, which can range between 1,200 cfs and 8,000 cfs (Freeman, 1998a, 1998b). The adverse effects of Thurlow Dam, particularly flow fluctuations for peaking hydropower generation, on downstream riverine fishes and habitats have been shown to be more severe as one approaches Thurlow Dam (Kinsolving and Bain, 1993; Scheidegger and Bain, 1995).

4.5.3.1.2 Reservoirs

The ACT basin has more than 170,000 surface acres of reservoir habitat. The largest reservoirs are Martin Lake (40,000 acres) on the Tallapoosa River and Weiss Lake (30,200 acres) on the Coosa River (FWS, 1998). Although these impoundments were constructed for navigation, flood control and/or hydroelectric purposes, they also provide significant public recreation opportunities. Generally, all of the mainstem reservoirs in the ACT basin support significant populations of at least the following popular fisheries: striped and white basses; largemouth and spotted basses; sunfishes or bream (particularly bluegill and redear sunfish); crappie; and channel, blue and flathead catfishes (FWS, 1998). Past management efforts have included stocking (e.g., temperate basses and hybrids, Florida largemouth bass, bluegill and redear sunfish, channel catfish) and regulation (e.g., number and size limits, closed-season species). Additional recreational and commercial fisheries specific to each subbasin are noted below.

4.5.3.1.2.1 Alabama River Subbasin

R.F. Henry Lock and Dam impound the Alabama River at river mile (RM) 245 and create Woodruff Lake, which extends about 81 miles upstream and covers about 12,510 acres at normal pool elevation (125 feet above mean sea level [msl]) (Corps, 1987). Millers Ferry Lock and Dam, located at RM 142 near Selma, Alabama, create Dannelly Lake, which extends 103 miles upstream to R. F. Henry Lock and Dam. This reservoir covers about 18,500 acres at normal pool elevation (80 feet msl). Claiborne Lock and Dam, located at RM 82, form Claiborne Lake, which extends upstream about 60 miles upstream to Millers Ferry Dam. This reservoir covers 5,930 acres at normal pool elevation (35 feet msl).

These impoundments support the above-mentioned fisheries, as well as southern walleye, and commercial fisheries for catfishes, freshwater drum and smallmouth buffalo (FWS, 1998). Other important fish species of concern that occur in this subbasin's lacustrine habitats include paddlefish, Alabama shad, blue sucker and Alabama sturgeon (FWS, 1998).

The Cahaba River is free-flowing along its 191-mile length. Consequently, no significant lacustrine habitats or associated fisheries occur in this drainage.

4.5.3.1.2.2 Coosa River Subbasin

The six mainstem reservoirs in the subbasin (Weiss, H. Neely Henry, Logan Martin, Lay, Mitchell, and Jordan) impound about 238 miles of the Coosa River and cover a total area of about 81,300 acres (FWS, 1998). These impoundments support the sport fisheries mentioned in the introduction to this section, as well as commercial fisheries for freshwater drum, smallmouth buffalo, and catfishes. Redeye bass (*Micropterus coosae*) also occur in these reservoirs but are generally restricted to the head of those lakes in which tailwater discharges from upstream dams occur. In addition, southern walleye have been reported from Logan Martin and Weiss Lakes (FWS, 1998). The well-known crappie fishery in Weiss Lake is particularly popular and consistently draws fishermen from out-of-state (FWS, 1998).

4.5.3.1.2.3 Etowah River Subbasin

Lake Allatoona impounds about 30 miles of the Etowah River and creates about 19,200 acres (full flood pool elevation 860 feet msl) of lacustrine habitat. This reservoir supports the common sport fishes as mentioned in the introduction to this section, as well as southern walleye, redeye bass and rainbow trout (*Oncorhynchus mykiss*) (Beissser, 1989). Fish and wildlife management efforts at Allatoona Reservoir are limited to a minimum continuous release of 240 cfs (= 7Q10 flow) from the dam and regulating water levels to control rough fish and improve black bass spawning success whenever possible (Corps, 1991, 1992).

4.5.3.1.2.4 Oostanaula-Conasauga-Coosawattee Subbasins

Carters Dam and Carters Reregulation Dam impound about 13 miles of the Coosawattee River subbasin and create a reservoir covering about 4,250 acres (maximum power pool elevation). Carters Lake supports a varied sport fishery. There are no impoundments on the mainstems of the Oostanaula and Conasauga Rivers.

4.5.3.1.2.5 Tallapoosa River Subbasin

The four reservoirs (Harris, Martin, Yates, and Thurlow) in this subbasin impound about 71 miles of the Tallapoosa River and create about 53,200 acres of lacustrine habitat. These reservoirs support the common sport fisheries mentioned in the introduction to this section, except for hybrid bass (no stocking since late 1980s), freshwater drum, and southern walleye. Smallmouth buffalo are absent from the two upstream impoundments, Martin and Harris Reservoirs. In addition, no striped or white bass fisheries occur in the uppermost Harris Reservoir (Freeman et al., 1997; FWS, 1998). Redeye bass are reported to occur in these reservoirs but are generally restricted to the head of those lakes in which tailwater discharges from upstream dams create flowing water conditions (FWS, 1998).

4.5.3.1.3 Estuarine

The Mobile Bay estuary consists of numerous habitat types, including marine waters, brackish bays and marshes, and inland rivers and swamps. Because of its habitat diversity,

the estuary provides spawning, nursery, and feeding grounds for a great number of estuarine-dependent fish and aquatic invertebrates.

Benthic invertebrates are considered to be the most important link for the overall biological production within Mobile Bay. Nematodes, copepods, polychaetes, and turbellarians are the most abundant groups of meiofaunal (less than 0.5 millimeter [mm]) benthic invertebrates that occur within the bay (TechCon, Inc., 1980). Annelids, primarily polychaetes, dominate the macrofaunal (greater than 0.5 mm size) benthos, both in diversity (147 species) and abundance (70 percent of total individuals collected) (TechCon, Inc., 1980). Other common macrofaunal benthic groups include arthropods, molluscs, and echinoderms. Comprehensive studies on the benthos of the Mobile-Tensaw River Delta are lacking. Unpublished studies of the lower delta have shown that river sediments are inhabited primarily by euryhaline marine macrofauna dominated by capitellid and spionid polychaetes. The freshwater benthos within the lower delta consists mostly of various insect larvae. In the upper delta areas, the dominant taxa includes the white crawfish (*Procambrus acutus acutus*), water boatman (*Corixidae*), and grass shrimp (*Palaemonetes kadiakensis*).

The primary commercial fishery species of the Mobile Bay estuary have been shrimp (brown shrimp [*Penaeus aztecus*], white shrimp [*P. setiferus*], and pink shrimp [*P. duorarum*]), blue crab (*Callinectes sapidus*), oysters (*Crassostrea virginica*), and various finfish (e.g., flounder, croaker, mullet, and menhaden). The Mobile Bay estuary is considered one of the most important habitats for these species in the Gulf of Mexico. Industrialization and natural impacts within the estuary watershed have resulted in reduced populations of these important aquatic resources. However, due to insufficient data, population trends for blue crab, shrimp, and finfish can not be accurately estimated.

Since 1986, oyster reefs in the estuary have been decimated by record drought conditions, infestation by the oyster drill (*Thais haemastoma*), and poor spat set. Presently, natural oyster reefs occur primarily in the lower reaches of the estuary with the most extensive reefs around the Dauphin Island Bridge at Cedar Point. In addition to the commercial value of the oyster itself, the oyster reefs of the Mobile Bay estuary support numerous fish and aquatic invertebrates that are important components of the estuarine foodweb, including the Gulf stone crab (*Menippe adina*), black drum (*Pogonia cromis*), red drum (*Sciaenops ocellatus*), and spotted seatrout (*Cynoscion nebulosus*).

Approximately 165 fish species have been documented in the Mobile Bay estuary (O'Neil and Metee, 1982). The single most important sportfishery species in the estuary is the spotted seatrout. The brackish seagrass flats of the estuary serve as the primary habitat for this species. Other sportfish species that occur in the estuary include the red drum, bluefish (*Pomatomus saltatrix*), jack crevalle (*Carynx hippos*), king and spanish mackerel (*Scomberomorus cavalla* and *S. maculatus*), sand seatrout (*Cynoscion arenarius*), and southern flounder (*Paralichthys lethostigma*). The upper reaches of Mobile Bay and the Mobile-Tensaw River Delta also support a significant freshwater sportfishery, which includes largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), warmouth (*L. gulosus*), and black and white crappie (*Pomoxis nigromaculatus* and *P. annularis*).

As mandated by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the Gulf of Mexico Fishery Management Council (GMFMC) prepared a draft amendment to its Fishery Management Plans (FMPs) in June 1998 designating essential fish

habitat (EFH) for 21 of over 60 species managed by GMFMC (NOAA, 1998). EFH refers to those waters and substrate necessary to support a sustainable fishery, including habitat for spawning, breeding, feeding, or growth to maturity. GMFMC is delineating EFH for the most important commercial and recreational species in the Gulf of Mexico to include areas in which a species is common, abundant, or highly abundant, based upon catch per unit effort data (NOAA, 1998). Additional designations will be included in subsequent FMP amendments as more data are gathered on the remaining species. As part of the review of this DEIS, NOAA's National Marine Fisheries Service (NMFS)/National Ocean Service (NOS) will assess whether the consultation process for EFH must be implemented due to potential impacts on habitat and areas designated as EFH in the final amendment and associated FMPs.

The draft FMP amendment delineates Mobile Bay up to the limit of permanent fresh water as EFH for red drum, gray snapper (*Lutjanus griseus*), brown shrimp, pink shrimp, white shrimp, Gulf stone crab, and Spanish mackerel. Food, salinity, temperature, and/or refuge areas (e.g., vegetation, oyster reefs) are the primary factors determining the distribution and abundance of these species in the estuary. In addition, the shrimp and other estuarine-dependent species provide prey for nearshore juvenile stages of the snapper-grouper complex of at least nine species, which is also managed under MSFCMA. ***Figure 4-82*** characterizes key aspects of habitat associations for the shrimp species, gray snapper, and red drum (Pattillo et al., 1997).

The aquatic habitats of the Mobile Bay estuary are also recognized as one of the most important stopover areas for migratory birds in North America. Dauphin Island and the Fort Morgan Peninsula serve as rest stops for numerous migratory bird species on their way to and from Central and South America. The Mobile-Tensaw River Delta and Mobile Bay provide essential wintering and stopover habitat for a wide variety of waterfowl, and also support about 70 species of resident bird species.

4.5.3.2 Environmental Consequences

4.5.3.2.1 Riverine

This section describes the general types of impacts associated with changes in hydrologic regimes to riverine communities of fish, mussels, and aquatic organisms. A detailed assessment is then presented of the potential for impacts to riverine habitat values under the no action and action alternatives, using the performance measure developed for the Comprehensive Study.

4.5.3.2.1.1 General Impacts of Alternative Flow Conditions

Generally, impacts to riverine communities and habitats from past water resource development, management, and use actions primarily result from impoundment and water quality changes. Impoundment eliminates riverine habitat, changes water quality, interrupts nutrient cycling and trophic webs, and concentrates pollutants and sediments within impounded waters, as well as interrupts the continuity of riverine habitats. In addition, riverine reaches downstream of dams are impacted by decreased flow volumes (annually and seasonally), altered flow regime cycles and rates of change, destabilized streambed and banks, and modified/fluctuating water quality in its tailwater discharges. These downstream impacts can eliminate or degrade riverine habitat, as well as interrupt continuity or connectivity within riverine habitats (e.g., between mainstem and/or tributaries), or between riverine and floodplain habitats.

FIGURE 4-82

Habitat Associations for Five Species with EFH in Designated Mobile Bay (ACT Basin)

Species	Life stage	Domain: Freshwater: Lacustrine	Domain: Freshwater: Riverine - coastal plain	Domain: Freshwater: Riverine - inland	Estuarine: Inlet mouth	Estuarine: Channel	Estuarine: Inter- and subtidal flats	Salinity Range: NEI: Tidal fresh (0-0.5‰)	Salinity Range: NEI: Mixing (0.5-25‰)	Salinity Range: NEI: Seawater (>25‰)	Venice System: Limnetic (0-0.5‰)	Venice System: Oligohaline (0.5-5‰)	Venice System: Mesohaline (5-18‰)	Venice System: Polyhaline (18-30‰)	Venice System: Euhaline (>30‰)	Temperature Range: 32-41°F	Temperature Range: 41-50°F	Temperature Range: 51-60°F	Temperature Range: 61-68°F	Temperature Range: 69-77°F	Temperature Range: 78-86°F	Temperature Range: >86°F	Marine: Beach/surf	Marine: Neritic	Marine: Oceanic	Substrate Preference: Mud/silt/clay	Substrate Preference: Sand	Substrate Preference: Pebble/cobble/gravel	Substrate Preference: Boulder/rocky outcrop	Substrate Preference: Shell	Substrate Preference: Submergent vegetation	Substrate Preference: Emergent vegetation	Substrate Preference: Floating vegetation	Substrate Preference: None	Depth Preference: Littoral: Intertidal	Depth Preference: Littoral: Subtidal	Depth Preference: Sublittoral: Inner shelf (32-164 ft)	Depth Preference: Sublittoral: Middle shelf (164-328 ft)	Depth Preference: Sublittoral: Outer shelf (328-656 ft)
Brown shrimp	A				●				●	●		●	●	●	●	●	●	●	●	●	●	●		●		●	●										●	●	
Penaeus	S									●					●				●	●	●			●		●	●											●	
aztecus	J				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●					●	●			●	●			
	L					●			●	●				●	●			●	●	●	●	●		●		●					●			●			●	●	
	E									●					●						●	●		●										●				●	
Pink shrimp	A				●	●	●			●				●	●		●	●	●	●	●	●		●		●	●			●						●	●	●	
Penaeus	S									●					●				●	●	●	●		●		●	●			●						●	●		
duorarum	J						●		●	●		●	●	●	●	●	●	●	●	●	●	●				●	●			●	●	●	●		●	●	●		
	L									●					●					●	●			●	●									●		●	●		
	E									●					●					●	●	●		●	●									●		●	●		
White shrimp	A					●			●	●		●	●	●	●		●	●	●	●	●	●		●		●	●						●				●		
Penaeus	S									●					●				●	●	●			●		●	●										●		
setiferus	J					●	●		●	●		●	●	●	●		●	●	●	●	●	●				●	●				●	●	●		●	●			
	L									●					●			●	●	●	●			●							●			●			●		
	E									●					●				●	●	●			●										●			●		
Gray snapper	A				●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●		●		●		●	●	●	●					●	●	
Lutjanus	S									●					●					●	●			●		●		●	●	●							●	●	
griseus	J				●	●	●	●	●	●	●	●	●	●	●				●	●	●	●		●		●			●	●	●	●			●	●	●		
	L								●	●		●	●	●	●				●	●	●			●		●					●					●	●		
	E									●				●	●					●	●			●					●	●							●	●		
Red drum	A				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			●						●	●	●	
Sciaenops	S																			●				●										●		●	●		
ocellatus	J		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			●	●		●		●	●			
	L						●	●	●	●	●	●	●	●	●				●	●	●	●		●		●	●				●		●		●	●			
	E						●		●	●				●	●					●	●			●										●		●	●		

E Egg
L Larvae
J Juveniles
S Spawning
A Adults

Source: Pattillo et al., 1997

Degradation of water quality in riverine habitats can also occur when municipal and industrial wastewater discharges are inadequately treated or land management practices are poorly exercised. There is concern that nonpoint source runoff has greatly increased suspended sediment loads and silt deposition throughout the ACT basin (FWS, 1998). Impaired water quality can result in the reduction, interruption in continuity, and/or elimination of useable riverine habitat with adverse effects on aquatic resources that depend on good quality waters (e.g., many benthic/riffle-dwelling fishes, mussels).

4.5.3.2.1.2 Riverine Habitat Performance Measure Assessment

This section analyzes the potential relative effects of the no action and action alternatives on riverine biota, using the riverine habitat performance measure developed as part of the Comprehensive Study (Freeman et al., 1997). The performance measure uses the Riverine Community Habitat Assessment and Restoration Concept (RCHARC) to derive habitat-value functions describing the relative similarity of depth and velocity conditions under alternative flow scenarios to depth and velocity conditions occurring under unregulated, natural flow conditions (Nestler et al., 1993, 1995). RCHARC is based on the premise that native riverine communities of fish, freshwater mussels, and other aquatic organisms evolved under patterns of spatial and temporal variability in physical habitat that result from long-term natural flow regimes, and therefore, managing regulated streams to mimic the spatial and temporal variability of natural streams will protect native riverine biodiversity. The habitat-value functions are useful for comparing alternative flow scenarios but do not quantify habitat suitability of a given flow regime for specific aquatic species or species assemblages (Freeman et al., 1997).

The RCHARC performance measure uses the 55-year unimpaired flows data set synthesized by the Corps (1997) as the best available approximation of natural flows in the basin. The performance measure computes a composite measure of habitat similarity based on empirically determined habitat-discharge relationships and mean monthly flow exceedance values extracted from the unimpaired daily flows data set and the HEC-5 model output for the no action and action alternatives. Scores range from 0 for no overlap in depth-velocity characteristics to 1.0 for identical representation of depth-velocity characteristics.

RCHARC performance measures were developed for 13 riverine habitat study sites in the ACT basin as documented by Freeman et al. (1997) and shown in ***Figure 4-81***. Nine of the sites are located on regulated reaches downstream of existing reservoirs, and therefore, represent habitats that potentially would be impacted by implementation of an allocation formula. These nine sites are:

- Site 3: Lower reach of the Coosawattee River downstream of Carters Reregulation Dam at river mile 0.6; representing deep-fast, raceway, and pool habitats
- Site 4: Lower reach of the Etowah River about 41 miles downstream of Allatoona Dam at river mile 6.2-7.2; representing extensive cobble shoals and deep main-channel pools experiencing large daily flow fluctuations from hydropeaking operations
- Site 5: Upper reach of the Coosa River upstream of Weiss Lake; representing deep, main channel pool habitats
- Site 8: Upper reach of the Alabama River 15 miles downstream of Woodruff Dam at river mile 229.9-231.3; representing mostly deep-fast habitat in channels modified by maintenance dredging and influenced by backwaters from downstream Dannelly Lake

- Site 9: Middle reach of the Alabama River 16 miles downstream of Millers Ferry Lock and Dam at river mile 125.4-127.6; representing mostly deep-fast habitat in channels modified by dredging and influenced by backwaters from downstream Claiborne Lake
- Site 10: Lower reach of the Alabama River 14 miles downstream of Claiborne Lock and Dam at river mile 66.7-69.5; representing shallow habitat ("shoaling areas"), deep-fast areas, and lateral pools
- Site 12: Middle reach of the Tallapoosa River 42 miles downstream of Harris Dam at river mile 95-99; representing deep, mid-channel pools and extensive, rocky shoals experiencing large daily flow fluctuations from hydropeaking operations
- Site 14: Lower reach of the Tallapoosa River 1.6 miles downstream of Thurlow Dam at river mile 48.1; representing the Fall Line zone containing deep main channel pools alternating with steep drops over bedrock ledges and rocky shoals
- Site 15: Lower reach of the Tallapoosa River 24 miles downstream of Thurlow Dam at river mile 25.4; representing the Coastal Plain portion of the lower river with pool habitats and shallow gravel bar deposits

Because Sites 4 and 12 experience substantial daily fluctuations in streamflow from upstream hydropeaking operations, habitat-value functions for these sites also were computed using estimates of average daily minimum and maximum flows to reflect the effects of hydropeaking on riverine habitat (Freeman et al., 1997). This procedure compares habitat values at the minimum and maximum flows to determine the lowest habitat value occurring over the range of peaking flows.

The detailed results of the performance measure assessment of potential impacts to riverine habitat are provided by FWS (1998) in ***Appendix E. Table 4-43*** summarizes the performance measure scores and ranking of scores across the no action and action alternative flow scenarios. A graphic example of riverine performance measure scores for the lower Alabama River (Site 10) is provided in ***Figure 4-83***.

Under the no action alternative, RCHARC performance measure scores ranged from 0.012 at Alabama River Site 8 to 0.781 at Coosa River Site 5 (***Table 4-43***). Alabama River Sites 8 and 9 consistently showed the lowest habitat similarity to unimpaired flows across all seasons (<0.150) , reflecting highly altered depth-velocity conditions at these sites. Site 3 on the Coosawattee River and Site 5 on the Coosa River consistently achieved the highest habitat similarity to unimpaired flows, with scores usually greater than 0.500. For most sites, there was a general trend of slightly decreasing similarity to unimpaired flows (i.e., lower scores) with increasing demand.

Under the no action alternative, Site 4 on the lower Etowah River and Site 12 on the middle Tallapoosa River also achieved scores exceeding 0.500 in some seasons; however, scores decreased substantially when daily hydropeaking operations were factored into the habitat-value functions (***Table 4-43***). In the most extreme case, habitat similarity declined from 0.712 using monthly flows to 0.241 using estimates of daily peaking flows at Site 12. This result demonstrates the potential for dramatic effects to riverine habitat stability and

TABLE 4-43
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternatives									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Winter (January to March):													
Coosawattee - Site 3	0.720	0.717	0.712	0.843	0.835	0.825	0.725	0.722	0.714	0.725	0.722	0.714	0.129
Rank	8	9	12	1	2	3	4.5	6.5	10.5	4.5	6.5	10.5	
Etowah - Site 4	0.469	0.434	0.407	0.616	0.606	0.575	0.406	0.369	0.333	0.418	0.374	0.331	0.285
Rank	4	5	7	1	2	3	8	10	11	6	9	12	
Etowah - Site 4 (with hydropeaking)	0.198	0.193	0.186	0.205	0.202	0.198	0.181	0.175	0.202	0.219	0.210	0.197	0.044
Rank	6.5	9	10	3	4.5	6.5	11	12	4.5	1	2	8	
Coosa - Site 5	0.562	0.138	0.502	0.724	0.709	0.693	0.566	0.557	0.548	0.536	0.530	0.525	0.199
Rank	5	12	11	1	2	3	4	6	7	8	9	10	
Alabama - Site 8	0.109	0.111	0.113	0.110	0.108	0.110	0.106	0.106	0.106	0.105	0.105	0.104	0.006
Rank	5	2	1	3.5	6	3.5	8	8	8	10.5	10.5	12	
Alabama - Site 9	0.149	0.149	0.149	0.140	0.141	0.144	0.152	0.153	0.154	0.152	0.153	0.154	0.014
Rank	8	8	8	12	11	10	5.5	3.5	1.5	5.5	3.5	1.5	
Alabama - Site 10	0.578	0.555	0.510	0.819	0.799	0.755	0.540	0.526	0.497	0.542	0.524	0.498	0.322
Rank	4	5	10	1	2	3	7	8	12	6	9	11	

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TABLE 4-43 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternatives									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Tallapoosa - Site 12	0.711	0.711	0.712	0.824	0.813	0.797	0.923	0.909	0.882	0.923	0.908	0.881	0.126
Rank	11.5	11.5	10	7	8	9	1.5	3	5	1.5	4	6	
Tallapoosa - Site 12 (with hydropeaking)	0.247	0.247	0.241	0.265	0.265	0.265	0.268	0.268	0.268	0.268	0.268	0.268	0.003
Rank	10.5	10.5	12	8	8	8	3.5	3.5	3.5	3.5	3.5	3.5	
Tallapoosa - Site 14	0.259	0.256	0.248	0.462	0.455	0.446	0.269	0.264	0.260	0.273	0.264	0.257	0.205
Rank	9	11	12	1	2	3	5	6.5	8	4	6.5	10	
Tallapoosa - Site 15	0.274	0.273	0.271	0.465	0.452	0.434	0.278	0.271	0.267	0.290	0.283	0.275	0.198
Rank	8	9	10.5	1	2	3	6	10.5	12	4	5	7	
Sum of Ranks	79.5	92.0	103.5	39.5	49.5	55.0	64.0	77.5	83.0	54.5	68.5	91.5	
Scenario Ranking	**8**	**11**	**12**	**1**	**2**	**4**	**5**	**7**	**9**	**3**	**6**	**10**	
Spring/Summer (April to July):													
Coosawattee - Site 3	0.668	0.664	0.656	0.923	0.835	0.906	0.653	0.650	0.645	0.661	0.658	0.650	0.278
Rank	4	5	8	1	3	2	9	10.5	12	6	7	10.5	
Etowah - Site 4	0.716	0.587	0.521	0.697	0.625	0.558	0.489	0.461	0.420	0.485	0.460	0.421	0.277
Rank	1	4	6	2	3	5	7	9	12	8	10	11	

(CONTINUED)

TABLE 4-43 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternatives									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Etowah - Site 4 (with hydropeaking)	0.260	0.244	0.231	0.214	0.207	0.195	0.195	0.250	0.239	0.257	0.243	0.231	0.062
Rank	1	4	7.5	9	10	11.5	11.5	3	6	2	5	7.5	
Coosa - Site 5	0.682	0.368	0.616	0.717	0.691	0.658	0.591	0.549	0.505	0.584	0.544	0.497	0.220
Rank	3	12	5	1	2	4	6	8	10	7	9	11	
Alabama - Site 8	0.060	0.059	0.061	0.052	0.057	0.058	0.069	0.070	0.070	0.069	0.069	0.070	0.018
Rank	8	9	7	12	11	10	5	2	2	5	5	2	
Alabama - Site 9	0.099	0.098	0.098	0.097	0.097	0.095	0.100	0.100	0.100	0.100	0.100	0.100	0.005
Rank	7	8.5	8.5	10.5	10.5	12	3.5	3.5	3.5	3.5	3.5	3.5	
Alabama - Site 10	0.393	0.351	0.291	0.563	0.524	0.445	0.252	0.226	0.211	0.239	0.223	0.206	0.357
Rank	4	5	6	1	2	3	7	9	11	8	10	12	
Tallapoosa - Site 12	0.420	0.416	0.413	0.880	0.861	0.817	0.562	0.550	0.525	0.571	0.559	0.533	0.347
Rank	10	11	12	1	2	4	6	8	3	5	7	9	
Tallapoosa - Site 12 (with hydropeaking)	0.224	0.222	0.221	0.276	0.275	0.272	0.242	0.239	0.274	0.245	0.241	0.235	0.041
Rank	10	11	12	1	2	4	6	8	3	5	7	9	
Tallapoosa - Site 14	0.500	0.501	0.504	0.652	0.646	0.647	0.438	0.429	0.413	0.415	0.383	0.377	0.275
Rank	6	5	4	1	3	2	7	8	10	9	11	12	

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TABLE 4-43 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

							Action Alternatives						
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Tallapoosa - Site 15	0.442	0.441	0.443	0.592	0.587	0.590	0.361	0.348	0.327	0.314	0.293	0.281	0.311
Rank	5	6	4	1	3	2	7	8	9	10	11	12	
Sum of Ranks	59.0	80.5	80.0	40.5	51.5	58.5	74.0	76.0	87.5	67.5	84.5	98.5	
Scenario Ranking	**4**	**9**	**8**	**1**	**2**	**3**	**6**	**7**	**11**	**5**	**10**	**12**	
Summer/Fall (August to December):													
Coosawattee - Site 3	0.678	0.681	0.687	0.678	0.671	0.676	0.820	0.650	0.823	0.659	0.661	0.666	0.173
Rank	5.5	4	3	5.5	8	7	2	12	1	11	10	9	
Etowah - Site 4	0.494	0.517	0.589	0.587	0.573	0.543	0.525	0.461	0.589	0.516	0.528	0.572	0.128
Rank	11	9	1.5	3	4	6	8	12	1.5	10	7	5	
Etowah - Site 4 (with hydropeaking)	0.288	0.276	0.273	0.182	0.180	0.243	0.300	0.250	0.432	0.333	0.299	0.411	0.252
Rank	6	7	8	11	12	10	4	9	1	3	5	2	
Coosa - Site 5	0.584	0.767	0.781	0.667	0.667	0.669	0.737	0.549	0.857	0.709	0.744	0.783	0.308
Rank	11	4	3	9.5	9.5	8	6	12	1	7	5	2	
Alabama - Site 8	0.012	0.013	0.015	0.028	0.028	0.028	0.015	0.070	0.016	0.015	0.015	0.016	0.055
Rank	12	11	8.5	3	3	3	8.5	1	5.5	8.5	8.5	5.5	

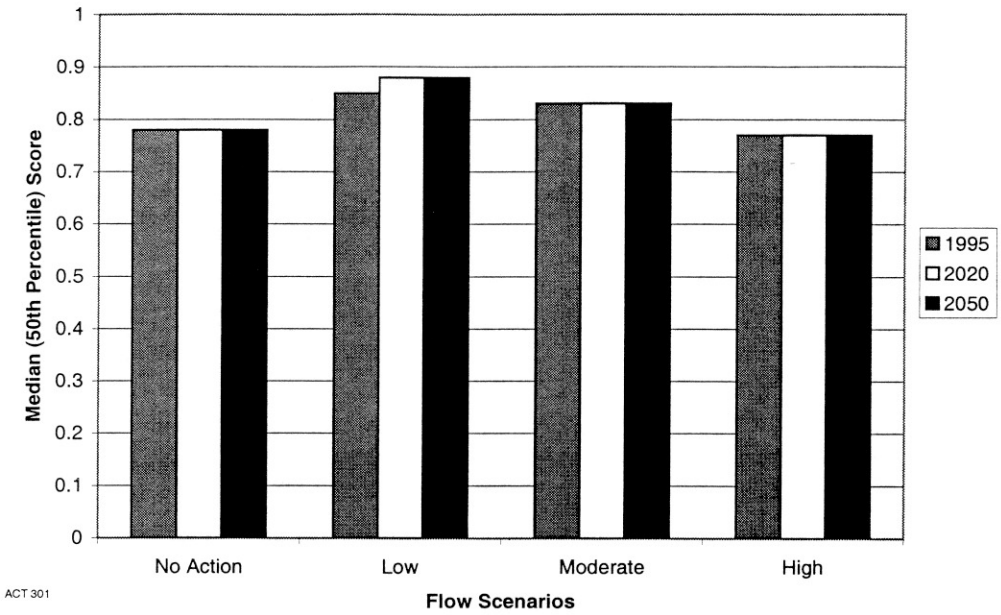
(CONTINUED)

TABLE 4-43 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

							Action Alternatives						
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Alabama - Site 9	0.034	0.034	0.034	0.033	0.033	0.032	0.033	0.100	0.033	0.033	0.033	0.033	0.068
Rank	3	3	3	8	8	12	8	1	8	8	8	8	
Alabama - Site 10	0.373	0.414	0.469	0.604	0.580	0.540	0.329	0.226	0.424	0.325	0.355	0.412	0.378
Rank	8	6	4	1	2	3	10	12	5	11	9	7	
Tallapoosa - Site 12	0.389	0.390	0.401	0.613	0.607	0.593	0.653	0.550	0.718	0.615	0.640	0.685	0.168
Rank	12	11	10	6	7	8	3	9	1	5	4	2	
Tallapoosa - Site 12 (with hydropeaking)	0.228	0.227	0.228	0.236	0.236	0.235	0.392	0.239	0.408	0.360	0.378	0.410	0.175
Rank	10.5	12	10.5	7.5	7.5	9	3	6	2	5	4	1	
Tallapoosa - Site 14	0.309	0.315	0.328	0.315	0.312	0.301	0.301	0.429	0.319	0.299	0.320	0.342	0.130
Rank	9	6.5	3	6.5	8	10.5	10.5	1	5	12	4	2	
Tallapoosa - Site 15	0.208	0.210	0.216	0.238	0.238	0.235	0.195	0.348	0.203	0.180	0.194	0.204	0.168
Rank	7	6	5	2.5	2.5	4	10	1	9	12	11	8	
Sum of Ranks	95	79.5	59.5	63.5	71.5	80.5	73	76	40	92.5	75.5	51.5	
Scenario Ranking	**12**	**9**	**3**	**4**	**5**	**10**	**6**	**8**	**1**	**11**	**7**	**2**	
Overall Weighted Sum of Ranks	233.5	252.0	243.0	143.5	172.5	194.0	211.0	229.5	210.5	214.5	228.5	241.5	
Overall Scenario Ranking	**9**	**12**	**11**	**1**	**2**	**3**	**5**	**8**	**4**	**6**	**7**	**10**	

Source: FWS, 1998; see ***Appendix E***

FIGURE 4-83
Riverine Habitat Performance Measure Scores, Lower Alabama River (Site 10), Spring/Summer (ACT Basin)



availability on a daily basis downstream of hydropeaking facilities in the basin. With hydropeaking, Sites 4 and 12 scored below 0.300 in all seasons.

Among the three action alternative flow scenarios, RCHARC performance measure scores varied from 0.015 at Alabama River Site 8 to 0.923 at Tallapoosa River Site 12 (***Table 4-43***). Scores generally varied more between flow scenarios than between demand levels within the same scenario. Site 3 on the Coosawattee River, Site 5 on the Coosa River, and Site 12 on the Tallapoosa River consistently achieved the highest habitat similarity to unimpaired flows, with scores exceeding 0.500 for nearly all flow scenarios. Of the nine riverine habitat study sites below existing dams, these three sites are influenced by the fewest number of upstream impoundments.

Alabama River Sites 8 and 9 consistently achieved the lowest habitat similarity to unimpaired conditions (less than 0.155) and showed narrow ranges of variation in scores between the high, moderate, and low flow scenarios (0.005-0.068) (***Table 4-43***). Hence, riverine habitat in these two reaches, which exhibits almost no potential for restoration of natural depth-velocity conditions because of existing impoundments (Freeman et al., 1997), would not be significantly affected by a water allocation formula. In contrast, Alabama River Site 10 located downstream shows the greatest potential for adverse effects to riverine habitat under alternative flow scenarios. This site showed the widest range of variation in scores between the three action alternative flow scenarios for all three seasons (0.322-0.378) (***Table 4-43***).

Hydropeaking showed pronounced effects on riverine habitat value at Site 4 on the lower Etowah River below Allatoona Dam and Site 12 on the middle Tallapoosa River below Harris Dam under the action alternative flow scenarios (***Table 4-43***). At these sites, the

difference in scores obtained using average monthly flow conditions versus daily hydropeaking conditions generally exceeded, and sometimes far exceeded, the range of scores across the three action alternative flow scenarios for either condition. This finding indicates that daily hydropower operations may exert substantially greater impacts on riverine habitat in these reaches than changes in monthly flow conditions associated with an allocation formula.

Based on the sum of ranks of the individual riverine sites across action alternative flow scenarios, the high flow scenarios rank highest in overall similarity of riverine habitat conditions to unimpaired flows during winter and spring/summer, while trends are less apparent for summer/fall (***Table 4-43***). The overall weighted sum of ranks shows the high flow scenarios as providing the most optimal flow conditions for maintenance of riverine habitat on an annual basis, followed by moderate and low flow scenarios.

River segments located downstream from existing mainstem reservoirs would be the ones most likely to experience direct effects of a water allocation formula agreement between the States of Georgia and Alabama (FWS, 1998). However, indirect effects, such as the construction of new reservoirs for additional storage capacity or growth in demands for consumptive water uses, could result in significant adverse effects on other river segments through habitat loss and fragmentation, altered flow regimes, and associated water quality changes. Further, allocation decisions could involve balancing minimum river flows with associated environmental and economic consequences between the Coosa River and the Tallapoosa River. The mainstems of both rivers, including the Little Tallapoosa River in the Tallapoosa River subbasin, flow across the State line from Georgia into Alabama (***Figure 4-81***).

Reaches of riverine habitat in the ACT basin with the greatest potential for significant adverse impacts resulting from indirect actions of an allocation formula would include the unregulated portion of the Tallapoosa subbasin upstream from Harris Lake in Georgia and Alabama, including the Tallapoosa and Little Tallapoosa Rivers; and unregulated portions of the upper coosa subbasin in Georgia and Tennessee, especially the Conasauga River and the Etowah River upstream from Allatoona Lake (***Figure 4-81***). These rivers harbor a majority of the native riverine aquatic biodiversity remaining in the ACT basin, including a number of endemic species of fish and invertebrates found only in those subbasins, and contain the last suitable reaches of free-flowing riverine habitat for numerous federal and state protected species of fish and freshwater mussels (see Section 4.5.4). These rivers also currently face substantial threats from urban development, nonpoint source runoff, municipal wastewater discharges, tributary impoundments (***Table 4-10***), mainstem impoundments (e.g., Tallapoosa River), and resulting habitat modification and water quality degradation.

The Cahaba River within the Alabama River subbasin also supports exceptional aquatic biodiversity; however, because its watershed lies entirely within Alabama, it would appear to be less vulnerable to foreseeable future indirect actions following an allocation decision.

4.5.3.2.2 Reservoir

This section describes the general types of impacts to reservoir fisheries and other aquatic resources associated with changes in flow conditions. A detailed assessment then focuses on 10 of the 15 mainstem reservoirs in the basin for which current operations result in substantial variation in water levels over the course of the year. These reservoirs are Carters

Lake, Lake Allatoona, Weiss Lake, H. Neely Henry Lake, Logan Martin Lake, Jordan Lake, Harris Lake, Martin Lake, Bob Woodruff Lake (R. F. Henry), and Bill Dannelly Lake (Millers Ferry). The detailed assessment uses a performance measure developed by FWS, based on work products of the Comprehensive Study, to characterize the potential for fisheries impacts under the alternative flow scenarios. Other reservoirs were excluded from the detailed assessment because most are operated more nearly in run-of-river modes, which tend to minimize pronounced variations in water levels. In addition, daily reservoir elevations under critical low flow periods are assessed relative to the potential for impacts associated with sustained drawdowns covering multiple spawning and rearing seasons.

General Impacts of Alternative Flow Conditions

The alternative flow scenarios would affect habitat for reservoir fisheries and other aquatic resources mainly through changes in water levels, changes in reservoir flushing rates (retention times), and associated changes in water quality parameters, such as primary productivity, nutrient loading, dissolved oxygen concentrations, and vertical stratification.

Seasonal water level fluctuations substantially changing the area of shallow-water habitats and shoreline vegetation inundated can significantly influence the reproductive success of resident fish populations. High water levels inundating shoreline vegetation during spawning periods frequently have been associated with enhanced reproductive success and strong year class development for largemouth bass, spotted bass, bluegill, crappie, and other littoral species (FWS, 1998; Ryder et al., 1995). Conversely, low or declining water levels can adversely affect reproductive success by reducing the area of available littoral spawning and rearing habitats. In West Point Lake, falling water levels during the rearing season were correlated with a decline in survival of young-of-year largemouth bass, although surviving fish were larger (Miranda et al., 1984).

A recent study of 11 Alabama reservoirs, which included six reservoirs in the ACT basin, found consistent relationships between the production of strong crappie year classes and wet winters prior to crappie spawning (Maceina and Stimpert, 1998). Wet winters resulted in shorter retention time (i.e., higher flushing rates) in reservoirs with stable water levels, and higher water levels in reservoirs fluctuating more than 6 feet or more per year, such as Weiss Lake. High winter inflows may favor crappie production by increasing nutrient loading, which in turn stimulates primary and secondary production later in the growing season (Maceina and Stimpert, 1998; Ploskey and Reinert, 1996). In reservoirs with stable water levels and low retention, longer post-winter retention also was associated with greater crappie production, possibly related to reduced flushing of young-of-year fish in the discharge from the impoundment and more stable feeding conditions (Maceina and Stimpert, 1998).

Substantial daily or weekly fluctuations in reservoir levels associated with hydropower peaking operations may negatively affect reservoir fisheries by dewatering spawning and nursery habitats for littoral species, exposing nests and eggs deposited in shallow-water habitats, and reducing the availability of shoreline cover and its associated invertebrate food supply.

4.5.3.2.2.1 FWS Performance Measure Assessment

FWS developed a performance measure to assess relative effects of the no action and action alternatives on reservoir fisheries habitat, based on the premise that greater departure of reservoir levels from optimum levels for critical guilds of fishes (e.g., littoral spawning, rearing) result in greater impacts to their habitats. The performance measure uses HEC-5

modeling output of daily reservoir elevations over the 55-year period of record and "acceptability levels" of reservoir elevations (i.e., suitability criteria) for critical guilds as identified for each reservoir by regional fisheries experts in an iterative questionnaire survey (Ryder et al., 1995). The performance measure also incorporates day-to-day reservoir level stability over critical spawning and rearing periods as a weighting factor, with stable or rising levels having a positive effect and falling levels having a negative effect on fish habitat. Performance measure scores were computed for each year in the period of record for each reservoir evaluated. Scores range between 0 for least acceptable and 1.0 for most acceptable reservoir level habitat conditions. The detailed results of this assessment are provided in CH2M HILL (1998b) (see ***Appendix E***) and are summarized below.

Median (50th percentile) performance measure scores under the no action alternative ranged from 0.52 at Lake Allatoona to 0.99 at Woodruff Lake (***Table 4-44***). ***Figure 4-84*** provides an example of the reservoir performance measure results. All 10 reservoirs showed little or no variation in performance scores between the three consumptive demand scenarios. Lake Allatoona and Harris Lake exhibited the greatest potential for reservoir fisheries impacts (i.e., lowest scores) under the no action alternative, with performance scores between 0.52 and 0.61. Substantial seasonal water level fluctuations associated with operations for flood control (e.g., winter drawdowns), downstream flow targets, and hydropower operations largely account for these comparatively low performance values. In contrast, Woodruff Lake currently operates at closer to optimum water levels for critical fishery guilds with less seasonal fluctuation, as indicated by a performance score of 0.99. The other seven reservoirs showed intermediate potential for fisheries impacts related to reservoir levels, as indicated by performance scores ranging from 0.71 to 0.87.

For Allatoona, Weiss, H. Neely Henry, Logan Martin, and Harris Lakes, the no action alternative showed a greater potential for reservoir fisheries impacts compared to the high, moderate, and low flow scenarios under the action alternative (***Table 4-44***). However, because the matrix of modeled scenarios was intended to bracket any foreseeable allocation formula, reservoir fisheries impacts under the no action alternative would be expected to fall within the range of impacts represented by the matrix of scenarios for the action alternative. The principal factor contributing to these lower scores under no action was the simulation of more pronounced seasonal drawdowns than under the low and moderate flow scenarios. The HEC-5 model of the high flow scenario eliminated seasonal drawdowns for flood control. In addition, daily hydropower peaking operations in the basin could not be reasonably modeled under the high, moderate, and low flow scenarios (see Section 4.4.1.2). Peaking operations, which were reflected under the no action alternative, typically result in daily to weekly water level fluctuations which also would be expected to contribute to lower performance measure scores.

Because of the differences in modeling assumptions masking seasonal and daily variations under the three action scenarios, absolute performance measure scores are not directly comparable between the action scenarios and the no action alternative. The range of potential impacts represented by the high, moderate, and low flow scenarios would be wider, and likely bracket the no action impacts, if seasonal drawdowns and hydropower peaking operations approaching existing levels were incorporated into the respective models. Based on more pronounced negative deviation of the no action scores from the action scenario scores, reservoirs most likely to show wider ranges of impacts include Allatoona, Harris, Logan Martin, and Weiss. In considering that the moderate flow scenario

TABLE 4-44
Median (50th Percentile) Reservoir Fisheries Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

					Action Alternatives									
		No Action Alternative			High Flow			Moderate Flow			Low Flow			
Reservoir[a]		1995	2020	2050	1995	2020	2050	1995	2020	2050	1995	2020	2050	Range
Lake Allatoona		0.52	0.52	0.52	0.80	0.81	0.81	0.84	0.83	0.83	0.86	0.86	0.86	0.06
	Rank	11	11	11	9	7.5	7.5	4	5.5	5.5	2	2	2	
Carters Lake		0.71	0.71	0.71	0.85	0.85	0.85	0.72	0.72	0.72	0.71	0.72	0.72	0.14
	Rank	10.5	10.5	10.5	2	2	2	6	6	6	10.5	6	6	
Weiss Lake		0.73	0.73	0.72	0.90	0.90	0.90	0.84	0.84	0.84	0.85	0.85	0.85	0.06
	Rank	10.5	10.5	12	2	2	2	8	8	8	5	5	5	
H. Neely Henry Lake		0.84	0.84	0.83	0.94	0.93	0.93	0.95	0.95	0.95	0.95	0.95	0.95	0.02
	Rank	10.5	10.5	12	7	8.5	8.5	3.5	3.5	3.5	3.5	3.5	3.5	
Logan Martin Lake		0.78	0.78	0.77	0.96	0.96	0.96	0.87	0.87	0.87	0.88	0.88	0.88	0.09
	Rank	10.5	10.5	12	2	2	2	8	8	8	5	5	5	
Jordan Lake		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.00
	Rank	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	
Harris Lake		0.60	0.61	0.61	0.86	0.86	0.86	0.84	0.84	0.84	0.85	0.85	0.85	0.02
	Rank	12	10.5	10.5	2	2	2	8	8	8	5	5	5	
Martin Lake		0.78	0.78	0.78	0.77	0.77	0.77	0.83	0.83	0.83	0.85	0.88	0.88	0.11
	Rank	8	8	8	11	11	11	5	5	5	3	1.5	1.5	

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TABLE 4-44 (CONTINUED)
Median (50th Percentile) Reservoir Fisheries Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternatives									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Reservoir*	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Woodruff Lake	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Rank	11	11	11	5	5	5	5	5	5	5	5	5	
Dannelly Lake	0.87	0.87	0.86	0.87	0.87	0.87	0.89	0.89	0.89	0.89	0.89	0.89	0.02
Rank	9	9	12	9	9	9	3.5	3.5	3.5	3.5	3.5	3.5	
Sum of Ranks	99.5	98	105.5	55.5	55.5	55.5	57.5	59	59	49	43	43	
Scenario Ranking	11	10	12	5	5	5	7	8.5	8.5	3	1.5	1.5	

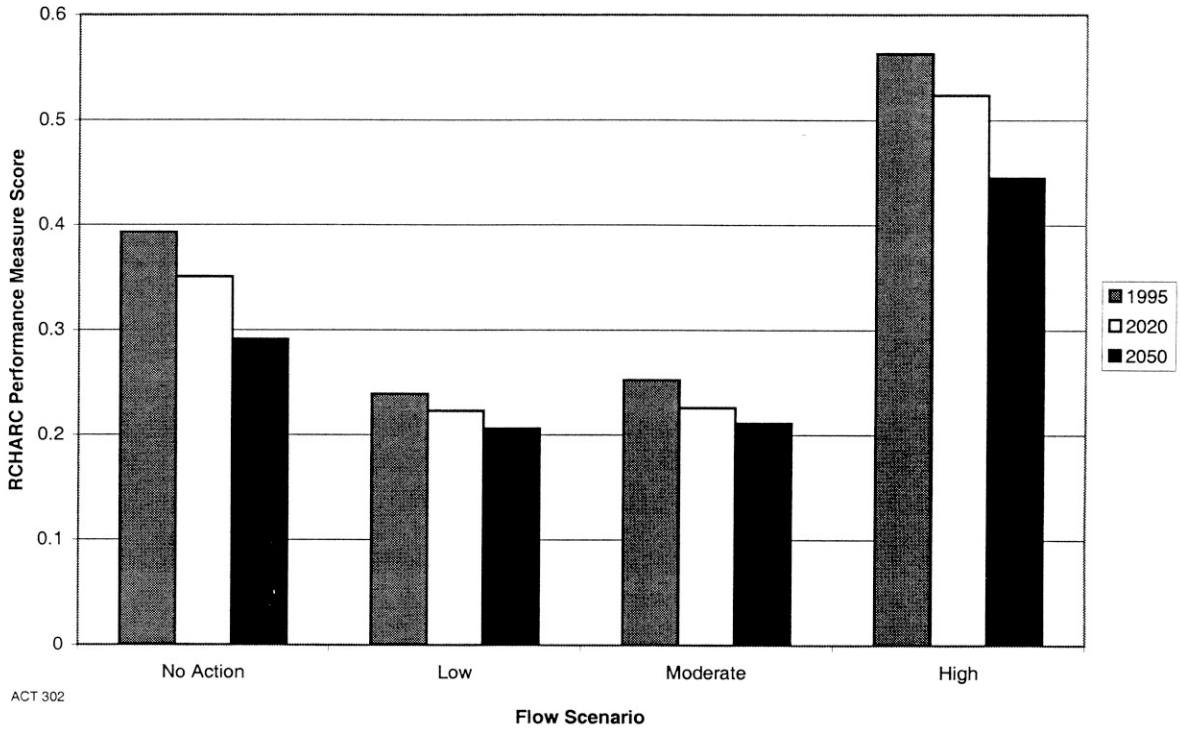
Individual reservoirs were ranked across all 12 flow scenarios in order of highest performance measure score (rank=1) to lowest score (rank=12). To avoid unequal weighting of reservoirs in summing the ranks, scenarios tied with the same score were each assigned a rank equivalent to the average of the rank positions occupied by the scenarios (e.g., three-way tie for first: rank = (1+2+3)/3 = 2).

Range represents range of scores under the action alternative.

* In the reservoir fisheries report (CH2M HILL, 1998) provided in ***Appendix E***, Woodruff Lake is referred to as R.F. Henry Reservoir, and Dannelly Lake is referred to as Millers Ferry Reservoir.

Source: CH2M HILL, 1998b; ***Appendix E***

FIGURE 4-84
Median Reservoir Fisheries Performance Measure Scores for Martin Lake (ACT Basin)



most closely resembles existing operations in the basin, it provides the best basis for comparison of general trends and ranges of impacts among the three action scenarios (see Section 4.4.1.2).

Among the three action scenarios, Lake Allatoona in the headwaters of the basin and Martin Lake on the Tallapoosa River achieved the highest performance measure scores (i.e., lowest potential for impacts) under the low flow scenario (***Table 4-44***). For these reservoirs, the lowest reservoir releases would maintain the most stable water levels on an annual basis. Conversely, Carters Lake, Weiss Lake, and Logan Martin Lake achieved the highest performance scores under the high flow scenario. This result may in part be related to the modeling of high flow scenarios without seasonal drawdowns for flood control. Elimination of drawdowns would tend to stabilize water levels on an annual basis and increase average annual reservoir levels, both of which would have positive effects on fish habitat. Woodruff Lake, Jordan Lake, H. Neely Henry Lake, Harris Lake, and Dannelly Lake showed little or no sensitivity across the action scenarios, as indicated by the narrow ranges of scores (0.00 to 0.02). Based on the wider range of performance measure scores observed across the action scenarios (***Table 4-44***), Carters Lake, Martin Lake, Logan Martin Lake, and Weiss Lake show the greatest potential for significant effects to reservoir fisheries habitat under the modeled action scenarios.

Based on the sum of ranks of individual reservoirs under each action scenario, the low flow scenarios ranked the highest as maintaining the most acceptable reservoir levels basin-wide for reservoir fisheries (***Table 4-44***). This result is consistent with the expectation that lower

reservoir releases during low flow periods are beneficial in sustaining higher and more stable reservoir levels.

4.5.3.2.2.2 Impacts of Critical Low Flow Periods

While FWS performance measure provides a means of comparing relative impacts between scenarios, it does not distinguish potential impacts resulting from sustained drawdowns covering multiple critical periods, such as spawning seasons. Examination of daily plots of reservoir water elevations for critical low flow periods indicates that, for headwater storage reservoirs, such impacts could be significant (CH2M HILL, 1998; see *Appendix E*). *Figure 4-85* provides an example of reservoir water level changes at Lake Allatoona during these low flow periods.

For Allatoona Lake, the optimum pool elevation for littoral spawning and rearing guilds of sport fishes is 840 feet. Water levels falling 3 feet or more below this elevation (837 feet and lower) show acceptability levels of 0.3 and lower, with zero acceptability occurring at water levels of 10 to 15 feet or more below optimum (Ryder et al., 1995). Comparison of the modeled action scenarios (1995 demands) for the critical low flow years of 1985 through 1989 shows that sustained drawdowns below 837 feet would extend about 5 months under the low flow scenario, up to 17 months under the moderate flow scenario, and up to 19 months under the high flow scenario (*Figure 4-85*). The moderate and high flow scenarios would affect two consecutive spawning seasons for largemouth bass, spotted bass, and crappie, and one entire rearing season. Further, under the high flow scenario, water levels would fall below 830 feet (zero acceptability) for an entire rearing season for these critical species. Thus, the high flow scenario under critical drought conditions could substantially influence reproductive success and recruitment in up to 2 year classes of sport fishes.

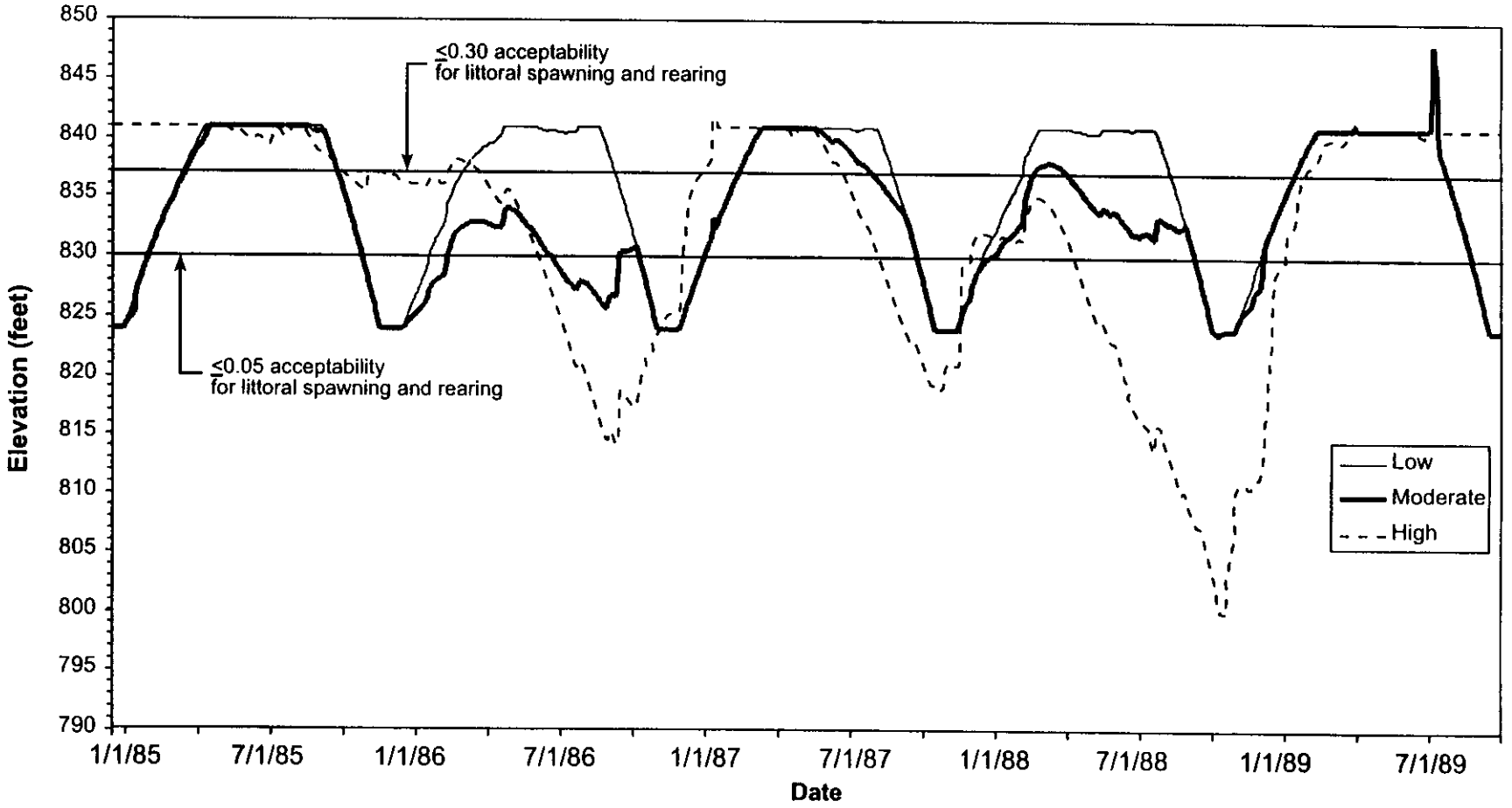
For the other two reservoirs examined for critical drought periods, Lake Harris exhibited similar effects under drought conditions, with sustained drawdowns under the high flow scenario mainly affecting the rearing and winter drawdown periods for largemouth bass, spotted bass, and crappie (CH2M HILL, 1998; *Appendix E*). Weiss Lake showed less marked differences between action scenarios in the duration of sustained drawdowns below critical levels.

4.5.3.2.3 Estuarine

The assessment of potential impacts to estuarine fish and aquatic resources within the ACT basin is based on the scientific literature and limited to general discussion of how fish and aquatic resources that are common to the Mobile Bay estuary may be affected by alterations to freshwater inflows.

The quantity, quality, and timing of river discharge into the Mobile Bay estuary is an integral component of estuarine habitat, affecting temperature and salinity regimes, nutrient loading, and primary productivity. These in turn largely determine the distribution and availability of habitats for estuarine-dependent life stages of fish, shellfish, and other aquatic organisms. Significant changes in the season-specific salinity characteristics of the estuary could preclude certain species' life stages from using previously suitable refuges, feeding areas, and nursery grounds. Substantial alterations in freshwater inflow could dramatically reduce the area or availability of some bottom types preferred by certain species or life stages (e.g., oyster reefs), resulting in crowding and interspecific competition for food or space. Significantly increased summer salinities also could allow nearshore juvenile stages of the snapper-grouper complex of species to enter estuaries and prey upon shrimp and other estuarine-dependent species in areas previously serving as safe refuge.

FIGURE 4-85
Daily Reservoir Elevations of Lake Allatoona. Action Alternative Flow Scenarios for the Critical Low Flow Period (ACT Basin)



Decreases in freshwater inflow associated with an allocation could potentially impact the Mobile Bay estuary ecosystem. A study conducted by NOAA (1998) for the ACF basin concluded that decreases in freshwater input into Apalachicola Bay indirectly increase oyster mortality by allowing predators of the oyster, such as the oyster drill, to colonize oyster beds. Although comparable studies have not been conducted in Mobile Bay, these results suggest that levels of oyster mortality could also be affected in Mobile Bay in response to substantial alterations in seasonal freshwater inflow.

Changes in cyclic freshwater inflow to Mobile Bay could also reduce nutrient loading. Altered nutrient loading could result in changes in seasonal levels of primary productivity, including the distribution and extent of floating and submersed aquatic vegetation.

The degree to which components of the Mobile Bay estuary ecosystem would be impacted by changes in freshwater inflow is directly dependent on the magnitude of the inflow reductions. The Alabama River joins the Tombigbee River (which is not part of the ACT basin), to form the Mobile River, which ultimately flows into Mobile Bay. Because the drainage areas of the Tombigbee and Alabama Rivers are similar in size, both rivers contribute roughly the same inflow volumes to the Mobile Bay estuary. Therefore, any reduction in flow volume of the Alabama River would result in an overall inflow reduction that is half of the original reduction volume. The potential impacts to resources associated with inflow reductions in the ACT basin would, thus, be diminished downstream of the confluence of the Tombigbee and Alabama Rivers.

While impacts to estuarine fish, shellfish, and other aquatic resources in Mobile Bay cannot be directly assessed with existing information, HEC-5 modeling results suggest that substantial flow accretion from the Cahaba River and other tributaries to the Alabama River would partly attenuate seasonal and weekly flow fluctuations resulting from alternative flow scenarios downstream of Claiborne Lake (Section 4.4.1.2). In addition, the substantial flows contributed by the Tombigbee River would further dampen any seasonal differences in flow characteristics between the action alternative flow scenarios. Thus, an allocation formula within the range of magnitudes currently being evaluated would be unlikely to exert significant adverse effects on estuarine fish, shellfish, and other aquatic resources in Mobile Bay.

4.5.4 Protected Species (Federal and State)

This section discusses the Federal and State threatened and endangered species that may be impacted by the alternative range of flow scenarios. The evaluation of protected species is based on an inventory of the basin completed by FWS under the Comprehensive Study (Ziewitz et al., 1997) and a comparison of the probable species in the basin with changes in stream flows and reservoir levels. Results of the analyses completed by FWS are summarized in the FWCA report (***Appendix E***). Supplemental surveys completed by the USGS under contract to the Corps, have been conducted and will be used to evaluate the potential impacts on key aquatic species. Data from these surveys were not yet available at the time the draft EIS was prepared but will be presented in the final EIS.

4.5.4.1 Affected Environment

The ACT basin supports 45 Federally protected (listed and proposed) and candidate species (***Appendix E***). This corresponds to 63 percent of the 71 Federally protected species in the

ACT and ACF basins. Also of concern are 160 species that are protected under State law (Alabama-57, Georgia-103) in the ACT basin (FWS, 1998).

Of the 205 Federally and State protected and candidate species in the ACT basin, 52 species are associated with riverine habitat and have the greatest potential to be impacted (e.g., reduced instream flows or trans-basin discharges, changes in existing reservoir management, or construction of new reservoirs) by implementation of a water allocation formula. ***Table 4-45*** lists the Federal and State protected species typically found in or near water systems and, therefore, those most likely to be affected by the final water allocation formula. Seventeen of these potentially impacted species are endemic to the ACT basin. ***Figure 4-86*** depicts the distribution of numbers of potentially affected Federally protected species by subbasin.

Of the Federally protected species, the only bird listed as potentially affected by the water allocation changes in the ACT basin is the wood stork. No rookeries are known to occur in the basin, but this species is sensitive to changes in water elevations at feeding areas. The wood stork feeds by tactile-location of small fish in shallow pools; with too little water, the fish are absent, and with excess water in the pools, tactile-location is ineffective.

The Gulf sturgeon is a Federally listed threatened fish that has been reported from the lower Mobile, Cahaba, Coosa, and Tallapoosa Rivers. Currently, adult Gulf sturgeon are thought to be confined below the Claiborne Lock and Dam on the Alabama River.

Nine Federally protected fish are found in the ACT basin, including the Gulf sturgeon and a variety of darters and other small species inhabiting the springs, tributaries, and rivers of this system. The pygmy sculpin, a threatened species, is known to occur only at Coldwater Spring and the spring run to its confluence with Dry Creek in Calhoun County, Alabama. This small spring pool remains cool year-round, proving suitable habitat for this species. The blue shiner is found only in the upper Coosa River drainage in Georgia and in two Little River tributaries in Alabama. This shiner inhabits small to medium streams over rocky substrate with moderate to slow current. The Etowah darter is a Federally listed endangered species that requires riverine or tributary watercourses with riffles and moderate to strong current. It is found only in the upper Etowah River system above Lake Allatoona in Georgia. The Cherokee darter, a threatened species, is present in the upper Coosa River system in Georgia. It is found in small to medium sized streams with gravel and cobble substrates.

A Federally listed endangered species, the Cahaba shiner, is found only in small portions of the mainstream of the Cahaba River in Shelby County, Alabama. Quiet shallow water immediately downstream of swift riffle areas is preferred habitat as the Cahaba shiner requires well oxygenated waters over sandy substrates and gravel beds. Another endangered species known to occur in the ACT basin is the amber darter. Critical habitat has been designated for this species on the Conasauga River in Tennessee and in Murray and Whitfield Counties, Georgia. This darter is found in mainstream river and large tributary habitat with moderate to swift currents. The goldline darter, a threatened species, is presently found only in the Coosawattee River system in Georgia and the Cahaba River

TABLE 4-45
Protected Species Potentially Affected by the Water Allocation Formula in ACT Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Georgia Status	Subbasin	Habitat Description
Birds							
Mycteria americana	Wood stork		E	SP	E	UCO, LCO, T	Forested wetland/shallow water
Fish							
Acipenser oxyrinchus desotoi	Gulf sturgeon		T	SP		AL	Riverine mainstream
Cottus pygmaeus	Pygmy sculpin	Y	T	SP		LCO	Riverine/tributary, coldwater spring (only)
Crystallaria asprella	Crystal darter			SP		AL, T	Riverine/mainstream/run
Cyprinella caerulea	Blue shiner	Y	T	SP	E	LCO, UCO	Riverine/mainstream/large tributary/rocky
Etheostoma brevirostrum	Holiday darter	Y	SC		T	LCO, UCO	Riverine/mainstream/tributary
Etheostoma chuckwachattee	Lipstick darter	Y			E	T	Riverine/mainstream/tributary shallow riffles
Etheostoma ditrema	Coldwater darter	Y	SC	SP	T	LCO, UCO, AL	Riverine/tributary/run/pool
Etheostoma etowahae	Etowah darter	Y	E		T	UCO	Riverine/mainstream/tributary/riffle
Etheostoma scotti	Cherokee darter	Y	T		T	UCO	Riverine/tributary small-medium streams
Etheostoma trisella	Trispot darter	Y	SC		T	UCO	Riverine/mainstream/tributary
Fundulus bifax	Stippled studfish	Y			E	T	Riverine/mainstream/tributary/low-velocity
Lythrurus bellus	Pretty shiner				T	T	Riverine/mainstream/tributary/pool/run
Notropis cahabae	Cahaba shiner	Y	E	SP		AL	Riverine/main stream/pool/clear waters

(CONTINUED)

TABLE 4-45 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACT Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Georgia Status	Subbasin	Habitat Description
Noturus munitus	Frecklebelly madtom			SP	E	AL, UCO	Riverine/mainstream/large tributary/riffles
Noturus nocturnus	Freckled madtom				E	UCO	Riverine/mainstream/tributary/ rocky subs
Percina antesella	Amber darter	Y	E		E	UCO	Riverine/mainstream/large tributary/riffle
Percina aurolineata	Goldline darter	Y	T	SP	T	UCO, AL	Riverine/mainstream/riffles and runs
Percina jenkinsi	Conasauga logperch	Y	E		E	UCO	Riverine/mainstream/riffles and runs
Percina lenticula	Freckled darter				E	UCO	Riverine/mainstream/riffles and runs
Percina shumardi	River darter				E	UCO	Riverine/mainstream/riffles and runs
Scaphirhynchus suttkusi	Alabama sturgeon		C			AL	Riverine/mainstream/large tributary, sand and gravel substrates
Mussels							
Epioblasma metastriata	Upland combshell		E	SP	E	UCO, AL	Riverine, stable gravel or sandy-gravel substrates
Epioblasma othcaloogensis	Southern acornshell	Y	E	SP	E	LCO, AL, UCO	Riverine/rock and gravel substrate
Lampsilis altilis	Fine-lined pocketbook		T	SP	T	AL, LCO, UCO, T	Riverine/stable gravel or sandy grave substrate
Lampsilis perovalis	Orange-nacre mucket		T	SP		AL	Riverine/stable gravel and sandy-gravel substrates
Medionidus acutissimus	Alabama moccasinshell		T	SP	T	UCO	Riverine/rivers and large creeks

(CONTINUED)

TABLE 4-45 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACT Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Georgia Status	Subbasin	Habitat Description
Medionidus parvulus	Coosa moccasinshell		E	SP	E	UCO	Riverine/stable gravel or sandy gravel substrate
Pleurobema decisum	Southern clubshell		E	SP	E	AL, T	Riverine/medium size rivers/stable substrate
Pleurobema georgianum	Southern pigtoe	Y	E	SP	E	UCO, LCO	Riverine/stable gravel and sandy gravel
Pleurobema perovatum	Ovate clubshell		E	SP	E	T	Riverine/stable gravel and sand gravel substrate
Ptychobranchus greeni	Triangular kidneyshell		E	SP	E	UCO, AL, LCO	Riverine/high quality riffle-run
Snails							
Tulotoma magnifica	Tulotoma	Y	E	SP		AL, LCO	Riverine/mainstream/tributary riffle
Reptiles							
Alligator mississippiensis	American alligator		T(s/a)	SP		AL, T	Riverine/palustrine/open water
Graptemys pulchra	Alabama map turtle			SP	R	UCO	Riverine/mainstream/trib/run/pool
Macroclemys temminckii	Alligator snapping turtle		SC	SP	T	LCO, AL, T	Riverine/mainstream/palustrine/ open water
Pseudemys alabamensis	Alabama red-bellied turtle		E	SP		AL	Riverine/mainstream/palustrine/ open; estuarine/sub and intertidal
Amphibians							
Desmognathus monticola	Seal salamander		E	SP		AL	Riverine/tributary/margin

(CONTINUED)

TABLE 4-45 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACT Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Georgia Status	Subbasin	Habitat Description
Plants							
Hymenocallis coronaria	Shoals spiderlily		SC		E	AL, T, LCO	Riverine, mainstream/rocky shoals and bedrock
Marshallia mohrii	Mohr's Barbara's button's		T		T	LCO, UCO	Palustrine/emergent/open
Platanthera integrilabia	Monkeyface orchid		SC		T	LCO, UCO, T	Palustrine/red maple-blackgum swamps
Ptilimnium nodosum	Harperella		E		E	LCO, UCO	Palustrine/riverine
Sagittaria secundifolia	Kral's water plantain		T		T	UCO	Riverine/tributary/riffle/run/pool/ margin
Sarracenia leucophylla	Whitetop pitcherplant		SC		E	T, AL	Palustrine/bogs, wet area
Sarracenia oreophila	Green pitcherplant		E		E	LCO, T, UCO	Palustrine/forested, bogs, streambanks
Sarracenia rubra ssp. *Alabamensis*	Alabama canebrake pitcherplant	Y	E			LCO, T	Palustrine, sandhills, seeps, bogs and swamps
Schisandra glabra	Bay-starvine				T	UCO	Palustrine/forested/emergent
Thalictrum debile	Trailing meadowrue				T	UCO	Palustrine/forested
Waldsteinia lobata	Piedmont barren strawberry				T	UCO	Rocky, acidic woods along with mountain laurel
Veratrum woodii	Ozark bunchflower			E	R	UCO	Palustrine/forested/emergent
Xyris tennesseensis	Tennessee yellow-eyed grass		E		E	LCO, UCO	Palustrine; margins in and along spring runs and wet meadows
Xyris scabrifolia	Harper's yellow-eyed grass		SC			AL	Palustrine, moist to wet peats of acid sphagnous bogs

(CONTINUED)

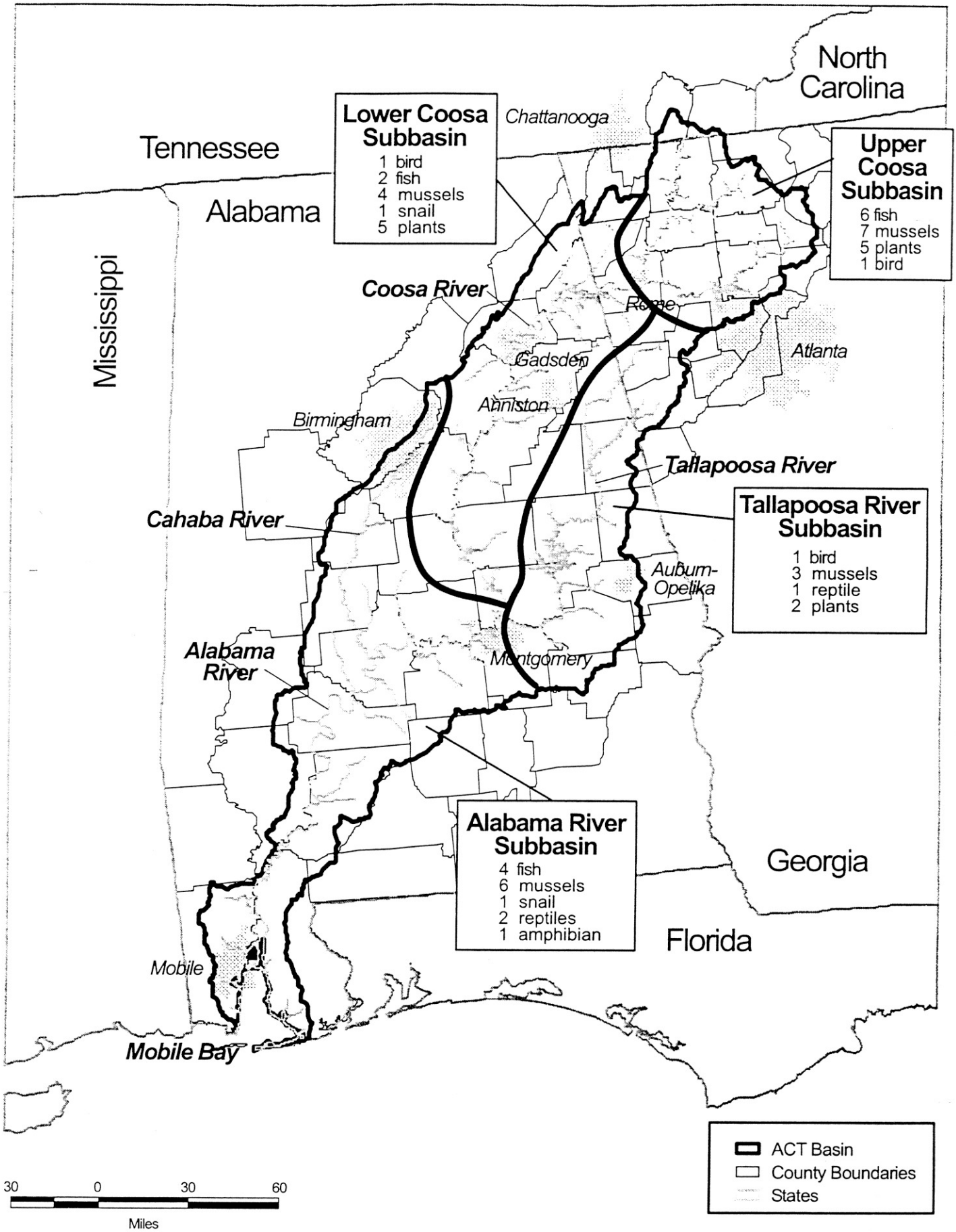
TABLE 4-45 (CONTINUED)

Protected Species Potentially Affected by the Water Allocation Formula in ACT Basin

E	Listed endangered
C	Candidate for listing as threatened or endangered
T	Listed as threatened
s/a	Species protected because of similarity to another officially listed species in the area
SC	Federal species of special concern, no legal status
SSC	State species of special concern, no legal status
R	Rare, no legal status
SP	Species formally protected
Y	Species is endemic to basin

Subbasins: CO = Coosa; UCO = Upper Coosa; LCO = Lower Coosa; AL = Alabama; T = Tallapoosa

FIGURE 4-86
Water-Dependent Federally Endangered and Threatened Species by Subbasin Within the ACT Basin



system in central Alabama. This darter inhabits rivers and large tributaries having swift current over gravel, cobble, bedrock, and boulder substrate. A Federally-listed endangered species, the Conasauga logperch, has designated critical habitat on the Conasauga River from Polk County, Tennessee, downstream to Murray County, Georgia. It is found only in a 148 feet reach of the river, in association with riffles and runs of moderately deep water with swift current over coarse substrates.

Ten mussel species present in the ACT basin are Federally listed as endangered or threatened. The upland combshell, an endangered species, is found in a small portion of the Conasauga River in Georgia and may be present in upper reaches of the Black Warrior and Cahaba River drainages in Alabama. Suitable habitat for this mussel is free-flowing rivers and large creeks with gravel and sandy-gravel substrates. The southern acornshell is also an endangered mussel found in large creeks and small rivers with rock and gravel substrate.

This species has been found in the Coosa River drainage of Georgia and the Cahaba River drainage of Alabama above the Fall Line. The fine-lined pocketbook is a threatened species found in the Coosa River and Talladega Creek systems in Alabama and the Etowah and Conasauga Rivers in Georgia. Preferred habitat is free flowing rivers and large creeks with gravel and sandy-gravel substrates. Another threatened species, the orange-nacre mucket, is known to occur in the Alabama River in Monroe County, Alabama. Medium-sized streams and moderate-sized rivers with gravel to sandy-gravel substrates are preferred habitat for this mussel.

Two moccasinshell species that potentially occur in the ACT basin are Federally protected. The Alabama moccasinshell, a threatened species, is found in the upper Coosa River drainage of northwest Georgia. It occurs in rivers and large creeks where substrates are boulders, cobbles, gravel, and sand. The Coosa moccasinshell mussel is endangered. It has been found in the Coosa River drainage of northeast Alabama and northwest Georgia where it occurs in association with free-flowing water over gravel and sandy-gravel substrates.

The southern clubshell is an endangered mussel found in scattered populations in the Coosa and Cahaba River systems and in Coastal Plain tributaries of the Tallapoosa River in Alabama. Preferred habitat is medium sized rivers with moderately high gradient and stable sand-gravel substrate. The southern pigtoe mussel, an endangered species, historically was found in the upper Coosa River drainage in Georgia, Alabama, and Tennessee, including the Chattooga, Coosawatee, and Conasauga Rivers. The most recent records of the southern pigtoe are from the Conasauga River above Dalton, Georgia. This species requires free-flowing streams and rivers with gravel and sandy gravel substrates.

Another endangered mussel, the ovate clubshell, also requires free-flowing small to large rivers and streams and sandy gravel substrate. Localized populations are known in Alabama from the Sipsey River in the Tombigbee River drainage, from tributaries to the Black Warrier drainage, and from Chewacla Creek in the Tallapoosa drainage. The triangular kidneyshell is an endangered species that occurs in the Coosa River drainage of north Georgia and the Cahaba River drainage in central Alabama.

One endangered species of snail, the tulotoma, was once thought to be extinct but has now been found in one isolated population in Alabama on the Coosa River mainstem and the lower segments of six Coosa River tributaries. This aquatic snail requires cool, clean, well-

oxygenated, free-flowing water with riffle and shoal areas. It is found on the underside of boulders in swift currents.

One reptile, the Alabama red-bellied turtle, is a Federally-listed endangered species known to occur in the ACT basin. It is present only in the Mobile Bay drainage in Mobile and Baldwin Counties, Alabama. This turtle feeds on submersed aquatic vegetation in riverine, palustrine, and estuarine habitats. The American alligator is listed as threatened because of similarity in appearance to the crocodile. It is found throughout the Coastal Plain in the ACT basin in Alabama. No Federally protected species of amphibian that occurs in the ACT basin is likely to be affected by a water allocation formula.

Of the 18 species of protected plants listed in ***Table 4-45***, 7 are designated threatened or endangered under Federal law. Two of the most water-dependent species listed are Kral's water plantain and loose water milfoil; consequently, these species would be more sensitive to changes in water elevation that might result from implementation of a water allocation formula in the ACT basin. Kral's water plantain is listed as threatened under both Federal and Georgia protected species legislation. A perennial aquatic herb, Kral's water plaintain , grows in riverine habitat, on exposed shoals, or in sand, gravel and silt in quiet pools up to 3 feet in depth. It has been collected from the Little River, a tributary of the Coosa River in DeKalb and Cherokee Counties in Alabama. It has also been found in the West Sipsey Fork and Town Creek, tributaries to the Black Warrior and the Tennessee Rivers, respectively. Loose water milfoil is listed as threatened in Georgia and a species of special concern under Federal regulations. It is a perennial aquatic plant endemic to the southeastern Atlantic and Gulf Coastal plains, growing in shallow waters of natural ponds, sinkholes, beaver ponds, impoundments, blackwater sloughs, ditches, and canals. Its abundance fluctuates from year to year because of local changes in the water table or in water quality. Species descriptions for other protected plants are provided in ***Appendix E***.

4.5.4.2 Environmental Consequences

4.5.4.2.1 General Impacts

The allocation formula may influence four types of direct or indirect actions that could affect the habitats of Federal and State protected species listed in ***Table 4-45***.

- Alteration of existing flow regimes by changes in the operations of existing dams and reservoirs
- Construction of new dams and reservoirs (see Section 4.4.1.1)
- Growth in demands for consumptive uses of water
- Water quality degradation

The agencies implementing or regulating these types of actions in compliance with the allocation formula would be responsible for determining the project-specific impacts to protected species, because the impacts would depend on where and how the actions occur. The following discussion of each of the four general types of actions that may affect protected species is intended to guide assessment efforts when those choices are faced.

4.5.4.2.1.1 Alteration of Flow Regimes by Changes in Operations of Existing Dams and Reservoirs

Little information is available on the linkages between flow regime characteristics and the life histories of protected species occurring in the basin. It might be possible to quantify optimal flow regimes for some or all of the riverine-dependent species, or even minimal flow regimes that would barely ensure each species' persistence in the basin. Such an effort would show that some species do best in wet years and others do best in dry years. However, overall biological diversity and ecosystem function benefit from inter-annual variations in species success (Tilman et al., 1994). Previous efforts at riverine ecosystem restoration have demonstrated that it is not possible to simultaneously optimize conditions for all species (Sparks, 1992, 1995; Toth, 1995). Therefore, the best strategy for protecting the ecology and biodiversity of the basin, including its protected species, is to maintain or restore to some extent the natural patterns of variability of flow regimes throughout the basin.

4.5.4.2.1.2 Construction of New Dams and Reservoirs

The construction of dams in riverine ecosystems abruptly, severely, and permanently alters many important physical and biological processes involving the movement of water, energy, sediments, nutrients, and biota (Gup, 1994). Sixteen dams impound mainstem channels of the ACT basin, eliminating, fragmenting, and dramatically altering riverine habitat.

The Comprehensive Study's Protected Species Report (Ziewitz et al., 1997) highlighted one effect of the conversion of flowing water habitat to still water: the decline or loss of river-dependent species, particularly fresh water mussels and snails. The Riverine Resources Report (Freeman et al., 1997) discussed the habitat fragmentation effects of dams in the ACT basin, in which 754 out of 1,338 total mainstem river miles (56 percent) remain unimpounded. Segments isolated by dams and reservoirs vary in length between 7 and 191 river miles. Ziewitz (1997) described similar declines in habitat for anadromous fishes, which is now restricted mainly to the 82-mile segment below Claiborne Lock and Dam. New dams in the ACT basin would replicate many of these impacts elsewhere in the basin and add to the cumulative alteration of natural flow regimes and habitat fragmentation. Depending on location, size, operating modes, and other factors, new dams would likely adversely affect, and possibly extirpate, some of the species listed in ***Table 4-45***.

4.5.4.2.1.3 Growth in Demand for Consumptive Uses of Water

The impacts analysis sections on riverine and estuarine communities show that the habitat performance measures and hydrologic parameters generally differ more between flow scenarios than between demand levels within flow scenarios; however, differences between demand levels are still evident. Because of simplifying assumptions necessary in the modeling efforts (Section 4.4.1.2), these differences may be underestimated in the simulated flow scenarios. Demands may actually vary substantially from year to year and may exert greater impacts on riverine and estuarine communities than suggested by the current simulations.

4.5.4.2.1.4 Water Quality Degradation

Riverine communities generally require clean water with sufficiently high dissolved oxygen concentration and appropriate temperatures. Water quality degradation is a frequently cited concern for the riverine-dependent species included in the Comprehensive Study's Protected Species Report (Ziewitz et al. 1997). It is quite likely that water quality is a

limiting factor for several of these species. Any actions under the formula that may alter water quality must address effects on the protected species.

4.5.4.2.2 Impacts of Modeled Alternatives

No terrestrial protected species would be affected by the water allocation formula because no terrestrial habitats are expected to be adversely affected. Based on the analyses conducted for freshwater wetlands, which showed that no significant adverse effects would result under any of the operational scenarios, floodplain-dependent and semi-aquatic protected species are not expected to be adversely affected. Once the final water allocation formula is known, and the new operational conditions at the reservoirs have been determined, additional NEPA documentation will be prepared that will evaluate the potential effects of the water allocation formula at specific locations.

Under the no action alternative, no terrestrial protected species would be affected because terrestrial habitats would not be adversely affected. Based on the analyses conducted for freshwater wetlands, no adverse impacts to floodplain-dependent and semi-aquatic protected species are anticipated from the no action alternative. Aquatic species also would not experience direct adverse effects from the no action alternative.

Under the action alternative, no direct impacts to protected terrestrial and wetland species are likely because these habitats would be minimally affected by any of the three flow scenarios (high, medium, or low flow). Impacts to aquatic species would be site specific depending on the species' habitat (reservoir or flowing waters) and on the season of greatest sensitivity to water level perturbations.

Federal and state protected species occurring in or near water systems in the ACF basin, and which therefore potentially could be affected by a water allocation formula, are listed in ***Table 4-45***. The numbers of potentially affected Federally endangered and threatened species are shown in ***Figure 4-86*** for each of four major subbasins. The Upper Coosa Subbasin supports the largest number of Federally listed aquatic species, including six fish, seven freshwater mussels, wood stork, and five plant species that live in riverine or wetland habitat. Many of these species occur in the Conasauga, upper Etowah, and Coosawattee River systems, which contain the longest remaining reaches of free-flowing river in the Coosa River drainage. Federally protected species in the Lower Coosa Subbasin include two fish, four mussels, one snail, the wood stork, and five plants. The Tallapoosa River Subbasin provides habitat for three protected species of mussels, wood stork, American alligator in the lower subbasin, and two plant species. Federally protected species in the Alabama River Subbasin include four fish, six mussels, one snail, two reptiles, and one amphibian.

Protected species habitats in the Upper Coosa subbasin and Tallapoosa River subbasin would be especially sensitive to adverse effects from indirect actions related to allocation decisions, such as the development of new water supply reservoirs or withdrawal of surface water to meet growing water demands. Rivers in these subbasins contain some of the longest remaining reaches of free-flowing river in the ACT basin that provide suitable habitat for native freshwater mussels and diverse assemblages of riverine fishes (see Section 4.5.3). Allocation decisions potentially requiring balancing of minimum river flows between the Coosa River and the Tallapoosa River could adversely affect protected aquatic species in one or both of these subbasins.

The Cahaba River in the Alabama River subbasin also supports several protected aquatic species and would be highly vulnerable to adverse effects of impoundments; however, because its watershed lies entirely within Alabama, it would appear to be less vulnerable to foreseeable future indirect actions following an allocation decision.

Section 7 consultation will be required if the implementation of the final allocation formula requires changes in operations that would affect Federally protected species. A biological assessment, if needed, would be completed for the final EIS.

4.5.5 Fish and Wildlife Management Facilities

Fish and wildlife management facilities include all fish hatcheries, wildlife refuges, and fish and wildlife management areas in the basin. An inventory of these facilities was completed for the Comprehensive Study and was used as the primary source of information for this evaluation. Potential impacts on other facilities in the basin were based on a review of the potential water shortages and water quality changes throughout the basin.

4.5.5.1 Affected Environment

At least six State or Federal facilities in the ACT basin actively use water in operations for fish and wildlife management (Ziewitz and Luprek, 1996). These facilities include fish hatcheries and a public fishing area. The facilities and their average annual use of water are:

- William "Bill" Dannelly Lake in Camden, Alabama, operated by the Corps with average annual use of 0.02 mgd of surface water from Alabama River
- Arrowhead Game Management Office in Armuchee, Georgia, operated by GDNR with average annual use of 0.05 mgd of surface water from Armuchee River
- Arrowhead Public Fishing Area in Armuchee, Georgia, operated by GDNR with average annual use of 0.3 mgd of surface water from Armuchee River
- Eastaboga Fish Hatchery in Eastaboga, Alabama, operated by Alabama Game and Fish Division (AGFD) with average annual use of 0.19 mgd of groundwater
- Marion State Fish Hatchery in Marion, Alabama, operated by AGFD with average annual use of 0.35 mgd of groundwater
- Summerville Fish Hatchery in Summerville, Georgia, operated by GDNR average with annual use of 2.19 mgd of groundwater

Average annual use of water at these six facilities totals 3.1 mgd. Nearly 90 percent of the current water supply is provided by groundwater, mainly for the three fish hatcheries. Water use peaks in the spring and is lowest in the summer.

4.5.5.2 Environmental Consequences

Managers at two of the six fish and wildlife management facilities, Arrowhead Public Fishing Area and Summerville Fish Hatchery in Georgia, indicated that current water supplies may not be adequate to meet future management needs (Ziewitz and Luprek, 1996). The public fishing area, which is a surface water user, needs about 0.1 mgd more water to reliably maintain water levels during the summer months of June to September. Summerville Fish Hatchery needs an additional 1.0 mgd in March and 0.3 mgd in April

through August to maintain production. However, managers at both facilities have indicated that deep wells could meet their future water needs (Ziewitz and Luprek, 1996). Therefore, an allocation formula would not be expected to adversely affect any existing fish and wildlife management facilities in the ACT basin.

4.6 Land Use

This section summarizes the existing land uses in the ACT basin and the potential impacts on land use from implementing the water allocation formula. A key assumption in this EIS was that water availability would not affect population growth or land use changes. This assumption was made because the potential effects of water availability on population growth and land use changes could not be quantified and were not addressed in the Comprehensive Study. However, it should be recognized that water availability actually would have an influence on population growth and land use change. For example, a local increase in water availability would likely promote increased growth in population and developed land uses.

The primary source for land cover information is a land cover data layer developed for EPA Region IV (1997a). The data were developed to provide generalized and consistent land use coverage for the south-central portion of EPA Region IV. A "first order" land cover classification product was constructed from leaves-off Landsat thematic mapping (TM) data acquired from 1988 to 1993. For the purposes of this DEIS, the land cover is assumed to be 1995. The major land cover uses in the ACT basin are categorized as Residential, Commercial and Industrial, Agricultural Production Land, Confined Feeding Operations, Forest Land, Barren Land, and Water. The overall proportions of these land cover categories in the ACT basin are illustrated in ***Figure 4-87***, and acreages associated with these land cover categories are summarized in ***Table 4-46***. ***Figure 4-88*** illustrates the distribution of these categories in the ACT basin.

The following sections provide additional information for the major land cover categories and relevant information about other land use in the region, including areas designated for special uses, such as recreation areas, national parks, and designated areas for fish and wildlife; areas with significant contaminated sites; and significant military land use areas.

FIGURE 4-87
Existing Land Cover in the ACT Basin

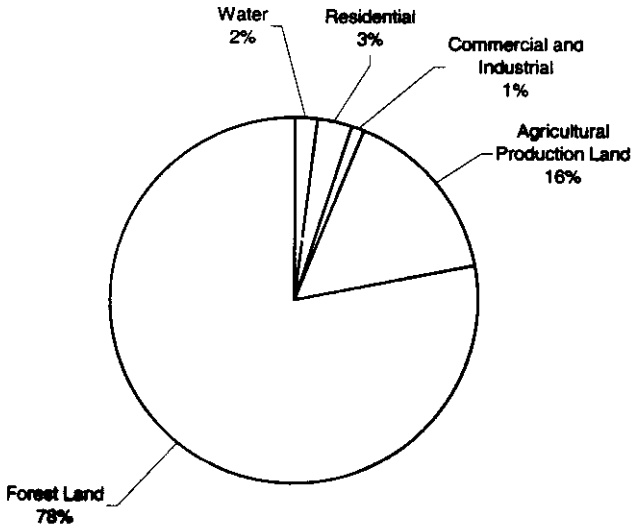


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FIGURE 4-88
Land Use Cover Patterns in the ACT Basin

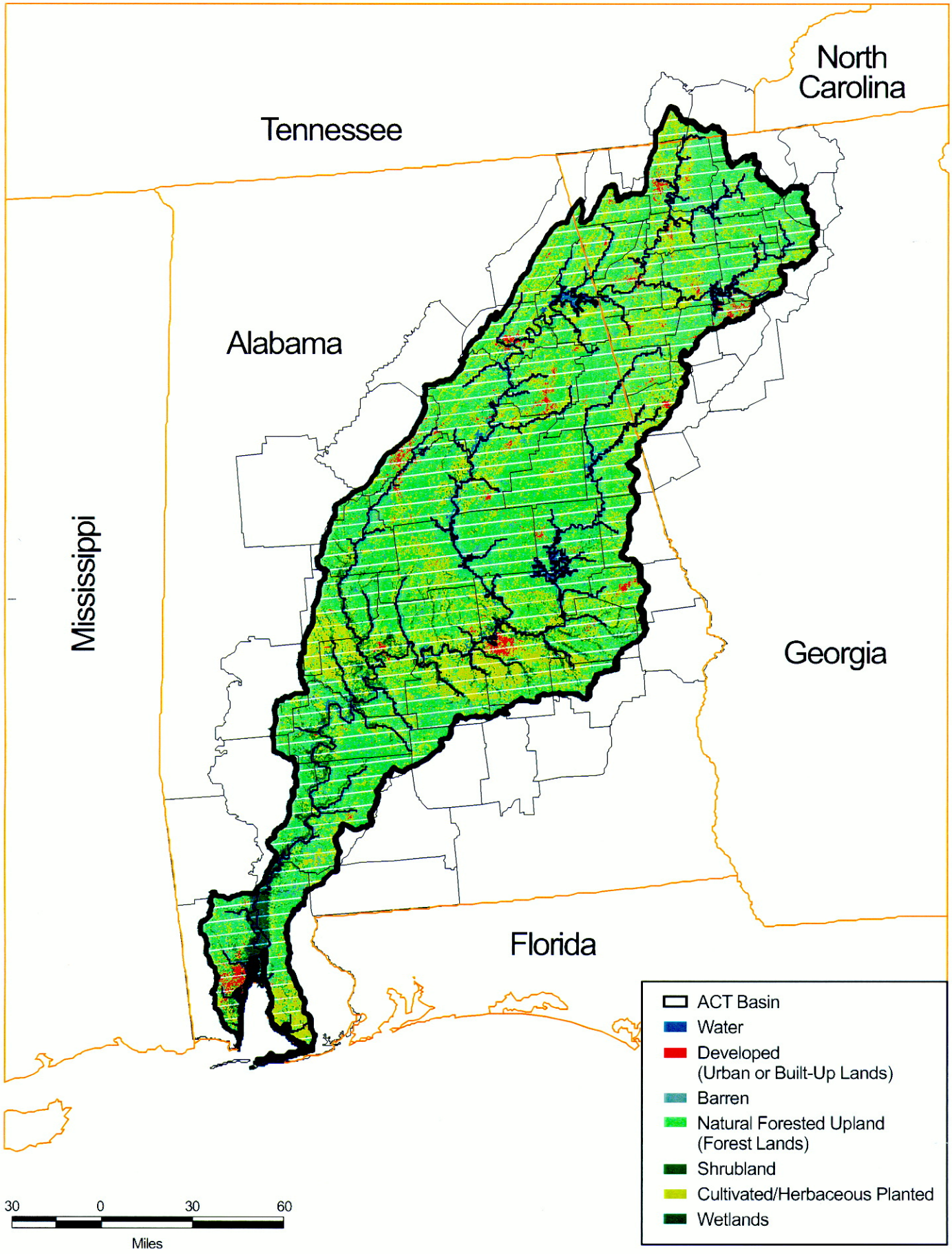

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TABLE 4-46
Existing Land Cover in the ACT Basin, Assumed 1995

Land Use Classifications	Acres	% of Total
Residential	408,700	3
Commercial and industrial	156,700	1
Agricultural production land	2,349,300	16
Confined feeding operations	6,000	0
Forest land	11,300,100	78
Barren land	14,400	0.1
Water	236,600	2
Total	**14,471,800**	**100**

Sources: ***Appendix D***

4.6.1 Developed (Residential/Commercial/Industrial)

The following section characterizes developed land uses within the ACT basin. All developed lands, including industrial, commercial, and residential land uses are discussed in this section. This section also highlights communities with populations over 25,000, as most development is clustered in the vicinity of these urban areas.

4.6.1.1 Affected Environment

Developed, or urban lands, represent approximately 4 percent of total land use in the ACT basin. Types of land uses in this category include low and high intensity residential, golf courses, urban parks, high intensity commercial and industrial uses, and some transitional uses.

Urban land uses are concentrated primarily within four metropolitan areas: the northwestern suburbs of Atlanta, Georgia (the City of Atlanta proper is split between the ACF basin and the Ocmulgee River basin); Birmingham, Alabama; Montgomery, Alabama; and Mobile, Alabama at the basin's outlet to the Gulf of Mexico. Approximately 26 percent of the ACT basin's population is in Georgia, corresponding to a large concentration of urban land around metropolitan Atlanta. Rapid growth in the headwaters of the ACT basin is transforming the character of northern portion of the basin from rural farmland and forest to a developed urban area. The area of the North Georgia mountains, including portions of the Coosa River basin, has become a popular retirement spot, and is experiencing an increase in urban growth. Urban land in the Alabama portion of the basin is mainly centered around the cities of Montgomery and the southeastern side of Birmingham. ***Table 4-47*** lists urban areas with populations greater than 25,000, and identifies the subbasin in which they are located.

TABLE 4-47
Urban Areas in the ACT Basin with Populations Greater than 25,000

Metropolitan Areas	County Name	Subbasin	1990 Census[a] Population
Marietta, Ga[b]	Cobb	Coosa River	44,129
Smyrna, Ga[b]	Cobb	Coosa River	30,981
Rome, GA	Floyd	Coosa River	30,326
Gadsden, AL	Etowah	Coosa River	42,523
Anniston, AL	Calhoun	Coosa River	26,623
Birmingham, AL	Jefferson	Coosa River	264,527
Auburn, AL	Lee	Alabama River	33,830
Montgomery, AL	Montgomery	Alabama River	195,471
Prichard, AL	Mobile	Alabama River	34,311
Mobile, AL	Mobile	Alabama River	204,490

[a] Population estimates based on the 1990 U.S. Census
[b] Part of the Atlanta Metropolitan Statistical Area

Note: Only the northwestern suburbs of the City of Atlanta fall in the ACT basin. The incorporated boundaries of Atlanta are split between the ACF basin and the Ocmulgee River basin.

Sources: EPA, 1996a

Residential land use comprises approximately 3 percent of the total land use in the ACT basin. These data, while demonstrating the population densities associated with the defined urban boundaries of major cities in the ACT basin, do not provide the complete picture of related urban development within the region. The communities surrounding Atlanta, for example, comprise a population estimated at over 2.5 million. A significant portion of this population is within the basin but in unincorporated areas, or in suburban areas with populations of less than 25,000.

Industrial land use accounts for 1 percent of total use in the basin. Within the region are a number of industrial and commercial areas of significance, such as along the Alabama River near Montgomery, and along the Choccolocco River east of Anniston, which reflect related urban land uses that have potential demands and effects on water resources in the region.

4.6.1.2 Environmental Consequences

Future land use conditions are extrapolated using population forecasts developed in the Comprehensive Study. A single population forecast was developed for the basin, independent of water allocation scenarios, because it is not possible to determine the effects of water availability on land use at this time. Utilizing the population and growth forecasts prepared in the Comprehensive Study, EPA then developed a single future land use forecast for future years. EPA utilized several sources to develop future land use in the projections for the various land use categories. These sources and the approach for future land use are documented in ***Appendix D,*** Non-point Source Pollutant Loading Evaluation.

Table 4-48 details existing and future urban land use for the basin. Residential land use is expected to increase by more than 50 percent between 1995 and 2050, from 408,700 acres to 626,800 acres. Although the increase is substantial, the percent of total land use devoted to residential will increase by only 1 percent, to 4 percent. Commercial and industrial land

uses are expected to increase by about 30 percent between 1995 and 2020, from 156,700 acres to 204,900 acres. The percent of total land devoted to commercial and industrial uses, however, will not change. This is expected regardless of the water allocation formula developed for the basin. No significant impacts to urban land use or municipalities are anticipated. Because there are only minor percent changes anticipated in the amount of land devoted to both residential and commercial/industrial uses, no impact is anticipated under any of the action scenarios. However, some changes in developed land uses are likely to result from changes in water availability.

TABLE 4-48
Existing and Future Urban Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Residential	408,700	3	506,000	3	626,800	4
Commercial and industrial	156,700	1	182,100	1	204,900	1

Source: See ***Appendix F***

4.6.2 Agricultural Lands

This section discusses land areas that have been modified for management for various agricultural. These land uses relate to water resource issues as a result of seasonal demands to meet irrigation requirements. In addition, some areas are significant sources of nonpoint source runoffs into surface waters.

4.6.2.1 Affected Environment

Agricultural lands include pasture and cropland, and confined feeding operations. Prime farmlands, which may be a significant component of agricultural lands, are described in Section 4.3.2. Agricultural land uses comprise the second largest land use in the ACT basin, accounting for approximately 16 percent of the total. Most of this agricultural acreage is cropland and pastures. Agricultural uses in the ACT basin include a wide variety of crops, such as corn, soybean, and peanuts, and most of the pasture and range uses are managed for beef and dairy cattle grazing (mostly in the southern portions of the ACT basin). There are large rural areas with mixed agricultural uses, such as livestock production (chickens and hogs), as well as various turf farms and other mixed rural land uses. These areas are scattered throughout the basin. The effects of agricultural land use on the basin's water quality and water supply are discussed in Section 4.4.2, Agricultural Demand, and Section 4.4.3, Water Quality.

4.6.2.2 Environmental Consequences

Table 4-49 details future land use totals for agricultural operations. Agricultural production land is expected to increase by 11 percent between 1995 and 2050, from 2,349,300 acres to 2,614,500 acres. The percent of land use devoted to this land use will increase from 16 percent to 18 percent. Approximately 6,000 acres are devoted to confined feeding operation land uses; this is expected to increase by 300 acres over future years. These changes in future agricultural land use are expected regardless of the water allocation formula developed for the basin and represent less than 1 percent change in the amount of

TABLE 4-49
Existing and Future Agricultural Land Uses

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Agricultural production land	2,349,300	16	2,471,300	17	2,614,500	18
Confined feeding operations	6,000	0	6,200	0	6,300	0

land devoted to agricultural operations. In addition, Section 4.7.3 documents that, while there would be minor shortages in meeting agricultural water demand requirements, there would be no impacts under any of the action scenarios. Although the effects of surface water availability on agricultural land use changes were not modeled, increases in agricultural land uses would likely be less under the low flow scenario, because surface water would not be as readily available for irrigation purposes. Under the high flow scenario, additional agricultural land use could be supported by surface water withdrawals and may result in increased agricultural land use. Indirect effects of land use changes that may follow implementation of an allocation formula could also result in losses of agricultural and prime farmlands, but specific impacts cannot be quantified at this time.

4.6.3 Forest Land

This section reviews the current land uses that include either natural wooded vegetation (forests) or areas managed for silviculture to provide wood products for pulp, lumber, or other needs (forested and shrub wetlands are also included in the forest category; detailed discussion of wetlands can be found in Section 4.5.1 of this document). Included in these areas are local, State, and national forests that provide multiple values related to public use and recreation, affect water resource issues by providing water retention and runoff controls, and reduce erosion and enhance water quality.

4.6.3.1 Affected Environment

Included in the forest category are deciduous forest, evergreen forest, mixed forest, deciduous shrubland, grassland/herbaceous, woody wetlands, and herbaceous wetlands. Forest land is the predominant land use in the ACT basin and accounts for approximately 78 percent of total land use. The Georgia portion of the Coosa River basin falls within the Cohutta and Armuchee Ranger Districts of the Chattahoochee National Forest. In addition, there are large forested areas under private ownership. Georgia currently has more privately owned forest land than any other state in the basin (NRCS, 1995). The mixed stands of hardwoods and pine covering the State support widespread lumber and pulpwood production. In Alabama, the Cahaba River runs through one unit of the Talladega National Forest, south of Birmingham; while a tributary of the Coosa River runs through another unit south of Anniston, Alabama. South of Auburn-Opelika, Alabama, a tributary to the Tallapoosa River runs through Tuskegee National Forest.

4.6.3.2 Environmental Consequences

The amount of land devoted to forest uses is forecast to decline by 5 percent between 1995 and 2050; from 11,300,100 to 10,767,900 acres (***Table 4-50***). The percent of land in the basin devoted to forest use will decline from 78 percent to 74 percent. This is expected regardless of the water allocation formula developed for the basin. Although the effects of the no

TABLE 4-50
Existing and Future Forested Areas

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Forest land	11,300,100	78	11,055,000	76	10,767,900	74

action and action alternative flow scenarios on forest land were not modeled, it is likely that surface water availability would affect changes in forest lands in the basin. For example, under the low flow scenario, less urban development may occur and would result in less change in forest land. In the high flow scenario, more urban development may occur and a great amount of forest land would be lost. The actual influence of the alternative on forest land cannot be quantified in this programmatic EIS.

4.6.4 Barren Lands and Water

This section summarizes the area distribution of barren lands and water-related uses in the ACT basin.

4.6.4.1 Affected Environment

Barren lands, which include bare rock and sand, quarries, strip mines, and gravel pits, cover approximately 14,400 acres, or less than 0.1 percent of the lands in the basin. Water resources, which include bays and estuaries, lakes, reservoirs, and streams, cover about 236,600 acres or 2 percent of the basin.

4.6.4.2 Environmental Consequences

The amount of land devoted to each of these land categories is expected to remain constant in future years, and neither increase nor decrease (see *Table 4-51*). This is expected regardless of the water allocation formula developed for the basin. As noted for forest land use, the actual influence of the alternatives on land use change cannot be quantified in this programmatic EIS. However, it is possible that additional reservoirs may be required in the no action alternative or low flow scenario, which would increase the amount of open water area in the basin.

TABLE 4-51
Existing and Future Water Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Barren land	14,400	0.1	14,400	0.1	14,400	0.1
Water	236,600	2	236,600	2	236,600	2

4.6.5 Recreation, National Parks, Refuges, Fish and Wildlife Management Facilities and Protected Sites

This section discusses the land use areas that have been designated for particular public or fish and wildlife uses. These include local, State, and Federal land areas that are designated to provide these uses.

4.6.5.1 Affected Environment

The ACT basin contains a variety of public lands and resource protection areas totaling approximately 705,000 acres, which are described in *Table 4-52*. Northern Georgia and Alabama contain several heavily used reservoirs, national and State parks, and resort communities that are favorite weekend and vacation destinations. *Figure 4-89* illustrates several of the major public lands in the basin.

TABLE 4-52
Public Land and Resource Protection Areas in the ACT Basin

Facility Name	County, State	Area (acres)
National Parks		
Horseshoe Bend National Military Park	Tallapoosa, AL	2,040
Tuskegee Institute National Historic Site	Macon, AL	5
Little River Canyon NPRES	Cherokee/DeKalb, AL	816
National Park-Forest	Shelby, AL	21
Kennesaw Mountain National Battlefield Park	Cobb, GA	267
State Parks		
Camden (Roland Cooper) State Park	Wilcox, AL	242
Chewacla State Park	Lee, AL	103
Cheaha State Park	Clay, AL	2,799
De Soto State Park	Cherokee/DeKalb, AL	5,067
Oak Mountain State Park	Shelby, AL	1,234
Paul M. Grist State Park	Dallas, AL	570
Various State park and forest lands	Baldwin/Cherokee/Bibb/Clay/Cleburne/ DeKalb/Jefferson/Randolph/Shelby/ Tallapoosa, AL	650
Tannehill State Park	Bibb/Jefferson/Tuscaloosa, AL	330
Wind Creek State Park (on Lake Martin)	Tallapoosa, AL	1,445
Rickwood Caverns State Park	Blount, AL	
Meaher State Park (Mobile Bay)	Baldwin, AL	1,327
James H. "Sloppy" Floyd State Park	Chattooga, GA	545
Cloudland Canyon State Park	Dade, GA	2,219
Amicalola Falls State Park	Dawson/Gilmer, GA	2,050
Fort Mountain State Park (just north of Carters Lake)	Murray, GA	3,428
George Washington Carver State Park	Bartow/Cherokee, GA	29

(CONTINUED)

TABLE 4-52 (CONTINUED)
Public Land and Resource Protection Areas in the ACT Basin

Facility Name	County, State	Area (acres)
John Tanner State Park	Carroll, GA	136
Red Top Mountain St. Park (on Lake Allatoona)	Bartow, GA	1,950
National and State Forest Lands		
Little River State Forest	Escambia / Monroe, AL	710
Talladega National Forest	Bibb/Calhoun/Cleburne/Dallas/Perry/ Talladega/Tallapoosa, AL	29,451
Tuskegee National Forest	Macon, AL	2,075
Weogufka State Forest	Coosa, AL	230
Wildlife Management Area		
Allatoona Lake WMA (Corps)	Bartow, GA	15,000
Berry College WMA	Floyd, GA	20,491
Blue Ridge WMA (CNF)	Fannin, GA	38,900
Cohutta WMA (CNF)	Murray/Fannin/Gilmer, GA	95,265
Coosawattee WMA	Dawson, GA	9,926
Crockford–Pigeon Mountain WMA	Walker, GA	17,118
Dawson Forest WMA	Dawson, GA	20,000
J. L. Lester WMA	Polk, GA	477
Otting Tract WMA	Walker, GA	700
John's Mountain WMA (CNF)	Gordan/Whitfield/Walker, GA	27,989
Paulding Forest WMA	Paulding, GA	26,222
Pine Log WMA	Bartow, GA	14,913
Rich Mountain WMA (CNF)	Gilmer, GA	22,061
Sheffield WMA	Bartow/Paulding, GA	3,183
Little River WMA	Cherokee/DeKalb, AL	15,255
Choccolocco WMA	Cleburne, AL	46,550
Cahaba River WMA	Bibb/Shelby, AL	41,500
Hollins WMA	Clay/Talladega, AL	30,640
Coosa WMA	Coosa, AL	37,763
Lowndes WMA	Lowndes, AL	8,585
Barbour County WMA	Barbour, AL	14,700
W.L. Holland & Mobile-Tensaw Delta WMA	Baldwin/Mobile, AL	46,700
Corps Lakes (excluding WMAs)		
Allatoona	Barton/Cobb, GA	37,607
Carters	Cobb/Forsyth, GA	8,900

(CONTINUED)

TABLE 4-52 (CONTINUED)
Public Land and Resource Protection Areas in the ACT Basin

Facility Name	County, State	Area (acres)
Woodruff	Autauga/Lowndes, AL	16,350
Dannelly	Wilcox, AL	19,773
Claiborne	Monroe, AL	8,642
Total Public Land and Resource Protection Acreage in the ACT Basin		**704,949**

AL Alabama
CNF Chattahoochee National Forest
GA Georgia
WMA Wildlife Management Area
NPRES National Preserve

Sources:
Environmental Systems Research Institute, Inc. (ESRI), 1997
National Park Service, 1998a
Alabama State Parks, 1998
Georgia Department of Natural Resources, 1998
Georgia Wildlife Management Areas, 1998
National Park Service, 1998b

Two popular National Park sites are found in the ACT basin. Horseshoe Bend National Military Park is located on a peninsula formed by a horseshoe-shaped bend of the Tallapoosa River. This was the site of the final battle of the Creek War of 1813 to 1814. The 2,040-acre park preserves the site of the battle and includes a visitor center and walking trails. The flow level of the Tallapoosa River is considered integral to experiencing this historic park. Little River Canyon National Preserve is located on top of Lookout Mountain in northeast Alabama. Sightseeing, picnicking, hiking, wading, white water paddling, canoeing, mountain biking, horseback riding and rock climbing are popular activities. Hunting, fishing, and trapping are permitted in designated areas.

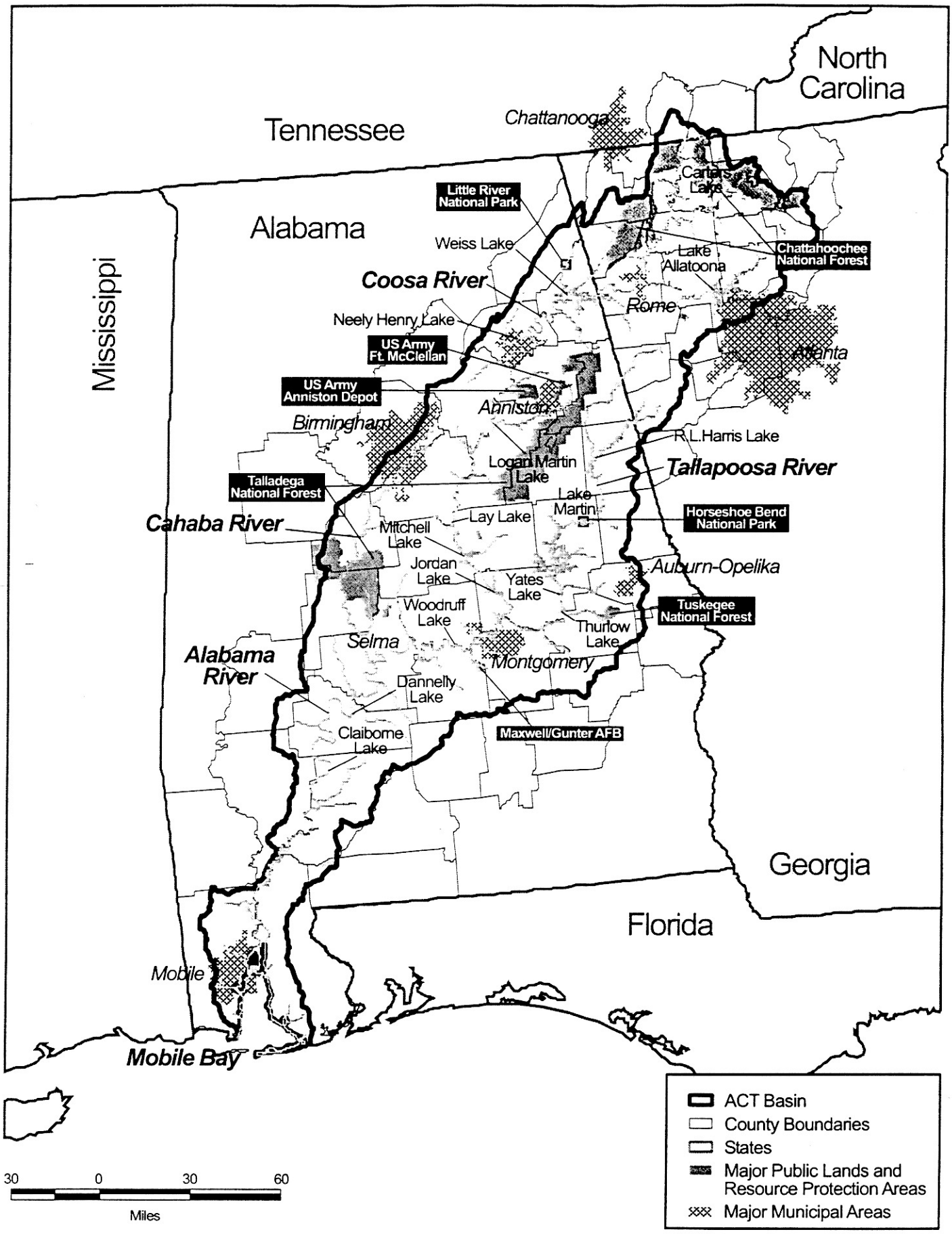
Approximately 91,272 acres (less than 1 percent) of land and water in the ACT basin are managed by the Corps, Mobile District. *Table 4-53* summarizes these acreages by project area. These lands are often bordered by other public lands and resource protection areas as noted in *Table 4-52*.

TABLE 4-53
Land and Water Acreage at Corps Projects in the ACT Basin

Project	Land Acreage	Water Acreage	Total Acreage
Carters Lake	4,650	4,250	8,900
Allatoona Lake	25,747	11,860	37,607
Alabama River Lakes (234.5 river miles)			44,765
R.E. "Bob" Woodruff	4,050	12,300	
William B. Dannelly	2,573	17,200	
Claiborne	2,792	5,850	
ACT basin total	**39,812**	**51,460**	**91,272**

Source: ***Appendix F***

FIGURE 4-89
Major Public Lands and Resource Protection Areas in the ACT Basin



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4.6.5.2 Environmental Consequences

No impacts are anticipated to refuges and protected sites from the range of flow scenarios or the no action alternative.

4.6.6 Contaminated Sites

This section reviews published accounts by EPA of abandoned contaminated waste sites on the EPA National Priorities List (NPL) as determined under the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and as amended by the Superfund Amendment and Reauthorization Act of 1986 (SARA). Contamination at active facilities is not included because these conditions are addressed under other programs, such as those enacted in accordance with the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA) through their facility-specific operating permits. These land uses have a potential effect on water resource issues through events that may cause a release of contaminants from these sites into surface or groundwater resources.

4.6.6.1 Affected Environment

The following contaminated sites in the ACT basin have been identified by EPA to be of sufficient concern, applying Superfund Criteria, to be placed on the NPL:

- Stauffer Chemical Company (Cold Creek Plant), U.S. Highway 43, Bucks, Mobile County, Alabama
- Army Anniston Depot (SE Industrial Area), Off Highway 202, Bynam, Calhoun County, Alabama
- Stauffer Chemical (Le Moyne Plant), U.S. Highway 443, Le Moyne, Mobile County, Alabama
- Redwing Carriers, Inc., 527 U.S. Highway 43, Saraland, Mobile County, Alabama
- Army Alabama Ammunition Plant, State Highway 235, Childersburg, Talladega County, Alabama
- Interstate Lead Company (ILCO), 1247 Borden Avenue, SE, Leeds, Jefferson County, Alabama
- Agriculture & Nutrition, 3017 Birmingham Highway, Montgomery, Montgomery County, Alabama
- Diamond Shamrock Corporation Landfill, W. Girard Avenue, Cedartown, Polk County, Georgia
- Cedartown Industries, Inc., S. Furnace Street, Cedartown, Polk County, Georgia
- Cedartown Municipal Landfill, 10 Street, 1.8 miles west of Cedartown, Cedartown, Polk County, Georgia
- Mathis Brothers Landfill, S. Marble Top Road, La Fayette, Walker County, Georgia

4.6.6.2 Environmental Consequences

The potential for environmental consequences to water quality from contaminated sites is primarily related to how close each contaminated site is to the river and stream channels being affected by the water allocation scenarios. In this context, the only potential major consequence is likely to result from the effects of erosion that could occur under allocation scenarios that have increased flows. Under this circumstance, increased flows could either transport contaminated materials into the river and stream channels or could compromise the integrity of any containment systems or structures already in place; however, this would only occur in those channels in which increasing flows are sufficient to initiate or accelerate erosion. Based on information available from the EPA Superfund database, it appears that only 1 of the 11 Superfund sites located within the ACT basin is situated along main river channels affected by the various water allocation scenarios (EPA, 1998a). At the 10 sites that are not situated along the affected river channels, there are no anticipated environmental consequences to surface water quality due to the presence of the Superfund sites, and it is unlikely that the various allocation scenarios will impact these sites.

In contrast, the one Superfund site located along an affected channel is the U.S. Army Alabama Ammunition Plant in Childersburg, Alabama. This facility is located near the confluence of the Coosa River, Tallasseehatchee River, and Talladega Creek. This facility includes several area of concern, but EPA database records do not indicate that any of the areas of concern are situated adjacent to the Coosa River. As a result, there are no anticipated environmental consequences to surface water quality based on the various allocation scenarios due to the presence of the Superfund sites.

Given the nature of this programmatic EIS, it will be necessary to evaluate the potential effects of any future proposed activities on any of these Superfund sites under project-specific environmental assessments.

4.6.7 Military Land Use

This section identifies major military lands within the ACT basin with readily available data, such as state map atlases and the U.S. Military SITES Installations database.

4.6.7.1 Affected Environment

There are three major military installations in the ACT basin (*Table 4-54*). Anniston Army Depot is located west of Anniston, Alabama, in the Coosa River basin. The depot covers over 108,000 acres of land. Fort McClellan is also located in the Coosa River basin, just north of Anniston, Alabama. Maxwell Air Force Base and Gunter Annex are located in Montgomery, Alabama, in the Alabama River basin.

TABLE 4-54
Military Installations in the ACT Basin

Facility Name	River Basin	State	Acres
U.S. Army Anniston Army Depot	Coosa	Alabama	108,000
U.S. Army Fort McClellan	Coosa	Alabama	45,679
Maxwell/Gunter Air Force Base	Alabama	Alabama	29,000

Source: U.S. Military, 1998

4.6.7.2 Environmental Consequences

No impacts are anticipated to military land from the range of flow scenarios or the no action alternative.

4.7 Socioeconomic Resources

Socioeconomic resources evaluated in this EIS include human population/demographics and economics. The population evaluation (Section 4.7.1) addresses general population patterns in the ACT basin, as well as environmental justice and children protection issues. The population projections are based on the studies completed for the Comprehensive Study (PMCL, 1996) and correspond with the population data used to develop the water demands included in the HEC-5 model (see Section 4.7.1 and *Appendix G*). The economics section (Section 4.7.3) addresses municipal and industrial water demands, navigation, electric power generation, agricultural water demands, flood control recreation, income, and employment. The economics sections were prepared by the Mobile District Corps' staff and are based on information developed during the Comprehensive Study and on economic modeling completed by the Corps specifically for this EIS. Existing or baseline conditions and potential environmental consequences resulting from the alternatives are presented.

Socioeconomic issues related to three counties in the Mobile Bay area (Baldwin, Mobile, and Washington Counties) were not examined in the Comprehensive Study because impacts from the water allocation formula were expected to be minimal there. However, footnotes are included in the tables in Section 4.7.1.1 to provide the reader with the demographic characteristics of these three counties.

4.7.1 Population/Demographics

The evaluation of population/demographics is based on population estimates developed for the Comprehensive Study to provide consistency between the water demands used in the hydrologic modeling (see Sections 1.3.3.3 and 4.4.1). This section summarizes the existing demographic conditions based on the Comprehensive Study and evaluates the potential environmental consequences of the alternatives.

4.7.1.1 Affected Environment

4.7.1.1.1 Demographics

As part of the Comprehensive Study, DRI/McGraw-Hill developed population projections through 2050 for each of the 42 counties in the Comprehensive Study-designated ACT basin. Forecasts through 2018 for the nation, for Georgia and Alabama, and for metropolitan areas within these states were generated using the DRI/McGraw-Hill August 1993 long-term (TREND-LONG0893) forecast (DRI/McGraw-Hill, 1996). The forecast horizon was extended to 2050 at the national level. Customized subbasin models were created to capture the unique characteristics of each region. Finally, a modeling system was developed to generate population forecasts for specific counties. The methodology used to develop the county-level population projections links population growth to job growth, with no incorporation of changes in commuter patterns. Therefore, counties currently emerging as "bedroom communities" are likely to have population projections that significantly underestimate current and future growth. While county-level population projects are expected to be less accurate, the basinwide figures presented in this section have been approved by the States and are expected to capture the overall growth of fast-developing areas.

The 42-county area in the ACT basin has experienced increases in population from 1975 to 1990, with the trend continuing into the 1990s. From 1975 to 1995, the population increased

roughly 22 percent, or an average of 1 percent annually. ***Table 4-55*** **presents the population** growth in the ACT basin that has occurred between 1975 and 1995.

Population projections prepared for the Comprehensive Study estimated 2.66 million people to be living in the ACT basin in 1995. Approximately 73.5 percent of the population in the ACT basin resided in Alabama. Georgia claimed 26.5 percent of the basin's residents. ***Figure 4-90*** illustrates the population distribution in the basin.

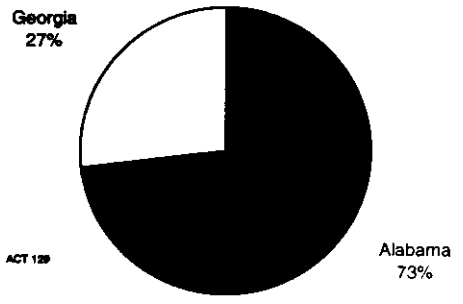
TABLE 4-55
Population Growth in the ACT Basin

Area	1975	1980	1985	1990	1995 Estimated
Alabama portion [a]	1,687,000	1,777,000	1,787,000	1,800,000	1,953,000
Georgia portion	495,000	529,000	570,000	647,000	705,000
ACT basin [a]	2,182,000	2,306,000	2,357,000	2,447,000	2,658,000

Source: DRI/McGraw-Hill, 1996

[a] These population estimates do not include the South Alabama area downstream of Claiborne Lock and Dam, which includes the counties of Baldwin, Mobile, and Washington and the Mobile Standard Metropolitan Statistical Area (SMSA). In 1995, the population in these three counties totaled 532,470.

FIGURE 4-90
Population Distribution in the ACT Basin



The 1995 population estimates presented here were used to develop the municipal and industrial water demands presented in Section 4.7.3.1.

4.7.1.1.2 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations. The order requires that federal agencies identify and address, as appropriate, disproportionately high and adverse human-health or environmental effects of its programs, policies, and activities on minority and low-income populations. By the memorandum of February 11, 1994, the President directed EPA to ensure that agencies

analyze environmental effects on minority and low-income communities, including human-health, social, and economic effects.

The term *minority population* includes persons who identify themselves on the Census as African-American, Asian or Pacific Islander, Native American or Alaskan Native, or Hispanic (CEQ, 1996). A minority population exists if the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population of the larger surrounding area (EPA, 1996b). A minority community may be either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans). Either type of group experiences common conditions of environmental exposure or effect. A selected appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or another similar unit with no artificial dilution or inflation of the affected minority population. A minority population also exists if there is more than one minority group present and the aggregate minority percentage meets one of the above-stated thresholds.

Analysis of demographic data for the ACT basin shows that the population is almost 75 percent white. African-Americans represent the next largest ethnic group, comprising more than 24 percent of the basin's population. ***Table 4-56*** shows the demographic characteristics of the basin. For Alabama, the proportion of minority persons living inside the ACT basin (30.7 percent) is higher than for the state as a whole (25.2 percent). However, in Georgia, the proportion of minority persons living within the basin is much smaller than the proportion for the state as a whole. Other minority groups are represented in similar proportions in the basin and in the surrounding states.

TABLE 4-56

Demographics for the ACT Basin, 1990

	White	African-American	American Indian, Eskimo, or Aleut	Asian or Pacific Islander	Other Race	Hispanic
Alabama portion of basin [a]	1,233,296	551,688	4,548	8,098	2,117	8,331
	68.5%	30.7%	0.3%	0.4%	0.1%	0.5%
Georgia portion of basin	595,731	45,402	1,807	1,776	2,956	6,292
	92.0%	7.0%	0.3%	0.3%	0.5%	1.0%
ACT basin [a]	1,829,027	597,090	6,355	9,874	5,073	14,623
	74.7%	24.4%	0.3%	0.4%	0.2%	0.6%
State of Alabama	2,975,247	1,019,743	18,295	21,754	5,548	23,579
	73.6%	25.2%	0.5%	0.5%	0.1%	0.6%
State of Georgia	4,603,396	1,744,882	15,283	73,757	40,898	101,379
	71.1%	26.9%	0.2%	1.1%	0.6%	1.6%
2-state area	7,578,643	2,764,625	33,578	95,511	46,446	124,958
	72.0%	26.3%	0.3%	0.9%	0.4%	1.2%

[a] The statistics presented here do not include the counties of Baldwin, Mobile, and Washington. The combined population in these three counties is 71 percent white; 27.4 percent African-American; 0.9 percent Hispanic; 0.8 percent American Indian, Eskimo, or Aleut; 0.7 percent Asian or Pacific Islander; and 0.1 percent other. Numbers total more than 100 due to rounding.

Source: U.S. Census Bureau, 1998

The existence of low-income persons in the ACT basin was determined from the 1990 U.S. Census statistical poverty threshold, which is based on income and family size. The Bureau of the Census defines a *poverty area* as having 20 percent or more of the residents with

incomes below the poverty threshold. Overall, 16.6 percent of the ACT basin's population is below the poverty level (***Table 4-57***). Within the basin, the proportion of persons below the poverty level is much higher in Alabama (18 percent) than in Georgia (11.6 percent). For Alabama, the proportion of low-income residents is almost the same in the basin as in the state as a whole. At a poverty rate of 18 percent, the Alabama portion of the basin (like the state itself) is close to the definition of a poverty area. For Georgia, the percentage of low-income persons is lower in the basin than in the state as a whole and is lower than the nationwide poverty rate of 12.8 percent.

TABLE 4-57
Persons Below the Poverty Level in the ACT Basin, 1990

	Persons for Whom Poverty Status Is Determined	Persons Below the Poverty Level	Percentage of Persons Below the Poverty Level
Alabama portion of basin [a]	2,293,364	413,500	18.0%
Georgia portion of basin	652,685	76,022	11.6%
ACT basin [a]	2,946,049	489,522	16.6%
State of Alabama	4,040,587	723,614	17.9%
State of Georgia	6,478,216	923,085	14.2%
2-state area	10,518,803	1,646,699	15.7%
United States	248,709,873	31,742,864	12.8%

[a] The statistics presented here do not include the counties of Baldwin, Mobile, and Washington. Of the combined population in these three counties, 19.7 percent were identified as "below the poverty level" in the 1990 U.S. Census.

Source: U.S. Census Bureau, 1998

4.7.1.1.3 Protection of Children

On April 21, 1997, the President issued Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, which recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health and safety risks. This EO requires federal agencies, to the extent permitted by law and mission, to identify and assess such environmental health and safety risks.

While EO 13045 does not provide guidance on what age children are to be protected, the Federal Interagency Forum on Child and Family Statistics, which was founded in 1994 and formally established by the EO, focuses on those aged 17 and under (Federal Interagency Forum on Child and Family Statistics, 1997). In the ACT basin, there were 647,836 children 17 and under identified in the 1990 Census. This represents more than 26 percent of the basinwide population. More than 73 percent of the children in the basin were residents of Alabama (475,544). The Georgia portion of the ACT basin had 172,292 children (27 percent).

4.7.1.2 Environmental Consequences

The evaluation of potential environmental consequences on population and demographics was based on the population projections developed during the Comprehensive Study (DRI/McGraw-Hill, 1996). A key assumption of the Comprehensive Study and the EIS has been that population growth will continue as projected, regardless of the availability of water.

4.7.1.2.1 Demographics

Growth in the ACT basin is projected to increase at an average of about 1 percent per year throughout the 55-year study period. *Table 4-58* presents the population projections for the basin through 2050. In 1995, approximately 73.5 percent of the population in the ACT basin resided in Alabama. Georgia claimed 26.5 percent of the population. By 2050, Georgia's share of the population is expected to decrease slightly, with 24.5 percent of the basin's residents expected to be living in that state. The percentage anticipated to be living in Alabama will increase to 75.5 percent.

TABLE 4-58
Projected Population in the ACT Basin

	1995[a]	2020	2050
Alabama portion of basin	1,953,000	2,496,000	3,199,000
Georgia portion of basin	705,000	845,000	1,037,000
ACT basin	2,658,000	3,341,000	4,236,000

[a] Estimated values
Source: Regional Economic Forecast of Population and Employment

Population distribution over the basin will change as an indirect result of the decision made by the Federal Commissioner. Intuitively, populations will increase in areas where water resources become more available and induce growth in some communities, while population declines may occur in other areas. These demographic changes will have additional secondary impacts on land use changes for residential development and support services, will affect water and wastewater treatment demands, and will affect local economics. However, these changes will be localized following water resource changes that are made by the States after the Federal Commissioner has made a decision on the allocation formula. Thus, although there will be impacts from population changes resulting from the selection of an alternative, this programmatic EIS cannot predict specific areas where these changes will take place. Further, because local and regional decisions may be made to implement specific water conservation and water quality measures, the impacts of these changes are also unpredictable until implementation EAs or EISs are completed. Therefore, for the purposes of modeling, it is assumed that there are no differences in population growth between the no action and the action alternative flow scenarios.

4.7.1.2.2 Environmental Justice

Analysis of demographic data indicates a low-income population in the Alabama portion of the ACT basin. The water allocation alternatives are not designed to create either a benefit or an adverse effect for any group or individual, and are not expected to create disproportionately high or adverse human health or environmental impacts on minority or low income populations in the ACT River basin. As indicated in Section 4.7.3.2, no significant impacts to the economy of the basin are expected to arise from the no action or action alternative scenarios addressed in this EIS. Likewise, no human health risks that would disproportionately impact minority or low-income communities have been identified in this EIS. However, the programmatic nature of this EIS precludes identifying specific areas with low income and minority populations of the basin that may experience demographic impacts, as described above.

4.7.1.2.3 Protection of Children

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, directs federal agencies to ensure that their policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. No human health risks (see Section 4.6.6.2) or safety risks arising from the no action and action alternative flow scenarios that would disproportionately affect children have been identified through this EIS process. Specific impacts arising from changes in stream flows or elevated or lowered lake levels cannot be addressed in a programmatic EIS such as this one, but will be addressed in the EAs that tier off of this document.

4.7.2 Recreation

The following section summarizes the existing recreation conditions in the ACT basin and the potential impacts on recreation associated with implementing the water allocation formula. Recreational opportunities associated with the reservoirs and riverine reaches are addressed separately. The evaluation of recreation within the ACT basin is based on information developed in the Comprehensive Study (Allen et al., 1997) and the evaluation of impacts completed by the Corps economics and planning staff.

4.7.2.1 Affected Environment

Phase I of the Comprehensive Study report (Allen et al., 1997) examined recreation at 25 reservoirs, rivers, and river reaches in the ACT and ACF river basins. The 15 ACT projects included in the study are listed in ***Table 4-59***. Five of these study projects are reservoirs operated by the Corps, with the remaining nine reservoirs operated by Alabama Power Company (APCO). The study projects were chosen by the Comprehensive Study Technical Coordination Group (TCG) based on their representation of the entire range of project characteristics in the basins. This analysis focuses on these projects, for which uniform data are available. There are other major recreation areas within the basin that were not analyzed as part of the Comprehensive Study, most notably, National Park Service (NPS) sites and U.S. Forest Service (USFS) sites. Information and use data on those recreation sites are presented to the extent that data were available.

TABLE 4-59
ACT Study Projects Included in Phase I of the Comprehensive Study

River	Official Name	Operated by	Common Name
Coosawatee	Carters Lake and Dam	Corps	Carters Lake
Etowah	Allatoona Lake and Dam	Corps	Lake Allatoona
	Etowah River between Allatoona Dam and confluence with Coosawatee (beginning of Coosa River)		
Coosa	Weiss Dam	APCO	Weiss Lake
	H. Neely Henry Dam	APCO	H. Neely Henry Lake
	Logan Martin Dam	APCO	Logan Martin Lake
	Lay Dam	APCO	Lay Lake
	Mitchell Dam	APCO	Mitchell Lake
	Jordan Dam and Bouldin Dam	APCO	Jordan Lake
Tallapoosa	R.L. Harris Dam	APCO	R.L. Harris Reservoir or Lake Wedowee
	Martin Dam (APC)	APCO	Lake Martin
	Yates Dam and Thurlow Dam APC)	APCO	Yates and Thurlow Dams
Alabama	Alabama River between Claiborne Dam and confluence with Tombigbee River		
	Alabama River Lakes		
	Robert F. Henry Lock and Dam; R.E. "Bob" Woodruff Lake	Corps	Lake Woodruff or Jones Bluff

(CONTINUED)

TABLE 4-59 (CONTINUED)
ACT Study Projects Included in Phase I of the Comprehensive Study

River	Official Name	Operated by	Common Name
	Wm. "Bill" Dannelly Lock and Dam	Corps	Lake Dannelly or Millers Ferry
	Claiborne Lock and Dam	Corps	Lake Claiborne
Cahaba	River segment		

APCO Alabama Power Company

R.E. "Bob" Woodruff Lake, Wm. "Bill" Dannelly Lake, and Claiborne Lake are collectively referred to as the Alabama River Lakes.

Source: Allen et al., 1997

The reservoirs, rivers, and streams of the ACT basin are used for a variety of recreational purposes. The reservoirs and rivers within the ACT basin provide important recreation opportunities for residents in northern Georgia and a majority of Alabama. Northern Georgia and Alabama contain several national forests, national and state parks, and resort communities that are favorite weekend and vacation destinations. The Georgia portion of the Coosa River basin falls within the heavily used Chattahoochee National Forest. The Cahaba and Coosa rivers run through the Talladega National Forest, south of Birmingham and Anniston, Alabama. South of Auburn-Opelika, Alabama, a tributary to the Tallapoosa River runs through Tuskegee National Forest.

The national forests provide both developed and dispersed recreation opportunities. The developed sites provide a range of primitive or modern facilities. Dispersed activities include hunting, fishing, boating, hiking and off-road vehicle riding (USFS, 1998).

Two popular National Park Service sites are found in the ACT basin. Horseshoe Bend National Military Park is located on a peninsula formed by the horseshoe-shaped bend of the Tallapoosa River. This commemorates the final battle of the Creek War of 1813-14. This 2,040-acre park preserves the site of the battle and includes a visitor center and walking trails, although current visitor use information is not available. Water related recreation facilities are not available at this park, but the flow level of the Tallapoosa River is considered integral to experiencing this historic park. Little River Canyon National Preserve, another popular NPS site located in the ACT basin, is a tributary to the Coosa River draining into Lake Weiss from the north. Sightseeing, picnicking, hiking, wading, advanced white water paddling, canoeing, mountain biking, horseback riding and rock climbing are popular activities at this 816-acre area. Hunting, fishing, and trapping are permitted in designated areas. This preserve is unlikely to be affected by an allocation formula due to its location on a free-flowing tributary of the Coosa River.

Downstream from Claiborne Lock and Dam, the Alabama River joins the Tombigbee River and flows south into Mobile Bay. The Tombigbee, an important commercial waterway, also provides riverine recreation opportunities, including fishing and. The Mobile Bay area also provides recreation opportunities, including deep sea fishing, freshwater fishing in the bays and bayous, and water sports.

Recreation use data were obtained from a survey administered to registered boat owners in the 101 counties located in the ACT and ACF basins. The Phase I survey consisted of a telephone survey that was administered to collect information on boater recreational use at

the ACF project sites during the 1995 recreation year. Estimates of number of trips were then adjusted based on the output of the hydrologic modeling (see the Corps recreation report in ***Appendix F***). Based on this, the Corps estimates that 2.3 million boating trips were made to the study projects (reservoirs and rivers) in the ACT basin in 1995, representing 9.3 million visitor-days of recreational boating. Summer was the most popular boating season, followed by spring. Together, these seasons account for 78 percent of the recreation use that occurs in the basins. Fall and winter, combined, account for only 22 percent of recreation use (***Table 4-60***).

TABLE 4-60
Annual Boat Recreation Visitation Estimates for ACF Basin

Total Trips (1995)	Total Visitors-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
2,307,358	9,293,926	12	34	44	10

Source: The estimates are based on a survey (Allen et al., 1997) that was adjusted based on the output of hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.1.1 Reservoir Recreation

Fifteen reservoirs in the ACT basin provide recreation opportunities and receive varying amounts of usage. Six of the reservoirs are located on the Coosa River, three on the Tallapoosa River, three on the Alabama River, and one each on the Coosawatee and Etowah Rivers. Facilities on the reservoirs provide a range of opportunities for recreation.

Table 4-61 details recreation facilities on each of the reservoirs. Where available, information is provided on the effects of reservoir levels on recreation facilities.

TABLE 4-61
Recreation Facilities on Reservoirs in the ACT Basin

Reservoir/ Surface Area	No. of Parks	Campsites	No. of Picnic Sites	Boat Ramps	Public Docks & Fishing Piers	Comment
Lake Martin/ 40,000 acres	12	981	201	23	4	There are three golf courses on the lake. Wind Creek State Park has 642 camping sites, marina, camp store, fishing pier, hiking trails, playground, and picnic areas. Recreation facilities and access begin to be affected when the reservoir is drawn down 5 feet below normal pool level. At 10 feet below normal pool level, only three to four public boat ramps are available, marina slips are impacted, and boating congestion increases.

(CONTINUED)

TABLE 4-61 (CONTINUED)
Recreation Facilities on Reservoirs in the ACT Basin

Reservoir/ Surface Area	No. of Parks	Campsites	No. of Picnic Sites	Boat Ramps	Public Docks & Fishing Piers	Comment
Lake Allatoona/ 19,860 acres	45	662	427	21	8	Camping, picnicking, hunting, fishing, boating, tennis courts and swimming facilities are available. Red Top Mountain State Park offers a 33-room lodge, restaurant, and meeting facilities. Facilities and access are impaired when the reservoir is 3 feet below normal pool level; most facilities are unusable when reservoir is drawn down 12 feet below normal pool.
Logan Martin Lake/15,263 acres		79	7	30	28	Pell City is situated on the shores of lake.
Weiss Lake/ 30,200 acres		1,480	384	38	12	World-renowned for Crappie fishing
H. Neely Henry Lake/11,200 acres		108	214	28	11	Gadsden is situated on the shores of the lake.
Jordan Lake/6,807 acres			22	11	1	The lake is located just north of Montgomery.
R.L. Harris Lake/ 10,661 acres	11	105	78	11	9	
Lay Lake/ 12,000 acres		18	22	21	15	
Carters Lake/ 3,220 acres	8	147	94	6	8	Public boat ramps, marina, two barrier-free fishing decks, day-use recreation areas containing picnic shelters are available. Lake is considered one of the best spotted bass fisheries in Georgia and has 12 lodging units.
Mitchell Lake/ 5,850 acres		26	44	11	2	
Yates and Thurlow Dam/ 2,000 acres and 574 acres			10	3	1	
Alabama River Lakes/ 12,510 acres, 18,500 acres, and 5,930 acres		505	387	33	8	There are 35 day-use recreation areas offering tennis courts, playing fields, basketball courts, fishing piers, boat ramps, swimming areas, nature trails, and picnic shelters. At Woodruff and Dannelly, draw-downs of 1.5 feet adversely impact recreation opportunities. Problems are worse in summer due to reduced river flows.

Source: Corps, 1988

Lake Martin is the most visited reservoir in the ACT basin. Lake Martin had approximately 2.4 million visitor-days in 1995, accounting for 27 percent of total visitor-days for all reservoirs. Lake Allatoona, located approximately 30 miles north of Atlanta, also enjoys high visitation with 1.5 million visitor-days. Yates and Thurlow Dam on the Tallapoosa River were the least visited projects in 1995, with approximately 25,000 visitor-days (0.1 percent of total visitor-days for all reservoirs). In general, the most heavily visited

reservoirs experienced the largest percentages of use during the summer. At six of the reservoirs (Jordan Lake, Lay Lake, Carters Lake, Mitchell Lake, Yates and Thurlow Dams and the Alabama River Lakes), spring is the most popular recreation season. *Table 4-62* provides detailed information for each reservoir.

TABLE 4-62
Annual Recreation Visitation Estimates for Reservoirs in the ACT Basin, 1995

	Total Trips	Total Visitor-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
Lake Martin	402,705	2,368,852	13	27	51	10
Lake Allatoona	378,297	1,454,988	12	35	44	11
Logan Martin Lake	309,041	1,343,657	7	32	50	11
Weiss Lake	293,625	1,276,630	7	41	43	9
H. Neely Henry Lake	170,431	501,268	12	29	53	6
Jordan Lake	160,906	498,663	13	39	36	11
R.L. Harris Lake	96,989	404,121	9	28	50	12
Lay Lake	149,977	453,185	17	43	31	9
Carters Lake	53,598	303,253	20	39	35	6
Mitchell Lake	63,658	164,816	16	39	34	12
Yates and Thurlow Dam	13,533	25,142	19	39	31	11
Alabama River Lakes[a]	131,164	166,030	15	43	33	9
Total	2,223,924	8,960,605				

[a] Alabama River Lakes include Woodruff Lake, Dannelly Lake, and Claiborne Lake.

Source: The estimates are based on a survey (Allen et al., 1997) that was adjusted based on the output of hydrologic modeling (see Corps recreation report in ***Appendix F***).

Table 4-63 details activity participation at each reservoir. Overall, boat fishing is the most popular recreation activity on reservoirs in the ACT basin. Pleasure boating, swimming, and picnicking were also important activities.

TABLE 4-63
Activity Participation on Project Reservoirs in the ACT Basin, 1995

Reservoir	Total Trips	Fishing: Shore (%)	Fishing: Boat (%)	Pleasure Boating (%)	Water Skiing (%)	Jet Skiing (%)	Swimming (%)	Camping (%)	Picnicking (%)
Lake Martin	402,705	29	74	60	38	19	50	21	40
Lake Allatoona	378,297	16	73	64	38	9	58	30	49
Logan Martin Lake	309,041	17	82	42	24	12	37	11	30
Weiss Lake	293,625	24	95	41	20	9	35	18	34
H. Neely Henry Lake	170,431	12	82	36	22	7	27	9	22
R.L. Harris Reservoir	96,989	11	96	28	14	4	25	8	19
Jordan Lake	160,906	13	82	42	17	11	31	6	22
Lay Lake	149,997	6	92	26	10	3	21	8	13
Carters Lake	53, 598	15	88	40	22	3	33	22	38

(CONTINUED)

TABLE 4-63 (CONTINUED)
Activity Participation on Project Reservoirs in the ACT Basin, 1995

Reservoir	Total Trips	Fishing: Shore (%)	Fishing: Boat (%)	Pleasure Boating (%)	Water Skiing (%)	Jet Skiing (%)	Swimming (%)	Camping (%)	Picnicking (%)
Alabama River Lakes [a]	131,164	11	88	40	17	3	29	18	27
Mitchell Lake	63,658	7	86	36	14	6	23	10	17
Yates and Thurlow Dam	13,533	2	95	13	6	2	2	-	4

[a] Alabama River Lakes include Woodruff Lake, Dannelly Lake, and Claiborne Lake.

Activities are not mutually exclusive, therefore, data will sum to more than 100 percent.

Source: The estimates are based on a survey (Allen et al., 1997) that was adjusted based on the output of hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.1.2 Riverine Recreation

The major rivers in the ACT basin include the Alabama, Coosa, Tallapoosa, Etowah, and Cahaba. There are also tributaries to each of these rivers where various recreation activities take place. Because the proposed action would only affect flows in the main stem rivers, the tributaries are not discussed in detail. The Comprehensive Study assessed river recreation on the Etowah, Cahaba, and Alabama Rivers. The Coosa and Tallapoosa Rivers were not included in the study, so secondary data are relied upon for describing recreation opportunities and use on these rivers.

The Alabama River receives the most boating recreation use in the ACT basin. Approximately 55 percent of river recreation, totaling over 186,000 visitor-days in 1995, occurred on the Alabama River. The Cahaba River received half the amount of recreation visitation as the Alabama River, with 91,000 visitor-days in 1995. The Etowah River received just over 55,000 visitor-days during the same period. Boat-based fishing and pleasure boating are the most popular activities on these three rivers. Swimming is also a favorite activity on the Cahaba River, with over 55 percent of visitors reported to have visited the area to swim. Swimming also occurs on the other rivers, but to a lesser degree.

The Corps estimated 1995 annual boating use on the Etowah, Cahaba, and Alabama Rivers to be 83,434 trips, translating to more than 333,000 visitor-days (see ***Table 4-64***). Spring is the most popular season for river recreation on the Etowah River, with over 50 percent of recreation use. On the Cahaba and Alabama rivers, summer recreation use is slightly higher than spring use. Recreation use is lowest on all rivers in the winter and fall seasons.

TABLE 4-64
Annual Recreation Visitation Estimates for Rivers in the ACT Basin, 1995

Rivers	Total Trips	Total Visitor-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
Etowah River (from Allatona Dam to Rome, GA)	14,410	55,866	12	53	33	2
Cahaba River (from its origin to the confluence with the Alabama River)	24,907	91,033	8	35	37	20
Alabama River (from Claiborne Dam to the confluence with the Tombigbee River)	44,117	186,422	10	31	40	19
Total	**83,434**	**333,321**				

Source: The estimates are based on a survey (Allen et al., 1997) that was adjusted based on the output of hydrologic modeling (see Corps recreation report in ***Appendix F***).

Because of its close proximity to the cities of Birmingham, Gadsden, and Anniston, the Coosa River in Alabama hosts a variety of recreational uses, including fishing, canoeing and kayaking. Part of the Coosa River's popularity is due to the consistency of its flows in the dry summer months when the only other dependable summer run for local boaters is 5 or more hours away on the Ocoee River in Tennessee.

Table 4-65 provides activity participation levels for the Etowah, Cahaba, and Alabama rivers. On all three rivers, fishing by boat is the predominant activity, accounting for a majority of recreation use. Pleasure boating is the next highest activity use, but it is far less common than fishing. Scuba diving occurs on the Cahaba River with some frequency, accounting for 10 percent of activity use.

TABLE 4-65
Activity Participation on Project Rivers in the ACT Basin, 1995

Riverine Projects	Total Trips	Fishing: Shore (%)	Fishing: Boat (%)	Pleasure Boating (%)	Water Skiing (%)	Jet Skiing (%)	Scuba Diving (%)	Swimming (%)	Camping (%)	Picnicking (%)
Etowah River (from Allatona Dam to Rome, GA)	14,410	10	85	39	NDA	NDA	NDA	19	11	23
Cahaba River (from its origin to the confluence with the Alabama River)	24,907	13	92	60	2	NDA	10	52	17	31
Alabama River (from Claiborne Dam to the confluence with the Tombigbee River)	44,117	11	86	45	22	2	2	34	25	35

NDA No data available

Activities are not mutually exclusive; therefore, data will sum to more than 100 percent.

Source: The estimates are based on a survey (Allen et al., 1997) that was adjusted based on the output of hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.2 Environmental Consequences

The effect to recreation visitation (specifically to estimated number of boat trips) was evaluated for two alternatives: the no action alternative and the three alternative flow scenarios modeled for the action alternative (low flow, moderate flow, and high flow). The effects of the alternatives were evaluated by overall annual visitation as well as seasonally, recognizing that the spring and summer seasons represent the highest visitation to the reservoirs (accounting for 75 to 80 percent of the boat trips in the ACT basin).

These three scenarios are measured against the no action alternative. However, because of modeling constraints (see Section 4.4.1.2), comparing the action alternative flow scenarios to the no action alternative is difficult because the model excluded flood control, navigation, and hydropower operations with the complexity of the modeling. The effect of the modeling constraints is evident when comparing the range of the action alternative flow scenarios to the no action alternative. In most cases, the modeling predicts that the range of possible flow scenarios produce higher visitation than the no action alternative. This would not necessarily be the case. In some cases, the low, moderate, and high scenarios would experience lower elevations, and lower visitation, than the model predicts.

To compare the effect of alternative operating scenarios on reservoirs, the evaluation relied on the water level/recreation visitation value functions developed as part of the Comprehensive Study. In that study, recreation use data was obtained through a two-phase recreation survey administered to registered boat owners in the 101 counties located in the ACT and ACF basins. The Phase I survey collected information on boater recreational use at each of the ACT and ACF project sites during the 1995 recreation year. The Phase II survey was a contingent use survey that queried respondents on how their recreation use of one of six impact projects would change as the result of low water conditions. From this information, value functions were developed for each recreation project for each season. The water level/trip visitation value functions provided estimates of the number of recreation trips boaters would make at any specific pool level within a range of water levels.

All alternatives were evaluated for 1995, 2020, and 2050 water consumptive demands. Population forecasts that were used to determine the recreation demand for the years were obtained from the Comprehensive Study. The establishment of recreation demand forecasts were based on two assumptions. First, that demand for recreation is directly related to population, so changes in recreation demand correspond to changes in population. Second, that recreation use in each forecast year can be estimated by calculating the percent change in population from the baseline year to a given forecast year and then multiplying the baseline use estimates by the percent population change.

4.7.2.2.1 Reservoir Recreation

Because of modeling constraints (see Section 4.4.1.2), in some individual reservoir cases the modeling predicts that the range of possible flow scenarios produce higher visitation than the no action alternative. This would not necessarily be the case. In some cases, the low, moderate, and high scenarios would experience lower elevations, therefore lower visitation, than the model predicts because the model did not include specific operations for peaking, navigation, or flood control. Nonetheless, this analysis compares the action alternative flow scenarios to the no action alternative.

Examination of the results of the ACT recreation summary analysis ***(Table 4-66)*** shows that the action alternative flow scenarios all provide higher recreation visitation than the no action alternative. The pattern shows decreasing or equal positive impacts from the low to moderate conditions and increasing positive impacts from the moderate to high flow conditions.

TABLE 4-66
Recreation Trips (ACT Basin)

	No Action Alternative	Action Alternatives		
Year		High Flow Scenario	Moderate Flow Scenario	Low Flow Scenario
1995	2,011,076	2,231,722	2,127,730	2,160,501
2020	2,583,441	2,823,369	2,732,211	2,783,709
2050	3,285,048	3,663,273	3,486,809	3,551,984

These data include the following reservoirs: Carters Lake, Lake Allatoona, Weiss Lake, H. Neely Henry Lake, Logan Martin Lake, Lay Lake, Mitchell Lake, R.L. Harris Reservoir, Lake Martin, Yates and Thurlow Dams, and Alabama River Lakes.

The model predicts that reservoir levels would yield nearly 3.3 million recreation trips for 2050 throughout the ACF basin under the no action alternative. In comparison, the low and moderate flow scenarios would yield 3.6 million trips and 3.5 million trips, respectively (or 200,000 to 300,000 more recreation trips annually). The high flow scenario would yield 3.7 million trips in 2050 (or 400,000 more trips annually than under the no action alternative).

The low flow scenario emphasizes maximum water conservation, thus higher pool levels. Annual visitation with this scenario was slightly higher than the moderate flow scenario (which most closely approximates existing conditions), and was higher than the no action alternative.

Recreation trips under the high flow scenario were about 5 percent lower than under the moderate flow scenario, and 11 percent higher than under the no action alternative. Two factors resulted in visitation being higher under the high flow scenario than the no action alternative. The first factor, which resulted in lower lake levels, was the high downstream minimum flow target. The second factor was not including the seasonal drawdown for flood control in the modeling, which caused average annual lake levels to be higher than would be expected.

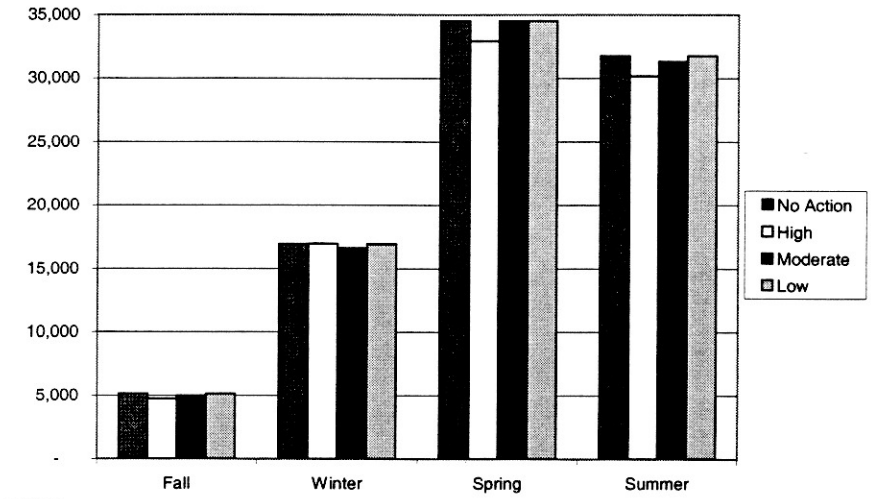
For run-of-the-river and river projects, there was no seasonal drawdown of the reservoirs. Therefore, as the minimum flow release was increased from the low to moderate to high scenarios, there were decreasing positive impacts as lake levels or flow decreased.

The following discussion describes impacts to individual reservoirs in year 2050. Note that Lay Lake, Mitchell Lake, Yates/Thurlow Dams, and the Alabama River Lakes were modeled as run-of-river projects. Therefore, the pool elevation at these projects will remain constant and a water allocation formula applied to the basin will not affect the pool elevation at these reservoirs. As a result, these projects were not included in determining direct impacts to recreation resulting from implementing a water allocation formula. The analysis compares the action flow alternative flow scenarios to the no action alternative. However, because the moderate flow scenario was modeled to be similar to current operations, this scenario was also used as a basis for comparing the different action alternative flow scenarios.

4.7.2.2.1.1 Carters Lake

Carters Lake receives minimal visitation in comparison to the other reservoirs. It is ranked 11th most visited of the 12 projects for which uniform data were available. The model data show that, in the year 2050, the action alternative flow scenarios provide less recreation visitation than the no action alternative in all seasons. ***Figure 4-91*** details seasonal information for the scenarios.

FIGURE 4-91
Carters Lake Comparison of Recreation Trips, 2050



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4.7.2.2.1.2 Lake Allatoona

Lake Allatoona is the most visited reservoir in the ACT basin. Nearly 80 percent of the visitation occurs in the spring and summer seasons. The modeling predicts that the action alternative flow scenarios (low, moderate, and high scenarios) result in significantly higher recreation visitation in spring and summer seasons compared to the no action alternative. However, the modeling did not include specific operations for peaking, navigation, or flood control for the action alternative. Therefore, both reservoir levels and visitation may be overstated. In fall, all alternatives yield similar visitation. In winter, the high flow scenario would lead to higher reservoir elevations, and therefore, higher visitation than the other scenarios. ***Figure 4-92*** compares seasonal recreation visitation in 2050 for the alternative flow scenarios.

4.7.2.2.1.3 Weiss Lake

Weiss Lake is the fourth visited reservoir in the ACT basin. Like the other reservoirs, most visitation occurs in the spring and summer seasons. Recreation visitation would generally be consistent (within 5 percent) for all alternatives in the spring and summer seasons (see ***Figure 4-93***). In the fall season, the modeling indicates that the action alternative flow scenarios would yield the highest number of recreation visits compared to the no action alternative. In winter, the high flow scenario would provide the highest visitation, followed by the no action alternative and the low and moderate flow scenarios.

FIGURE 4-92
Lake Allatoona Comparison of Recreation Trips, 2050

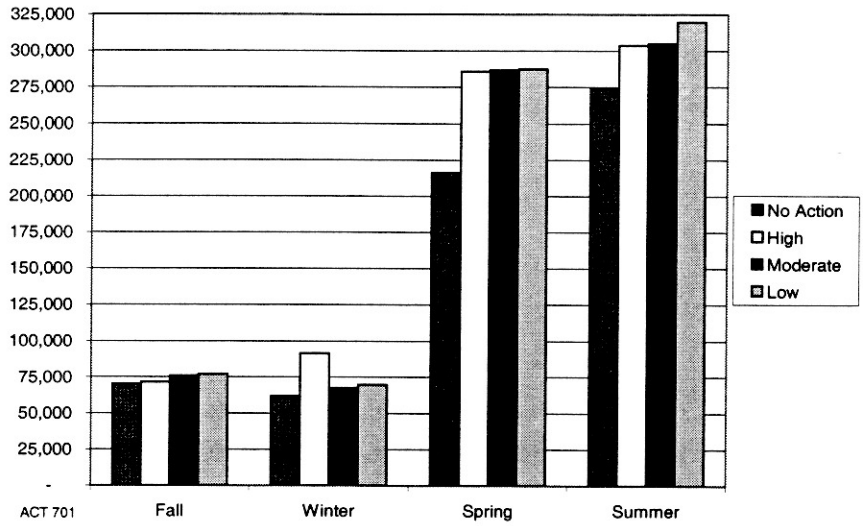
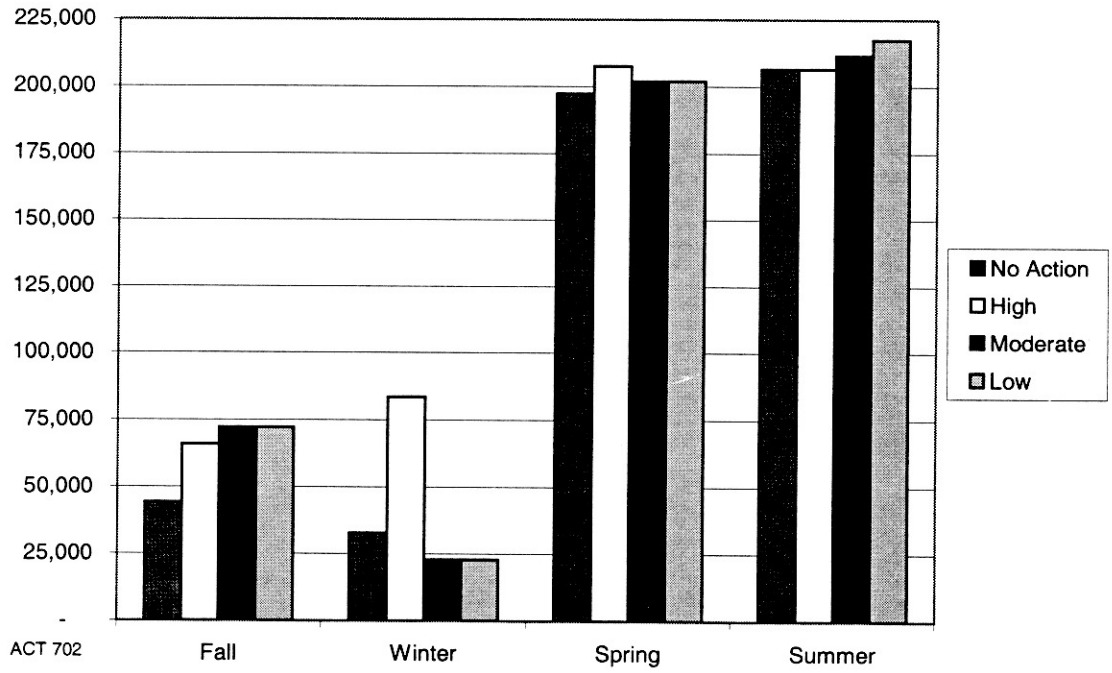


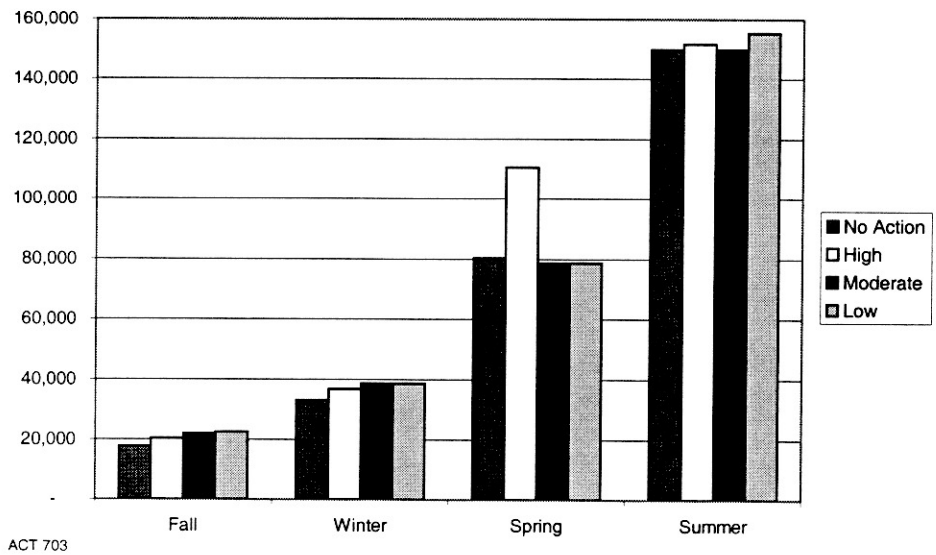
FIGURE 4-93
Weiss Lake Comparison of Recreation Trips, 2050



4.7.2.2.1.4 H. Neely Henry Lake

H. Neely Henry Lake is the fifth visited reservoir in the ACT basin (it receives less than half the annual visitation of Lake Allatoona). Most visitation occurs in the spring and summer seasons. Visitation would be relatively similar for all the alternatives during the summer, fall, and winter seasons. In spring, however, visitation would be similar for all alternatives except the high flow scenario. The high flow scenario would lead to greater reservoir elevations in winter, and therefore, higher visitation potential (see ***Figure 4-94***).

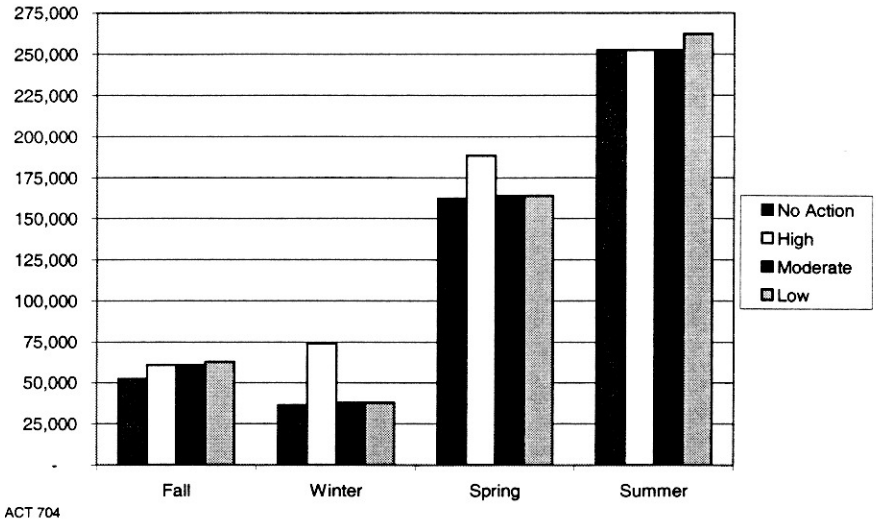
FIGURE 4-94
H. Neely Henry Lake Comparison of Recreation Trips, 2050



4.7.2.2.1.5 Logan Martin Lake

Logan Martin Lake is the third most visited reservoir in the ACT basin, with spring and summer being the most popular recreation seasons. Comparing the action alternative flow scenarios to the no action alternative in the winter and spring seasons, the low and moderate flow scenarios would produce similar recreation visitation to the no action alternative. The model predicts that the high flow scenario would provide higher reservoir levels, and therefore, higher visitation. For the summer season, the low flow scenario would produce higher visitation, compared to the no action and moderate and high flow scenarios. Visitation would be relatively constant for all alternatives for the fall season. ***Figure 4-95*** compares seasonal recreation visitation in 2050 for the alternatives.

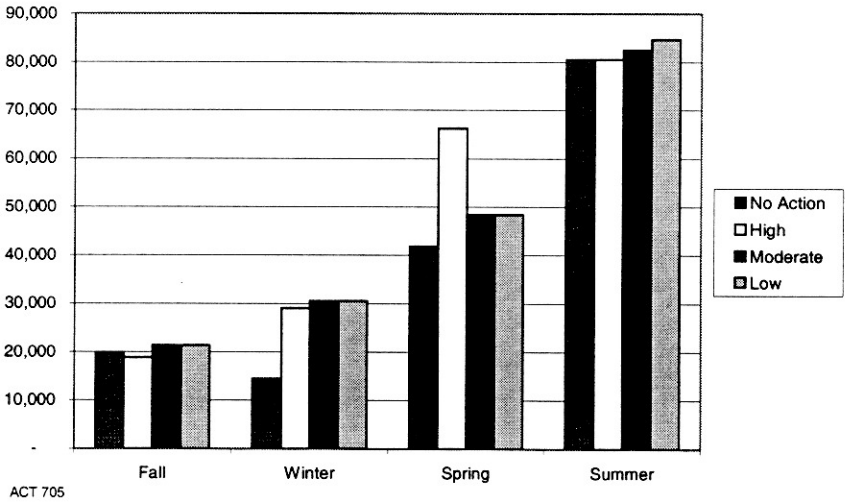
FIGURE 4-95
Logan Martin Lake Comparison of Recreation Trips, 2050



4.7.2.2.1.6 R.L. Harris Lake

R. L. Harris Lake is the eighth most visited of the 12 reservoirs in the ACT basin. Most visitation occurs in the spring and summer seasons. The modeling predicts that, in the winter and spring seasons, the no action alternative flow scenarios would yield more recreation visitation than the no action alternative. In spring, modeling indicates that the high flow scenario would result in 40 to 60 percent more recreation visitation than the other alternative scenarios. In the fall, visitation would be constant for all the alternatives. *Figure 4-96* compares seasonal recreation visitation in 2050 for the alternatives.

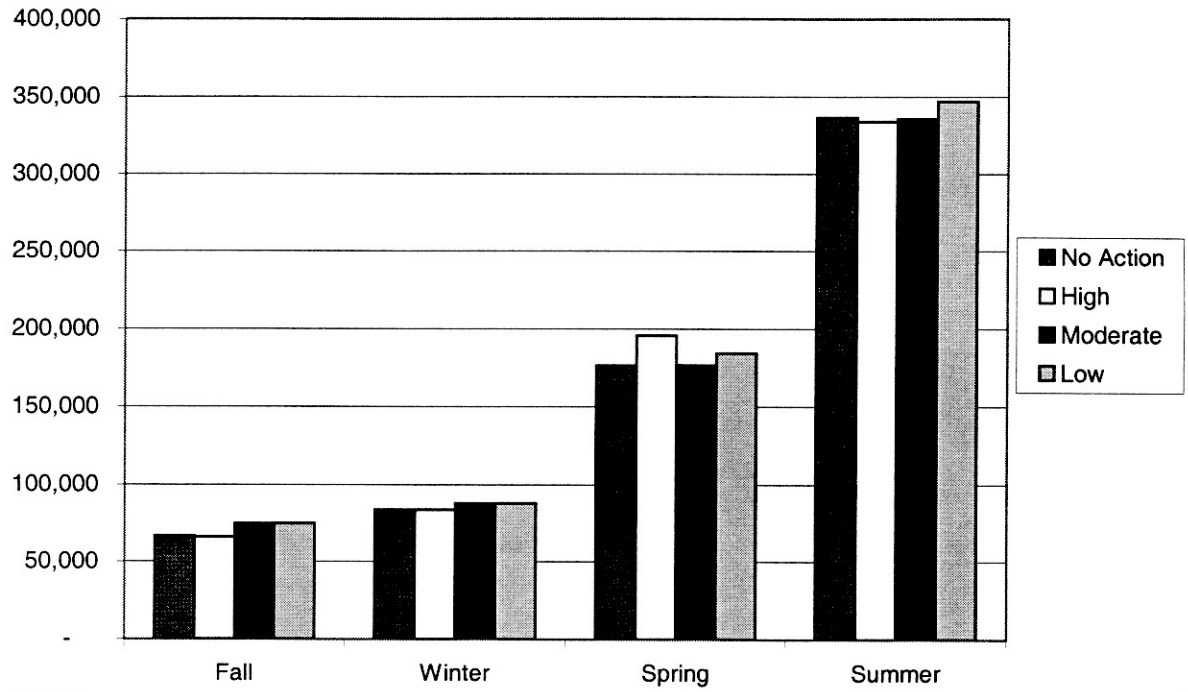
FIGURE 4-96
R.L. Harris Lake Comparison of Recreation Trips, 2050



4.7.2.2.1.7 Lake Martin

Lake Martin is the second most visited reservoir in the ACT basin, and receives nearly as much visitation as Lake Allatoona. The model predicts that, for all seasons, there is no appreciable difference between the action alternative flow scenarios and the no action alternative for any of the seasons. ***Figure 4-97*** compares seasonal recreation visitation in 2050 for the alternatives.

FIGURE 4-97
Lake Martin Comparison of Recreation Trips, 2050



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Overall in the ACT basin, the low flow scenario provides the most benefit for recreation. This scenario maintains stable reservoir levels, which enhance recreation in the summer, the most popular season. This, in turn, leads to increased recreation visitation over the no action scenario. In contrast, the high flow scenario provides consistent flows in the rivers, which often leads to reduced reservoir levels (depending on the season). Further, the lack of including several parameters within the modeling effort (e.g., specific operations for peaking, navigation, or flood control) makes it difficult to reconcile some of the data. For instance, at most of the reservoirs, the high flow scenario looks better in the winter months than it would actually be if the additional parameters were factored into the modeling. In some cases, the low, moderate, and high flow scenarios would experience lower elevations, and therefore, lower visitation, than the model predicts.

4.7.2.2.2 Riverine Recreation

The primary free flowing segments in the ACT basin are in the headwaters above Weiss Lake and on the Cahaba River. There would be no impacts or changes in the Cahaba because there are no regulated reservoirs on this river. The riverine sections above Weiss Lake could be impacted by changes to discharges at Allatoona and Carters Lakes. Impacts to riverine recreation resources in this area were assessed on the Coosa River at Rome, Georgia. This marks the beginning of the Coosa River, where the Etowah and Oostanaula Rivers join to form the Coosa River. Two hydropower dams and reservoirs are located in this subbasin: Allatoona Dam on the Etowah River, and the Carters Dam and Reregulation Dam on the Coosawattee River.

The low flow scenario would result in reduced riverine flows compared to the moderate flow scenario. Low summer flows would be about 40 percent lower. High summer flows would typically be 20 percent higher under the low flow scenario as compared to the moderate flow scenario. This is because the low flow scenario maintains water levels near the top of the conservation pool, so when rainfall occurs, the reservoirs have no excess storage and have to discharge flows, resulting in higher downstream flows.

The high flow scenario would enhance riverine recreation during low summer flow periods over the moderate flow scenario. Low summer flows would be 40 to 50 percent higher for the high flow scenario as compared to the moderate flow scenario.

4.7.3 Economics

The direct economic impacts of implementing a water allocation formula were evaluated by comparing the alternative flow conditions to the no action alternative. Modeling was completed by the Corps and focuses on the impacts to municipal and industrial water supply, recreation, and employment. Indirect economic impacts were determined using the Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Construction Engineering Research Laboratory (CERL). For its input, the EIFS model uses the direct economic impacts as changes in spending (see Section 1.3.3.7 and ***Appendix F*** for a description of the economic modeling approach).

4.7.3.1 Affected Environment

This section describes the affected environment, or the baseline conditions, for the economic resources in the ACT basin. Municipal and industrial water demands, navigation, power generation, agriculture, recreation, and flood control are discussed.

4.7.3.1.1 Municipal and Industrial Water Demands

A critical function of the ACT rivers is to supply water. Municipalities draw water from the rivers and reservoir pools for their water supplies. Industrial plants, such as pulp and paper mills and poultry processing operations, use water in their production processes. Recreation-related businesses, such as country clubs, use water to irrigate golf courses. Various state and county parks use water for irrigation and water supply. In many ways, these water uses support local jobs and contribute to the economy. Section 4.4.2 summarizes the municipal and industrial water demands for 1995 developed for the Comprehensive Study.

4.7.3.1.2 Navigation

The Alabama River is an authorized navigation project located in southwest Alabama, stretching 289 miles from its confluence with the Mobile River to the City of Montgomery. There is an existing, authorized 9-foot by 200 foot navigation channel on the Alabama River from its junction with the Mobile River to Montgomery, Alabama, including three sets of locks and dams.

Alabama River traffic is almost entirely related to forest products and pulp (85 percent), and is dominated by just a few large cargo shippers. A more diverse traffic base would occur if the river served the heavy industries located above the present head of navigation at Montgomery, but that can only be realized by constructing the authorized Coosa River navigation improvements. Commercial traffic peaked in the mid 1980s at 4 million tons and then fell to the present level of less than 1 million tons. The decrease in commerce on the river since 1985 is probably attributable to competitive rates offered by other modes and the low reliability of the river during the mid 1980s drought. Although full navigation is not available for a relatively significant proportion of the time, the data reveal that there are few instances of sustained barge light-loading (which occurred during drought years). Virtually all tows are full-loaded to 8.5 or 9 feet. Flat deck sand and gravel barges are loaded to 7 feet (Institute of Water Resources, 1997).

Table 4-67 shows Alabama River waterborne commerce in 1995, as reported by the Waterborne Commerce Statistics Center, U.S. Army Corps of Engineers, New Orleans, Louisiana.

TABLE 4-67
Alabama River Waterborne Commerce

Commodity	1995 Projected Tonnage[a]
Non-metallic minerals	6,000
Forest products and pulp	676,000
Crude petroleum	57,000
Petroleum products	54,000
Total	**793,000**

[a] Rounded to the nearest thousand
Source: Institute of Water Resources, 1997

4.7.3.1.3 Power Generation

The ACT rivers are heavily developed for hydropower generation. The power resources serve residential, commercial, agricultural, and industrial users. Some of the agricultural and industrial users are dependent on economical power sources for continued operations.

The ACT basin's electrical power resource is dominated by thermal (steam) generation. Thermal resources are 77 percent of the basin's total—76 percent steam turbine and 1 percent combustion turbine. Hydropower and pumped storage accounts for the remaining 23 percent. Net annual energy demand for 1995 was estimated to be 32,486,368 megawatt hours (MWh). Alabama Power Company and Georgia Power Company produce 61 percent (1,102 megawatts [MW]) of the MW generated through hydropower and pumped storage; the remaining 39 percent is generated at federal projects. All energy produced by steam and combustion turbines in the ACT basin (6,019 MW) is generated at facilities owned by Alabama Power Company, Georgia Power Company, or Southern Electric Company. *Table 4-68* presents the main stem dams/reservoirs, the owner, and the total power capacity.

TABLE 4-68
Operative Mainstem Dams/Reservoirs in the ACT Basin

River/Project Name	Owner	Total Capacity (MW)[a,b]
Coosawattee River		
Carters Dam and Lake	Corps	575[b]
Etowah River		
Allatoona Dam and Lake	Corps	80[b]
Coosa River		
Weiss Dam and Lake	APCO	98[a]
H. Neely Henry Dam and Lake	APCO	98[a]
Logan Martin Dam and Lake	APCO	143[a]
Lay Dam and Lake	APCO	164[a]
Mitchell Dam and Lake	APCO	156[a]
Jordan Dam and Lake	APCO	116[a]
Bouldin Dam and Lake	APCO	226[a]

(CONTINUED)

TABLE 4-68 (CONTINUED)
Operative Main Stem Dams/Reservoirs in the ACT Basin

River/Project Name	Owner	Total Capacity (MW)[a,b]
Tallapoosa River		
Harris Dam and Lake	APCO	126[a]
Martin Dam and Lake	APCO	150[a]
Yates Dam and Lake	APCO	33[a]
Thurlow Dam and Lake	APCO	54[a]
Alabama River		
Robert F. Henry Lock and Dam/R.E. "Bob" Woodruff Lake	Corps	68[a]
Millers Ferry Lock and Dam/William "Bill" Dannelly Reservoir	Corps	75[a]
Total		2,143.6

[a] Overload capacity
[b] Nameplate capacity

APCO Alabama Power Company
Source: ***Appendix D***

The Southern Subregion of the Southeastern Electrical Reliability Council (SERC) and the larger North American Electric Reliability Council (NERC) consists of three control areas: i.e., areas controlled by the Alabama Electric Cooperative, the South Mississippi Electric Power Association, and the Southern Company. The Southern Company has five operating companies: Alabama Power Company, Georgia Power Company, Gulf Power Company, Mississippi Power Company, and Savannah Electric and Power Company.

SERC collects monthly peak hour demand data and net energy for the Southern Subregion. Each utility's peak hour demand and net energy were aggregated for each month. Then a summer and winter peak hour demand was identified by the month with the highest peak in each season. The net annual energy is the summation of the aggregated monthly net energies. Peak hour demand (MW) and net annual energy (MWh) for the Southern Subregion are presented in ***Table 4-69*** (Corps, unpublished draft).

TABLE 4-69
Peak Hour Demand (MH) and Net Annual Energy (MWh), Southern Subregion

Year	Gross National Product (1987 Dollars, in Billions)	Peak Hour Demand (MW)	Net Annual Energy (MWh)	Demand Change (Percent)	Energy Change (Percent)	Load Factor
1995	$ 5,354	35,098	180,234	2.58	0.35	0.59

4.7.3.1.4 Agricultural Water Supply

Agriculture is a vital component of the regional economy and, therefore, the availability of adequate water supplies for agricultural purposes is important. According to the U.S. Census, in 1990 approximately 40,500 people in Alabama were employed in the agriculture, forestry, or fisheries industries. Georgia had 73,647 residents employed in these industries in 1990. Potential shortages in meeting agricultural water demands could result in

significant economic impacts in portions of the ACT basin. Section 4.4.2 summarizes the 1995 agricultural water demands for the basin.

4.7.3.1.5 Flood Control

Flood control has long been an important focus of the Corps and the reservoirs it operates. Within the ACT basin, Lake Allatoona provides important flood control storage, with spillway sufficient capacities sufficient to discharge floods with return intervals of 500 years. The 500-year floodplain below the dam extends through Bartow and Floyd Counties. The floodplain begins at the Lake Allatoona Dam and concludes on the Coosa River downstream of the Etowah River's confluence with the Oostanaula River. Additional flow control benefits are provided by Carters Lake and the Alabama Power projects during certain stages of plant operations but they are not included in these economic analyses.

The majority of the floodplain structures are located in the cities of Cartersville, Euharlee, and Rome, Georgia. The floodplain below the Lake Allatoona Dam consists of 1,132 residential structures, 9 public structures, and 189 commercial structures. Tax assessor-appraised residential structure values range from a $5,000 trailer to a $450,000 home, with a floodplain total residential structure value of $65.8 million. Residential structure content values are estimated to total $29.1 million. Public structures in the floodplain have a total value of $847,000. The structures range in value from a $35,000 utility building to a $150,000 sewage treatment facility. Public structure inventory and equipment values total $168,000 and $741,000, respectively. The floodplain tax- appraised commercial structure values range from a $10,000 office building to a $119 million industrial plant, with a floodplain total commercial value of $213.6 million. Commercial structure inventory and equipment values total $25 million and $54.3 million, respectively. The total land value in the floodplain is estimated to be $389.6 million.

The Water Management Office (EN-HW) of the Corps has developed an *Annual Damage Reduction Summary* that estimates the flood damages prevented by two projects in the ACT basin: Allatoona Lake and Carters Lake. The cumulative flood damages prevented by Allatoona Lake through 1996 were estimated to be approximately $15.1 million. It was estimated that the Carters Lake project prevented cumulative damages of $265,655 through 1996.

Other lakes in the basin, such as Weiss, H. Neely Henry, Logan Martin, and Harris, also provide flood control value, but this protection has not been calculated.

4.7.3.1.6 Fish and Wildlife Utilization

The total commercial fishery landings in Alabama in 1995 were approximately $49.6 million, or 6 percent of the $724.6 million generated in the Gulf of Mexico (Department of Commerce, 1996a). In 1995, commercial fishery landings at Bayou La Batre were valued at $37.5 million, or 76 percent of the total landings in the state. However, these landings values change substantially from year to year based on climatic conditions, normal changes in the fish and shellfish populations, and numbers and effectiveness of commercial fishermen. For example, the dollar landings value at Bayou La Batre was $24.3 million in 1993 and $37.5 million in 1995, then returned back to $28.6 million in 1996.

The most commercially important species included shrimp, menhaden, blue crab, snapper, grouper, and oysters (Department of Commerce, 1996b). Recreational fishing in the Gulf of

Mexico accounts for 25 percent of the total number of trips in the United States. The most commonly caught nonbait species were spotted seatrout, pinfish, saltwater catfish, and striped bass.

4.7.3.1.7 Recreation Economics

The Phase I survey, completed in conjunction with the Comprehensive Study (Allen et al., 1997) estimated spending at the 12 study projects in the ACT basin. Because the survey was restricted to registered boaters, per-trip spending estimates were probably higher than those for the entire population of recreation users. Other recreation studies have shown that boaters have higher per-trip expenditures and higher levels of discretionary spending than non-boaters.

Information gathered for the Phase I survey indicated that boat owners spent a total of $516.6 million dollars in 1995 during their trips to the projects in the ACT basins, with $240.3 million dollars contributed directly to the projects' local economies. These expenditures included such items as gas, meals, lodging, fees, and groceries, but did not include expenditures for boats. Two types of expenditures were reported: those made inside a 30-mile radius of the project (local) and those made outside a 30-mile radius.

Per-visit National Economic Development (NED) benefits were also developed. These benefits measure consumer surplus, or the difference between the maximum amount someone will pay for a resource and the actual price paid. Travel cost models, based on observed behavior, provided a means of estimating NED benefits. Travel cost analysis can be used to estimate a demand curve, which shows the relationship between price and quantity demanded. Since nearby visitors face a lower cost in travel-related expenses, they are expected to visit more frequently than those who live a greater distance. The relationship between visitation rates and the travel costs from different zones or areas are used to calculate consumer surplus, or NED benefits.

Table 4-70 presents local and total per-trip spending, total annual spending, per-trip NED benefits, and total annual NED benefits for the 12 study reservoirs in the ACT basin.

TABLE 4-70
Local and Total Per-Trip Spending, Total Annual Spending, Per-Trip National Economic Development (NED) Benefits, and Total Annual NED Benefits

Project	Total Trips	Local Spending Per Trip	Total Spending Per Trip	Total Annual Spending	NED Benefits Per Trip	Total Annual NED Benefits
Lake Martin	402,705	$190.80	$248.90	$100,233,275	$36.83	$14,831,625
Lake Allatoona	378,297	$22.50	$92.50	$34,992,473	$41.82	$15,820,381
Logan Martin Lake	309,041	$161.80	$414.40	$128,066,590	$26.03	$8,044,337
Weiss Lake	293,625	$103.90	$239.30	$70,264,463	$35.58	$10,447,178
H. Neely Henry Lake	170,431	$37.00	$168.80	$28,768,753	$31.65	$5,394,141
Jordan Lake	160,906	$63.40	$121.10	$19,485,716	$12.24	$1,969,489
R.L. Harris Reservoir	96,989	$68.60	$156.50	$15,178,779	$37.44	$3,631,268

(CONTINUED)

TABLE 4-70 (CONTINUED)
Local and Total Per-Trip Spending, Total Annual Spending, Per-Trip National Economic Development (NED) Benefits, and Total Annual NED Benefits

Project	Total Trips	Local Spending Per Trip	Total Spending Per Trip	Total Annual Spending	NED Benefits Per Trip	Total Annual NED Benefits
Lay Lake	149,997	$25.50	$58.60	$8,789,824	$35.65	$5,346,680
Carters Lake	53,598	$35.80	$100.80	$5,402,678	$44.44	$2,381,895
Mitchell Lake	63,658	$69.50	$328.60	$20,918,019	$34.28	$2,182,196
Yates and Thurlow Dam	13,533	$11.70	$101.50	$1,373,600	$15.75	$213,145
Alabama River Lakes	131,164	$64.80	$102.80	$13,483,659	$23.88	$2,400,685
Total	**2,223,944**			**$446,957,829**		**$72,663,020**

Alabama River Lakes include Woodruff Lake, Dannelly Lake, and Claiborne Lake.
The accuracy of the per-trip expenditures vary with the number of responses received per recreation area and the ability of the respondent to correctly remember and report expenses for an average trip.

Source: Perr, 1997

Total annual spending within the local economy was highest at Lake Martin ($89.6 million), with Lake Logan Martin having the highest total annual spending ($149.9 million). Average trip expenditures were highest for Lake Logan Martin at $414.40 per trip. The NED benefit per trip was highest at Carters Lake ($16.46); the total annual NED benefit was highest at Lake Allatoona ($6.9 million).

4.7.3.1.8 Income

According to projections prepared for the Comprehensive Study, total personal income in the 42-county ACT basin was nearly $50.7 billion in 1995, almost double the 1985 total personal income of $26.7 billion (***Table 4-71***). Personal income includes both wage (labor) and non-wage income, such as dividends and interest and transfer payments.

TABLE 4-71
Total Personal Income in the ACT Basin

	1985	1995 (estimated)
Alabama portion of basin	$20,254,000,000	$37,902,000,000
Georgia portion of basin	$6,460,000,000	$12,776,000,000
ACT basin	$26,714,000,000	$50,678,000,000

Source: DRI/McGraw-Hill, 1996

Per capita personal income is the total personal income in an area, divided by the number of people living there. A comparison of real per capita income (in 1987 dollars, to adjust for inflation) in the ACT basin shows steady growth, at an average of 2.3 percent annually from 1975 to 1985 and 1.7 percent annually from 1985 to 1995 (***Table 4-72***).

Real per capita income in the Alabama portion of the ACT basin is somewhat higher than in the Georgia portion, which is similar to the State of Alabama as a whole. As in the surrounding State of Georgia, growth in real per capita income in the Georgia portion of the

ACT basin slowed considerably between 1985 and 1995 (1 percent annual average), compared to 3 percent annual growth between 1975 and 1985 (*Table 4-72*).

In current dollars, 1995 per capita income was estimated to be $19,067 in the ACT basin, $19,407 in the Alabama portion of the basin, and $18,122 in the Georgia portion of the basin.

TABLE 4-72
Real Per Capita Income Trends in the ACT Basin[a]

	1975	Annual Average 1975-1985 (%)	1985	Annual Average 1985-1995 (%)	1995[b]
Alabama portion of basin	$10,085	2.1	$12,177	1.9	$14,447
Georgia portion of basin	$9,392	3.0	$12,175	1.1	$13,489
ACT basin	$9,933	2.3	$12,176	1.7	$14,193
Alabama	$9,518	2.3	$11,706	2.0	$13,997
Georgia	$10,428	3.2	$13,717	1.5	$15,730

[a] To adjust for inflation in annual comparisons, all dollar values are adjusted to 1987 equivalents
[b] Estimated
Source: DRI/McGraw-Hill, 1996

4.7.3.1.9 Employment

Employment levels in the ACT basin, which contains or borders on several growing metropolitan areas (including Atlanta, Birmingham, Montgomery, and Mobile), have been slowly but steadily increasing. Between 1985 and 1995, the number of jobs grew at an annual rate of 2.4 percent, comparable to the 2.2 percent annual growth between 1975 and 1985 (*Table 4-73*). The growth rate in both portions is similar to that of the State of Alabama but less than the State of Georgia, which grew nearly 5 percent per year between 1975 and 1985, before slowing to 2.5 percent between 1985 to 1995.

For 1995, total employment in the ACT basin was estimated at 722,695, of which 77 percent was in the Alabama portion of the basin and 23 percent in the Georgia portion.

TABLE 4-73
Employment Trends in the ACT Basin[a]

	Alabama Portion of Basin	Georgia Portion of Basin	ACT Basin	Alabama	Georgia
1975 employment	557,801	164,894	722,695	1,155,445	1,755,674
Annual average growth 1975-1985	2.1%	2.2%	2.2%	2.4%	4.6%
1985 employment	676,749	201,838	878,587	1,427,114	2,569,502
Annual average growth 1985-1995	2.3%	2.6%	2.4%	2.3%	2.5%
1995 employment[a]	835,751	253,428	1,089,179	1,762,052	3,213,460

[a] Total nonfarm employment
Source: DRI/McGraw-Hill, 1996

More than 80 percent of all jobs in the ACT basin are provided by the private sector, i.e., non-farm employers (*Table 4-74*). The primary sources of employment are manufacturing, trade, and services, each of which employed an estimated 22 percent of non-farm workers in 1995. The Georgia portion of the ACT basin is much more dependent on manufacturing (37.4 percent), particularly the textiles industry, than the Alabama portion (about 18 percent),

while the Alabama portion relies more on service jobs (24 percent) than the Georgia portion (15.5 percent). The manufacturing sector has been shrinking in the ACT basin, having fallen from 31 percent of non-farm jobs in 1975 to 27 percent in 1985 to 22 percent in 1995.

TABLE 4-74
Estimated Nonfarm Employment by Industry in the ACT Basin in 1995

	Alabama Portion of Basin		Georgia Portion of Basin		ACT Basin	
	Number	Percent	Number	Percent	Number	Percent
Total Nonfarm Employment	**835,751**	**100**	**253,428**	**100**	**1,089,179**	**100**
Mining	3,409	0.4	513	0.2	3,922	0.4
Construction	44,099	5.3	11,333	4.5	55,432	5.1
Manufacturing	148,496	17.8	94,838	37.4	243,334	22.3
Transportation and public utilities	47,381	5.7	9,949	3.9	57,330	5.3
Wholesale and retail trade	192,436	23.0	52,203	20.6	244,639	22.5
Finance, insurance, and real estate	45,825	5.5	7,639	3.0	53,464	4.9
Services	201,197	24.1	39,397	15.5	240,594	22.1
Private Sector Subtotal	**682,843**	**81.7**	**215,872**	**85.2**	**898,715**	**82.5**
Government	152,908	18.3	37,556	14.8	190,464	17.5

Source: DRI/McGraw-Hill, 1996

4.7.3.2 Environmental Consequences

4.7.3.2.1 Municipal and Industrial Water Supply

No significant municipal and industrial economic impacts to water supply were identified. Results of the hydrologic modeling and the risk-based analysis of water supply shortages show that there were only small, seasonal shortages expected to occur for all of the action alternatives.

The low flow scenario has a relatively minor negative impact across the basin, with an Average Annual Equivalent adverse impact of approximately $1.3 million. The moderate flow scenario is expected to result in a $78,000 adverse impact. The high flow scenario is expected to result in a positive impact of approximately $2.35 million. See *Appendix F*, Tables F-11-1 and F-11-2, for additional details.

4.7.3.2.2 Navigation

The evaluation of navigation impacts was completed by the Corps and summarized in a separate report (*Appendix F*). The following section summarizes of this analysis.

Results of the HEC-5 modeling described in Section 4.4 were used to determine the percent of time depth would be available for navigation. Availability of four navigation depths, including 9 feet (full navigation), 8.5 feet, 8.0 feet and 7.5 feet, were determined for the alternative scenarios of high, moderate, and low flow, respectively. These statistics are provided for each month to address the seasonal trends that occur during the yearly wet and dry periods.

The annual commodity forecasts were also determined and seasonally apportioned by month on the basis of past patterns, as extracted from the Lock Performance Monitoring System records (Corps' National Inland Waterways Lock Statistics database). Annual commodity forecasts from the Navigation Element of the Comprehensive Study are

summarized in *Table 4-75* for the years 1995, 2020, and 2050. To evaluate cost impacts associated with lack of available river depth, transportation costs for each commodity were developed on the assumption that commodities that could not be shipped by water because of inadequate navigation depths would have to be shipped by other methods (*Appendix F*). These transportation costs were estimated for each year in the HEC-5 period of record (1939 to 1993) and converted to an annual average value. This approach was used to determine average yearly transportation costs for the no action and action alternative scenarios (*Table 4-76*).

TABLE 4-75
Commodity Forecasts, Short Tons

	Farm Products	Non-Metallic	Forest Products	Industrial Chemicals	Petroleum Products	Commodity Total
1995	333	541,667	732,133	3,067	38,267	1,369,267
2020	498	629,726	919,680	5,450	54,820	1,664,905
2050	809	700,512	1,431,470	10,220	88,086	2,290,075

Source: Comprehensive Study, Navigation Element

TABLE 4-76
Average Yearly Transportation Costs

Year	No Action	High Flow	Moderate Flow	Low Flow
1995	$3,122,147	$3,372,879	$3,216,086	$3,214,577
2020	$3,924,926	$4,157,320	$3,976,204	$3,971,967
2050	$5,470,470	$5,938,605	$5,668,781	$5,664,456

The annual direct impacts on navigation were estimated by determining the difference between the no action and action alternative average annual shipping costs (*Table 4-77*). Direct navigation impacts were assessed to be distributed to the States of Alabama and Georgia based on the number of counties serviced by the waterway in each state. This distribution was used in the analysis of impacts on employment and income. Results of this analysis indicate that the economic impacts associated with the alternatives are small compared to the total transportation costs. Impacts ranged from 1.2 percent ($47,041) in transportation costs for the no action alternative under the low flow scenario in 2020 to 8.6 percent ($468,135) in the high flow 2050 flow scenario.

TABLE 4-77
Direct Impacts on Navigation

	High Flow	Moderate Flow	Low Flow
1995	($250,732)	($93,939)	($92,430)
2020	($232,394)	($51,278)	($47,041)
2050	($468,135)	($198,311)	($193,986)
Average annual	($256,916)	($78,840)	($75,669)

4.7.3.2.3 Power Generation

The power values associated with the ACT-ACF hydropower projects were based on the detailed analysis of two separate years. Because the benefit analysis was based on hourly data, it was not practical to run simulations for all 55 years of historic data. The analysis

assumes that the water conditions in 1992 represent an "average" year, and energy generation in this year is assumed to represent the average annual condition.

Tables 4-78, 4-79, and *4-80* present the overall direct impacts in the ACT basin for all hydropower projects. Average annual direct impacts were ($6,597,693), ($2,394,817), and ($2,163,940) for the high, moderate, and low flow scenarios, respectively. These impacts are assumed to occur proportionately across the states of Alabama and Georgia with ($3,298,847) for high flow, ($1,197,409) for moderate flow, and ($1,081,970) for low flow impacts. This assumption is supported by the fact that the power goes to the marketing agency that primarily serves preference customers in both states for all the projects, whether in Alabama or Georgia.

TABLE 4-78
ACT Average Annual Hydropower Energy Production (MWh)

	No Action	High Flow	Moderate Flow	Low Flow
1995	5,494,066	5,256,896	5,409,637	5,421,095
2020	5,457,753	5,231,137	5,374,809	5,381,134
2050	5,410,430	5,196,759	5,328,994	5,331,240

TABLE 4-79
ACT Average Annual Hydropower Energy Gain (MWh)

	High Flow	Moderate Flow	Low Flow
1995	-237,169	-84,428	-72,971
2020	-226,616	-82,944	-76,619
2050	-213,672	-81,437	-79,190

TABLE 4-80
ACT Average Annual Hydropower Energy Direct Impacts (1998$)

	High Flow	Moderate Flow	Low Flow
1995	($6,808,922)	($2,423,866)	($2,094,925)
2020	($6,505,951)	($2,381,253)	($2,199,676)
2050	($6,134,329)	($2,337,980)	($2,273,484)
Average annual	($6,597,693)	($2,394,817)	($2,163,940)

In addition to the economic effects that are included in these estimates, additional impacts could be seen in capacity shortage to the Federal Power Program, which markets power from Corps projects to the southeastern states. These shortages, while undefined at this time, have the potential to require the Federal government to buy additional capacity to meet contractual obligations to its customers, primarily public bodies and cooperatives.

The above impacts to energy generated in the basin do not capture all of the potential impacts (e.g., capacity issues) to power generation. For example, a signification portion of the revenue collected by the Federal Government through the Federal Power Program is capacity based. Capacity reductions can occur as a result of lower flows. While flows may be available for thermal generation, a plant's intake may not function because of its elevation

during unusually low flow periods. Since steam plants are an integral part of the electrical system in the Southeast, the stability of the electrical system could become an issue if low flows caused any one or more of these plants to shut down. Further, transmission restraints may prevent additional energy from simply being purchased from off-system. *Appendix F,* Section 4, presents additional information on impacts on power generation that are expected to result under the action alternative flow scenarios, along with information on the limitations of the modeling.

4.7.3.2.4 Agricultural Water Supply

The evaluation of potential economic affects on the agricultural water supply was completed by NRCS based on the studies completed by NRSC during the Comprehensive Study and a review of potential water supply shortages developed by the Corps (Section 4.4.2.3). Any water supply shortages identified for agriculture were to be used to estimate potential economic impacts based on crop damage data developed during the Comprehensive Study. The methodology to estimate crop damage was designed to identify the loss of yield and associated income with decreasing availability of irrigation water during key plant growth stages for major crops in the basin. *Appendix F* includes the agricultural impact report prepared by the NRCS and the Municipal and Industrial Water Supply report developed by the Corps, which provides detailed descriptions of the methodology used to assess agricultural water supply impacts.

Under all alternative scenarios (no action and action alternatives), no impacts from water supply shortages were identified for agricultural irrigation needs. The HEC-5 model used to develop the water supply shortage estimates focuses on water withdrawn from the primary rivers in the ACT basin. Because the majority of all agricultural water supply used in the ACT basin is supplied by groundwater, shortages in meeting agricultural water supply needs would not be expected. Consequently, the limited amount of surface water used for agricultural purposes in the ACT basin are met under all the alternatives. No significant impacts on agricultural production or income are expected under any of the alternatives, and, therefore, no economic effects would occur.

4.7.3.2.5 Flood Control

Both the no action and the action alternative flow scenarios hold permanent flood control storage allocations constant. Since the alternatives all preserve the permanent flood control allocations, flood control impacts are zero for the action alternatives, when compared to the no action alternative.

By examining the impacts (damages) that would arise from eliminating this storage, an estimate of the value the existing allocations provide can be calculated. For the ACT basin, the impacts of eliminating permanent flood control storage at Allatoona Lake were examined. The total average annual impact of decreasing the existing storage allocation to zero is estimated to be ($4,833,640) and depends on the extent of flood flows in the period under review. These impacts represent damages that would occur to property located in the floodplain downstream of Allatoona Dam.

Allatoona Lake is currently operated with a seasonal (winter) drawdown. The high flow alternative assumes that this drawdown is eliminated. No evaluation of the impacts associated with this operating approach has been performed.

Additional detail of the Economic Analysis Section's broad-brush analysis of flood control impacts is included in ***Appendix F***.

4.7.3.2.6 Fish and Wildlife Utilization

The economic benefits of fisheries and wildlife uses in the basin show wide-ranging fluctuations that follow natural events related to predation, climate, land use changes, and natural resource management in the region. No detailed economic analysis has been completed for the range of species that might be affected under either the no action or action alternative flow scenarios. However, as discussed in the previous Biological Resources sections, action alternative flow scenarios that reduce available habitat area or use for these resources may be expected to include parallel impacts on the economic attributes of these species. Thus, the low flow scenario would afford positive economic benefits to recreational use of reservoir fisheries but would have a negative impact on benefits that might be provided for downstream fisheries, such as trout fishing. Conversely, the high flow scenario would be expected to have a negative economic impact on recreational fishing in reservoirs.

The impacts of these alternatives on the commercial and recreational fish and shellfish uses of Mobile Bay have not been specifically evaluated for this programmatic EIS. Effects on some species may result from changes that reduce nutrients and increase loss from predators, and such effects may have a negative economic effect on these resources.

4.7.3.2.7 Recreation Economics

The following section discusses the development of the direct economic impacts for ACT projects. It should be noted, however, that Lay Lake, Mitchell Lake, Yates/Thurlow Dams, and Lake Claiborne (Alabama River Lakes) were modeled in the HEC-5 program as run-of-river projects. Therefore, the pool elevation at these projects will remain constant and a water allocation formula applied to the basin will not affect the pool elevation at these reservoirs. As a result, these projects were not included in the determination of direct economic impacts to NRCSrecreation resulting from the implementation of a water allocation formula.

Examination of the results of the ACT recreation summary analysis (***Table 4-81***) shows that the action alternative flow scenarios all have higher economic benefits than the no action alternative flow scenario. The pattern shows generally decreasing or equal positive impacts from the low to moderate conditions, and increasing positive impacts from the moderate to high flow conditions.

The low flow scenario emphasizes maximum water conservation, thus higher pool levels. Average annual benefits under this scenario were higher than the no action alternative, and slightly higher than the moderate flow scenario, which most closely approximates existing conditions.

TABLE 4-81
Recreation Economic Impacts, ACT Basin

		Action Alternative		
	No Action Alternative	High Flow Scenario	Moderate Flow Scenario	Low Flow Scenario
Year	Recreation Value ($)	Recreation Value ($)	Recreation Value ($)	Recreation Value ($)
1995	71,820,885	80,255,001	76,670,407	77,889,885
2020	92,495,331	102,140,797	98,692,684	100,649,961
2050	117,892,257	132,280,186	126,168,031	128,660,557

Source: Corps recreation report in ***Appendix F***

Recreation benefits under the high flow scenario were about 5 percent higher than the moderate flow scenario. This occurred for two reasons. The first, which resulted in lower lake levels, was the high downstream minimum flow target, which was included in the modeling. The second factor was not including the seasonal drawdown for flood control in the modeling. This caused winter reservoir levels in reservoirs, and therefore, visitation to be much higher than under the other scenarios or no action alternative. The high flow scenario is artificially high as a result of the modeling assumptions.

For run-of-the-river and river projects, there was no seasonal drawdown of the reservoirs. Therefore, as the minimum flow release was increased from the low to moderate to high scenarios, there were decreasing positive impacts as lake levels or flow decreased.

A summary of the direct economic impacts to the ACT basin by state is displayed in *Table 4-82*.

TABLE 4-82
Impact Summary Annual Average, ACT Basin

State	Low ($)	Moderate($)	High ($)
Alabama	2,774,066	1,764,403	4,468,881
Georgia	4,753,092	4,056,050	5,048,995.
Total	**7,527,158**	**5,820,453**	**9,517,876**

Source: Corps recreation report in ***Appendix F***

4.7.3.2.8 Income

This section presents the future baseline conditions for income in the ACT basin and addresses the anticipated indirect impacts on income associated with the water allocation scenarios. Information presented in this section is summarized from economic reports prepared by the Corps (*Appendix F*).

By 2020, according to projections for the Comprehensive Study, personal income in the ACT basin is expected to total $195,927,000. By 2050, personal income is projected to total $838,949,000.

As *Table 4-83* shows, the Comprehensive Study projects slower growth in real per capita income in the future. Real per capita income is expected to increase by 1.1 percent from 1995 to 2020, and by only 0.7 percent between 2020 and 2050, discounting inflation. The Georgia portion of the basin is expected to experience this slowdown earlier than the Alabama portion. Factors contributing to this expectation of weak economic growth include a loss of manufacturing jobs and an increase in the number of elderly residents, while the share of working age population in the area declines.

TABLE 4-83
Projected Real Per Capita Personal Income in the ACT Basin[a]

	1995[b]	Annual Average 1995-2020	2020	Annual Average 2020-2050	2050
Alabama portion of basin	$14,447	1.2%	$18,757	0.7%	$21,988
Georgia portion of basin	$13,489	0.9%	$16,580	0.6%	$19,100
ACT basin	$14,193	1.1%	$18,206	0.7%	$21,276

[a] To adjust for inflation in annual comparisons, all dollar values are adjusted to 1987 equivalents.
[B] Estimated values
Source: *Regional Economic Forecast of Population and Employment*

To estimate regional economic impacts, direct changes in income are conveyed to a regional economic impact model, called the Economic Impact Forecasting System (EIFS). This model estimates regional economic impacts for the study area, as well as sub-areas within the study area. Four factors are examined as the primary indicators of socioeconomic change: business volume, employment, personal income, and population (population impacts are discussed in Section 4.7.1).

The model also provides rational threshold values (RTVs), which are used to assess the level of significance of regional economic impacts that may be identified. The RTVs provide a basis for comparing the impacts of an action to the historical fluctuations in a particular area. The RTV analysis uses the fluctuations of the four indicator variables from the average growth rates within the affected area, over time, to set boundaries (threshold values) that can be used assess the magnitude of an action's impacts. These boundaries determine the amount of change required to significantly affect an individual area. If the changes predicted by the EIFS forecast models fall outside these boundaries, the changes may affect the economy of the region significantly. Additional information about the EIFS model and the RTV method is provided in ***Appendix F***.

The total direct economic impact for the ACT basin when comparing the no action alternative (no impact) to the low flow scenario is an increase of $4,003,000 (annual average). Total direct economic impact when comparing the no action alternative to the moderate flow scenario is an annual increase of $3,269,000 (annual average). Total direct economic impact when comparing the no action alternative to the high flow scenario is an annual increase of $5,017,000 (annual average). The direct economic impact values, by economic use, for the basin and states, are displayed in ***Table 4-84***.

TABLE 4-84
Direct Economic Impacts by State and ACT Basin

Economic Use	ACT Basin Total	Alabama Total	Georgia Total
Low Flow Scenario			
Recreation	$7,527,000	$2,774,000	$4,753,000
M & I water supply	($1,284,000)	$1,214,000	($71,000)
Inland navigation	($76,000)	($76,000)	$0
Electric power	($2,164,000)	($1,082,000)	($1,082,000)
Agricultural water supply	$0	$0	$0
Total Direct Impacts	**$4,003,000**	**$402,000**	**$3,600,000**
Moderate Flow Scenario			
Recreation	$5,821,000	$1,764,000	$4,056,000
M & I water supply	($78,000)	($386,000)	$308,000
Inland navigation	($79,000)	($79,000)	$0
Electric power	($2,395,000)	($1,197,000)	($1,197,000)
Agricultural water supply	$0	$0	$0
Total Direct Impacts	**$3,269,000**	**$102,000**	**$3,167,000**
High Flow Scenario			
Recreation	$9,518,000	$4,469,000	$5,049,000
M & I water supply	$2,354,000	$1,325,000	$1,209,000
Inland navigation	($257,000)	($257,000)	$0
Electric power	($6,598,000)	($3,299,000)	($3,299,000)
Agricultural water supply	$0	$0	$0
Total Direct Impacts	**$5,017,000**	**$2,238,000**	**$2,779,000**

All dollar values used in the EIFS model are adjusted to 1987 equivalents; however, values presented in this table are stated at a 1998 price level.
M & I Municipal and industrial

The regional or indirect impacts on personal income and business volume associated with the low, moderate, and high flow scenarios for the ACT basin and individual states are displayed in *Table 4-85*. The RTVs for the basin and states are presented for comparison. Little or no impacts on the regional economies of the affected areas were identified for the scenarios. Also, none of the impacts approached the RTV levels for the ACT basin or the states of Alabama or Georgia.

According to the EIFS model, the low flow scenario, when compared to the no action alternative, would cause personal income to increase by $1.7 million annually within the ACT basin, compared to the total personal income of $50.7 billion in 1995 in the basin. This represents an annual change of only 0.003 percent. The total indirect impact on business volume is $13.3 million or 0.017 percent. The indirect impact on personal income and business volume is slightly higher in Alabama than in Georgia, but none of the state and basin impacts are significant when compared to the RTVs.

TABLE 4-85
Regional Economic Impacts on Personal Income and Business Volume by State and Basin

Category	Annual Change	Percent Change	RTV Required for Significance (%)	Significance of Impact
Low Flow Scenario				
ACT Basin				
Business volume	$13,268,000	0.017	7.497	No
Personal income	$1,738,000	0.003	6.683	No
ACT Basin – State of Alabama				
Business volume	$1,361,000	0.002	6.853	No
Personal income	$183,000	0.000	5.828	No
ACT Basin – State of Georgia				
Business volume	$8,223,000	0.042	10.216	No
Personal income	$940,000	0.007	9.686	No
Moderate Flow Scenario				
ACT Basin				
Business volume	$10,835,000	0.014	7.497	No
Personal income	$1,418,000	0.003	6.683	No
ACT Basin – State of Alabama				
Business volume	$345,000	0.001	6.853	No
Personal income	$47,000	0.000	5.828	No
ACT Basin – State of Georgia				
Business volume	$7,233,000	0.037	10.216	No
Personal income	$826,000	0.006	9.686	No
High Flow Scenario				
ACT Basin				
Business volume	$16,628,000	0.021	7.497	No
Personal income	$2,177,000	0.004	6.683	No
ACT Basin – State of Alabama				
Business volume	$7,555,000	0.013	6.853	No
Personal income	$1,014,000	0.002	5.828	No
ACT Basin – State of Georgia				
Business volume	$6,347,000	0.033	10.216	No
Personal income	$725,000	0.006	9.686	No

The moderate flow scenario, when compared to the no action alternative, would cause personal income to increase by $1.4 million annually within the ACT basin. This represents an annual change of only 0.003 percent for the basin. Business volume in the ACT basin would increase by $10.8 million. At the state level, the impact is distributed evenly between Georgia and Alabama.

The high flow scenario, when compared to the no action alternative, would cause personal income to increase by $2.1 million annually within the ACT basin. This represents an annual change of only 0.004 percent for the basin. This increase in personal income is higher in

Alabama than in Georgia. None of the state and basin impacts are significant when compared to the RTVs.

4.7.3.3 Employment

This section presents the future conditions for employment in the ACF basin and presents the expected indirect impacts to employment associated with the water allocation scenarios. Information presented in this section is summarized from economic reports prepared by the Corps (***Appendix F***).

Dependence on the manufacturing industry, especially textiles, is expected to restrain employment growth in the ACT basin in the future. According to the Comprehensive Study, the migration of local firms abroad and increasing international competition will cause manufacturing employment to decline at an annual rate of 1.6 percent between 1990 and 2050. Manufacturing is forecasted as providing only 6.4 percent of nonfarm employment in the ACT basin by 2050.

As a result, overall job growth in the ACT basin is expected to slow considerably to an annual average of 0.7 percent between 1995 and 2050 (***Table 4-86***). Forecasts show only minimal job growth (0.1 percent annually) in the Georgia portion of the basin, while the Alabama portion would fare better, at 0.8 percent annual growth, but still much slower than the steady 2-percent growth trend of the 1975 to 1995 period.

TABLE 4-86
Projected Nonfarm Employment in the ACT Basin

	Alabama Portion of Basin	Georgia Portion of Basin	ACT Basin
1995 employment[a]	835,751	253,428	1,089,179
2020 employment[b]	1,036,075	260,553	1,296,628
2050 employment[c]	1,222,516	274,138	1,496,654
Annual average growth 1995-2020	**0.8%**	**0.1%**	**0.7%**

[a] Estimated values
[b] Forecasted values
Source: *DRI-McGraw Hill, 1996*

According to the EIFS model, the low flow scenario, when compared to the no action alternative, would cause employment to increase by an annual total of 69 jobs (0.006 percent) in the ACT basin. When compared to a baseline of nearly 1.1 million non-farm jobs in 1995; to the (annual average) employment growth of 0.7 percent projected to occur between 1995 and 2050; and to the calculated RTVs, which represent typical historic fluctuations in employment for the ACT basin, this represents little or no impact on regional employment.

The moderate flow scenario, when compared to the no action alternative, would cause employment to increase only minimally, by an annual total of 56 jobs (0.005 percent) in the ACT basin (***Table 4-87***). This represents little or no impact on regional and state employment.

TABLE 4-87
Regional Economic Impacts: State and Basin Results

Category	Annual Change	Percent Change	RTV Required for Significance (%)	Significance of Impact
Low Flow Scenario				
ACT Basin				
Employment	69	0.006	2.272	No
ACT Basin – State of Alabama				
Employment	7	0.001	1.895	No
ACT Basin – State of Georgia				
Employment	41	0.016	3.911	No
Moderate Flow Scenario				
ACT Basin				
Employment	56	0.014	2.272	No
ACT Basin – State of Alabama				
Employment	2	0.000	1.895	No
ACT Basin – State of Georgia				
Employment	36	0.014	3.911	No
High Flow Scenario				
ACT Basin				
Employment	87	0.008	2.272	No
ACT Basin – State of Alabama				
Employment	40	0.004	1.895	No
ACT Basin – State of Georgia				
Employment	32	0.013	3.911	No

The high flow scenario, when compared to the no action alternative, would cause employment to increase modestly, by an annual total of 87 jobs (0.008 percent) in the ACT basin. The increase is somewhat greater in Alabama than in Georgia, but these changes represent little or no impact on regional and state employment.

4.8 Air Quality and Noise

This section of the EIS addresses the potential impacts of the proposed water allocation formula on air quality conditions and noise levels in the ACT basin. Air quality is addressed on a basinwide basis and focuses on areas with existing air quality problems or non-attainment areas. Noise conditions are summarized and future impacts evaluated based on typical noise levels expected around general land use areas (urban vs. suburban).

4.8.1 Air Quality

Air quality conditions in the ACT basin and the potential impacts on air quality are summarized in this section. The analysis of air quality is based on information available from EPA (1998b). No modeling was required to complete the air quality evaluation. In addition, the analysis of air quality assumes, as noted in Sections 4.6 and 4.7.1, that water availability would not influence growth and land use changes that would have negative impacts on air quality.

4.8.1.1 Affected Environment

EPA has established national ambient air quality standards for the following seven criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than or equal to 2.5 microns ($PM_{2.5}$), particulate matter less than or equal to 10 microns (PM_{10}), and sulfur dioxide (SO_2). *Table 4-88* lists the national ambient air quality standards for each pollutant in terms of the level of the standard, the associated averaging time, and the form of the statistic used to evaluate compliance. There are two types of standards: primary and secondary. Primary standards protect against adverse health effects, whereas secondary standards protect against welfare effects, such as damage to crops, vegetation, buildings, and decreased visibility.

TABLE 4-88
National Ambient Air Quality Standards

	Primary Standard (Human Health-Related)		Secondary Standard (Human Welfare-Related)	
Pollutant	**Type of Average**	**Standard Level Concentration[a]**	**Type of Average**	**Standard Level Concentration**
Carbon monoxide (CO)	8-hour[b]	9 ppm (10 mg/m^3)	No secondary standards	
	1-hour[b]	35 ppm (40 mg/m^3)	No secondary standards	
Lead (Pb)	Maximum quarterly average	1.5 µg/m^3	Same as primary standard	

(CONTINUED)

TABLE 4-88 (CONTINUED)
National Ambient Air Quality Standards

Pollutant	Primary Standard (Human Health-Related)		Secondary Standard (Human Welfare-Related)	
	Type of Average	Standard Level Concentration[a]	Type of Average	Standard Level Concentration
Nitrogen dioxide (NO_2)	Annual arithmetic mean	0.053 ppm (100 5 μg/m³)	Same as primary standard	
Ozone (O_3)	8-hour	0.08 ppm[d] (156 μg/m³)	Same as primary standard	
Particulate matter < 2.5 microns ($PM_{2.5}$)	Annual arithmetic mean[b]	15 μg/m³	Same as primary standard	
	24-hour[c]	65 μg/m³	Same as primary standard	
Particulate matter < 10 microns (PM_{10})	Annual arithmetic mean[b]	50 μg/m³	Same as primary standard	
	24-hour[c]	150 μg/m³	Same as primary standard	
Sulfur dioxide (SO_2)	Annual arithmetic mean[b]	0.03 ppm (80 μg/m³)	3-hour[b]	0.50 (1,300 μg/m³)
	24-hour[c]	0.14 ppm (365 μg/m³)		

μg/m³ Micrograms per cubic meters

a Parenthetical value is an approximately equivalent concentration.
b Particulate standards use PM 10 as the indicator pollutant. The annual standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 μg/m 3; the 24-hour standard is attained when the expected number of days per calendar year above 150 μg/m 3 is equal to or less than one, as determined by Appendix K of the Particulate Matter (PM) NAAQS.
c Not to be exceeded more than once per year.
d The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one, as determined according to Appendix H of the Ozone National Ambient Air Quality Standards (NAAQS).

Source: EPA, 1997b

There are primary standards for all of the criteria pollutants; some pollutants (PM_{10} and SO_2) have primary standards for both long-term (annual average) and short-term (24 hours or less) averaging times. Short-term standards protect people from any adverse health effects associated with peak short-term exposures to air pollution, while long-term standards protect people from adverse health effects associated with short- and long-term exposures to air pollution. There are secondary standards for each criteria pollutant except CO. Secondary standards are identical to the primary standard with the exception of SO_2.

Air quality in the ACT basin is generally good with most of the basin in attainment for the seven priority pollutants monitored by EPA. There are, however, two designated nonattainment areas in the adjacent ACF basin. The Atlanta metropolitan area is designated in serious nonattainment for ozone and the Columbus, Georgia, area is designated in nonattainment for lead. The ozone nonattainment in the Atlanta metropolitan area has been

attributed primarily to automobile emissions. The lead nonattainment area around Columbus has been attributed to industrial emissions (EPA, 1997b).

There are a number of Class I air quality areas located in the ACT basin. The Class I air quality designation is designed to protect areas of significant natural, cultural, or historic value from significant adverse effects that could result from an impact on air quality. Class I air quality areas include national parks, wilderness areas, national wildlife refuges, national historic parks, national monuments, and national seashores. ***Table 4-89*** lists the Class I air quality areas in the ACT basin.

TABLE 4-89
Class I Air Quality Areas in the ACT Basin

Site	General Location
Horseshoe Bend National Military Park	Tallapoosa, AL
Tuskegee Institute National Historic Site	Macon, AL
Cohutta Wilderness Area	Fannin, GA
Rich Mountain Wilderness Area	Gilmer GA
Kennesaw Mountain National Battlefield Park	Cobb, GA

4.8.1.2 Environmental Consequences

The water allocation formula is not expected to result in any direct adverse effects on regional air quality. Although air quality is partially a function of population, for the purposes of this EIS, population is assumed to be independent. As a result, it is assumed than any pollutant nonconformities that develop during the period evaluated in this EIS would have occurred under the range of flow scenarios or the no action alternative. However, impacts on air quality will occur as growth continues across the basin. In addition, added impacts to air quality may result if the final allocation formula requires changes in hydropower operations that result in greater dependence on fossil fuel power generation.

4.8.2 Noise

This section provides an overview of the noise concerns typically evaluated for an EIS, a summary of the existing conditions, and an evaluation of the potential impacts on noise levels in the ACT basins associated with the no action and action alternatives.

Noise levels in the environment are usually expressed in terms of hourly equivalent sound pressure levels (L_{eq}) in terms of decibels on the A-weighted scale (dBA). When expressed in this manner, noise levels approximate the response of the human ear by filtering out some of the noise in the low and high frequency ranges that the ear does not easily detect. The A-weighted scale is also used in most local ordinances and standards. The L_{eq} is defined as the average noise level, on an energy basis, for a specific period of time (e.g., hourly). Many environmental studies use the day-night noise level (L_{dn}) because it accounts for the greater annoyance of noise during nighttime hours. The L_{dn} values are typically calculated by averaging hourly L_{eq} sound levels for a 24-hour period and adding a weighting factor to the nighttime L_{eq} values. The weighting factor, which reflects the increased sensitivity to noise during nighttime hours, is added to each hourly L_{eq} sound level before the 24-hour L_{dn} is calculated.

4.8.2.1 Affected Environment

Existing noise levels in the ACT basin were estimated by using a number of reports prepared by EPA on general noise conditions in the United States. A summary report by EPA (1974) indicates that national noise level trends can be used to represent regional noise conditions on a broad basis. Individual discrepancies may occur, especially in areas with a high concentration of specialized industrial land uses, but in general the noise levels are consistent within a specific land use area across the country.

The range of L_{dn} in the United States is very large, from 20 to 30 dB estimated for a quiet wilderness area to 80 to 90 dB in the most noisy urban areas, and to still higher values within the property boundaries of some governmental, industrial, and commercial areas that are not accessible to the general public. The measured range of values of day-night sound levels outside dwelling units ranges from 44 dB on a farm to 88.8 dB outside an apartment located adjacent to a highway. The dominant sources for outdoor noise in urban residential areas are motor vehicles, aircraft, and voices as indicated in ***Table 4-90***.

TABLE 4-90
Percent Contribution of Each Source Identified by Respondents Classifying their Neighborhood as Noisy on a National Basis

Source	Percentage
Motor vehicles	55
Aircraft	15
Voices	12
Radio and TV sets	2
Home maintenance equipment	2
Construction	1
Industrial	1
Other noises	6
Not ascertained	6

Source: Bolt Beranek and Newman, Inc., 1971

The percentage of the population in the ACT basin estimated to reside in areas in which the day-night sound level exceeds various values is given in ***Table 4-91***. The values in the table are based on national values (EPA, 1973, and Galloway and Eldred, no date). In the areas in which the L_{dn} exceeds 60 dB, the proportion between the number of people residing in areas in which the outdoor noise environment is dominated by aircraft and those residing in areas in which motor vehicles dominate is approximately one to four. This proportion is almost identical to the proportion found in the national survey, previously summarized in ***Table 4-90***, when people were asked to judge the principal contributing sources of neighborhood noise.

TABLE 4-91
Estimated Percentage of People Residing in Urban Areas that Are Exposed to Various Levels of Outdoor Day/Night Average Sound Level

	Noise Caused by			
Outdoor L_{dn} Exceeds	Urban Traffic	Freeway Traffic	Aircraft Operations	Total
60	44	2	12	58
65	18	2	5	25
70	5	1	3	9
75	<1	<1	<1	<1
80	<1	<1	<1	<1

Sources: EPA, 1973
Gallows and Eldred, no date

Using the data presented in *Table 4-91*, it is possible to estimate the percentage of urban population in the ACT basin exposed to various noise levels. The data summarized in *Table 4-92* show that the majority of people residing in urban areas in the ACT basin have outdoor L_{dn} values ranging from 48 dB to 72 dB, with a median value of 59 dB. The majority of the remainder of the population residing in rural or other nonurban areas is estimated to have outdoor L_{dn} values ranging from 35 to 50 dB.

TABLE 4-92
Estimated Percentage of the Urban Population Residing in Areas with Various Day-Night Noise Levels Together with Customary Qualitative Description of the Area

Description	Typical Range L_{dn} in dB	Average L_{dn} in dB	Estimated Percentage of Urban Population	Average Census Tract Population Density, Number of People Per Square Mile
Quiet suburban residential	48-52	50	12	630
Normal suburban residential	53-57	55	21	2,000
Urban residential	58-62	60	28	6,300
Noisy urban residential	63-67	65	19	20,000
Very noisy urban residential	68-72	70	7	63,000

Source: EPA, 1974

4.8.2.2 Environmental Consequences

The water allocation formula is not expected to result in any direct adverse effects on noise. Although noise is partially a function of population, for the purposes of this EIS, population is assumed to be independent. As a result, it is assumed than any increase in noise levels in specific areas that develop during the period evaluated in this EIS would have occurred under the range of flow scenarios or the no action alternative.

4.9 Cultural Resources

This section summarizes the existing conditions of cultural resources in the ACT basin and the potential environmental consequences on those resources. Unlike many of the other environmental resources areas addressed in this EIS, cultural resources were not inventoried during the Comprehensive Study. Therefore, the Corps completed a basinwide evaluation of cultural resources to summarize the existing conditions and to estimate the potential impacts on the resources from a change in water management. No site-specific surveys were completed. Instead, the Corps used an extensive literature search and predictive modeling based on information provided by the Alabama, Georgia, and Florida State Historic Preservation Office site files to evaluate cultural resources at a programmatic level.

The area of cultural resources encompasses a wide range of phenomena, including:

- Archaeological sites — artifact concentrations, features, or structural remains
- Standing structures — commercial or residential dwellings, schools, bridges, or other facilities
- Landscapes and multiple resources — battlefields, rural or residential districts, and associated groups of buildings, facilities, or communities
- Traditional cultural properties — places of particular traditional importance to Native American communities or tribes

Significant cultural resources have the ability, or potential ability, to contribute important information to the broad patterns of our collective history, or to embody important historical styles or characteristics, or to faithfully represent a locality associated with a significant historic event or person(s). This value is measured by the resources' eligibility for nomination to the National Register of Historic Places, under the guidelines of the National Historic Preservation Act.

4.9.1 Affected Environment

This section outlines the cultural and historical background associated with the project area, focusing on identifying general associations between resources and their prehistoric or historic time periods. A review of specific historic patterns with detailed references is provided in ***Appendix G.***

The extent of human settlement in North America generally and the ACT basin specifically can be categorized by the following archaeological and historical time periods:

- Paleoindian (10,000 to 8,000 BC)—initial colonization, and early hunting and gathering
- Archaic (8,000 to 1,000 BC)—development of regional territories, and hunting and gathering
- Woodland (1,000 BC to 00 AD)—agricultural communities and spread of pottery technology

- Mississippian (900 to 500 AD)—large villages, ceremonial mounds, and large trade networks
- Exploration (1,500 to 700 AD)—early European contact with explorers and missionaries
- Colonial (1,700 to 781 AD)—British, French, and Spanish colonialism to the revolution
- Antebellum (1781 to 865 AD)—southern agronomy, plantation societies, and steamboats
- Postbellum (1865 to 890 AD)—tenant farming, reconstruction, and population out-migration
- Industrialization (1890 to 929 AD)—urbanization, factories, and railroad expansion
- Great Depression (1929 to 941 AD)—economic collapse, Work Projects Administration (WPA), and major reservoir projects
- World War II (1941 to 945 AD) — economic restructuring and wartime industries
- Cold War Era (1945 to 89 AD) — prosperity, suburbanization, and decentralized settlement

Each time period provides specific types of resources to the archaeological and historical records that may be affected by one or more of the alternatives assessed in this EIS.

Paleoindian archaeological sites consist of either surface finds of isolated fluted projectile points, or deeply buried features and artifacts, sometimes associated with the remains of a now-extinct prey species (usually mammoths, mastodons, ground sloths, archaic bison, camels, or horses). Poor preservation has limited the number of substantial Paleoindian sites found in the east, but they can occur in near-river areas and can be adversely impacted by the effects of erosion. Because the rarity of Paleoindian period projectile points has made them particularly prized by collectors, a known Paleoindian site may undergo vandalism if access to the site is unrestricted.

Archaic resources, which are more numerous than earlier Paleoindian ones, frequently do not provide significant information to the study of prehistory. Since the sites were widely distributed in the uplands, and were usually of short duration, a large proportion of Archaic sites are not likely to be adversely affected by the hydrologic alternatives. However, some Archaic period sites do occur in near-river or near-reservoir areas and represent longer duration occupations. These sites in particular provide a much-needed understanding of the regional settlement patterns of Archaic people and provide insight into their social relationships. Such sites are likely to be adversely affected by increased erosion and unlimited or increased access.

Woodland period resources are not as frequently encountered as Archaic period sites, due to the reduced dispersement associated with increased horticulture. However, Woodland sites are more frequently encountered in near-river or near-reservoir areas. They also are more likely to contain significant subsurface remains. Erosion of riverbanks or floodplains caused by an increase in hydrological flow or rapid fluctuations of reservoir levels might adversely affect the significant component of these archaeological resources. Some archaeological resources, such as fish weirs, are located in very high impact areas, such as the river channel itself. Although not just associated with the Woodland period, these resources could

possibly face increased erosion and/or vandalism due to increased and decreased rates of flow.

The *Mississippian* period is typically associated with the construction of large-scale ceremonial mounds. As aboveground resources, mounds are not only adversely affected by erosion and very high levels of vandalism, but since they are frequently incorporated into State or Federal monuments or parks, they include a strong visual component that may be adversely affected by increased rates of flooding and deposition. Deposition could conceivably adversely affect other types of archaeological sites, but generally burial of an archaeological locality by sediment helps to preserve it. (Mounds and aboveground resources are associated with other time periods as well, especially Woodland and even Archaic).

The period of *European contact and early exploration* presents the first introduction of European manufactured goods to the region, but since historical documentation enhances our understanding of the timeframe, we know that there were only minimal levels of interaction. Typical archaeological resources of the time period include some of the first substantial European architectural remains (missions and early fortifications), trails, and battlefields (historic landscapes). Many of these sites are in near-river or near-reservoir areas and would be adversely affected by increased rates of erosion, deposition (for visual components), and unregulated access.

The *Colonial* period provides many of the same types of sites to the archaeological and historical records, but missions disappear and fortifications increase. Due to the historical significance of the American Revolution, battlefields become more important. The Colonial period is also the first time period with known, standing historic structures. Since early communities were frequently located near waterways, the effects of erosion and deposition on known, historic standing structures may be adverse. Likewise, adverse affects due to increased erosion on in-water resources, such as shipwrecks and ferries, can be expected.

The *Antebellum* period is represented by the development of the southern plantation system. Examples of historical standing structures and substantial archaeological components are more frequent. Steamboats began to travel up and down the waterways, contributing to the creation of waterway control mechanisms. Antebellum archaeological components in the river channels or back swamps include mill remnants, steamboat and ferry wrecks, and both inundated and functioning locks and dams. Near-river or near-reservoir resources include standing structures, historic communities, early railroads, structural remains, Civil War battlefields, and plantation landscapes. Increased erosion and deposition would cause the largest adverse effects on such resources. Vandalism due to unregulated access would especially adversely affect Civil War battlefields.

Since the *Postbellum* period is a largely a time of abandonment and reconstruction, it does not contribute a high percentage of unique archaeological or structural components to the basin. Tenant farming on the old plantations was a dominant activity with a consequential increase in deforestation due to clearing of new fields for cotton. The demise of the steamboat was paralleled by the rise of the railroad. Waterways came under further control for navigation, reservoir construction, and flood protection. Railroad bridges are a common Postbellum in-water resource, subject to the adverse effects of increased erosion.

The *Industrial* period, based primarily on the expanse of wartime industries to meet the needs of a burgeoning urban population, introduced some of the first large-scale industrial complexes. Railroad yards and support facilities are frequently located in near-river areas and are subject to the effects of both erosion and deposition through frequent flooding. Entire residential communities linked to industrial complexes are still preserved in some near-river areas. Although there are fewer significant archaeological localities associated with the Industrial period, the number of standing structures increases dramatically. The effects of increased access to these resources may be minimal, but changes to rates of flooding are critical.

The *Great Depression* brought about the creation of the Works Progress Administration (WPA). This government program rapidly increased the effort spent on waterway management. Many of the existing reservoirs, locks, and dams were created during this time period. Although most are still active in the system, they are associated with a pattern of historic activity. The engineering facilities themselves may be considered historically significant. The alternatives assessed in this report should be expected to affect them on some level, although perhaps not adversely.

The *World War II and Cold War* eras brought about the creation of several types of historic resources likely to be affected by the proposed alternatives. With the growth of suburbs around the time of World War II and the increased availability of automobiles, commuting time was reduced. It became possible to live further outside the city, thus escaping increased smog and congestion. Suburban neighborhoods developed and brought with them their own unique architectural styles and rapidly expanding roadways. Many of these resources are located in near-reservoir areas and might be adversely affected by rising reservoir levels. In contrast, some other historically significant structures are located almost exclusively on military facilities, and are important for their association with the Cold War (especially relating to nuclear weapons manufacturing or storage). Military facilities are frequently located in near-river areas and their Cold War resources may be adversely affected by increased erosion or deposition due to changes in flooding patterns.

A large number of standing structures, principally residential or commercial buildings not yet 50 years of age, are currently ineligible for historical significance evaluation. However, many are considered excellent examples of important architectural styles and will "come of age" within the next few decades. Since the proposed alternatives consider conditions through 2050, an evaluation of the impacts to potentially important resources (possibly up to very recently built structures) needs to be addressed. Many of the adverse affects projected by the three alternatives may apply to such resources.

4.9.2 Environmental Consequences

This section presents the expected effects of the alternative flow scenarios assessed in this EIS on cultural resources in the basin. The information presented in this section is general unless specific sites or properties would be adversely affected by one or more of the alternatives. Direct, indirect, and cumulative impacts are identified and assessed as having little or no impact, low significance, or high significance as defined in Section 4.1.

In the previous section, the overview of cultural resources in the ACT basin summarized the kinds of effects expected to occur after implementing one or more of the hydrologic alternatives. Specifically the expected types of effects are:

- Erosion: removal of soil or other material that protects or supports a resource
- Deposition: addition of sediment or other materials to a resource
- Access: any effect that allows visitation to a resource

These types of effects will not occur uniformly across the basin, and some level of each is currently occurring (or would also occur in a "no-change" hydrologic scenario). Therefore, the discussion of impacts to cultural resources is derived from a baseline condition represented by the current level of ongoing effects.

The primary sources of *erosion* to all cultural resources in the basin are hydrologic flow (in-channel and near-shore currents, plus periodic dam or flood gate releases), runoff (rain water, flooding, and reservoir draw-down), wave action (at reservoir and river margins), and animal disturbance (trampling along shore and water crossings in pasture areas). Each of these sources can cause slumping and landslides in particularly steep areas with erodable soils, as well as channeling and scouring of soils. Exposure of artifacts or archaeological features in such situations will cause redeposition of materials, chemical alterations, rapid deterioration, and/or complete disappearance both in and out of the water. For historic properties and landscapes, the effects are more likely to include undermining of supports or retaining walls, visual or structural damage, and alteration of the visual setting of the resource.

The principal sources of *deposition* to all cultural resources in the basin are flood deposition (sediment fallout from seasonal and periodic inundation of floodplains) and underwater siltation (sediment fallout from in-channel or near-shore currents). Deposition sources generally provide additional protection from erosion or vandalism to archaeological localities, but they can also introduce chemical alterations and prevent discovery (particularly for shipwrecks). For historic properties, the principal effects of deposition may include an alteration of the visual or aesthetic appeal of a property or landscape.

Access is a type of impact that cannot easily be predicted or regulated. Recreational visits to both archaeological and historic properties frequently lead to their damage or alteration. Much of the damage may be inadvertent (such as pathway or trail cutting), but some is due to indirect or direct forms of vandalism. Avocational surface collection of projectile points is probably the most common form of human-induced site alteration, but the occasional small- or large-scale excavation may do the most damage. Similarly, direct or indirect physical damage may often be inflicted on historic structures or landscapes. When access to cultural resources is limited (as with restricted or monitored parks and structures, deeply buried or inundated sites, and controlled access to location information), it becomes possible to keep direct or indirect vandalism at a minimum. With changes in the hydrologic models, however, the control over vandalism will decrease since previously inundated or eroded areas may become open to visitation. That control may be regained over time with continual monitoring efforts.

To address the potential effects most efficiently, and to evaluate the differences between the proposed alternative scenarios, a series of spatial "areas of concern" were defined. Each of these spatial categories are the areas most likely to show some kind of impact from the proposed hydrologic models. ***Table 4-93*** lists the area categories by alternative and the number of acres impacted. The spatial calculations are based on the Geographic Information System (GIS) model discussed in ***Appendix G.***

Using the databases of recorded cultural resources for Alabama and Georgia, a model was constructed to calculate areas of high potential for encountering cultural resources. This "predictive model" (discussed in detail in *Appendix G)* was overlaid on a digital base map of the ACT basin by using a GIS model. In conjunction, a model was developed that highlighted each of the spatial categories described in *Table 4-93.* That digital model was also overlaid on the same base map. Areas were then calculated for the intersection between the two models.

TABLE 4-93
Potential Cultural Resource Impacts by Alternative

			Action Alternatives		
Categories of Areas with High Cultural Resources Sensitivity	**Year**	**No action Alternative (acres)**	**Low Flow Conditions (acres)**	**Moderate Flow Conditions (acres)**	**High Flow Conditions (acres)**
Inside river bend	1995	233,094	233,712	233,841	234,073
	2020	232,998	233,707	233,855	234,038
	2050	232,946	233,702	233,833	233,964
Outside river bend	1995	94,946	95,198	95,250	95,344
	2020	94,906	95,195	95,257	95,329
	2050	94,884	95,193	95,247	95,299
Inundated by river channel	1995	377,196	378,196	378,406	378,780
	2020	377,040	378,189	378,431	378,723
	2050	376,956	378,179	378,392	378,604
Inundated by reservoir	1995	182,459	183,225	183,044	182,943
	2020	182,385	183,197	183,057	182,940
	2050	182,343	183,141	183,037	182,936
Below dam release gates or lock	1995	6,869	6,887	6,892	6,899
	2020	6,867	6,887	6,892	6,897
	2050	6,864	6,887	6,892	6,894
Near slack water	1995	557,591	559,069	559,378	559,931
	2020	557,361	559,059	559,415	559,847
	2050	557,235	559,044	559,358	559,669
Total for all areas	1995	1,452,155	1,456,289	1,456,808	1,457,969
	2020	1,451,557	1,456,237	1,456,904	1,457,366
	2050	1,451,231	1,456,143	1,456,753	1,457,366

No effort was made to project decreases or increases in impact because of the tendency for archaeological research activities to decline (i.e., more complete areas being thoroughly surveyed) or the potential for recent structures to become historically significant in the coming years. With this in mind, it is apparent that although we have hydrologic models for 2020 and 2050, they are not particularly meaningful for cultural resources.

The hydrologic flow formulas calculated for each of the alternative scenarios were used to develop a basic understanding of the differences across the basin for each of the flow scenarios. The baseline data (the intersection between the spatial categories and the predictive scenario) was used to represent the current levels of erosion and deposition, with the no action, high, moderate, or low flow alternatives signaling a proportional change in impacts equivalent to the difference in flow rates. The acres of impact, therefore, represent a relative summary of the difference in total impact by alternative.

To compare the no action alternative and the action alternative flow scenarios, a summary of the total culturally sensitive area affected in each spatial category by alternative and flow scenario was calculated. Along with an understanding of the types of impacts generated by each hydrologic effect, those totals were used to develop an alternatives analysis.

The *no action alternative* is expected to be nearest the current rates of erosion, deposition and access. It is assumed that the pool elevations of reservoirs will not change, along with the water levels in the river channel itself. Over time, the same impacts will occur as in the action alternatives described in the following text, but to a lesser degree, mostly because a lack of change will not immediately affect the impact of access to resources. Clearly, access impacts to cultural resources will increase as reservoir levels go down in the coming decades, but they will be counteracted by the decrease in erosion and deposition that will also occur.

The *high flow action alternative scenario* will generate the most significant increases in erosion and deposition. The most likely places for erosion are along the outside riverbends because the increased rate of flow causes faster rates of river meandering. Generally, this will affect archaeological localities either on the riverbank, or above steep slopes adjacent to it. The most erodable soils are located below the Fall Line, and they will undergo the greatest increase to adverse impacts from erosion. It is anticipated that rates of erosion will increase above the Fall Line as well, but river meandering will be proportionally slower due to less erodable rocky soils. The extreme upland tributaries will undergo the least amount of change to rates of erosion and are less likely to contain significant archaeological resources as well.

The high flow scenario will also greatly affect riverbed deposits. The increased erosion is most likely to occur in channel deposits below dam spill gates or in shoals. The greatest effects will be removing the soil that protects deeply buried archaeological sites, destroying fish weirs, undermining dams and bridges, and disturbing shipwrecks. Farther downstream, these effects are likely to be proportionally greater.

Increased rates of deposition will result as well. As the river increases its meandering, the inside riverbends will catch a large percentage of the sediment removed from the outside riverbends. This is likely to expand sandbars toward the river channel and to bury additional archaeological deposits. This is considered beneficial since it prevents access and protects the site from erosion, but it is not likely to play a large part in protecting resources, since few intact significant resources will be located in such areas.

Deposition in flood zones will increase with the high flow scenario, since more water will fill the river channel and less will be stored in reservoirs. At times of high precipitation, large expanses of flat terraces will become inundated. As the waters recede, sediment will be deposited on top of archaeological sites. However, at the same time, receding

floodwaters will carve channels in some places, as well as chemically alter archaeological deposits. The effects to historic structures will be most damaging with structural or visual alterations.

The high flow scenario is likely to mean a lowering of the pool elevation in many of the reservoirs. This will expose archaeological sites in the draw-down zone to the effects of both erosion and increased access. Many such sites may already be highly disturbed, but the impact is adverse nonetheless.

The *moderate flow action alternative scenario* will likely be a compromise between the high and low flow scenarios. It is assumed that the pool elevations of reservoirs may change, along with the water levels in the river channel itself, but not as drastically in either direction as the high or low flow scenarios. The same impacts will occur as in the high flow scenario, but to a lesser degree. Likewise, more of those impacts will occur than in the low flow scenario.

Because of the tendency for access to be unrestricted in both the high and low flow scenarios for different areas, the moderate flow scenario will likely have the lowest levels of impact on access to resources. Either increasing or decreasing flow results in access impacts, but keeping the water at moderate levels (near where they currently are) leaves access impacts unchanged. The degree of access impacts is unknown, at this time but is expected to be great, considering the large amount of land within or adjacent to the draw-down zones of reservoirs (the entire reservoir could be considered within the draw-down zone).

The *low flow action alternative scenario* will reduce the levels of erosion that are currently taking place over much of the basin. The reduced level of sediment in suspension will likewise reduce the amount of deposition. However, since more water will be held in reservoirs, the areas currently within the reservoir draw-down zones might expand. Inundation of near-reservoir land would increase the number of archaeological sites subject to underwater siltation and subsequent chemical alteration. Therefore, an increase in deposition rates and the need for additional archaeological or historic structure surveys may be necessary.

The lowering of the water level in river channels would also expose previously inundated sites to access by potential vandals. This would be especially significant for large historical components, such as shipwrecks. The impact may increase surveying for such resources but would complicate means for their protection. Likewise, access to island sites may become easier.

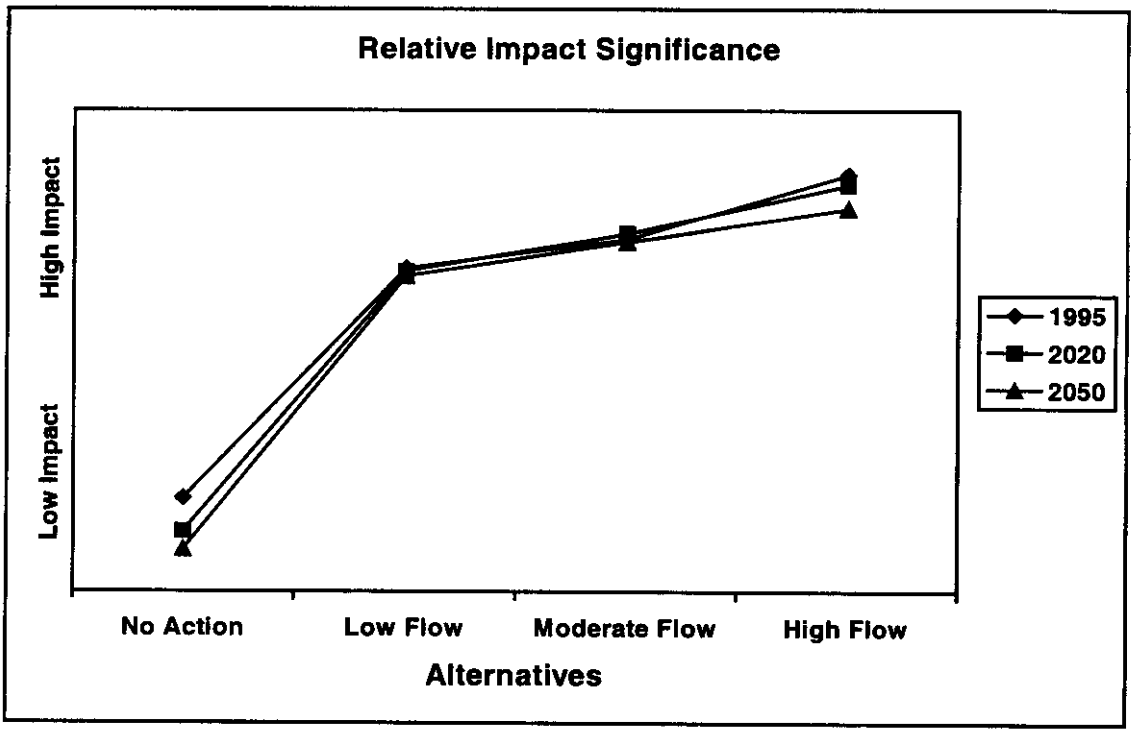
Since flooding would not be as dramatic as in the high flow scenario, the effects of erosion and deposition on floodplain archaeological sites and historic structures will be reduced. Some sites may still undergo erosion from upland runoff, and even at slightly higher levels of impact since additional sediment is not being added to the sites. However, that that impact is substantially smaller than would be expected in the high flow-increased flooding scenario.

Generally, the effects estimated for the low flow scenario are more beneficial or involve fewer potential adverse effects to existing resources than the high or moderate scenarios. The no action alternative is the least adverse for cultural resources; however, cultural resources are affected.

For the action alternatives flow scenarios, there are potentially adverse issues with access to sites, and the need for additional surveying around reservoirs, but overall those impacts are not as adverse as the effects of erosion on in-water or near-water resources predicted by both the moderate and high flow scenarios. Charted graphically in ***Figure 4-98,*** the impact significance is similar among the action alternative flow scenarios.

In any model, however, one of the most adverse effects may be the increased erosion caused by rapid fluctuation in flow release rates. It would be expected that regardless of the overall hydrologic flow rate, any rapid draw-down or daily pool fluctuations would cause significant damage to both inundated and near-shore cultural resources. If daily fluctuations were minimized, then the low flow scenario might be considered the least damaging alternative flow scenario. If daily or otherwise rapid fluctuations were present, however, all of the action alternative flow scenarios would result in larger amounts of erosion than might be expected.

FIGURE 4-98
Level of Relative Impact Significance to Cultural Resources



4.10 Cumulative Effects

Cumulative effects are defined in 40 CFR 1508.7 as follows:

> *...the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*

Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Additive effects include multiple actions affecting a single resource that singly have little or no impact but collectively result in greater, potentially less desirable impacts. Interactive effects may be either countervailing or synergistic. Countervailing effects occur when the net adverse cumulative effect is less than the sum of the individual effects; i.e., the combined effects reduce the impacts that might otherwise be expected from the individual impacts. Synergistic effects result in a net adverse cumulative effect that is greater than the sum of the effects by individual actions (CEQ, 1997).

An evaluation of cumulative effects must address activities or actions that take place over a specified geographic area (spatial) and time period (temporal). For this EIS the spatial component includes the ACT river basin of 22,820 square miles, and the temporal aspects cover the specific time frames that reflect impacts for 1995, 2020, and 2050. Thus, the consideration of impacts over such a large area and for an extensive planning period (greater than 50 years) reflects many of the cumulative impacts that might be expected for the alternatives evaluated. However, consideration of specific cumulative effects has been included in the following section for each resource area.

4.10.1 Geology and Soils

Cumulative impacts related to soils include the potential for increased sedimentation over time and along multiple reaches or reservoirs within a basin or subbasin. This increase in sedimentation over time, in conjunction with other sources of sedimentation, could produce localized areas of reduced habitat for aquatic resources. The magnitude and location of these effects would be more likely under conditions that increase reservoir or streambank erosion (high flow conditions), although the greater flows may transport or flush the sediments farther downstream over time. Conversely, under a low flow scenario, sediments from upstream or other sources may be more likely to accumulate in reservoirs (reducing transport downstream), and where erodable materials are transported in streams, the sediments are less likely to be flushed out over time and sediments could accumulate. Alternative water allocation formulas that are likely to promote increased urbanization and development may also be expected to introduce additional sediment for transport and deposition in streams.

4.10.2 Water Resources

4.10.2.1 Water Quantity

Incremental changes in water quantity may result in cumulative effects on natural resources, economics, land use, cultural resources, and air quality. These cumulative effects are discussed below for the respective resource areas. Effects on water supply demands, including M&I, thermal and hydropower generation, agriculture, and navigation, are

directly linked to the quantity of water available in the basin under the no action alternative and range of flow scenarios (action alternative).

With the no action alternative, water demands would continue to increase, but, with no changes in water management, the cumulative increase in water withdrawals would result in water shortages and failure to meet the various demands. Cumulative impacts on natural resources, power generation, navigation, and M&I needs would result.

In the low flow scenario, the maximum amount of reservoir storage is reserved for water supply so that the cumulative effects on water availability from the reservoirs would be minimized. Low releases from multiple reservoirs in a single subbasin would result in cumulative effects on resources in the lower basin that depend on greater flows during critical low flow periods. In addition, the decreased availability of water for agricultural irrigation would result in cumulative increases in groundwater usage and potential impacts on the aquifers, and further reductions in contribution of groundwater to streamflow in the basin.

With the high flow scenario, where less water is reserved for water supply storage and more water is released for downstream flow needs during critical periods, the cumulative effects on reservoir water availability would result in the need for alternative strategies to meet water demands in the upper portions of the basin. The increases in water shortages under the high flow scenario could result in an increase in interbasin water transfers into the ACT basin to meet the additional demands, resulting in cumulative effects on adjacent river basins. Water shortages could also increase the potential for additional water supply reservoir construction in the portions of the basin.

4.10.2.2 Water Quality

Cumulative impacts that could result in decreased water quality are projected to occur under the no action alternative as a result of continued increases in wastewater discharges and nonpoint source pollution, along with increased consumptive surface water withdrawals. The low flow scenario results in the lowest stream flows in the basin during critical periods, and would cause the greatest cumulative effects. For example, the assimilative capacity of the rivers, which may already be stressed by existing discharges, would be further reduced as a result of the decreased flows, and wastewater discharges would have to be reevaluated to ensure that NPDES wastewater permit limits are sufficient to maintain water quality. Degradation in water quality under the low flow scenario would also increase the level of treatment required for water supply to meet drinking water quality standards. Under the high flow scenario, the additional stream flows during critical periods would provide additional dilution and mixing, resulting in reduced impacts on water quality, and could have a cumulative positive effect on water quality and other resource uses in the basin.

4.10.3 Biological Resources

4.10.3.1 Vegetation Resources

The potential cumulative effects on terrestrial vegetation communities are limited to indirect effects over time as a result of continued societal growth and development. Loss of forested habitat would continue under the no action alternative, but at a very low rate. Cumulative effects resulting in increased loss of terrestrial vegetation communities may be

associated with development of additional local or community-based reservoirs to meet local water supply demands. These changes in land use would have a cumulative effect on vegetation resources. Under the low flow scenario, as reservoirs are held full through the flood season, increased severity of flood events could occur downstream, resulting in increased erosional loss of bank vegetation.

Wetland communities are not predicted to experience significant impacts under any of the modeled scenarios. Cumulative losses would occur under any alternative that promotes added pressure for land use changes and urban or residential development. Increased demand for water supply reservoirs has the greatest potential for wetlands loss over time through construction and impoundment. In addition, under the low flow scenario, water shortages for agricultural demands in the basin would likely be met by increased groundwater utilization. The increased use of groundwater would likely result in cumulative effects on wetlands in the localized areas of high groundwater pumping.

4.10.3.2 Wildlife Resources

Wildlife resources are not likely to be affected due to the changes in water management in the basin. Any alternative that promotes continued development in areas of important wildlife habitat would result in a cumulative loss to wildlife. Greater potential for cumulative loss of these habitats may be expected under any flow scenarios where, over time, increased pressure will be placed on local communities to build additional water supply reservoirs.

4.10.3.3 Fish and Aquatic Resources

Continued incremental instream flow reductions, which are predicted under the no action alternative, are likely to have cumulative negative effects on fish and aquatic resources. With the low flow scenario, it is likely that sediments would build up in some reaches of riverine habitats over time as a result of reduced frequency of flushing flows and would reduce the available habitat critical for fish spawning. Reduction in water quality in riverine reaches under this scenario would also reduce available habitat for aquatic resources. Increased habitat for reservoir fisheries, however, may be expected under this scenario.

Conversely, the selection of an allocation formula that follows the high flow scenario may be expected to provide improved riverine habitat for fish and other aquatic resources, promote improvements in water quality, and flush sediments from streams. Additional reservoirs that might be required over time to meet water demands in the basin may also have a negative, localized impact on stream aquatic resources that are in areas affected by these impoundments. The high flow scenario, over time, would reduce the available habitat for reservoir fisheries, although new reservoir development would provide replacement habitats for these species. Incremental increases in groundwater usage, especially in south Georgia, as a result of decreased surface water availability would reduce the groundwater contribution to stream flow through springs. This reduction could limit the extent of cold-water habitats for fish in the vicinity of the springs.

4.10.3.4 Protected Species

There are a number of protected species that could potentially be affected in the ACT basin, with mussels and fish the species of greatest concern. Impacts on these aquatic species would depend on site-specific conditions and the incremental changes in stream flows and

reservoir levels. The cumulative effects of the construction and operation of reservoirs throughout the ACT basin have been significant. The reduction in unregulated stream habitat has resulted in impacts on a number of freshwater mussels and fish (particularly migratory) species.

With the no action alternative, cumulative negative effects on aquatic protected species are likely to continue. The low flow scenario would likely result in greater cumulative effects on aquatic protected species than the high flow scenario as a result of reductions in water quality and increased sedimentation. Also, increased construction of new water supply reservoirs on small rivers and streams in the upper basin area, which would continue the incremental loss of habitat for some of the protected species.

4.10.4 Land Use

It is intuitive that land use changes will follow decisions made on water allocation. However, because of the myriad of site-specific reservoir operations available to implement an allocation formula, and the very localized impacts that would result from changes in land use, this programmatic EIS has not included direct impacts of an allocation formula on land use changes in the modeling of alternatives.

Cumulative effects of the water allocation decision on land use would probably occur and may result in indirect or secondary impacts on other resources associated with this change in land use. The primary cumulative effect would be conversion of agricultural or forested lands to urban and residential land uses. Some of this conversion would continue under the no action alternative. With the high flow scenario, it is possible that growth would slow in the urban areas due to water shortages, and the cumulative changes in land use would be less than with the no action alternative. However, induced demand for additional water supply reservoirs would promote localized changes in land use elsewhere in the basin, and increased demand for interbasin transfers to satisfy this demand may result in decreased water availability and resultant decreased opportunity for development in adjacent river basins.

4.10.5 Socioeconomic Resources

4.10.5.1 Population and Demographics

Population changes will follow decisions made regarding water allocation, with increased growth in areas that are able to provide expanded supplies to meet M&I demands. However, because of the options available in implementing an allocation formula, and the very localized impacts that would result from changes in population demographics, this programmatic EIS has not included direct impacts of water allocations on population changes in the analysis. Although it is difficult to accurately determine what changes would occur, water availability is likely to affect population growth in the basin. Cumulative effects can be expected on the existing most populated areas, such as Montgomery, Alabama. However, changes in water availability may also shift rates of population growth in the basin to other basins within the region. Alternatively, interbasin transfers into the ACT basin may allow continued growth at the expense of assured growth in the other basins.

4.10.5.2 Recreation

Recreation is most important on the larger reservoirs in the basin that afford opportunities for boating, fishing, and camping, including Lake Allatoona, Lake Martin, Logan Martin Lake, and Weiss Lake. Cumulative effects on recreation may occur if adequate water is not available to support the recreation activities within the basin. This may result in the redistribution of recreational activity to other areas inside or outside of the basin, possibly leading to losses to the local economy.

With the low flow scenario, reservoir-related recreation uses would expand, resulting in increased boat traffic and increased demand for the recreational resources on the reservoirs. The frequency of recreational use in streams or river reaches during low flow periods would decline. Conversely, under a high flow scenario, recreational uses that include rafting, kayaking, and trout fishing may expand, with a concomitant reduction in reservoir recreational uses over time.

4.10.5.3 Economics

Because this is a programmatic EIS that covers a range of potential water allocation alternatives, the economic impacts have, in many ways, already been evaluated from a cumulative perspective when compared to a normal single-project EIS. Cumulative effect analyses were conducted within the context of resource, ecosystem, and human community thresholds/levels of stress beyond which the desired condition degrades. The magnitude and extent of the effect on a resource depends on whether the cumulative effects exceed the capacity of the resource to sustain itself and remain productive. The natural ecosystem and the human community have maximum levels of cumulative effects that they can withstand before the desired conditions of ecological functioning and human quality of life deteriorate. Three indicators of community stress that may reflect cumulative impacts are economic indicators, population density, and housing shortages.

With the no action alternative, continued demands would have localized impacts that affect the ability to sustain economic growth in urban areas, and pressure would continue for seeking alternative strategies that meet these demands away from populated areas. The cumulative effects of these changes may be substantial negative impacts on larger urban areas. With the low flow scenario, shifting operations to reduce downstream releases could have negative cumulative economic impacts due to reductions in hydropower generation, agricultural uses, and navigation. Positive benefits reflected in increased M&I growth in the upper basin would be expected in areas using these retained water supplies. The high flow scenario, while providing positive economic benefits to hydropower, agricultural, and navigation needs could be expected to have localized negative impacts on meeting M&I demands near upstream urban areas.

4.10.6 Air Quality and Noise

No significant cumulative effects on air quality and noise are likely under any of the alternatives evaluated. It is possible that the incremental increase in growth in the basin during the planning period would result in cumulative effects on air quality. With the no action alternative, air quality is likely to decline as a result of the continued population and industrial growth in the basin. This decline in air quality would be caused by the cumulative emissions of all existing and new sources in the area. Alternative scenarios that result in localized changes in land use and expanded population growth may also be

expected to cause continued or increased deterioration in air quality, especially around urban areas. Reductions in hydropower use that might result from a low flow scenario could also result in cumulative effects on air quality in the region through a shift to fossil fuel powered plants.

4.10.7 Cultural Resources

Cumulative effects on cultural resources would occur under the no action and all of the range of alternative flow scenarios evaluated. The low flow scenario was predicted to have the least overall direct impact on cultural resources and would probably have the least cumulative effect. Lower stream flows during critical periods would expose fewer resources along stream banks. Also, reservoir levels would fluctuate less in the low flow scenario, resulting in less bank erosion along the reservoir shoreline. However, more frequent downstream flood events could occur, resulting in increased erosion or exposure of cultural resources during flood events over time. The incremental changes in sediment deposition, erosion, and vandalism (through site access in reservoir areas) resulting from the high flow scenario may be expected to have the greatest cumulative impact over time by expanding the areas where opportunities would increase for loss of these resources.

4.11 Mitigation Considerations

Mitigation actions are measures taken to avoid, offset, reduce, or compensate for the adverse effects to the environment that may potentially result from implementing the proposed action. Specific mitigation actions cannot be addressed until a specific allocation formula has been identified and specific plans are developed to implement the formula. The purpose of this section in this draft programmatic EIS is to recognize the responsibility to identify those mitigation actions that may be necessary once the agreed upon formula is known; and to describe the process to determine appropriate mitigation measures for implementation of an allocation formula. At this stage of the evaluation process, only broad categories of mitigation for certain types of impacts can be addressed. After receiving public review and comments on the draft EIS, and after an allocation formula is agreed to by the States, the potential for certain types of impacts that may result from implementation of the allocation formula can be determined. The final programmatic EIS will evaluate the range of impacts anticipated to result from implementing the formula, and will address the appropriate categories of mitigation actions for certain anticipated types of impacts at the conceptual level of planning. Specific mitigation actions would be developed in conjunction with development of the specific plans for implementating of the formula.

The next step in the process of implementing the formula, after it has been agreed upon, is to determine how the various water control structures (dams or reservoirs) within the river basin would be regulated or operated to achieve the flows or other parameters required by the formula. Once the specific operation plans for the water control projects are determined, then specific mitigation measures will be also be developed, as determined necessary, to compensate for impacts related to these changes in operations. Prior to implementation of these specific alternative operation plans, the proposed actions and proposed mitigation actions would be addressed in tiered, or follow on site-specific NEPA documents. These tiered NEPA documents could be in the form of follow-on EISs or environmental assessments, depending upon the nature and scope of the changes and associated impacts.

Effects upon all relevant resources resulting from implementing the formula will be evaluated to determine if mitigation measures are appropriate. Mitigation actions would address direct, indirect and cumulative impacts, as identified. Appropriate mitigation actions may not be limited to actions taken by the Federal government, but could also include certain mitigation actions that could be taken by local, regional, or state governments or by private entities. Typical examples of the how the appropriate categories of mitigation will be identified and evaluated are described below.

4.11.1 Water Quantity

The main focus of the formula development being addressed by the States is to equitably allocate water quantity among the concerned States. Each State will then in turn determine how the quantity and uses will be distributed within the State. Mitigation of impacts on water quantity is an inherent part of the State's responsibility. Mitigation methods to meet remaining water demands could include alternative sources of water supply, alternative water conservation methods, and public programs to encourage wise use of water resources.

4.11.2 Water Quality

Should implementation of the formula have the potential to lower ambient conditions below established standards, methods to avoid or offset the effect will be identified. These methods may include upgrading wastewater treatment facilities in affected stream segments and/or examining ways of controlling runoff and effluent discharges during critical periods.

4.11.3 Aquatic Resources

Should implementation of the formula adversely effect aquatic biological resources such as fish, wildlife, wetlands, or especially any threatened or endangered species or habitat, methods to avoid or offset the effects may include establishing rigidly controlled flow conditions at those specific sites, or during certain critical periods. There may even be opportunities to enhance those resources while addressing appropriate mitigation measures. Impacts related to increased groundwater pumpage, such as decreased flow in springs that provide cold water habitat for fish, could be mitigated by controlling the location or timing of pumpage, through local or State programs, during critical periods.

4.11.4 Geology and Soils

The most likely effect from implementing the formula may be increased erosion and sedimentation problems within the basin. Regulation of specific reservoir levels and flow releases will be closely evaluated not only to meet the formula requirements but to avoid adding to the current erosion problems. Additional local measures may be necessary to reduce sedimentation into streams and reservoirs. The potential for localized sinks or subsidence features could be mitigated by limiting groundwater pumpage in the vicinity of specific, localized vulnerable areas. This type of action would be implemented by local or State programs.

4.11.5 Recreation

Should implementation of the formula affect recreational activities within the basin, methods of avoiding or offsetting the effects may include controlling flows to the desired levels, if feasible, during critical periods. Again, just as for the aquatic resources, opportunities to enhance recreation may be determined during the mitigation identification process.

4.11.6 Conclusion

The above examples are not intended to be inclusive but are intended to present the methodology in addressing mitigation measures in this ongoing evaluation process. Each of the resources and the effects described in Section 4, Affected Environment and Consequences, will be evaluated in detail with appropriate mitigation measures identified in the follow-on, site-specific NEPA documents as specific operation plans are developed for implementing the allocation formula.

4.12 Other NEPA Considerations

4.12.1 Unavoidable Adverse Effects

Unavoidable adverse effects are those environmental consequences of an action that cannot be avoided either by changing the nature of the action or through mitigation. Under the alternatives considered for this EIS, the physical laws that affect sedimentation and erosion that might result from increased reservoir fluctuations or changes in stream flow are unavoidable and potentially adverse. These effects include damage or increased access to cultural resources and impacts to water quality and biological resources. There also are losses for some recreational uses when reservoirs or streams are below certain levels that are also unavoidable. Other reductions in water level elevations that may be linked to conditions of drought under the low flow scenario can also have an unavoidable effect on navigation.

4.12.2 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources is defined as the loss of future options. The term usually refers to non-renewable resources, such as minerals or cultural resources, or to those resources that are renewable only over a very long period of time, such as wetlands and riparian habitats. Irretrievable commitments apply to the loss of production, harvest, or use of renewable natural resources, such as might arise from a seasonal shift in water use that affected the growth of a particular crop during a critical season.

For example, erosion of soils as a result of increased reservoir fluctuations or downstream export of these soils by increased stream flows would result in irreversible and irretrievable losses. Similar losses of resources that would be irreversible and irretrievable might include impacts to protected species or cultural resources where these losses were not recoverable.

5. List of Preparers

Staff/Section	Education	Years of Experience	Technical Expertise
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David Luckie	B.A., Economics	14	Economics, water supply analysis
Bernard Moseby	M.B.A.	24	Economics, power generation, navigation analysis
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Allen Lucas	M.A., Zoology	23	Water quality, NEPA compliance review
Bruce Henry	M.S., Environmental Engineering	22	Water quality, reviewer, NEPA compliance review
Howard Marshall	Ph.D., Marine Sciences	31	Water quality, reviewer

Fish and Wildlife Service			
Carl Couret	M.S., Zoology	23	Fish and Wildlife Coordination Act report, ACT basin
Lee Andrews	M.S., Forestry	12	Wildlife, wetlands, protected species
Natural Resources Conservation Service			
Gary Jones	M.S., Agricultural Economics	35	Agricultural water resource economics
Jimmy Bramblett	M.S., Agricultural Economics	9	Water resources
CH2M HILL			
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Tom Simpson	Ph.D., Biology	27	Project manager, ACT EIS
Glenn Dukes	M.S., Water Resources Engineering	29	Senior consultant
Steve Layman	Ph.D., Biology	13	Aquatic resources
Susan Bogus	M.S., Civil and Environmental Engineering	8	Water resources co-task leader
Anita Allen	B.S., Zoology	10	Wetlands, endangered species, terrestrial ecosystems
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Mohammed Lahlou	Ph.D., Environmental Engineering	18	Principal manager

6. Coordination

Copies of the draft EIS were distributed to the following elected officials, agencies, tribes, organizations, individuals, and others for review in late September 1998. Newsletters and news releases were published announcing the availability of the draft EIS. Copies of the document were sent to approximately 60 libraries in the ACT and ACF river basins.

Federal Elected Officials and State Governors

Senator Richard Shelby	Alabama	Washington, DC
Senator Jeff Sessions	Alabama	Washington, DC
Senator Bob Graham	Florida	Washington, DC
Senator Connie Mack	Florida	Washington, DC
Senator Max Cleland	Georgia	Washington, DC
Senator Paul Coverdell	Georgia	Washington, DC
Congressman Sonny Callahan	Alabama	Washington, DC
Congressman Terry Everett	Alabama	Washington, DC
Congressman Bob Riley	Alabama	Washington, DC
Congressman Robert Aderholt	Alabama	Washington, DC
Congressman Robert Cramer, Jr.	Alabama	Washington, DC
Congressman Spencer Bachus	Alabama	Washington, DC
Congressman Earl Hilliard	Alabama	Washington, DC
Congressman Joe Scarborough	Florida	Washington, DC
Congressman Allen Boyd	Florida	Washington, DC
Congressman Jack Kingston	Georgia	Washington, DC
Congressman Sanford Bishop, Jr.	Georgia	Washington, DC
Congressman Mac Collins	Georgia	Washington, DC
Congressman Cynthia McKinney	Georgia	Washington, DC
Congressman John Lewis	Georgia	Washington, DC
Congressman Newt Gingrich	Georgia	Washington, DC
Congressman Bob Barr	Georgia	Washington, DC
Congressman Saxby Chambliss	Georgia	Washington, DC
Congressman Nathan Deal	Georgia	Washington, DC
Congressman Charlie Norwood	Georgia	Washington, DC
Governor Fob James	Alabama	Montgomery, AL
Governor Lawton Chiles	Florida	Tallahassee, FL
Governor Zell Miller	Georgia	Atlanta, GA

Federal Agencies

Department of Energy (10)	Office of Environmental Compliance	Washington, DC
Southeastern Power Administration (3)		Elberton, GA
Federal Energy Regulatory Commission (5)	Advisor on Environmental Quality	Washington, DC
Department of the Interior (12)	Office of Environmental Policy	Washington, DC
Department of the Interior (2)	Office of Environmental Policy and Environmental Compliance	Atlanta, GA
National Park Service (5)	Regional Office	Atlanta, GA
Fish and Wildlife Service (3)	Panama City Field Office	Panama City, FL
Fish and Wildlife Service (2)	Daphne Field Office	Daphne, AL
Fish and Wildlife Service (1)	Brunswick Field Office	Brunswick, GA
Fish and Wildlife Service (1)	Brunswick Suboffice	Ft. Benning, GA
U.S. Geological Survey (2)	Regional Office	Norcross, GA
U.S. Geological Survey (2)	Alabama District Office	Montgomery, AL
U.S. Geological Survey (2)	Florida District Office	Tallahassee, FL
U.S. Geological Survey (2)	Georgia District Office	Atlanta, GA
U.S. Geological Survey (1)		Snellville, GA
U.S. Geological Survey (1)	Biological Resources Division	Athens, GA
Federal Emergency Management Agency (5)		Washington, DC
Federal Emergency Management Agency (1)	Regional Director	Atlanta, GA
Environmental Protection Agency (5)	Office of Federal Activities	Washington, DC

Federal Agencies

Environmental Protection Agency (10)	Region IV	Atlanta, GA
National Oceanic And Atmospheric Administration (4)	Ecology and Environmental Conservation	Washington, DC
National Oceanic And Atmospheric Administration (1)	National Marine Fisheries Service	Silver Springs, MD
National Oceanic And Atmospheric Administration (2)	National Ocean Service	Silver Springs, MD
Advisory Council on Historic Preservation (1)		Washington, DC
Federal Maritime Administration (1)	Office of the Secretary	Washington, DC
Federal Maritime Administration (1)		New Orleans, LA
U.S. Coast Guard (2)	8th District	New Orleans, LA
U.S.D.A., Forest Service (2)	Southern Regional Office	Atlanta, GA
U.S.D.A., Forest Service (1)	State Forests of Alabama	Montgomery, AL
U.S.D.A., Natural Resources Conservation Service (3)	Alabama State Conservationist	Auburn, AL
U.S.D.A., Natural Resources Conservation Service (2)	Florida State Conservationist	Tallahassee, FL
U.S.D.A., Natural Resources Conservation Service (3)	Georgia State Conservationist	Athens, GA
U.S. Department of Housing and Urban Development (2)		Atlanta, GA
Federal Highway Administration (2)		Atlanta, GA
U.S. Department of Health and Human Services (2)	Center for Env. Health, Special Programs	Atlanta, GA
Heritage Conservation and Recreation Service (1)	Environmental Compliance, SE Region	Atlanta, GA
ACT River Basin Commission (1)	Federal Commissioner Lindsay Thomas	Atlanta, GA
U.S. Army Corps of Engineers (3)	Hydrologic Engineering Center	Davis, CA
U.S. Army Corps of Engineers (2)	Waterways Experiment Station	Vicksburg, MS
U.S. Army Environmental Policy Institute (1)		Atlanta, GA
U.S. Department of Justice (2)		Washington, DC

Native American Tribes

United Keetoowah Band of Cherokee Indians	Chief	Tahlequah, OK
Eastern Band of Cherokee Indians	Principal Chief	Cherokee, NC
Miccosukee Tribe	Chairman	Miami, FL
Poarch Band of Creek Indians	Chairman	Atmore, AL
Cherokee Nation of Oklahoma	Principal Chief	Tahlequah, OK
Seminole Tribe of Florida	Chairman	Hollywood, FL
Alabama-Quassarte Tribal Town		Henryetta, OK
Muscogee (Creek) Nation	Principal Chief	Okmulgee, OK
Seminole Nation of Oklahoma	Principal Chief	Wewoka, OK
Thlopthlocco Tribal Town	Town King	Okemah, OK
Kialegee Tribal Town	Town King	Wetmuka, OK
Coushatta Tribe	Chairman	Elton, LA
Alabama-Coushatta Tribe of Texas	Chairperson	Livingston, TX
Chickasaw Nation	Governor	Ada, OK
Choctaw Nation of Oklahoma	Chief	Durant, OK

State and Local Agencies

Alabama Department of Economic and Community Affairs (3)	Office of Water Resources	Montgomery, AL
Alabama Department of Environmental Management		Montgomery, AL
Alabama Department of Conservation and Natural Resources (2)	Game and Fish Division	Montgomery, AL
Alabama Department of Conservation and Natural Resources	Game and Fish Division	Wetumpka, AL
Alabama State Historic Preservation Officer	Alabama Historic Commission	Montgomery, AL
Alabama State Docks		Mobile, AL
Alabama Forestry Commission		Montgomery, AL
Alabama Department of Public Health		Montgomery, AL
Birmingham Regional Planning Commission		Birmingham, AL
West Alabama Planning and Development Council		Northport, AL
Alabama-Tombigbee Regional Commission		Camden, AL
South Alabama Regional Planning Commission		Mobile, AL
Top of Alabama Regional Council of Governments		Huntsville, AL
Central Alabama Regional Planning and Development Commission		Montgomery, AL
South Central Alabama Development Commission		Montgomery, AL
East Alabama Regional Planning and Development Commission		Anniston, AL
Lee-Russell Council of Governments		Opelika, AL
City of Leesburg		Leesburg, AL
Tuscaloosa Park and Recreation Authority		Tuscaloosa, AL
City of Jacksonville		Jacksonville, AL
Mobile County Health Department		Mobile, AL

State and Local Agencies

Cherokee County Water Authority		Centre, AL
Town of Coosada		Coosada, AL
Baldwin County Commission		Foley, AL
City of Centre		Centre, AL
City of Alabaster		Alabaster, AL
City of Sylacauga	City Planning	Slacauga, AL
City of Orange Beach	Planning Department	Orange Beach, AL
Tallapoosa County	Board of Registrars	Dadeville, AL
Northwest Florida Water Management District (2)		Havana, FL
Florida Department of Environmental Protection (2)		Tallahassee, FL
Georgia Department of Natural Resources (3)	Environmental Protection Division	Atlanta, GA
Georgia Department of Natural Resources	Wildlife Resources Division	Social Circle, GA
Georgia State Clearinghouse (5)		Atlanta, GA
Georgia Department of Community Affairs		Atlanta, GA
Georgia State Historic Preservation Officer	Historic Preservation Section	Atlanta, GA
Board of Commissioners		Ft. Gaines, GA
Paulding County Water Authority		Dallas, GA
City of Cartersville (2)		Cartersville, GA
Cherokee County Water Authority		Canton, GA
Chatsworth Water Commission		Chatsworth, GA
Floyd County	Planning	Rome, GA
West Georgia Regional Water Authority		Buchanan, GA

Public and University Libraries

Adelia M. Russell Library		Alexander City, AL
Gadsden Public Library		Gadsden, AL
Monroe County Public Library		Monroeville, AL
Auburn Public Library		Auburn, AL
Mobile Public Library		Mobile, AL
Chilton-Clanton Public Library		Clanton, AL
Selma Public Library		Selma, AL
Jacksonville Public Library		Jacksonville, AL
Montgomery City-County Library		Montgomery, AL
St. Clair County Library		Pell City, AL
Rainwater Memorial Library		Childersburg, AL
White Smith Memorial Library		Jackson, AL
Chambers County Library		Valley, AL
Anniston Main Library		Anniston, AL
Houston Love Memorial Library		Dothan, AL
Birmingham Central Library		Birmingham, AL
Evergreen Public Library		Evergreen, AL
Carnegie Library		Eufaula, AL
Jacksonville State University	Houston Cole Library	Jacksonville, AL
University of Alabama at Birmingham	Mervyn H. Sterne Library	Birmingham, AL
University of Alabama	Gorgas Library	Tuscaloosa, AL
Auburn University		Auburn, AL
University of South Alabama	University Library	Mobile, AL
Apalachicola Municipal Library		Apalachicola, FL
Calhoun County Public Library		Blountstown, FL
Leon County Public Library		Tallahassee, FL
Bay County Public Library		Panama City, FL
Chattahoochee Public Library		Chattahoochee, FL
Jackson County Public Library		Marianna, FL
Florida State University	Strozier Library	Tallahassee, FL
University of Florida	George A. Smathers Library	Gainesville, FL
U.S. Environmental Protection	Region IV Library	Atlanta, GA
LaGrange Memorial Library		LaGrange, GA
Thomasville Cultural Center Library		Thomasville, GA
Dougherty County Public Library		Albany, GA
Southwest Georgia Regional Library		Bainbridge, GA
Cordele/Crisp County Carnegie Library		Cordele, GA
North Columbus Branch Library		Columbus, GA
Macon/Bibb County Public Library		Macon, GA
Griffin/Spalding County Library		Griffin, GA

Public and University Libraries

Rome/Floyd County Library		Rome, GA
Newnan/Coweta Public Library		Newnan, GA
Cobb County Library System	Acworth Branch	Acworth, GA
Douglas County Public Library		Douglasville, GA
Calhoun/Gordon County Library		Calhoun, GA
Dalton Regional Library		Dalton, GA
Bartow County Library		Cartersville, GA
Athens Regional Library		Athens, GA
Cobb County Library System	Central Office	Marietta, GA
Atlanta/Fulton County Public Library	1 Margaret Mitchell Square North	Atlanta, GA
East Hall Public Library		Gainesville, GA
Lumpkin County Library		Dahlonega, GA
Chatsworth/Murray County Library		Chatsworth, GA
Georgia Institute of Technology	Price-Gilbert Memorial Library	Atlanta, GA
University of Georgia Libraries	Government Documents	Athens, GA
Kennesaw State University	Horace W. Sturgis Library	Kennesaw, GA
Georgia State University	William Russell Pullen Library	Atlanta, GA
Gainesville College	John Harrison Hosch Library	Gainesville, GA
Columbus State University	Library	Columbus, GA
State University of West Georgia	Ingram Library	Carrolton, GA

Organizations

First Name	*Last Name*	*Organization*	*City*	*State*
Steve	Hughes	Alabama River Pulp	Perdue Hill	AL
Richard	Kinne	Blackbelt Tourism Council	Camden	AL
John	Moore	Boise Cascade Corp	Whatley	AL
		Clear Springs, Inc	Lincoln	AL
David	Stein	Dixie Sailing Club	Montgomery	AL
Dennis	Goldsmith	Jefferson County Schools	Birmingham	AL
James	DeCosmo	Kimberly Clark Corporation	Mobile	AL
C.	Bedsole	Kimberly-Clark Corporation	Mobile	AL
Missy	Middlebrooks	Lake Martin Resource Association	Alexander City	AL
Richard	Bronson	Lake Watch of Lake Martin	Alexander City	AL
Isabella	Trussell	Logan Martin Lake Protection Association	Pell City	AL
Ray	Cox	Metro Bank	Pell City	AL
John	Ward	National Association of Retired Federal Employees	Montgomery	AL
Rick	Wallace	Sea Grant Advisory Services	Mobile	AL
Wayne	Sanders	The Country Store	Equality	AL
Martha	Moore	Union Camp Corporation	Prattville	AL
James	Mobley	Alabama Peanut Producer Association	Dothan	AL
Roy	Kendrick	Alabama Soil and Water Conservation District	Montgomery	AL
Dennis	Block	Alabama Water Resources Research Institute	Auburn	AL
David	Bayne	Auburn University	Auburn	AL
Glenn	Waddell	Balch & Bingham	Birmingham	AL
William	Satterfield	Balch & Bingham	Birmingham	AL
		Bio-Diversity	Birmingham	AL
		Birmingham Audubon Society	Birmingham	AL
Jim	Bain	C/O Russell Lands Inc	Alexander	Al
Fred	Dobbs	Dobbs Realty	Alexander City	AL
Bill	Whatley	First Realty	Alexander City	AL
Bill	Irby	James River Corporation	Pennington	AL
Jim	Bain	Lake Martin Living Magazine	Alexander City	AL
John	Glasier	Lake Watch of Lake Martin	Dadeville	AL

Organizations

First Name	*Last Name*	*Organization*	*City*	*State*
Don	Greer	Logan Martin Lake Protection Association	Pell City	AL
Brian	Frennea	Ryan-Walsh	Mobile	AL
Nicholas	Barchie	Seaport Shipping of Alabama	Mobile	AL
Margie	Welch	Sierra Club - Alabama Chapter	Mobile	AL
Dan	Patel	Southern Company Services	Birmingham	AL
William	Andreen	The University of Alabama School of Law	Tuscaloosa	AL
Gena	Todia	Wetland Resources	Daphne	AL
Neil	Grigg	Colorado State University	Fort Collins	CO
		Appalachian Regional Comm	Washington	DC
		Earth Justice Legal Defense Fund	Tallahassee	FL
William	Landing	Florida State University	Tallahassee	FL
Bill	Harley	Florida Wildlife Federation	Tallahassee	FL
Irene	Harley	Florida Wildlife Federation	Tallahassee	FL
James	Martin	ASCL Corp.	Athens	GA
Laurie	Ashmore	Brown & Caldwell Consultants	Conyers	GA
Harry	McGinnis	Burriss Institute, Kennesaw State College	Kennesaw	GA
George	Stanton	Columbus State University	Columbus	GA
Ken	Edelstein	Creative Loafing	Atlanta	GA
W.	Gray	Dellinger Management Co., Inc.	Cartersville	GA
Mark	Crisp, P.E.	GDS & Associates, Inc.	Marietta	GA
Bob	Herrington	Georgia Southwestern State University	Americus	GA
Bill	Frazier	Georgia's Streams/Fish Traps	Decatur	GA
David	Ashley	Jordan, Jones and Goulding, Inc.	Atlanta	GA
Roger	Bauer	Lake Lanier Advisory Council	Cumming	GA
Gene	Blakley	Minutemen Recreation Association	Kennesaw	GA
Tim	Cole	Paulding County Water Authority	Dallas	GA
Robert	Rowe	Rowe Realty Co., Inc.	Columbus	GA
Harold	Jones	Southeastern Power Administration	Elberton	GA
John	Fleetwood	Stamp Creek Subdivision	White	GA
Jackie	Sellers	The University of Georgia	Athens	GA
James	Emery	Emery & Garrett Groundwater, Inc.	Meredith	NH
		Alabama-Quassarte Tribal Town	Henryetta	OK
Sally	Bethea	Upper Chattahoochee Riverkeeper	Atlanta	GA
Constance	Hunt	World Wildlife Fund	Washington	DC
Wesley	Woolf	Southern Environmental Law Center	Atlanta	GA
Chester	McConnell	Wildlife Management Institute	Lawrenceburg	TN
Dave	Pendleton	Sea Port Marine Corp	Chesapeake	VA
Richard	Palmer	University of Washington	Seattle	WA

Individuals

First	*Last*	*City*	*State*
Stanley B.	Atkins	Cropwell	AL
Mark	Bagley	Cropwell	AL
Kay	Bain	Pell City	AL
Robert	Baker	Vincent	AL
Don	Bass	Cropwell	AL
Neil	Bell	Pell City	AL
M.	Briggs	Telladega	AL

Individuals

First	*Last*	*City*	*State*
John	Calhoun	Alpine	AL
Tom	Collins	Jackson's Gap	AL
H.	Cosper	Gadsden	AL
H.V.	Cropp	Pell City	AL
Marl	Cummings	Mobile	AL
John	Cummins	Montgomery	AL
Mike	Deason	Alpine	AL
Perry	Doak	Pell City	AL
Allen	Folts	Birmingham	AL
William	Frost	Pell City	AL
Richard	Gecoma	Cropwell	AL
Frank	Gibson	Gilbertstown	AL
B.	Golden	Pell City	AL
R.	Gonzalez	Vincent	AL
Joseph	Griffey	Auburn	AL
George	Hammond	Dadeville	AL
Andy	Hawkins	Pell City	AL
William	Hays	Pell City	AL
Robert	Hodge	Theodore	AL
William	Jeffers	Pell City	AL
Robert	Kratzer	Montgomery	AL
Charles	Lanier	Pell City	AL
Jack	Lincoln	Pell City	AL
E.	Mann	Pell City	AL
Lawrence	Martens	Pell City	AL
Rodney	Martin	Pell City	AL
Walter	McDaniel,III	Pell City	AL
William	McDonald	Cropwell	AL
Lee	Overton	Alpine	AL
Janis	Owen	Cropwell	AL
W.	Pate	Cropwell	AL
Holland	Powell	Pell City	AL
Bonnie	Prescott-Lowry	Pell City	AL
B.	Ray	Prattville	AL
Vernon	Reynolds	Eclectic	AL
Donald	Sanders	Talladega	AL
D.	Scott	Mobile	AL
Walter	Shaddix	Talladega	AL
James	Shannon	Cropwell	AL
Wyndol	Shaw	Alpine	AL
Coy	Shell	Riverside	AL
Richard	Sherman	Cropwell	AL
David	Shirley	Cropwell	AL
Randle	Shumate	Pell City	AL
Charles	Smith	Cropwell	Al
Gerald	Sparks	Mobile	AL
H.	Spivey	Talladega	AL
Gene	Suttle	Cropwell	AL

Individuals

First	*Last*	*City*	*State*
Ann	Tate	Birmingham	AL
Chuck	Thomas	Birmingham	AL
Kenneth	Thompson	Talladega	AL
John	Tiffany	Talladega	AL
Don	Tolbert	AXIS	AL
W.	Tuttle	Talladega	AL
Joe	Vance	Pell City	AL
Bestor	Ward	Mobile	AL
Perry	Webb	Pell City	AL
Dick	Whatley	Pell City	AL
Henry	Wilson	Cropwell	AL
Gary	Beisser	Calhoun	GA
James	Brown	Atlanta	GA
W.	Cider	Rydel	GA
Harrison	Collett	Canton	GA
Christopher	McWhirter	Atlanta	GA
Don	Smith	Tallapoosa	GA
David	Turner	Cartersville	GA
Jere	Weyman	Chatsworth	GA
James	Crouse	Warren	OH
Ronnie	Avery	Phenix	AL
Rosemary	Benedict	Alexander City	AL
Karl	Beulurth	Montgomery	AL
Vance	Braswell	Cropwell	AL
Alvin	Diamond	Troy	AL
Joseph	Donofro	Dothan	AL
Danny	Dyess	Dothan	AL
Phillip	Gadilhe	Birmingham	AL
Greg	Harber	Birmingham	AL
Mel	Osingd	Cropwell	AL
Scott B.	Pierce	Mobile	AL
Lem	Rainwater	Pell City	AL
Robert	Reid, Jr.	Birmingham	AL
Chris	Spivey	Pell City	AL
Dell	Stone	Alexander City	AL
Albert	Townes	Cropwell	AL
Sam	Vrachalus	Mobile	AL
Gerald	Watson	Abbeville	AL
Bill	Winters	Satsuma	AL
Dan	Tonsmeire	Midway	FL
Jerry	Buchanan	Columbus	GA
Tom	Burnett	Chamblee	GA
Alvin	Burrell	Decatur	GA
Kip	Duchon	Decatur	GA
Boyd	Duncan	Duluth	GA
Daniel	Fobas	Dunwoody	GA
Glynn	Groszmann	Roswell	GA
Harold	Hudgens	Albany	GA

Individuals

First	*Last*	*City*	*State*
Peter	Kalla	Powder Springs	GA
Doug	Mercer	Cumming	GA
Ralph	Moore	Union City	GA
Judy	Noles	Atlanta	GA
Jim	Patsios	Woodland	GA
Robert	Phelps	Atlanta	GA
Dan	Provence	Bainbridge	GA
Richard	Santiago	Tyrone	GA
John	Springer	Midland	GA
John	Strickland	Dalton	GA
James	Swancy	Ranger	GA
James	Williams	Gainesville	GA
Michael	Wolfe	Atlanta	GA
Mr. & Mrs.	Fitzpatrick	Pass Chrictian	MS
Walter	Wunderlich	Knoxville	TN
Pete	Conroy	Jacksonville	AL
Jean	Jackson	Collinsville	AL

7. Literature Cited

Alabama Department of Environmental Management (ADEM). 1998. Draft Section 303(d) List for Alabama.

Alabama Department of Environmental Management. 1992. Water quality report to Congress for calendar years 1990 and 1991. Unnumbered report. Montgomery, AL.

Alabama State Parks web page. 1998. *http://www.vten.com/vten_main/state_parks_main/parks_1a.html.*

Allen, D.S., R.S. Jackson, and A.L. Perr. 1996. *Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint Comprehensive Study, Recreation Demand Element.* Final Draft Report. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

American Whitewater Affiliation (AWA) web page. 1998. *http://www.awa.org/awa/river_ project. html.*

Anderson, David G. 1994. *The Savannah River Chiefdoms: Political Change in the Late Prehistoric Southeast.* University of Alabama Press, Tuscaloosa.

Arthur, J.D. and F.R. Rupert. July 1-7, 1989. "Selected Geomorphic Features of Florida." In *The Lithostratigraphy and Hydrostratigraphy of the Floridan Aquifer System in Florida.* Field Trip Guidebook T185, Tampa to Tallahassee, Florida. American Geophysical Union.

Ashby, S.L., J.B. Waide, R.P. Barbiero, R.H. Kennedy, L.D. Peyman Dove, H. Boswell, G. Buell, and L.S. Johnson. April 1996. *Identification, Compilation, and Analysis of Water Quality Data for the Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa (ACT/ACF) Comprehensive Basin Study.* U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

Barker, A.W., and T.R. Pauketat (eds.). 1992. "Lords of the Southeast: Social Inequality and the Native Elites of Southeastern North America." *Archaeological Papers of the American Anthropological Assn.*, #3.

Barksdale, H., and Moore, J.D. (eds.). 1976. *Water Content and Potential Yield of Significant Aquifers in Alabama.* Geological Survey of Alabama Open-File Report.

Barkuloo, J.M., L.Patrick, L. Stitch and W.J. Troxel. 1987. *Natural Resources Inventory Apalachicola-Chattahoochee-Flint River Basin.* Fish and Wildlife Service.

Bolt Beranek and Newman, Inc. 1971. *Survey of Annoyance from Motor Vehicle Noise.* Automobile Manufacturers Association, Inc. Report 21.

Bossong, C.R. 1989. *Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama-Area* 2. U.S. Geological Survey Water-Resources Investigations Report 88-4177.

Brown, F. and S.M.L. Smith. 1997. *The Riverkeeper's Guide to the Chattahoochee River.* CI Publishing: Atlanta, Georgia.

Burkhead, N.M. 1993. Status survey for two freshwater fishes, the Cherokee and Etowah darters (*Pisces*, Percidae), endemic to the Etowah River system of north Georgia. Final report submitted to the U.S. Fish and Wildlife Service, Jacksonville Field Office. 25 p.

Burkhead, N.M., J.D. Williams, and B.J. Freeman. 1992. A River Under Siege. *Georgia Wildlife* 2 (2):10-17.

Burkhead, N.M., S. J. Walsh, B.J. Freeman and J.D. Williams. 1997. Status and restoration of the Etowah River, an imperiled southern Appalachian ecosystem. In: *Aquatic fauna in peril: the southeastern perspective*; ed. G.W. Benz and D.E. Collins. Special publication 1, Southeast Aquatic Research Institute, Lenz Design & Communications, Decatur, GA. 554 pp.

Caldwell, R.E., and R.W. Johnson. 1982. *General Soil Map – Florida*. 1:50,000 scale. U.S. Department of Agriculture, Soil Conservation Service.

CEQ (see Council on Environmental Quality)

CH2M HILL. 1998. *Reservoir Fisheries Assessment for the Alabama-Coosa-Tallapoosa (ACT) and the Apalachicola-Chattahoochee-Flint (ACF) Water Allocation Formula Environmental Impact Statements*. Prepared for the U.S. Army Corps of Engineers, Mobile District.

Chapman, M. J., B.J. Milby and M. F. Peck. 1993. *Geology and Ground-Water Resources of the Zebulon, Georgia Area*. U.S. Geological Survey Water-Resources Investigation Report 93-4161.

Clewell, A.F. 1977. *Geobotany of the Apalachicola River Region*. Florida Department of Natural Resources. Florida Marine Research Publications No. 26:6-15.

Collier, M., R.H. Webb, and J.C. Schmidt. 1996. *Dams and Rivers: A Primer on the Downstream Effects of Dams*. U.S. Geological Survey Circular 1126.

Comprehensive Water Resource Study Partners. September 1995. *Alabama-Coosa-Tallapoosa, Apalachicola-Chattahoochee-Flint River Basins Water Resources Study Status Report*.

Corps (see U.S. Army Corps of Engineers)

Couch, C. A., E. H. Hopkins, and P. S. Hardy. 1996. *Influences of Environmental Settings on Aquatic Ecosystems in the Apalachicola-Chattahoochee-Flint River Basin*. U.S. Geological Survey Water-Resources Investigations Report 95-4278.

Council on Environmental Quality (CEQ). 1996. *Draft Guidance for Addressing Environmental Justice Under NEPA*.

Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T. 1979. *Classification of Wetlands and Deepwater Habitats of the United States:* Fish and Wildlife Service, FWS/OBS-79/31.

Cressler, C.W., C.J. Thurmond, and W.G. Hester. 1983. *Ground Water in the Greater Atlanta Region*. Georgia Geologic Survey Information Circular 63.

Cressler, C.W., M.A. Franklin, and W.G. Hester. 1976. *Geohydrology of Bartow, Cherokee and Forsyth Counties*. Georgia Geologic Survey Information Circular 63.

Davis, M.E. 1987. *Stratigraphic and Hydrogeologic Framework of the Alabama Coastal Plain:* U.S. Geological Survey Water-Resources Investigation Report 87-4112.

Davis, M.M. 1997. *Tri-State Comprehensive Study Riparian Wetland Element, Report 1: Relationship between Flow and Habitat Value in the Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint (ACT/ACF) River Basins*. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Miscellaneous Paper EL-97-2.

Davis, W. Y., M. T. Beezhold, E. M. Opitz, and B. Dziegielewski. June 1996. *ACT-ACF Comprehensive Study Municipal and Industrial Water Use Forecasts*. Planning and Management Consultants, Ltd.

DeJarnette, S.S. 1989. *Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama; Area 6*. U.S. Geological Survey Water-Resources Investigations Report 87-4113.

Dove, L.P. and M.R. Kress. 1997a. "Wetland Characterizations in the Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint (ACT/ACF) River Basins." In *Tri-State Comprehensive Study Riparian Wetland Element: Report 2*. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Miscellaneous Paper EL-97-2.

Dove, L.P. and M.R. Kress. 1997b. "Wetland Characterizations Within Four Lake Study Areas in the Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint (ACT/ACF) River Basins." In *Tri-State Comprehensive Study, Reservoir Resource Element: Report 3*. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Miscellaneous Paper EL-97-2.

Drennen, D. 1995. "Ring-Billed Gulls, *Larus delawarensis*, Feeding on Mussels." *Alabama Birdlife*, Vol. 41, No. 2.

DRI/McGraw-Hill. January 1996. *The Regional Economic Forecast of Population and Employment Comprehensive Study*.

Elder , J.F., and Cairns, D.J. 1982. *Production and Decomposition of Forest Litter Fall on the Apalachicola River Flood Plain, Florida:* U.S. Geological Survey Water-Supply Paper 2196.

Ellis, R. May 19, 1998. Ranger, Claiborne Lake, Alabama. Personal communication with Betsy Horton, CH2M HILL. Atlanta, Georgia.

Environmental Systems Research Institute, Inc. (ESRI). 1997. Streetmap GIS software.

EPA (see U.S. Environmental Protection Agency)

Federal Interagency Forum on Child and Family Statistics. 1997. *America's Children: Key National Indicators of Well-Being*.

Federal Power Commission (FPC). December 1973. Final Environmental Impact Statement: Crooked Creek Project No. 2628-Alabama. No. FPC-PWR-2628.

Fish and Wildlife Service (FWS). June 5, 1998. *Fish and Wildlife Coordination Act Report for the Apalachicola-Chattahoochee-Flint River Basin Water Allocation Formula*. Working draft. Report to the U.S. Army Corps of Engineers, Mobile District.

Fish and Wildlife Service (FWS). 1993a. *Technical draft recovery plan for the blue shiner (Cyprinella caerulea)*. U.S. Fish and Wildlife Service, Jackson, Mississippi. 18 p.

Fish and Wildlife Service (FWS). 1993b. *Endangered and threatened wildlife and plants; proposed threatened status for the Cherokee darter and proposed endangered status for the Etowah darter*. U.S. Fish and Wildlife Service, Jacksonville, Florida. 25 p.

Fish and Wildlife Service (FWS). 1992. *Regional Wetlands Concept Plan, Southeast Region.*

Fish and Wildlife Service (FWS). June 5, 1988. *Fish and Wildlife Coordination Act Report for the Apalachicola-Chattahoochee-Flint River Basin Water Allocation Formula*. Report to the U.S. Army Corps of Engineers, Mobile District. Prepared by FWS with assistance from FWS Ecological Services Division, Brunswick, Georgia, and US Geological Survey, Biological Resources Division, Athens, Georgia.

Fish and Wildlife Service (FWS). 1986. *Recovery Plan for Conasauga Logperch (Percina jenkinsi) and amber darter (Percina antesella)*. U.S. Fish and Wildlife Service, Atlanta, Georgia. 34 p.

Fish and Wildlife Service (FWS). Undetermined date. *Anadromous Fish Habitat in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins*. Report to the Technical Coordination Group of the ACT-ACF Comprehensive Study, Panama City, Florida.

Florida Department of Environmental Regulation. 1992. *1992 Water Quality Assessment for the State of Florida* (main report). FDER, Division of Water Management.

FPC (see Federal Power Commission)

Freeman, B.J. 1993. Georgia's Protected Fishes: The Need for Basin-Wide Management. Pages 293-295 in Proceedings of the 1993 Georgia Water Resources Conference. The University of Georgia, Athens.

Freeman, M.C. 1998a. *Existing Flow Conditions in the Alabama-Coosa-Tallapoosa River Drainage*. Report for U.S. Army Corp of Engineers, Mobile District.

Freeman, M.C. 1998b. *Biological Implications of Flow Alterations in the Regulated Reaches of the ACT and ACF Drainages*. Report for U.S. Army Corps of Engineers, Mobile District.

Freeman, M. C., J. M. Nestler, and P. N. Johnson. 1997. *Riverine Resources: Water Needs and Environmental Effects Analyses in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins*. Final Report to the Technical Coordinating Group of the ACT-ACF Comprehensive Study. U.S. Geological Survey, Biological Resources Division, Patuxent Wildlife Research Center, Athens, GA.

Frick, E.A., D.J . Hippe, G.R. Buell, C.A. Couch, E.H. Hopkins, D.J. Wangness, and J.W. Garrett. 1998. *Water Quality in the Apalachicola-Chattahoochee-Flint River Basin, Georgia, Alabama, and Florida, 1992-95*. U.S. Geological Survey Circular 1164.

Galloway, D. and Eldred, K.. No date. *100-Site Report*. Prepared for U.S. Environmental Protection Agency (EPA) Office of Noise Abatement and Control.

Georgia Department of Natural Resources (GDNR). 1998. Georgia State Parks web page. *http://www.dnr.state.ga.us/dnr/parks.html.*

Georgia Department of Natural Resources (GDNR). 1997. *Chattahoochee River Basin Management Plan 1997*. Draft plan. Environmental Protection Division.

Georgia Department of Natural Resources (GDNR). 1996. *Water Quality in Georgia, 1994-1995*. Environmental Protection Division.

Georgia Department of Natural Resources. 1992. *Water Quality in Georgia, 1990-1991.* Environmental Protection Division, Atlanta, GA.

Georgia Geological Survey. 1976. *Geologic Map of Georgia.* Georgia Geological Survey SM-3, 1:500,000 scale.

Georgia Wildlife Management Areas web page. 1998. *http://ganet.ganet.org/ns-search/wild/game_mgmt/wmalist.html.*

Gholson, A.K., Jr. 1984. "History of Aquatic Weeds in Lake Seminole." *Aquatics,* v. 14.

Greenfield, Jim, EPA. Personal communication. 1998.

Gulf Engineers & Consultants, Inc. (GEC). June 1994. *Facility Inventory for the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa Basins Recreation Report.* Volume I (Main Report), and Volume II (Attachment). U.S. Army Corps of Engineers, Mobile District.

Gup, T. 1994. "Dammed from Here to Eternity: Dams and Biological Integrity." *Trout* 35:14-20.

Guthrie, G.M., M.J. Nielson, and S.S. DeJarnette. 1994. "Preliminary Hydrogeologic Evaluation of the Alabama Piedmont." In *Proceedings of a Conference on Ground Water in the Piedmont of the Eastern United States.* Clemson University. Clemson, SC.

Hayes, L.R., M.L. Masila, and W.C. Meeks. 1983. *Hydrology and Model Evaluation of the Principal Artesian Aquifer, Dougherty Plain, Southwest Georgia.* Georgia Geologic Survey.

Heath, R.C. 1989. "The Piedmont Ground-Water System." In *Proceedings of a Conference on Ground Water in the Piedmont of the Eastern United States.* Clemson University. Clemson, SC.

Hicks, D.W., H.E. Gill, and S.A. Longsworth. 1987. *Hydrogeology, Chemical Quality, and Availability of Ground Water in the Upper Floridan Aquifer, Albany, Georgia.* U.S. Geological Survey Water-Resources Investigations Report 87-4145.

Hoffman, P. E. 1994. "Lucas Vazquezde Ayllon's Discovery and Colony." In *The Forgotten Centuries: Indians and Europeans in the American South, 1521-1704.* C. Hudson and C. Tesser (eds). University of Georgia Press, Athens.

Hudson, C. 1994. "The Hernando de Soto Expedition, 1539-1543." In *The Forgotten Centuries: Indians and Europeans in the American South, 1521-1704.* C. Hudson and C. Tesser (eds), University of Georgia Press, Athens.

Institute of Water Resources and the Mobile District. November 1997. *Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basin Study Navigation Water Demand Element.* Preliminary Draft Report.

Isphording, W.C. 1985. *Sedimentological Investigation of the Apalachicola Bay, Florida Estuarine System.* Draft report for the US Army Corps of Engineers, Mobile District.

Jackson III, H.H. 1995. *Rivers of History: Life on the Coosa, Tallapoosa, Cahaba, and Alabama.* University of Alabama Press, Tuscaloosa.

Journey, C.A. and J.B. Atkins. 1997. *Ground-Water Resources of the Tallapoosa River Basin in Georgia and Alabama—Subarea 5 of the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa River Basins*. U.S. Geological Survey Open-File Report 96-433.

Kidd, R.E. 1987. *Geohydrology and Susceptibility of Aquifers to Surface Contamination in Alabama – Area 5*. U.S. Geological Survey Water-Resources Investigations Report 88-4083.

Kidd, R.E., J.B. Atkins, and J.C. Scott. 1997. *Ground-Water Resources of the Alabama River Basin in Alabama*—Subarea 5 *of the Apalachicola-Chattahoochee–Flint and Alabama-Coosa-Tallapoosa River Basins*. U.S. Geological Survey Open-File Report 96-473.

Kinsolving, A.D. 1989. Flow Regulation and Shoreline Fish Assemblages in Two Southeastern Rivers. M.S. Thesis. Auburn University: Auburn, Alabama.

Kinsolving, A.D., and M.B. Bain. 1993. Fish Assemblage Recovery along a Riverine Disturbance Gradient. Ecological Applications, 3(3).

Leigh, D.S. 1994. *Mercury Storage and Mobility in the Floodplains of the Dahlonega Gold Belt.* Environmental Resources Center, Atlanta, Ga., Technical Completion Report, ERC 02-94.

Leitman, H.M. 1984. *Forest Map and Hydrologic Conditions, Apalachicola River Flood Plain, Florida.* U.S. Geological Investigations Atlas HA-672, 1 map.

Leitman, H.M., J.E. Sohm, and M.A. Franklin. 1983. *Wetland Hydrology and Tree Distribution of the Apalachicola River Flood Plain, Florida:* U.S. Geological Survey Water-Supply Paper 2196.

Lewis III, F.G. 1997. *Apalachicola River and Bay Water Demand Element: Summary and Integration of Apalachicola Bay Studies*. Northwest Florida Water Management District, Havana, Florida.

Light, H.M., M.R. Darst, and J.W. Grubbs. 1997. *Aquatic Habitats in Relation to River Flow in the Apalachicola River Floodplain, Florida.* U.S. Geological Survey Open-File Report 97-665.

Light, H.M., M.R. Darst and J.W. Grubbs. 1995. *Hydrologic Conditions, Habitat Characteristics, and Occurrence of Fishes in the Apalachicola River Floodplain, Florida: Second annual report of progress, October 1993- September 1994.* U.S. Geological Survey Open-File Report 95-167.

Livingston, R.J. 1991. "Historical Relationships Between Research and Resource Management in the Apalachicola River Estuary: Ecological Applications." *Ecological Society of America*, v. 1, no. 4.

Livingston, R.J. 1983. *The Ecology of the Apalachicola Bay system: An Estuarine Profile*. Fish and Publication.

Lott, Bill, ADEM. Personal communication. 1998.

Maceina, M. J., and M. R. Stimpert. 1998. "Relations Between Reservoir Hydrology and Crappie Recruitment in Alabama." *North American Journal of Fisheries Management* 18:104-113.

Marois, K.C. 1997. *Plants and Lichens, Vertebrates, Invertebrates, and Natural Communities*. Florida Natural Areas Inventory.

Marshall, R.A. (ed.). 1987. "The Emergent Mississippian." *Proceedings of the Sixth Mid-South Conference Archaeological Conference, June 6-9, 1985.* Mississippi State University, Cobb Institute of Archaeology. Occasional Papers no. 87-01.

Martin, W.H., S.G. Boyce, and A.C. Echternacht. 1993. *Biodiversity of the Southeastern United States: Upland Terrestrial Communities.* John Wiley and Sons, New York.

Masila, M.L. and L.R. Hayes. 1988. *Hydrogeology and Simulated Effects of Ground-Water Development of the Floridan Aquifer System, Southwest Georgia, Northwest Florida, and Southernmost Alabama.* U.S. Geological Survey Professional Paper 1406-H.

Mattraw, H.C., Jr., and J.F. Elder. 1984. *Nutrient and Detritus Transport in the Apalachicola River, Florida.* U.S. Geological Survey Water- Supply Paper 2196-C.

Mauldin, A.C., and J.C. McCollum. 1992. *Status of the Chattahoochee River Fish Population Downstream of Atlanta, Georgia.* Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Ga. Unnumbered report.

Mayden, R.L. and B.R. Kuhajda. 1989. "Systematics of *Notropis cahabae,* a new cyprinid fish endemic to the Cahaba River of the Mobile Basin." *Bull. Alabama Mus. Nat. Hist.* 9:1-16.

Mayer, Gregory C. 1997. *Ground-Water Resources of the Lower-Middle Chattahoochee River Basin in Georgia and Alabama, and Middle Flint River Basin in Georgia – Subarea 3 of the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa River Basin.* U.S. Geological Survey Open File Report 96-483.

McMakin, T., J.W. Gardner, and B.G. Harvey. 1996. *Archaeological Survey and Cold War Assessment of Maxwell Air Force Base and Gunter Air Force Station, Mongomery, Alabama.* Report submitted to the U.S. Army Corps of Engineers, Mobile District, Mobile, AL by Brockington and Associates, Norcross, GA. Report #603.

Menzel, R.W. 1983. *Genetics and the Potential for Oyster Production in Apalachicola Bay. Apalachicola Oyster Industry: Proceedings of a Conference.* Edited by Scott Andree. Sea Grant Report No. SGR-57. Gainesville, Florida.

Middleton, R.G. 1968. *Soil Survey of Dougherty County, Georgia.* U.S. Department of Agriculture, Soil Conservation Service.

Miller, D. May 19, 1998. Personal communication with Betsy Horton, CH2M HILL. Atlanta, Georgia. Alabama Power Company, Birmingham, Alabama.

Miranda, L. M., W. L. Shelton, and T. D. Bryce. 1984. "Effects of Water Level Manipulation on Abundance, Mortality, and Growth of Young-of-Year Largemouth Bass in West Point Reservoir, Alabama-Georgia." *North American Journal of Fisheries Management,* 4:314-320.

Mooty, W.S. and R.E. Kidd. 1997. *Groundwater Resources in the Cahaba River Basin in Alabama—Subarea 7 of the Apalachicola-Chattahoochee–Flint and Alabama-Coosa-Tallapoosa River Basins.* U.S. Geological Survey Open-File Report 96-470.

NOAA (see National Oceanic and Atmospheric Administration)

Office of Air Quality Planning and Standards. 1996. *National Air Quality and Emissions Trends Report.*

O'Neil, P. E., and M. F. Mettee, eds. 1982. Alabama coastal region ecological characterization. Volume 2. A synthesis of environmental data. U.S. Fish and wildlife Service, Office of Biological Services, Washington, D. C. FWS/QBS-82/42.

National Oceanic and Atmospheric Administration (NOAA) and Florida State University. June 8, 1998. *Environmental Impact Statement Report: Apalachicola Bay, Florida Component.* Submitted to U.S. Army Corps of Engineers, Mobile, Alabama. Principal Investigators: M.E. Monaco and C.J. Kline III.

National Park Service (NPS). 1998a. Horseshoe Bend National Military Park web page. *http://www.nps.gov/hobe.html.*

National Park Service (NPS). 1998b. Little River Canyon National Preserve web page. *http://www.nps.gov/liri.html.*

Natural Resources Conservation Service (NRCS). 1998. *http://www.ftw.nrcs.usda.cov/stat_data.html.*

Natural Resources Conservation Service (NRCS). March 1996. *ACT/ACF River Basins Comprehensive Study: Agricultural Water Demand, Appendix B: Basinwide Management Shared Vision Data.* U.S. Department of Agriculture, Athens, GA.

Natural Resources Conservation Service (NRCS). 1995. *ACT/ACF Basins Comprehensive Study: Agricultural Water Demand, Executive Summary.* U.S. Department of Agriculture, Athens, GA.

Nestler, J. M., J. Frischen, R. T. Milhous, and J. Troxel. 1986. *Effects of Flow Alterations on Trout, Angling, and Recreation in the Chattahoochee River Between Buford Dam and Peachtree Creek.* U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report EL-86-10.

Nestler, J. M., L. T. Schneider, and D. Latka. July 1993. "RCHARC: A New Method for Physical Habitat Analysis." In *Engineering Hydrology*, a symposium sponsored by the American Society of Civil Engineers, San Francisco, CA.

Nestler, J. M., L. T. Schneider, D. C. Latka, and P. N. Johnson. 1995. *Physical Habitat Analysis Using the Riverine Community Habitat Assessment and Restoration Concept (RCHARC): Missouri River Case History.* U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report EL-95-18.

NRCS (see Natural Resources Conservation Service)

Omernik, J.M. 1987. "Ecoregions of the Conterminous United States." *Annals of the Association of American Geographers*, v. 77.

Patillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries, Volume II: Species Life History Summaries.* ELMR Rep. No. 11. NOAA/NOS Strategic Environmental Assessments Division. Silver Spring, Maryland.

Peebles, Christopher S. 1986. "Paradise Lost, Strayed, and Stolen: Prehistoric Social Devolution in the Southeast." In *The Burden of Being Civilized: An Anthropological Perspective*

on the Discontents of Civilization. M. Richardson and M.C. Webb (eds.) Southern Anthropological Society Proceedings 18, University of Georgia Press, Athens.

Perkins, H.F., and M. E. Schiffer. 1977. *Soil Associations and Land Use Potential of Georgia Soils*. Scale 1:750,000. U.S. Department of Agriculture, Soil Conservation Service.

Perr, A.L. March 28, 1997. "Recreation Demand Element." *ACT/ACF Comprehensive Study*. Section II, ACT-ACF 1995 Recreational Boating Survey. Market Facts, Inc. McLean, VA.

Perritt, R. and D. Drennen. 1995. *Resource Sensitivity Effects on Navigation and Wildlife and Planning for the ACF River Basin*. Proceedings of the 1995 Georgia Water Resources Conference.

Pierson, J.M., W.M. Howell, R.A. Stiles, M.F. Mettee, P.E. O'Neil, R.D. Suttkus, and J.S. Ramsey. 1989. "Fishes of the Cahaba River System in Alabama." *Geological Survey of Alabama Bulletin* 134.

Planert, M. and J.L. Pritchett. 1989. *Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama - Area 4*. U.S. Geological Survey Water-Resources Investigations Report 88-4133.

Planning and Management Consultants Limited (PMCL). 1996. *ACT-ACF Comprehensive Study, Municipal and Industrial Water Use Forecasts Final Report*. Summary Report, Technical Report; and two data diskettes. Prepared for the U.S. Army Corps of Engineers, Institute for Water Resources.

Ploskey, G. R., and T. R. Reinert. 1996. *Assessing Impacts of Water Management on Reservoir Fish Reproductive Success in The Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint River Basins*. Technical Report. U.S. Army Engineer District, Mobile, AL.

Plummer, G.L. 1975. "Eighteenth Century Forests in Georgia." Georgia State University, Atlanta, GA. *Bulletin of the Georgia Academy of Science* v. 33, no. 5.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. "A Method for Assessing Hydrologic Alteration Within Ecosystems." *Conservation Biology* Volume 10, Number 4.

Richter, B.D., J.V. Baumgartner, R. Wigington, and D.P. Braun. 1997. "How Much Water Does a River Need?" *Freshwater Biology* 37:231-249.

Robinson, J.L., C.A. Journey, and J.B. Atkins. 1997. *Ground-Water Resources of the Coosa River Basin in Georgia and Alabama—Subarea 6 of the Apalachicola-Chattahoochee–Flint and Alabama-Coosa-Tallapoosa River Basins*. U.S. Geological Survey Open-File Report 96-177.

Rose, S. 1998. Water Allocation for the Apalachicola-Chattahoochee-Flint Rivers Basin: Scenario Projection of Social Effects. Masters Thesis: University of Alabama. Tuscaloosa, Alabama.

Ryder, S., J. Taylor, and J. H. Crance. 1995. "Relations Between Reservoir Surface Water Elevations and Reservoir Fisheries." In *Comprehensive Study Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins*. U. S. Army Corps of Engineers, Mobile, AL.

Sassaman, Kenneth E. 1993. *Early Pottery in the Southeast: Tradition and Innovation in Cooking Technology*. University of Alabama Press, Tuscaloosa.

Scheidegger, K.F., and M.B. Bain. 1995. Larval Fish Distribution and Microhabitat Use in Free-flowing and Regulated Rivers. *Copeia*.

Scott, J.C., R.H. Cobb, and R.D. Castleberry. 1987. *Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama, Area 8*. U.S. Geological Survey Water-Resources Investigation Report 86-4360.

Sehlinger, B. and D. Otey. 1995. *A Paddler's Guide to Southern Georgia: A Canoeing and Kayaking Guide to the Streams of the Western Piedmont, Coastal Plain, Georgia Coast, and Okefenokee Swamp*. 2nd edition. Menasha Ridge Press, Birmingham, Alabama.

Shepard, T.E., P.E. O'Neil, S.W. McGregor and S.C. Harris. 1994. "Water quality and biomonitoring studies in the upper Cahaba River drainage of Alabama." Geological Survey of Alabama Bulletin 160.

Smith, Marvin T. 1989. "Aboriginal Population Movements in the Early Historic Period Interior Southeast." In P.H. Wood, G.A. Waselkov, and M.T. Hatley (eds.) *Powhatan's Mantle: Indians in the Colonial Southeast*. University of Nebraska Press, Lincoln.

Soil Conservation Service. 1974. *General Soil Map, State of Alabama*. 1:1,000,000 scale.

Sparks, R.E. 1995. "Need for Ecosystem Management of Large Rivers and their Floodplains." *BioScience* 45.

Sparks, R.E. 1992. "Risks of Altering the Hydrologic Regime of Large Rivers." In Cairns, J. et al. (eds.) *Predicting Ecosystem Risk. Vol. XX. Advances in Modern Environmental Toxicology*. Princeton Scientific Publishing Co., Princeton, NJ.

Stamer, J.K., R.N. Cherry, R.E. Faye, and R.L. Kleckner. 1979. *Magnitudes, Nature, and Effects of Point and Nonpoint Discharges in the Chattahoochee River Basin, Atlanta to West Point Dam*. U.S. Geological Survey Water- Supply Paper 2059.

Stewart, J.W. 1964. *Infiltration and Permeability of Weathered Crystalline Rocks at the Georgia Nuclear Laboratory, Dawson County, Georgia*, U.S. Geological Survey Bulletin 1133-F.

Stewart, J.W., J.T. Callahan, and R.F. Carter. 1964. *Geologic and Hydrologic Investigation at the Site of the Georgia Nuclear Laboratory, Dawson County, Georgia*. U.S. Geological Survey Bulletin 1133-F.

Tarbuck, E. J. and F.K. Lutgens. 1984. *The Earth - An Introduction to Physical Geology*. Charles E. Merrill Publishing.

TechCon, Inc. 1980. Final report to Mobil Oil Exploration and Producing Southeast, Inc., environmental monitoring program for test well in Mobile Bay, Alabama. Mobil Oil Exploration and Producing Southeast, Inc., New Orleans, LA. 7 vol.

Tilman, D., J.A. Downing, and D.A. Wedin. 1994. "Does Diversity Beget Stability?" *Nature*. 371:257-264.

Tonsmeire, D., D.J. Cairns, E. Hemmert, and P.L. Ryan. 1996. *Apalachicola River and Bay Management Plan*. Northwest Florida Water Management District, Program Development Series 96-1.

Torak, L.J., G.S. Davis, G.A. Strain, and J.G. Herdon. 1993. *Geohydrology and Evaluation of Water-Resource Potential of the Upper Floridan Aquifer in the Albany Area, Southwestern Georgia.* U.S. Geological Survey Water-Supply Paper 2391.

Torak, L. J. and R. J. McDowell. 1996. *Ground-Water Resources of the Lower Apalachicola-Chattahoochee-Flint River Basin in Parts of Alabama, Florida, and Georgia – Subarea 4 of the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa River Basins.* U.S. Geological Survey Open File Report 95-321.

Toth, L.A. 1995. "Principles and Guidelines for Restoration of River/Floodplain Ecosystems: Kissimmee River, Florida." In Carins, J. (ed.) *Rehabilitating Damaged Ecosystems.* 2nd ed. Lewis Publishers/CRC Press, Boca Raton, FL.

Travnichek, V.H., and M.J. Maceina. 1994. Comparison of Flow Regulation Effects on Fish Assemblages in Shallow and Deep Water Habitats in the Tallapoosa River, Alabama. *Journal of Freshwater Ecology.* 9: 207-216.

Travnichek, V.H., M.B. Bain, and M.J. Maceina. 1995. Recovery of a Warmwater Fish Assemblages after the Inundation of a Minimum-flow Release Downstream from a Hydroelectric Dam. *Trans. Am. Fish. Soc.* 124: 836-844.

U.S. Army Corps of Engineers (Corps). 1998. "Existing Conditions Model, Surface Water Availability." *ACT/ACF Comprehensive Water Resources Study.* Unpublished draft.

U.S. Army Corps of Engineers (Corps). 1997. "Unimpaired Flow, Surface Water Availability." *ACT/ACF Comprehensive Water Resources Study.* Volume 1.

U.S. Army Corps of Engineers (Corps). 1992. Allatoona water control manual, Etowah River, Georgia. U.S. Army Corps of Engineers, Mobile District. Summary of July 7, 1992 revisions to manual.

U.S. Army Corps of Engineers (Corps). 1991. Alabama-Coosa River water control manual, Appendix A (Allatoona Reservoir, Etowah River, Georgia). U.S. Army Corps of Engineers, Mobile District. Revised December 1991.

U.S. Army Corps of Engineers (Corps). 1987. *Final Supplement to Final Environmental Statements: Alabama and Georgia (Operation and Maintenance).* Mobile District.

U.S. Army Corps of Engineers (Corps). May 1976. *Final Environmental Statement: Alabama-Coosa Rivers, Alabama and Georgia (Operation and Maintenance).* Mobile District.

U.S. Army Corps of Engineers (Corps). April 1974a. *Final Environmental Statement: Carters Dam and Lake, Coosawattee River, Georgia.* Mobile District.

U.S. Army Corps of Engineers (Corps). November 1974b. *Final Environmental Statement: Allatoona Dam and Lake, Georgia (Flood Control and Power).* Mobile District.

U.S. Army Corps of Engineers (Corps). November 1974c. *Final Environmental Statement: Millers Ferry Lock and Dam, Alabama River, Alabama.* Mobile District.

U.S. Army Corps of Engineers (Corps). 1974d. *Final Environmental Statement: Jones Bluff Lock and Dam, Alabama River, Alabama.* Mobile District

U.S. Army Corps of Engineers (Corps). September 1973a. *Final Environmental Statement: Channel Stabilization Structures, Alabama River, Alabama.* Mobile District.

U.S. Army Corps of Engineers (Corps). November 1973b. *Final Environmental Statement: Claiborne Lock and Dam, Alabama River.* Mobile District.

U.S. Army Corps of Engineers (Corps). Undated. *Alabama-Coosa-Tallapoosa River and Apalachicola-Chattahoochee-Flint Rivers Basins Comprehensive Study.* Power Resources – Water Demand Power Branch, North Pacific Division.

U.S. Army Corps of Engineers (Corps). Undated. *Municipal and Industrial Water Demand Impact Analysis: Alabama-Coosa-Tallapoosa Basin.* Unpublished report.

U.S. Census Bureau, 1998. U.S. Census web page. http://www.census.gov

U.S. Department of Agriculture Forest Service (USFS). 1998. USFS web page. *http://www.r8web.com/forests.html.*

U.S. Department of Agriculture Forest Service. April 10, 1998. Chattahoochee-Oconee National Forests web page. *http://www.fs.fed.us/conf/rec_head.html.*

U.S. Department of Commerce. 1996a. *Fisheries of the United States, 1995.* Current Fisheries Statistics Number 9500.

U.S. Department of Commerce. 1996b. *Our Living Oceans: The Economic Status of US Fisheries, 1996.* NOAA Technical Memorandum NMFS-F/SPO-22.}

U.S. Environmental Protection Agency (EPA). 1998. EPA web page *http://www.epa.gov/superfund/oerr/siteinfo/basic.html.*

U.S. Environmental Protection Agency (EPA). 1998. Noise Pollution Clearinghouse web page. *http://www.nonoise.org/library/levels74/levels74.htm#use of identified environmental noise levels.*

U.S. Environmental Protection Agency (EPA) Region IV. 1997a. *Land Cover Data Set, South-Central portion.* (Landsat TM data acquired in 1998 and 1990-1993). Version 1. EROS Data Center, Sioux Falls, SD.

U.S. Environmental Protection Agency (EPA). 1997b. *National Air Quality and Emissions Trends Report, 1996.* Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency (EPA). May 1996a. *BASINS CDROM version 1, 1993-1994.* Office of Water/Office of Science and Technology. EPA-823-C-96-004.

U.S. Environmental Protection Agency (EPA). July 12, 1996b. *Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analysis.* Review Draft. Office of Federal Activities.

U.S. Environmental Protection Agency (EPA). 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Office of Noise Abatement and Control. Report 550/9-74-004.

U.S. Environmental Protection Agency (EPA). 1973. *Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure.* Office of Noise Abatement and Control.

U.S. Geological Survey (USGS). 1998. Geographic Names Information System web page. *http://mapping.usgs.gov/www/gnis.GNISQuery.html.*

U.S. Geological Survey (USGS). 1986. Hydrologic Events and Surface-Water Resources in National Water Summary: U.S. Geological Survey Water-Supply Paper 2300.

U.S. Geological Survey (USGS). 1978. *Land Use and Land Cover Digital Data, 1972-78, Apalachicola, Atlanta, Dothan, Greenville, Macon, Phenix City, Rome, Tallahassee, and Waycross Quadrangle.* Scale 1:250,000.

U.S. Military SITES Installations Database web page. 1998. *http://www.dmdc.osd.mil/sites/owa/OVERVIEWS.html.*

Wharton, C. H. 1978. *The Natural Environments of Georgia.* Georgia Geologic Survey Bulletin 114.

Wharton, C.H., H.T. Odum, K. Ewel, M. Duever, A. Lugo, R. Boyt, J. Bartholomew, E. DeBellevue, S. Brown, M. Brown, and L. Duever. 1977. *Forested Wetlands of Florida – Their Management and Use.* Gainesville, Florida, University of Florida.

Wolfe, S.H., J.A. Reidenauer, and D.B. Means. 1988. *An Ecological Characterization of the Florida Panhandle.* Fish and Wildlife Service Biological Report 88(12), Minerals Management Service OCS Study\MMS 88-0063.

Wood, Peter H. 1989. "The Changing Population of the Colonial South: An Overview by Race and Region, 1685-1790." In P.H. Wood, G.A. Waselkov, and M.T. Hatley (eds.) *Powhatan's Mantle: Indians in the Colonial Southeast.* University of Nebraska Press, Lincoln.

Yarnell, Richard A. 1993. "The Importance of Native Crops During the Late Archaic and Woodland Periods." In C.M. Scarry (ed.) *Foraging and Farming in the Eastern Woodlands.* University Press of Florida, Gainesville.

Ziewitz, J. 1998. *Fish and Wildlife Coordination Act Report for the Apalachicola-Chattahoochee Flint River Basin Water Allocation Formula.* Working draft.

Ziewitz, J.W., B.K. Luprek, and J.W. Kasbohm. 1997. *Protected Species Inventory and Identification in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins.* Volume I. Fish and Wildlife Service, Panama City, Florida.

Ziewitz, J.W. 1997. *Anadromous Fish Habitat in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins.* Fish and Wildlife Service, Panama City, Florida.

Ziewitz, J.W. and B.K. Luprek. 1996. *Water Needs of Fish and Wildlife Management Facilities in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins.* Report to the Technical Coordination Group of the ACT-ACF Comprehensive Study. Fish and Wildlife Service, Panama City, Florida.

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Acronyms and Abbreviations

ACF	Apalachicola-Chattahoochee-Flint (Rivers)
ac	acre
ac-ft	acre-foot
ACHP	Advisory Council on Historic Preservation
ACT	Alabama-Coosa-Tallapoosa (Rivers)
ADECA	Alabama Department of Economic and Community Affairs
ADEM	Alabama Department of Environmental Management
ADCNR	Alabama Department of Conservation and Natural Resources
AGFD	Alabama Game and Fish Division
AL	Alabama
APCO	Alabama Power Company
ASA(CW)	Assistant Secretary of the Army for Civil Works
BASINS	Better Assessment Science Integrating Point and Nonpoint Source (Model)
BOD	biochemical oxygen demand
BRD	(USGS) Biological Research Division
BWWB	Birmingham Water Works Board
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERL	(U.S. Army) Construction Engineering Research Laboratory
CFR	*Code of Federal Regulations*
cfs	cubic feet per second (1 cfs = 0.646 mgd)
CNF	Chattahoochee National Forest
CO	carbon monoxide
Corps	U.S. Army Corps of Engineers
CSO	combined sewer overflow
CWA	Clean Water Act
dBA	decibels on A-weighted scale
DO	dissolved oxygen
DOJ	(U.S.) Department of Justice
EA	environmental assessment
EFH	essential fish habitat
EIFS	Economic Impact Forecasting System
EIS	Environmental Impact Statement
EO	Executive Order
EOP	end-of-period
EPA	(U.S.) Environmental Protection Agency
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute, Inc.
F	Fahrenheit
FDEP	Florida Department of Environmental Protection
FEMA	(U.S.) Federal Emergency Management Agency
FERC	(U.S.) Federal Energy Regulatory Commission
FGFWFC	Florida Game and Fresh Water Fish Commission
FMP	Fishery Management Plan
FR	*Federal Register*
FS	(U.S.) Forest Service, Department of Agriculture
ft	feet
FWCA	Fish and Wildlife Coordination Act
FWS	(U.S.) Fish and Wildlife Service, Department of the Interior
FY	fiscal year
GA	Georgia
GDNR	Georgia Department of Natural Resources
GEC	Gulf Engineers & Consultants, Inc.
GEPD	Georgia Environmental Protection Division
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
GPC	Georgia Power Company
gpm	gallons per minute
GWRD	Georgia Wildlife Resources Division
HEC	Hydrologic Engineering Center (U.S. Army Corps of Engineers)
IHA	Indicators of Hydrologic Alteration

kW	kilowatt
LOA	letter of agreement
MA	(U.S.) Maritime Administration (Department of Transportation)
mgd	million gallons per day (1 mgd = 1.55 cfs)
mg/L	milligrams per liter
M&I	municipal and industrial
mi^2	square miles
MLRA	Major Land Resource Area
mm	millimeter
MOA	memorandum of agreement
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
msl	mean sea level
MW	megawatts
MWh	megawatt hour
NA	not applicable
NAAQS	National Ambient Air Quality Standards
NAWQA	National Water Quality Assessment
NDA	no data available
NED	National Economic Development
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Council
NHPA	National Historic Preservation Act
NMFS	(U.S.) National Marine Fisheries Service (NOAA)
NOAA	(U.S.) National Oceanic and Atmospheric Administration (Department of Commerce)
NOI	Notice of Intent
NOS	(U.S.) National Ocean Service (NOAA)
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPRES	National Preserve
NPS	(U.S.) National Park Service, Department of the Interior
NRA	National Recreation Area
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture)
NRHP	National Register of Historic Places
NWFWMD	Northwest Florida Water Management District
PCB	polychlorinated biphenyl
PL	Public Law
PM_{10}	particulate matter (less than 10 microns in aerodynamic diameter)
PMCL	Planning and Management Consultants Limited, Inc.
POS	plan of study
ppt	parts per thousand
PROSYM	Propriety Hourly Power System Evaluation Model
RCHARC	Riverine Community Habitat Assessment and Restoration Concept
RCRA	Resource Conservation and Recovery Act
RM	river mile
ROD	Record of Decision
ROI	region of influence
RTV	rational threshold value
RVA	range of variability approach
RWU	Riparian Wetland Unit
SARA	Superfund Amendment and Reauthorization Act of 1986
SEPA	(U.S.) Southeastern Power Administration (Department of Energy)
SERC	Southeastern Electrical Reliability Council
SHPO	State Historic Preservation Officer
SIP	state implementation plans
SMSA	Standard Metropolitan Statistical Area
SO_2	sulfur dioxide
STATSGO	State Soil Geographic Database
TCG	Technical Coordination Group
TM	thematic mapping
USC	United States Code
USGS	U.S. Geological Survey, Department of the Interior
WCSC	Waterborne Commerce Statistics Center
WES	Waterways Experiment Station (U.S. Army Corps of Engineers)
WMA	Wildlife Management Area
WPA	Works Projects
WWTP	wastewater treatment plant Administration

Alternatives Considered Applicable to the ACT Basin EIS

Demand Year	No Action Alternative	Action Alternative Flow Scenarios		
		High Flow Conditions	Moderate Flow Conditions	Low Flow Conditions
1995	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995). Consumptive demands associated with thermal power generation were modeled and included in the calculation of total demands. One set of thermal power demands was used for all the alternatives.

Reservoir releases in this table refers to the operation of reservoirs to maintain or enhance flows in the river during critical low periods.