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GAO

Report to the Honorable
Van Hilleary, House of Representatives

May 1999

TENNESSEE VALLEY AUTHORITY

Future Study of Lake Levels Should Involve Public and Consider Costs and Benefits

GAO/RCED-99-154

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-282488

May 17, 1999

The Honorable Van Hilleary
House of Representatives

Dear Mr. Hilleary:

As requested, this report addresses how the Tennessee Valley Authority (TVA) manages and operates its multipurpose tributary projects—consisting of dams and lakes on the tributaries of the Tennessee River—for various purposes, such as flood control, navigation, hydroelectric power production, and recreation. Our report provides information and analyses on the purposes served by these projects, operational changes made to these projects in 1990, actions taken by TVA since 1990 to address requests for changes in project operations, and TVA's plans for any future changes in project operations. This report also provides a recommendation to the Chairman of TVA's Board of Directors.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will provide copies of the report to appropriate House and Senate Committees; interested members of Congress; Craven Crowell, Chairman, TVA's Board of Directors; The Honorable Jacob Lew, Director, Office of Management and Budget; and other interested parties. We will also make copies available to others on request.

Please call me at (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix VI.

Sincerely yours,

Susan Kladiva
Associate Director, Energy,
Resources, and Science Issues

Executive Summary

Purpose

The Tennessee Valley Authority (TVA), a wholly owned government corporation, is, by some measures, the nation's largest electric power producer. TVA is also responsible for the use, conservation, and development of the natural resources related to the Tennessee River. In carrying out these responsibilities, TVA relies on an integrated system of 54 dams and associated components—referred to as projects—to harness the Tennessee River and its tributaries to serve various purposes, such as navigation and flood control, for the public's benefit. Thirteen of these projects, referred to as multipurpose tributary projects, consist of dams and lakes on the tributaries to the Tennessee River, such as the Douglas and Cherokee projects, that provide multiple public benefits. Concerns have been raised about TVA's operation of these multipurpose tributary projects to satisfy the multiple and often competing public benefits.

Representative Van Hilleary asked GAO to provide information on (1) the purposes served by TVA's multipurpose tributary projects and how TVA operates these projects within its integrated system, (2) the operational changes TVA made to these projects as a result of its December 1990 review of its project operations and the major factors influencing these changes, (3) the actions TVA has taken since the 1990 review to address requests for changes in the way it operates these projects, and (4) TVA's plans for any future changes in the way it operates these projects. GAO is also providing information on a selected update by TVA of its analysis performed in the 1990 review.

Background

TVA was established by the Tennessee Valley Authority Act of 1933 to, among other things, improve the navigability and control flooding of the Tennessee River and provide for the Valley's agricultural and industrial development. The generation and transmission of hydroelectric power was established by law as an additional benefit secondary only to navigation and flood control. To carry out its river management responsibilities, TVA constructed or acquired its 54 projects to serve many purposes. These projects have a dam and can include several components, such as a lake behind the dam and hydroelectric power facilities at the dam. Some of these projects were constructed for specific purposes, such as producing hydroelectric power. Other projects, such as the 13 multipurpose tributary projects, were constructed for multiple purposes, such as producing hydroelectric power and helping control flooding.

TVA has guidelines, which it refers to as lake level policies, that prescribe the levels that must be maintained at the lakes at various times during the

year. Under these guidelines, most of the multipurpose tributary projects are subject to significant lake level changes during the year as a result of TVA's flood control and hydroelectric power production efforts. Annually, TVA lowers the lake levels at these projects during the late summer and fall in order to provide space for the rainfall and runoff that occurs in the winter and early spring. According to TVA, while large storms can occur throughout the year, the major regional floods on the Tennessee River normally occur between December and April. As TVA lowers the lake levels, a process referred to as the "drawdown" of the lakes, TVA generates hydroelectric power with the water released from the dams. As the flood risk diminishes in the spring, TVA allows the lake levels to rise from rainfall and runoff flowing into the lake in order to reach desirable summer levels for recreational purposes.

TVA has performed studies and reviews in the past examining whether changes in lake levels could be made to improve recreational uses of TVA lakes. The most recent review was published in December 1990, which resulted in TVA delaying the annual lake-level drawdown at multipurpose tributary projects from Memorial Day to August 1. This delayed drawdown allowed lake levels at these projects to remain higher during the summer recreation season.

Results in Brief

The operation of the multipurpose tributary projects[1] serves several purposes—primarily navigation and flood control, and to the extent consistent with these purposes, hydroelectric power production. These three operating priorities are contained in the TVA Act. TVA can permit operation of the projects for other purposes, such as recreation and water quality, subject to the three statutory purposes. In operating its integrated system, TVA often finds that the multiple purposes served by the projects can conflict and/or compete with each other. As a result, TVA attempts to balance the various purposes served to provide the greatest public benefits from the waters of the Tennessee River and its tributaries while adhering to the operating priorities.

A key change resulting from its December 1990 review of project operations was TVA's delaying the annual lake drawdown at the multipurpose tributary projects from Memorial Day to August 1. The major factor influencing this change was that, of the seven alternatives examined

[1]For this report, GAO defines multipurpose tributary projects as including 14 projects—the 13 projects mentioned (Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Melton Hill, Norris, Nottely, South Holston, Tellico, Tims Ford, and Watauga)—and another project (Blue Ridge) because this project has an annual drawdown cycle similar to most of the other 13 projects.

in the 1990 review, this alternative had the least impact on TVA's systemwide cost of supplying electric power. All of the alternatives reduced TVA's ability to generate hydroelectric power during periods of peak power demand. TVA estimated that the selected alternative would require replacing some hydroelectric power with power from more expensive generation sources, at an annual average cost of $2 million (in 1990 dollars).

Since the 1990 review, little has changed in how TVA operates its multipurpose tributary projects. Because it had been receiving an increasing number of requests to analyze changes in the lake levels for individual lakes, TVA determined that a piecemeal approach raised questions of fairness in how each lake would be treated within TVA's system. TVA officials also believed that there was great uncertainty surrounding the future of the electric utility industry due to deregulation and restructuring. Therefore, in March 1997, TVA established a 4-year moratorium on making any changes in lake levels.

TVA has recognized that any future changes to its policies impacting lake levels require further study. In July 1998, an internal TVA task force report recommended that TVA continue its moratorium and start reevaluating policies impacting lake levels within the next 2 to 4 years. The task force also noted the complexities involved in carrying out such a study and identified several areas requiring further attention. Among these are a proactive communication plan with the public and better evaluation methodologies for costs and benefits. GAO agrees that further study is warranted and that public and other stakeholder involvement is critical to the success of TVA's reexamination efforts. Equally important, however, is a comprehensive analysis of the costs and benefits of any alternatives analyzed. This report makes a recommendation directed to the Chairman of TVA's Board of Directors to ensure these actions take place.

Principal Findings

TVA Balances Various Purposes of Multipurpose Tributary Projects

The multipurpose tributary projects serve various purposes. These purposes include maintaining a navigable waterway between Knoxville, Tennessee, and Paducah, Kentucky; reducing the risk of flooding throughout the Tennessee Valley, especially at Chattanooga, Tennessee;

and providing hydroelectric power. In addition to these primary purposes, these projects can also serve recreational and water quality purposes.

In operating these projects, TVA faces a balancing act of how to maximize the benefits of the available water to meet all of the purposes. TVA's ability to lower and raise the lake levels during the year is a key element in this balancing act. For example, TVA lowers the lake level for Douglas—a multipurpose tributary project—50 feet from 990 feet on August 1 to 940 feet above sea level on January 1. TVA does so to reduce the risk of flooding while also allowing for hydroelectric power production during periods of peak power demand. When the flood risk diminishes, TVA allows the lake levels to rise so that desirable summer recreation levels are achieved by Memorial Day.

Changes Resulting From 1990 Review and Cost Impacts Estimated in 1990 and 1999

Resulting from its 1990 review,[2] a key policy change TVA implemented in 1991 was a 2-month delay in the annual lake drawdown of the multipurpose tributary projects. This change meant that the drawdown of the lake levels could begin on August 1—some 2 months later than TVA's previous policy of the lake-level drawdown starting on Memorial Day. Thus, lake levels were allowed to remain higher during June and July under this new policy.[3] Although various factors influenced TVA's decision, the impact on TVA's systemwide cost of supplying electric power resulting from the 2-month delay in the annual drawdown was the major factor TVA considered when examining the seven alternatives. Other factors TVA considered were minimizing the impacts on the environment and flood risk in the Valley and increasing recreational opportunities at the lakes. TVA selected the alternative having the lowest impact on its systemwide cost of supplying electric power.

TVA used a complex methodology in estimating this impact. TVA estimated an annual average increase of $2 million (in 1990 dollars) in its systemwide cost of supplying electric power for the lake-level alternative selected. Other alternatives were not selected, including maintaining the lake levels higher until Labor Day or October 31, because the annual average

[2]Tennessee River and Reservoir System Operation and Planning Review, TVA (Dec. 1990). This review examined a number of issues, including potential changes in the lake levels at the multipurpose tributary projects.

[3]This policy also allowed TVA to fill the affected lakes above the August 1 levels. By doing so, TVA could conduct a limited drawdown, referred to as a "restricted" drawdown, of the lake levels during June and July and use this additional water to generate hydroelectric power during periods of peak power demand in these 2 months, while still meeting the lake levels on August 1, when "unrestricted" drawdown could begin.

increases in TVA's systemwide cost of supplying electric power were estimated at $84 million and $93 million, respectively (in 1990 dollars). However, TVA's methodology did not attempt to quantify other types of costs, such as impacts to flood control and navigation operations. In addition, TVA did not attempt to quantify potential benefits that may result from increased recreation or tourism by maintaining summer lake levels longer.

To illustrate what the potential future impacts could be on TVA's systemwide cost of supplying electric power given the considerable changes in the electricity industry since 1990, GAO requested that TVA analyze two alternatives that were similar to those TVA examined in the 1990 review. These two alternatives were judgmentally selected to show the potential impact of an additional 1-month drawdown delay for all of the projects and an additional 2-month drawdown delay for three of the projects. In 1990, TVA adopted a policy to begin the drawdown of the lake levels on August 1. It was this policy against which TVA evaluated the alternatives in 1999. By contrast, in 1990 TVA evaluated alternatives against a Memorial Day drawdown date. In the 1999 update, as in 1990, TVA identified systemwide cost increases of supplying electric power.

TVA's 1999 analysis showed that delaying drawdown of the lake levels at the multipurpose tributary projects from August 1 until Labor Day could result in estimated increased systemwide costs of supplying electric power ranging from $0 to $88 million annually, with an average annual estimated cost of $47 million (in 1999 dollars). The results for the second alternative examined—three of the lakes having an October 1 drawdown date with others keeping the August 1 drawdown—showed potential cost impacts ranging from a $2 million decrease in costs to a $33 million increase in costs annually, with an average annual estimated cost increase of $14 million (in 1999 dollars). TVA cautioned, however, that both the 1990 and 1999 estimates were subject to a great deal of uncertainty due to future hydrological conditions, electricity prices, and other variables. While a complete evaluation of the cost-estimation methodologies used by TVA was beyond the scope of GAO's work, the general approach used by TVA in 1990 and 1999 appeared to be reasonable.

Little Action Taken to Change Project Operations Since 1990 Despite Requests From Users

Although TVA continued to receive requests from individuals and organizations during the 1990s to make additional changes to lake levels, its policies have changed little. In March 1997, TVA adopted a 4-year moratorium on making any changes to lake levels because it believed such

action would (1) position TVA better for future competition in the electric utility industry, (2) minimize the public's perception of favoritism for any particular lake within the system, and (3) allow time for TVA to determine how studies of lake levels should be evaluated in the future.

Even though TVA had implemented a moratorium, it commented on two studies conducted by non-TVA organizations on the estimated benefits to local economies resulting from lake levels being kept higher during the year.[4] TVA criticized certain aspects of the studies, such as the scope, methodology, and assumptions. TVA noted that one of the studies lacked proper recognition of the multipurpose roles served by TVA's projects and how changes would impact the entire system of projects. GAO also noted that these studies were limited because they considered only the impacts on TVA's systemwide cost of supplying electric power that were estimated by TVA and estimated benefits pertaining to only a few counties adjacent to the lakes in question. Neither study performed a comprehensive analysis of benefits and costs of proposed lake-level changes. Such comprehensive analyses must be performed in order to provide a balanced evaluation.

TVA Plans Further Study of Multipurpose Tributary Projects

TVA recognizes that further study of its policies impacting lake levels is warranted and that it must do more to prepare for an eventual reexamination. TVA's internal task force has recommended that TVA proceed slowly, however, because it needs to develop the evaluation methods necessary to adequately perform a reexamination. The task force reported that TVA needs to (1) better define flood risk impacts, (2) refine water resource planning and operation models to better simulate the operation of the integrated system of projects under various scenarios, and (3) develop economic growth and development analysis methods to better represent expected impacts under alternative policies impacting lake levels. In addition, TVA does not want to set unrealistic expectations about how quickly any decisions could be reached about whether changes are or are not needed to policies impacting lake levels because of the extensive time that may be required to examine the range of environmental issues involved.

GAO agrees that a reexamination of TVA policies impacting lake levels is warranted. GAO also agrees that formal and continuing communication with the public and other stakeholders will be an extremely important

[4]Economic and Fiscal Consequences of TVA's Draw-Down of Cherokee and Douglas Lakes, Center for Business and Economic Research, University of Tennessee (Oct. 1998) and The Economic Impact of Alternate TVA Lake Management Policies, North American Water Management Institute, Inc., Athens, GA (Dec. 1997).

factor in TVA's reexamination. These communications are needed to (1) further educate TVA regarding the concerns and needs of the various stakeholders that must be considered in the reexamination process, (2) give TVA additional opportunities to explain the operation of its integrated system and the complexities involved in evaluating changes to the system, (3) establish realistic expectations of the time required to reevaluate changes in policies impacting lake levels, (4) keep the public informed of TVA's ongoing activities and progress achieved, and (5) increase the overall credibility of the reexamination process.

Past evaluations examining changes to lake levels have tended to emphasize either the costs associated with the potential change as has been the case with TVA's efforts or localized economic benefits as has been the case with studies performed by non-TVA organizations. When reexamining any potential changes in lake levels, a balanced and comprehensive decision can only be reached through consideration of the costs and benefits of the alternatives examined.

Recommendation

GAO recommends that the Chairman of TVA's Board of Directors (1) provide for a formal and continuing communication process for the public and other stakeholders to actively participate in TVA's efforts to reexamine its policies impacting lake levels and (2) ensure that TVA's reexamination efforts consider the costs and benefits of any potential changes to policies impacting lake levels.

Agency Comments

GAO provided a copy of a draft of this report to TVA for its review and comment. TVA's comments and GAO's responses to those comments are included as appendix I. TVA also provided some technical clarifications that have been incorporated in this report where appropriate. TVA stated that GAO had conducted a comprehensive assessment of TVA's tributary lake operating policies and that the draft report fairly summarized the issues influencing TVA's operations. Regarding GAO's recommendation that TVA provide for a formal and continuing communication process, TVA stated that it is essential that the public continue to be involved in decisions that affect how the Valley's water resources are used. TVA also recognized that there is an opportunity to improve its communications with stakeholders. TVA added that it remains committed to communicating fully with its stakeholders and others who depend on the integrated management of the Tennessee River system.

Regarding GAO's recommendation that TVA's reexamination efforts consider the costs and benefits of potential changes, TVA stated that in operating the river system for the greatest public benefit, it continues to look for new methodologies that will provide for a more objective analysis of the tradeoffs among competing demands. TVA stated that certain water uses, such as hydropower and flood control, lend themselves more readily to quantitative analysis, while other operating objectives, such as economic development and environmental impacts, continue to be more difficult to quantify. TVA added that it remains committed to providing lake users and other beneficiaries with the best information it has on the most likely impacts of changes in lake operations so that such lake users and other beneficiaries are aware of the tradeoffs and consequences of policy changes.

TVA also emphasized in its comments that not all costs are monetary. TVA stated that as it works to meet multiple needs with a finite resource, increased costs can take the form not only of higher electricity prices but also reduced flood control benefits, lessened environmental quality, and reductions in other benefits. TVA added that costs in any form become costs to some segment of the public.

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Abbreviations

CLUA	Cherokee Lake Users Association
EA	environmental assessment
EIS	environmental impact statement
GAO	General Accounting Office
HLOLE	Hourly Loss of Load Expectation
LOUD	Lake Owners and Users of Douglas
MW	megawatt
NEPA	National Environmental Policy Act
TVA	Tennessee Valley Authority
USFS	U.S. Forest Service
WSM	Weekly Scheduling Model

Introduction

The Tennessee Valley Authority (TVA), a wholly owned government corporation, is, by some measures, the nation's largest electric power producer. TVA, as a multipurpose, independent federal corporation, is responsible for managing both power and nonpower programs,[1] including the use, conservation, and development of the natural resources related to the Tennessee River. In carrying out these responsibilities, TVA relies on an integrated system of 54 dams and associated components—referred to as projects—to harness the Tennessee River and its tributaries to serve various purposes for the public's benefit. These purposes include maintaining navigable waterways, protecting the public from floods, producing hydroelectric power, and providing recreational opportunities on TVA lakes. Concerns have been raised about TVA's operation of a key component of its integrated system—the multipurpose tributary projects, consisting of dams and lakes on the tributaries to the Tennessee River, such as the Cherokee and Douglas projects—to satisfy the multiple and often conflicting public benefits.

Background

TVA was established by the Tennessee Valley Authority Act of 1933 to, among other things, improve the navigability and to provide for the flood control of the Tennessee River and provide for the agricultural and industrial development of the Tennessee Valley. The generation and transmission of hydroelectric power was established by law as an additional benefit resulting from these activities, secondary only to river operations to support navigation and flood control. Over time, other project purposes beyond navigation, flood control, and hydroelectric power production began to be recognized for various projects. Two such purposes were recreation and water quality. These purposes, however, are subordinate to the statutory purposes of navigation, flood control, and hydropower.

To carry out its river management responsibilities, TVA constructed or acquired 54 projects primarily along the Tennessee River and its tributaries as an integrated system to serve many purposes.[2] These 54 projects have a dam and can include several components, such as a lake behind the dam and hydroelectric power facilities at the dam. Some of these projects were constructed for specific purposes, such as producing hydroelectric power. Other projects serve multiple purposes. For example, 13 of the projects located on the tributaries of the Tennessee River are

[1]See Tennessee Valley Authority: Information on Nonpower Programs (GAO/RCED-98-133R, Mar. 31, 1998) for additional information.

[2]One of the 54 projects is located on a tributary of the Cumberland River.

classified as multipurpose tributary projects serving various purposes, such as navigation, flood control, hydroelectric power production, and/or recreation. In addition, there are other multipurpose projects located on the main portion of the Tennessee River, and these projects serve, among other things, navigation and power production purposes, but have limited flood control capabilities.

TVA has guidelines, which it refers to as lake-level policies, that prescribe the levels that must be maintained at the lakes at various times during the year. For example, TVA has established certain lake levels—referred to as "target" levels—that should be met on January 1, March 15, June 1, and August 1. The January 1 and March 15 targets are maximum levels and the June 1 and August 1 targets are minimum levels. Under these guidelines, most of the multipurpose tributary projects are subject to significant lake-level changes during the year as a result of TVA's flood control efforts. Annually, TVA lowers the lake levels at these projects during the late summer and fall in order to provide additional storage space so that the projects can help control flooding. This storage space, which TVA refers to as flood control capacity,[3] is designed into the multipurpose tributary projects[4] so that rainfall and runoff in the winter and early spring can be held back behind the dams to help ease or potentially avert a flooding situation downstream from the dam. According to TVA, while large storms can occur throughout the year, the major regional floods on the Tennessee River normally occur between December and April. This lowering of water levels for flood control purposes, a process referred to as the "drawdown" of the lakes, occurs between August 1 and January 1, and also allows TVA to generate hydroelectric power with the water released from the dams during periods of peak power demand in the summer. During the winter, the water levels are allowed to increase slowly through mid-March from rainfall and runoff flowing into the lakes, and then more rapidly through Memorial Day, allowing for increased recreational uses of the lakes during the late spring/early summer period.

Over the years, TVA has performed studies and reviews examining whether changes in lake levels could be made to improve recreational uses of TVA

[3]For example, three of the multipurpose tributary projects have over 3.7 million acre-feet of flood control capacity available on January 1. An acre-foot is a unit of measurement used to describe the amount of storage in a reservoir. One acre-foot equals the volume of water covering 1 acre (43,560 square feet) to a depth of 1 foot.

[4]For this report, we define multipurpose tributary projects as including 14 projects—the 13 projects mentioned (Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Melton Hill, Norris, Nottely, South Holston, Tellico, Tims Ford, and Watauga) and another project (Blue Ridge) because this project has an annual drawdown cycle similar to the other 13 projects.

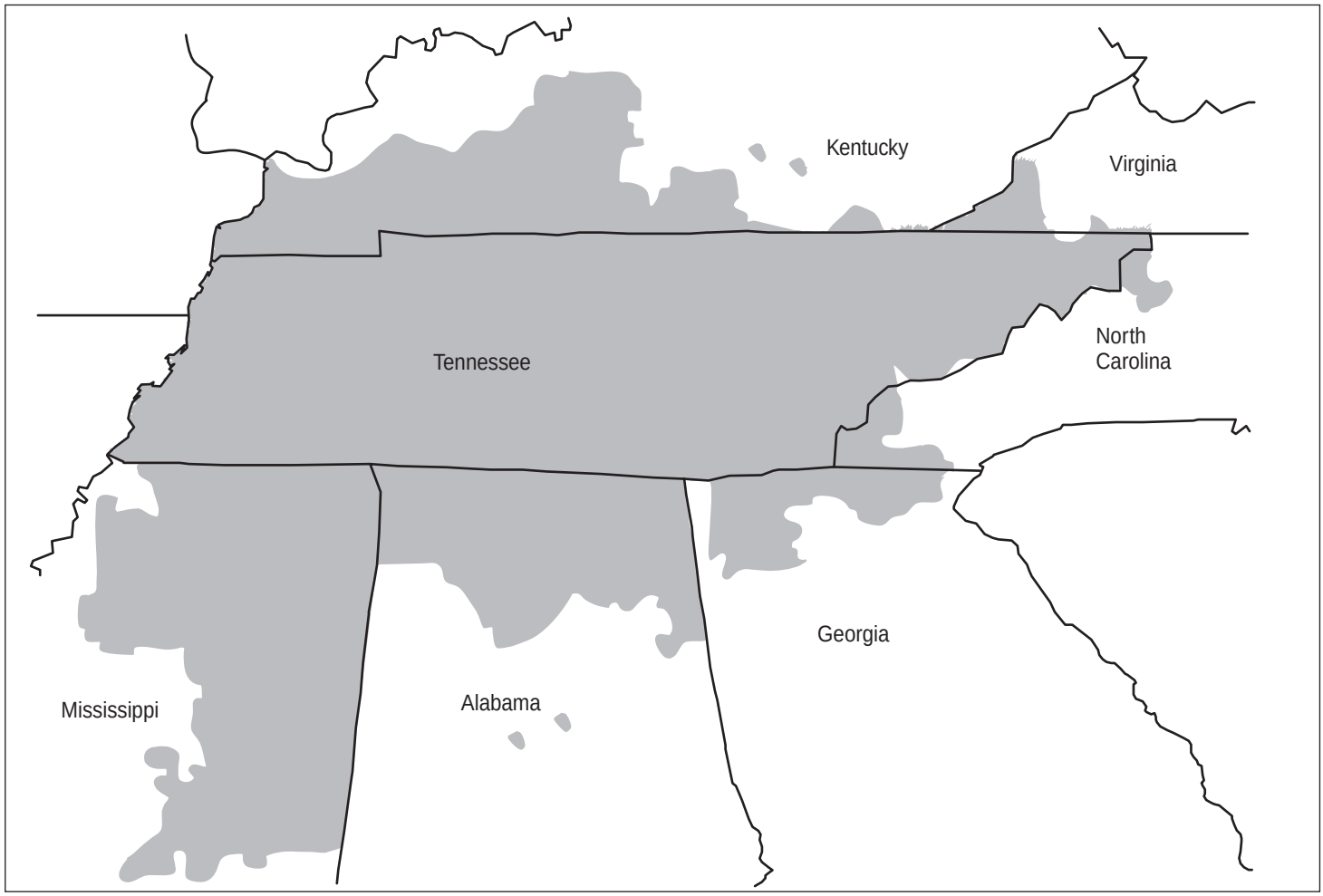
lakes. The most recent review was published in December 1990. This 1990 review entitled, Tennessee River and Reservoir System Operation and Planning Review, resulted in TVA delaying the annual lake-level drawdown at multipurpose tributary projects from Memorial Day to August 1. This delayed lake-level drawdown allowed lake levels to remain higher during the summer recreation season.

TVA supplies the energy needs of about 8 million people over a service area covering 80,000 square miles, including most of Tennessee and parts of six surrounding states (see fig. 1.1). In fiscal year 1998, TVA had about 28,500 megawatts of generating capacity,[5] which consisted of 11 fossil plants (59 units), 3 nuclear plants (5 units), 29 hydroelectric plants (with 109 units), 4 combustion turbine plants (48 units), and 1 pumped storage plant[6] (with 4 units). TVA's hydroelectric power facilities constitute slightly over 19 percent, or about 5,500 megawatts, of TVA's total generating capacity. TVA had total operating revenues of $6.7 billion in fiscal year 1998 and generated about 155 billion kilowatt-hours of energy, with TVA's hydropower facilities accounting for about 15.7 billion kilowatt-hours, or about 10 percent, of that energy.

[5]TVA's total generating capacity includes 405 megawatts from the U.S. Army Corps of Engineers' projects on the Cumberland River system.

[6]A pumped storage plant is designed to generate hydroelectric power during peak periods of demand by releasing water previously pumped into an elevated storage reservoir, usually during periods of low power demand.

Figure 1.1: TVA Service Area



Source: TVA.

Objectives, Scope, and Methodology

Representative Van Hilleary requested that we provide him with information showing how TVA manages and operates its multipurpose tributary projects for various purposes, such as flood control, navigation, hydropower production, and recreation. Specifically, we provide information on (1) the purposes served by TVA's multipurpose tributary projects and how TVA operates these projects within its integrated system, (2) the operational changes TVA made to these projects as a result of its

December 1990 Tennessee River and Reservoir System Operation and Planning Review and the major factors influencing these changes, (3) the actions TVA has taken since the 1990 review to address requests for changes in the way TVA operates these projects, and (4) TVA's plans for any future changes in the way it operates these projects. We also provide information on a selected update by TVA of its analysis performed in the 1990 review.

The primary agency included in our work was TVA. We contacted other agencies, including the U.S. Army Corps of Engineers, to obtain information on the effects of TVA's operations on various project purposes, such as water quality or navigation. We also visited and/or contacted a limited number of stakeholders affected by TVA's project operations, such as lake user groups, commercial businesses located on or downstream from the projects, local and state government officials, and state and federal environmental officials. The purpose of these discussions was to gain a sense of some of the issues concerning TVA stakeholders. At each entity, we interviewed officials and obtained pertinent records, as appropriate.

To determine the purposes served by TVA's multipurpose tributary projects and how TVA operates its system of projects to satisfy these purposes, we examined TVA documentation and authorizing legislation and interviewed TVA officials. We obtained information describing TVA's operation of its multipurpose tributary projects and how TVA balances the various purposes for which these projects were authorized. We also held discussions with a limited number of stakeholders affected by TVA's operations in order to describe the various issues that TVA faces in the operation of its projects and how the operation affects such stakeholders. In addition, we toured two of the multipurpose tributary lakes—Cherokee and Douglas—in the fall of 1998 to view the extent of drawdown that had taken place since August 1, 1998.

In order to describe the operational changes TVA made in 1991 to its multipurpose tributary projects as a result of its December 1990 Tennessee River and Reservoir System Operation and Planning Review and what major factors influenced those changes, we examined TVA's 1990 review and interviewed TVA officials. We also reviewed information on the alternative drawdown dates that TVA examined, the constraints and issues considered in TVA's review, and the methodologies used to determine the additional energy and capacity costs associated with delaying the drawdown of the tributary projects. In addition, we requested that TVA

analyze two alternatives included in its 1990 review to provide a more current estimate of the increase in TVA's systemwide cost of supplying electric power resulting from the implementation of these alternatives. One of these alternatives involved extending the drawdown to start on Labor Day for all of the projects. The other alternative involved extending the drawdown to start on October 1 for three projects, with the other projects maintaining an August 1 drawdown date. We judgmentally selected these alternatives to show the potential impact of a 1-month drawdown delay for all of the projects and an additional 2-month delay for three of the projects.

For TVA's 1990 estimates of the impacts on TVA's systemwide cost of supplying electric power resulting from lake-level alternatives, we reviewed the December 1990 Tennessee River and Reservoir System Operation and Planning Review. We also reviewed the available documentation that TVA officials provided to us on their 1990 cost estimates and discussed with them the data and methodology they used for their estimates.

We also held discussions with TVA officials to determine to what extent market conditions and evaluation methodologies have changed since 1990. Because changes have occurred since 1990, we requested that TVA analyze two of the alternatives evaluated in 1990 to illustrate what the potential impacts of these alternatives could be in the future. TVA officials provided us with oral presentations of the methodology used and the results of the 1999 update. In addition, the officials provided us with a summary of their assumptions, methodology, caveats, and results. In conducting the 1999 analyses, TVA considered its planned and/or ongoing efforts to purchase peaking power (that is, power needed for the periods of greatest power demand) and install additional natural gas combined-cycle combustion turbines.

We developed a general understanding of TVA's cost-estimation methodology, including the three computer models used in the cost estimation. The three models are: (1) the Weekly Scheduling Model (WSM) of TVA's hydrological and hydroelectric system, (2) the PowrSym power production costing model, and (3) the Hourly Loss of Load Expectation (HLOLE) capacity planning model. Some of the data inputs that TVA used, specifically its forecast of electricity market prices over the next 25 years, are proprietary TVA data.

We asked TVA officials whether the data and methodology that it used to estimate the impact on its systemwide cost of supplying electric power were reviewed by internal or external reviewers. We also asked whether TVA uses the same data and similar methodology for its own operations and planning. A contractor tested the HLOLE model and found it to be accurate for a large power system such as TVA's. TVA reported that it tested WSM prior to the 1990 cost analysis and that it performed well. TVA also reported that it uses the same data (including the electricity price forecast) and models for its own capital budgeting decisions and other internal purposes. We did not independently evaluate the reliability of the data and the models that TVA used.

To determine what actions TVA has taken since the 1990 review to address requests for changes in the way the multipurpose tributary projects are operated, we examined TVA's policies since 1991 regarding how it addresses requests for changes to its operations and interviewed TVA officials. We examined information showing why and when such policies were implemented. We also reviewed two recent studies (conducted by groups external to TVA) showing estimates of economic benefits to local communities due to changes to policies impacting lake levels associated with TVA lake-level drawdown activities at certain lakes and TVA's responses to these studies. We examined the first study, Economic and Fiscal Consequences of TVA's Draw-Down of Cherokee and Douglas Lakes,[7] which was issued in October 1998, and met with the principal authors from the University of Tennessee's Center for Business and Economic Research. We also examined the second study, The Economic Impact of Alternate TVA Lake Management Policies,[8] which concentrated on economic impacts of TVA's policies on three north Georgia lakes—Blue Ridge, Chatuge, and Nottely. We met with officials from the North American Water Management Institute, Inc., who prepared the study for interested stakeholders in north Georgia. We also discussed the strengths and weaknesses of both these recent studies with the authors and with TVA officials. We also evaluated these studies using water project evaluation guidelines of the U.S. Water Resources Council. While it is not required for privately commissioned studies to follow these guidelines, we used them because, in our view, they constitute the best available guidance on this type of economic analysis.

[7]Prepared for Land Owners and Users of Douglas by the Center for Business and Economic Research, University of Tennessee, (Oct. 1998).

[8]Prepared for the Mountain Lakes Study Committee by the North American Water Management Institute, Inc., Athens, GA, (Dec. 1997).

To explain TVA's plans for any future changes in the way it operates the multipurpose tributary projects, we held discussions with TVA officials and examined TVA documentation to determine TVA's current efforts and potential plans for any future review of its operations. In addition, we reviewed budgetary documentation regarding activities that TVA has funded for fiscal year 1999 and/or budgeted for future years for the examination of any new or improved analytical tools aimed at evaluating how changes in lake levels affect flood risk, navigation, and economic development.

We also obtained TVA's views on the necessity of an environmental impact statement with regards to any future changes to TVA's operating policies affecting the multipurpose tributary projects. We reviewed the requirements of the National Environmental Policy Act of 1969 (NEPA) and pertinent court cases from recent years to determine how the NEPA requirements might apply to TVA and its policies impacting lake levels.

We did not independently verify the data we obtained from TVA or the other entities we contacted.

We conducted our review from October 1998 through May 1999 in accordance with generally accepted government auditing standards.

Multipurpose Tributary Projects—Why Do They Exist and How Are They Operated

TVA's network of projects exists for a variety of reasons and is operated for many purposes. In operating these projects, TVA is guided by the operating priorities contained in the TVA Act. These priorities require that TVA operate its system of projects primarily to promote navigation and flood control and, to the extent consistent with these purposes, for hydroelectric power production. While TVA uses two sets of broadly defined policies or guidelines—one for lake levels and the other for reservoir releases—to guide the operation of the projects within the integrated system, operational limitations exist at these projects due to the project design characteristics. Although some of the multiple purposes served by these projects conflict, TVA attempts to maximize the benefits of the Tennessee River while adhering to the operating priorities of the projects.

TVA's 54 Projects Exist for a Variety of Reasons

TVA has constructed or acquired 54 projects which differ in age, size, and authorized purposes. One type of these projects—the multipurpose tributary project—consists of dams and lakes on the tributaries to the Tennessee River and provides multiple public benefits. These projects have significant changes in lake levels during the year to support flood control and hydroelectric power production efforts.

TVA defines its projects in four categories: multipurpose tributary projects, multipurpose main river projects, single-purpose power projects,[1] and nonpower tributary projects. Figure 2.1 shows the location of the multipurpose tributary projects and the multipurpose main river projects within the Tennessee Valley. Figure 2.2 illustrates how these projects are integrated into the Tennessee River. These figures were provided to us by TVA.

Multipurpose Tributary Projects

TVA has 13 multipurpose tributary projects, located on various tributaries connecting to the Tennessee River. These projects were constructed to serve multiple purposes, including hydroelectric power production and one or more of the following: flood control, navigation, recreation, and water supply. Most of the projects in this category have a significant amount of available storage space for flood control purposes. As a result, TVA operates these projects primarily for flood control and hydroelectric power production purposes and annually draws the lake levels down in

[1]For this report, we have included one of these projects—Blue Ridge—in our definition of a multipurpose tributary project because (1) even though it is a single-purpose power project, it has an annual lake-level drawdown similar to most of the 13 multipurpose tributary projects and (2) TVA has considered it as being very similar to the multipurpose projects in past reviews involving such projects.

the late summer and fall to help ease or potentially avert flooding in the winter. The multipurpose tributary projects are: Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Melton Hill, Norris, Nottely, South Holston, Tellico,[2] Tims Ford, and Watauga.

Multipurpose Main River Projects

Along the main portion of the Tennessee River, TVA operates and maintains nine multipurpose main river projects, which serve multiple purposes, including navigation and hydroelectric power production and, in most cases, flood control. In comparison to the multipurpose tributary projects, these projects maintain fairly stable lake levels. However, most of the projects in this category have some available flood storage space for water in the lake, and as a result, TVA operates these projects for flood control purposes and conducts a limited drawdown of the lake levels to prepare for potential flooding events in the winter.

Single-Purpose Tributary Projects

TVA maintains and operates 10 single-purpose tributary projects on tributaries of the Tennessee River that were constructed or acquired strictly for hydroelectric power production.[3] However, these projects also benefit other purposes, including recreation, water supply and, in the instance of the Blue Ridge project, flood control. Most of these projects have no storage space available in the lake for flood control purposes, and the water that flows to the project is generally sent directly through the hydroelectric power facilities to generate power.

Nonpower Tributary Projects

TVA has 22 projects located on tributaries to the Tennessee River that do not have hydroelectric power facilities and are operated for a variety of purposes, such as flood control, recreation, and water supply. Some of these projects have storage space within the lakes, and TVA operates these projects for flood control purposes and draws the lake levels down to prepare for potential flooding events in the winter. Some of the projects are essentially overflow structures, requiring little operator intervention except during special maintenance operations.

[2]This project does not have a power facility; the water from it is diverted to the Fort Loudoun project, which has a power facility.

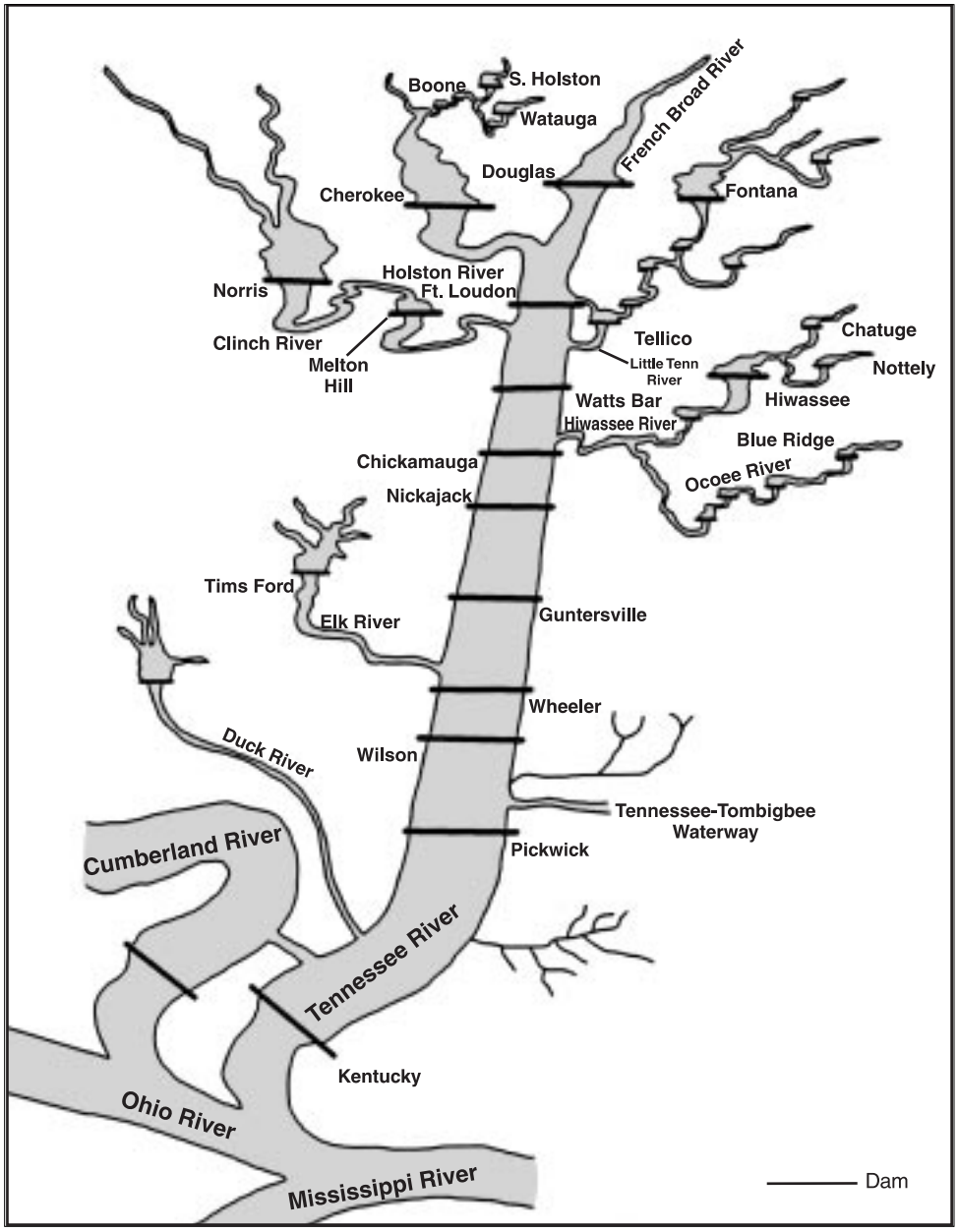
[3]One project is located on the Caney Fork River, a tributary of the Cumberland River. For this report, the project is classified as a Tennessee River single-purpose tributary project. In addition, another project has no hydroelectric facilities, but it provides a small reservoir for cooling water intake at a fossil plant.

Figure 2.1: Location of TVA's Multipurpose Tributary Projects and Multipurpose Main River Projects

▬ Dam

Multipurpose Tributary Projects	Multipurpose Main River Projects
Blue Ridge	Chickamauga
Boone	Fort Loudoun
Chatuge	Guntersville
Cherokee	Kentucky
Douglas	Nickajack
Fontana	Pickwick
Hiwassee	Watts Bar
Melton Hill	Wheeler
Norris	Wilson
Nottely	
South Holston	
Tellico	
Tims Ford	
Watauga	

Figure 2.2: How TVA's Multipurpose Tributary Projects and Multipurpose Main River Projects Are Integrated Into the Tennessee River



Multipurpose Tributary Projects Have Significant Lake-Level Changes

While all 54 projects were built or acquired as part of TVA's integrated system of projects and all of the projects contribute to TVA's attempts to maximize the value of the available water in the Tennessee River, the

multipurpose tributary projects generally have more significant changes in lake levels during the year. For example, the target lake level for Douglas—a multipurpose tributary project—decreases 50 feet from 990 feet on August 1 to 940 feet above sea level on January 1. On the other hand, the target lake level for Fort Loudoun—a multipurpose main river project—only decreases 6 feet from 813 feet on August 1 to 807 feet above sea level on January 1. Table 2.1 shows differences between the August 1 and January 1 target lake levels at the multipurpose tributary projects.

Table 2.1: August 1 and January 1 Target Lake Levels for TVA's Multipurpose Tributary Projects

In feet above sea level

Multipurpose tributary projects	August 1 target level	January 1 target level	Difference
Blue Ridge	1,682	1,668	14
Boone	1,382	1,358	24
Chatuge	1,923	1,912	11
Cherokee	1,060	1,030	30
Douglas	990	940	50
Fontana	1,693	1,644	49
Hiwassee	1,515	1,465	50
Melton Hill	[a]	[a]	[b]
Norris	1,010	985	25
Nottely	1,770	1,745	25
South Holston	1,721	1,702	19
Tellico	813	807	6
Tims Ford	[c]	873[c]	[b]
Watauga	1,949	1,940	9

[a]These dates do not have a set level due to the small change in lake levels; the full range is from 790 to 796 feet above sea level, with a normal operating range of 793 to 795 feet above sea level.

[b]Not applicable.

[c]The Tims Ford project has no August 1 target level. However, it does have a minimum elevation requirement of 883 feet above sea level from May 15 through October 15 and a January 1 target level of 873 feet above sea level.

Source: TVA.

The changes in lake levels resulting from the annual drawdown at most of these multipurpose tributary projects are significantly greater than the lake-level changes in the multipurpose main river projects due to the topography, the design of the projects, and the purposes for which they were intended. Figures 2.3 and 2.4 show photographs, which TVA provided to us, of what two multipurpose tributary projects look like as a result of the annual lake-level drawdown between the summer and January 1.

Figure 2.3: Fontana Multipurpose Tributary Project Prior to and After Drawdown

Figure 2.4: Hiwassee Multipurpose Tributary Project Prior to and After Drawdown

Navigation, Flood Control, and Hydropower Are Priority Purposes for Multipurpose Tributary Projects

TVA primarily operates its multipurpose tributary projects for navigation, flood control, and hydroelectric power production, as specified in the TVA Act. Over time, however, TVA has recognized a variety of other purposes that also benefit from TVA's operation of its projects. These additional purposes include recreation and water quality.

- Navigation - TVA's system of nine navigation locks at its main river projects is part of a 650-mile transportation route from Knoxville, Tennessee, to Paducah, Kentucky, which links the Tennessee Valley with the Mississippi and Ohio River systems, connecting ports in 21 states. Commerce moved on the Tennessee River has increased from about 2 million tons in the 1930s to about 49 million tons in 1997. According to TVA, over $450 million worth of products are transported annually via barges through the river. As a standard in the U.S. inland waterway industry that dates back to the 1920s, barges are designed for a 9-foot draft for navigation purposes.[4] In order to provide navigability on the Tennessee River, TVA maintains a minimum channel depth of 11 feet. Under normal weather conditions, the operation of the multipurpose tributary projects for flood control and hydroelectric power production provides enough reliable water downstream to maintain navigation depths on the river. However, during dry periods, TVA may have to release water from certain main river and/or tributary projects to meet required navigation depths. In addition, during floods and low-flow periods, TVA's integrated system affects navigation on the Mississippi River and the lower Ohio River. For example, TVA may at times, release water to help maintain navigable channels on the Ohio and Mississippi Rivers during low-flow periods. TVA can also reduce water releases from its projects to mitigate flooding on these rivers during hazardous, high-flow periods.
- Flood control - One of the primary purposes for TVA's development and maintenance of its integrated system of projects is to protect the inhabitants of the Tennessee Valley from loss of property and life as a result of flooding. An area within the Tennessee Valley that is very susceptible to flooding is the city of Chattanooga, which sits at a point just before the Tennessee River passes through the Cumberland Mountains. Before the construction of TVA dams to control the flow of water, major storms would force the river to flood its banks. While TVA's system of projects is not sufficient to eliminate all flooding, in most cases, it significantly reduces the risk of major damages and loss of life. As of April 1998, TVA estimated that the cumulative value of flood damages

[4]The term "draft" refers to the vertical distance that towboats and barges extend below the water surface.

prevented at Chattanooga by the operation of the TVA's integrated system of projects since 1936 totaled approximately $4.4 billion.

- Hydroelectric Power Production - TVA's hydroelectric power facilities serve as its most economical and versatile source of electricity. Electricity generated by TVA's hydroelectric power facilities, which are made up of 113 hydropower units at 30 projects, constitutes approximately 10 percent of TVA's annual total electricity production.[5] While the lake levels are managed within a specific operating range, TVA attempts to produce as much electricity as possible from the available water at the times when the power is most valuable, without disrupting flood control and navigation requirements. Hydroelectric power production is considered the most economical source of electricity because its incremental costs of production are cheaper than any other power sources. In addition, TVA's hydroelectric power facilities are more versatile than other power sources, due to the ability to turn units on more quickly than other units to meet peak power demands, system emergencies, and voltage regulation on the transmission system.

  TVA attempts to schedule releases of water through its hydroelectric power facilities at the tributary projects to avoid releasing more water into the Tennessee River than the main river hydropower facilities can handle. While water can be released downstream through a project's spillways whenever necessary, TVA tries to minimize such releases in favor of releasing water through the hydropower facilities to produce electricity. To maximize the value of its hydroelectric power, TVA schedules the production of hydroelectric power during the periods of greatest power demand to offset the use of other, more expensive, sources of power. Due to power usage in the Valley, daily peak demands in the winter typically last a few hours in the morning and a few hours in the evening. Often, severely cold weather conditions in the winter only last for a few days at most. In contrast, the typical daily summer peak demands last 8 or more continuous hours a day and the extremely hot weather driving these demands can last multiple days or even weeks. Based on TVA's demand forecasts, TVA officials predict that the summer peak demand for power will consistently exceed the winter peak demand in the future. While TVA schedules most of the hydroelectric power generation to help meet the daily peak power demands, at times hydroelectric power facilities are operated 24 hours a day while water is released for other purposes, such as water quality or flood control.

[5]TVA's hydroelectric power facilities include the Raccoon Mountain pumped storage project, which has four hydropower units.

In addition to operating its multipurpose tributary projects for the statutory purposes of navigation, flood control, and hydropower generation, TVA also manages these projects for other purposes, if consistent with the three statutory purposes.

- Recreation - TVA regulates its lakes to provide recreational opportunities consistent with its flood control, navigation, and power production responsibilities. TVA estimates that its lakes attract millions of visitors each year for a variety of water-related activities, including swimming, fishing, water skiing, and boating. TVA also provides recreational opportunities on the Tennessee River downstream from TVA projects. For example, TVA releases water at the Ocoee No. 2 project for whitewater recreation during certain times of the year.
- Minimum flows for water quality - Prior to 1991, TVA had fewer requirements to provide minimum flows from its projects for the benefit of aquatic life downstream from TVA projects. While water quality benefits were often provided as a result of TVA operations for flood control, power production, and navigation, TVA could shut off water releases, with a few exceptions, downstream from its projects. Shutting down the flow of water downstream from TVA projects can have severe effects on aquatic life. In December 1990, TVA recommended that increased minimum flows be provided at some of its mainstream and tributary projects and dissolved oxygen levels be improved in water released downstream from 16 of its projects. TVA's implementation of these recommendations helped recover over 180 miles of aquatic habitat and improved dissolved oxygen levels in over 300 miles of the Tennessee River. TVA also attempts to stabilize lake levels during the spring to support the spawning season for a variety of fish species that can be found in the Tennessee River and TVA's lakes. These fish species deposit their eggs primarily during the spring, at various times from February through June, depending on the species and water temperature. In addition, minimum flow requirements affect other issues related to water quality, such as water supply, heated discharges from coal and nuclear plants, and wastewater discharges from industries.

Water Supply – Water is withdrawn at approximately 330 points along the Tennessee River and its tributaries to benefit approximately 4 million citizens of the TVA region. TVA's operation of its multipurpose tributary and mainstream projects provides the necessary water flows to allow water supply pumping mechanisms to function properly. On average, over 9 billion gallons of water are withdrawn from the river system each day. According to TVA, over 75 percent of the water withdrawn is returned to a river, stream, or lake after use.

Heated Discharges from Coal and Nuclear Plants - TVA operates coal and nuclear plants on or near lakes along the Tennessee River and its tributaries for power-generation purposes. TVA provides minimum flows from its multipurpose projects to supply cooling water for its coal and nuclear power plants. In turn, the coal and nuclear plants discharge the water back into the Tennessee River at a warmer temperature. If needed, TVA provides releases from upstream multipurpose projects to reduce the effects of the upstream flow of heated discharge water.

Wastewater Discharges from Industries - Industries operating along the Tennessee River and its tributaries can apply for and receive approval for permits from state pollution control agencies for the release of municipal and industrial effluents into the Tennessee River and its tributaries. TVA provides historical flow data to the state pollution control agencies to help them set appropriate permit limits, based on TVA's normal operations of its projects. If an industry desires additional flow for the assimilation of its effluent beyond what is provided from normal project operations, the industry must reimburse TVA for the costs it incurs in providing these flows.

Several Factors Influence How TVA Operates Its Multipurpose Tributary Projects

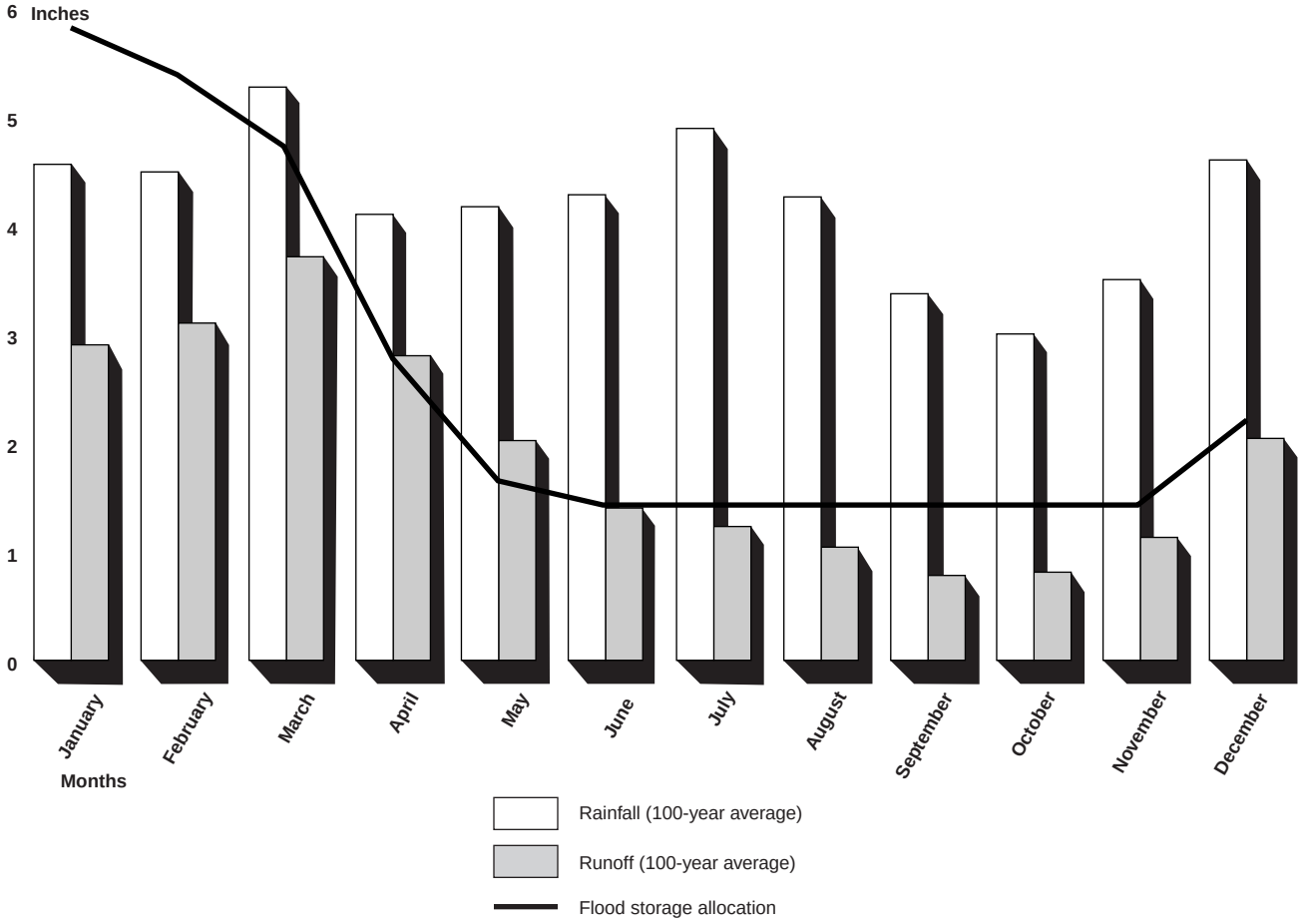
In addition to the operating priorities contained in the TVA Act, there are several factors that influence how TVA operates its multipurpose tributary projects. TVA's establishment of two sets of broadly defined policies or guidelines—one for lake levels and the other for reservoir releases—is one example. An additional constraint on operations is the specific design characteristics associated with each of the projects. Within the limitations of such factors, TVA attempts to balance the various purposes served to provide the greatest public benefits of the Tennessee River within the parameters of its operating priorities and the individual project design characteristics.

TVA follows two sets of broadly defined policies or guidelines in the operation of its mainstream and tributary projects: lake-level policies and reservoir release policies. Lake-level policies prescribe a maximum, minimum, or range of lake levels that must be maintained at a given time of year. TVA graphically presents the lake-level requirements on line graphs called "operating curves," which show the lake-level requirements throughout the year for flood control purposes, target recreational levels, and the range of water levels within which hydroelectric power can be generated. Reservoir release policies prescribe a maximum or minimum

flow that must be maintained from a project over an hourly, daily, weekly, or biweekly period for navigation and water quality purposes.

On the tributary lakes, TVA's policies require that the lake levels be lowered annually during the summer through early winter to the projects' January 1 target levels, primarily to help control potential floods during the winter and early spring. Figure 2.5 (provided to us by TVA) shows that, based on historical data of the TVA region, the wettest periods of the year tend to occur between December and March. During this period, the days are shorter, weather is colder, and the vegetation is dormant, which results in a much greater amount of precipitation running off to the streams and rivers than occurs in late spring, summer, and early fall. Thus, there is a significantly higher risk of flooding during the January through March period. The drawdown of the lake levels also provides for hydropower generation to help meet the peak power demands of the summer and provides augmented river flows for water quality and navigation purposes during the summer and fall, historically dry periods of the year. As the flood risk diminishes during late winter and early spring, TVA allows the lakes to accumulate water in order to reach desirable summer levels by Memorial Day. Prior to 1991, TVA began the annual drawdown of the lake levels of its multipurpose tributary projects anytime after Memorial Day. Resulting from the changes implemented in 1991, the lake-level drawdown for these projects now begins August 1.

Figure 2.5: Monthly Rainfall, Runoff and Flood Storage Allocation Above Chattanooga



Another factor that TVA must consider in operating its integrated system of projects is the design characteristics of the projects. These characteristics are quite varied for the multipurpose tributary projects. For example, all, except one, have hydropower facilities, with installed generating capacity ranging from a low of 10 megawatts at Chatuge to a high of 239 megawatts at Fontana. All, except one, have the ability to alleviate potential flooding, with capacity at January 1 ranging from a low of 68,500 acre feet at Blue Ridge to three projects—Norris, Cherokee, and Douglas—each having over 1 million acre feet. The total area of the lakes at normal summer maximum

ranged from 3,290 acres at Blue Ridge and 4,310 acres at Boone to 34,200 acres at Norris. In addition, TVA manages shoreline miles at its projects, ranging from a low of 68 miles at Blue Ridge and 102 miles at Nottely to 809 miles at Norris. One project—Melton Hill—has a navigation lock. Table 2.2 lists various characteristics for the multipurpose tributary projects.

Table 2.2: Various Characteristics of TVA's Multipurpose Tributary Lakes

	Flood control capacity (in acre feet)					
Multipurpose tributary lake	January 1	March 15	June 1	Length of shoreline (in miles)	Area of lake at normal summer maximum (in acres)	Installed generating capacity (in total megawatts)
Blue Ridge	68,500	40,800	13,100	68	3,290	22
Boone	92,400	60,400	12,900	127	4,310	81
Chatuge	93,000	73,300	13,900	128	7,050	10
Cherokee	1,011,800	807,800	146,700	395	30,300	135
Douglas	1,251,000	1,008,600	237,500	512	30,400	146
Fontana	580,000	580,000	73,400	238	10,640	239
Hiwassee	270,200	216,100	35,000	165	6,090	166
Melton Hill	[a]	[a]	[a]	193	5,690	72
Norris	1,472,800	1,113,000	512,000	809	34,200	131
Nottely	100,000	79,100	12,300	102	4,180	15
South Holston	290,200	220,100	106,100	182	7,580	39
Tellico	120,000	120,000	32,000	357	15,860	None
Tims Ford	219,600	167,200	78,000	309	10,600	45
Watauga	223,000	152,800	108,500	105	6,430	58

[a]There is no flood storage allocation.

Source: TVA.

TVA Faces Balancing Act Between Operating Priorities and Users' Interests

Many people and entities use the water in the Tennessee River and its tributaries for various purposes and are directly affected by TVA's operating policies regarding its multipurpose tributary projects. However, the needs of these various users often conflict and/or compete with each other, and TVA must attempt to balance its operations to best meet the needs of these users while adhering to its operating priorities of flood control, navigation, and hydropower generation.

Lake user groups, such as the Land Owners and Users of Douglas (LOUD) and the Cherokee Lake Users Association (CLUA), which primarily include the residents and commercial businesses located on or near the tributary lakes and those that use the lakes for recreational purposes, have sought higher lake levels throughout the year. These groups argue that higher lake levels result in enhanced recreational opportunities, which have become a growing percentage of the economy in the counties encompassing and surrounding the lakes. The groups also argue that higher lake levels have a positive affect on property values. Marina owners on the Douglas and Cherokee Lakes explained that their business is significantly reduced starting in late summer as a result of TVA's lake-level drawdown beginning on August 1. According to these individuals, many marina owners have closed down their businesses in the past because of TVA's policies impacting lake levels. Local government officials tended to reiterate the concerns of the lake users and stressed the importance of recreation and tourism in their local economies. While all of these entities and organizations recognized that changes made as a result of TVA's 1990 review did improve lake levels, they all believe that TVA's policy of beginning the lake-level drawdown on August 1 has a severe impact on the tourism and recreational trade in these areas.

Other users, such as a barge operator and a boat manufacturer, had very different views on TVA's operation of its integrated system. These users cited minimum channel levels on the Tennessee River as their primary concern. TVA's policy of maintaining an 11-foot channel allows the barge operator to move products up and down the river and gives the boat manufacturer the ability to test its newly constructed boats. Any significant changes to TVA's operating policies that may have a negative effect on downstream flow of water could have a significant impact on such businesses. Still other users, such as TVA's power distributors, who purchase TVA's wholesale power and then resell the power to the retail consumers, are primarily concerned with any increase in the cost of power that would result from changes in TVA's policies impacting lake levels. TVA's current policies allow for significant hydroelectric power generation during the peak periods of power demand, when the power is most valuable. Any shift in these policies could result in a higher cost of power for TVA, which could, in turn, increase the cost of power to the power distributors and retail customers.

Emergency management officials near Chattanooga and businesses located near TVA projects are concerned with potential increased risks of flooding that may result from changes in TVA's operating policies. Officials

representing state and federal environmental agencies expressed concerns with the quality of the water that flows down the Tennessee River through TVA's projects. Environmental concerns include the concentration of wastewater in the river flow that results from industries located along the river and the change in temperature and/or the level of oxygen in the water that may affect aquatic habitats in the river.

Multipurpose Tributary Project Operations Were Changed as a Result of TVA's 1990 Review

Over the past 3 decades, TVA has instituted two sets of significant changes in the way the multipurpose tributary projects are operated. The last change—made in 1990—resulted in a 2-month delay in the annual drawdown of the lake levels at the multipurpose tributary projects during the summer. TVA rejected a number of other lake-level alternatives because they would have resulted in higher systemwide costs of supplying electric power. Of the seven alternatives evaluated at that time, TVA adopted the one having the least cost increase—estimated at an annual average of $2 million (in 1990 dollars). TVA used a complex methodology in estimating the impacts on TVA's systemwide cost of supplying electric power of lake-level alternatives. However, this methodology did not quantify (1) other cost impacts, such as impacts to flood control and navigation operations, or (2) the economic benefits of the alternatives evaluated. Because market conditions and evaluation methodologies have changed since 1990, we requested that TVA analyze two of the alternatives evaluated in 1990 to illustrate what the potential impacts on TVA's systemwide cost of supplying electric power could be in the future. This 1999 analysis showed that delaying the drawdown of tributary lakes from August 1 to Labor Day could result in potential increased costs ranging from $0 to $88 million annually depending on various assumptions, with an average estimated increase of $47 million (in 1999 dollars). TVA cautioned that both the 1990 and 1999 estimates were subject to a great deal of uncertainty due to future hydrological conditions,[1] electricity prices, and other variables.

1971 Study Led to Higher Winter Lake Levels

In 1971, TVA conducted a study to modify, if possible, some portions of its operations to improve recreational uses of TVA's multipurpose tributary projects within the framework of the statutory requirements for flood control, navigation, and hydropower generation. As a result of this study, TVA concluded that raising the January 1 target levels and the normal minimum levels[2] of nine of its multipurpose tributary projects should provide higher lake levels during the winter in most years.[3] According to TVA's analysis, such changes would not significantly affect its ability to provide flood control during the month of January. TVA also predicted that

[1]Hydrological conditions characterize water volumes and flows that affect TVA's objectives of flood control, navigation, power supply, etc.

[2]The normal minimum level refers to the lowest lake elevation that the project would be operated at under normal conditions. TVA would not schedule operations below this elevation without the Board of Directors' approval.

[3]As a result of this study, TVA modified lake levels at Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga. No modifications in operations at Boone Lake were proposed. According to TVA, the original design of the Boone project specified operations at prescribed seasonal elevations.

higher winter levels would improve the chances of the lakes filling to higher levels in the spring, thus enhancing recreational opportunities. For example, target levels for January 1 were increased as much as 10 feet at Cherokee and Hiwassee. In addition, the normal minimum level at Douglas was raised 20 feet while increases in the other lakes ranged from 30 to 100 feet. Table 3.1 highlights the changes TVA implemented in 1971.

Table 3.1: Changes Made in 1971 to Multipurpose Tributary Lake Levels

In feet above sea level

Multipurpose tributary lakes[a]	Changes to January 1st target levels			Changes to normal minimum levels		
	Pre-1971 level	1971 level	Increase	Pre-1971 level	1971 level	Increase
Chatuge	1,910	1,912	2	1,860	1,905	45
Cherokee	1,020	1,030	10	980	1,020	40
Douglas	935	940	5	920	940	20
Fontana	1,615	1,620	5	1,525	1,580	55
Hiwassee	1,455	1,465	10	1,415	1,450	35
Norris	978	985	7	930	960	30
Nottely	1,743	1,745	2	1,690	1,735	45
South Holston	1,702	1,702	0	1,616	1,675	59
Watauga	1,934	1,940	6	1,815	1,915	100

[a]These lakes are the only multipurpose tributary lakes that were changed in 1971.

Source: TVA.

1990 Review Resulted in Latest Changes in TVA's Policies Impacting Lake Levels

In the late 1980s, TVA undertook an operation and planning review of its system of projects. Among the reasons for this review was to reexamine the trade-offs TVA makes in balancing the various purposes served by the multipurpose tributary projects. This review, which examined seven lake-level alternatives, ultimately resulted in about a 2-month delay of the annual lake-level drawdown from Memorial Day until August 1. Several factors influenced the changes to TVA's policies impacting lake levels. These factors included recommended year-round minimum flows on the Tennessee River that would improve water quality and support navigation and the effect of operating changes on TVA's ability to generate hydropower.

Reasons Why the 1990 Review Was Undertaken

In September 1987, TVA's Board of Directors authorized a review to determine whether the operating priorities for its projects that had been

set out in the TVA Act over 50 years earlier still made sense given the changes that had taken place in the Tennessee Valley since the 1930s. Although the act directed that the system of projects be managed primarily for navigation and flood control and then for power generation, there was a recognition in the late 1980s that other benefits had also become important to residents of the Valley. Specifically, concerns had been raised that TVA's policies often resulted in prolonged periods without releases from the dams. As a result, the effects on aquatic life could be severe because areas downstream from the projects were essentially dry for periods of time. In addition, public demand for abundant supplies of clean water and for recreation on TVA's lakes and streams was competing with the demand for the benefits associated with the continued production of low-cost TVA hydropower. By the time the review was authorized, growing numbers of lake users had asked TVA to reexamine the trade-offs it makes in balancing the various purposes when operating its integrated river system.

1990 Review Results in Delay of Annual Lake-Level Drawdown Date Until August 1

In December 1990, TVA released the results of its work examining lake management policies in a report entitled, Tennessee River and Reservoir System Operation and Planning Review. In carrying out the work for its review, TVA followed the National Environmental Policy Act by preparing a detailed statement on the environmental impact of proposed actions that could significantly affect the quality of the human environment. By preparing an environmental impact statement, "TVA sought to ensure that the environmental effects of reservoir operating alternatives were thoroughly investigated and that ample opportunities for pubic review and comment were provided." Referred to by TVA as its "Lake Improvement Plan," this review evaluated (1) three alternatives to provide additional minimum flows from TVA dams to improve reservoir releases downstream and (2) seven alternatives to stabilize lake levels by delaying the drawdown of lake levels until August 1 or later.

As a result of TVA's analyses, the 1990 review recommended that (1) TVA increase minimum flow requirements from mainstream and tributary projects and increase dissolved oxygen levels in the releases from 16 of its dams and (2) maintain summer target levels in 10 multipurpose tributary

projects until August 1st(Alternative 1).[4] On the basis of TVA's analyses, these alternatives were preferred because they provided the most benefits at the least cost to TVA. Table 3.2 shows the seven lake-level alternatives TVA evaluated.

Table 3.2: Lake-Level Alternatives Analyzed by TVA During 1990 Review

Alternative	Drawdown restricted from Memorial Day to	Projects affected
1	August 1 for 10 projects	Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga
1A	August 1 for 7 projects and October 1 for 3 Knoxville area projects	October 1 for the Cherokee, Douglas, and Norris projects and August 1 for the other 7 projects
1B	August 1 for 8 projects and October 1 for 2 Tri-Cities area projects	October 1 for the South Holston and Watauga projects and August 1 for the other 8 projects
1C	August 1 for 9 projects and October 1 for 1 project	October 1 for the Fontana project and August 1 for the other 9 projects
1D	August 1 for 6 projects and October 1 for 4 Hiwassee basin projects	October 1 for the Blue Ridge, Chatuge, Hiwassee, and Nottely projects and August 1 for the other 6 projects
2	Labor Day for 10 projects	Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga
3	October 31 for 10 projects	Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga

Source: TVA.

In TVA's evaluation of lake-level alternatives, TVA estimated that changes in the operation of its system of projects would increase TVA's systemwide cost of supplying electric power. On the basis of TVA's assumption of 60

[4]During the review, the 10 TVA projects analyzed for lake-level changes included 9 multipurpose tributary projects that were subject to significant summer drawdown—Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga. The Blue Ridge project—which is a single-purpose power project—was also included because it has an annual drawdown cycle similar to multipurpose tributary projects. The remaining four multipurpose projects—Boone, Melton Hill, Tellico, and Tims Ford—not included in the review were excluded for various reasons. Boone was excluded because its original design included its operation at prescribed seasonal elevations that result in a constant lake elevation from Memorial Day through Labor Day. Melton Hill does not have an annual drawdown; it is operated in a fixed range of about 793 feet to 795 feet. Tellico, which is connected by an ungated canal to Fort Loudoun Lake, has a lake elevation essentially the same as Fort Loudoun—a multipurpose main river project. Because Fort Loudoun is targeted to reach its summer lake level by April 15 and its drawdown does not begin until November 1, Tellico has a flat summer lake level until November 1. Tims Ford, by design and original project allocation, has always been operated with a minimum summer lake elevation of 883 feet, which extends until October 15.

hours of peak generation per week during the summer, a delay in the drawdown of lake levels would limit TVA's ability to generate hydropower during those peak hours. To maximize the value of its hydropower, TVA attempts to schedule hydropower generation during the periods of greatest demand to offset the use of other, more expensive, sources of power generation. According to TVA's records, the highest and longest periods of peak demand occur during the summer. For example, the daily summer peak demands last 8 or more continuous hours a day. Given that TVA's power resources are constant, limiting TVA's ability to generate hydropower during such peak periods may force TVA to use more expensive sources of generation to meet the demand. While much of the water that could have been used to generate peak power could eventually be shifted to offpeak times later in the year, the demand for power during these offpeak periods is lower than the demand for power during peak periods. As a result, the net effect of this shift in hydroelectric power production would generally result in a net increase in TVA's systemwide cost of supplying electric power.

TVA made some adjustments to Alternative 1 that made it the most attractive alternative examined in the 1990 review. For example, TVA reduced the effects of lake-level changes on its ability to generate hydropower during peak periods in the summer by developing "sloping" target lake levels for the multipurpose tributary projects. The sloping target levels allowed TVA to fill the lakes above the August 1 summer target levels. By doing so, TVA could conduct a limited drawdown, referred to as a "restricted" drawdown,[5] of the lake levels during June and July and use this additional water to generate hydroelectric power during periods of peak power demand in these 2 months, while still meeting the target lake levels on August 1, when "unrestricted" drawdown could begin. However, applying sloping target levels to other alternatives, such as the Labor Day alternative, prevented the use of enough water for hydropower generation during peak demand periods in June, July, and August because water would have to be reserved to provide minimum flows throughout the extended summer period. In addition, TVA recommended that it provide minimum flows using turbine pulsing, which allows TVA to produce power

[5]TVA officials stated that this "restricted" drawdown in June and July can total several feet of lake-level elevation. Examples cited were 11 feet at Cherokee, 10 feet at Watauga and Fontana, and 8 feet at South Holston.

while releasing the water.[6] Other options of providing minimum flows from the projects would result in the total loss of power generation from the released water.

Table 3.3 shows the effects of the changes on the August 1 lake levels of the 10 multipurpose tributary projects considered in the 1990 review. To illustrate what the current lake levels are, we show in appendix II the monthly minimum and maximum lake levels that occurred during calendar year 1998 at the multipurpose tributary projects, and in table 3.4 we highlight the total elevation change that occurred during calendar year 1998 at these projects. In addition, table 3.5 shows the key target lake levels during the year.

[6]Turbine pulsing refers to a process whereby water is released through the turbines of a TVA tributary project by operating the turbines for short periods of time throughout the day. For example, TVA recommended that at six projects it would "pulse" the turbines for 30 to 60 minutes every 4 hours when the turbines otherwise would not be operating. While operating the turbines in this manner, TVA also has the ability to generate hydropower.

Table 3.3: Effect of 1990 Changes to Multipurpose Tributary Median Lake Levels

In feet above sea level

	Median lake levels (Aug. 1)[a]		
Multipurpose tributary project	**Prior to 1990 review[b]**	**After 1990 review[c]**	**Change**
Blue Ridge	1,680.2	1,683.1	+2.9
Boone	[d]	[d]	N/A
Chatuge	1,920.5	1,924	+3.5
Cherokee	1,054.1	1,061.5	+7.4
Douglas	984.4	990.9	+6.5
Fontana	1,677.9	1,696.6	+18.7
Hiwassee	1,514.1	1,517.2	+3.1
Melton Hill	[d]	[d]	N/A
Norris	1,005	1,013.2	+8.2
Nottely	1,767.8	1,771.2	+3.4
South Holston	1,718.2	1,722	+3.8
Tellico	[d]	[d]	N/A
Tims Ford	[d]	[d]	N/A
Watauga	1,941.9	1,950.7	+8.8

[a]The term "median" refers to the middle number in an ordered series of numbers. If the series contains an even number of items, then the median refers to the number midway between the two middle numbers in the ordered series of numbers.

[b]Based on data from 1972 through 1990.

[c]Based on data from 1991 through 1998.

[d]The Boone, Melton Hill, Tellico, and Tims Ford projects were not included in TVA's 1990 study.

Source: TVA.

Table 3.4: Multipurpose Tributary Lake Levels—Minimum and Maximum Level in Calendar Year 1998

In feet above sea level

Multipurpose tributary lake	Minimum elevation in calendar year 1998		Maximum elevation in calendar year 1998		Total elevation change
	Elevation	Month	Elevation	Month	
Blue Ridge[a]	1,621.38	November	1,689.07	April	67.69
Boone	1,351.35	January	1,383.80	May	32.45
Chatuge	1,911.08	December	1,926.31	June	15.23
Cherokee	1,026.37	December	1,071.76	June	45.39
Douglas	940.29	December	995.36	April	55.07
Fontana	1,625.68	December	1,705.34	June	79.66
Hiwassee	1,460.31	December	1,524.30	June	63.99
Melton Hill	790.10	March	796.44	April	6.34
Norris	977.02	January	1,030.38	April	53.36
Nottely	1,740.84	December	1,778.09	June	37.25
South Holston	1,689.40	January	1,732.29	April	42.89
Tellico	807.45	February	815.09	April	7.64
Tims Ford[a]	856.01	January	890.14	June	34.13
Watauga	1,930.63	January	1,960.69	April	30.06

[a]TVA said that the elevations for Blue Ridge beginning in September were abnormally low due to a special drawdown for maintenance inspection that is conducted once every 5 years. In addition, TVA said that the elevations for Tims Ford in January and February were abnormally low due to a special drawdown for repairs.

Source: TVA.

Table 3.5: Multipurpose Tributary Lake Level Targets Throughout the Year

In feet above sea level

Multipurpose tributary lake	Flood control level		Minimum targeted summer levels	
	January 1	March 15	June 1	August 1
Blue Ridge	1,668	1,678	1,685	1,682
Boone	1,358	1,375	1,382	1,382
Chatuge	1,912	1,916	1,924	1,923
Cherokee	1,030	1,042	1,061	1,060
Douglas	940	958	992	990
Fontana	1,644	1,644	1,696	1,693
Hiwassee	1,465	1,482	1,517	1,515
Melton Hill	[a]	[a]	[a]	[a]
Norris	985	1,000	1,012	1,010
Nottely	1,745	1,755	1,772	1,770
South Holston	1,702	1,713	1,723	1,721
Tellico	807	807	813	813
Tims Ford	873	879	883	883
Watauga	1,940	1,951	1,950	1,949

[a]These dates have no set level due to the small fluctuation in lake levels; the full range is from 790 to 796 feet above sea level, with a normal operating range of 793 to 795 feet above sea level.

Source: TVA.

Several Factors Influenced the 1990 Changes

According to TVA's analysis, none of the lake-level alternatives considered in the 1990 review would have negatively affected flood control and navigation on the Tennessee River. All of the alternatives required TVA to reach flood control target levels by January 1, in preparation for the winter months, where flood risk is the greatest in the Tennessee Valley. Navigation on the Tennessee River would be supported by recommended year-round minimum flows, and navigation during the typically dry fall months would benefit from additional flows from the delayed lake-level drawdown. Each of the alternatives that maintained summer target lake levels at the multipurpose tributary projects would increase recreational opportunities on these lakes. However, some of the alternatives, such as the alternative that delayed the annual lake-level drawdown at the multipurpose tributary projects until October 31 (Alternative 3), could have increased the risk of flooding of the Ohio and Mississippi Rivers, which connect with the Tennessee River near Paducah, Kentucky. According to TVA, no rigorous flood risk analysis was performed by TVA as

part of the evaluation of Alternatives 2 and 3 because these alternatives were the most expensive and therefore studied the least. The increased flooding risk results from TVA's attempts to draw down its lakes to their January 1 levels in a 2-month period as opposed to starting the lake-level drawdown earlier in the summer. TVA's analysis also concluded that the October 31 alternative could have negative effects on navigation on the Ohio and Mississippi Rivers during dry years.

Also, according to TVA, Alternative 1 was selected to maintain summer target lake levels until August 1 because it provided the most benefits at the least cost and because this alternative did not have a significant effect on flood control or navigation efforts on either the Tennessee River or the Ohio and Mississippi Rivers. The reservoir release alternative implemented by TVA increased minimum flows from its mainstream and tributary projects and increased dissolved oxygen levels in the releases from 16 of its projects. TVA said that the following benefits would be realized as a result of the changes implemented from the 1990 review:

- Minimum flows and aeration of releases would recover over 180 miles of aquatic habitat and improve levels of dissolved oxygen in over 300 miles of river.
- Higher summer lake levels would increase lake recreation visitation by approximately 21 percent.
- Scenic views would be improved.
- Opportunities for tourism and second home development would be increased.
- Reservoir fisheries, due to increased survival of young fish, would be improved.
- Water depth for commercial navigation on the lower Ohio and Mississippi Rivers would be increased during September and October, the months of lowest flow.

Another significant factor that TVA considered in its selection of alternatives impacting lake levels and reservoir releases was the effect of any operating changes on TVA's ability to generate hydropower. TVA attempts to schedule releases of water through its hydropower facilities at the multipurpose tributary projects during periods of greatest power demand to offset the use of other, more expensive, sources of power. The greatest and longest peak power demand periods occur during the summer. Any shift in the availability of water for hydropower generation due to policies impacting lake levels could restrict TVA's ability to generate hydropower during these peak periods. If a portion of TVA's hydropower

generation is delayed until later in the year, TVA must meet the peak power needs by using more expensive forms of generation, which would increase TVA's cost to produce power. On the basis of analyses using a complex set of models and methodologies, TVA estimated that the lake-level alternative that maintained summer target lake levels until August 1 had the smallest cost increase impact to the power program.

TVA's 1990 Review and Its 1999 Analysis of Two Lake-Level Alternatives Both Estimate Increases in TVA's Systemwide Cost of Supplying Electric Power

The estimated impact to TVA's systemwide cost of supplying electric power resulting from delaying the lake-level drawdown of the multipurpose tributary projects in the summer was a major factor influencing TVA's selection among the seven lake-level alternatives considered. TVA estimated that delaying the lake-level drawdown at its multipurpose tributary projects from Memorial Day to August 1 or later would increase its systemwide annual average cost of supplying electric power by $2 million to $93 million (in 1990 dollars), depending on the alternative. TVA's 1990 cost estimation involved a complex methodology using hydrologic and electric supply and demand computer models and extensive data. Our evaluation of TVA's 1990 efforts included a review of the available documentation supporting the key elements of its calculations of the impacts on its systemwide cost of supplying electric power. Because market conditions and evaluation methodologies have changed since 1990, we requested that TVA update its estimated systemwide cost impacts of implementing lake-level alternatives similar to two of the alternatives considered in 1990—Alternative 1A (an additional 2-month drawdown delay for three of the projects) and Alternative 2 (an additional 1-month drawdown delay for all of the projects).

TVA's March 1999 analysis showed that the two alternatives would increase TVA's systemwide cost of supplying electric power by an estimated annual average cost of $14 million and $47 million, respectively (in 1999 dollars). TVA cautioned that both the 1990 and 1999 estimates were subject to a great deal of uncertainty. Some elements of uncertainty were built into the 1999 estimates. For example, the estimated $14 million increase could be as low as $(-) 2 million (negative $2 million—that is, benefits, not costs) or as high as $33 million, depending on hydrological conditions, future electricity prices, and other factors. However, TVA said that there were other important elements of uncertainty that it did not attempt to, and could not easily, model. TVA has emphasized that a comprehensive evaluation of proposed policy changes would go well beyond estimating the effect of the changes on TVA's systemwide cost of supplying electric power and would also have to consider important equity implications of

proposed changes. While a complete evaluation of the cost-estimation methodologies TVA used was beyond the scope of our work, the general approach TVA used in 1990 and 1999 appeared to be reasonable.

The analyses of lake-level alternatives conducted by TVA in 1990 and 1999 concentrated on developing estimated costs of various alternatives. TVA's 1990 study recognized and discussed various benefits and costs—in addition to the systemwide costs of supplying electric power—of changes to lake levels, such as the impacts to flood control and navigation efforts. However, TVA's estimates related only to the systemwide costs of supplying electric power. TVA officials explained that TVA does not currently possess adequate tools and methodologies to develop such quantitative assessments. Similarly, TVA's analyses did not attempt to quantify, in monetary terms, the potential benefits that may occur as a result of the lake-level alternatives. For example, TVA explained that it does not have adequate mechanisms to capture visitation statistics at its lakes or to estimate the monetary effects of recreation and tourism on local economies. In its 1990 review, TVA based its analyses of recreation visits at TVA lakes on an inventory of access facilities, staff judgment, and interviews with facility operators. While TVA concluded that lake-level Alternative 1 would increase recreation visits by 21 percent, TVA did not attempt to quantify this estimated visitor increase into monetary terms.[7]

We provide additional information in appendix III about the methodologies used and the results of TVA's 1990 review and its 1999 analysis.

Conclusions

The key changes resulting from TVA's 1990 review were to improve water quality and aquatic habitat and to extend the recreation season on TVA lakes by delaying the annual drawdown of the multipurpose tributary project lake levels for an additional 2 months during the summer. The impact on TVA's systemwide cost of supplying electric power resulting from the delay in the annual lake-level drawdown was the major factor influencing these changes. TVA's analyses show that even when only looking at these cost impacts, there is still a level of uncertainty associated with the results because of the assumptions being made. In addition, TVA did not attempt to quantify potential benefits that may result from

[7]TVA officials explained that a panel of nine external reviewers for the 1990 study advised TVA to fully describe the benefits and costs of each alternative, including estimated power costs, and focus public participation during the NEPA review of the draft environmental impact statement on which alternative was best rather than on how monetary estimates were calculated for benefits for which no market value exists.

increased recreation or tourism by maintaining summer lake levels longer. Furthermore, neither TVA's 1990 review nor the 1999 analysis TVA performed at our request attempted to quantify the potential cost effects on other aspects of TVA's operations, such as flood control and navigation. Therefore, decisions about how to regulate the levels of the lakes have not been based on a complete evaluation of the overall costs and benefits of such actions.

Little Has Changed in Multipurpose Tributary Project Operations Since the 1990 Review Despite Requests From Users

Although TVA continued to receive requests from individuals and organizations for changes to the multipurpose tributary projects after the 1990 review, little has changed in how TVA operates these projects. TVA raised concerns about the growing number of requests from lake users asking TVA to analyze multiple lake-level alternatives for individual lakes. TVA decided that a "piecemeal" approach to analyzing the issues involved raised questions of fairness in how each of the multipurpose tributary projects would be treated within the TVA system. As a result of the numerous requests, in March 1997, TVA decided to establish a 4-year moratorium on changes to policies impacting lake levels. TVA cited several reasons for taking this action, including allowing TVA time to evaluate how studies on policies impacting lake levels should be evaluated in the future. Since the moratorium's implementation, one group of lake users has submitted a request to TVA for changes to policies impacting lake levels. In addition, TVA has commented on two studies discussing the potential economic benefits resulting from maintaining higher lake levels later in the year at Cherokee and Douglas Lakes in Tennessee, and Blue Ridge, Chatuge, and Nottely Lakes located in northern Georgia. TVA's comments on these two studies were critical of several aspects of the studies, including the scope, methodology, assumptions, and data used to estimate the economic benefits. TVA also said that the two studies lacked a proper recognition of the multipurpose roles served by TVA's system of projects and how changes in lake levels may impact its operations and management of the entire Tennessee River system. Our examination of the two studies identified limitations in the studies' methodologies and scope. For example, both studies are limited in their scope because the benefits they estimated are only those associated with increased lake visitation pertaining to a few counties adjacent to the lakes.

In 1997 TVA Decided to Establish 4-Year Moratorium on Changes to Project Operations

Despite the changes made to its policies impacting lake levels earlier this decade, TVA has continued to receive a number of requests to make further changes. TVA ultimately decided in March 1997 to implement a 4-year moratorium on making any further changes to these policies. There were a number of factors influencing TVA's decision, including a belief that the moratorium would minimize the public's perception of favoritism for any particular lake and would also allow time for TVA to evaluate how studies on policies impacting lake levels should be evaluated in the future.

Requests for Changes Made From 1990 Through 1997

After the 1991 Lake Improvement Plan was implemented, requests for changes to TVA's lake-level policies slowed for a year or two but began again in 1993. According to TVA, constituents were no longer satisfied with

the changes made in 1991, or new constituents were not aware of the changes that had been made. In these instances, when TVA received requests for changes, TVA's staff would acknowledge these requests and meet with interested individuals and/or organizations. Requests from individuals, although acknowledged, were seldom evaluated in detail. Requests from organizations which, after a limited review, would tend to have a low or negligible cost with few negative impacts, were further evaluated by an internal inter-disciplinary team. A few of these were implemented, either on a permanent or trial basis. TVA staff would decide which requests deserved further attention and then perform some level of study to be able to answer questions about potential impacts of the changes. In at least two instances, TVA made offers to "sell" higher lake levels to two groups (the state of North Carolina for Fontana Lake and a group of concerned citizens at Blue Ridge Lake). Other studies were underway for Boone Lake and the North Georgia lakes when the moratorium was implemented.

By March of 1997, several requests for changes to policies impacting lake levels had been submitted to TVA. For example, (1) TVA had completed a preliminary study that examined the power and flood control impacts of extending Boone Lake's level later into the fall; (2) TVA had met with the Mountain Lakes Study Committee, which was performing an economic analysis of 17 alternative drawdown scenarios for the Blue Ridge, Chatuge, and Nottely Lakes; (3) the Cherokee Lake Users Association had met with TVA and proposed changes to the annual drawdown policy at Cherokee Lake; (4) individual users at South Holston and Watauga Lakes were requesting changes in policy at those lakes; and (5) there were miscellaneous requests for changes in operation at other TVA tributary and main river projects.

TVA staff had performed analyses for Boone Lake, which indicated that the impacts on TVA's systemwide cost of supplying electric power associated with the requested changes were relatively small, with a net present value of less than $1 million. TVA estimated that increased systemwide cost of supplying electric power associated with the requested changes at Boone Lake was much less than for other TVA lakes analyzed in the past, primarily because the changes in the lake levels during the year at Boone Lake were smaller in comparison to other lakes, and TVA already extended the summer target lake level at Boone Lake until Labor Day.[1] As a result, TVA would not need to shift power production at Boone Lake from the peak

[1]The original design of the Boone project included its operation at prescribed seasonal elevations. For example, the lake is operated at a constant elevation of about 1,382 feet above sea level from Memorial Day through Labor Day.

summer months to the fall. In addition, the flood impact analyses indicated that based on historic data, flood control at Boone Lake would not be impacted. However, TVA indicated that potential storms would have an impact on the frequency of floods downstream from Boone Lake.

Factors Influencing TVA's March 1997 Moratorium

TVA became concerned that more and more users were requesting studies for the lakes they used, resulting in an analysis of the system on a piecemeal basis. To TVA, this raised a "fairness" issue of treating these lakes differently in the TVA system. Of particular concern to TVA was the relatively low impact that the requested changes at Boone Lake would have on TVA's systemwide cost of supplying electric power. TVA believed that the implementation of these changes would give even more favoritism to a lake that already had high lake levels envied by users at other tributary lakes, while also promoting a "first come/first served" attitude to the lake users. For example, if the earliest request for lake-level changes were granted for an individual lake, it may make changes to other lakes more expensive when implemented later. Additional concerns cited by TVA included: (1) difficulties with the current methodology to systematically and objectively address possible flood concerns; (2) the great uncertainty surrounding the future of the electric utility industry due to deregulation and restructuring; (3) implementing changes at any lake would raise the expectation for changes at all lakes; and (4) although the cost of Boone Lake changes were relatively small, the lake users were not prepared to reimburse TVA for the increased systemwide cost of supplying electric power, and TVA was not prepared to pass this cost to the ratepayer.

In March 1997, TVA's Board of Directors agreed with the Executive Committee's determination that a moratorium on changes to policies impacting lake levels was the proper course of action.[2] According to TVA, the 4-year moratorium would position it better for future competition in the electric utility industry, by retaining the current operating flexibility afforded by its hydroelectric power facilities. TVA also believed that the moratorium would minimize the public's perception of favoritism for any particular lake on the system and would allow time for TVA staff to evaluate how studies on policies impacting lake levels should be evaluated in the future.

[2]The Board of Directors appointed TVA's nine senior officers to the Executive Committee. This committee meets regularly to coordinate TVA's activities across organizational lines and to ensure that matters requiring Board approval are appropriately referred.

December 1997 Request for Changes to Policies Impacting Lake Levels From Users of Douglas Lake

On December 9, 1997, the President of LOUD, requested that TVA review and consider the organization's alternative policy to the annual drawdown at Douglas Lake. The LOUD proposal, compared with TVA's existing policy, would permit a slower summer drawdown period and a higher January 1 target lake level. LOUD believes that TVA's existing policy requiring a elevation of 940 feet above sea level at January 1 (the lowest target level during the year) is too restrictive. According to LOUD, a proposed level of 956 feet above sea level at March 1 (the proposed lowest target level during the year) is more realistic. LOUD also believes that its proposal would (1) provide higher lake levels for the late summer, fall, and winter seasons; (2) present a more scenic view of the lake in the winter; and (3) increase the probability of filling the lake in the spring. Table 4.1 captures the differences in lake levels on the first day of each month between LOUD's proposal and TVA's median lake levels for the past 8 years.

Table 4.1: Comparison of Douglas Lake Monthly Elevation Differences—LOUD's Alternative vs. TVA's Median Lake Levels

In feet above sea level

1st day of month	LOUD alternative	TVA's median lake levels[a]	Difference
January	970	944	+ 26
February	963	947	+ 16
March	956	957	- 1
April	972	974	- 2
May	985	990	- 5
June	994	994	0
July	993	994	- 1
August	991	991	0
September	989	985	+ 4
October	985	972	+ 13
November	981	959	+ 22
December	976	951	+ 25

[a]Based on data from 1991 through 1998 for the first day of each month.

Source: LOUD and TVA.

Study of the Economic and Fiscal Consequences of TVA's Draw-Down of the Cherokee and Douglas Lakes

Prior to LOUD's formal December 9, 1997, request to TVA, another group—the Cherokee Lake Users Association—had been making requests for TVA to increase the lake levels at Cherokee Lake. After the LOUD proposal had been formally made to TVA, the LOUD and CLUA groups sought to develop additional information that would show the potential economic benefits resulting from higher lake levels at both the Cherokee and Douglas Lakes. Towards this end, both organizations were instrumental in ensuring that the state of Tennessee and local governments within a six-county region surrounding both lakes would fund a study exploring "the benefits which might accrue to residents of and visitors to a six-county region surrounding Douglas and Cherokee Lakes, should TVA alter its lake level policy."[3] The study, Economic and Fiscal Consequences of TVA's Draw-Down of Cherokee and Douglas Lakes (henceforth, the Cherokee and Douglas Study), was completed in October 1998 and was conducted by the University of Tennessee's Center for Business and Economic Research. TVA received copies of the report and met with the authors of the report, as well as LOUD and CLUA representatives in January 1999. The meeting was scheduled by TVA at the request of LOUD for the purpose of sharing comments and answering questions about the report.

The study used several methodologies to estimate the economic impacts of changes to lake levels on areas bordering the two lakes. The study concludes that positive economic and fiscal impacts would result from proposed changes to policies impacting lake levels. LOUD representatives and TVA identified weaknesses in the study. In addition, in our review of the Cherokee and Douglas Study, we have noted some limitations in the study's scope. We provide additional information in appendix IV about this study, including both TVA's and our comments on the study.

Mountain Lakes Study Committee Report on Georgia Lakes

About the same time that LOUD was making its formal proposal requesting TVA to change its operating policy at Douglas Lake, another group, the Mountain Lakes Study Committee published a report entitled, The Economic Impact of Alternate TVA Lake Management Policies (henceforth, the Georgia Mountain Lakes Study). This report focuses on the areas surrounding the three TVA lakes in northern Georgia—Blue Ridge, Chatuge, and Nottely. The Georgia Mountain Lakes Study estimated very favorable benefit-cost ratios for delaying the drawdown of lake levels at Blue Ridge, Nottely, and Chatuge Lakes in northern Georgia from August 1 to October 1. In addition to benefit-cost estimates, the study focuses on

[3]The six counties are: Cocke, Grainger, Hamblen, Hawkins, Jefferson, and Sevier.

options for funding TVA's increased cost to its power program due to changes to policies impacting lake levels.

TVA criticized the Georgia Mountain Lakes Study on methodological grounds. In our view, the study's estimates of costs and benefits of lake-level alternatives does not conform with recommended federal guidelines for the evaluation of major actions on federal water projects. We provide additional information in appendix V about this study, as well as TVA's comments and our comments on the study.

Conclusions

TVA implemented the March 1997 moratorium on making any changes to policies impacting individual lake levels because of concerns about fairness in how each project would be treated within TVA's integrated system. The moratorium, however, has not stopped groups of lake users from submitting studies to TVA showing what they perceive as the economic benefits that would accrue to the local areas surrounding the lakes. Although the results of the studies can be questioned in a number of areas, the studies do show that lake users are becoming more concerned about identifying and documenting benefits from maintaining higher lake levels at certain TVA lakes. We found that the (1) benefit estimations used in the studies are not directly comparable with TVA's estimates of its systemwide costs of supplying electric power due to differences in the scope of the analyses and (2) studies did not include any detailed evaluation of the costs of changes to policies impacting lake levels; the studies concentrated on economic benefits to the regions surrounding the affected lakes. According to federal guidelines, a comprehensive examination of both costs and benefits is recommended when conducting analyses of actions related to federal water projects.

Formal and Continuing Communication Process With the Public and Other Stakeholders Needed in Future Lake-Level Study

While keeping the 4-year moratorium in place, TVA has recognized that further study of the multipurpose tributary projects is warranted. To pursue this issue, TVA created an internal lake-level policy task force. In July 1998, the task force reported that a reevaluation of policies impacting lake levels should be initiated within the next 2 to 4 years. TVA has budgeted funds to address specific needs that would be required to support future reevaluation efforts. TVA also needs to decide what evaluation option should be pursued under the National Environmental Policy Act guidelines when assessing the environmental effects of any proposed changes to TVA's policies impacting lake levels.

TVA Recognizes That Various Lake-Level Issues Need to Be Addressed

Despite the implementation of its March 1997 moratorium, TVA has continued to face ever increasing public concerns about its lake-level management policies. According to TVA, concerns have been received from organized user groups and individual constituents and have been expressed in many ways, including calls and letters, referrals through political staffs, and also through public forums such as newspaper editorials. In reacting to these concerns, TVA's Resource Group made a February 1998 briefing to the Executive Committee.[1] The Resource Group cited four reasons for the briefing: (1) it had been a year since the moratorium was put in place, and a briefing could describe the types of requests and concerns still being directed toward TVA; (2) the membership on the Executive Committee is dynamic, and it was important that all TVA offices and organizations be aware of these continuing concerns; (3) it was important that staff reiterate to the Board what the 1991 Lake Improvement Plan did and did not address in terms of operating policy; and (4) to request that the Executive Committee consider whether it was in TVA's and its customers' and constituents' best interest to consider launching a new comprehensive evaluation of its policies impacting lake levels at that time.

Resulting from this briefing, the Lake Level Policy Task Force was created and charged with the responsibility to determine the advisability and necessity of conducting a reevaluation of TVA's policies impacting lake levels. Representatives from many TVA internal organizations participated on the task force to ensure that all TVA constituents were represented. The task force included no organizations external to TVA. The task force investigated the pros and cons of implementing a new study at that time,

[1]On February 8, 1999, the Resource Group was merged with two other TVA offices—Hydro Operations and Hydro Engineering Services—to form a new organization called River System Operations and Environment. According to TVA, this organizational change was made to strengthen the integration of river system management with all operations.

as well as estimating the time and expense of such a study. The task force's results, including recommendations, were summarized in an internal July 1998 report, which was the basis for additional briefings for the Executive Committee in September 1998 and January 1999.

The Task Force Recommended That TVA Begin Preparation for Future Reevaluation

The Lake Level Policy Task Force report recommended that while TVA should continue its moratorium on any changes impacting lake levels, a reevaluation of such changes should be initiated within the next 2 to 4 years. According to TVA officials, this was a recognition that demands for changes would continue to increase from lake user constituents, and eventually these changes would likely have to be addressed in a comprehensive study. The task force estimated that the cost to conduct a comprehensive review of TVA's current policies impacting lake levels would total approximately $8 million and would require 3 to 5 years to complete and five full-time employees with additional support staff from various organizations. The report also concluded that, in order to conduct such a review, TVA needed to (1) refine/develop and apply analytical tools aimed at reevaluating flood risk, the impact of policy changes to its systemwide cost of supplying electric power, and economic benefits related to lake-level changes, and (2) develop and implement a proactive communication plan to increase public understanding of TVA's integrated river system operations.

Through its task force's efforts, TVA has recognized that it needs to improve its evaluation techniques, given the tools and advanced methodologies currently available. According to TVA, preparatory work in this area includes several items, such as (1) refining power evaluation techniques and tracking the evolving market aspects under deregulation guidelines; (2) refining water resource planning and operation models, such as the Weekly Scheduling Model and RiverWare[2] to better simulate operation of the integrated system of projects under postulated alternative operation scenarios; and (3) developing objective economic growth and development analysis methods that better represent impacts that could be expected under alternative lake-level scenarios.

Because of the lead time necessary to define these analysis techniques, develop the software, and acquire meaningful data, TVA has determined

[2]RiverWare, according to TVA, is a river basin modeling tool with features for simulating or optimizing operation of the system for multiple purposes over varying time horizons with time steps ranging from hourly to monthly. RiverWare is currently used for daily operations scheduling, and TVA anticipates that the planning aspect of this model will eventually supplement or possibly replace the Weekly Scheduling Model.

that some consistent effort was warranted to begin making these improvements so as not to unduly delay analyses in the future if and when they are undertaken. The task force estimated that such an effort would cost approximately $2 million and would require between 2 to 3 years to complete. TVA has budgeted additional funds to support several actions in preparation for an eventual reevaluation of its policies impacting lake levels. TVA has allocated $1.5 million for fiscal years 1999 through 2001 for various activities, including the preliminary evaluation of proposed changes impacting lake levels and the development of flood risk tools. As shown in table 5.1, TVA has divided this additional funding under two ongoing programs: Alternate Operations Evaluation and Flood Risk Reduction. The funds allocated for fiscal year 1999 have been approved; however, TVA has not approved the planned budgets for succeeding years.

Table 5.1: Funding Budgeted for TVA Activities Related to the Lake Level Policy Task Force's Recommendations

	Fiscal year			
Funding category	**1999 (approved)**	**2000 (budgeted)**	**2001 (budgeted)**	**Total**
Alternate operations evaluations	$100,000	$200,000	$200,000	$ 500,000
Flood risk reduction	200,000	400,000	400,000	1,000,000
Total	**$300,000**	**$600,000**	**$600,000**	**$1,500,000**

Source: TVA.

The additional funding for the Alternate Operations Evaluation Program is designated for improvements in economic evaluation procedures and/or data collection support. TVA envisions a 3-year effort to better define economic analysis techniques and to acquire data that would support these analyses. As part of this effort, TVA is planning to examine recreational use at several TVA lakes to begin establishing a database for future lake visitation evaluations. These improvements were estimated to cost $500,000 and require about 3 years. Under the Flood Risk Reduction Program, TVA has budgeted an additional $1 million over the next 3 years to improve the methodology used to establish flood frequencies and to objectively determine the impact that changes in operations would have.

In addition to the $1.5 million, TVA provides annual funding to both of these programs for various activities related to improving their tools and methodologies for evaluating policies impacting lake levels. Under the Alternate Operations Evaluation Program, TVA spent $364,000 during fiscal

year 1998 for continuing annual program activities, such as (1) preliminary evaluations of proposed changes impacting lake levels; (2) staff support for TVA's land and water management divisions to promote working together to increase internal knowledge on how land and water issues are related; (3) support for staff to maintain expertise in system evaluation tools, such as the Weekly Scheduling Model, and to improve the reliability and accuracy of such tools through minor modifications; and (4) the development of new evaluation tools to complement or eventually replace existing tools for planning river operations. TVA has allocated $380,000 for fiscal year 1999 and $393,000 for fiscal year 2000 for the same activities.

TVA has also indicated that monitoring of impacts of the possible utility deregulation scenarios has been a continuing process for the past several years, and new aspects present themselves each year. TVA also said that it had invested more than $1 million in the development of a new integrated river system-modeling tool, called RiverWare, currently in use for daily operations scheduling. TVA has been examining the possibilities of using this model in a planning mode for future studies, as a complementary tool to the Weekly Scheduling Model, or possibly as a replacement. TVA's annual efforts under the Flood Risk Reduction Program in recent years have focused on the development of flood damage curves for various communities within the Tennessee Valley. These curves depict the flood damage that would occur at these sites as a function of the flood level on the river. TVA has also developed flood distribution diagrams for 19 sites throughout the Valley. These diagrams present a chart of the historical flood events that occurred at these sites over the period of record. Flood profiles have also been established for several lakes, which estimate the elevations along the lakes and the statistical frequency at which these elevations occur. TVA spent $551,000 during fiscal year 1996 and $849,000 during fiscal year 1997 on flood risk reduction activities. TVA's budget allocations for fiscal years 1998 and 1999 provide $500,000 each year to continue the development of flood risk indicators and profiles and flood damage curves. TVA has increased its budget allocation for these activities to $520,000 for fiscal year 2000. In addition, TVA has cosponsored an effort conducted by the National Weather Service to update and improve its rainfall frequency analysis for the Tennessee Valley. TVA's portion of the funding totaled $250,000 during fiscal years 1997 and 1998.

TVA has stated the overall reasons why the 4-year moratorium should continue. However, TVA has not informed the public and other stakeholders of its recent and planned activities regarding a future reevaluation of its policies impacting lake levels. By conducting internal studies and developing the necessary tools and methodologies before

announcing a comprehensive reevaluation of TVA's policies impacting lake levels, the task force believes TVA would reduce the risk of raising public expectations of "immediate" changes in operating policies and would help ensure that the significant resources required for a NEPA study would be well spent. The task force recognized that TVA needed to develop and implement a "proactive communication plan to increase public understanding of the operation of its system of projects, reduce conflict, and build rapport with stakeholders." The task force recommended that TVA incorporate public participation in its studies, where appropriate, to ensure the credibility of the studies.

The July 1998 report recognized that the purpose of the communication plan is to "better explain lake operating policies and tradeoffs to Members of Congress, their staffs, distributors, lake users, and other stakeholder groups" and to demonstrate TVA's "continued willingness to listen to and better understand stakeholder concerns." The report also noted that two of the key messages that TVA needed to communicate were (1) any lake-level changes will shift benefits with impacts on flood risk, power, navigation, and conditions for aquatic life and that evaluating these impacts is a complex task requiring time, money, and broad input, and (2) TVA's commitment to improving communication with stakeholder groups. In addition, the report indicated that several new mechanisms to increase public involvement in river system operations would be evaluated. One example was annual or semiannual workshops for lake user groups. These workshops would include presentations on operations of its system of projects and associated tradeoffs, opportunities for stakeholders to bring concerns to the attention of TVA management, and interaction among specific interest groups, such as recreation, flood reduction, and navigation beneficiaries. Implementing the communication plans outlined in TVA's task force report would help to ensure that the public and other stakeholders are kept informed of TVA's activities and future plans as TVA prepares for a reexamination of its policies impacting lake levels.

TVA Has Several Options Available When Assessing the Environmental Effects of Alternative Policies Impacting Lake Levels

When TVA conducts its reevaluation of its policies impacting lake levels, one of the more significant concerns it must consider is the effect of any policy changes on the environment of the Tennessee Valley. The National Environmental Policy Act of 1969 requires federal agencies to prepare a detailed statement on the environmental impact of proposed major federal actions that could significantly affect the quality of the human environment. In conducting its 1990 study, TVA developed an environmental impact statement (EIS) to ensure that the environmental effects of the operating alternatives were thoroughly investigated and that ample opportunities for public review and comment were provided. However, under NEPA, there are several different levels of review that can be used to analyze the environmental effects of policy changes.

Under the NEPA regulations, there are three levels of NEPA review: environmental assessments (EA), EISs, and categorical exclusions. EAs are supposed to be and typically are brief documents that still provide some level of detail about proposed actions and alternatives, may have some public involvement, and typically take several weeks to a number of months to complete. At the end of an EA process, the agency either issues a Finding of No Significant Impact or initiates an EIS process. EISs provide the most detailed analyses of a proposed action and alternatives, have the most formal public involvement process, and typically take the longest to complete. Categorical exclusions are basically categories of actions that an agency predetermines would normally not result in significant environmental impacts. Under NEPA regulations, agencies can proceed with an action that qualifies as a categorical exclusion without conducting any further environmental review.

On the other hand, courts have recognized that NEPA is not applicable to the continued operation of projects when operations conform to statutory directives or when operations do not deviate from existing design capacities and constraints. In addition, decisions about water flow through federally operated dams and related matters have consistently been held not to constitute major federal actions. Instead, courts have considered such activity as “routine managerial actions” not subject to NEPA.

In the final analysis, however, if TVA believes it to be necessary or advisable to prepare an EIS or perform any other type of environmental review under NEPA, that decision would likely be respected by the courts. Our review found no federal court decisions in which preparing an EIS was found to have been unreasonable. NEPA was intended to facilitate reasoned

and informed decision-making, in which the environmental impacts of federal actions would be given due weight.

According to TVA officials, TVA approaches NEPA from both a policy and a legal perspective. TVA recognizes that a wide range of operational changes can be made without evoking the NEPA process. However, TVA believes that there can be proposed changes in operations that could result in environmental changes that should be understood before decisions are made. By adopting the three levels of review created by NEPA, TVA does conduct a limited environmental review of most of the actions that are proposed to be categorically excluded and documents this review in writing. TVA believes that because it operates its projects as an integrated system and balances multiple purposes, any changes to its operating policies should be examined to determine the effects on the environment. However, a complete EIS is not necessary in all instances. Assuming the proposed change is not categorically excluded, TVA officials said that it is likely that TVA's actions would involve at least the preparation of an EA or, if substantial enough of a change, a supplement to the existing EIS or another EIS. According to these officials, TVA anticipates that considerable updating of the material in the 1990 review would be required to more fully explain and document all environmental changes that might result from the implementation of any other alternatives.

Conclusions

It has been nearly a decade since the last significant changes to TVA's policies on lake levels. During the current moratorium, TVA has initiated various internal actions through its lake level policy task force in preparation for a future reexamination of existing policies. TVA has been hesitant to make a formal announcement that a reexamination is needed because (1) it does not have all of the needed evaluation methodologies in place to perform a reexamination and (2) such an announcement would, in TVA's view, set unrealistic expectations about how quickly any decisions could be reached about whether changes are or are not needed, given the time needed to conduct the reevaluation under the NEPA process.

We agree with TVA that a reexamination of its policies impacting lake levels is warranted. An important aspect for TVA to consider in its reexamination efforts is formal and continuing communication with the public and other stakeholders. These communications are needed to (1) further educate TVA regarding the concerns and needs of the various stakeholders that must be considered in the reexamination process, (2) give TVA additional opportunities to explain the operation of its integrated system and the

complexities involved in evaluating changes to the system, (3) establish realistic expectations of the time required to reevaluate changes in policies impacting lake levels, (4) keep the public informed of TVA's ongoing activities and progress achieved, and (5) increase the overall credibility of the reexamination process.

Past evaluations examining changes to policies impacting lake levels have tended to emphasize either the costs associated with the potential change as has been the case with TVA's efforts or the localized benefits as has been the case with studies performed for users of the lakes. When reexamining any potential changes to policies impacting lake levels, a balanced and comprehensive decision can only be reached through consideration of the costs and benefits of the alternatives examined.

Recommendation

We recommend that the Chairman of TVA's Board of Directors (1) provide for a formal and continuing communication process for the public and other stakeholders to actively participate in TVA's efforts to reexamine its policies impacting lake levels and (2) ensure that TVA's reexamination efforts include consideration of both the costs and benefits of any potential changes to policies impacting lake levels.

Agency Comments and Our Evaluation

TVA stated that we had conducted a comprehensive assessment of TVA's tributary lake operating policies and that the draft report fairly summarized the issues influencing TVA's operations. Regarding our recommendation that TVA provide for a formal and continuing communication process, TVA stated that it is essential that the public continue to be involved in decisions that affect how the Valley's water resources are used. TVA also recognized that there is an opportunity to improve its communications with stakeholders. TVA added that it remains committed to communicating fully with its stakeholders and others who depend on the integrated management of the Tennessee River system.

Regarding our recommendation that TVA's reexamination efforts consider the costs and benefits of potential changes, TVA stated that in operating the river system for the greatest public benefit, it continues to look for new methodologies that will provide for a more objective analysis of the tradeoffs among competing demands. TVA stated that certain water uses, such as hydropower and flood control, lend themselves more readily to quantitative analysis, while other operating objectives, such as economic development and environmental impacts, continue to be more difficult to

quantify. TVA added that it remains committed to providing lake users and other beneficiaries with the best information it has on the most likely impacts of changes in lake operations so that such lake users and other beneficiaries are aware of the tradeoffs and consequences of policy changes.

TVA also emphasized in its comments that not all costs are monetary. TVA stated that as it works to meet multiple needs with a finite resource, increased costs can take the form not only of higher electricity prices but also reduced flood control benefits, lessened environmental quality, and reductions in other benefits. TVA added that costs in any form become costs to some segment of the public.

Comments From the Tennessee Valley Authority

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902-1499

O. J. "Ike" Zeringue
President and Chief Operating Officer

May 12, 1999

Ms. Susan Kladiva
Associate Director, Energy,
Resources, and Science Issues
United States General Accounting Office
Washington, DC 20548

Dear Ms. Kladiva:

Thank you for your recent letter giving us the opportunity to comment on the draft version of your study of TVA lake levels.

Many people and industries depend on the Tennessee River for a number of uses, and TVA's challenge is the effective integrated management of the nation's fifth largest river system for the benefit of the greatest number of people. TVA's historic mandate is to manage the river system for the overall public good, balancing power production, flood control, navigation, recreation and economic development. We appreciate the expertise and professionalism your staff brought to this assessment. In TVA's opinion, the GAO has conducted a comprehensive assessment of our tributary lake operating policies and fairly summarized the issues which influence our operations.

As your report affirms, competition for the Valley's water resources continues to grow, and new demands cannot always be accommodated without negative impact to other water users. As the report recommends, it is essential that the public continue to be involved in decisions that affect these balances. We completed our own comprehensive examination of our lake level operating policy in 1990 with the participation of various stakeholders from the public. As one result of that effort, TVA extended the summer pool level of ten tributary lakes until August 1. We also instituted a toll-free telephone line to provide lake information. That lake information line now receives more than one million calls per year, and much additional information is shared through TVA's Internet site (www.tva.gov).

Seasonal publications, such as *River Neighbors*, also address water and land issues and reach more than 30,000 lake users. At the same time, we recognize there is opportunity to improve our communication with stakeholders, and we continue to explore new avenues to exchange information with all members of the public. We remain committed to communicating fully with our stakeholders on this issue as well as others who depend on the integrated management of the Tennessee River system.

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Ms. Susan Kladiva
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The report recommends that any TVA re-examination effort consider the costs and benefits of any potential changes. In operating the river system for the greatest public benefit, we continue to look for new methodologies that will provide for a more objective analysis of the tradeoffs among competing demands for the resources of one river. Certain water uses such as hydropower and flood control lend themselves more readily to quantitative analysis. Other operating objectives, such as economic development and environmental impacts, continue to be more difficult to quantify, making dollar comparisons between these areas problematic. TVA remains committed to provide lake users and other beneficiaries with the best information we have on the most likely impacts of changes in lake operations so that they are aware of the tradeoffs and consequences of policy changes.

As requested, we re-evaluated the power costs associated with two of the alternatives included in our 1990 study, and we are comfortable with the results of that analysis as presented in the report. TVA would like to emphasize to report readers that this type of analysis includes many uncertainties. Power pricing occurs on a minute-to-minute basis and is influenced by market demands, the weather, environmental issues, availability of supply, and other factors. In addition, the utility industry itself is experiencing fundamental changes as it moves toward a deregulated environment. If these analyses were repeated a year from now, the results and conclusions drawn from them would likely be different.

Moreover, not all costs are monetary. In operating to serve the public, TVA delivers low-cost electricity prices while also providing for flood control, navigation and other uses of the river system. As we work to meet multiple needs with a finite resource, increased costs can take the form not only of higher electricity prices but also reduced flood control benefits, lessened environmental quality, and reductions in other "benefits." Ultimately, costs in any form become costs to some segment of the public.

The cost factor in decisions to allocate resources becomes particularly important in years when we have little rainfall, and we would caution readers to remember that the low range of power cost cited in the report occurs only when we have abundant rainfall. During those years, we are in the fortunate position of having both higher lake levels and lower power costs.

We appreciate the efforts of your staff in taking a comprehensive look at the many complexities surrounding water management and lake level issues in the Tennessee Valley. Your review will likely generate additional opportunities for discussion between TVA and the many water users in the Tennessee Valley, and we welcome these opportunities.

Sincerely,

O. J. Zeringue

Multipurpose Tributary Lake-Level Changes—Minimum and Maximum Monthly Levels During Calendar Year 1998

In feet above sea level

Months during 1998	Blue Ridge[a]	Boone	Chatuge	Cherokee	Douglas	Fontana	Hiwassee
January							
Minimum	1,651.18	1,351.35	1,912.19	1,027.04	940.51	1,627.98	1,462.78
Maximum	1,664.27	1,359.19	1,916.05	1,033.25	961.37	1,655.43	1,485.81
February							
Minimum	1,664.10	1,353.59	1,913.42	1,033.06	950.66	1,651.42	1,475.43
Maximum	1,678.13	1,361.90	1,915.60	1,036.82	960.99	1,656.09	1,481.55
March							
Minimum	1,678.11	1,359.27	1,915.26	1,036.79	955.25	1,653.65	1,478.79
Maximum	1,684.30	1,365.55	1,919.59	1,051.83	971.45	1,660.21	1,491.88
April							
Minimum	1,682.30	1,364.29	1,919.40	1,051.41	971.45	1,659.34	1,491.88
Maximum	1,689.07	1,379.38	1,924.55	1,069.27	995.36	1,693.52	1,515.95
May							
Minimum	1,683.77	1,376.69	1,924.26	1,066.91	991.84	1,693.52	1,515.83
Maximum	1,687.18	1,383.80	1,925.35	1,070.99	993.98	1,702.75	1,524.25
June							
Minimum	1,685.90	1,380.69	1,925.00	1,069.02	993.05	1,700.59	1,520.80
Maximum	1,687.95	1,383.24	1,926.31	1,071.76	995.20	1,705.34	1,524.30
July							
Minimum	1,682.63	1,381.51	1,923.12	1,060.53	991.06	1,693.64	1,516.89
Maximum	1,686.09	1,383.72	1,925.15	1,069.31	993.23	1,700.65	1,521.08
August							
Minimum	1,673.89	1,380.92	1,919.16	1,052.02	976.90	1,679.02	1,506.15
Maximum	1,682.68	1,383.04	1,923.12	1,060.75	991.06	1,693.69	1,517.40
September							
Minimum	1,654.10	1,378.90	1,915.63	1,042.61	965.81	1,655.21	1,491.17
Maximum	1,673.96	1,382.50	1,919.16	1,052.09	976.91	1,679.02	1,506.38
October							
Minimum	1,630.60	1,372.91	1,913.69	1,036.16	954.22	1,639.47	1,472.30
Maximum	1,654.10	1,379.00	1,915.80	1,042.67	966.04	1,655.25	1,491.25
November							
Minimum	1,621.38	1,361.33	1,911.95	1,029.17	946.72	1,633.45	1,464.85
Maximum	1,630.65	1,373.12	1,913.69	1,036.76	954.33	1,639.60	1,472.59
December							
Minimum	1,624.72	1,355.28	1,911.08	1,026.37	940.29	1,625.68	1,460.31
Maximum	1,636.16	1,361.63	1,912.05	1,030.07	946.78	1,633.45	1,465.42

Melton Hill	Norris	Nottely	South Holston	Tellico	Tims Ford[a]	Watauga
791.46	977.02	1,742.39	1,689.40	807.51	856.01	1,930.63
794.88	986.00	1,749.67	1,699.26	810.60	866.16	1,940.20
791.17	986.00	1,748.28	1,699.26	807.45	865.01	1,940.01
794.98	992.63	1,754.07	1,712.01	810.50	874.00	1,948.68
790.10	992.63	1,753.82	1,712.01	807.51	874.00	1,948.02
794.99	1,006.52	1,761.98	1,723.05	810.60	881.94	1,956.42
790.79	1,006.43	1,761.98	1,721.65	808.25	881.69	1,954.13
796.44	1,030.38	1,772.47	1,732.29	815.09	886.25	1,960.69
792.05	1,020.15	1,772.34	1,728.43	811.72	884.60	1,956.83
794.97	1,024.25	1,775.98	1,731.84	813.11	885.98	1,959.42
792.30	1,019.15	1,775.39	1,728.46	811.88	885.84	1,957.24
795.05	1,021.23	1,778.09	1,730.64	814.42	890.14	1,959.85
790.40	1,015.00	1,770.29	1,721.30	812.07	886.92	1,949.22
794.88	1,019.15	1,775.53	1,728.90	813.30	887.68	1,957.88
792.45	1,006.96	1,762.82	1,713.28	812.17	886.18	1,942.60
795.10	1,015.03	1,770.41	1,721.32	813.48	888.06	1,949.30
792.58	996.87	1,755.19	1,703.21	812.37	883.68	1,935.52
794.71	1,006.99	1,762.85	1,713.28	813.30	886.19	1,942.62
790.27	987.52	1,747.59	1,697.18	812.05	880.66	1,934.03
794.89	996.88	1,755.28	1,703.26	813.13	883.93	1,935.68
792.68	980.95	1,744.95	1,696.31	808.94	875.61	1,933.80
794.63	987.55	1,747.64	1,697.25	812.69	880.68	1,934.11
792.48	977.39	1,740.84	1,693.65	807.78	870.88	1,932.17
794.98	981.18	1,745.01	1,696.34	809.61	875.61	1,934.04

[a]TVA said that the elevations for Blue Ridge beginning in September were abnormally low due to a special drawdown for maintenance inspection that is conducted once every 5 years. TVA also said that the elevations for Tims Ford Lake in January and February were abnormally low due to a special drawdown for repairs.

Source: TVA.

TVA's 1990 Review and Its 1999 Analysis

This appendix provides information from TVA's 1990 review, entitled Tennessee River and Reservoir System Operation and Planning Review, about the increased systemwide costs of supplying electric power that TVA estimated for a range of lake-level alternatives and a description of the methodologies used in TVA's analysis. In addition, this appendix summarizes the results of an analysis TVA performed in 1999 at our request that updated its estimated systemwide cost impacts of implementing lake-level alternatives similar to two of the alternatives considered in the 1990 review.

TVA's 1990 Review

TVA Estimated Systemwide Costs of Supplying Electric Power for a Wide Range of Lake-Level Alternatives in 1990

In 1990, TVA estimated that various alternative policies for managing lake levels at some of its multipurpose tributary projects would result in increasing its annual average systemwide costs of supplying electric power by $2 million to $93 million (in 1990 dollars), depending on the alternative (see table III.1). TVA used a complex methodology to estimate the cost impacts of the seven lake-level alternatives, each of which involved a delay of the starting date for the drawdown of lake levels from Memorial Day to later dates in the summer or fall.

TVA's methodology focused on characterizing the electricity supply resources (commonly referred to as capacity) it would need and how it would deploy these resources in order to meet demand from its customers under the different lake-level alternatives. TVA computed differences in resource needs between each alternative and the "base case" scenario. The base case refers to a "no-change" scenario that maintains the existing policy of starting the lake-level drawdown anytime after Memorial Day. Differences in capacity needs and in the utilization and scheduling of different sources of generation were then translated into cost differences.

For example, delaying the drawdown of the lake levels until Labor Day (Alternative 2) was more expensive than the base case because less water would be available for hydroelectric generation during the period of peak electricity demand in late summer. The cost impact can be broken into

two components, "energy costs" and "capacity costs."[1] For example, under Alternative 2:

- Delaying the drawdown of the lake levels from Memorial Day to Labor Day meant that there would be less hydroelectric generation during a period of peak summer demand. The shortfall would be compensated by incremental production of electricity from other sources, such as coal-fired plants or combustion turbine units. However, the energy costs of fossil-fuel sources (coal, petroleum based, and gas) are higher than the energy costs of hydroelectric power generation. This pattern would be reversed in the fall and early winter, when more hydroelectric generation is available. However, because more electricity is demanded and produced in late summer than in early winter, the net effect would be higher energy costs.
- The reduction of hydroelectric generation capacity due to delaying the drawdown of the lake levels to Labor Day was significant enough that TVA would have to acquire incremental fossil-fueled electric generation capacity to replace it. In effect, this meant that TVA could not rely on increasing the utilization of its existing plants, but it would have to build new capacity. This cost is over and above the higher energy costs.

Table III.1 displays TVA's estimated energy and capacity costs associated with each of the alternatives considered in the 1990 review.

[1]Energy represents the volume of electricity delivered over a period of time and is measured in kilowatt-hours. Capacity, on the other hand, is measured in kilowatts and represents the rate at which energy can be delivered at a moment in time. For example, 20 100-watt light bulbs burning for one-half hour would use 1,000 watt-hours (or 1 kilowatt-hour). In this case, the capacity demanded would be 2 kilowatts and the energy used would be 1 kilowatt-hour. Energy costs include fuel and other costs that depend on operating levels, but exclude capital costs. Capacity costs are the fixed costs of an electric power system (such as the capital cost of a generation plant) that do not vary with the level of operation.

Table III.1: Estimated Impact of Lake-Level Alternatives Evaluated by TVA in 1990 on TVA's Systemwide Cost of Supplying Electric Power

In millions of 1990 dollars

Alternative	Annual energy cost		Required capacity addition (in megawatts)	Initial capital cost	Annual capital cost	Total annual cost
	Average	Range				
1	$ 2	$ –9 to $20	0	0	0	$ 2
1A	$ 6	$ –7 to $ 30	100	$ 74	$ 9	$ 15
1B	$ 9	$ –9 to $ 20	10	$ 7	$ 1	$ 10
1C	$ 3	$ –9 to $ 20	30	$ 22	$ 3	$ 6
1D	$ 3	$ –9 to $ 20	0	0	0	$ 3
2	$ 16	$ –4 to $ 60	750	$ 560	$ 68	$ 84
3	$ 25	$ –4 to $ 56	750	$ 560	$ 68	$ 93

Source: TVA, Tennessee River and Reservoir System Operation and Planning Review, Table 28, p. 116, (Dec. 1990).

TVA's 1990 Cost Estimates Are Based on Complex Modeling and Extensive Data

TVA's 1990 cost-estimation methodology involved the use of three computer models and extensive data inputs to simulate its hydroelectric generation capabilities and operations, and its overall costs of supplying electric power using all its electricity generation assets under the different alternatives. The modeling effort accounted for considerable uncertainty in hydrologic conditions, which leads, in turn, to uncertainties in cost estimates.

To determine differences in the cost of electric supplies between alternative lake policy scenarios and the base case (no-change) scenario, TVA used three models. TVA also used extensive data on hydrological conditions; its own electricity supply capabilities, operations and costs; and its customers' electricity demand. On the basis of the data, the models, and standard analytical techniques, TVA determined (1) its hydro and nonhydro electricity generation capabilities under each lake-level alternative, (2) the most efficient way it could schedule its power plants to meet demand, and (3) its costs of meeting demand under each alternative. TVA conducted this analysis for 1 year, 1993, when electric supplies from its own sources were expected to equal demand.[2] TVA examined hydrological uncertainty by applying the one year of incremental power supply costs for 1993 to each of the previous 87 years (1903-1989) for

[2]According to TVA, it chose a balanced year, 1993 (in which its self-generated supply of electricity was expected to equal demand), to avoid overestimating or underestimating the cost of delaying the drawdown of lake levels.

which it had hydrological data. Briefly, TVA's modeling procedure was as follows:

The Weekly Scheduling Model (WSM): This is a TVA-developed model that is used to simulate weekly hydroelectric power capabilities and production based on hydrologic conditions. WSM considers various constraints on water releases imposed to meet navigation, flood control, environmental, and recreational objectives. TVA used WSM to determine weekly hydroelectric production under each lake-level scenario.

PowrSym Dispatch Model: This is a power production costing model that is used to determine the most efficient combination of electric generation assets to meet a given level of demand. This model uses data on TVA's hydro and nonhydro power generation to determine which plants should generate the needed electricity to meet demand at any given time, and it calculates associated energy costs. For the lake-level scenario analysis, TVA fed the weekly hydroelectric power production data into the PowrSym model to calculate its energy costs under each lake-level scenario. PowrSym scheduled the weekly hydropower production on an hourly basis together with all of TVA's other power resources to minimize overall production costs.

The Hourly Loss of Load Expectation (HLOLE) Model: This model is used to determine electric generation capacity needed to maintain the reliability of the power system. TVA input the power supply data resulting from the previous steps into the HLOLE model in order to determine the different electric generation capacity needs under each alternative and to compare them to the capacity needs of the base case. On the basis of assumptions on the construction costs of certain types of power plants, TVA then converted the resulting differences to capacity cost differences among scenarios.[3] The hydrologic uncertainties as depicted in 87 years of highly variable weather-related data, resulted in wide ranges of cost estimates.[4] For example, the annual average estimate of the energy cost of Alternative 2, as reported in table III.1, was $16 million (in 1990 dollars). However, TVA reported a wide range of uncertainty around this average.[5] When required

[3]In 1990, TVA assumed that any expansion of its power generation capacity would be in the form of new coal-fired and combustion turbine power plants. A combustion turbine is an electricity generating unit that is similar in design to a jet engine. The combustion turbine uses natural gas or other light hydrocarbon fuel to fire a turbine engine that is connected to an electric generator.

[4]In addition to considering an average-year for 87 years of hydrology, TVA considered hydrologic scenarios based on an extremely dry year and an extremely wet year among the 87 years.

[5]TVA reported a range between $(–)4 million (negative $4 million, that is, benefits instead of costs) annually, and up to $60 million annual energy costs (in 1990 dollars).

capacity additions were included, the total average annual cost was estimated at $84 million (in 1990 dollars).

TVA's 1999 Analysis

TVA Updated Systemwide Costs of Supplying Electric Power for Two Lake-Level Alternatives in 1999

We asked TVA to update its cost estimates of two lake-level alternatives because market conditions and evaluation methodologies have changed considerably since 1990. One key difference in the 1999 update was that the 1990 base case was no longer the base case in 1999. In 1991, TVA decided to adopt Alternative 1 as a permanent policy. This decision meant delaying the start of the lake-level drawdown at TVA's multipurpose tributary projects from Memorial Day to August 1. As a result, Alternative 1 became the new base case. Furthermore, the electricity supply industry had changed considerably, due to deregulation and the introduction of competition;[6] technological progress; and environmental factors. We and TVA agreed on the broad issues to be considered in TVA's cost updates. Due to the difficulty of trying to update all of the alternatives considered in the 1990 analysis, we requested that TVA update only two alternatives—Alternative 1A (an additional 2-month drawdown delay for three of the projects) and Alternative 2 (an additional 1-month drawdown delay for all of the projects). The results of TVA's March 1999 analysis, as detailed in table III.2, indicate average annual cost increases of $14 million and $47 million (in 1999 dollars) in its systemwide cost of supplying electric power for Alternative 1A and Alternative 2, respectively, but with very wide ranges of uncertainty for each.

[6]In the past, electricity was supplied by regulated entities (utilities) that acted as monopolies within their franchise areas. Monopolistic utilities generated their own electricity supplies and sold them through their distribution systems and were allowed to charge rates based on their costs plus a regulated rate of return. As deregulation progresses, electricity supplies are being increasingly produced by independent companies operating in unregulated, competitive markets. The current trend is for the monopolistic function of utilities to be increasingly limited to their transmission and distribution systems. Less and less of the electricity is self-generated by utilities and more by unregulated suppliers. The utilities purchase the electricity from the unregulated suppliers at competitive rates and use its transmission and distribution system to transport it to customers in the franchise area.

Table III.2: Estimated Impact of Lake-Level Alternatives Evaluated by TVA in 1999 on TVA's Systemwide Cost of Supplying Electric Power—Differences Between Alternatives and Base Case

In millions of 1999 dollars

Alternative	Annual average cost	Annual cost—low	Annual cost—high
1A	$14	$(-) 2	$33
2	$47	0	$88

Source: TVA.

TVA's procedures for updating cost estimates in 1999 differ in several significant ways from its 1990 estimation procedure, largely because conditions have changed. The differences include the following:

- The 1999 base case is different, as mentioned earlier.
- Whereas the 1990 procedure estimated annual costs for a single year, 1993, the 1999 procedure estimated average annual costs for the entire future period, 1999 through 2023. TVA broke this 25-year period into 2 sub-periods, 1999 through 2001, and 2002 through 2023.
- The 1999 methodology uses the WSM model in a similar fashion to determine different hydroelectric capacities and production for each of the scenarios. However, the 1999 methodology uses a 25-year future time horizon for the analysis and breaks the 25 years into two periods. During the first 3 years, TVA would purchase forward contracts from electric power suppliers outside its territory in order to replace lost hydropower, while additional generating capacity would be built to compensate for its reduced hydro generation capacity.[7] The transmission costs associated with importing this power into the TVA power system were included in the cost estimates for these 3 years.[8] TVA assumes that, starting in 2002, the newly built capacity will supply any shortages due to changes in policies impacting lake levels. However, in contrast with its 1990 approach, TVA did not calculate the cost of lake-level alternatives based on its own costs of the energy and capacity needed to compensate for reduced hydroelectric power generation. Instead, TVA used its forecast market prices in the cost calculations.[9] This change in approach reflects the trend away from

[7]A forward contract is an agreement between two parties for the purchase/sale of electric supplies at some future time under such conditions as the two agree on. The forward contracts that TVA purchases are for firm power, that is, power that the seller guarantees will be delivered to the buyer. Firm power is priced in a way that reflects both energy and capacity costs.

[8]Transmission is the process of conducting the flow of electricity at high voltages from the points of generation to the location of groups of electricity users. TVA assumed that it would obtain transmission at a price of $1.80/kilowatt-month for the 3-month summer period (July-September).

[9]TVA actually used three sets of forecast market prices representing a low-, medium-, and high-price scenarios.

regulated cost-based prices and towards competitive market-based prices in the electric industry. The main difference between the two approaches is that the 1990 cost-based approach assigns all the costs of the additional capacity to each lake-level alternative. In contrast, the use of market prices in the 1999 analysis means that only a portion of the cost of additional capacity is assigned to each lake-level alternative.[10]

- The use of TVA's models in 1999 was different from 1990. The key difference is that PowrSym was used in 1990 to model only TVA's power system in order to estimate energy cost differences among scenarios. In 1999, however, the PowrSym Multi-Area model (which is different from the PowrSym production costing model) was used to forecast electricity market prices for power in 23 southern, midwestern, and some eastern states.
- During the 3-year period, 1999-2001, TVA's analysis does indicate the need for additional generation capacity to compensate for lower hydroelectric capacity under Alternatives 1A and 2. However, TVA's analysis of delays in the drawdown of lake levels yielded smaller impacts on hydroelectric generation capacity in 1999 than in 1990. For example, in 1990 TVA estimated that Alternative 2 would require TVA to build 750 megawatts (MW) of additional electric generation capacity. In contrast, in 1999, TVA estimated that Alternative 2 would require TVA to build 250 MW of additional capacity. This difference is due to the different base case (August 1st start date of the lake-level drawdown instead of Memorial Day), technological advances resulting in lower construction costs and higher power plant efficiencies for new capacity, improved reliability of TVA's nuclear and fossil-fueled plants, and improved availability of power for purchase from other suppliers. For the 1999 analysis, the type and cost of electric generation capacity that TVA acquires during the first 3 years differ considerably from its assumed capacity additions in the 1990 methodology. This reflects technological progress, increased efficiency, and lower costs.[11]

[10]It should be noted that the additional capacity may or may not be built by TVA. It may be built by another power producer that sells the power to TVA at market rates. Whether it is built by TVA or by another producer, the additional capacity will supply power to TVA's customers only during the peak hours affected by the change to policies impacting lake levels. Outside these peak hours, the power from the additional capacity can be sold elsewhere at market rates. Since market rates effectively reflect both energy and capacity (capital) costs, not all the capital costs of the replacement capacity are counted towards the cost of the lake-level alternative. The remaining capital costs are paid by other users of this capacity who purchase power outside of these peak hours.

[11]TVA assumes the expansions of its electric generating capacity during the 3-year construction period will be in the form of a combined cycle plant. Combined-cycle power plants are generating units that combine a combustion turbine and a heat recovery steam generator. The steam generator uses the exhaust from the combustion turbine to generate steam that, in turn, drives a steam turbine.

- The 1990 analysis did not consider the impacts of lake-level alternatives on cooling requirements for some of its fossil-fuel generating plants. The 1999 analysis added some costs associated with such impacts.[12]
- The 1999 analysis also assigns a value for the "ancillary services" associated with the flexibility of hydroelectric generation.[13] This value raised TVA's estimates of the impacts on its systemwide cost of supplying electric power of the lake-level alternatives by 10 to 15 percent—a range of 0 to $4 million for Alternative 1A and from 0 to $11 million for Alternative 2 (in 1999 dollars). This change in the 1999 methodology is due to the assumption that market-like transactions for ancillary services have emerged and are likely to grow.[14]
- TVA handled hydrologic and electricity price uncertainties a different way for the 1999 analysis, reflecting the fact that the 1999 analysis had a 25-year future time horizon, while the 1990 analysis focused on a single year, 1993.[15]
- TVA's 1999 analysis also considered the effect of more stringent future air pollution regulations to take effect in 2010, which would essentially make hydropower more valuable. TVA's 1999 analysis, using the more stringent regulations, would result in somewhat higher estimated impacts.[16] This was not a factor in the 1990 analysis.

[12]TVA told us that changes to policies impacting lake levels have implications on water use to cool some of its nuclear and fossil-fired electric plants. Given water temperature requirements in National Pollution Discharge Elimination System permits, changes in policies impacting lake levels could effectively reduce the output of some plants. TVA estimated the costs related to cooling requirements as ranging from 0 for Alternative 1A to $1 million to $4 million for Alternative 2 (in 1999 dollars).

[13]Ancillary services are defined as those services that are necessary to support the transportation of power from power plants to customers while maintaining reliable operation of the transportation system in accordance with good utility practice. Hydroelectricity commands a premium for its "ancillary" value, associated with its operational versatility that is particularly valuable for regulating the transportation of electricity on power lines. The versatility of hydroelectric power plants lies in the fact that they can be brought into service quickly and cheaply. In contrast, bringing a large coal-fired power plant into service and taking it off-line is both time-consuming and costly.

[14]TVA told us that there is considerable uncertainty regarding how ancillary services will be valued in future electricity markets. TVA believes that the use of a 10-percent to 15-percent cost escalation factor was conservative, based on recent evidence of the valuation of hydroelectric power's versatility.

[15]For the 1999 analysis, TVA used 96 years of hydrologic data (1903-1998) and a 25-year forecast of hourly electricity prices. For each lake-level alternative, WSM processed the 96 years of hydrology into 72 sets of simulations, each consisting of 25 years of hydropower system performance data, which were multiplied by the 25-years of forecasted hourly electricity prices to estimate costs. The first set started with 1903 and ended with 1927; the second set started with 1904 and ended with 1928; etc., until the 72nd set, started with 1974 and ended with 1998. The 72 sets differed in terms of hydroelectric generation, depending on the hydrologic data of each of them. TVA reported its cost estimates to reflect a range from particularly dry, to medium, to very "wet" sets of 25 years. As mentioned, the price uncertainty was addressed by using three sets of forecast market prices.

[16]For example, TVA estimated that these more stringent regulations would increase the average systemwide cost to supply electric power for Alternative 1A by $1.2 million and for Alternative 2 by $2.3 million (in 1999 dollars and based on a medium price forecast).

- TVA's 1990 analysis relied on a discount rate of 7 percent. In the 1999 analysis, TVA used both a 6-and an 8-percent discount rate. The 6-percent rate resulted in marginally higher costs than the 8-percent rate in the 1999 analysis.
- TVA's 1999 analysis also recognized that a change in TVA's policy impacting lake levels would also impact a class of direct industrial customers.[17]

TVA officials told us that the 1999 estimates of cost impacts of the lake-level alternatives were lower than the respective 1990 estimates for a number of reasons. As mentioned earlier, one reason is that the base case in 1999 (August 1st lake-level drawdown) is different from the 1990 base case (Memorial Day lake-level drawdown). In the 1990 analysis, for example, Alternative 2 required TVA to acquire 750 MW of additional electric generation capacity, as compared to an estimated 250 MW for Alternative 2 in the 1999 analysis. Furthermore, whereas the entire capital cost of the 750 MW was counted in the cost estimate of delaying the lake-level drawdown in 1990, the same was not true for the cost of the 250 MW in 1999. Electricity deregulation and the increasing trend to competitive market pricing contribute to lowering costs and improving the utilization of resources. Technological advances have lowered the cost of electricity and improved operating efficiencies.

TVA Emphasized That Uncertainties Exist in Its Cost Analyses

TVA officials told us that great uncertainties in today's electricity supply industry go well beyond the uncertainty that its 1999 modeling exercise attempted to depict. Electricity deregulation has started in some states and is being considered in other states and possibly at the federal level. TVA assumes that electricity deregulation will result in the development of an electricity spot market. TVA assumes that, starting in the year 2002, it can rely on such a market for power purchases to make up for any shortfalls that will result from alternative policies impacting lake levels.

[17]These customers have Economy Surplus Power contracts with TVA, which allow them to buy a portion of their electricity needs at low rates (TVA's hourly marginal costs) because TVA has the option to turn off their power supplies during periods of peak demand when it needs more supplies to serve its firm customers. Firm customers pay higher rates because they have a higher priority. Hourly marginal costs (and hence Economy Surplus Power rates) will increase during the summer because more expensive generation sources will be used to replace hydropower losses due to delays in the drawdown of lake levels.

However, how quickly such a market will develop and how reliable it will be remains to be seen.[18]

Environmental regulation may also have significant consequences on the industry, possibly causing major shifts from coal-fired electricity generation to less polluting sources of generation. International agreements on global warming, resulting in even more stringent environmental regulations, are an added source of uncertainty. All of these factors may have profound impacts on electricity costs and prices in the future.

[18]As mentioned, TVA's 1999 analysis assumed that, during the period 1999-2001, it would rely on forward contracts from electric power suppliers outside its region for power losses due to lake-level alternatives. TVA officials, however, also said that this assumes that there will be sufficient transmission capacity to import the needed power. TVA officials, however, think that transmission capacity is another source of uncertainty that they did not model explicitly. Transmission capacity may indeed constrain TVA's ability to rely on power purchases from suppliers outside of its region.

Study Examining Cherokee and Douglas Lakes

This appendix gives a brief description of the study entitled, Economic and Fiscal Consequences of TVA's Draw-Down of Cherokee and Douglas Lakes (henceforth, the Cherokee and Douglas Study), which was prepared by the University of Tennessee's Center for Business and Economic Research. As mentioned in chapter 4, this study used different approaches to estimate the positive economic impacts of lake-level changes on areas bordering the two lakes. This appendix also summarizes views of the study expressed by representatives of the LOUD and TVA, and our comments on the study.

Study Estimates Local Benefits Resulting From Proposed TVA Changes to Policies Impacting Lake Levels

LOUD and CLUA representatives believe that their proposed TVA changes to policies impacting lake levels will have positive economic and fiscal impacts on the six counties bordering the two TVA lakes. According to the study, LOUD's and CLUA's proposals for changes to policies impacting lake levels are closest to a set of lake draw-down delays that TVA considered in its 1990 review as Alternative 1A.[1] The Cherokee and Douglas Study commissioned by these groups estimated that delaying the drawdown of the lakes would increase regional income by $0.6 million to $5.7 million.

The study used different approaches to estimate the impact of lake-level changes on income, employment, and local sales tax revenues of the six counties surrounding the two lakes. One approach started with an estimate of the impact of delayed drawdown on expenditures in the six-county region due to increased visitation to the two lakes by non-county residents. The researchers interviewed about 75 visitors who came to Douglas and Cherokee from outside the six-county region.[2] The survey asked respondents about their expenditures within the six-county region during their visits to the two lakes. Each respondent was shown a picture of Douglas Lake at an elevation of about 20 feet below normal summer recreational season level. Respondents were then asked if a delay in drawdown would result in him or her making more or less visits to the Douglas or Cherokee lakes and to other area lakes. On the basis of data

[1]This alternative calls for delaying drawdown at Douglas and Cherokee, and a third lake, Norris, from Memorial Day to October 1, in addition to delaying lake-level drawdown at seven other tributary projects in eastern Tennessee to August 1. According to TVA, the LOUD and CLUA proposals are different from Alternative 1A as defined in the 1990 EIS. The LOUD and CLUA proposals request significant changes in the January 1 target lake levels, but Alternative 1A does not consider such changes. The study did not independently estimate any costs resulting from the proposed changes. The study reported TVA's 1990 estimated impacts of the proposed changes on the systemwide cost of supplying electric power, adjusted for inflation to reflect 1998 values.

[2]The researchers conducted 161 in-person interviews of visitors to Douglas and Cherokee, with roughly an equal number of visitors (80) being interviewed at each of the lakes. Of those interviewed, the percentages of nonresidents were 59 percent at Douglas and 36 percent at Cherokee.

gathered from the survey, the study estimated increases in retail expenditures in the six counties due to increased visitation by nonresidents of about $1 million to $1.8 million per year. (See table IV.1.)

Two other approaches in the study started by estimating the impact of changes to policies impacting lake levels on total retail sales in the six-county region.[3] The first approach used statistical techniques to analyze whether there was a significant relationship between monthly lake levels and the region's monthly retail sales. The analysis confirmed such a relationship and estimated that drawdown delays from August 1 to October 1 would add about $1.6 million to annual total retail sales in the six-county region. The second approach based on retail sales impact was based on 200 responses to a survey of commercial establishments in the six-county region. The survey asked businesses to estimate how much their retail sales were likely to increase if drawdown of the two lakes were delayed. While a total of 1,088 surveys were sent to selected commercial establishments in the six-county region, the response rate to the survey was only about 18 percent. The results of this survey were reported in the study as an estimated increase in annual retail sales of about $7.1 million due to the drawdown delays.

The study used these estimates of expenditures and retail sales increases to derive measures of impacts of changing lake levels on income, employment, and sales tax revenues in the six-county region. The annual impacts due to lake drawdown delays were estimated as follows: increases in income of about $0.6 million to $5.7 million; increases in employment of between 205 and 2,106 full-time job equivalents; and increases in local sales tax revenues of about $39,000 to $239,000.[4] (See table IV.1.)

[3]The study did not attempt to isolate the impact on retail purchases by nonresidents of the six-county region. Instead, the impact of changes to policies impacting lake levels on total retail sales was estimated.

[4]The study reported the results of two other approaches that the researchers used to estimate drawdown delay benefits; namely, a "benefits transfer approach" and another approach based on "angler's choices of reservoirs." The former yielded relatively low benefit estimates, while the latter yielded a "conservative estimate of losses to anglers" of $11 million annually. These results, however, were not reported in the study's summary table entitled "Comparison of Economic Impacts Resulting from Higher Lake Levels in August and September for Douglas and Cherokee Lakes."

Table IV.1: Comparison of Measures of Economic Impacts Resulting From Higher Lake Levels in August and September for the Douglas and Cherokee Lakes

Economic measure	Survey of lake visitors	Statistical retail analysis	Commercial establishments retail survey
Increased expenditures/ retail sales	$1 million - $1.8 million	$1.6 million	$7.1 million
Income impact	$0.6 million - $1 million	$0.7 million	$5.7 million
Employment impact[a]	205 – 357 full-time jobs	259 full-time jobs	2,106 full-time jobs
Local sales tax revenue	$48,117 - $84,185	$38,868	$239,187

[a]Full-time equivalent jobs; assumes all employment gains accrue in August and September.

Source: Center for Business and Economic Research, The University of Tennessee, Economic and Fiscal Consequences of TVA's Draw-Down of Cherokee and Douglas Lakes, Knoxville, TN, p. xii, (Oct. 1998).

In addition to estimates of impacts on the six-county income, employment, and sales tax revenues, the study pointed out that delays in the drawdown of lake levels would likely have significant impacts on the values of properties that are adjacent to the two lakes. The study did not attempt to produce independent estimates of such impacts but reported the results of research done elsewhere on related issues. Two of the cited studies suggest significant negative effects of the drawdown of lake levels on the value of adjacent properties.

LOUD and TVA Pointed to a Number of Weaknesses in the Cherokee and Douglas Study

Both LOUD and TVA representatives told us that the study had several weaknesses. LOUD representatives stressed that the benefits reported in the study were "low" estimates of potential benefits. The authors of the study agreed, citing that due to limited funding, the study suffered from limitations that probably resulted in underestimating benefits. LOUD representatives pointed out, for example, that one estimate of the impact of delays in the drawdown of lake levels in the study is based entirely on the respondents to the commercial establishment survey. The response rate to the survey was quite low (about 18 percent), and the study assumed that only the respondents' retail sales would increase due to delaying the drawdown of the lakes and that that nonrespondents would not experience increases in retail sales. The study's authors agreed that this approach could have under-estimated retail sales impacts. On the other hand, the authors pointed out that respondents would also have an incentive to inflate their estimates of retail sales increases due to delays in

the drawdown of lake levels in the hopes of influencing a decision to maintain higher lake levels.

LOUD representatives emphasized that the most important benefit to the local economy would not be the increased visitation to the lakes, but rather to an increase in the re-location of retirees and others from outside the region. The representatives believe that the economic implications of this migration to the region are likely to far exceed the estimates reported in the study.

TVA had a number of concerns regarding the Cherokee and Douglas Study, including, but not limited to, the fact that

- the study estimates the impacts of delayed drawdown only on a six-county region as opposed to impacts on the entire TVA region and the United States as a whole. However, TVA noted that delays in the drawdown of lake levels could affect flood control and navigation on the Tennessee, Ohio, and Mississippi Rivers. In addition, TVA must consider impacts on hydroelectric power generation, flood control, water quality, and water supply as they affect the nation, the broader TVA region, as well as the six-county region. For example, TVA's 1990 review quantified potential impacts on hydroelectric power generation revenue and considered potential flood control and navigation impacts on the lower Ohio and Mississippi Rivers;
- the results of the study's survey of lake visitors suggest that the benefits claimed for the six-county region could be shifted from the immediate surrounding areas. In other words, benefits to the six-county region could be partly at the expense of neighboring counties;
- the study does not deal with possible increases in costs associated with expanding the six-county region's infrastructure to accommodate increased visitation and economic growth; and
- increased employment may be in the form of temporary importation of laborers into the area, with little effect on local unemployment.

TVA also raised some methodological concerns about the study, such as the accuracy of some of the survey results and the rigor of the statistical analysis of the effect of lake levels on retail sales.

The Cherokee and Douglas Study Is Limited to the Evaluation of Economic Benefits of the Six-County Region

The authors of the Cherokee and Douglas Study intended to evaluate only economic benefits to the six-county region of proposed changes to policies impacting lake levels. In contrast, federal guidelines for economic evaluation of federal water projects recommend a more comprehensive evaluation of costs and benefits of actions related to water projects.[5] Both TVA and the authors of the study have recognized these guidelines as relevant for evaluating the changes to policies impacting lake levels under consideration.

According to the guidelines, an evaluation of plans related to water resources requires the estimation of expected changes in the economic value of national output of goods and services from a plan. Although the guidelines recommend consideration of other costs and benefits, such as environmental costs and benefits, its only required estimation is changes in the economic value of national goods and services produced.

Expansion of the study's analysis to areas beyond the six-county region in accordance to these guidelines could result in substantially different estimates of benefits. This difference would be especially true if the major portion of the study's estimated gains in the six-county region is due to transfer of economic activities into these counties from outside the region. At the national level, inter-regional transfers of economic activities, in general, result in no net change in the value of output of goods and services produced and result in no national benefit.

Consistent with its stated scope, the study does not attempt to independently quantify any other costs and benefits resulting from the proposed delay of the drawdown of lake levels.[6] It should be noted, however, that the study's estimates of economic benefits pertain only to the six-county region surrounding the lake. Because of their limited geographical scope, such benefit estimates are not comparable to TVA's estimate of its systemwide cost of supplying electric power.

[5]U. S. Water Resource Council, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, (Mar. 10, 1983). These guidelines establish standards and procedures for use by federal agencies in the formulation and evaluation of alternative plans for water related studies.

[6]The Cherokee and Douglas Study reports TVA's 1990 estimate of the annual impact on TVA's systemwide cost of supplying electric power at $18.6 million (adjusted from the 1990 figure of $15 million for inflation to reflect 1998 values).

Study Examining Georgia Mountain Lakes

This appendix gives a brief description of the study entitled, The Economic Impact of Alternate TVA Lake Management Policies (henceforth, the Georgia Mountain Lakes Study), which was prepared for the Mountain Lakes Study Committee by the North American Water Management Institute, Inc. As mentioned in chapter 4, this study focused on estimating economic benefits to areas bordering three TVA lakes—Blue Ridge, Chatuge, and Nottely. The study also analyzed options for funding TVA's increased cost to its power program due to changes to lake level policies. This appendix also summarizes views of the study expressed by TVA and our comments on the study.

The Georgia Mountain Lakes Study Estimated Favorable Benefit-Cost Ratios for Delaying Lake-Level Drawdown at Three TVA Lakes in Georgia

The Georgia Mountain Lakes Study estimated very favorable benefit-cost ratios for delaying the drawdown of lake levels at Blue Ridge, Chatuge, and Nottely Lakes in northern Georgia from August 1 to October 1. In addition to benefit-cost estimates, the study focuses on options for funding TVA's increased cost to its power program due to changes to policies impacting lake levels.

Similar to the Douglas and Cherokee Study, the Georgia Mountain Lakes Study did not estimate the impact on TVA's systemwide cost of supplying electric power resulting from the drawdown of lake levels. Instead, the study applied simple modifications to cost estimates reported in TVA's 1990 review, obtaining an estimated increase in TVA's systemwide cost of supplying electric power of $750,000. The study's benefit estimates relied on 1990 TVA and U.S. Forest Service (USFS) visitation statistics for the three lakes and a 1990 USFS lake visitors' expenditures survey for the Blue Ridge and Hiwassee Lakes. The study extrapolated the visitation data to 1995, and applying the expenditures data, computed "incremental impacts of lake visitation" due to delaying the drawdown of the lakes. The benefits to Fannin, Union, and Towns counties were reported as ranging from $3.7 million to $24.3 million for delaying drawdown to October 1, and from $4.6 million to $30.2 million for delaying drawdown to October 31. The study combined its benefit and cost figures to compute highly favorable benefit-cost ratios as indicated in table V.1.[1]

[1]The benefit-cost ratio is a measure of the proportion of benefits to costs and is derived simply by dividing the former by the latter. For example, a benefit-cost ratio of 40.0 suggests that benefits exceed costs 40 times.

Table V.1: Incremental Impacts of Lake Visitation for Three Georgia Mountain Lakes

Economic measure	Based on figures extrapolated from 1990 TVA lake visitation statistics	Based on figures extrapolated from 1990 USFS lake visitation statistics	Based on figures extrapolated from 1990 TVA lake visitation statistics	Based on figures extrapolated from 1990 USFS lake visitation statistics
	Delay until October 1	Delay until October 1	Delay until October 31	Delay until October 31
Benefits	$3,681,646	$24,278,817	$4,611,715	$30,176,781
Costs	$750,000	$750,000	$750,000	$750,000
Benefit-cost ratio	4.9	32.4	6.2	40.2

Source: The Economic Impact Of Alternate TVA Lake Management Policies, North American Water Management Institute, Inc., (Dec. 1997).

The study also focused on different methods of funding the increased costs of TVA power supplies associated with this change to policies impacting lake levels. Ten funding mechanisms were identified and discussed. All 10 funding mechanisms are of a local nature, in the sense that those who pay are either county residents or users of services offered within the counties. These options include surcharges on county customers of electric supply companies, local boating fees and fishing licenses, hotel-motel taxes, and a special assessment tax for lakefront properties. The study computed various measures of impacts of the funding alternatives, such as increases in individual electric customers' monthly charges; increases in boat licenses and fees; increases in hotel-motel tax rates; and increases in lakefront property tax rates. The Georgia Mountain Lakes Study discussed the various options with respect to impacts on payees and political feasibility.

TVA Criticized the Georgia Mountain Lakes Study on Several Counts

TVA had a number of concerns regarding the Georgia Mountain Lakes Study. According to TVA:

- The study did not present sufficient information on its data, assumptions, and methodology to permit a professional review.
- The study used "very old" data. TVA also suggested that data projections were done in a way that inflated benefits estimates.
- The study failed to address other benefits and costs adequately. The study focused only on benefits to the three Georgia counties and only on the impact on TVA's systemwide cost of supplying electric power. For example, the study did not consider possible adverse effects of drawdown delays on

navigation and flood protection.[2] The study failed to account for infrastructure and land development costs that would have to be made to accompany the projected increase in lake visitation. TVA also criticized the study for failing to properly recognize the multipurpose role of TVA's system of projects and the interdependencies among the purposes of the projects.

- The study did not take into consideration that some of the increased visitation and estimated benefits might be transfers from other activities that visitors would otherwise have chosen.
- In discussing options for local funding of TVA's increased electricity production costs, the study fails to recognize that some local residents would not benefit from lake drawdown delays. According to TVA, the study fails to address the ability of the local population to compensate TVA for the increased electricity production costs.

The Georgia Mountain Lakes Study Uses Simplistic Estimates of Costs and Benefits of Lake Drawdown Delays

The cost and benefits estimation methodology used in the Georgia Mountain Lakes Study does not conform to recommended federal guidelines for evaluation of major actions at federal water projects. The study's benefit estimates are simply measures of increased expenditures, which are not acceptable measures of economic benefits under federal guidelines. In addition, the cost estimates used in the study are based on very simple extrapolations from TVA's 1990 cost estimates.

On the cost side, the study relied on TVA's 1990 estimates of the systemwide cost of supplying electric power of Alternative 1D. In the 1990 study, Alternative 1D called for delaying drawdown at Blue Ridge, Nottely, and Chatuge, as well as Hiwassee (not included in this study) from Memorial Day to October 1, and for delaying drawdown at six other multipurpose tributary projects from Memorial Day to August 1. TVA estimated that this alternative would increase its annual systemwide cost of supplying electric power by $3 million in 1990 dollars. The study then reduced this amount by $2 million because TVA's 1990 estimate of delaying drawdown from Memorial Day to August 1 (for all 10 tributary lakes) was estimated to cost $2 million annually. The study's authors then prorated the remaining $1 million over the four lakes, assigning $250,000 to each. Because the Hiwassee project was not considered in the study, the cost of the drawdown delay for the three remaining lakes was reported as

[2]It should be noted that, according to TVA's 1990 cost impact analysis, there does not appear to be significant navigation and flood control impacts for Alternative 1D. This alternative delays the beginning of summer drawdown from Memorial Day to October 1st for Hiwassee, Blue Ridge, Nottely, and Chatuge Lakes, and to August 1st for six other tributary lakes. Because the study evaluates impacts of drawdown delays from an August 1st base, as opposed to a Memorial Day base, the navigation and flood control implications, if any, should be even less significant.

$750,000. This cost calculation is over-simplistic because it ignores changed conditions between 1990 and 1997, when the study was conducted. Furthermore, the $750,000 was not adjusted for inflation.

The study's estimated benefits to the three counties also do not conform with federal guidelines. They are estimates of increased expenditures in the three counties due to increased visitations by lake users. Not all expenditure increases, however, can legitimately be counted as net economic benefits to the three counties. The study fails to translate the increased expenditure to net economic benefits. Similar to the Cherokee and Douglas Study, the Georgia Mountain Lakes Study falls short of being a comprehensive study of the costs and benefits of lake-level alternatives.

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