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# INVIRONMENTAL QUALITY FEATURES OF DUKE POWER COMPANY'S

KEOWEE-TOXAWAY PROJECT

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#### INTRODUCTION

This report summarizes the environmental quality features of Duke Power's Keowee-Toxaway Project located in northwestern South Carolina and western North Carolina. From its conception and throughout its planning and execution, the project with its many interrelated elements has been considered as an integrated development with the objective of providing reliable, low-cost electric generation and of enhancing its beneficial effects upon the environment. A number of project elements are under the regulatory jurisdictions of a variety of governmental agencies. Licenses, permits, contracts, agreements or understandings have been sought from 61 entities of government. Throughout these proceedings, Duke Power has coordinated the many interrelated project elements so that the integrated result will maximize project objectives.

#### PROJECT DESCRIPTION

As ultimately planned, the project will include two major takes, several smaller reservoirs in high mountain saddles, and electric generating capacity of about 10 million kilowatts. Long-range planning includes a variety of developments utilizing these water resources along with 150,000 acres of surrounding land.

The project lies at the meeting of the Piedmont hills and the Southern Blue Ridge Mountains in Oconee and Pickens County, South Carolina and Transylvania County, North Carolina, and along the Keowee River and its tributaries. Initial power developments totaling 3,408,000 kw will include the Keowee Hydro Station, Jocassee Hydro Station with pumped-storage, and the Oconee Nuclear Station. The environmental aspects, as well as the power output and economic justification, of these three developments are interwoven, and do not lend themselves to separate analysis for any one of the power stations.

Lake Keowee, impounded by dams on adjacent rivers, will have a shoreline of 300 miles and 18,400 surface acres. Each of the two dams is of compacted earthfill, and the 140,000 kw Keowee Hydro Station includes two generators with fixed-blade waterwheels served by a common tunnel from a single intake. At the upper end of Lake Keowee, the 385 foot high Jocassee dam is under construction, comprised of compacted rockfill structure with an impervious core. With 310 feet of static head above Lake Keowee, Lake Jocassee will have a surface area of 7565 acres and a shoreline of 75 miles. The Jocassee powerhouse will contain four 152.5 mw reversible pumped-turbine units. The first thermal station contemplated for the project is now under construction on the shore of Lake Keowee. Oconee Nuclear Station consists of three units of 886,300 kw each, utilizing pressurized water type reactors. As the initial phases of the project, the Keowee, Jocassee and Oconee developments are all currently under construction with an estimated completion cost of over onehalf billion dollars.

Electric power provides the economic justification for the project. With deliberate planning, other improvements are being integrated into the project although they do not contribute to the finite economic justification. Nevertheless, these features have been embraced because of their contribution to the environment and quality of life in the area served, which in the long run is expected to reflect favorably on the Company's business.

#### ALTERNATIVES TO KEOWEE-TOXAWAY PROJECT

In January 1965, Duke applied to the Federal Power Commission for a license to construct the Keowee Hydroelectric Station, to utilize the Keowee reservoir as a source of cooling water for three large thermal plant sites, and to build the Jocassee Hydroelectric Station. These three purposes were essential to the economic justification of the project, and Duke made it clear that it could not undertake the project at all unless the license covered the two initial hydroelectric stations and use of Lake Keowee as cooling water for the first thermal plant site. After consulting with the Department of Interior, the Army Engineers, the South Carolina Pollution Control Authority, the South Carolina Wildlife Resources Department, and other federal and state agencies, the FPC license was issued and provided for these developments including the use of cooling water at the site where Oconee Nuclear Station is now under construction.

The alternatives to Keowee-Toxaway would be a high-head pumpedstorage project elsewhere in the Southern Blue Ridge Mountains on Company land to develop 750 mw of peaking capacity plus a large thermal plant located on an unimpounded river in the Company's service area with cooling water to be recirculated through several large cooling towers. During the FPC licensing proceedings, it was clearly established that the Keowee-Toxaway Project offered advantages of economics and of environmental quality when compared to the alternatives.

## ENVIRONMENTAL QUALITY FEATURES

Features designed to minimize adverse impacts and to enhance environmental benefits are summarized as follows:

## Cooling Water and Thermal Effects

The original impetus for examining the feasibility of the Keowee-Toxaway Project was as a search for new sources of cooling water for large thermal-electric generating plants needed in South Carolina. For many years, Duke has used its hydro reservoirs as sources of cooling water, being careful to limit the capacity of each steam plant so that the cooling duty was entirely commensurate with the potential of the lake, with the environment, and with other uses of the lakes. Beginning in 1926, Duke has completed 22 steam-electric generating units on manmade lakes utilized as sources of cooling water and to dissipate the waste heat of condensation before recirculation through the condensers. In this period, temperature rises similar to Oconee's have been consistently employed, and ... adverse effects on the ecology have been detected. In 1959, Duke established a full time Water Resources Research Department consisting of field and laboratory personnel whose function is to examine the limnological and thermal behavior of its lakes to serve as the basis for making sound site decisions as well as engineering design of future plants. Using the research results developed by this group and consultants, plus the work of others in this field, a thermal regime model of the proposed Lake Keowee was constructed for each month of the year for examination of various combinations of heat dissipation. These studies, using criteria confirmed by field measurements on Duke's existing power lakes in the region, established that Lake Keowee could readily dissipate the heat rejected to the cooling water by 7000 mw of thermal generating capacity distributed among three sites. Two future sites would involve cooling waters from the lake's surface, and the third site, selected for Oconee, would utilize the heat sink of the hypolimnetic waters during the summer. Cooling water for Oconee Nuclear Station will come from the bottom of the lake under a skimmer wall across the intake canal at sufficiently low velocity to prevent disturbing the naturally occurring summer stratification of the lake. This intake water will be of such low temperature that, after the addition of heat in Oconee's condensers, it is returned to the lake near or below the naturally occurring summer temperature of the lake surface. During seasons of highest natural water temperatures, the

cooling water supplies to Oconee, being hypolimnetic, are relatively barren biologically. A similar skimmer wall has been in successful service since 1965 at Duke's most recent steam plant on Lake Norman in North Carolina, and its performance confirmed by thermal and biological studies.

During cooler months of mid-October to mid-May when the lake will be isothermal throughout its depth, the warmed discharge water will float on the surface and rapidly dissipate its heat by back-radiation, conduction and evaporation. The temperature will return to its equilibrium level within this dissipation zone and prior to recirculation into the Oconee intake. During these months, the maximum temperature will not exceed the 93.2°F specified in the South Carolina Water Classification Standards. From mid-May until sometime during August in most years, when the discharge water returning to the lake is often cooler than the natural occurring surface, the water will sink below the surface to an intermediate level for later thermal dissipation during the fall mixing period. Again, the discharge temperature will comply with water classification standards. In late summer and up until the advent of fall mixing, the discharge temperature will be at or near the surface temperature and will again remain on the lake surface for dissipation. During extremely warm weather and drawdown of the lake occasioned by low streamflows, the temperature at the point of discharge is expected to be higher than 93.2°F, but will comply with the standards which provide for measurement after an adequate zone for mixing with the receiving waters.

The results of Duke's studies leading to the design of the Oconee cooling water system were reviewed with the South Carolina Pollution Control Authority and the U S Fish and Wildlife Service. To obtain an independent opinion, the Department of Interior retained Dr C J Velz and associates of the University of Michigan to make a separate study. After receiving Dr Velz's report, on April 7, 1966, then Secretary of Interior Stuart Udall wrote the Federal Power Commission concluding that the thermal effects of the proposed nuclear plant would "produce no detrimental effects upon the fishery resources" within Duke's proposed lakes and would not "be deleterious to the recreational resources." As is done at other Duke plants, when Oconee goes into service, field tests will be made to compare results with predicted behavior and to serve as a further basis for developing the two future thermal plants on Lake Keowee.

## Downstream Water Quality

Also as a result of the predicted limnological models of Lake Keowee, a submerged weir was constructed upstream of the Keowee hydro intake. This weir, similar to the one in service at a Duke hydro plant since 1963, is expected to retain the cool hypolimnetic waters in the summer and release oxygen rich waters from the surface in the interest of downstream water quality and waste assimilative capacity. Confirmation of the effectiveness of this weir will be a part of the continuing water resources research program.

# Release of Water from Storage to Augment Downstream Benefits

By an agreement signed in October 1968 with the U S Army Corps of Engineers and the Southeastern Power Administration of the Department of Interior, during periods of low natural streamflow Duke will release from the lakes stored water to augment the government power generation and navigation flows in the Savannah River downstream.

#### Environmental Radioactivity

During normal and abnormal operating conditions, the levels of radioactivity in liquid and gaseous effluents from Oconee Nuclear Station will be a small fraction of the permissible limits prescribed by federal regulations for protection of public health and safety. This will be confirmed by a continual environmental radioactivity monitoring program conducted by Duke with back-up environmental monitoring by the South Carolina Board of Health and the U S Atomic Energy Commission. Solid radioactive wastes containing radioactivity will be packaged and shipped to licensed reprocessing or disposal facilities.

# Recreation

Keowee-Toxaway is expected to attract extensive recreational use. Eight recreational areas are being constructed around Lake Keowee, and three around Lake Jocassee. These areas range from a 21 acre development with launching ramps and parking areas to a 155 acre complex that will additionally involve campgrounds, picnic areas, complete sanitary facilities and bathhouses, boat storage facilities and marinas. Near the upper end of Lake Jocassee, a wilderness campground is being developed, accessible only by hiking trail or water. Duke has donated 1000 acres of land to South Carolina for development of the Keowee-Toxaway State Park. As recreational use expands in the future, a variety of additional facilities is contemplated.

## Soil Conservation

To retain topsoil in place and to provide soil storage of rain and prevent rapid run-off, 150,000 acres of Duke property in the watershed around Lakes Keowee and Jocassee have been placed under scientific forest management for maximum sustained water yield by Duke's professional foresters. The yield from saw timber and pulpwood helps pay the cost of the program including taxes and reforestation.

# Ireservation of Virgin Timber

In the mountains above Lake Jocassee along the Whitewater River, a 15 acre area vas discovered to have a virgin stand of 18 species of trees indigenous to the Appa'achian Mountains. Several of the trees are giants of their species, with some Chestnut Oaks measuring close to 5 feet in diameter at a point  $4\frac{1}{2}$  feet from the ground. The tract has been named the Coon Branch Natural Area, and its elevation ranges between 2000 and 2200 feet above sea level. Duke has registered this tract with the Society of American Foresters for preservation as a scientific natural area.

# Historical Salvage

Prior to their inundation by Lake Keowee, extensive diggings were made for archeological salvage at the sites of Ft Prince George, an early British outpost, and old Keoweetown, headquarters of a part of the lower Cherokee Nation. The recovered artifacts are in possession of state and local museums.

#### Fishing Resources

Although only partially filled, Lake Keowee has been stocked with fingerlings and already sportsmen attest to the results. Both Lakes Keowee and Jocassee are expected to contribute substantially to the area's sport fishing opportunities.

# Wildlife

In 1965, Duke donated the use of over 100,000 acres of Keowee-Toxaway Project watershed lands to the South Carolina Wildlife Resources Department and the North Carolina Wildlife Resources Commission for game propagation and management purposes. Gamefood was planted along the company forestry roads through the area, and the state agencies are building up the game population to support controlled public hunting in selected areas. Already, frequent deer and an occasional wild turkey have been seen by those working on the Jocassee dam.

# Public Health

In addition to its mosquito control program, Duke's Department of Public Health and Sanitation works closely with state and county health agencies to establish high quality standards of sanitation that will be applied to all waterfront developments.

## Water Supply

Nineteen towns, cities and water districts have been using the other existing Duke reservoirs as their source of water supply without charge, and now the twentieth, the Town of Seneca, South Carolina, has begun withdrawing its public water supply from the partially filled Lake Keowee. As water needs grow, it is expected that increasing and additional water supplies will be provided by the Keowee-Toxaway Project.

# Flood Control

The dams have a freeboard above full power pool of 15 feet which provides for temporary surcharge storage to reduce the downstream effect of major floods that may occur.

# Education

On a hill overlooking Lake Keowee and the Oconee Nuclear Station is the Keowee-Toxaway Visitors Center completed in July 1969. The center consists of three main parts: a visitor room containing a scale model of the entire project, a series of exhibit chambers telling the story of man's development and use of energy resources, and a large fully equipped auditorium where programs can be tailored to the audience. Although its location is in a remote area far removed from normal travel routes, during its first year of operation 250,000 visitors toured the center. School officials in the surrounding area have adopted the use of the center, and school science classes are now regularly scheduling visits. As indirect support of educational functions, consulting faculty members and research associates representing a wide spectrum of disciplines from five universities have been engaged so far to perform research or consulting studies in direct support of the project. The institutions represented include Clemson University, The University of South Carolina, The University of North Carolina at Chapel Hill, North Carolina State University, and Georgia Institute of Technology. University faculty members, with Duke's cooperation, are presently contemplating research in beneficial uses of the warm water effluent from Oconee Nuclear Station. Two plans now under consideration are in the areas of fish farming and increased production of horticultural products by warm-water irrigation.

# Scenic Beauty

Special care has been taken to preserve areas of scenic beauty, and further to make these areas more accessible to the public. Duke has offered the free use of 25 miles of right-of-way for future development of a scenic highway among the high ridges overlooking the project. Meantime, the use of trails for hikers and campers is now available.

# Residential, Commercial and Industrial Development

Long-range plans for such developments are being coordinated with the official planning agencies of the two counties involved so that the future growth of such developments can be encouraged and coordinated by professional planners.

## Economic Development

Keowee-Toxaway is located in the Appalachian area. The Appalachian Regional Development Program calls for investment of up to \$1 billion in federal seed money to serve as impetus for economic development of the 359 county Appalachian area covering parts of eleven states. Development currently under way as a part of Duke's Keowee-Toxaway Project will result in investment of over one-half billion dollars in private monies in the three Appalachian counties of North and South Carolina in which the project lies. The concomitant economic activity, spurred by a range of activities from tourism to taxes paid on this investor owned project, is expected to be very substantial.

# CONCURRENCE OF STATE AGENCIES

In connection with Duke's application to the Federal Power Commission for license to construct the hydroelectric developments and to use Lake Keowee for cooling water, the South Carolina Water Pollution Control Authority transmitted the following resolution to the FPC:

"It was moved, seconded, and passed that

"WHEREAS, the South Carolina Water Pollution Control Authority is an agency of the State of South Carolina established within the State Board of Health for the administration of laws and programs relating to water pollution within the State: "WHEREAS, Duke Power Company has applied to the Federal Power Commission for a license under the Federal Power Act to construct the Keowee-Toxaway Project located on the Keowee and tributary rivers in Pickens and Oconee Counties, South Carolina;

"AND WHEREAS, Duke Power Company's application for said license indicates that they contemplate provision for maintaining oxygen content of water discharged by the Keowee development during the summer months;

"AND WHEREAS, Duke Power Company, by its program of hydroelectric plant operation and reservoir management, has clearly demonstrated its willingness to fully cooperate with State agencies in areas of water pollution control and public health;

"WHEREAS, the proposed Keowee-Toxaway Project is not expected to have any net detrimental effect upon water pollution and public health in the State of South Carolina, but will make available to adjacent and nearby municipalities an adequate supply of high quality water for the foreseeable future; "NOW THEREFORE BE IT RESOLVED that the South Carolina Water Pollution Control Authority endorses Duke Power Company's proposed Keowee-Toxaway Project in Pickens and Oconee Counties, South Carolina.

"RESOLVED FURTHER that a copy of this resolution be transmitted to the Secretary, Federal Power Commission, Washington, D C. "(Resolution as passed by the South Carolina Water Pollution Control Authority in executive session on February 24, 1965.)"

In connection with the licensing of Oconee Nuclear Station, at the public hearing held in Walhalla, South Carolina on August 29, 1967 before the Atomic Safety and Licensing Board, the following testimony was given by Mr William T Linton, Director of the Division of Engineering of the South Carolina Board of Health and also Director of the State Pollution Control Authority:

> "Mr Chairman, I am presenting this in the name of Dr E Kenneth Aycock, State Health Officer and Chairman of the Pollution Control Authority, and I would like first to express his regrets at his inability to be here.

"I would like also to add my welcome to those that have been advanced to you gentlemen and to say that South Carolina is extremely pleased and honored to have you here. "I am reading this as it is written and ask that it be so recorded.

'Mr Chairman, my name is E Kenneth Aycock, M D, State Health Officer and Chairman of the South Carolina Pollution Control Authority. In these capacities, I represent the only legally constituted agencies whose official concerns are for the health of the people of South Carolina and the protection of the environment from waste products discharged into it. 'The purpose of this statement is to acquaint the Atomic Energy Commission and this Board with the knowledge that our agencies support the application by Duke Power Company for licenses to build and operate the nuclear power generating facility known as the Oconee Nuclear Station, Units 1, 2 and 3, in Oconee County, South Carolina.

'We have had many occasions in the past to become acquainted with Duke Power Company in matters pertaining to fossil-fueled generating plants and have found them to be competent and quite cooperative.

'Our staff has had the privilege of associating indirectly with this company in its position as a member of the Carolinas-Virginia Nuclear Power Associates, which has operated the experimental nuclear power plant at Parr, South Carolina for several years. 'During the several years surrounding the construction and operation of the Parr Reactor, our staff conducted, and is conducting, environmental surveys to insure the health and safety of our citizens. Very close cooperation between our staff and the CVNPA staff has always existed, including technical assistance when monitoring equipment became inoperative, the sharing of samples and information and many other evidences of mutual help. This same spirit of cooperation on the part of Duke Power Company has already been demonstrated in this endeavor. Assistance has been pledged in the matter of locating sampling sites during the pre-operational and post-operational phases for surveillance purposes. All information sought by us has received prompt attention. In short, Duke Power Company has displayed complete willingness to assist our agencies in the discharge of their responsibilities.

'The Safety Analysis Report and Amendments have been analyzed by our staff, as have the comments made by the National Center for Radiological Health of the U S Public Health Service. As a result of these analyses, we see no reason why the operation of the Duke Power Company's Oconee Nuclear Station in the manner specified should contravene any of our requirements.

'Personally, and in our official capacity, it gives us considerable pleasure to say again that we endorse the application for the license being sought by the Duke Power Company.' ''Thank you, Mr Chairman.''

The following is quoted from a letter of November 1, 1965, to the Federal Power Commission from Mr James W Webb, Director, Division of Game, S C Wildlife Resources Department:

> "Duke Power Company immediately, upon purchase of approximately 68,000 acres of land for development of this project in South Carolina, entered into a cooperative agreement with this Department for the conservation and management of the fish and wildlife resources on this area permitting us to regulate the hunting and fishing on this area and to provide public hunting and fishing on the area. We immediately moved fisheries and wildlife technicians into the area and have been developing thearea for public use.

> "The construction of the proposed Keowee and Jocassee Lakes will add tremendously to the recreation for the public and will be a terrific attraction to tourists and campers as well as fishermen, boating enthusiasts and sightseers.

"Duke Power Company and our personnel have worked very closely together in drawing up plans for providing access to these waters and we not only approve of the plans for the recreational features planned by Duke Power Company, but our personnel helped in the planning and preparation of these recreational features. This

Department and Duke Power Company have worked closely together in other areas in providing access and recreational features to waters created by their impoundments and I am sure that should there be need for additional recreational features and access points, that we will have no difficulty in obtaining them from Duke Power Company."

### CONCLUSIONS

Compared to the alternative developments, the Keowee-Toxaway Project utilizes a man-made lake for dissipation of the waste heat of condensation from a nuclear-electric generating station instead of cooling towers, and offers the following environmental enhancements not found in the alternative: downstream flow augmentation in periods of dry weather, extensive recreational opportunities, soil conservation measures, perservation of virgin timber, recovery of historical information and artifacts, substantial fisheries resources, wildlife preservation and propagation, public water supply. floct control, and opportunities for enjoyment of scenic beauty; along with include directly with the Project's many features.

# Publications

Other publications relating to the Keowee-Toxaway Project and its environment are available from Duke Power Company, Box 2:78, Charlotte, N C, 28201. They include:

"The Forests & Flowers of Keowee-Toxaway" "Flowers, Ferns, Shrubs and Trees found at Keowee-Toxaway" by Dr C Leland Rodgers, Chairman, Dept of Biology, Furman University

"Duke Power - The Environment" "Keowee-Toxaway" "The Story of Energy" "The Keowee-Toxaway Project" "Lake Keowee Map"