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south carolina
electric & gas
company

VIRGIL C. SUMMER NUCLEAR STATION

operating license environmental report

VOLUME I

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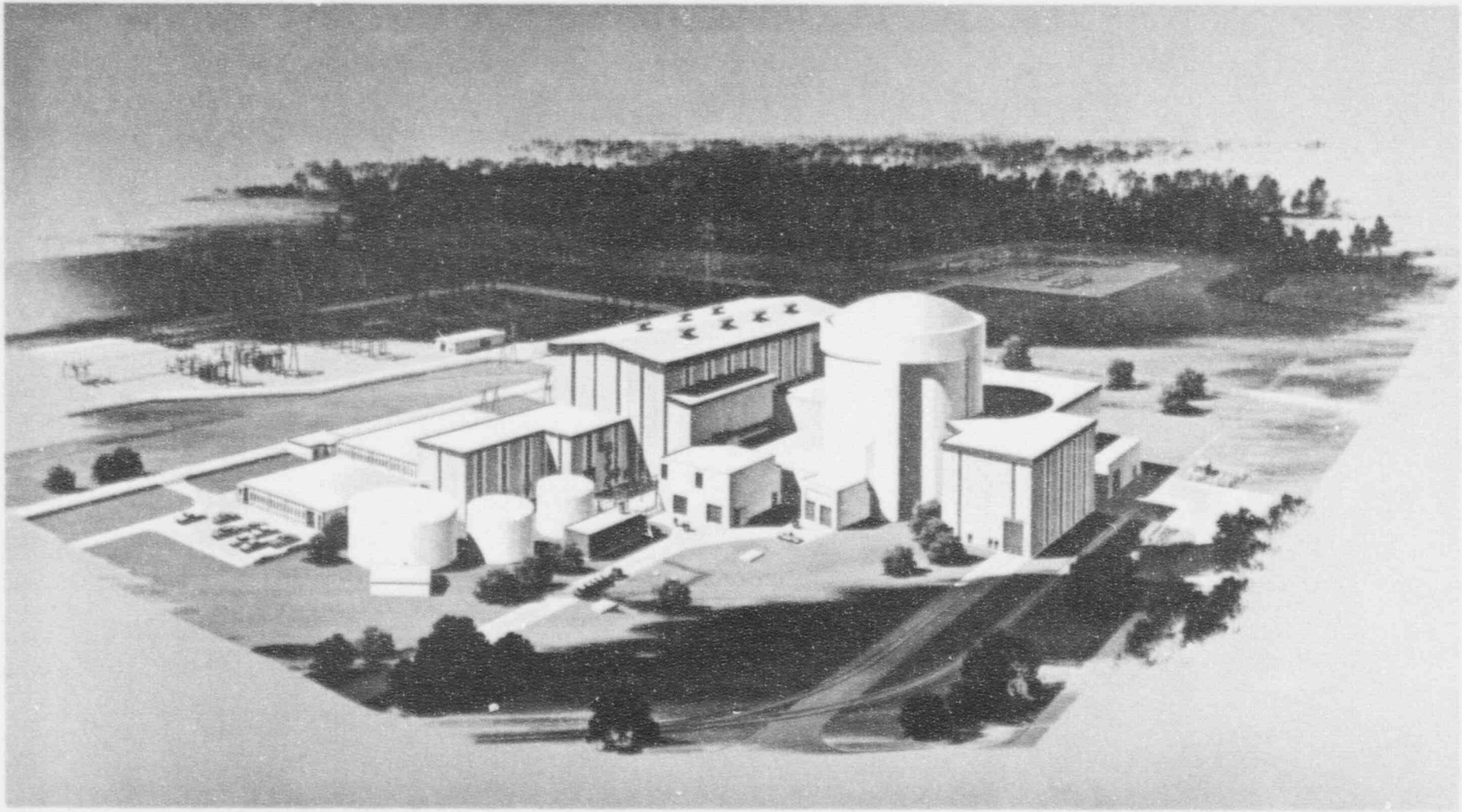

TABLE OF CONTENTS

Section	Title	Page
	1.0 PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION	
1.1	NEED FOR POWER	1.1-1
1.1.1	Load Characteristics	1.1-11
1.1.1.1	Load Analysis	1.1-12
1.1.1.2	Demand Projections	1.1-14
1.1.1.3	Power Exchanges	1.1-25
1.1.2	System Capability	1.1-27
1.1.2.1	Capacity Planning	1.1-29
1.1.2.2	Fuel Sources	1.1-32
1.1.2.3	Power Transfers	1.1-33
1.1.2.4	Bulk Power Systems - SERC - CRISP	1.1-34
1.1.3	Reserve Margins	1.1-36
1.1.3.1	Reserve Requirements and Criteria	1.1-36
1.1.3.2	Need for Plant	1.1-37
1.1.3.3	Relation of Interconnections to Capacity	1.1-39
1.1.3.4	Reserve Margin Responsibility	1.1-40
1.1.4	External Supporting Studies	1.1-40
1.1.5	References	1.1-41
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCE OF DELAY	1.3-1

LIST OF TABLES

Table	Title	Page
1.1-1	South Carolina Electric & Gas Company - Part I Load, Capability, and Reserves; Part II - Generation Capability	1.1-42
1.1-2	South Carolina Public Service Authority - Part I Load, Capability, and Reserves; Part II - Generation Capability	1.1-44
1.1-3	Virginia-Carolinas Subregion - Existing Interties with Adjoining Regions	1.1-46
1.1-4	Southeastern Electric Reliability Council - Projected Capability, Maintenance, Intercouncil Exchange, and Reserve in MW - 1976-1986	1.1-47
1.1-5	Southeastern Electric Reliability Council - Long Range Capacity, Peak Load, and Reserve	1.1-48
1.1-6	Virginia-Carolinas Subregion - Projected Capacity, Load, and Reserve in MW - 1976-1985	1.1-49
1.1-7	Virginia-Carolinas Subregion - Projected Load, Generating Capability, and Reserve - 1986-1995	1.1-50
1.1-8	Virginia-Carolinas Subregion - Total Projected Peak Loads in MW - 1976-1985	1.1-51

LIST OF FIGURES

Figure	Title
1.1-1	SCE&G Service Area
1.1-2	SCPSA Service Area
1.1-3	Load Duration Curve - SCE&G, 1980
1.1-4	Load Duration Curve - SCE&G, 1981
1.1-5	Load Duration Curve - SCPSA, 1980
1.1-6	Load Duration Curve - SCPSA, 1981
1.1-7	Load, Capacity and Reserves - SCE&G, 1965-1985
1.1-8	Load, Capacity and Reserves - SCPSA, 1965-1985

LIST OF TABLES (Continued)

Table	Title	Page
1.1-9	Virginia-Carolinas Subregion - Projected Peak Loads by Utility in MW - Monthly 1976-1977; Seasonal 1976-1985	1.1-52
1.1-10	Peak Loads and Annual Energy - South Carolina Electric & Gas - 1965-1986	1.1-53
1.1-11	Peak Loads and Annual Energy - SCPSA - 1965-1986	1.1-54
1.1-12	Comparison of Actual and Forecast Total Territorial Peak Loads - South Carolina Electric & Gas Company	1.1-55
1.1-13	Comparison of Actual and Forecast Total Territorial Sales - South Carolina Electric & Gas Company	1.1-56
1.1-14	Comparison of Actual SCPSA Monthly Demand and Energy Used with Projections	1.1-57
1.1-15	Response to FPC Order 496 - South Carolina Electric & Gas Company	1.1-58
1.1-16	Response to FPC Order 496 - South Carolina Public Service Authority	1.1-61
1.1-17	SCE&G System Operations - Peak Hour Conditions	1.1-64

1.0 PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

1.1 NEED FOR POWER

The Virgil C. Summer Nuclear Station, a 900 MW base load plant, will be an essential addition to the capacity of the systems of the South Carolina Electric & Gas Company (SCE&G) and the South Carolina Public Service Authority (SCPSA). Joint ownership of the plant will be on the basis of an undivided two-thirds to SCE&G and one-third to SCPSA. Allocation of power produced by the plant will also be on a two-thirds, one-third basis, 600 MW to SCE&G and 300 MW to SCPSA. SCE&G is the agent for both utilities in the construction period and will continue in that role during operations.

The need for additional power in the systems of the applicants and in the general region is demonstrated by the historical and projected growth in demand for power in the respective service areas of the two utilities and in the Virginia-Carolinas (VACAR) subregion of the Southeastern Electric Reliability Council (SERC) of which they are a part.

SCE&G, with headquarters in Columbia, S. C., provides both electricity and gas to customers in its service area. The company also has two wholly owned subsidiaries, Energy Subsidiary, Inc., and South Carolina LNG Company, Inc. In addition, SCE&G provides urban bus service in the cities of Columbia and Charleston.

The service areas of the two utilities overlap to a large extent, as shown in Figures 1.1-1 and 1.1-2.

SCE&G's service area includes 24 of South Carolina's 46 counties and more than 12,000 square miles (about 40 percent of the state's land area). The population of the service area is approximately 1.2 million persons. Electricity is provided at retail to more than 304,000 customers (as of the end of 1975) in 127 communities. In addition, three municipalities and six electric co-ops are served. Natural gas is provided to more than 159,000 customers (as of the end of 1975) in 70 communities. Columbia and Charleston are the two major electrical load centers in the service area.

SCPSA has its headquarters in Moncks Corner, S. C., about 35 miles north of Charleston. The authority is an entity of the State of South Carolina, created in 1934 to provide flood control, drainage and navigation services, and electric power. Electric service is provided directly at retail to approximately 37,000 residential and commercial customers in 8 communities, 3 military establishments, and 21 large industrial customers. Wholesale sales are made to 2 communities and to 15 individual electric distributive cooperatives represented by the Central Electric Power Cooperative (CEPC). SCPSA's direct service area consists of most of the counties of Berkeley, Horry, and Georgetown. However, as shown in Figure 1.1-2, the transmission area served through the co-ops extends to 35 of the 46 counties of South Carolina. The total number of customers served by SCPSA, both directly and indirectly, is about 220,000.

Much of the extended transmission network operated by SCPSA is owned by the 15 members of the CEPC but leased by SCPSA.

The transmission systems of SCE&G and SCPSA are interconnected for exchange purposes at several points now, and additional interconnections are planned as the nuclear plant nears completion. Other existing interconnections for SCE&G are with Georgia Power Company, Duke

Power Company, Carolina Power & Light Company, and, through the Southeastern Power Administration (SEPA), with Georgia Power Company, Duke Power Company, and SCPSA. SCPSA, likewise, has interconnections to Carolina Power & Light and to SEPA and an indirect interconnection through SEPA with Georgia Power and Duke Power. The SEPA connection exists primarily for wheeling power to the cooperatives.

To meet the increasing demand for power within its service area, SCE&G has implemented a program of additions to its generating capacity. Between 1965 and 1975, SCE&G's installed capability was more than doubled - from 1,178 MW to 2,851 MW, an increase of 142 percent, for an average annual increase of nearly 9.3 percent (Table 1.1-1). The additions to capacity in that period (adjusted for re-ratings) were:

Hydro	59 MW
Fossil base load	1,417 MW
Gas turbine	197 MW
	1,673 MW

In this 1965-1975 decade, the territorial peak demand has increased at an average annual rate of 8.6 percent.

Over the period 1975 to 1985, capacity adjustments of an additional 1,450 MW are planned, as follows:

Internal combustion retirement	-131 MW
Pumped storage peaking unit	480 MW
Nuclear plant	600 MW
Other hydro	1 MW
Fossil base load plant	500 MW
	1,450 MW

These additions will constitute a 51 percent increase in system capability. During this period, the territorial peak demand is projected to grow at an average annual rate of 6.9 percent, from 1,931 MW in 1975 to 3,752 MW in 1985 (Table 1.1-1).

The reserve margin is expected to be 45.1 percent in 1979 and 36.3 percent in 1980, with the addition of the nuclear plant capability prior to the summer peak load in 1979. Without the nuclear plant, projected reserve margins would be:

1979	22.2 percent
1980	14.8 "
1981	10.5 "
1982	3.6 "
1983	-2.9 "
1984	5.3 "
1985	-1.4 "

The 600 MW of capacity represented by the Virgil C. Summer Nuclear Station will constitute 15.8 percent of the SCE&G installed capacity at year end 1979. Without this capacity and with a loss of production on Williams No. 1, the next largest unit, with 580 MW of capacity, the projected territorial reserve margin would fall to 3 percent. If responsibility for firm sales to Duke Power and Carolina Power & Light is considered, no margin would exist.

SCPSA substantially increased its system capability in the period 1965-1975 from a net capability of 242 MW to 1,092 MW, an increase of 351 percent, for an average annual increase of 16.2 percent (Table 1.1-2). The additions to capacity were:

Coal fired, base units	600 MW
Coal fired, intermediate units	170 MW
Gas turbine, peaking units	80 MW
	850 MW

In this decade, the actual peak load increased from 336 MW to 943 MW, for an average annual growth rate of 10.8 percent. Over the period 1975 to 1985, capacity adjustments of an additional 1,168 MW are planned, as follows:

Coal fired, base unit	280 MW
Coal fired, intermediate units	560 MW
Virgil C. Summer Nuclear Station	300 MW
Gas turbine, peaking unit	28 MW
	1,168 MW

These additions will constitute a 107 percent increase in capacity over that existing at year end 1975. During the decade 1975-1985, the peak demand is projected to grow at an average annual rate of 8.1 percent per year. With the addition of the 300 MW of capacity from the nuclear plant, the reserve margins are expected to be 36.5 percent in 1979 and 26.5 percent in 1980 (see Table 1.1-2). Without the nuclear plant, projected reserve margins would be:

1979	14.4 percent
1980	6.1 "
1981	-1.6 "
1982	8.4 "
1983	1.3 "
1984	9.2 "
1985	2.4 "

The 300 MW of capacity represented by the nuclear plant will constitute 17.6 percent of the SCPSA installed capacity at year end 1979. Without this capacity and with a loss of production on either of Winyah units 1 or 2, each of which have 280 MW of capacity, the projected reserve margin would be -6.2 percent.

There are no alternatives to meeting projected loads that would not require the construction or acceleration of planning and construction for new facilities. This action is not possible within the available time frame for SCE&G or SCPSA. Availability of the nuclear plant will provide an adequate reserve for SCE&G until a new base load fossil plant can be built in the mid 1980's and also for SCPSA until a new intermediate fossil plant can be built in the early 1980's.

Other utilities in the VACAR subregion and in SERC are experiencing growth in demand and difficulties in financing and constructing new generating capacity. This situation diminishes the opportunity for large transfers of energy between utilities. Further, it is noted that there is little in the way of diversity among the utilities in the VACAR subregion. They are in the same climatic zone and experience their summer peak loads usually within the same week. Therefore, the option of purchasing additional power is not promising because there is no assurance as to its availability.

Both SCE&G and SCPSA are members of SERC and the VACAR subregion. Members of SERC are:

Alabama Electric Cooperative
Alabama Power Company
Big Rivers Electric Corporation
Carolina Power & Light Company
Crisp County Power Commission

Duke Power Company
Florida Power Corporation
Florida Power & Light Company
Fort Pierce Utilities Authority
Gainesville/Alachua County Regional Utilities
Georgia Power Company
Gulf Power Company
Henderson Municipal Power & Light
Jacksonville Electric Authority
Lakeland Dept. of Electric & Water Utilities
Mississippi Power Company
Nantahala Power & Light Company
Orlando Utilities Commission
Savannah Electric & Power Company
South Carolina Electric & Gas Co.
South Carolina Public Service Authority
South Mississippi Electric Power Association
Southeastern Power Administration
Tallahasee Electric Department
Tampa Electric Company
Tapoco, Inc.
Tennessee Valley Authority
Vero Beach Municipal Utilities
Virginia Electric and Power Company
Yadkin, Inc.

SERC includes utilities in the states of Florida, Alabama, Georgia, North and South Carolina, Tennessee, and parts of Mississippi, Virginia, Kentucky, and West Virginia and is subdivided into four subregions - Florida, Southern, Tennessee Valley Authority (TVA), and VACAR.

SERC has ties to other adjacent councils for emergency transfer capability, including Mid-America Interpool Network, East Central Area Reliability Coordination Agreement, Mid-Atlantic Area Council, and the Southwest Power Pool.

Membership in VACAR includes Carolina Power & Light Company, Duke Power Company, SCE&G, SCPSA, Southeastern Power Administration, Virginia Electric and Power Company, and Yadkin, Inc. SEPA provides capacity only.

In addition to interconnections with other councils, VACAR members have interties with adjacent regions (see Table 1.1-3).

SERC functions primarily in a coordinating, reporting, and planning role. Criteria have been established with respect to uniform load forecasting, uniform generator ratings, and reliability in system planning so as to prevent cascading and to limit adverse impacts of disturbances. Projections have been made on overall council capability and reserves for the period 1976 through 1995 (Tables 1.1-4, 1.1-5). These are based on the individual 383-3 reports submitted to the FPC, consolidated to account for intercouncil exchanges.

Two significant points should be made with respect to Tables 1.1-4 and 1.1-5. First, the projected reserves decline from 1976 to 1995, based on current plans for added capacity; and second, the summer and winter peaks for the council are very nearly the same for the period 1976-1986.

In commenting upon the load data, SERC has emphasized the following:

1. Peak loads are highly weather sensitive and there is a high probability that peaks in excess of those reported are likely to be experienced with above and below normal temperatures.
2. An expression of reserves in percent is not necessarily a valid measure of adequacy as reliability of power supply.

3. Because SERC covers a large geographical area, with wide ranges of temperatures in its subregions, a summation of projected load and capability can be erroneous because diversity of peak loads is not analyzed.
4. Expectations of future additions do not indicate a committed course of action. Many factors could affect the additions of capacity, including: economic uncertainties, financing problems, site availability, increased fuel costs, fuel availability, conservation practices, environmental restrictions, and regulatory actions.

SERC projects a 7 percent average annual increase in peak load from 1976 to 1985 and a 6 percent average annual increase from 1985 to 1995.

In Tables 1.1-6 and 1.1-7 projected capacity, load and reserve data are presented for the VACAR subregion for the period 1976 to 1995. As with SERC, the projected reserve margin shows a continuing decline from 29.2 percent in the summer of 1976 to 8.4 percent in the summer of 1995. It is also noteworthy that the projected winter peak load will exceed the summer peak load beginning in the winter of 1983-1984, due largely to the growing use of electricity for heating and the decreasing availability of natural gas. If the Virgil C. Summer Nuclear Station is not available for the summer peak of 1979, the projected VACAR margin as a function of load responsibility will decline from 23.0 percent to 20.2 percent, and in 1980, from 19.0 percent to 16.3 percent. Limited load diversity within VACAR increases the importance of this unit to the overall reliability of the subregion.

Energy conservation can be considered as prevention of physical waste, technological develcpments to improve energy conversion processes, and a means by which demand for energy is decreased. Both SCE&G and SCPSA are encouraging conservation in their service areas and taking into account in their projections the probability of a reduced growth in total demand,

or possibly a reduction in the per capita growth in the use of electric energy. Neither SCE&G nor SCPSA are conducting advertising programs that will stimulate the growth of demand. In fact, both are encouraging economy in the use of energy and counseling on its wise use. Both have provided information to users and the general public on the value of insulation and on the energy saving features of more efficient appliances and heating equipment. There has been widespread publicity on the cost to consumers of uneconomic use of energy. It is also believed that the increases in rates and the pass-through of higher energy costs to the utilities customers has deterred some growth in consumption. However, despite increased costs to consumers and an economic recession, there has been increased use of electrical energy in all economic sectors.

There is little either utility can do to curb some of the increases in energy consumption. Much of the demand is industrial, and such economies as can be effected in the short run have occurred. Over the long term, more efficient equipment will be installed by industry to reduce the energy input per unit of production. Since, in many instances extensive capital outlays are required, this "one-time saving" will be slow in being realized. Again, there are many attractions for new industry in the service areas of both utilities that are likely to bring new industry despite increasing electrical rates.

With respect to the electrical sector, use of natural gas for heating will be on the decline, and in some areas no new connections are being made. This fact forces homeowners into the use of electric heat and increases the demand for electrical energy despite any conservation program. The expectation of further conversions from natural gas and oil to electrical energy is inherent in the planning of both utilities.

To date, it has not been possible to isolate as a factor the effect of any national conservation measures upon demand in these service areas

nor even to determine what the elasticity of demand is with respect to price. It is recognized that strong national leadership on conservation could bring about some reductions in demand, but it is believed that such potential reductions are included in the reduced rate of growth projected by both utilities over the next ten years.

Minor inconsistencies exist between data reported previously to the FPC and to VACAR and data shown herein. These are largely the result of the programs of both utilities for testing and re-rating the capacities of individual generating units and of revisions to expected industrial demands.

1.1.1 LOAD CHARACTERISTICS

The utilities in the VACAR subregion normally experience annual peak loads during the summer, typically in August. Yadkin, a small captive producer, is an exception in that it hits a peak (160 to 200 MW) during several months of the year. Because the utilities are in the same climatic zone their summer peaks are frequently on the same day or within the same week. As a result, there is very little diversity within the subregion. A 1975 study by VACAR shows that for the period 1968-1974, the percent difference between simultaneous peak load and noncoincident peak load ranged from 0.72 to 2.45 percent with an average for the seven year period of 1.28 percent. This illustrates that there is virtually no load diversity among the VACAR systems at the time of the summer peak.

Winter peak loads for some of the utilities are increasing faster than the summer peak loads because of increased demand for electric heating. For SCE&G, for example, the 1976 peak in July of 1994 MW was 3.3 percent higher than the peak of 1975. But, the winter peak in January 1976 was 15 percent higher than the winter peak for 1975. Higher winter than

summer peaks are forecast for the Duke Power Company (Duke) by the winter of 1976-77 and for the Virginia Electric Power Company (VEPCO) by the winter of 1985-86. Carolina Power & Light (CP&L) expects the summer and winter peaks to be the same by 1976. The VACAR winter peak load will exceed the summer peak by the winter of 1983-84. Data on projected peak loads for the VACAR subregion are provided in Tables 1.1-8 and 1.1-9.

1.1.1.1 Load Analysis

Table 1.1-10 presents past and projected peak load demands and annual energy requirements for SCE&G over the period 1965-1989.

Growth in peak load and annual energy requirements, based on Table 1.1-10, is shown below for past periods and as projected for the future.

	Percent Growth (SCE&G)			
	Territorial Demand		Annual Energy Requirements	
Period	Percentage Increase	Avg. Annual Growth	Percentage Increase	Avg. Annual Growth
1965 - 1970	72.8	11.6	60.1	9.9
1970 - 1975	32.7	5.8	32.5	5.8
1965 - 1975	129.3	8.7	118.5	7.8
1975 - 1980	40.7	7.1	29.3	5.3
1980 - 1985	38.1	6.7	25.9	4.7
1975 - 1985	94.3	6.9	62.7	5.0

Growth in both peak demand and in annual energy requirements, as shown in this summary and in Table 1.1-10, was relatively high for the period 1965 through 1973. The economic recession and higher energy prices curtailed growth somewhat for the following two years.

Projected capability and loads for SERC and VACAR are provided in Tables 1.1-5 through 1.1-9.

SCE&G peak load values shown on Table 1.1-10 are 10 MW greater than those reported in the 1976-1985 FPC 383-3 filing for the years 1976 and 1977, due largely to the revision of a projected industrial demand.

The proposed nuclear facility is listed in the 1976-1985 FPC 383-3 filing as one of four capacity additions planned by SCE&G over the next ten years. As shown in Table 1.1-1 there are two increments in pumped storage capacity of 240 MW each in 1977 and 1978, the nuclear plant, with 600 MW allocated to SCE&G in 1979, and a new facility, coal fired, of 500 MW in 1984. As noted in the FPC filings the nuclear plant is projected to have 900 MW of net dependable capacity, with undivided joint ownership by SCE&G and SCPSA on a two-thirds, one-third basis.

The expected annual load duration curves for the first two full annual reporting periods for the Virgil C. Summer Nuclear Station (1980 and 1981) are shown in Figures 1.1-3 and 1.1-4. These figures clearly show the importance of the nuclear plant to the base load requirements of SCE&G.

Table 1.1-11 presents past and projected peak load demands and annual energy requirements for SCPSA over the period 1965-1985. Growth in peak load and annual energy requirements based on Table 1.1-11 may be summarized as follows:

	Percent Growth (SCPSA)			
	Territorial Demand		Annual Energy Requirements	
Period	Percentage Increase	Avg. Annual Growth	Percentage Increase	Avg. Annual Growth
1965 - 1970	78.6	12.3	64.5	10.5
1970 - 1975	57.2	9.5	45.8	7.8
1965 - 1975	180.6	10.9	140.0	9.1
1975 - 1980	55.5	9.2	55.7	9.3
1980 - 1985	40.9	7.1	40.0	7.0
1975 - 1985	119.1	8.2	118.0	8.1

As shown in this summary and in Table 1.1-11, growth in both peak demand and in annual energy requirements was high for the period 1965 through 1973. The economic recession and higher energy prices contributed to a reduced growth rate for the following two years. It is noted that in 1967 and 1971 both SCE&G and SCPSA experienced relatively low annual increases in annual peak loads and annual energy requirements. Both are in the same climatic zone, which contributes to the lack of diversity between the two utilities.

The proposed nuclear facility is listed in the 1976-1985 FPC 383-3 filing as one of four major capacity additions planned by SCPSA over the next ten years. As shown in Table 1.1-2 these are the second coal fired unit of 280 MW to be completed at Winyah in 1977, the Virgil C. Summer Nuclear Station with 300 MW allocated to SCPSA, in 1979 and two coal fired units of 280 MW capacity each to be added in the early to mid-1980's.

The expected annual load duration curves for the first two full annual FPC reporting periods for the nuclear plant (1980 and 1981) are shown in Figures 1.1-5 and 1.1-6. These figures clearly demonstrate the importance of the plant to the base load requirements of SCPSA.

Load duration curves are not shown for the combined utilities nor for VACAR, since each utility is responsible for meeting its own load. VACAR does not have consolidated generation planning responsibility.

1.1.1.2 Demand Projections

1.1.1.2.1 SCE&G Extrapolation Methods

Demand projections made by SCE&G involve a combination of extrapolation techniques, judgment based on experience, and economic correlations.

The extrapolation methodology includes the following steps:

1. Collection and maintenance of historical data.
2. Analysis of data to establish those factors that have influenced load growth in the past.
3. An extrapolation of trends into the future.
4. Periodic comparisons of performance and previous forecasts so as to make appropriate adjustments.

In forecasting sales, a disaggregated approach has been used, involving individual treatment of each major customer classification as discussed in the following sections.

1.1.1.2.1.1 Residential

Residential sales are broken into two categories: residential with space heating and residential without space heating. Each category is analyzed individually to estimate total residential sales. Numbers of customers and average per capita energy use are the two factors which are independently applied in each category to estimate future sales. Historical trends are developed from the compound growth sheets for five years for both average use and number of customers, and these trends are then expressed graphically.

1.1.1.2.1.2 Commercial

Commercial sales are subdivided into two classes: large and other.

Other sales are determined by projected number of customers and average use based on five years' compound growth expressed graphically.

Sales to large customers are projected individually for each customer based on periodic reports from the customer and on five years' compounded growth rates expressed graphically.

1.1.1.2.1.3 Industrial

Total industrial sales are determined by projecting the needs of each customer (based on periodic estimates from the customer as to future energy requirements) and on five years' compound growth rates expressed graphically. This category is subdivided into large, small, and DuPont (ERDA).

1.1.1.2.1.4 Street Lighting

Street lighting is projected, using compound growth rates over the previous five years, with trends expressed graphically.

1.1.1.2.1.5 Other Sales to Public Authorities

Total sales within this classification are subdivided into sales to the State of South Carolina and other sales. Each of these categories is projected individually from compounded growth rates over the five year period. Information gathered by the Commercial Department is also reviewed as a basis for judgmental modification. Trends developed are expressed graphically.

1.1.1.2.1.6 Sales for Resale

This classification is composed of sales to municipalities and non-associated companies.

Sales to municipalities are projected on an individual basis from information supplied by the municipalities on estimated future energy requirements and from graphical expressions of compound growth rates for five year periods.

Sales to nonassociated companies are projected according to their estimates of future energy requirements and on the basis of existing contracts.

1.1.1.2.2 Econometric Models for SCE&G

SCE&G has been successful in forecasting its system loads by the extrapolation method. However, it is recognized that the techniques utilized will yield acceptable results only when it can be assumed the factors affecting energy use remain much the same. Recent events, such as the petroleum embargo, the increased costs for fuel, and the uncertainties of the future, suggest that this assumption is no longer valid. Hence, an additional method has been adopted.

An econometric model has been developed with the aid of Charles T. Main and Associates. The model projects customer energy use based on correlation with relevant economic sectors within the state. A brief description of the model and the underlying assumption follows.

For the past several years the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce has compiled data on the contribution to personal income within the State of South Carolina made by various sectors of the economy within the state (1). Through multiple regression analysis, the growth rates of three of these economic sectors were found to correlate well with the growth rate of energy sales. These three sectors are: 1) the finance, insurance, and real estate sector (FIN); 2) the transportation, communication, and public utilities sector (TRNS);

and 3) the professional services sub-sector (PROSERV). The model is of the form:

Growth rate in energy sales = C_1x (growth rate FIN) + C_2x (growth rate TRNS) + C_3x (growth rate PROSERV),

where C_1, C_2, and C_3 are weighting coefficients.

From projected values made by the BEA for each of the above economic sectors, substitution into the model gives the projected growth rates for energy sales. Demand is then calculated, based on load factors and projected energy use.

In addition to compiling historical data necessary in developing an econometric model, the BEA projected various economic sectors to 1990. Current projections are keyed to the Census Bureau's series "E" national population projection. Economic projections are based on long-run trends and ignore the cyclical fluctuations which characterize the short-run path of the economy.

General assumptions underlying the BEA's projections are as follows (1):

"1) Growth of population will be conditioned by the fertility rates of recent years.

2) Nationally, reasonably full employment, represented by a 4 percent unemployment rate, will prevail in both decades for which projections are made; as in the past, unemployment will be disproportionately distributed regionally, but the disproportion will diminish.

3) The projections are assumed to be free of the immediate and direct effects of wars.

4) Continued technological progress and capital accumulation will support an annual growth of 2.9 percent in private output per man-hour.

5) New products that will appear will be accommodated within the existing industrial classification system.
6) Growth in output can be achieved without ecological disaster or serious deterioration, although diversion of resources for pollution control will cause changes in the industrial mix of output.
7) The composition of personal consumption will continue to change."

Regional projections are based on the following additional assumptions (1):

"1) Factors that have influenced historical shifts in 'export' industry location will continue into the future but the sharpness of the shifts will diminish.
2) Trends toward area self-sufficiency in 'residentiary' industries will continue.
3) Workers will migrate to areas of economic opportunities and away from slow-growth or declining areas.
4) Regional earnings per worker and income per capita will continue to converge toward the national average.
5) Regional employment/population ratios will tend to move toward the national ratio except in 'retirement' areas."

Growth rates for the economic sectors selected were found to correlate well with energy sales. It is noted that the BEA has projected a reduced rate of growth for the economic sectors of finance, transportation, and professional services in future years. This is one reason why the projected growth in demand is less than that actually experienced for the period 1958-1975.

Table 1.1-10 presents projections of peak load and annual energy requirements for SCE&G together with estimates of year-by-year increases in

territorial peak demand and annual energy. The territorial demand is estimated to increase at an average annual rate of about 7 percent beyond 1977. Annual increases in energy requirements are estimated to increase at differing rates, year-by-year, based largely on the projections for the industrial sector made by major industrial users. Over the period 1975 to 1985 the territorial load is projected to increase 94 percent, compared to 129 percent for the period 1965-1975, in which the average annual rate of growth was 8.7 percent. Annual energy requirements are projected to increase 58 percent from 1975 to 1985, for an average annual rate of growth of 4.7 percent, compared to an increase of 118 percent from 1965-1975 and an average annual rate of growth of 8.1 percent. (Also see tabulation at beginning of Section 1.1.1.1.)

1.1.1.2.3 SCPSA Projections

Demand projections made by SCPSA involve a combination of extrapolative techniques and judgment. As with SCE&G, independent estimates are made for each of the major customer classifications based on information obtained from co-ops and major users. These estimates are combined and increased by 5.5 percent for transmission, conversion, and distribution losses to obtain net energy for load. A continuing growth is projected for the peak demand for power at an initial rate of about 8 percent, projected from 1974. Because of a milder summer, the peak load of 943 MW in 1975 was lower than expected, but the projected peak of 1064 MW was exceeded by July of 1976. A lower growth rate in both peak load and annual energy was experienced in the period 1970-1975 than in the period 1965-1970. On the basis that at least part of the lower rate of increase reflected improved energy management, energy conservation programs, and response to higher prices, the projections by SCPSA shown in Table 1.1-11 and in the tabulation at the beginning of Section 1.1.1.1 were manipulated to provide for lower growth rates. A "sum of the least squares" technique and a smoothing constant were applied to the pro-

jections of historical trend data, modified by user inputs, to obtain load and energy estimates to 1986. The effect of the smoothing constant can be seen in the gradually reduced rate of increase for both series of estimates (see Table 1.1-11).

1.1.1.2.4 Recent Growth History

Relevant to a consideration of demand projects is a review of the recent past. Average annual growth rates (based on Tables 1.1-10 and 1.1-11) are shown below for both utilities for basic territorial load and annual energy for recent time intervals.

	Average Annual Percent Growth			
	Peak Demand		Annual Energy	
Time Period	SCE&G	SCPSA	SCE&G	SCPSA
1965 - 1970	11.6	12.3	9.9	10.5
1970 - 1975	5.8	9.5	5.8	7.8
1965 - 1975	8.7	10.9	7.8	9.1

These growth rates are higher than those for the U. S. as a whole. National gains in annual energy consumed had been in the range of 6 percent until the Arab oil embargo and the subsequent price increases for oil. Total U. S. energy consumption increased 6.8 percent in 1973, was about zero in 1974, and only 2.2 percent in 1975. As shown on Tables 1.1-10 and 1.1-11, annual energy for both utilities was above these figures for these three critical years.

By summer of 1976 both utilities were substantially ahead of 1975 figures for annual energy, and it is not unlikely that the projections made are conservative.

Despite the continuing recession in 1975, which accounted for a decline in industrial use, residential and commercial use has continued to in-

crease. The effect of price increases in curtailing use was less than expected. Now, with a recovering economy, industrial use is likely to increase more than was originally anticipated.

Both utilities have experienced a steady growth in the number of residential and total customers. Over the 15 year period from 1960-1975 SCE&G's residential customers increased by 65.3 percent, for an average annual growth rate of 3.4 percent. Total customers increased by 60.7 percent, for a growth rate of 3.2 percent. The number of electric heating customers, though in 1975 only 14.3 percent of total customers, has increased almost 42 times between 1961 and 1975.

SCE&G's residential use more than doubled between 1960 and 1975, for a growth rate of 5 percent. The highest residential customer use was 11,291 kwh in 1973. There was a 5 percent decline in usage in 1974 followed by a 2 percent increase in 1975. Between 1972 and 1975 the average price per kwh sold for residential consumption increased by 67 percent, whereas in the preceding 12 years rates had decreased by 9.4 percent. Despite the dramatic rise in rates occasioned by increased fuel and operating costs, consumer demand continued to grow.

SCPSA has experienced similar growth in both customers and unit consumption. Between 1970 and 1975 the number of customers increased at an average annual rate of 6.3 percent, and the per capita residential use increased at a rate of 10.9 percent.

Estimates of increased rates of consumption by the two utilities for various customer classifications are:

	Average Annual Rates of Increase	
	SCE&G 1975-80 (%)	SCPSA 1975-85 (%)
Residential	3.8	10.1
Commercial	3.4	10.5
Industrial	8.4	5.0
Military	(included in industrial)	5.0
Municipals	2.1	3.7
Cooperatives	3.3	9.6

Past and future growth in demand is closely related to population changes. In the period April 1, 1970 to July 1, 1975, South Carolina's population increased by an estimated 227,000 persons, a gain of 8.8 percent. This may be compared to a gain of 4.8 percent in the same period for the U. S. The gain in this recent five year period was greater than the 9.4 percent recorded for the previous decennial period of 1960 to 1970 (2).

Because of South Carolina's attractions for industry - land, labor, climate, tax structure, resources and port facilities, additional population in-migration is anticipated. This will, of course, increase the demand for power. Of relevance is the fact that an estimated 89 percent of the state's 1970-1975 gain in population occurred in counties served by SCE&G and SCPSA.

For either utility it has not as yet been possible to isolate the elasticity of demand with respect to price. It is clear that when a heat wave occurs and lasts for several days any inhibitions related to the cost of energy are lost when the air conditioning units are turned to high to provide relief from the heat.

It is recognized by both utilities that conservation and energy management are critically important. Both have mounted extensive public relations campaigns involving all forms of media to educate customers on

means by which energy use can be reduced. Materials are distributed or made readily available on insulation, the energy efficiency ratios of various appliances, energy management for home, office and industry and other topics with the objective of encouraging conservation. Neither of the utilities advertises in any way so as to stimulate increased use of energy. Neither utility has adopted tail-up rates, but SCPSA's summer rate is 20 percent higher than its winter rate for residential and commercial users. It is hoped that this will restrict the growth in peak loads.

Despite efforts to conserve, the reduced availability of natural gas as an energy source will increase the demand for electricity. In most areas of the state no new gas distribution lines are being extended, and in some areas no new connections are being made. Industrial curtailment and interruptible plans are already in effect, and some industry is turning to electricity in order to be sure of a non-interruptible energy source.

Two of the major problems related to forecasting energy demand have to do with industry. With an economic recession, a cut-back by a major industrial facility may have a significant effect on peak loads. Also, even though industrial planners generally review new facility plans with a utility several years in advance of the actual requirement for energy, this may cause problems. Many of the new plants may have substantial power requirements. Even with a four year lead time, this may have a substantial impact upon reserve margins. With a recession, a utility may get 3 to 4 months, or less, notice of a cutback. The need for restoration of a large load may come with an equally short lead time.

Monthly data for SCE&G for both actual and previously forecasted peak demands and sales are given in Tables 1.1-12 and 1.1-13. Similar data

for SCPSA on energy and peak demand are presented in Table 1.1-14. These tables demonstrate that earlier forecasts have proven to be reasonably accurate.

Copies of reports supplied to the FPC in response to Order 496 are provided in Tables 1.1-15 and 1.1-16.

1.1.1.3 Power Exchanges

Historically, SCE&G has been a power exporter at the time of annual peak loads, but the long-term plans of the company do not contemplate a continuation of this practice. In recent years the power exchanges occurring at the time of peak load were as follows:

Year	1970	1971	1972	1973	1974	1975
Sales - MW	345	457	665	646	249	148
Purchase - MW	318	240	264	93	59	12

Firm sales contracts, shown below, now exist with two members of VACAR and with one Southern company. These contracts expire before the end of 1980.

	SCE&G Firm Sales Contracts in MW				
Power Company	1976	1977	1978	1979	1980
Carolina Power & Light	52	52	52	52	52
Duke	21	21	21	21	21
Georgia Power	75	75	75		
TOTAL	148	148	148	73	73

As a member of VACAR, SCE&G will continue to make short-term sales and to adhere to the terms of the VACAR reliability agreement. This agreement provides for augmenting the reliability of the combined systems.

SCE&G has interconnections with CP&L, Duke, SCPSA, and Georgia Power; Georgia Power is in the Southern subregion. The two ties to Georgia aid in interchanges between the VACAR, Southern, and TVA subregions of SERC.

Other than the firm contract sales noted above, it is not possible to predict the nature or magnitude of future short-term power exchanges. They will depend upon the actual reserves of SCE&G, VACAR, SERC, and contingencies which may occur within these subregions. It is, of course, reasonable to expect a balanced pattern of short-term power exchanges in future years, but these have varied widely in the past.

SCPSA relies upon imported power to meet about one-tenth of its peak load and to meet other normal system demands. A long-term contract with SEPA provides for delivery of 105 MW of firm power, with another 50 MW being available for emergencies or reserve. The average annual energy available from SEPA is 300 Gwh. Of this, about two-thirds is wheeled to three preferred customers: the Town of Bamberg, the City of Georgetown, and the CEPC.

In calendar year 1975 the following energy interchanges were made by SCPSA:

Power Company	SCPSA Received	SCPSA Delivered
SCE&G	793.9 Gwh	604.5 Gwh
SEPA	551.2 Gwh	51.6 Gwh
CP&L	430.7 Gwh	608.2 Gwh

In this period SCPSA received a net of 511.5 Gwh of energy.

Interconnections are maintained with SEPA, SCE&G, and CP&L, and indirectly through SEPA to Duke and Georgia Power.

1.1.2 SYSTEM CAPACITY

Both SCE&G and SCPSA participate in interchange arrangements. However, each member is responsible for planning and arranging its own power supply. (SCPSA does have a long-term agreement with SEPA providing for 105 MW of firm power and 50 MW of reserve power.) So that economies of scale can be achieved, SCE&G and SCPSA will share the costs, output and undivided joint ownership of the Virgil C. Summer Nuclear Station.

With these exceptions, each utility is concerned with and responsible for the adequacy and the reliability of its own generation system. As a means of ensuring system adequacy and reliability, SCE&G maintains a ten year load forecast and generation schedule to determine when capacity additions will be needed to meet load requirements and to provide the required reserve margin. The generating planning schedules are frequently reviewed to evaluate projected availability and costs of alternative fuels, lead times for capacity additions, projected peak loads and reserve requirements, and other factors affecting the cost and reliability of the company's long-range expansion plans.

Similarly, SCPSA reviews its generating planning schedule several times a year in order to plan for new capacity additions. Each review involves the evaluation of fuel, operating and maintenance costs of several alternative capacity schedules, and the selection of that schedule which provides the lowest total generation cost. Timing of additional capacity and the amount of capacity to be added is determined by anticipated growth in peak demand and in total energy and by the reserve requirement. Units selected for capacity additions are those which are most cost-effective in meeting overall requirements.

Table 1.1-1 presents SCE&G data on territorial peak load, load responsibility, generation capability and reserves, both historical and forecast,

and capacity factor ranges for base units. Complete detail is given on the generation capability of each unit over the period 1971 to 1985, with a schedule provided of planned new capacity and re-ratings. Total resources are compared with total load responsibility to derive reserve capacity. The actual situation existing in the SCE&G system at the hour of peak load is presented in Table 1.1-17 for the years 1971-1975. This tabulation illustrates the diversity of power exchanges that can occur at peak hour conditions and the importance of maintaining reserve capacity to permit short-term or emergency sales to neighboring utilities. Included are economic exchanges which can also be made when utilities have adequate reserve capacity.

Load responsibility, capability and reserve capacity are shown graphically for SCE&G in Figure 1.1-7, both with and without the nuclear plant. The reserve margin declines very rapidly after 1979 and without the plant fails to meet SCE&G reserve criteria in 1980 and later. As discussed in Sections 1.1.3 and 1.3, SCE&G would retain the 131 MW of peaking capacity now scheduled for retirement in 1979 if the Virgil C. Summer Nuclear Station were not available. Since this represents only 22 percent of the capacity of the nuclear plant, it will not significantly affect the declining reserve margins beyond 1980. Further, the obsolescent peaking capacity will be uneconomic and unreliable in operation.

Table 1.1-2 presents data for SCPSA on territorial peak load, generation and total capability and reserves, both historical and forecast, and capacity factor ranges. Detail is given on the generation capability of each unit over the period 1971 to 1985, with a schedule provided of planned new capacity. Total resources are compared with peak loads to derive reserve capacity. The actual situation existing in the SCPSA system at the hour of peak load for the years 1971-1975 follows.

SCPSA System Operations
Peak Hour Conditions (in MW)
1971-1975

	1971	1972	1973	1974	1975
Actual System Generation	653	716	697	728	842
Purchases from SEPA	53	73	92	83	105
Purchases from SCE&G			50	100	
Sales to SCE&G	-80	-50			
Inadvertent Exchanges	-4	-3	-10		-4
Territorial Peak Load	622	736	829	911	943

Over this time period it was not necessary for SCPSA to draw the full power (105 MW) available from SEPA except in 1975. Contract purchases were made from SCE&G in 1973 and 1974 because the apparent reserve margin was declining (see Table 1.1-1). A firm reserve purchase agreement for 50 MW was concluded with SEPA, effective in 1975. It was possible to make economy sales to SCE&G without jeopardizing reserve margins in 1971 and 1972.

Peak load, generating and total capability and reserve margins are presented graphically for SCPSA in Figure 1.1-8. Without the nuclear plant, the reserve margin deteriorates very rapidly and remains far below the reserve margin criteria after 1978.

1.1.2.1 Capacity Planning

Capacity planning by the two utilities must be closely related to the availability of fuels for generating the peak load and energy demands of the systems. The nature of the shifts that must be made is clearly illustrated by the changes in energy sources between 1975 and 1976 for SCE&G. The following tabulation shows actual 1975 sources and expected 1976 sources.

SCE&G Energy Source	1975 (in percent)	1976 (in percent)
Coal	55	70
Oil and Distillate	27	22
Hydro	7	5
Natural Gas	11	3
	100	100

Within the short period of one year, natural gas was virtually eliminated from use because of shortages, and other energy sources were substituted; in 1968 natural gas had provided 41 percent of the total energy. Of relevance is the planning by energy source for firm peak capability between 1976 and 1985.

SCE&G Peak Firm Capability by Energy Source

Energy Source	1976 (in percent)	1980 (in percent)	1985 (in percent)
Coal	57.6	43.3	49.9
Oil and Distillate	33.8	21.9	19.4
Hydro (including pumped storage)	8.6	19.0	16.8
Nuclear	-	15.8	13.9
	100.0	100.0	100.0

Planning by SCPSA for energy sources will involve significant shifts over the next few years and out to 1985 as shown in the following tabulations.

SCPSA
Projected Sources of Energy Supply
Fiscal Years

Energy Sources	1976 (in percent)	1982 (in percent)
Coal	80.7	64.8
Oil and Distillate	0.4	0.5
Hydro	15.6	7.8
Nuclear	-	25.0
SEPA (Hydro)	3.3	1.9
	100.0	100.0

SCPSA Peak Firm Capability by Energy Source

Energy Sources	Fiscal Years 1975 (in percent)	1980 (in percent)	1985 (in percent)
Coal	64.3	58.2	68.1
Oil and Distillate	16.0	12.2	9.3
Hydro	10.9	7.2	5.5
Nuclear	-	16.6	12.7
SEPA (Hydro)	8.8	5.8	4.4
	100.0	100.0	100.0

The critical importance of the nuclear plant is clearly evident, as is the continuing dependence on coal as a primary source.

Major capacity additions planned by or under construction for SCE&G are: 1) Fairfield Pumped Storage Units 1 through 4, 240 MW, in 1977 and Units 5 through 8, 240 MW, in 1978; 2) Virgil C. Summer Nuclear Station, 600 MW in 1979, and 3) a coal fired plant, 500 MW, in 1984. Also in 1979 there will be the scheduled retirement of 131 MW of peaking capacity (IC Turbines).

Major units planned by or under construction for SCPSA are: 1) Winyah Unit 2, 280 MW, coal fired, in 1977; 2) Virgil C. Summer Nuclear Station, 300 MW, in 1979; and two coal fired units, 280 MW each, at undetermined sites in 1982 and 1984. If a second nuclear station is built by SCE&G, SCPSA will have the right to acquire a one-third interest.

SCPSA's hydro capacity may be affected by the Cooper River Rediversion Project proposed by the U. S. Army Corps of Engineers. This project, which has been authorized by the U. S. Congress as a solution to silting problems in Charleston Harbor, would divert a substantial part of the flow of the Cooper River into the Santee River. As part of the project, the Corps will build an 84 MW hydro plant near St. Stephens,

S. C., and the plant output will be made available to SCPSA. The output of the St. Stephens plant, plus a limited output from the Jeffries plant estimated at 44 MW, should equal the present output from Jeffries. SCPSA will be compensated for any net loss in energy resulting from the project and will compensate the Corps for any added capacity used.

1.1.2.2 Fuel Sources

In 1976, SCE&G will require over 3 million tons of coal. Some 66 percent of this coal is purchased under contractual agreements with the remainder purchased on the spot market. Four of the six major steam generating plants now in operation are coal fired, and each of these is supplied by unit train delivery from western Virginia, eastern Kentucky, and Tennessee mines. Coal inventories of 60 to 80 days are normally maintained at the plant site. Two plants are fired by No. 6 oil. SCE&G has purchased uranium in sufficient quantities for initial fuel loading, provided Westinghouse Corporation continues to abide by its agreement made under a court order.

SCPSA receives coal for its fossil units at the Jeffries and Winyah No. 1 plants by unit train under long-term contracts with three coal-mining companies. Less than unit train quantities are received from another company for the Grainger plant. Inventories of 60 to 90 days are maintained. Approximately 1.7 million tons are burned per year. About 600,000 gallons of No. 2 oil are used per year for peaking and 200,000 barrels of No. 6, largely for peaking. Consideration has been given to the concept of coal mine ownership to ensure a source of supply, but the associated problems are recognized.

1.1.2.3 Power Transfers

Historically, SCE&G has been a power exporting company, while SCPSA has had a long-term firm contract with SEPA to provide 105 MW of power. Both have had short-term purchase and sale contracts and have responded to emergency needs of other systems.

As shown in Table 1.1-1, SCE&G has some firm sales contracts in existence, all of which will expire before 1981. No firm sales contracts are planned beyond that time period, but it is reasonable to anticipate a balanced pattern of short-term exchange in future years. The nature and magnitude of future exchanges cannot be predicted since they will depend on factors outside the control of SCE&G such as heat and cold waves and their intensity and duration; diversity among nearby utilities or power pools; reserve levels maintained by VACAR and SERC; emergencies in neighboring utilities; and economic interchanges.

SCPSA will continue its long-term contract with SEPA providing for 105 MW of firm power and up to 50 MW of reserve power, but there are no plans for other firm contracts for purchase or sale. However, depending upon capability, there may be short-term sales of economy power or response to emergency. Any discrepancies between the SCPSA unit generation capabilities listed in Table 1.1-2 and those reported in FPC filings are due primarily to minor adjustments in the ratings of individual units.

Load forecasts and generation schedules for SCE&G, SCPSA and all other members of VACAR are reported annually in accordance with FPC order 383-3.

1.1.2.4 Bulk Power Systems - SERC - CRISP

Both utilities constantly assess their bulk power systems to ensure that long-range planning criteria are met. As members of VACAR both SCE&G and SCPSA conduct load flow and transient stability studies. Long-range analyses are made out ten years in advance to aid in planning and assessing the reliability of the bulk power systems. As active members of SERC they establish planning criteria that will ensure that the systems planned for the future will meet the requirement set forth in SERC's "Criteria for Reliability in System Planning (CRISP)."

To accomplish this objective, specific application of the SERC criteria has been made to the systems of each utility.

The requirements of the SERC-CRISP LOCAL AREA CRITERIA will be satisfied if each system is so designed that during any of the following contingencies only short-term overloads, low voltages, and local losses of load will occur and that after appropriate switching and redispatching, all loads can be served with reasonable voltages and no substantial line and/or transformer overloads (10 percent is considered a maximum tolerable overload).

1) Loss of any bus and associated facilities operating at a voltage level of 115 kV or above.
2) Loss of any line operating at a voltage level of 115 kV or above.
3) Loss of entire generating capability in any one plant.

The SERC-CRISP, REGIONAL CRITERIA are directed only at preventing cascading. Cascading is defined as the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in an uncontrolled, widespread collapse of system power that

cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies. The criteria are clear and specific and therefore must be applied as quoted below.

SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL
CRITERIA FOR RELIABILITY IN SYSTEM PLANNING

LOCAL AREA CRITERIA

"It is recognized that the reliability of power supply in local areas is the responsibility of individual SERC members and that each system has internal criteria relating to the more common contingencies. It is further recognized that there are severe contingencies which are credible but of a low probability of occurrence, which may result in conditions such as islanding and/or loss of load. Such conditions are considered acceptable so long as they are so controlled as to limit the adverse impact of the disturbance and to leave the system or systems in such condition as to permit rapid load restoration and/or reconnection."

REGIONAL CRITERIA

"The objective of the regional criteria is to assure that the SERC bulk power systems are planned so that cascading outages will not result from any foreseeable contingencies. These criteria are, therefore, directed only at preventing cascading.

Each of the SERC member systems will be planned to avoid cascading upon the occurrence of the following contingencies:

1) Loss of Generation. Sudden loss of entire generating capability in any one plant.
2) Loss of Load. Sudden loss of a large load or major load center.

3) Loss of Transmission. The outage of the most critical transmission line caused by a three-phase fault during the outage of any other critical transmission line.
Sudden loss of all lines on a common right-of-way.
Sudden loss of a substation (limited to a single voltage level within the substation plus transformation from the voltage level), including any generating capacity connected hereto.
Delayed clearing of a three-phase fault at any point on the system due to failure of a breaker to open."

1.1.3 RESERVE MARGINS

1.1.3.1 Reserve Requirements and Criteria

The operating reserve policies of both SCE&G and SCPSA are to maintain a minimum reserve equal to 20 percent of the firm annual peak load (firm responsibility) or the largest unit, whichever is greater. Tables 1.1-1 and 1.1-2 and Figures 1.1-7 and 1.1-8 present data on historical and projected loads, resources, and reserves. The tables show total system reserves in MW and as a percentage of load responsibility, the required 20 percent of load responsibility, or peak load, and the size of the largest unit in MW for the period 1965-1985.

For SCE&G, total load responsibility is given, which is the sum of the historical or anticipated territorial peak load plus firm sales contracts. Beyond 1980 load responsibility and territorial peak load are the same. Resources consist of generation capability and firm purchases. For SCE&G, generation capability and total capability (resources) have been the same except in past years when firm purchase agreements existed. None are planned for future years. The amount of 105 MW for SCPSA's

firm contract with SEPA is added to its generation capability for the figure representing total capability (resources). Reserves are presented as a percentage of load responsibility.

System reserves for SCE&G were below the 20 percent margin and the size of the largest unit for most of the period 1965 through 1970. With the planned additions to capacity of the Fairfield Pumped Storage Units in 1977 and 1978, the projected system reserves will be greater than the size of the largest unit until completion of the nuclear plant in 1979. Even with the plant, the projected reserves may fall below the size of the largest unit in 1983 and 1985.

SCPSA's reserves were adequate on the basis of both criteria, the recommended 20 percent margin and the size of the largest unit, from 1965 to 1967, but fell behind in 1968 and 1969. They were adequate in 1970 and 1971, but below criteria for 1972 to 1974. The agreement to purchase 50 MW of reserve capacity from SEPA and a firm purchase of 100 MW from SCE&G in 1974 precluded the necessity for emergency purchases. Projected reserves will be below the recommended criteria in 1976 but will meet them until the nuclear plant is completed. Even with the addition of new capacity planned for 1982 and 1984, SCPSA is projected to fail to meet one or both criteria in 1981, 1983, and 1985.

1.1.3.2 Need for Plant

Tables 1.1-1 and 1.1-2 and Figures 1.1-7 and 1.1-8 clearly show the importance of the nuclear plant to SCE&G and SCPSA. Without the plant SCE&G's projected reserve margin for 1979 would be 22 percent and approximately equal to the size of the largest unit (580 MW) in the system. Between 1980 and 1985, the reserve margin without the Virgil C. Summer Nuclear Station would be below 20 percent (ranging between -2.9 and +14.8 percent despite the projected addition of 500 MW in capacity in

1984. The reserves without the Virgil C. Summer Nuclear Station would be negative by 1983 and again in 1985, even with the proposed new 500 MW unit.

In fact, as discussed below, SCE&G would maintain a larger-than-projected margin by retaining in service the obsolescent and economically inefficient peaking units (131 MW) scheduled for retirement in 1979. The effect of retaining these units for use to meet peak loads (without the availability of the nuclear plant), would modify the reserve margins as follows:

Total Reserves	1979	1980	1981	1982	1983	1984	1985
MW	712	543	436	243	37	316	80
Percent of Load Responsibility	27.2	19.5	15.1	7.9	1.1	9.0	2.1

Following 1979 the reserve criteria would not be met in any year.

A similar situation would exist for SCPSA. The reserve margin would decline from nearly 24 percent in 1978 to 14 percent in 1979 and range between -1.6 and 9.2 percent through 1985. The reserves would fall below the size of the next largest unit (280 MW) and become negative in 1981. Even with the addition of 280 MW units in 1982 and 1984, the reserves would fail to meet reserve criteria.

The nuclear plant will constitute an important part of the installed generation capability of each utility, as shown in the following:

Virgil C. Summer Nuclear Station
Capacity as a Percentage of Total Installed Capacity

	1979	1980	1981	1982	1983	1984	1985
SCE&G	15.8	15.8	15.8	15.8	15.8	14.0	14.0
SCPSA	17.6	17.6	17.6	15.2	15.2	13.3	13.3
Combined	16.4	16.4	16.4	15.6	15.6	13.7	13.7

1.1.3.3 Relation of Interconnections to Capacity

SCE&G maintains ten 115 kV and four 230 kV interconnections with neighboring utilities (see Section 1.1.1.3). Additional interconnections planned for service by 1978 include two 230 kV lines from the nuclear plant to SCPSA plus one 230 kV tie between SCPSA's Charity Switching Station and SCE&G's Williams plant in 1977. These ties ensure an additional measure of reliability for SCE&G and SCPSA and other nearby interconnected utilities by providing the means for sale or purchase of reserve capacity in response to need. SCE&G has two ties outside VACAR, both 115 kV lines to Georgia Power Company. These two ties permit the firm contract sale of 75 MW to Georgia and also aid in non-firm or emergency interchanges between the VACAR, Southern, and TVA subregions of SERC.

Because the Virgil C. Summer Nuclear Station is to be operated by SCE&G and is located geographically within the SCE&G system, the SCPSA portion (300 MW allocated) of power will be delivered into the SCPSA system over ties with other utilities in addition to the two direct lines between the Virgil C. Summer Nuclear Station bus and SCPSA. SCPSA has five 115 kV ties with SCE&G, and three additional 230 kV ties will be completed by 1978. There are three 230 kV and one 115 kV ties with CP&L now, and plans are for three additional 230 kV ties to be completed by 1979. In addition, there is a tie at the County Line Substation to the Clark Hill Hydro Plant owned by SEPA. This is an indirect tie to SCE&G, Duke, and Georgia Power Company since these companies are also tied to Clark Hill.

The existing and future interconnections of SCE&G and SCPSA with each other and with other utilities have little effect on capacity requirements. Their primary purpose, except for the nuclear plant and SEPA ties, is to increase reliability, reduce new transmission construction and provide a means to import power during emergency capacity outages.

The overlapping service areas of SCE&G, SCPSA, and CP&L and the numerous ties permit local generation to supply local loads despite differences between ownership of generation capacity and responsibility for load.

Based on the delays in construction and cancellation of new generation capacity in VACAR and SERC, neither SCE&G and SCPSA are confident of being able to obtain other than emergency power from nearby utilities in the future. Tables 1.1-4 through 1.1-7 present estimates of future reserve capacity for SERC and VACAR. The SERC estimates show that reserves will decline below 20 percent in 1985 and continue to decline to 13 percent in the following decade. VACAR estimates indicate a decline to 19 percent in the summer of 1980, with a continuing decline to 10.8 percent in the summer of 1985, and 11.5 percent in the winter of 1985-86. Thereafter, it is estimated that the reserve margin will vary between 8 and 13 percent over the following decade. These reserve margins are too low for any utility to be assured of emergency power on an on-call basis.

1.1.3.4 Reserve Margin Responsibility

Neither SCE&G nor SCPSA has any contractual reserve margin responsibility within the VACAR subregion of SERC.

1.1.4 EXTERNAL SUPPORTING STUDIES

Documents filed annually in response to FPC Order 383-3 are consolidated by SERC to present the "SERC Coordinated Bulk Power Supply Program." The most recent issue is that of April 1, 1976.

Data from that report are contained in Tables 1.1-4 through 1.1-9. Estimates are presented on capability and reserves for SERC and VACAR, pro-

jected peak loads for VACAR, and projected peak loads for the load responsible utilities in VACAR. SEPA, which has no load responsibility, is not included. As indicated in Section 1.1.3.3 above, reserve margins are expected to deteriorate severely for both SERC and VACAR.

A report prepared by SERC dated April 1, 1976 entitled "Coordinated Bulk Power Supply Program, 1976-1985," discusses area-wide generation capabilities, load forecasts, and criteria for reliability in system planning.

1.1.5 REFERENCES

1. U. S. Department of Commerce, "Area Economic Projections 1990," U. S. Department of Commerce, Bureau of Economic Analysis, U. S. Gov't. Printing Off. Stock No. 0324-00490

2. Division of Research and Statistical Services, South Carolina State Budget and Control Board, "Population News Release", May 26, 1976.

3. Southeastern Electric Reliability Council, "Criteria for Reliability in System Planning - 1976, Coordinated Bulk Power Supply Program 1976-1995", April 1, 1976.

4. Southeastern Electric Reliability Council, "Response to FPC Order 383-3 1976-1995," Southeastern Electric Reliability Council, 1976.

TABLE 1.1

SOUTH CAROLINA ELECTRIC &
PART 1: LOAD, CAPABILI
1965 - 19

LOAD (MW)	1965	1966	1967	1968	1969	1970	1971	1972
Territorial Peak Load	842	941	969	1212	1290	1455	1489	1646
Firm Sales Contracts	206	148	148	148	188	188	148	148
TOTAL LOAD RESPONSIBILITY	1048	1089	1117	1360	1478	1643	1637	1794
RESOURCES (MW)								
Generation Capability	1178	1176	1391	1423	1432	1875	2011	2456
Firm Purchases		45						91
TOTAL CAPABILITY	1178	1221	1391	1423	1432	1875	2011	2547
RESERVES								
System Reserves - MW	130	132	274	63	-46	232	374	753
Percent Reserves (1)	12.4	12.1	24.5	4.6	-3.1	14.1	22.8	42.0
Reserves Without VCSNS - MW (2)								
Percent Reserves								
Required 20 Percent - MW	210	218	223	272	296	329	327	359
Largest Unit - MW	130	130	215	215	215	385	385	385

(1) System reserves as percentage of total load responsibility.

(2) Assumes 900 MW capacity of Virgil C. Summer Nuclear Station is allocated:
turbines retired on SCE&G system in 1979.

Note: This statement does not include historical short-term purchases and sa
Generation capabilities are based on data in SCE&G Statistical Supplem
values reported in the FPC-12 documents which report values at year en

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GAS COMPANY DATA
TY, AND RESERVES
85

	Actual			Projected								
1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1762	1819	1931	2045	2193	2350	2547	2716	2896	3089	3295	3516	3752
148	248	148	148	148	148	73	73					
1910	2067	2079	2193	2341	2498	2620	2789	2896	3089	3295	3516	3752
2918	2883	2851	2852	3092	3332	3801	3801	3801	3801	3801	4301	4301
2918	2883	2851	2852	3092	3332	3801	3801	3801	3801	3801	4301	4301
1008	816	772	659	751	834	1181	1012	905	712	506	785	549
52.8	39.5	37.1	30.1	32.1	33.4	45.1	36.3	31.3	23.0	15.4	22.3	14.6
						581	412	305	112	-94	185	-51
						22.2	14.8	10.5	3.6	-2.9	5.3	-1.4
382	413	436	439	468	500	524	558	579	618	659	703	750
590	580	580	580	580	580	600	600	600	600	600	600	600

600 MW to SCE&G and 300 MW to SCPSA. Also assumes 131 MW of IC

les which would modify the actual reserve margins at time of system peak.
ents which report values at time of system peak. These may vary from
d.

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PART 2: GENER

Unit	Primary Energy Source	Use	Capacity Factor Range (1) (in percent)	1971
Urquhart #1,2 & 3	Coal	Base	50-72	260
McKeekin #1 & 2	Coal	Base	52-87	258
Canadys #1,2 & 3	Coal	Base	28-55	473
Wateree #1 & 2	Coal	Base	46-65	385
Williams #1	No. 6 Oil	Base	38-48	
Hagood	No. 6 Oil	Base		94
Parr	No. 2 Oil	Peaking		60
New Unit	Coal	Base		
Saluda	Hydro	Peaking		216
Parr	Hydro	Base (2)		15
Columbia	Hydro	Base (2)		10
Stevens Creek	Hydro	Base (2)		9
Neals Shoals	Hydro	Base (2)		4
Fairfield	Pumped Storage	Peaking		
Virgil C. Summer	Nuclear	Base	52-80 (3)	
Burton #1,2,3	No. 2 Oil	Peaking		33
Faber Place	No. 2 Oil	Peaking		11
Canadys	No. 2 Oil	Peaking		16
Hardeeville	No. 2 Oil	Peaking		16
Coit #1 & 2	No. 2 Oil	Peaking		40
Urquhart #1 & 2	No. 2 Oil	Peaking		36
Parr #1,2,3 & 4	No. 2 Oil	Peaking		70
Williams #1 & 2	No. 2 Oil	Peaking		
Mobile Unit				5
TOTAL INSTALLED GENERATION CAPACITY				2011

NEW CAPACITY S

ADDITIONS, RETIREM

Urquhart	Coal	Base	
McKeekin	Coal	Base	
Canadys	Coal	Base	
Wateree	Coal	Base	29+
Williams No. 1	No. 6 Oil	Base	
New Unit	Coal	Base	
Saluda	Hydro	Peaking	70+
Fairfield	Pumped Storage	Peaking	
Other	Hydro	Base	
V.C. Summer	Nuclear	Base	.5-
Other - Gas Turbine Units	No. 2 Oil	Peaking	37.4+
NET CHANGE			136+

(1) 1976 - 1983 major units only.
(2) Run of River.
(3) 52 percent based on 12 months, or 78 percent for 8 months of actual

ABLE 1.1-1 (Continued)

ATION CAPABILITY IN MW, 1971 - 1985

ANSTEC APERTURE CARD

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Actual				Projected									
1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
260	250	250	250	250	250	250	250	250	250	250	250	250	250
258	252	252	252	252	252	252	252	252	252	252	252	252	252
473	432	432	422	422	422	422	422	422	422	422	422	422	422
770	740	740	720	720	720	720	720	720	720	720	720	720	720
	590	580	580	580	580	580	580	580	580	580	580	580	580
94	94	94	94	94	94	94	94	94	94	94	94	94	94
60	60	41	41	41	41	41	41	41	41	41	41	41	41
												500	500
216	206	206	206	206	206	206	206	206	206	206	206	206	206
15	14	14	14	14	14	14	14	14	14	14	14	14	14
10	10	10	10	10	10	10	10	10	10	10	10	10	10
9	9	9	9	9	9	9	9	9	9	9	9	9	9
4	4	4	4	5	5	5	5	5	5	5	5	5	5
					240	480	480	480	480	480	480	480	480
							600	600	600	600	600	600	600
33	30	30	30	30	30	30							
11	10	9	9	9	9	9							
16	15	15	15	15	15	15							
16	15	15	15	15	15	15							
40	32	32	32	32	32	32							
36	30	30	30	30	30	30							
70	64	64	64	64	64	64	64	64	64	64	64	64	64
60	56	56	54	54	54	54	54	54	54	54	54	54	54
5	5												
2456	2918	2883	2851	2852	3092	3332	3801	3801	3801	3801	3801	4301	4301

SCHEDULE

ENTS, RERATINGS

	10-												
	6-												
	41-		10-										
385+	30-		20-										
	590+	10-											
												500+	
	10-												
					240+	240+							
	1-			1+									
							600+						
60+	30-	25-	2-				131-						
445+	462+	35-	32-	1+	240+	240+	469+					500+	

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service.

TABL

SOUTH CAROLINA PUBLIC
PART 1: LOAD, CAP
1965

LOAD - MW	1965	1966	1967	1968	1969	1970	1
Total, Territorial Peak Load	336	374	384	459	504	600	
RESOURCES - MW							
Generation Capability	242	412	412	412	412	732	
Firm Purchases	160	105	105	105	145	105	
Total Capability	402	517	517	517	557	837	
RESERVES							
System Reserves - MW	66	143	133	58	53	237	
Contract Reserve Purchases - MW							
Total Reserves - MW	66	143	133	58	53	237	
Percent Reserves (1)	19.6	38.2	34.6	12.6	10.5	39.5	
Reserves without VCSNS - MW (2)							
Percent Reserves							
Required 20 Percent - MW	67	75	77	92	101	120	
Largest Unit (2) MW	46	85	85	85	85	160	

(1) Total reserves as percentage of territorial load.

(2) Assumes 900 MW capacity of Virgil C. Summer Nuclear Station

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CARD

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Aperture Card

SERVICE AUTHORITY DATA
ABILITY, AND RESERVES
- 1985

	Actual				Projected									
971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
622	736	829	911	943	1064	1158	1256	1359	1466	1577	1692	1812	1937	2066
732	772	792	812	1092	1120	1400	1400	1700	1700	1700	1980	1980	2260	2260
105	105	105	205	105	105	105	105	105	105	105	105	105	105	105
837	877	897	1017	1197	1225	1505	1505	1805	1805	1805	2085	2085	2365	2365
215	141	68	106	254	161	347	249	446	339	228	393	273	428	299
			50	50	50	50	50	50	50	50	50	50	50	50
215	141	68	156	304	211	397	299	496	389	278	443	323	478	349
34.6	19.2	8.2	17.1	32.2	19.8	34.3	23.8	36.5	26.5	17.6	26.2	17.8	24.7	16.9
								196	89	-22	143	23	178	49
								14.4	6.1	-1.6	8.4	1.3	9.2	2.4
124	147	166	182	189	213	232	251	272	293	315	338	362	387	413
160	160	160	160	280	280	280	280	300	300	300	300	300	300	300

is allocated - 600 MW to SCE&G and 300 MW to SCPSA.

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TABL

PART 2: GENERATI

UNIT NAME	PRIMARY ENERGY SOURCE	USE	CAPACITY FACTOR RANGE (in percent)	1
Jeffries #1,2,3,4,&6	Hydro	Intermediate	40-80	
Spillway #1	Hydro	Base	60-70	
Jeffries Steam #1 & 2	No. 6 Oil	Peaking	3-20	
Jeffries Steam #3	Coal	Base	70-80	
Jeffries Steam #4	Coal	Base	70-80	
Grainger Steam #1 & 2	Coal	Intermediate	30-60	
Winyah Steam #1	Coal	Base	40-80	
Winyah Steam #2	Coal	Base	30-70	
Undetermined Unit #1	Coal	Intermediate	20-60	
Undetermined Unit #2	Coal	Intermediate	20-60	
One-Third Interest Virgil C. Summer Station	Nuclear	Base	52-80	
Myrtle Beach Gas Turbine Plant	No. 2 Oil	Peaking	2-6	
Hilton Head Gas Turbine Plant	No. 2 Oil	Peaking	2-3	
Total Installed Capability				

NEW CAPACITY

Myrtle Beach, 2 Gas Turbine Units	No. 2 Oil	Peaking	
Hilton Head, 1 Gas Turbine Unit	No. 2 Oil	Peaking	
Hilton Head, 1 Gas Turbine Unit	No. 2 Oil	Peaking	
Winyah, Unit No. 1	Coal	Base	
Myrtle Beach, 1 Gas Turbine Unit	No. 2 Oil	Peaking	
Winyah, No. 2	Coal	Base	
V.C. Summer Nuclear Station	Nuclear	Base	
Undetermined Site	Coal	Intermediate	
Undetermined Site	Coal	Intermediate	
TOTAL ADDITIONS			

ANSTEC APERTURE CARD

Also Available on Aperture Card

ON CAPABILITY IN MW, 1971 - 1985

	Actual				Projected									
971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
92	92	92	92	92	92	92	92	92	92	92	92	92	92	92
160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
				280	280	280	280	280	280	280	280	280	280	280
						280	280	280	280	280	280	280	280	280
											280	280	280	280
													280	280
								300	300	300	300	300	300	300
20	60	60	60	60	88	88	88	88	88	88	88	88	88	88
		20	40	40	40	40	40	40	40	40	40	40	40	40
732	772	792	812	1092	1120	1400	1400	1700	1700	1700	1980	1980	2260	2260

SCHEDULE

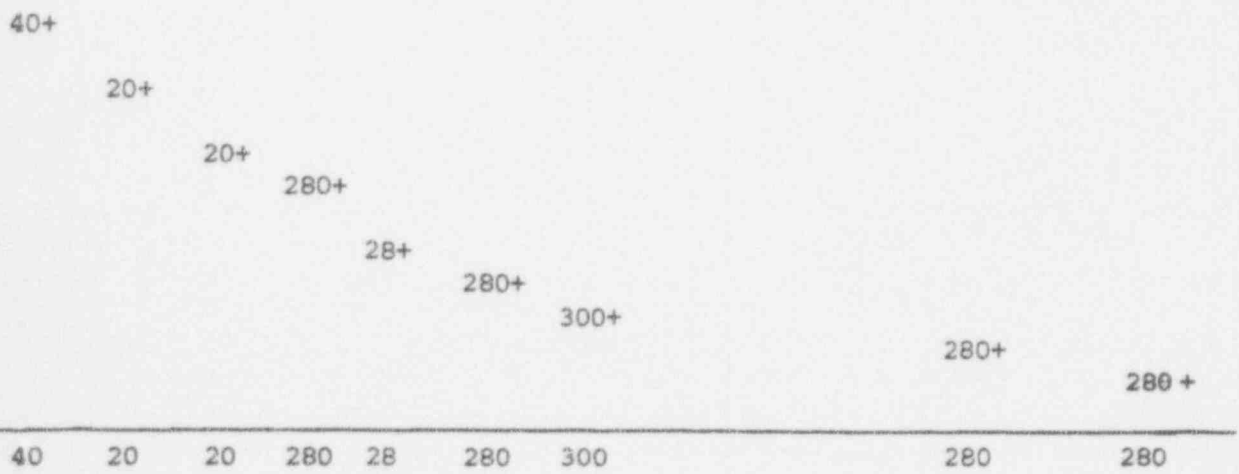

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TABLE 1.1-3

VIRGINIA-CAROLINAS SUBREGION
EXISTING INTERTIES WITH ADJOINING REGIONS

Utility	Adjoining System	Interconnection Location	Voltage (kV)
Carolina Power & Light Company	Appalachian Power Company	Walters-Kingsport	138
		Burnsville	138
		Roxboro-Danville	138
	Tennessee Valley Authority	Walters-Douglas	115
Duke Power Company	Appalachian Power Company	McGuire-Jacksons Ferry	500
		Dan River-Fieldale	138
	Georgia Power Company	Hartwell via SEPA[2]	230
		Greenwood-Clark Hill via SEPA[2]	115
		Tallulah Falls	115
South Carolina Electric & Gas Company	Georgia Power Company	Urquhart-Augusta[1]	115
		Clark Hill via SEPA[2]	115
South Carolina Public Service Authority	Georgia Power Company	Clark Hill via SEPA[2]	115
Virginia Electric and Power Company	Allegheny Power System	Mt. Storm-Pruntytown	500
		Doubs	500
	Appalachian Power Company	Dooms-Cloverdale	500
		Altavista	138
		Bremo	138
		Hinton	138
	Potomac Electric Power Co.	Pleasant View-Dickerson	230

[1] Double points of interconnection; [2] SEPA - Southeastern Power Administration

TABLE 1.1-4

SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL

PROJECTED CAPABILITY, MAINTENANCE, INTERCOUNCIL EXCHANGE, AND RESERVE IN MW

1976-1985

Season[1]	Peak Hour Load	Council Capability	Scheduled Maintenance	Power From[2] ECAR	MAIN	SPP	Net Capability	L.R.[3]	Reserve[4] MW	%L.R.[3]
76 S	79377	101251	996	+400	-260	-1500	98895	80740	19518	24.2
76-77 W	79109	106520	6114	-200	+260	+1500	101966	76914	22857	29.7
77 S	85994	108851	1369	+400	-260	-1500	106122	87319	20128	23.0
77-78 W	84829	114807	6738	-200	+260	+1500	109629	82634	24800	30.0
78 S	92485	117962	1220	+400	-260	-1500	115382	93810	22897	24.4
78-79 W	90932	122658	8210	-200	+260	+1500	116008	88737	25076	28.3
79 S	98902	126289	1132	+400	-260	-1500	123797	100226	24895	24.8
79-80 W	97108	128421	7826	-200	+260	+1100	121755	95312	24647	25.9
80 S	105637	130084	225	+300	-260	-1100	128799	106411	23162	21.8
80-81 W	103377	133048	8624	-300	+260	+1100	125484	101431	22107	21.8
81 S	112443	135891	25	+300	-260	-1100	134806	111967	22363	20.0
81-82 W	110250	142690	6492	-300	+260	+1100	137258	108054	27008	25.0
82 S	119552	145413	--	+300	-260	-1100	144353	119826	24801	20.7
82-83 W	117284	148547	5625	-300	+260	+1100	143982	114838	26698	23.2
83 S	126971	154602	--	+300	-260	-1100	153542	127045	26571	20.9
83-84 W	126139	157682	6032	-300	+260	+1100	152710	123493	26571	21.5
84 S	136290	165377	--	+300	-260	-1100	164317	136364	28027	20.6
84-85 W	135045	169451	6597	-300	+260	+1100	163914	132399	28869	21.8
85 S	144737	171774	--	+300	-260	-1100	170714	144811	25977	17.9
85-86 W	143123	175529	7291	-300	+260	+1100	169298	140477	26175	18.6

(1) S = Summer; W = Winter

(2) MAIN = Mid-America Interpool Network; SPP = Southwest Power Pool; ECAR = East Central Area Reliability Coordi Agreement

(3) L.R. = Load Responsibility - net system load plus firm sales and minus firm purchases.

(4) After scheduled maintenance. Source: Reference 3.

TABLE 1.1-5

SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL
LONG RANGE CAPACITY, PEAK LOAD, AND RESERVE

Year	Capacity (in MW)	Peak Load (in MW)	Reserve (in percent)
1986	182792	157119	16.3
1987	195012	166462	17.2
1988	206018	176253	16.9
1989	217168	186414	16.5
1990	228414	197183	15.8
1991	239364	208445	14.8
1992	252407	220286	14.6
1993	265631	232864	14.0
1994	280682	245893	14.2
1995	293793	259617	13.2

Source: Reference 3.

TABLE 1.1-6

VIRGINIA-CAROLINAS SUBREGION
PROJECTED CAPACITY, LOAD AND RESERVE IN MW
1976-1985

Season[1]	Installed Capacity	Interchanges ECAR	Interchanges Southern	Scheduled Outages	Resources Available For Peak	Total Peak Load	Load Reserve Not Req'd	L.R.[2]	Reserve MW	Reserve %L.R.[2]
76 S	32,315	+400	-75	25	32,615	25,280	187	25,093	7,335	29.2
76-77 W	32,909	-200	-75	1,830	30,804	24,401	225	24,176	6,403	26.5
77 S	34,539	+400	-75	896	33,968	27,098	225	26,873	6,870	25.6
77-78 W	37,511	-200	-75	1,750	35,486	26,297	225	26,072	9,189	35.2
78 S	36,857	+400	-75	896	36,286	29,255	225	29,030	7,031	24.2
78-79 W	38,787	-200	-75	2,875	35,637	28,338	225	28,113	7,299	26.0
79 S	39,129	+400		896	38,633	31,451	300	31,151	7,182	23.0
79-80 W	39,592	-200		2,010	37,382	30,537	300	30,237	6,845	22.6
80 S	39,718	+300		25	39,993	33,649	200	33,449	6,344	19.0
80-81 W	41,465	-300		1,577	39,588	32,790	200	32,590	6,798	20.8
81 S	41,778	+300		25	42,053	36,001	200	35,801	6,052	16.9
81-82 W	44,048	-300		1,239	42,509	35,173	200	34,973	7,336	21.0
82 S	43,884	+300			44,184	38,384	200	38,184	5,800	15.2
82-83 W	44,509	-300			44,209	37,678	200	37,478	6,531	17.4
83 S	45,581	+300			45,881	40,862	200	40,662	5,019	12.3
83-84 W	47,245	-300			46,945	41,315	200	41,115	5,630	13.7
84 S	49,153	+300			49,453	43,471	200	43,271	5,982	13.8
84-85 W	51,427	-300			51,127	44,108	200	43,908	7,019	16.0
85 S	50,892	+300			51,192	46,208	200	46,008	4,984	10.8
85-86 W	52,766	-300			52,466	47,056	200	46,856	5,410	11.5

(1) S = Summer; W = Winter

(2) L.R. = Load Responsibility - net system load plus firm sales and minus firm purchases.

Source: Reference 3.

TABLE 1.1-7

VIRGINIA-CAROLINAS SUBREGION[1]
PROJECTED LOAD, GENERATING CAPABILITY, AND RESERVE
1986 - 1995

Year	Total Load (in MW)	Generating Capability (in MW)	Reserve (in percent)
1986	49,055	54,875	11.9
1987	52,026	58,764	13.0
1988	55,134	62,185	12.8
1989	58,407	66,456	13.8
1990	61,988	69,756	12.5
1991	65,786	73,326	11.5
1992	69,771	76,796	10.1
1993	73,952	81,736	10.5
1994	78,337	86,456	10.4
1995	82,950	89,896	8.4

(1) It is anticipated that the capacity to be installed by members of the Virginia-Carolinas Subregion during the period 1986 through 1995 will be approximately 11.2 percent hydro, 56.9 percent nuclear, and 31.9 percent fossil-fueled.

Source: Reference 3.

TABLE 1.1-8

VIRGINIA-CAROLINAS SUBREGION
TOTAL PROJECTED PEAK LOADS (in MW)

Monthly - 1976-1977

Month	1976	1977
Jan	22,800	24,336
Feb	21,858	23,579
Mar	20,695	22,332
Apr	19,295	20,854
May	20,106	21,574
June	23,599	25,285
July	24,666	26,445
Aug	25,280	27,098
Sept	23,231	24,917
Oct	21,081	22,747
Nov	22,101	23,842
Dec	23,026	24,850

Seasonally - 1976-1985

Season	Load
S 76	25,280
W 76-77	24,401
S 77	27,098
W 77-78	26,297
S 78	29,255
W 78-79	28,338
S 79	31,451
W 79-80	30,537
S 80	33,649
W 80-81	32,790
S 81	36,001
W 81-82	35,173
S 82	38,384
W 82-83	37,678
S 83	40,862
W 83-84	41,315
S 84	43,471
W 84-85	44,108
S 85	46,208
W 85-86	47,056

Source: Reference 3.

TABLE 1.1-9

VIRGINIA-CAROLINAS SUBREGION
PROJECTED PEAK LOADS BY UTILITY IN MW
MONTHLY 1976 - 1977; SEASONAL 1976 - 1985

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
CP&L	5,001	4,694	4,317	4,101	4,263	4,964	5,255	5,396	5,062	4,446	4,683	4,889
Duke	8,867	8,673	8,323	7,673	7,759	8,774	9,128	9,263	8,679	8,298	8,944	9,171
SCE&G	1,654	1,520	1,475	1,470	1,770	1,920	1,970	2,035	1,970	1,580	1,530	1,640
SCPSA	817	869	768	739	842	969	1,043	1,064	1,020	857	824	946
Yadkin	160	162	162	162	162	162	160	162	160	160	160	160
VEPCO	6,301	5,940	5,650	5,150	5,310	6,810	7,110	7,360	6,340	5,740	5,960	6,220
1976	22,800	21,858	20,695	19,295	20,106	23,599	24,666	25,280	23,231	21,081	22,101	23,026
CP&L	5,396	5,077	4,669	4,435	4,611	5,369	5,683	5,836	5,475	4,809	5,065	5,288
Duke	9,566	9,357	8,979	8,317	8,410	9,511	9,894	10,041	9,408	8,936	9,631	9,876
SCE&G	1,783	1,639	1,590	1,585	1,899	2,060	2,113	2,183	2,113	1,695	1,640	1,757
SCPSA	881	936	834	797	914	1,045	1,135	1,158	1,111	927	896	1,029
Yadkin	200	200	200	200	200	200	200	200	200	200	200	200
VEPCO	6,510	6,370	6,060	5,520	5,540	7,100	7,420	7,680	6,610	6,180	6,410	6,700
1977	24,336	23,579	22,332	20,854	21,574	25,285	26,445	27,098	24,917	22,747	23,842	24,850

Summer	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
CP&L	5,396	5,836	6,330	6,821	7,342	7,904	8,492	9,086	9,707	10,363
Duke	9,263	10,041	10,949	11,764	12,615	13,504	14,431	15,399	16,411	17,467
SCE&G	2,035	2,183	2,350	2,547	2,716	2,896	3,089	3,295	3,516	3,752
SCPSA	1,064	1,158	1,256	1,359	1,466	1,577	1,692	1,812	1,937	2,066
Yadkin	162	200	200	200	200	200	200	200	200	200
VEPCO	7,360	7,680	8,170	8,760	9,310	9,920	10,480	11,070	11,700	12,360
	25,280	27,098	29,255	31,451	33,649	36,001	38,384	40,862	43,471	46,208

Winter	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
CP&L	5,396	5,836	6,330	6,821	7,342	7,904	8,492	9,086	9,707	10,363
Duke	9,566	10,301	11,073	11,883	12,731	13,621	14,553	16,552	17,621	18,740
SCE&G	1,783	1,921	2,068	2,255	2,414	2,586	2,769	2,966	3,178	3,406
SCPSA	946	1,029	1,117	1,208	1,303	1,402	1,504	1,611	1,722	1,837
Yadkin	200	200	200	200	200	200	200	200	200	200
VEPCO	6,510	7,010	7,550	8,170	8,800	9,460	10,160	10,900	11,680	12,510
	24,401	26,297	28,338	30,537	32,790	35,173	37,678	41,315	44,108	47,056

Source: Reference 4.

TABLE 1.1-10

PEAK LOADS AND ANNUAL ENERGY
SOUTH CAROLINA ELECTRIC & GAS
1965-1986

YEAR	ANNUAL PEAK LOADS: BASIC TERRITORIAL LOAD (MW)	ANNUAL INCREASE (%)	DUPONT[1] MW	TOTAL TERRITORIAL (MW)	ANNUAL ENERGY REQUIREMENTS: GWH[2]	ANNUAL INCREASE (%)
1965	771	12.1	71	842	4,481.0	10.1
66	867	12.4	74	941	4,933.6	6.9
67	894	3.1	75	969	5,274.3	13.0
68	1144	28.0	68	1212	5,959.0	10.4
69	1224	7.0	66	1290	6,581.6	9.0
70	1385	13.2	70	1455	7,175.3	7.2
71	1419	2.4	70	1489	7,693.4	8.6
72	1576	11.1	70	1646	8,358.4	10.0
73	1688	7.1	74	1762	9,190.1	0.5
74	1749	3.6	70	1819	9,232.6	2.8
75	1861	6.4	70	1931	9,508.4[3]	6.7
76	1965	5.6	80	2045	10,130.7	8.0
77	2103	7.0	90	2193	10,940.5	5.3
78	2250	7.0	100	2350	11,518.1	3.5
79	2407	7.0	140	2547	11,924.9	3.1
80	2576	7.0	140	2716	12,295.6	3.7
81	2756	7.0	140	2896	12,756.0	4.2
82	2949	7.0	140	3089	13,294.6	4.7
83	3155	7.0	140	3295	13,920.0	5.2
84	3376	7.0	140	3516	14,642.3	5.7
85	3612	7.0	140	3752	15,473.6	5.7
86	3865	7.0	140	4005	16,354.8	5.7
87	4136	7.0	140	4276	17,288.9	5.7
88	4425	7.0	140	4565	18,279.0	5.7
89	4735	7.0	140	4875	19,328.5	

(1) These values did not necessarily occur at the time of basic territorial peak.

(2) 1965-1975 values from FPC 12 reports; 1976-1989 values from 1/1/75 SCE&G energy forecast.

(3) Adjusted FPC 12 value to reflect borderline receipts.

TABLE 1.1-11

PEAK LOADS AND ANNUAL ENERGY
SCPSA
1965-1986

YEAR	ANNUAL PEAK LOADS		ANNUAL ENERGY REQUIREMENTS	
	TERRITORIAL LOAD (MW)	ANNUAL INCREASE (%)	GWH	ANNUAL INCREASE (%)
1965	336		1,955.4	
66	374	11.3	2,069.2	5.8
67	384	2.7	2,247.1	8.6
68	459	19.5	2,557.3	13.8
69	504	9.8	2,814.0	10.0
70	600	19.0	3,217.5	14.3
71	622	3.7	3,430.2	6.6
72	736	18.3	3,834.3	11.8
73	829	12.6	4,351.8	13.5
74	911	9.9	4,572.6	5.1
75	943	3.5	4,692.3	2.6
76	1065	12.8	5,372.4	14.5
77	1158	8.8	5,822.2	8.4
78	1256	8.5	6,294.5	8.1
79	1359	8.2	6,789.3	7.9
80	1466	7.9	7,306.5	7.6
81	1577	7.6	7,846.1	7.4
82	1692	7.3	8,408.2	7.2
83	1812	7.1	8,992.8	7.0
84	1937	6.9	9,599.7	6.7
85	2066	6.7	10,229.2	6.6
86	2199	6.4	10,881.0	6.4

TABLE 1.1-12

COMPARISON OF ACTUAL AND
FORECAST TOTAL TERRITORIAL PEAK LOADS
SOUTH CAROLINA ELECTRIC & GAS COMPANY

Actual Peak (MW)

	1972	1973	1974	1975	1976
January		1354	1330	1394	1654
February		1328	1360	1381	1513
March		1197	1281	1377	1351
April		1196	1331	1314	1394
May		1471	1703	1656	
June		1689	1714	1807	
July		1762	1819	1739	
August		1744	1801	1931	
September		1689	1685	1891	
October	1250	1535	1274	1415	
November	1250	1228	1336	1393	
December	1288	1342	1440	1549	

Forecast Peak (MW)

January		1470	1375	1394	1654
February		1320	1371	1451	1520
March		1265	1239	1376	1475
April		1210	1239	1425	1470
May		1370	1400	1674	
June		1850	1750	1832	
July		1820	1859	1938	
August		1910	1950	1957	
September		1699	1834	1812	
October	1310	1435	1424	1485	
November	1330	1440	1424	1485	
December	1400	1550	1448	1542	

TABLE 1.1-13

COMPARISON OF ACTUAL AND
FORECAST TOTAL TERRITORIAL SALES
SOUTH CAROLINA ELECTRIC & GAS COMPANY

Actual Sales (MWH)

	1972	1973	1974	1975	1976
January		739,060	712,220	733,686	885,990
February		668,743	664,028	651,211	747,500
March		677,455	691,747	695,475	763,449
April		652,571	681,167	670,021	736,922
May		730,217	817,931	798,090	
June		839,083	837,564	862,429	
July		942,293	922,503	880,999	
August		931,961	928,576	1,001,509	
September		855,876	801,980	854,246	
October	663,379	744,419	710,017	777,897	
November	666,702	675,456	704,949	747,127	
December	683,249	725.134	744,162	827,299	

Forecast Sales (MWH)

January		721,600	802,600	734,800	830,800
February		673,500	765,000	738,800	727,300
March		689,900	745,100	727,100	767,900
April		652,600	722,000	720,400	740,800
May		693,000	775,200	769,300	
June		789,700	880,000	872,300	
July		938,100	995,800	958,600	
August		975,000	1,014,200	959,900	
September		850,000	923,500	895,500	
October	697,200	961,700	818,500	839,100	
November	662,800	687,200	784,800	763,300	
December	704,200	729,700	813,200	788,200	

TABLE 1.1-14

COMPARISON OF ACTUAL SCPSA MONTHLY DEMAND AND ENERGY USED WITH PROJECTIONS

	ACTUAL		PROJECTED IN WINTER 1971-72	
	Energy (MWH)	Demand (MW)	Energy (MWH)	Demand (MW)
1972 - Oct.	300852	560	295100	537
Nov.	317829	612	305100	616
Dec.	335132	662	329200	608
1973 - Jan.	363881	680	352000	676
Feb.	334000	699	315200	648
Mar.	323011	589	325500	592
Apr.	308664	575	292500	544
May	328983	642	307900	578
June	384856	717	375200	743
July	456482	809	416800	753
Aug.	440377	829	401400	763
Sept.	393278	803	348400	665
Oct.	340084	692	322400	588
Nov.	318809	628	335900	683
Dec.	359365	697	362800	671
1974 - Jan.	324854	659	389700	749
Feb.	331049	712	348500	720
Mar.	338249	651	357800	654
Apr.	330208	617	320600	594
May	370105	752	334800	631
June	409548	871	414500	826
July	479794	911	461800	835
Aug.	462001	867	442300	845
Sept.	390769	796	385300	731
Oct.	357667	694	351200	642
Nov.	369287	721	369800	757
Dec.	409046	767	399700	741
1975 - Jan.	391766	753	431400	828
Feb.	345768	760	385300	800
Mar.	358977	775	395500	721
Apr.	314511	666	350200	648
May	370918	780	364000	688
June	420823	830	460100	918
July	464637	890	511700	925
Aug.	507803	943	487300	935
Sept.	392559	890	424900	804
Oct.	351080	652	384700	702
Nov.	355414	713	406200	840
Dec.	418028	875	440400	817
1976 - Jan.	465505	900	477600	918
Feb.	372744	790	426000	888
Mar.	376885	738	436000	796
Apr.	370314	688	382500	708

TABLE 1.1-15

RESPONSE TO FPC ORDER 496

RESPONDING UTILITY*/ SOUTH CAROLINA ELECTRIC & GAS COMPANY

Appendix 1
Sheet 1 of 3
FPC Form No. 19

Line No.			1973 Dec.	1974 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)x1000															
1			831	774	756	697	823	942	1009	1105	1120	1063	947	916	937	11920
	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)	Line 1 only														
2			5000	10000	10000	5000	5000	9700	9700	19000	19000	10000	8700	5000	5000	121100
	III. Projected monthly reductions that may result from the following conservation procedures:															
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities.	a.	250	250	250	200	200	200	200	300	300	300	300	400	450	3600
4		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2. Curtailment of non-essential generating station auxiliaries at power plants.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3. Appeals to large commercial and industrial customers to curtail non-essential use.	a.	10500	11500	11500	11400	11400	11300	11300	20000	15300	14300	14300	14400	14500	171700
8		b.	1500	2500	2500	1500	1500	2000	2000	15000	15000	6000	2700	1500	1500	55200

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines (MWH).

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 20 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse foreseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

TABLE 1.1-15 (Continued)

Line No.				1973 Dec.	1974 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
9	4.	Appeals to the public to	a.	22500	23100	22900	19600	20700	23700	36600	38400	40500	34800	27400	28600	28700	367500
10		curtail non-essential use	b.	2500	5000	5000	2500	2500	5700	5700	20000	20000	5900	4000	2500	2500	83800
11	5.	Interruption of contrac-	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		tually interruptible load.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	6.	Reduction of system	a.	6300	6500	6400	5700	6000	6800	7600	8700	8900	8200	7000	6700	6900	91700
14		voltage.	b.	1000	2500	2500	1000	1000	2000	2000	3100	3100	3000	2000	1000	1000	25200
15	7.	Reduction in use of elec-	a.	2000	2000	2000	1900	1800	2800	1800	1800	1800	1800	1850	1900	2000	25450
16		tricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	8.	Reduction of hours of	a.	10000	10000	10000	7300	9000	9500	7500	7500	7500	7500	8000	10000	10000	113800
18		operation of commercial centers.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	9.	Reduction of use by in-	a.	11500	10500	10000	10000	10000	10000	10000	10000	13000	14000	14000	14000	14000	151000
20		dustrial customers whose output is not essential to the public health and safety.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	10.	Elimination of outdoor	a.	50	50	50	50	50	0	0	0	0	25	50	50	50	425
22		nighttime sporting events.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	11.	Elimination of outdoor	a.	1500	1500	1500	1500	1400	1400	1300	1300	1300	1300	1400	1500	1500	18400
24		commercial advertising display.	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	12.	Other (identify).	a.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26			b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTE: It is recognized the savings envisioned by use of Item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

TABLE 1.1-15 (Continued)

Line No.			1973 Dec.	1974 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-*	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	fired generation within	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	the utility's system.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			IC turbines are used only for peaking and emergency conditions.													
4	2. Engaging in inter-company	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	and inter-area transfers	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	in order to maximize the use of coal-fired capacity.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Interreliability Agreements implement this plan, depending upon the availability of coal.													
7	3. Modifying operating re-	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	serve policy to permit com-	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	bustion turbines and internal combustion engines to be considered as reserve when shut down.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			This is our present operating practice.													
10	4. Other (identify).	a.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12		c.	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*Forecast of No. 6 oil use has been reduced to optimize coal generation

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

TABLE 1.1-16

RESPONSE TO FPC ORDER 496

RESPONDING UTILITY*/ SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

Appendix 1
Sheet 1 of 3
FPC Form No. 19

Line No.			1973 Dec.	1974 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	1. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)		339494	359064	339671	336390	304907	284614	366118	396682	396335	338068	312645	332564	350690	4117749
2	11. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)		0	0	0	0	0	0	0	2000	3000	0	0	0	0	0
	111. Projected monthly reductions that may result from the following conservation procedures:		90	95	72	73	62	66	65	67	70	65	68	69	83	855
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities.	a.														
4		b.	0	0	0	0	0	0	0	0	00	0	0	0	0	0
5	2. Curtailment of non-essential generating station auxiliaries at power plants.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3. Appeals to large commercial and industrial customers to curtail non-essential use.	a.	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
8		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

*12 months-Calendar Year 1974

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse foreseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the rpeorting utility. The Emergency Report Form shall be filed in duplicate.

EMERGENCY ACTION FOR CONSERVATION OF PETROLEUM AND NATURAL GAS
NOTE: The Authority Wholesales energy to 15 Coops and 2 municipalities.

TABLE 1.1-16 (Continued)

Line No.				1973	1974											
				Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
9	4.	Appeals to the public to curtail non-essential use	a.	2483	2928	2948	2421	2167	2424	3002	4374	4801	4578	3314	2021	2483	37461
10			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	5.	Interruption of contractually interruptible load.	a.	2500	208	208	208	208	208	208	208	208	208	208	208	212	2500
12			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	6.	Reduction of system voltage.	a.	827.8	976.1	982.7	806.9	722.4	808.8	1000.8	1457.9	1600.4	1526.0	1104.7	673.7	827.8	12488.2
14			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	7.	Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	2417	2417	2417	2417	2417	2417	2417	2417	2417	2417	2417	2417	2417	29004
16			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	8.	Reduction of hours of operation of commercial centers.	a.	138	163	164	135	121	135	167	243	267	255	184	113	138	2085
18			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	9.	Reduction of use by industrial customers whose output is not essential to the public health and safety.	a.	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	120000
20			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	10.	Elimination of outdoor nighttime sporting events.	a.	13.6	12.0	17.2	8.5	12.0	28.9	21.2	20.5	21.9	22.0	22.0	28.2	13.6	228.0
22			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	11.	Elimination of outdoor commercial advertising display.	a.	23	23.8	23.8	22.7	22.7	21.6	21.6	21.6	21.6	22.7	22.7	22.7	23.8	271.3
24			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	12.	Other (identify).	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26			b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: It is recognized the savings envisioned by use of Item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

TABLE 1.1-16 (Continued)

Line No.			1973 Dec.	1974 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:		0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1. Optimizing use of coal-	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	fired generation within	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	the utility's system.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2. Engaging in inter-company	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	and inter-area transfers	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	in order to maximize the use of coal-fired capacity.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3. Modifying operating re-	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	serve policy to permit c	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	combustion turbines and internal combustion engines to be considered as reserve when shut down.	c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4. Other (identify).	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

NOTE: The Authority already uses coal fired units and hydro to the maximum extent possible due to cost.

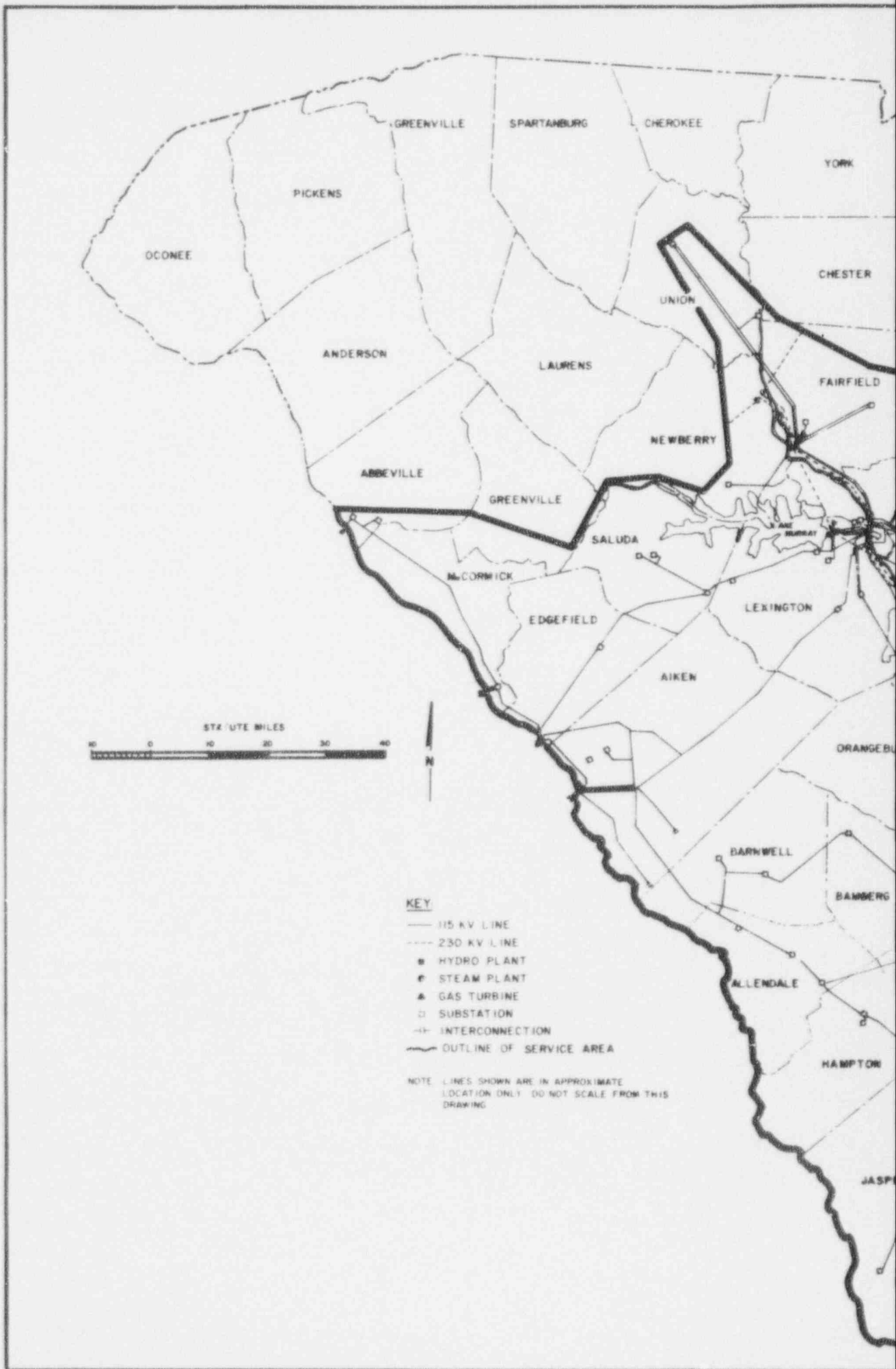
TABLE 1.1-17

SCE&G SYSTEM OPERATIONS
PEAK HOUR CONDITIONS (IN MW)
1971-1975

	1971	1972	1973	1974	1975
Actual System Generation	1706	2047	2315	2009	2067
Purchases - Firm Contract		47(1)			
Short-Term or Emergency	240	213	93	55	
Sales - Firm Contract	-148	-148	-149(2)	-249(2)	-148
Short-Term or Emergency	-304	-517	-492		
Inadvertent Exchanges	- 5	4	- 5	4	12
Territorial Peak Load	1489	1646	1762	1819	1931

(1) The full contract of 91 MW was not in affect at the time of system peak.

(2) These values show up in Table 1.1-1 as 148 and 248, respectively. The CP&L contract allows for a 52 MW sale during certain months and 53 MW for other months throughout each year. In 1973 and 1974, CP&L was purchasing 53 MW at the hour of system peak.


GREENVILLE
SPARTANBURG
CHEROKEE
YORK
PICKENS
OCONEE
CHESTER
UNION
ANDERSON
LAURENS
FAIRFIELD
NEWBERRY
ABBEVILLE
GREENVILLE
SALUDA
McCORMICK
EDGEFIELD
LEXINGTON
AIKEN
STATUTE MILES
40 0 40 20 30 40
N
BARNWELL
BAMBERG
ALLENDALE
HAMPTON
KEY
115 KV LINE
230 KV LINE
HYDRO PLANT
STEAM PLANT
GAS TURBINE
SUBSTATION
INTERCONNECTION
OUTLINE OF SERVICE AREA
NOTE LINES SHOWN ARE IN APPROXIMATE LOCATION ONLY DO NOT SCALE FROM THIS DRAWING

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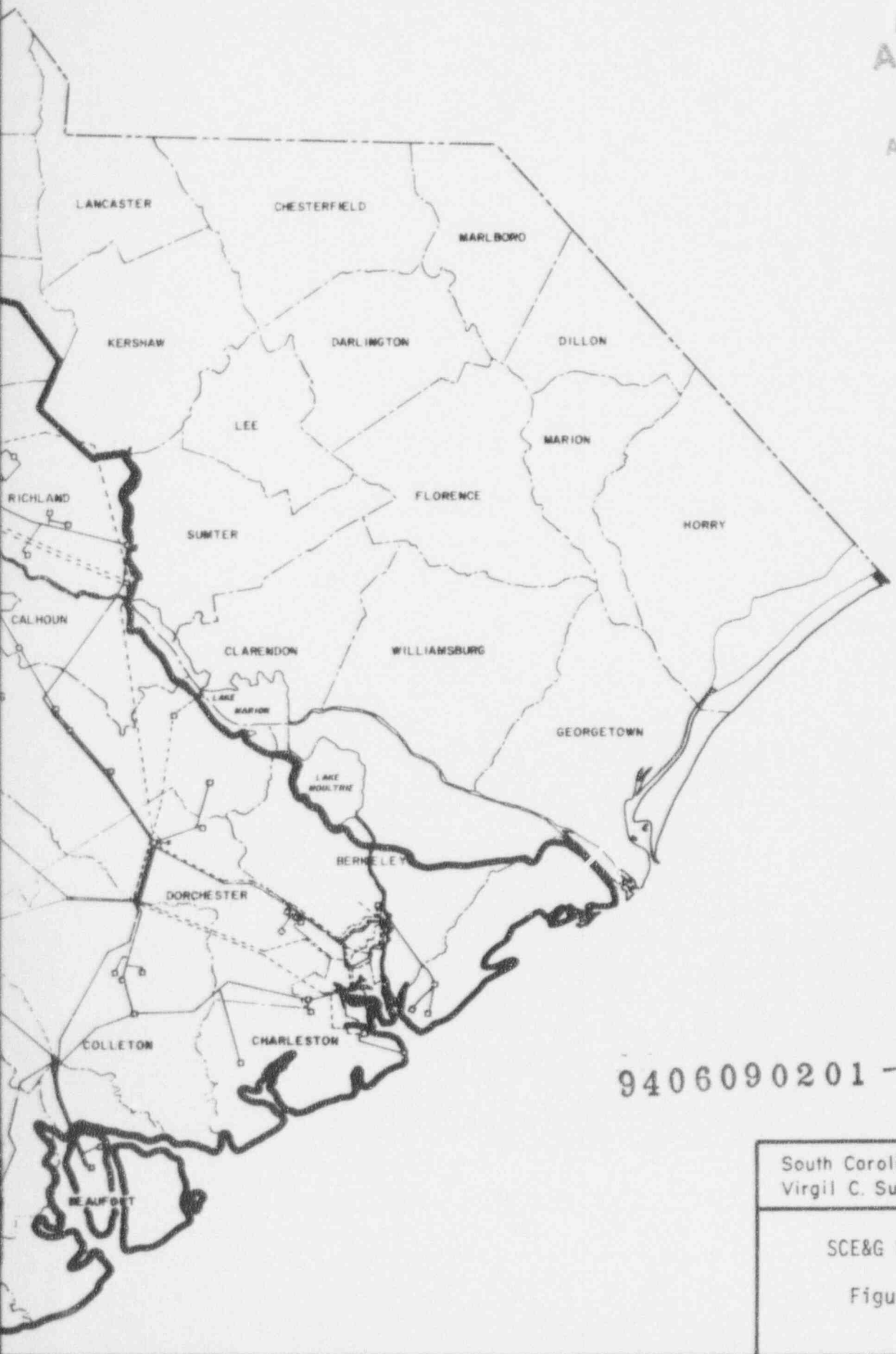

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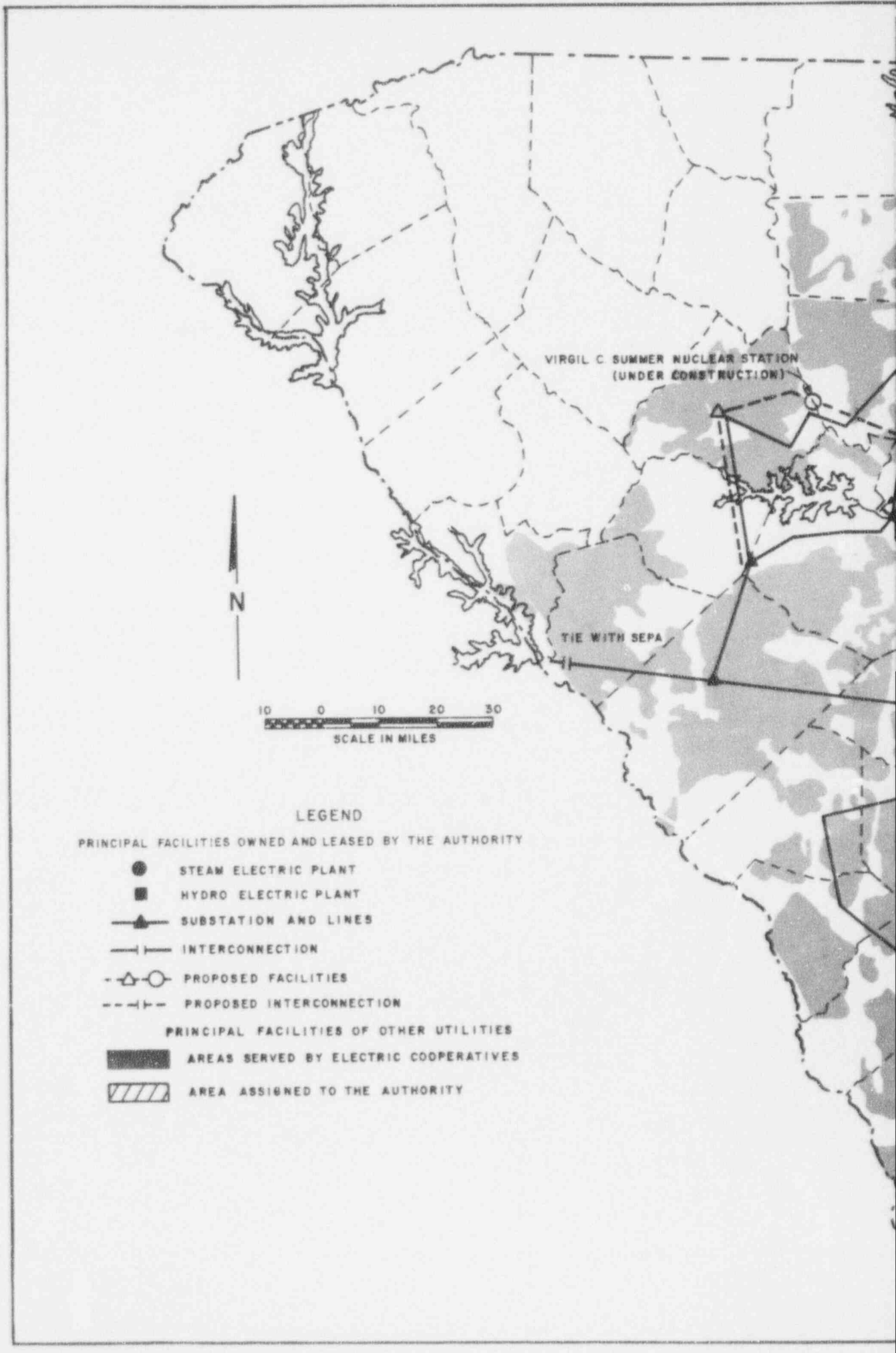
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

SCE&G Service Area

Figure 1.1-1


VIRGIL C. SUMMER NUCLEAR STATION
(UNDER CONSTRUCTION)
TIE WITH SEPA
N
10 0 10 20 30
SCALE IN MILES
LEGEND
PRINCIPAL FACILITIES OWNED AND LEASED BY THE AUTHORITY
STEAM ELECTRIC PLANT
HYDRO ELECTRIC PLANT
SUBSTATION AND LINES
INTERCONNECTION
PROPOSED FACILITIES
PROPOSED INTERCONNECTION
PRINCIPAL FACILITIES OF OTHER UTILITIES
AREAS SERVED BY ELECTRIC COOPERATIVES
AREA ASSIGNED TO THE AUTHORITY

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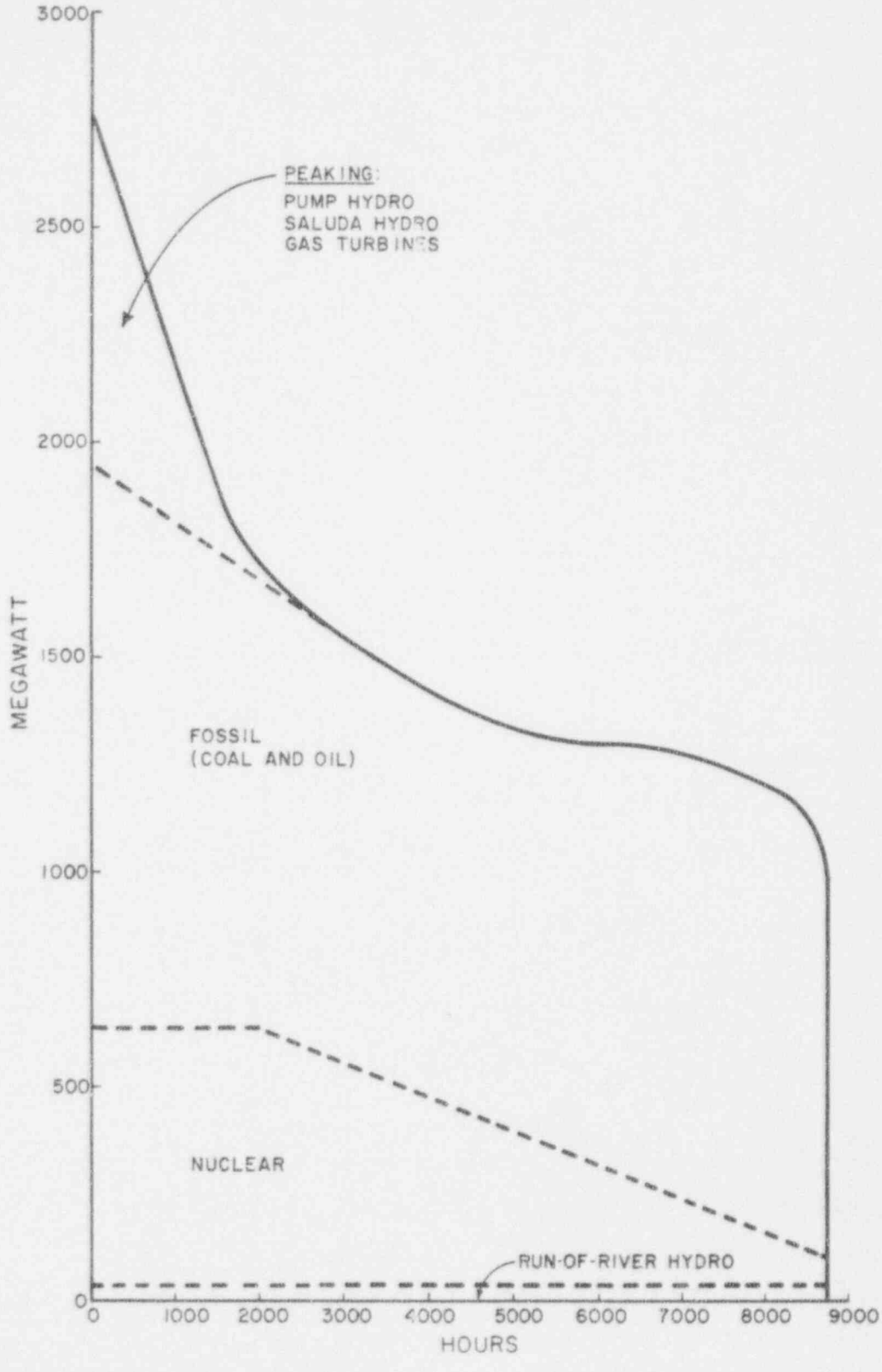
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

SCPSA Service Area

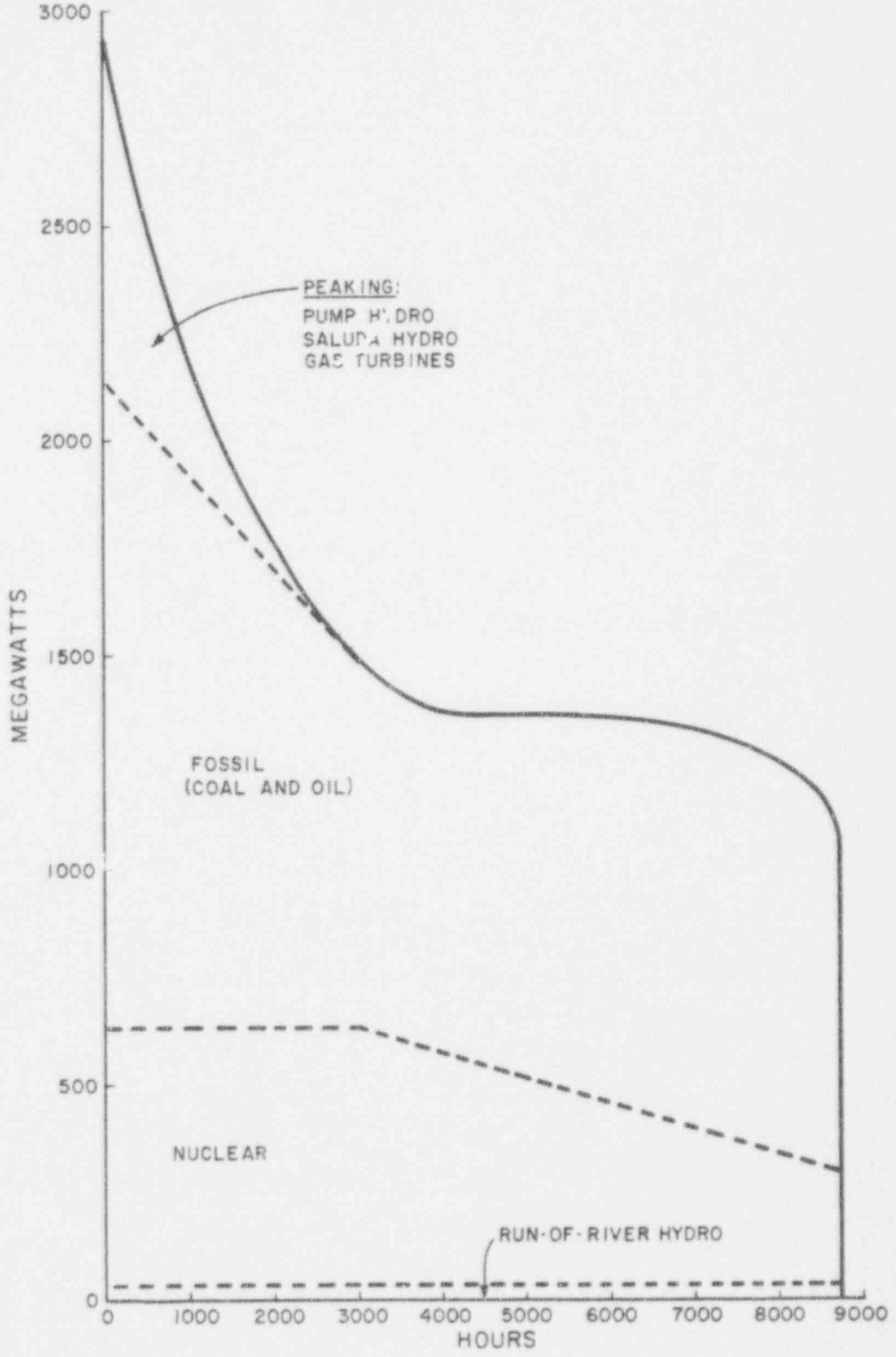
Figure 1.1-2



South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load Duration Curve
SCE&G 1980

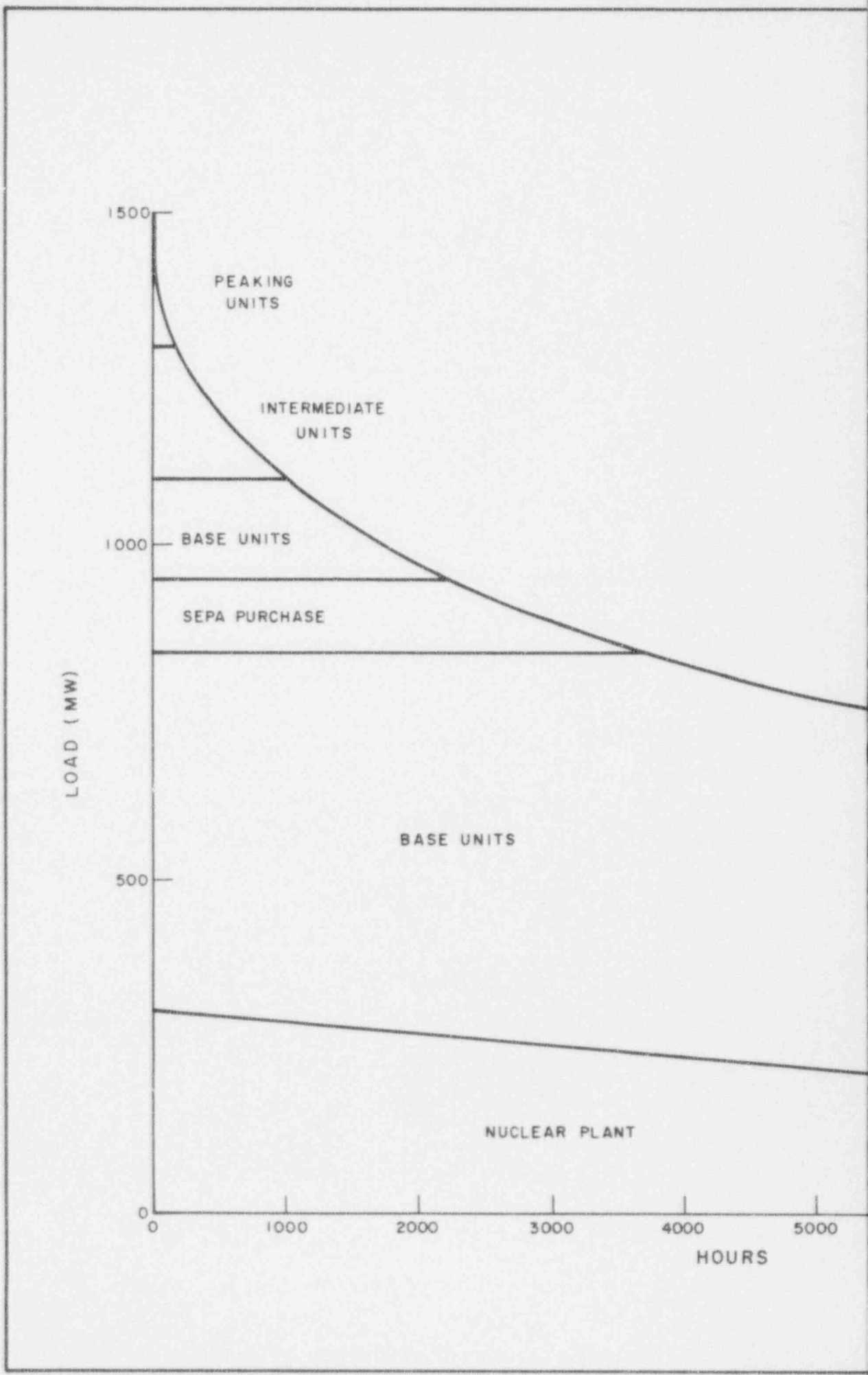
Figure 1.1-3



South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load Duration Curve
SCE&G 1981

Figure 1.1-4


1500
PEAKING
UNITS
INTERMEDIATE
UNITS
1000
BASE UNITS
SEPA PURCHASE
LOAD (MW)
BASE UNITS
500
NUCLEAR PLANT
0
0
1000
2000
3000
4000
5000
HOURS

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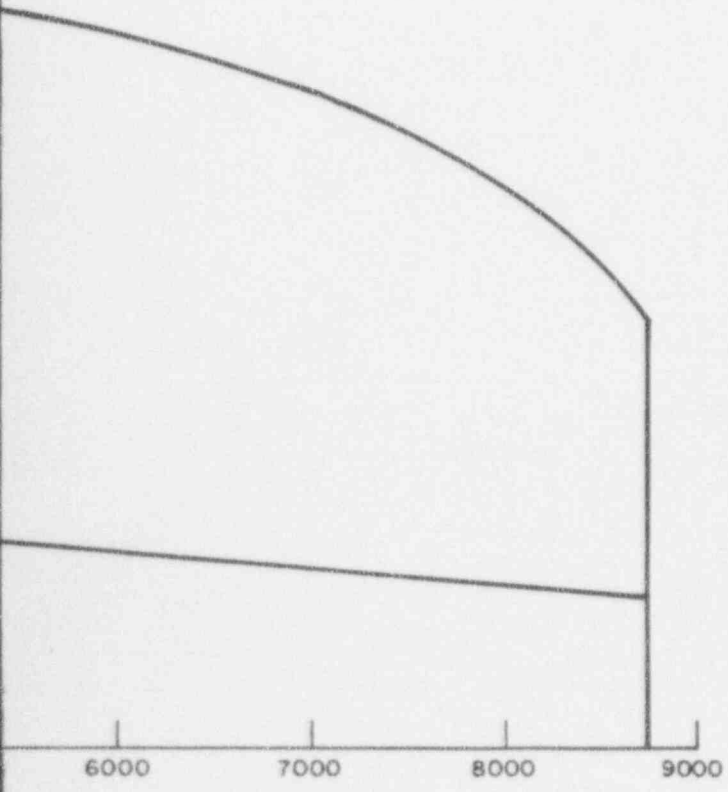
POINTS PLOTTED

MW	HR
1466	1
1266	262
1066	1154
966	2025
866	3219
766	5117
666	7184
455	8760



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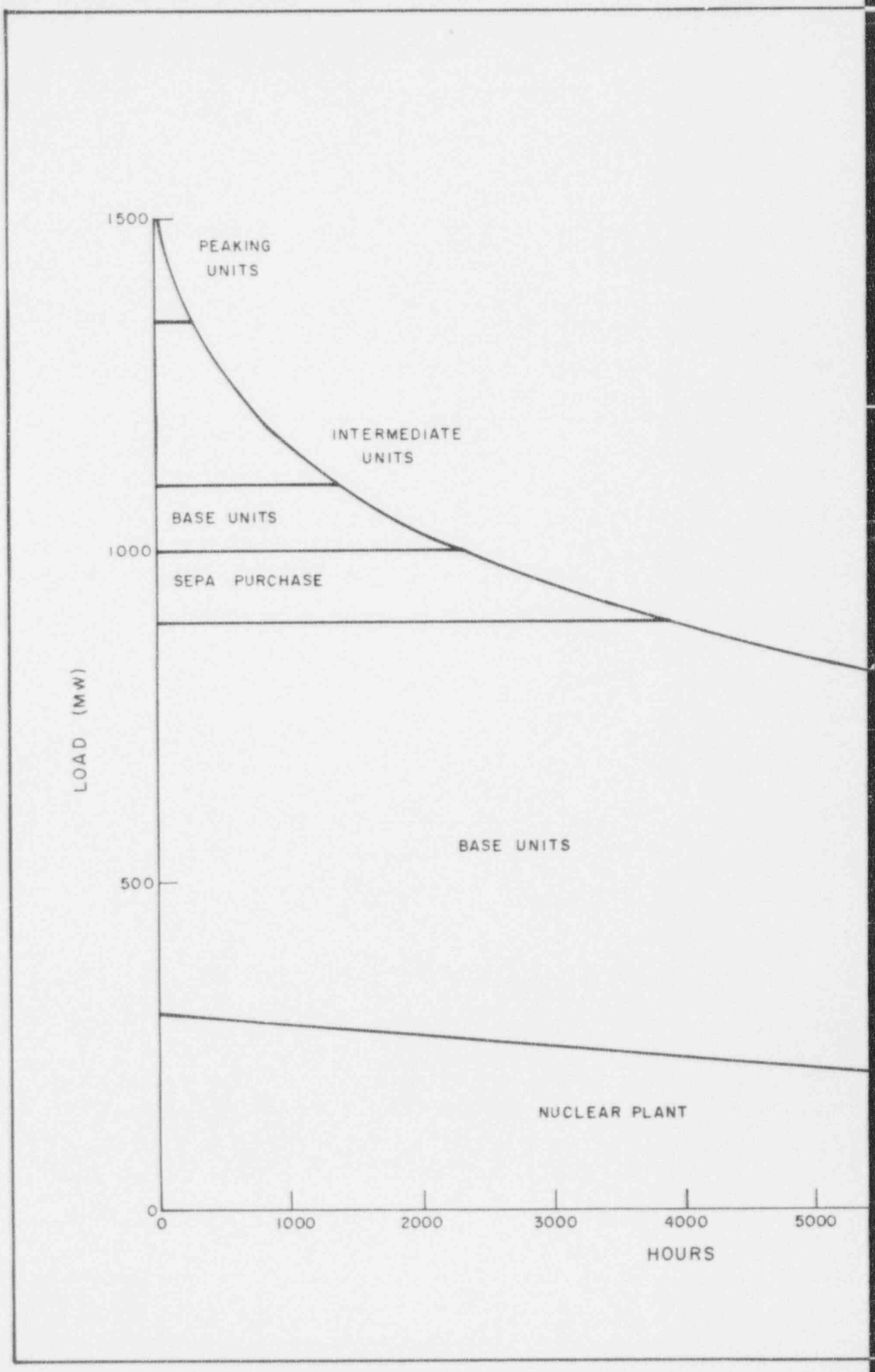
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load Duration Curve
SCPSA 1980

Figure 1.1-5


1500
PEAKING
UNITS
INTERMEDIATE
UNITS
BASE UNITS
1000
SEPA PURCHASE
LOAD (MW)
BASE UNITS
500
NUCLEAR PLANT
0
0
1000
2000
3000
4000
5000
HOURS

ANSTEC
APERTURE
CARD

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POINTS PLOTTED

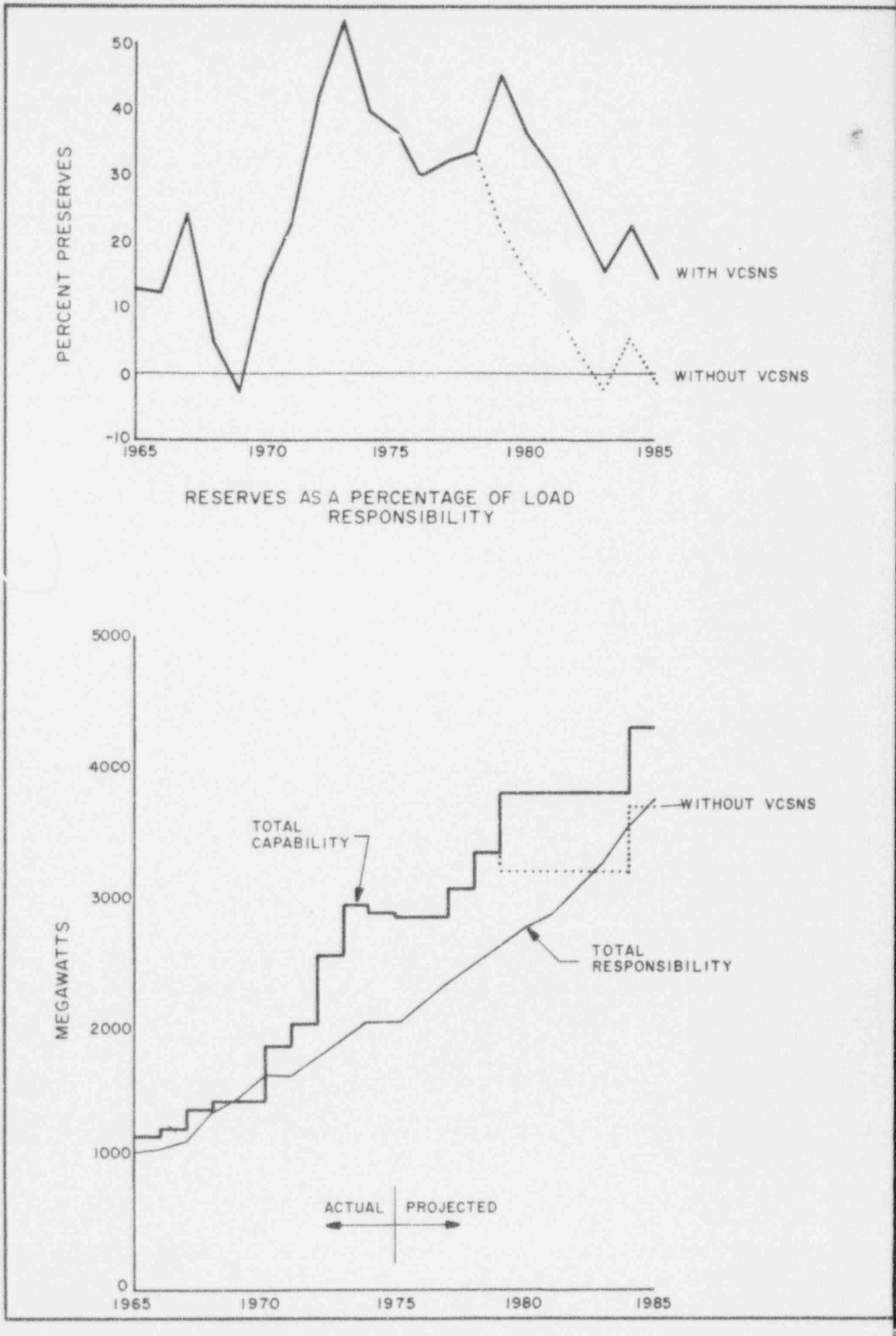
MW	HR
1577	1
1362	262
1147	1154
1039	2025
932	5219
824	5117
716	7184
479	8760

9406090201 - 08

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load Duration Curve
SCPSA 1981

Figure 1.1-6


50
40
30
20
10
0
-10
PERCENT PRESERVES
1965
1970
1975
1980
1985
WITH VCSNS
WITHOUT VCSNS
RESERVES AS A PERCENTAGE OF LOAD RESPONSIBILITY
5000
4000
3000
2000
1000
0
MEGAWATTS
TOTAL CAPABILITY
WITHOUT VCSNS
TOTAL RESPONSIBILITY
ACTUAL
PROJECTED
1965
1970
1975
1980
1985

Year	Total Capability With VCSNS	Total Capability W/O VCSNS	Total Load Responsibility	Reserves-% With VCSNS	Reserves-% W/O VCSNS
1965	1178		1048	12.4	
1966	1221		1089	12.1	
1967	1391		1117	24.5	
1968	1423		1360	4.6	
1969	1432		1478	- 3.1	
1970	1895		1643	14.1	
1971	2011		1637	22.8	
1972	2547		1794	42.0	
1973	2918		1910	52.8	
1974	2883		2067	39.5	
1975	2851		2079	37.1	
1976	2852		2193	30.1	
1977	3092		2341	32.1	
1978	3332		2498	33.4	
1979	3801	3201	2620	45.1	22.2
1980	3801	3201	2789	36.3	14.8
1981	3801	3201	2896	31.3	10.5
1982	3801	3201	3089	23.0	3.6
1983	3801	3201	3295	15.4	- 2.9
1984	4301	3701	3516	22.3	5.3
1985	4301	3701	3752	14.6	- 1.4

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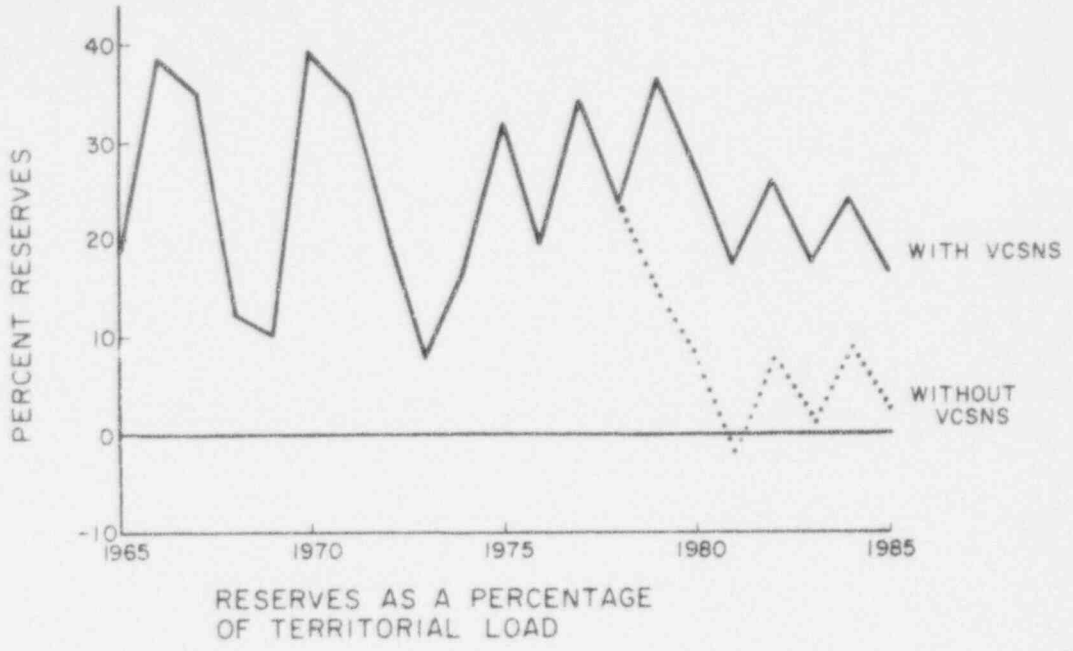
Note: VCSNS = Virgil C. Summer Nuclear Station

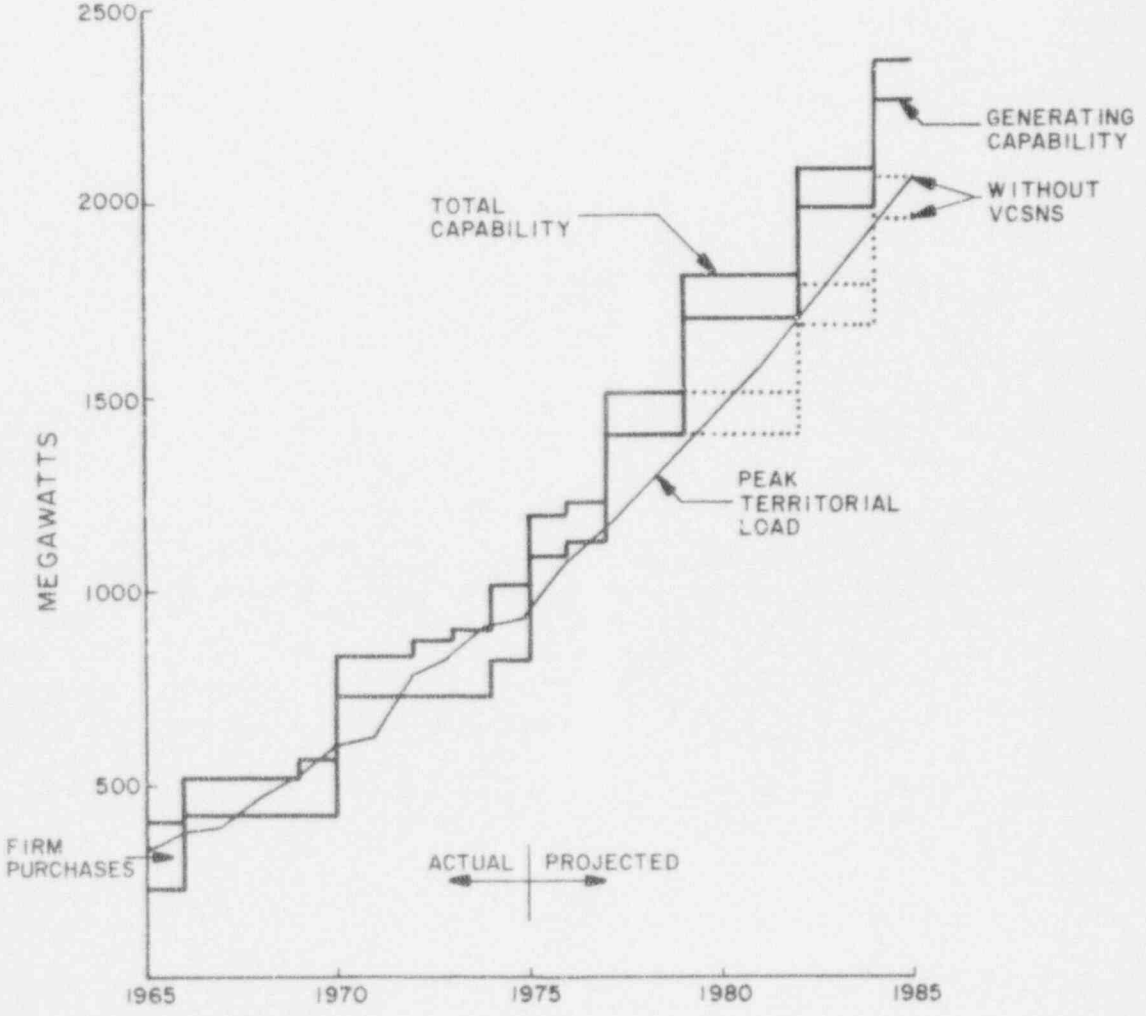
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load, Capability and Reserves
SCE&G
1965 - 1985

Figure 1.1-7



RESERVES AS A PERCENTAGE OF TERRITORIAL LOAD



Year	Total Capability With VCSNS	Total Capability W/O VCSNS	Generating Capability With VCSNS	Generating Capability W/O VCSNS	Territorial Load	Reserves With VCSNS	Reserves W/O VCSNS
1965	402		242		336	19.6	
1966	517		412		374	38.2	
1967	517		412		384	34.6	
1968	517		412		459	12.6	
1969	557		412		504	10.5	
1970	837		732		600	39.5	
1971	837		732		622	34.6	
1972	877		772		736	19.2	
1973	897		792		829	8.2	
1974	1017		812		911	17.1	
1975	1197		1092		943	32.2	
1976	1225		1120		1064	19.8	
1977	1505		1400		1158	34.3	
1978	1505		1400		1256	23.8	
1979	1805	1505	1700	1400	1359	36.5	14.4
1980	1805	1505	1700	1400	1466	26.5	6.1
1981	1805	1505	1700	1400	1577	17.6	- 1.6
1982	2085	1785	1980	1680	1692	26.2	8.4
1983	2085	1785	1980	1680	1812	17.8	1.3
1984	2365	2065	2260	1960	1937	24.7	9.2
1985	2365	2065	2260	1960	2066	16.9	2.4

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Note: VCSNS = Virgil C. Summer Nuclear Station

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Load, Capability and Reserves
SCPSA
1965 - 1985

Figure 1.1-8

1.2 OTHER OBJECTIVES

The Virgil C. Summer Nuclear Station will have no objectives other than that of producing electric power.

1.3 CONSEQUENCES OF DELAY

The consequences of delay would be serious for both SCE&G and SCPSA in terms of reduced reserve margins. Lowered reserve margins in VACAR are also of concern, as is the fact that any delays would adversely affect the nation's fuel conservation program. Moreover, as described in Chapter 8 and briefly below, the impact of delay upon industry, employment, and income would be very serious.

A delay of one year in the operation of the proposed nuclear facility would adversely affect SCE&G's generation reserves and service reliability (see Table 1.1-1). The projected reserve capacity to meet the 1979 summer peak would be reduced from 1181 MW to 581 MW, a reduction of 600 MW. However, if the nuclear unit is delayed, 131 MW of inefficient IC turbine peaking capacity planned for retirement in 1979 would be kept operational for another year, resulting in an actual reduction to 712 MW and a reserve capacity of 27.2 percent of load responsibility in 1979. If the nuclear unit is not available, the required energy for the year of delay will be generated in fossil plants and will require an additional 1,423,000 tons of coal and 424,000 barrels of oil. Based on current fuel cost estimates, which will undoubtedly increase, millions of dollars of added expense will be incurred for fossil fuels. Delay of the nuclear unit will also reduce the effectiveness and economics of the 480 MW pumped storage facility to be located adjacent to the nuclear site. Problems associated with reserve adequacy, increased operating costs and inefficient operations will be much greater if load grows at a faster rate than forecasted.

Although there is no contractual reserve margin responsibility within the VACAR subregion, the intent of the VACAR Reliability Agreement is to allow member companies to call on other members for emergency capa-

city when needed. Postponing the proposed facility would further decrease the VACAR margins (see Tables 1.1-6 and 1.1-7). Within the next few years an increasing percentage of VACAR capacity will comprise 800 to 1100 MW size nuclear and fossil fuel units. The possibility of several large generating units being unavailable during peak load periods increases the importance of the Virgil C. Summer Nuclear Station to the overall reliability of the VACAR subregion.

With a one year delay, SCPSA would not be appreciably affected, assuming that the SEPA contracts for firm power and reserve capacity remain unchanged. Without the nuclear plant, SCPSA's 1979 reserve capacity will drop from 496 MW to 196 MW. As a function of peak load, SCPSA's percentage of reserve capacity will drop from 36.5 percent to 14.4 percent (see Table 1.1-2).

With a two year delay, the situation for SCE&G becomes more serious, as follows:

1. For the summer peak of 1980 the reserve capacity would be reduced from an estimated 1012 MW to 412 MW, or from 36.3 percent to 14.8 percent. If it is possible to delay retirement of the peaking units (131 MW) the reserve capacity would be 543 MW or 19.5 percent of load responsibility. This is slightly below the 20 percent reserve criterion and 6 percent below the capacity of the largest unit.
2. Additional fossil fuel required to replace the nuclear energy for the two year delay is estimated to be approximately 2,772,000 tons of coal and 704,000 barrels of oil.
3. If the two largest SCE&G units (Wateree No. 1, 360 MW, and Williams No. 1, 580 MW) are off line for any reason during the 1980 summer peak demand period as presently forecasted, it will be necessary to import 528 MW from neighboring utilities to avoid loss of load. If the peaking units are retained, the requirement will be 397 MW.

This assumes all other SCE&G units are fully available, which is a very unlikely condition. The lack of load diversity within the VACAR subregion, coupled with declining reserves in both the VACAR and Southern subregions, reduces the possibility that this capacity will be available for transfer during emergencies.

Joint studies have been made to test the interconnected transmission system capability to import power for the following plant contingencies:

1. Williams off, Canadys reduced. Total capacity import tested = 1000 MW.
2. Summer off, Fairfield reduced. Total capacity import tested = 1000 MW.
3. Wateree off, Canadys reduced. Total capacity import tested = 1000 MW.

The results of these studies indicate that, if reserve generating capacity is available in neighboring utilities, such transfers can be effected but that certain sectors of the SCE&G system will experience increased line loadings and lower than normal voltages. If the proposed nuclear facility is not in service during contingencies such as the above outages, the result of importing the additional power into SCE&G's system would be further increases in line loadings.

A second year of delay would result in the SCPSA reserve capacity during the 1980 summer peak load dropping from 389 MW to 89 MW or from 26.5 percent to 6.1 percent (see Table 1.1-2). SCPSA would approach other VACAR companies to purchase 150 MW of firm capacity to retain a safer reserve margin of about 16.3 percent. The likelihood of success in obtaining a contract for firm power is not certain.

If the nuclear plant is delayed three years, SCE&G's reserves, for the 1981 summer peak, considering the 480 MW of pumped storage and the aged and uneconomical 131 MW of IC turbines, will amount to only 436 MW, or 15.1 percent. This is an unacceptable reserve level, below the 20 percent margin (579 MW) and the capacity of the largest unit other than the nuclear plant (580 MW). Forecast error, extremely hot weather, capacity reductions due to auxiliary equipment outages, and forced unit outages could leave SCE&G deficient in generation and seriously jeopardize reliability of service. With a three year delay of power from nuclear energy the additional consumption of fossil fuels would be a total of 4,171,000 tons of coal and 1,621,000 barrels of oil.

A three year delay for SCPSA would mean that negative reserves would be experienced for the summer peak of 1981. These are estimated to be -22 MW or a -1.6 percent margin. Were sufficient notice available, the 280 MW coal fired unit now scheduled for 1982 would be rescheduled for commercial operation at an earlier date.

Table 1.1-9 shows both summer and winter projected peak loads for the VACAR companies with their load responsibility. Reserve margins without the nuclear plant will become negative for SCE&G in 1983 and in 1985. For SCPSA this would occur in 1981.

It is already too late to make plans that would result in the addition of substitute capacity for the nuclear plant to SCE&G's system prior to 1979. The only option would be to try to purchase the capacity from neighboring utilities. Projections indicate this alternative is not a viable option.

If additional capacity is not added to the SCE&G system after 1978, severe measures will have to be taken to restrict load growth so as to

maintain reserve margins and adequacy of service. The impacts of not adding this capacity would generally be to:

1. Prohibit the location of new industry in the service area;
2. Discourage and inhibit the expansion of existing industrial, commercial and other customers;
3. Seriously jeopardize the economic and physical well-being of service area population;
4. Bring about frequent curtailment and interruption of electric service to all classes of customers during emergency and peak load conditions.

The last point has serious implications for both SCE&G and SCPSA. Both utilities serve continuous process industries such as steel and textile mills, plastics plants, and others that require uninterrupted and reliable service. If operations are stopped, even briefly, costs due to loss of product, machine overhaul, and cleaning and start-up can amount to millions of dollars. Days may be required to return to full-scale operation. Problems due to unreliable electric service and the related costs would, over a period of time, cause a significant decline in the value of production in industries that are vital to the South Carolina economy. There would be a decline in the rate of growth of employment, increased unemployment, and reduced expansion by industries now interested in the advantages offered by the South Carolina environment.

It is also important to note that a major concern is not with the systems' abilities to import power but with the strong possibility that neighboring utilities will not have capacity available for export to SCE&G and SCPSA. Both the VACAR and Southern Company subregions are projecting continued reductions in reserve capacity. The estimated VACAR reserves, including the proposed nuclear unit, will be down to 15.2 percent in 1982 from 23.0 percent in 1979. These figures take on added significance when compared with the estimated 1976 reserves of 29.2 percent (see Table 1.1-6).

TABLE OF CONTENTS

Section	Title	Page
	2.0 SITE CHARACTERISTICS	
2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
2.1.1	Site Location and Description	2.1-1
2.1.1.1	Specification of Location	2.1-1
2.1.1.2	Site Area	2.1-1
2.1.1.3	Boundaries for Establishing Effluent Release Limits	2.1-2
2.1.2	Exclusion Area Authority and Control	2.1-2
2.1.2.1	Authority	2.1-2
2.1.2.2	Control of Activities Unrelated to Plant Operation	2.1-4
2.1.3	Population and Population Distribution	2.1-5
2.1.3.1	Population Within 10 Miles	2.1-7
2.1.3.2	Population Between 10 and 50 Miles	2.1-9
2.1.3.3	Transient Population	2.1-11
2.1.4	Uses of Adjacent Lands and Waters	2.1-13
2.1.4.1	Land Use	2.1-13
2.1.4.2	Water Use	2.1-24
2.1.5	References	2.1-27
2.2	ECOLOGY	2.2-1
2.2.1	Terrestrial Ecology	2.2-1
2.2.1.1	Background	2.2-1
2.2.1.2	Vegetation	2.2-3
2.2.1.3	Birds	2.2-4
2.2.1.4	Amphibians and Reptiles	2.2-7
2.2.1.5	Mammals	2.2-7

TABLE OF CONTENTS (Continued)

Section	Title	Page
2.2.2	Aquatic Ecology	2.2-12
2.2.2.1	General Aquatic Ecology Description	2.2-12
2.2.2.2	Water Quality	2.2-15
2.2.2.3	Aquatic Flora	2.2-18
2.2.2.4	Aquatic Fauna	2.2-21
2.2.3	References	2.2-27
2.3	METEOROLOGY	2.3-1
2.3.1	General Climate	2.3-1
2.3.2	Site Meteorology	2.3-3
2.3.2.1	Temperature and Water Vapor	2.3-3
2.3.2.2	Wind Characteristics	2.3-4
2.3.2.3	Precipitation	2.3-5
2.3.2.4	Storms	2.3-5
2.3.3	Air Pollution	2.3-7
2.3.4	Regional Comparison	2.3-8
2.3.5	Topographic Effects	2.3-8
2.3.6	References	2.3-9
2.4	HYDROLOGY	2.4-1
2.4.1	Surface Water	2.4-1
2.4.1.1	Rivers and Streams	2.4-1
2.4.1.2	Lakes and Reservoirs	2.4-2
2.4.1.3	Flow Characteristics	2.4-4
2.4.2	Ground Water	2.4-7
2.4.3	References	2.4-9
2.5	Geology	2.5-1
2.5.1	References	2.5-2

TABLE OF CONTENTS (Continued)

Section	Title	Page
2.6	REGIONAL HISTORIC, SCENIC, CULTURAL AND NATURAL FEATURES	2.6-1
2.6.1	References	2.6-2

LIST OF TABLES

Table	Title	Page
2.1-1	Communities Within 50 Miles of The Virgil C. Summer Nuclear Station, 1970	2.1-31
2.1-2	Population for Selected South Carolina Counties, 1930 to 2020	2.1-34
2.1-3	Recreational Use Within 50 Miles of The Virgil C. Summer Nuclear Station, 1975	2.1-35
2.1-4	Land Use in Site Region in 1958 and 1967	2.1-37
2.1-5	Land Use in Lexington, Richland, Newberry and Fairfield Counties, 1972-1973	2.1-38
2.1-6	Land Use Within Five Miles of the Site, 1976	2.1-39
2.1-7	Significant Land Use and Boundary Distances by Sectors	2.1-40
2.1-8	Dairies in Fairfield, Newberry, Richland, and Lexington Counties, 1976	2.1-41
2.1-9	Schools, Hospitals and Prisons Within 10 Miles of The Virgil C. Summer Nuclear Station, 1976	2.1-43
2.1-10	Industrial Facilities Within Fives Miles of the Site	2.1-44

LIST OF TABLES (Continued)

Table	Title	Page
2.1-11	Reported Industrial, Municipal, and Domestic Wells Within 20 Miles of Site	2.1-45
2.1-12	Wells and Springs Within Two Miles of Site	2.1-49
2.1-13	Significant Downstream Surface Water Users	2.1-52
2.2-1	Water Quality Data from USGS Stations	2.2-31
2.2-2	Total Concentration of Certain Heavy Metals Above and Below Parr Reservoi	2.2-32
2.3-1 through 2.3-13	Statistics and Diurnal Variation of Meteorological Parameters	2.3-13 - 2.3-25
2.3-14	Values of Mean, Average and Extreme Daily Maximum, and Average and Extreme Daily Minimum Surface Temperatures (°F) in The Site Area	2.3-26
2.3-15	Monthly and Annual Average Relative Humidity (%) at Columbia (1967-1973)	2.3-27
2.3-16	Monthly and Annual Mean, and Extreme Maximum and Minimum Dewpoint Temperatures (°F) at Columbia, S. C. (1971-1975)	2.3-28

LIST OF TABLES (Continued)

Table	Title	Page
2.3-17 through 2.3-42	Wind Frequency Distributions, 1975	2.3-29 - 2.3-80
2.3-43	Monthly and Annual Precipitation Means and Extremes in The Site Area (in inches)	2.3-81
2.3-44	Monthly and Annual Average Snowfall for The Site Area and Extremes for Selected Stations	2.3-82
2.3-45	Mean Number of Thunderstorm Days at Selected Stations in the Region	2.3-83
2.3-46	Monthly Variation of Extreme "Fastest Mile" Winds at Columbia and Greenville-Spartanburg	2.3-84
2.4-1	Major Historical Floods and Average Flow on The Broad River	2.4-10
2.4-2	Flood Frequency at Richtex, South Carolina	2.4-11
2.4-3	Low Flow Frequency and Duration at Richtex, South Carolina	2.4-12
2.4-4	Laboratory Permeability Test Data - Major Plant Structure Area	2.4-13

LIST OF TABLES (Continued)

Table	Title	Page
2.4-5	Field Permeability Test Data - Service Water Pond Area	2.4-14
2.4-6	Ground Water Quality Results	2.4-15

LIST OF FIGURES

Figure	Title
2.1-1	Regional Location Map
2.1-2	Site Location Map
2.1-3	Site Area Map
2.1-4	Resident Population Distribution up to 10 Miles, 1970
2.1-5	Resident Population Distribution Between 10 and 50 Miles, 1970
2.1-6	Projected Resident Population Distribution up to 10 Miles, 1979
2.1-7	Projected Resident Population Distribution Between 10 and 50 Miles, 1979
2.1-8	Projected Resident Population Distribution up to 10 Miles, 1980
2.1-9	Projected Resident Population Distribution Between 10 and 50 Miles, 1980
2.1-10	Projected Resident Population Distribution up to 10 Miles, 1990

LIST OF FIGURES (Continued)

Figure	Title
2.1-11	Projected Resident Population Distribution Between 10 and 50 Miles, 1990
2.1-12	Projected Resident Population Distribution up to 10 Miles, 2000
2.1-13	Projected Resident Population Distribution Between 10 and 50 Miles, 2000
2.1-14	Projected Resident Population Distribution up to 10 Miles, 2010
2.1-15	Projected Resident Population Distribution Between 10 and 50 Miles, 2010
2.1-16	Projected Resident Population Distribution up to 10 Miles, 2019
2.1-17	Projected Resident Population Distribution Between 10 and 50 Miles, 2019
2.1-18	Projected Resident Population Distribution up to 10 Miles, 2020
2.1-19	Projected Resident Population Distribution Between 10 and 50 Miles, 2020
2.1-20	Projected Cumulative Residential Population - 1979

LIST OF FIGURES (Continued)

Figure	Title
2.1-21	Projected Cumulative Residential Population - 2019
2.1-22	National Forests, State Parks, and Selected Recreation Areas Within 50 Miles of The Site
2.1-23	Projected Cumulative Residential and Weighted Transient Population - 1979 and 2019
2.1-24	Topographic Features Within 5 Miles of The Site
2.1-25	Land Use Within 5 Miles of The Site
2.1-26	Land Use Within 10 Miles of The Site, 1966-1968
2.1-27	Plan of The Virgil C. Summer Nuclear Station
2.1-28	Airport Facilities Map
2.1-29	Future Land Use Within 5 Miles of The Site
2.1-30	Reported Municipal, Industrial, and Domestic Well Locations: 2 - 20 Miles
2.1-31	Domestic Well and Spring Locations: 0 - 2 Miles
2.4-1	Map of Site Vicinity Showing Major Hydrologic Features
2.4-2	Monticello Reservoir Area and Capacity Curves

LIST OF FIGURES (Continued)

Figure	Title
2.4-3	Parr Reservoir Area and Capacity Curves
2.4-4	The Broad River Watershed to Richtex, S. C., Including Significant Existing and Proposed Dams
2.4-5	Site Water Table
2.5-1	Regional Physiography Map
2.5-2	Geologic Belt Map of South Carolina
2.5-3	Areal Geologic Map
2.6-1	Historic, Scenic, and Cultural Features in Site Vicinity

2.0 SITE CHARACTERISTICS

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 SITE LOCATION AND DESCRIPTION

2.1.1.1 Specification of Location

The Virgil C. Summer Nuclear Station site is in Fairfield County, S. C., approximately 15 miles southwest of the county seat of Winnsboro and 26 miles northwest of Columbia, the state capital. The site is in a sparsely populated rural area. The nearest community is Jenkinsville, approximately 3 miles southeast of the site. The Broad River is located approximately 1 mile west of the site and flows in a southerly direction. Lake Murray, 12 miles south of the site, is a 50,000 acre reservoir utilized for hydroelectric power generation and recreation. A regional location map (Figure 2.1-1) and a site location map (Figure 2.1-2) indicate the plant location with respect to local and regional features.

The reactor building is located at latitude N34°17'54.1" and longitude W81°18'54.6". Universal Transverse Mercator (UTM) grid coordinates, Zone 17, for the reactor building are N3,795,086 and E470,996.

2.1.1.2 Site Area

The plant features and site area map (Figure 2.1-3) indicates the site boundary, plant property line, and the location of principal plant structures in relation to existing features in the area. The exclusion area consists of a zone within approximately 1 mile of the reactor building. This area encompasses parts of Monticello Reservoir and the Fairfield Pumped Storage Facility. South Carolina Electric & Gas Company has acquired, by purchase, all land within the site boundary. For

purposes related to the operation of the nuclear facilities, the plant property line is considered to coincide with the site boundary and boundary lines of the plant exclusion area. The plant property, as defined herein, covers approximately 2,200 acres.

The representation of the reservoir in the immediate vicinity of the site and the boundaries of the reservoir shown in Figure 2.1-3 are approximations of the final configuration of the area.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

The site exclusion area identified in Figure 2.1-3 is the selected boundary for establishing effluent release limits. The release points for both liquid and gaseous effluents are described in Section 3.1; that section also provides the minimum distances between the various release points and the exclusion area boundary.

The site boundary is approximately 5,350 feet south, east, and north from the reactor building, and is at least 5,850 feet from the reactor building in a westerly direction.

Routine operational radiological effluents at and beyond this area boundary are within the limits established by 10 CFR 20 and 10 CFR 50, Appendix I.

2.1.2 EXCLUSION AREA AUTHORITY AND CONTROL

2.1.2.1 Authority

South Carolina Electric & Gas Company (SCE&G) and South Carolina Public Service Authority (SCPSA), as joint owners, maintain absolute ownership

of all land within the site boundary as identified on Figure 2.1-3. This area is also the site exclusion area for the Virgil C. Summer Nuclear Station. SCE&G, as applicant, has the authority to control all activities within this area.

SCE&G maintains control of access to and activity within this area and has the authority to remove personnel and/or material when deemed necessary. Mineral rights within this area are also owned by SCE&G and SCPSA, and are also under the control of SCE&G as manager of the plant.

The exclusion area for the nuclear station is not and will not be traversed by other than wholly owned land accesses. The closest primary public road, S. C. 215, lies approximately 6,800 feet east of the reactor building centerline and is outside the exclusion area.

The Broad River is approximately 6,050 feet west of the reactor building and is outside the exclusion area. The southern portion of the Monticello Reservoir lies within the exclusion area. The closest railroad not owned by SCE&G and SCPSA lies 5,850 feet to the southwest on the outside edge of the site boundary. Figure 2.1-3 shows river, reservoir, and railroad locations.

SCE&G and SCPSA own and maintain the section of railroad facilities within the exclusion area. These facilities are used for receipt and shipment of carload freight to and from the Virgil C. Summer Nuclear Station in accordance with an agreement between Southern Railway Company and the applicant. The applicant is the sole authority for control of these rail facilities.

There is an easement through the exclusion area for a 115 kV transmission line owned by Duke Power Company. Terms of the easement provide

for the applicant to maintain control over the use of the land involved in the easement. Maintenance and upkeep of the right-of-way may be performed only upon authorization by the applicant.

The only non-station related activities conducted within the exclusion area are those related to the Fairfield Pumped Storage Facility and its possible recreational use.

The location of the Fairfield Pumped Storage Facility is shown on Figure 2.1-3. Personnel of this facility are limited to employees of SCE&G and therefore are subject to administrative controls of the company. The pumped storage facility is staffed by approximately 10 people during day shift and one operator for each night shift. The estimated time to evacuate all personnel from this facility is 10 minutes if the plant is not running and 20 minutes if the units must be shut down.

2.1.2.2 Control of Activities Unrelated to Plant Operation

Recreational activities within the exclusion area are under the control of the applicant. Appropriate warning signs notify the public of the exclusion area. Floating markers will be placed along that portion of the Monticello Reservoir encompassed by the exclusion area and shall be maintained during the operating life of the plant.

The applicant maintains the right to limit access and to control evacuation from the exclusion area. Normal evacuation of persons within the exclusion area is estimated to take no more than 20 minutes.

2.1.3 POPULATION AND POPULATION DISTRIBUTION

The location of the site in relation to the surrounding cities and towns within a 50 mile radius is shown on Figure 2.1-1. Communities for which census population data are available are listed, together with their 1970 populations, in Table 2.1-1 (incorporated cities, towns, villages, and unincorporated places of 1,000 or more persons).

The base (1970) population distribution has been taken from the PSAR for the Virgil C. Summer Nuclear Station. Projections are based on available estimates produced in December 1975, by the Bureau of Economic Analysis (BEA) for the U. S. Army Corps of Engineers, South Atlantic Division (1).

Within the 10 mile radius, population distribution was based on a house count using county highway maps prepared from aerial photographs. A household population size of 3.5 was used in converting the house count into population. This factor is an average of the household size for Fairfield and Newberry Counties, taken from the 1970 census of population.

Beyond the 10 mile radius, the 1970 population distribution utilized the smallest geographic unit for which census data were available: city, town, unincorporated place, or census county division. The population wheel composed of 10 annular rings and 16 segments was superimposed upon a map of these census geographic units. The census units within each cell of the wheel were identified, and the population associated with each unit was proportioned into the appropriate cell, assuming uniform population distribution.

Two population projections thus derived are presented in Sections 2.1.3.1 and 2.1.3.2. The low projection in each section is based upon the rates of change for counties in South Carolina recently projected by the BEA (1).

These local area projections are an extension of the OBERS water resources program which produced projections for the nation and its subareas. Both studies utilized the Bureau of Census Series E projections which assumed a completed cohort fertility rate of 2.11 children per woman. The high projection utilized alternate rates presented in Appendix B of the 1975 Corps of Engineers/BEA study (1). This alternate projection reflects the future growth estimates of the S. C. Division of Research and Statistics (2). The higher growth rates are based upon the fact that South Carolina appears atypical of the nation as a whole. Between 1970 and July 1974, South Carolina experienced a considerably higher growth rate than the Series E projections anticipated. This rapid population growth has resulted from increased economic development and gains in employment opportunities which induced a high net in-migration, reversing the historical net out-migration which had been experienced by the state for decade[illegible] Historical and projected populations for counties all or partia[illegible] within the 50 mile radius are presented in Table 2.1-2.

Projections for 1980, 1990, 2000, 2010, and 2020 were prepared by the following method: 1970 values for each cell were broken down into the component parts related to each county within a cell. This was done on an areal basis, assuming population homogeneity. Each component value was increased or decreased according to the county's rate of change, and then the components were summed to reach the new cell total. Data for 1979 (the start of the plant life) and 2019 (the end of the plant life) were extrapolated from the total change for the decades from 1970 to 1980 and from 2010 to 2020.

Differences between population projections for 2010 in this report and those presented in the PSAR for the Virgil C. Summer Nuclear Station result from the fact that the PSAR reflected more heavily local area projections prepared at the county level, while this report utilizes more recently available county projections made by agencies at the state

and federal levels (though representatives of local agencies participated in the preparation of the projections made by the higher level agencies).

The high estimate, based on BEA's alternate projections, is only 1.6 percent lower for the 50 mile area than the PSAR projection. Counties which generally show lower growth include Greenwood, Saluda, and portions of Richland. New estimates for Lexington, Kershaw, Chester, Spartanburg, and the counties bordering Spartanburg (Cherokee, Union, and Laurens Counties) reflect higher populations. The new estimates for the Rock Hill portion of York County are slightly lower than previously forecast, but the projected populations are higher for the balance of the county.

Growth in the Camden area is now projected to be higher, while estimates for Columbia, Newberry, and Greenwood have dropped.

The population projected within the 0 to 10 mile area is 21 percent higher than the earlier projection (8,552 persons versus 7,072 persons). This change is likely to be a result of the projection methodology used for this report, which assumed even population distribution when applying the county growth projections.

Population distributions for the area within 10 miles (discussed in Section 2.1.3.1) and for that between 10 and 50 miles (discussed in Section 2.1.3.2) appear in Figures 2.1-4 to 2.1-19.

2.1.3.1 Population Within 10 Miles

Within 10 miles of the plant the 1970 estimated population was 6,370 (a density of 20.3 persons per square mile). The following communities included in the 1970 Census of Population are within the 10 mile radius:

Communities	1970 Population	Distance (in miles) and Direction from Site
Peak	87	4 S
Pomaria	264	6 W
Little Mountain	240	9 SW
Chapin	342	9 SSW

Other communities within the 10 mile radius, not included in the 1970 census published data, are Parr, Jenkinsville, Monticello, and Blair.

Within 5 miles the 1970 estimated population was 1,203 (a density of 15.3 persons per square mile). The communities within 5 miles are Peak, Parr, Jenkinsville, and Monticello.

The highest population densities out to 10 miles are in the three sectors between south-southwest and west-southwest (Figure 2.1-4) and are partly related to the presence of the communities of Pomaria, Little Mountain, and Chapin and their better developed local road system.

The 1979 projected population within 5 miles ranges from 1,214 (15.5 persons per square mile) to 1,291 (16.4 persons per square mile). Within 10 miles, the 1979 projections range from 6,527 (20.8 persons per square mile) to 6,899 (22.0 persons per square mile). No major population increase is projected by either of the two alternate methods utilized, nor is any major redistribution of population.

Research undertaken at the time of the PSAR revealed that some population decreases may occur in some of the subareas within a 5 mile radius of the plant due to the abandonment of some small, marginal farms. These changes are too small, however, to be reflected in the population wheels which were produced from the BEA Series E and BEA Alternate projections described above.

The 2019 low and high projections for the 10 mile radius are 7,115 and 8,844, with an average density of 22.6 and 28.2 persons per square mile, compared with a 1970 density of 20.3. Thus the changes are not anticipated to be great. The high projection results in a large percentage change but increases density by only eight persons per square mile.

By the year 2019, the projected end of plant life, the low and high projections for the 5 mile radius are 1,261 and 1,584, respectively, an absolute increase from 58 to 381 persons. These increases would result in an average density ranging from 16.1 to 20.2 persons per square mile, compared with 15.3 in 1970.

As noted above, future projections were made by applying uniformly the county growth rates. This may have the effect of increasing population estimates of the rural, inner 10 miles too rapidly. This method of population estimation is, however, as accurate as one applying subjective judgment on changes within small geographic areas over a span of 40 years.

2.1.3.2 Population Between 10 and 50 Miles

The largest accumulated population in the site region in 1970 was between the 20 and 30 mile circles (Figure 2.1-5), with the highest concentration of people being in the southeast and south-southeast segments. This area includes Columbia, West Columbia, Cayce, Forest Acres, and Fort Jackson. Seventy percent of the total for this annulus occurs in the cell in which Columbia and its suburbs are located. The second highest population is found between the 40 and 50 mile radii, with concentrations in the north-northeast, northeast, west, and west-northwest segments. Centers of population within the 40 to 50 mile northern segments include York, Rock Hill, and Lancaster. Greenwood, Laurens, and Clinton account for most of the population in the westerly segments.

The highest population density (2,138 persons per square mile) was found in the cell formed by the southeast sector and the 20 to 30 mile annulus, and was accounted for by the city of Columbia. The second highest density (288 persons per square mile) was in the area of Rock Hill, 40 to 50 miles north-northeast. No other cell exceeded a density of 250 persons per square mile.

Projections for 1979 (the first year of plant life), for 2019 (the projected last year of plant life), and for each decennial year from 1980 to 2020 are presented in Figures 2.1-7, 2.1-9, 2.1-11, 2.1-13, 2.1-15, 2.1-17, and 2.1-19.

Not included in these projections are some qualitative predictions of probable growth for two portions of the 10 to 50 mile are which are based upon information received from the S. C. Division of Research and Statistical Services (3). These estimates are not reliably quantifiable either as to magnitude or point of time. They have not been included by the state in their official projections for counties. Consequently, they are treated here descriptively rather than quantitatively. The first area is Fairfield County, especially the east and east-northeast sectors between 10 and 30 miles. It is anticipated that growth will be accelerated in this area by the future construction of Interstate 77. This major route will provide vastly improved access south to Columbia and north to Charlotte, N. C., providing improved highway transit into the industrial heart of Ohio. This new access, together with the new county revenues which will be generated by the Virgil C. Summer Nuclear Station, is expected to cause some in-migration into Fairfield County, probably centering in the Winnsboro and Ridgeway areas.

Another growth area is anticipated to be that portion of Lexington County west and northwest of Columbia (the southeast sector between 10

and 30 miles). The area is served by Interstate 26, which provides access to Columbia, and this advantage, together with the attraction of Lake Murray, is already generating rapid suburban development as well as industrial growth. Much of this growth, including a planned new community of 25,000 (Harbison) will occur in the area between 10 and 20 miles southeast of the site.

Figure 2.1-20 graphically presents the estimated cumulative population for the entire 50 mile radius for the year 1979, the year of initial plant operation, compared with a hypothetical cumulative population which would result from a uniform density of 500 persons per square mile. Figure 2.1-21 presents to projected population for the year 2019 compared with a hypothetical population at 1,000 persons per square mile. Only the high projections have been plotted, since they are well below the hypothetical values.

2.1.3.3 Transient Population

Three types of transient population generators are discussed in this section: recreation attractions, industrial facilities, and communities. The purpose is to determine where population concentrations may occur on a daily or seasonal basis in excess of that indicated by residential distributions. In the study region, manufacturing has tended to locate in rural areas along major highways, introducing patterns of cross commuting between rural areas and urban centers which tend to offset any significant in-migration associated with the daily commuting of workers.

Population concentrations on the periphery of the 50 mile radius, together with recreational areas, are the significant transient population generators with regard to the daily or seasonal spatial redistribution of population into the 50 mile area from outside.

Six categories of communities, based on size, have been identified within the 50 mile radius. These categories indicate the relative ability of the communities to provide economic, cultural, institutional, and administrative functions for surrounding areas, thereby generating population concentrations on a temporary basis. The communities, their 1970 populations, and their size category are shown in Table 2.1-1. It is expected that these communities will continue to dominate the spatial organization of population in the region.

Recreation facilities tend to generate seasonal, temporary population peaks, especially if the facilities are associated with outdoor activities such as hunting, camping, water sports, etc. During these times of seasonal activity the facilities will not only concentrate populations from the general vicinity but may also attract persons outside the study region, thereby increasing overall population levels within the area. Within 50 miles of the site are 7 state parks, 3 administrative units of the Sumter National Forest, and several areas used for public hunting and fishing (see Figure 2.1-22). Users of these recreational facilities totaled approximately 1.7 million during 1975. Of these, it is estimated that approximately 2 to 10 percent were campers using the facilities on an overnight basis. Table 2.1-3 indicates where these facilities are in relation to the site and the total usage of each area during 1975.

The most significant recreation attraction within 20 miles of the site is Lake Murray, a 50,000 acre reservoir 10 miles northwest of Columbia. Due to its proximity to Columbia and to two interstate highways in the area, the lake is becoming a major recreational attraction. A shoreline survey of the lake in 1973 identified 4,910 homes of which 1,651 were year-round residences. Private homes and condominiums for fulltime residence near the eastern end of the lake are a significant part of the

development. Total annual visitor days on the lake in 1973 for non-residential users are estimated at 1.8 million.

Figure 2.1-23 is a graphic illustration of cumulative residential and weighted transient populations for the years 1979 and 2019, compared with hypothetical populations at a density of 500 and 1,000 persons per square mile, respectively. The results of these graphs may be misleading, since some of the population is being double-counted. Many users of the recreation facilities reside within the radii locating the facility and thus are tabulated twice. However, determination of user origins is precluded by lack of data. Most of the recreational usage is expected to be located outside the low population zone in the small recreation area, approximately 4 to 6 miles north of the reactor building.

2.1.4 USES OF ADJACENT LANDS AND WATERS

2.1.4.1 Land Use

2.1.4.1.1 Regional Overview

The site lies within the Southern Piedmont Land Resource Area as defined by Austin (4). This resource area covers 59,000 square miles and includes parts of Virginia, North Carolina, South Carolina, Georgia, and Alabama. In South Carolina, the Southern Piedmont Area extends from the Fall Line west to the Blue Ridge Mountains across the state in a continuous belt 100 to 115 miles wide. Elevations throughout the Southern Piedmont vary from 300 to 1,000 feet; the topography is gently rolling

to hilly, with narrow stream valleys. Local relief may vary from 20 to more than 200 feet.

Climatology of the area is discussed in Section 2.3. The climate is temperate, and the growing season in the resource area is 200 to 240 days.

Rainfall and perennial streams are major sources of water. Ground water supplies are small, but domestic sources usually depend upon wells. Streams, springs, and small ponds are important sources of livestock water. The potentially large water supplies available from perennial streams generally have not been exploited but are being developed.

Throughout the region, most of the land is in small farms, with some federal and, increasingly, urban uses. In 1967, only about a fifth of the area was in cropland, with cash crops such as cotton, corn, grain sorghums, small grains, hay, and soybeans predominating. In 1967 about one-tenth of the area was in pasture or grazing land. Recently, a trend toward livestock farming has resulted in an increase in pasture and grazing land, with a subsequent decrease in cropland; this trend will probably continue. In 1967, approximately three-fifths of the area was in forests, mainly small farm woodlands, with some areas in national forests or other large holdings. Pulpwood is a major forest product, with hardwood and pine lumber also important in some areas. Despite the large forest holdings and decreasing trend in cropland, about 54 percent of the area is suitable for cultivation. A discussion of the soils of Newberry and Fairfield Counties is presented in Section 2.4 of Appendix 2A. Erosion is the dominant soil limitation (4).

2.1.4.1.2 Land Use Within 50 Miles of the Site

Land use statistics for the twelve counties within 50 miles of the site (Table 2.1-4) were developed from the South Carolina Soil and Water

Conservation Needs Inventory, dated May 1970 (5). The inventories of each county were based on a standardized classification scheme, for two separate years, 1958 and 1967. Such an inventory not only provides a basis for comparison among the counties, but it also may be used to identify definite trends in land use changes. In both inventory years, forested land uses predominated, with more than 60 percent of the 12 county average occurring in this category. Agricultural land (cropland and pasture) ranked second, with approximately 20 percent of the average for the two years. However, between 1958 and 1967, cropland decreased more than 5 percent. During the same period, urban, pasture, and forest land uses increased.

The chief crops grown in the region are cotton, soybeans, small grains, corn, and vegetables. Livestock enterprises, mainly beef and dairy cattle operations, are increasing at the expense of land devoted to field crops, resulting in a net shift from cropland to pasture in the region.

Land use in the four counties surrounding the site was updated using data available from the Computerized Land Use Information System for South Carolina (CLUIS). This system is presently being developed by the South Carolina Land Resource Commission and the University of South Carolina (6). Land use data available for Fairfield, Newberry, Lexington, and Richland Counties date from 1972 to 1973 (see Table 2.1-5).

The predominance of forestry land use in Fairfield County is denoted by the fact that over 80 percent of the land is in such uses. Approximately 20 percent of the land in Lexington, Richland, and Newberry Counties was in agricultural use, while Fairfield totaled 7 percent. Very little of Fairfield County was devoted to urban uses; approximately 1 percent was in residential use. Farming activity in Newberry and Fairfield Counties is devoted to small grains, pasture feed crops, and

cattle. Most farms are owned and operated by part-time farmers, who work in local industries.

2.1.4.1.3 Land Use Within 5 Miles of the Site

2.1.4.1.3.1 General

Significant physical and cultural landscape features within 5 miles of the plant are shown on Figure 2.1-24. The features presented include those standard on 7-1/2 minute USGS topographic maps, the exclusion area boundary, and the limits of Monticello Reservoir.

Land use categories within 5 miles of the site (Figure 2.1-25) depicted were chosen on the basis of land uses occurring in the area. Aerial photography taken in April 1976 (7), along with field surveys and aerial reconnaissance undertaken in July 1976, were the principal sources for land use data. The present land use categories as shown in Figure 2.1-25 may be compared with uses in 1966-1968 as shown in Figure 2.1-26. The 1966-1968 land use map covers a 10 mile radius and is based on soil types. The percentage of land in each land use category within the 5 mile area is presented in Table 2.1-6. Tabulation of the various land uses was accomplished by the use of dot grids.

Forested land uses predominate, with over 78 percent of the land in the 5 mile radius in this category. Cropland and pasture uses comprise 12.8 percent, while urban land use comprises less than 2 percent of the total area.

The incidence of cropland is greater west of the plant site in Newberry County. In Fairfield County, forestry was predominant. Most residential development has occurred along S. C. 215 from Jenkinsville north to Monticello.

The site proper comprises approximately 200 acres. Parr Reservoir, now covering about 1,850 acres, will be enlarged by 2,500 acres. Monticello Reservoir will inundate about 6,800 acres. By the time plant operation begins, SCE&G will have acquired ownership or control of over 11,000 acres.

The Monticello Reservoir area was not included in the land use tabulations (Table 2.1-6) nor was the site exclusion area. Analysis of topographic maps and 1970 aerial photos indicates the Monticello Reservoir area was at one time approximately 82 percent forest and 17 percent pasture and cropland. The exclusion area was totally forested.

2.1.4.1.3.2 Agricultural Land Use

Distances of the nearest cow, goat, residence, and vegetable garden to the site boundary in the 16 sectors around the plant are indicated on Table 2.1-7. These data were gathered during the field survey of July 1976. It will be noted from that table that the nearest cow is located about 1.5 miles from the plant in the WSW direction. The nearest cow currently being milked is located about 4 miles NW of the plant.

Dairies in Richland, Lexington, Fairfield, and Newberry Counties are listed in Table 2.1-8, which also indicates the number of cows per dairy and their distance and direction from the site.

2.1.4.1.3.3 Public Facilities and Institutions

Table 2.1-9 indicates schools, hospitals, nursing care facilities, prisons, and jails within 10 miles of the site, their location with respect to the reactor, building and present populations of these facilities.

2.1.4.1.3.4 Recreational Land Uses

The plant site is within the Carlisle Game Management Area (Figure 2.1-22). Within 50 miles of the site are 7 state parks, 3 administrative units of the Sumter National Forest, and several areas used for public hunting and fishing. Use of these facilities has been discussed in Section 2.1.3.3, Transient Populations. Historic, scenic, and natural areas are discussed in Section 2.6.

2.1.4.1.3.5 Industrial Facilities

The only industrial facilities not associated with the proposed project within 5 miles of the Virgil C. Summer Nuclear Station site are those in or near Jenkinsville and Monticello, 2.5 miles southeast and 4.5 miles north-northeast of the plant site, respectively. Both towns are located in Fairfield County. These industrial (and commercial) facilities are shown on Figure 2.1-27 and are described on Table 2.1-10.

The nuclear plant site is in Fairfield County, as are several other SCE&G facilities, namely, the 480 MW Fairfield Pumped Storage Facility, the 70 MW Parr Steam Plant, and the 14.88 MW Parr Hydro Station. The Parr Hydro Station is on the Broad River approximately 2.5 miles southwest of the nuclear station. The Parr Steam Plant and the decommissioned Carolinas-Virginia Tube Reactor lie within a short distance of the east end of Parr Dam. The Fairfield Pumped Storage Facility is located at Frees Creek, about one-half mile east of the Broad River and about 1 mile west of the nuclear plant.

2.1.4.1.3.6 Transportation Facilities

Highways

Highway access to the plant is via S. C. 215 from Columbia, or by Interstate 26 to S. C. 176 and then to S. C. 213 (Figure 2.1-27). S. C. 215 and 213 merge at the center of Jenkinsville and continue north together for 3.2 miles. S. C. 215 continues on in a northerly direction; S. C. 213 veers off to the northeast. S. C. 215/213 transects the eastern sector of the 5 mile zone from north to south at an approximate distance of 6,800 feet due east from the reactor building; this is the nearest approach of a primary state highway to the plant. S. C. 311 (secondary road system) is 0.7 miles in length, is generally oriented east-west connecting S. C. 215/213 to the site area. Its primary use is as an access road for the Virgil C. Summer Nuclear Station.

Railroads

Three railroad lines, two of the Southern Railway (8) and one of the Columbia-Newberry-Laurens Railway, are within 10 miles of the plant site (Figure 2.1-27). Alston, S. C., 2 rail miles southeast of Parr, functions as an active junction for freight operations of the Southern Railway. The line running northerly from Alston through Parr and Strother passes west of the site along the east bank of the Broad River, approximately 1 mile from the reactor building. This line provides rail access to the Virgil C. Summer Nuclear Station, with a spur track leading off the main line from a switch southwest of the site. The spur will branch into several sidings within the plant area. Two freight trains per day utilize the main line of the Southern Railway, with a 1970 traffic load of about 150 cars each. No passenger traffic utilizes the main line.

The Southern Railway line running westerly from Alston to Pomaria carries two daily through runs from Spartanburg, with a 1970 average traffic level of about 150 cars per run. In addition, up to six local freight runs may use this line, with a 1970 average traffic level of about 30 cars each. No passenger trains serve this line, and its closest approach to the site is about 3.5 miles at points between Alston and Hope Station.

The third line belongs to the Columbia-Newberry-Laurens Railroad, running between Columbia and Newberry. This line connects with the Southern Railway line just east of Prosperity. The railway's closest approach to the site occurs near Little Mountain, at a distance of over 7.5 miles.

Waterways

Virgil C. Summer Nuclear Station is approximately 1 mile east of the Broad River which, near the site, is about 2,000 feet wide and quite shallow, ranging from a few feet to about 15 feet in depth. In 1965, as part of a study related to bridge construction planning, the U. S. Army Corps of Engineers compiled a listing of navigable rivers. This study indicated that there was at that time no commercial navigation on the Broad River, nor is there any at the present time (9).

2.1.4.1.3.7 Military Facilities

There are no military facilities within 10 miles of the site.

2.1.4.1.3.8 Airports

There are no airports within 5 miles of the Virgil C. Summer Nuclear Station. Locations of airports within the general area of the site are shown on Figure 2.1-28. Fairfield County Airport lies approximately 10 miles east of the site and is the closest airport; three single-engine planes are permanently based at the facility. The asphalt runway is 3,200 feet in length; its orientation is 40° and 220° (10). The airport is unattended (11), but yearly operations have been estimated at 3,000 and 5,000 (an operation consists of a take-off or a landing).

2.1.4.1.3.9 Pipelines

A buried natural gas pipeline extends from the southeast to the Parr Steam Plant. The closest approach of the pipeline to the Virgil C. Summer Nuclear Station occurs at the steam plant, a distance of approximately 2.5 miles to the southwest. The pipeline does not lie within the Monticello Reservoir watershed. The line was installed approximately six years ago to utilize excess natural gas available to SCE&G for fuel to the steam plant. The pipeline is 12 inches in diameter and is buried at a depth of 3 feet, and has a maximum operating pressure of 700 psi.

2.1.4.1.4 Future Land Use

2.1.4.1.4.1 Fairfield County

The western half of Fairfield County, in which the Virgil C. Summer Nuclear Station is located, is a sparsely developed area, characterized by small rural communities which have developed at the crossroads of major highways. Future growth in the area is expected to be minor, with some residential development occurring along those sections of S. C. 215 in the vicinity of the nuclear plant site. Since much of the

northwestern part of the county is in national forest holdings, the amount of land available for urban development is quite limited, ensuring the continued rural nature of the area (12).

By comparison, the eastern half of the county, including the Winnsboro area, is more developed and is likely to experience substantially greater development than the western half. Most of the present urban development is within the vicinity of Winnsboro or along U. S. 21. The completion of Interstate 77 is expected to be a substantial growth factor. When completed, this interstate will connect the area with the cities of Cleveland and Akron in Ohio. The State of South Carolina has also planned to construct a small reservoir in the vicinity of Winnsboro for recreation, residential, and employment center (industrial and commercial) use (12).

2.1.4.1.4.2 Newberry County

The city of Newberry is the geographic and economic center of Newberry County. Interstate 26 has precipitated moderate development around Newberry and is expected to remain a growth factor. Predictions are for the eventual linking of Newberry, Prosperity, Little Mountain, and Chapin by development associated with the interstate highway. Other parts of the county are not expected to grow at the levels associated with the Newberry area. Much of the northern portions of the county are in national forest land holdings and therefore unavailable for development for other land uses (12).

2.1.4.1.4.3 Richland-Lexington Counties

Major development in these two counties is expected to occur in the suburbs of Columbia and eastward along Interstate 26 and the north shore of Lake Murray. Growth radiating outward along major highways from the

central urban area is already evident. Future growth along Interstate 77, U. S. 176, and U. S. 76 northward from Columbia is also expected (12).

2.1.4.1.4.4 Projections of Industrial Growth

Most future industrial development within 10 to 20 miles of the site is expected to be in the vicinity of Winnsboro in Fairfield County, and in the Irmo area in Lexington and Richland Counties (13) (14). Industrial growth in the Winnsboro area, approximately 15 miles east-northeast of the site, is expected as the result of the completion of Interstate 77 between Columbia, S. C., and Charlotte, N. C., and because of increased tax revenues to Fairfield County from the plant. This increase in tax base may be used by the county to lower tax rates and/or to increase the level of public services. Such actions could be a strong inducement for the location of new industry in the county. This is most likely to occur in the Winnsboro area because the urban infrastructure is more developed there than in most parts of the county. Good access (via Interstate 77) to major market areas will be an additional inducement.

The Irmo area, about 16 miles south-southeast of the site, has already experienced rapid industrial growth during the past 5 to 7 years because of its proximity to Columbia, its location on Interstate 26, and the growing labor force in Lexington County. These factors are expected to continue to attract industry to the area, although there are no known plans for major developments at this time. The planned Harbison New Town with an anticipated 1995 population of 25,000 is to be located just to the northwest of Irmo, and new industry is part of the projected development.

2.1.4.1.4.5 Future Land Use Within 5 Miles of the Site

Figure 2.1-29 depicts land use projected for the site vicinity in the year 1995. The figure is by necessity of a general nature, but the continuation of existing patterns is evident. Some residential development is expected along S. C. 215. By 1995, Monticello Reservoir will be the most obvious feature of the landscape. Very little urban development is anticipated in the area; forestry and agricultural uses are expected to predominate.

2.1.4.1.4.6 Zoning

Fairfield County at present has no zoning ordinances which apply to rural areas of the county. The zoning ordinances in use apply only to urban areas of the county, therefore, they will not affect the plant site area. There are no plans for enacting zoning ordinances or other development restricting measures in the plant vicinity (15).

2.1.4.2 Water Use

2.1.4.2.1 Ground Water Use

Ground water within the region is principally used for individual households and for livestock. Within 20 miles of the site, approximately 100 wells have been recorded for municipal, industrial, and domestic purposes. Data for these wells are listed on Table 2.1-11. The well locations within approximately 20 miles of the site are shown in Figure 2.1-30. The data presented for ground water use were primarily taken from South Carolina Department of Health and Environmental Control compilations (16), providing the latest and most accurate information available. Except for a few cases, data were not available for water levels, elevations and drawdowns.

Ground water in the region occurs in bedrock fractures and overburden soils. Wells in the region range from 62 to 365 feet deep, but are commonly less than 200 feet deep and yield about 10 GPM or less. Yields of up to 55 GPM have been reported. However, such yields are obtainable only from a small fraction of the region's wells. When water requirements are large, surface water must be developed because large yields cannot be obtained from wells in either bedrock or overlying soil. Ground water within a 20 mile radius of the site is currently used for domestic and small industry purposes. Since it is generally not possible to develop wells in the area with yields greater than a few tens of gallons per minute, it is likely that ground water use patterns will not change significantly in the future. Consumption of ground water should increase in proportion as the resident population in the area increases. Estimates of the region's population growth are presented in Section 2.1.3.

The site is located in a relatively undeveloped area. There are no wells or domestically used springs down gradient from the site. The nearest location of ground water withdrawal is a well approximately 1 mile to the east (Figure 2.1-31). The nearest large group of domestic water wells is along S. C. 215 about 1.5 miles east of the site, and in Jenkinsville approximately 2.5 miles southeast of the site.

Locations of wells within an approximate 2 mile radius of the site were compiled by interviewing residents. These wells are listed in Table 2.1-12 and shown on Figure 2.1-31. These local wells supply water for 42 residences and 4 stores. The wells extend into rock, range from 65 to 365 feet in depth, and typically yield less than 10 GPM. The only nearby public water supply is the Jenkinsville Water Company; 3 of its 5 wells are within approximately 2 miles of the site. The Jenkinsville Water Company supplies water to 51 residences and one business within two miles of the site. Sixteen of these residences are also connected

to operable private wells. Ground water will not be used to supply any of the water required for the operation of the Virgil C. Summer Nuclear Station.

Future use of local ground water is considered related to the area's resident population projections. It is estimated that the resident population within 2 miles of the site will remain approximately static through the year 2019. Local ground water consumption should not, therefore, experience sizable deviations from approximate current levels.

2.1.4.2.2 Surface Water Use

The surface water hydrology of the region surrounding the site is described in Section 2.4. Recreational uses of surface water are associated with transient population. Present and projected recreational uses for reservoirs, lakes, rivers, and streams are discussed in Section 2.1.3.3, Transient Population.

Downstream of the Virgil C. Summer Nuclear Station, surface water is withdrawn by a number of municipalities and industries (17). The single largest downstream surface water user is the city of Columbia, approximately 28 river miles from the site. The City of Columbia is the nearest population center and utilizes three intakes on the Broad River and one intake on the Saluda River. West Columbia has one intake on the Saluda River. Columbia has an average daily use of 29.8 million gallons per day, with nearly all the municipal water being obtained from the Broad River.

Other significant downstream surface water users are listed in Table 2.1-13. This table includes a summary of significant downstream surface water users, their location, average daily use of drinking water, source of supply, and associated populations with the water user.

Irrigation in Fairfield County and Newberry County is virtually non-existent. Mr. M. H. Lynn (18), the Fairfield County agent and Mr. Henry L. Eason (19), the Newberry County agent, did not cite anyone irrigating the land at the present time. Irrigation along the Broad River in the near future is very unlikely because most of the land along the river bank is pastureland.

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TABLE 2.1-1

COMMUNITIES WITHIN 50 MILES OF THE
VIRGIL C. SUMMER NUCLEAR STATION, 1970

1970 Population Category	Place	Distance From Site (Miles)	Direction	1970 Population
Over 100,000	Columbia[1]	26	SE	113,542
35,000 - 99,999	None	--	--	--
10,000 - 34,999	Greenwood	48	W	21,069
	Laurens	43	W	10,298
	Rock Hill	46	NNE	33,846
	Union	34	NNW	10,775
5,000 - 9,999	Camden	40	E	8,532
	Cayce	27	SE	9,967
	Chester	29	N	7,045
	Clinton	35	W	8,138
	Forest Acres	27	SE	6,808
	Lancaster	44	NE	9,186
	Newberry	17	W	9,218
	West Columbia	26	SE	7,838
	York	47	N	5,081
1,000 - 4,999	Baldwin-Argon Mills	29	N	1,042
	Batesburg	30	SSW	4,036
	Buffalo	37	NW	1,461
	Edgefield	49	SW	2,750
	Eureka	29	SSW	1,524
	Great Falls	30	NE	2,727

TABLE 2.1-1 (Continued)

1970 Population Category	Place	Distance From Site (miles)	Direction	1970 Population
1,000 - 4,999 (continued)	Irwin	38	NE	1,424
	Joanna	30	WNW	1,631
	Johnston	42	SW	2,552
	Jonesville	43	NNW	1,447
	Kershaw	47	ENE	1,818
	Lancaster Mills	44	NE	2,558
	Leesville	28	SSW	1,907
	Monarch	33	NNW	1,726
	Ninety-Six	40	W	2,166
	Pacolet	50	NNW	1,418
	Pacolet Mills	49	NNW	1,666
	Saluda	33	SW	2,442
	Sandy Run	40	SSE	2,169
	South Congaree	29	SSE	1,434
	Springdale	27	SSE	2,638
	Springdale	39	ne	3,193
	Watts Mills	39	WNW	1,181
	Whitmire	22	NW	2,226
	Winnsboro	15	ENE	3,411
	Winnsboro Mills	15	ENE	2,312
0 - 999	Arcadia Lakes	28	SE	741
	Ardincaple	28	SE	726

1970 Population Category				
0 - 999 (Continued)	Boyden Arbor	27	SE	416
	Carlisle	22	NNW	670
	Chapin	9	SSW	342
	Forest Lake	27	SE	39
	Gilbert	26	S	186
	Irmo	16	SSE	517
	Lexington	22	SSE	969
	Little Mountain	9	SW	240
	Peak	4	S	87
	Pineridge	29	SSE	633
	Pomaria	6	WSW	264
	Prosperity	14	WSW	762
	Ridgeway	22	E	437
	Silverstreet	22	W	156
	Summit	26	SSW	130

(1) Includes population of Ft. Jackson, S.C.

Source: Reference 2.

TABLE 2.1-2

POPULATION FOR SELECTED SOUTH CAROLINA COUNTIES, 1930 TO 2020
(Population Figures in Thousands of People)

County	1930	1940	1950	1960	1970	1974	1980	1990	2000	2010	2020	Percent Change 1960-1970	Percent Change 1970-1974
Aiken	47.4	49.9	53.1	81.0	91.0	93.7	92.4	94.0	93.8	94.6	95.0	12.3	2.9
Calhoun	16.7	16.2	16.2	14.8	10.8	10.6	10.5	12.0	12.5	13.2	13.5	-12.0	-1.5
Cherokee	32.2	33.3	34.9	35.2	36.8	39.7	40.8	43.2	44.2	45.4	46.4	4.5	8.0
Chester	31.8	32.6	32.6	30.9	29.8	30.7	31.9	33.3	33.8	34.1	34.4	-3.5	3.1
Edgefield	19.3	17.9	16.6	15.7	15.7	16.4	14.9	14.7	14.5	14.4	14.3	-0.3	4.5
Fairfield	23.3	24.2	21.8	20.7	20.0	19.8	20.2	21.1	21.2	21.1	21.1	-3.4	-0.8
Greenwood	36.1	40.1	41.6	44.3	49.7	51.8	54.6	59.9	63.0	65.7	67.9	12.2	4.3
Kershaw	32.1	32.9	32.3	33.6	34.7	35.8	37.8	44.9	49.5	53.3	55.8	3.4	3.1
Lancaster	28.0	33.5	37.1	39.4	43.3	45.3	45.8	48.1	49.0	49.7	50.2	10.1	4.5
Laurens	42.1	44.2	47.0	47.6	49.7	49.7	50.0	53.0	55.9	57.0	NA	4.4	0.0
Lexington	36.5	36.0	44.3	60.7	89.0	111.5	129.1	174.1	204.4	227.5	251.4	46.6	25.2
McCormick	11.5	10.4	9.6	8.6	8.0	8.2	7.3	7.1	6.6	6.2	NA	-7.8	2.6
Newberry	34.7	33.6	31.8	29.4	29.3	30.2	30.0	31.0	31.2	31.3	31.3	-0.5	3.1
Orangeburg	63.9	63.7	68.7	68.6	69.8	76.0	76.8	83.1	86.7	89.1	91.1	1.8	8.9
Richland	87.7	104.8	142.6	200.1	233.9	249.3	245.0	271.2	289.1	318.0	340.1	16.9	6.6
Saluda	18.1	17.2	15.9	14.5	14.5	14.6	15.5	16.0	16.2	16.5	16.9	-0.2	0.2
Spartanburg	116.3	127.7	150.3	156.8	173.7	189.9	205.6	239.1	260.9	281.6	297.5	10.8	9.3
Sumter	45.9	52.5	57.6	74.9	79.4	82.6	85.0	89.7	94.2	97.9	101.6	6.0	4.0
Union	30.9	31.4	31.3	30.0	29.2	30.2	31.8	33.4	34.1	34.9	33.7	-2.9	3.4
York	53.4	58.7	71.6	78.8	85.2	92.5	92.2	101.5	106.7	111.2	114.7	8.2	8.6

Figures for 1980 to 2020 represent the low estimate (BEA, Series E). The high estimate added the following percentage rate to the low estimate: 1980 - +6.5%; 1990 - +5.6%; 2000 - +4.6%; 2010 - +3.6%; 2020 - +2.8%.

Source: Years 1930 to 1960, Reference 23; Years 1970 and 1974, Reference 2; Years 1930 to 2020, Reference 1.

TABLE 2.1-3

RECREATIONAL USE WITHIN 50 MILES OF THE VIRGIL C. SUMMER NUCLEAR STATION, 1975

Recreation Area	Distance From Site (Miles)	Direction	Visitor Annual Overnight	Visitor Annual Daytime	Visitor Peak Monthly	Visitor Low Monthly	Total Annual Visitor Days	Weighted Annual Transient Population
Sumter National Forest (2)								
Enoree Admin. Unit	5-10	N, NNW, NW WNW, W	1,700	83,700	NA (1)	NA	85,400	25,597
Tyger Admin. Unit	5-40	N, NNW, NW WNW, W	11,500	146,500	NA	NA	185,000	60,328
Edgefield Admin Unit	40-50	WSW	2,500	127,400	NA	NA	129,900	44,924
Chester State Park (3)	27	N	4,475	127,069	20,728	3,288	131,544	46,789
Dreher Island State Park	16	SSW	5,985	12,008	2,449	388	17,993	9,984
Greenwood State Park	37	WSW	34,704	439,492	99,896	6,448	474,196	181,055
Sesquicentennial State Park	25	SE	16,874	347,234	77,168	9,948	364,108	132,503
Rose Hill State Park	29	NW	None	53,708	7,772	2,396	53,708	17,885
N.R. Goodall State Park	45	E	None	101,059	23,528	1,420	101,059	33,683
Landsford Canal	40	NE	--	--	--	--	Under Construction	--

TABLE 2.1-3 (Continued)

Recreation Area	Distance From Site (Miles)	Direction	Visitor Annual Overnight	Visitor Annual Daytime	Visitor Peak Monthly	Visitor Low Monthly	Total Annual Visitor Days	Weighted Annual Transient Population
Lake Murray	12-20	SSE, S, SSW, SW	NA	NA	NA	NA	1,791,442	596,550
Central Piedmont Hunt Unit, Includes Game Management Areas: Broad River, Fair Forest, Enoree, Carlisle	1-50	N, NNW, NW, WNW, W	NA	50,000	NA	NA	50,000	16,665
Wateree Lake And Adjacent Game Management Areas of Dutchman Creek and Wateree	30-40	NE, ENE, E	NA	75,000	NA	NA	75,000	24,998
Lake Greenwood	35-40	W	NA	60,000	NA	NA	60,000	19,998
Congaree Region	40-50	SE	NA	20,000	NA	NA	20,000	6,666

(1) NA - Not Available

(2) Sumter National Forest: Reference 22

(3) State Parks: Reference 23

(4) Hunting & Fishing: Reference 24

Table 2.1-4

LAND USE IN SITE REGION IN 1958 AND 1967[1]
(use in percent)

Total County Land (Acres)		Chester 374,000	Fairfield 447,000	Greenwood 286,000	Kershaw 503,000	Lancaster 323,000	Laurens 449,000	Lexington 455,040	Newberry 405,120	Richland 479,000	Saluda 283,000	Union 330,000	York 438,000	Average 12-County Area
Federal Land	1958	3.2	2.7	3.5	0	0	4.5	0	13.6	11.5	1.4	17.0	0.7	3.9
	1967	3.2	2.7	3.5	0	0	4.5	0	13.6	11.5	1.7	17.0	0.7	3.9
Percent Change														0
Urban and Built-Up	1958	4.3	1.3	5.2	2.1	2.3	3.9	6.9	4.4	10.2	0.8	2.7	6.0	4.2
	1967	4.2	2.8	6.3	2.9	9.3	5.4	10.5	4.3	17.6	1.2	3.2	9.2	6.4
Percent Change														+2.2
Cropland	1958	15.2	11.2	17.9	19.1	16.9	24.2	22.6	19.8	15.6	25.2	12.0	21.2	18.4
	1967	12.4	6.0	11.2	13.0	10.0	15.0	20.9	12.4	13.1	19.5	7.6	15.3	13.1
Percent Change														-5.3
Pasture	1958	12.1	7.5	10.8	2.0	5.4	9.4	2.7	4.3	3.5	11.8	6.5	10.4	7.2
	1967	11.4	7.1	14.1	3.2	6.6	11.1	3.5	8.8	2.9	17.3	9.4	11.8	8.9
Percent Change														+1.7
Agricultural (Cropland plus Pasture)	1958	17.6	18.7	28.7	21.1	25.3	23.6	25.3	24.1	19.1	37.0	18.5	31.6	24.2
	1967	24.2	13.1	25.3	16.2	16.6	26.1	24.6	21.2	16.0	36.8	17.0	27.1	22.0
Percent Change														-2.2
Forest	1958	61.7	75.5	60.0	72.8	66.9	54.7	64.3	55.1	56.1	57.6	55.6	55.7	61.3
	1967	66.6	80.0	63.1	77.7	69.3	61.2	61.2	58.3	52.7	57.0	61.2	58.0	64.2
Percent Change														+2.9
Other Land	1958	3.5	1.7	2.1	3.9	7.4	3.1	2.8	2.5	2.7	2.8	6.1	4.8	3.6
	1967	1.8	0.9	1.4	2.9	3.7	2.4	2.4	2.1	0.7	2.8	1.5	3.5	2.2
Percent Change														-1.4

[1] The area within 50 miles of the site is within all or parts of the 12 counties listed in this table.

Source: Reference 5.

TABLE 2.1-5

LAND USE IN LEXINGTON, RICHLAND, NEWBERRY AND FAIRFIELD COUNTIES, 1972-1973
(In Percent)(1)

Land Use	County			
	Lexington	Richland	Newberry	Fairfield
Residential	4.8	6.9	1.6	.9
Manufacturing	.3	.9	.1	.0
Transportation	.3	.3	.0	.0
Trade & Services	.2	.4	.0	.0
Recreation	6.0	2.2	.1	.0
Agriculture	22.2	18.3	25.0	7.0
Forestry	65.9	57.5	71.0	90.8
Mining	.2	1.6	.0	.1
Undeveloped	.0	.0	2.2	1.1

(1) Totals may not equal 100% due to rounding or missing data.

Source: Reference 6.

TABLE 2.1-6

LAND USE WITHIN FIVE MILES OF THE SITE, 1976

Category	Percent
Residential	1.0
Industrial/Commercial	.8
Cropland or Pasture	12.8
Forest Land	78.2
Water	4.2
Cleared Land	3.0

Source: Reference 7.

TABLE 2.1-7

SIGNIFICANT LAND USE
AND BOUNDARY DISTANCES BY SECTORS

	Nearest Cow[1] (Miles)	Nearest Goat[1] (Miles)	Nearest Residence (Feet)	Nearest Residence (Miles)	Nearest Site Boundary (Feet)	Nearest Site Boundary (Miles)	Nearest Vegetable Garden (Miles)
N	3.4	NF[2]	20,000	3.78	5,333	1.01	3.85
NNE	3.0	NF	15,000	2.84	5,333	1.01	2.95
NE	2.50	NF	7,933	1.50	5,400	1.02	1.5
ENE	3.2	NF	7,266	1.37	5,400	1.02	1.39
E	1.52	NF	7,466	1.41	5,333	1.01	1.52
ESE	1.7	3.2	5,866	1.1	5,333	1.01	1.1
SE	1.9	NF	7,200	1.36	5,333	1.01	1.35
SSE	1.55	NF	13,000	2.46	5,333	1.01	2.45
S	3.3	NF	20,600	3.90	5,333	1.01	3.95
SSW	3.4	3.4	18,066	3.42	5,466	1.03	3.4
SW	3.05	NF	16,066	3.04	5,733	1.08	3.05
WSW	1.52	NF	17,200	3.25	5,866	1.11	3.22
W	2.25	5.32	13,400	2.53	5,866	1.11	2.77
WNW	2.5	NF	16,000	3.03	5,866	1.11	4.15
NW	4.0**	NF	20,866	3.95	5,733	1.08	4.0
NNW	2.60	NF	14,933	2.82	5,466	1.03	2.8

(1) **Indicates cows/goats are milked.

(2) NF = Not found closer than 3.2 miles.

Source: Field Survey, July 1976.

TABLE 2.1-8

DAIRIES IN FAIRFIELD, NEWBERRY, RICHLAND AND LEXINGTON COUNTIES, 1976

Dairy Name or Owner	Approximate Number of Cows	From Site	
		Direction	Distance (in miles)
Lexington County			
1. Joe E. & Bernard Rawls Dairy	120	S	23.4
2. Elmer L. Amick Dairy	60	S	28.2
3. Oakdale Farms	117	S	30.7
4. Clyde Shimpert Dairy	83	S	34.6
Richland County			
1. Sam McGregor	200	SE	35.6
2. Leon Powers	425	SE	34.0
3. Lanham Bros. Dairy	100	SE	48.8
4. John G. Richards School	102	SE	21.0
Fairfield County			
1. Arthur L. Park	50	NE	11.5
2. C. M. Coleman	55	N	11.1
3. Jack P. Coleman	20	N	11.7
4. D. P. Coleman	90	N	12.2
5. W. Y. Propst	30	N	13.0
Newberry County			
1. Henry Anderson	150	W	19.2
2. J. M. Bowers	20	WSW	21.9
3. Bill Ballentine	40	W	20.7
4. Bash River Jersey	150	W	21.0
5. Jim Brasswell	150	W	22.7
6. Bishop Bros.	100	W	22.5
7. Sam Boozer	75	W	31.7
8. W. D. Cromer	200	WNW	15.0
9. J. M. Clary	200	W	25.2
10. Henry Parr	312	W	18.9
11. Marvin Hamm	150	W	16.9
12. Jenkins Bros.	75	WNW	17.2
13. Mike Griffin	80	W	6.44
14. R. M. Long	35	WSW	23.0
15. Bill Long	175	W	21.9
16. Turmon Long	30	WSW	16.5
17. Moyer Farms	125	W	20.4
18. Francis Neel	55	W	23.0
19. W. W. Parr	150	W	19.2
20. Harold Pitts	250	W	24.3

Dairy Name or Owner	Approximate Number of Cows	From Site Direction	From Site Distance (in miles)
Newberry County, Continued			
21. Russel and Lewis Ridder	56	SW	12.3
22. James Ridde	50	SW	10.1
23. Tom Ridde	50	SW	9.4
24. Al Bushy	220	W	20.7
25. Palmer Shealy	85	W	6.74
26. Super Bros.	80-85	WNW	6.7
27. Allen Senn	75	W	27.2
28. Frank Senn	200	W	24.3
29. John B. Shealy	100	W	21.8
30. F. M. Satterwhite	20	W	23.8
31. Charles McGinnis	300	W	26.8
32. Claude Satterwhite	275	W	24.4
33. Fred Wertz	20	W	24.8
34. Jeff Waldrop	175	W	22.6
35. Ralph Waldrop	175	W	23.8
36. David Waldrop	320	W	23.6
37. Heywood Long	100	W	23.5
38. Virgil and Kennit Graham	90	W	5.15
39. D. W. and W. R. Graham	125	WNW	7.19
40. Marion Filker	50	WNW	9.1

Source: Reference 25.

TABLE 2.1-9

SCHOOLS, HOSPITALS AND PRISONS WITHIN 10 MILES OF THE VIRGIL C. SUMMER NUCLEAR STATION, 1976

Facility	Distance From Site (Miles)	Direction	Population (Pupils	Staff)
Schools[1]				
Whitehall Elementary	1.7	ENE	111	9
Pomaria Elementary	6.0	WSW	273	13
Germany Middle	7.0	WSW	286	14
McCrorey-Liston Elementary	7.0	N	311	19
McCrorey-Liston High	7.0	N	437	26
Chapin Elementary	9.0	S	559	27
Chapin High	9.0	S	644	33
Little Mountain Elementary	9.0	SW	381	17
Hospitals[2]				
None				
Rest Homes[2]				
Lowman Home - Wynne C. Boliek ICF	10.0	SSE	265/195[3]	
Prisons/Jails[4]				
None				

Sources: (1) Reference 26
(2) Reference 27
(3) Reference 28
(4) Reference 29

TABLE 2.1-10

INDUSTRIAL FACILITIES WITHIN FIVE MILES OF THE SITE

Company	From Plant Site: Distance (in miles)	From Plant Site: Direction	Products	Current Employment
Nylene Corp.	2.6	SE	Nylon pellets Brush bristle Monofilament fish line	10
Farm Milling Service	3.6	NE	Animal feed Fertilizer	7
Interstate Materials, Inc. Division of Clement Bros. Co.	3.0	NE	Crushed stone (granite)	35
Interstate Materials, Inc. Division of Clement Bros. Co.	4.8	NW	Sand	6
Winnsboro Granite Corp.	4.8	NE	Dimension stone	20

Source: Field Survey, July 1976

TABLE 2.1-11

REPORTED INDUSTRIAL, MUNICIPAL, AND DOMESTIC WELLS WITHIN 20 MILES OF SITE

Well Location (1)	Owner	Source Description	Average Yield MGD	Remarks
1	City of Carlisle	3 wells		
2	Big Boy Truck Stop	1 well		
3	Rocky Creek Point	1 well	0.004	
4	City of Ridgeway	3 wells	0.030	
5	City of Jenkinsville	3 wells	0.100	
6	Mid County Water District	2 wells	0.002	
7	Nylene Corp.	4 wells	0.072	
8	Arrowood S/D (2)	2 wells	0.016	
9	Royal Hills S/D (2)	2 wells	0.040	
10	McCrorey Liston	2 wells		
11	Richard Winn Acad.	1 well		
12	Greenbrier	1 well		
13	Kelly Miller	1 well		
14	J. H. Kennedys Store	1 well		
15	Willinghams	1 well		
16	Triangle Restaurant	1 well		
17	Genes Cafe Groc.	1 well		
18	City of Chapin	3 wells	0.022	
19	Woodlake Shores	1 well	0.004	
20	Lakewood Estate	1 well		
21	Lakeland Shores	2 wells	0.008	
22	Blackgate Bank	1 well	0.004	
23	Murry Lodge Estate	2 wells	0.003	
24	Stephenson Lake	2 wells		
25	Indian Cove	2 wells	0.001	
26	Dutchman Shores	3 wells	0.001	
27	Milmont Shores	2 wells	0.002	

Well Location	Owner	Source Description	Average Yield MGD	Remarks
28	Vanarsdale S/D[2]	2 wells	0.004	
29	Lesene Woods	1 well		
30	Hallmark Shores	2 wells	0.014	
31	Arrowhead Shore	2 wells	0.015	
32	Laurel Meadows	2 wells	0.004	
33	Selwood Shores	1 well		
34	Tri City Trailer Pk.	1 well	0.002	
35	Hoods Trailer Pk.	1 well		
36	Irmo Trailer Pk.	1 well	0.001	
37	Wates Trailer Pk.	2 wells		
38	Hendrix Trailer Pk.	1 well	0.002	
39	Taylor Landing	2 wells		
40	Taylors Landing	1 well		
41	Jakes Boat Landing	2 wells	0.075	
42	Lake Murray TP	2 wells		
43	Lindlers Trailer Pk.	1 well		
44	Moore Mob. Ho. Pk.	1 well	0.011	
45	Weeds Mob. Ho. Pk.	1 well		
46	Rikard Nursing	3 wells		
47	Utopia School	1 well		
48	Watergate Conds.	1 well	0.064	
49	Cemitha Court	2 wells	0.029	
50	Dutchman Cove	1 well		
51	Cold Stream Country Club	2 wells		
52	Prosperity, S. C.	well field	0.270	
53	Little Mountain, S. C.	2 wells		
54	Old School Mfg.	1 well	0.005	
55	Kendall Co. Oakl.	1 well	0.080	
56	Hollands Landing	2 wells		

TABLE 2.1-11 (Continued)

Well Location	Owner	Source Description	Average Yield MGD	Remarks
57	Shealy Trailer Pk.	2 wells	0.001	
58	Brigmans	1 well		
59	White Mob. Homes	2 wells	0.022	
60	Koon Trailer Pk.	1 well		
61	Bill Werts Trailer Pk.	1 well	0.001	
62	Gateway TP	3 wells		
63	Buddy Neal Pk.	2 wells		
64	Bedenbaugh TP	1 well		
65	Rikard Elem. School	1 well		
66	Pomaria Elem.	1 well		
67	Garmany School	1 well		
68	Mid Carolina Hi	1 well		
69	Boys Farm, Inc.	1 well		
70	Summers Dr. Inn	1 well		
71	Hilltop Dr. Inn	1 well		
72	Bonners Snack Shp.	1 well		
73	Dowd Truck Stop	1 well		
74	Newberry Inn	1 well		
75	Sunset Dr. Inn	1 well		
76	Hailes Truck Stop	1 well		
77	Mill Dera Apts.	1 well		
78	Whitakers Lodge	2 wells		
79	Mollys Rock Rec.	1 well		
80	Hollands 66 Marina	1 well		
81	Holiday Acres	1 well		
82	Dutch Village	4 wells		
83	Ballentine Est.	1 well	0.008	
84	Lincolnshire	8 wells	0.629	
85	Crane Forest	4 wells	0.015	
86	Raintree Acres	2 wells		

Well Location	Owner	Source Description	Average Yield MGD	Remarks
87	Tiffany Gardens	2 wells		
88	Lowman Home	6 wells		
89	Blythewood School	2 wells		
90	Bethel	1 well		
91	Wells Marina	2 wells	0.002	
92	Jones Steak House	1 well		
93	Whales Tail	1 well		
94	Jacks Tourist Court	1 well		
95	South Carolina Electric & Gas	1 well	0.019	Well 62' deep 4" diameter
96	South Carolina Electric & Gas	1 well	0.043	Well 120' deep 6" diameter
97	Winnsboro Granite Co.	1 well		Supplies 2 homes
98	Winnsboro Granite Co.	1 well		Supplies finishing plant
99	Winnsboro Granite Co.	1 well		Supplies 5 homes
100	Rion Crushed Stone (Martin Marietta)	1 well		Well 100' deep 6" diameter Cased 20'

(1) Numbers refer to location on Figure 2.1-30.

(2) S/D = Subdivision.

Source: Reference 16.

TABLE 2.1-12

WELLS AND SPRINGS WITHIN TWO MILES OF SITE

Well No.(1)	Name of Owner	Well Depth (Ft.)	Water Level ft. Depth	Water Level ft. Ele.	Casing Depth (Ft.)	Pump Type/ Yield (GPM)	Remarks(2)
1	Bernice Brown	-	-	-	-	-	Well
2	John Henry Ginyard	-	-	-	-	-	Well
3	Clara Spencer	-	-	-	-	-	Well
4	Alex Harper III	-	-	-	-	-	Well for 2 houses
5	R. E. Harper, Sr.	141	69	-	40	Jet/6	Well*+
6	Wilbert Gladney	-	-	-	-	-	Well
7	John Henry Stevenson	-	-	-	-	-	Well
8	Bubba Crompton	-	-	-	-	-	Well
9	Ellie Harper	-	-	-	-	-	Well
10	Mae Francie Burns	-	-	-	-	-	Well
11	Mary White	-	-	-	-	-	Well
12	Olin Summers	-	-	-	-	Submer-sible	Well
13	Andrew Wilson	-	-	-	-	-	Well for 2 houses
14	Mae Richards	-	-	-	-	-	Well
15	Henry Mills	-	-	-	-	-	Well
16	Henry Johnson	185	30	-	-	Jet	Well for store & 4 house trls.
17	Eddie Thompson	185	40	398	-	Submer-sible	Well*
18	Nathan Harper	168	90	-	88	Jet/7	Well for 1 house & 1 trailer*
19	Eddie Martin	207	-	-	-	Jet	Well
20	James Thompson	300+	-	-	-	Jet	Well
21	Carrie Lee Martin	-	-	-	-	-	Well for 1 house & 1 trailer

TABLE 2.1-12 (Continued)

Well (1)	Name of Owner	Well Depth (Ft.)	Water Level ft. Depth	Water Level ft. Ele.	Casing Depth (Ft.)	Pump Type/ Yield (GPM)	Remarks (2)
22	Clement Brothers Cons. (3)	-	-	-	-	Submer-sible	Well
23	Jenkinsville Water Co.	365	60	-	56	Submer-sible/ 50	Well 6" dia-meter
24	W. Martin	115	-	-	-	Jet	Well*
25	B. T. Martin	104	89	-	80+	Jet/3	Well for 2 homes*
26	B. T. Martin	65	-	-	-	Jet	Well for store
27	Siles Eubanks	75	-	-	-	-	Well for 3 houses
28	Whitehall Church	-	-	-	-	-	Well*
29	Robert Martin	235	47	399	-	Jet	Well for 2 houses
30	Wendel Martin	-	-	-	-	-	Well for 3 houses
31	Nathan F. Rabb	-	-	-	-	-	Well for 2 houses*
32	Whitehall School	-	-	-	-	Jet	Well*+
33	M. W. Hollins, Sr.	76	35	-	-	Jet	Well
34	Jenkinsville Water Co. Well #1	265	60	-	85	Submer-sible/19	Well 6" diameter+
35	Mario Hollins	-	-	-	-	-	Well
36	James Tuck Baten	65	-	-	-	-	Well for store and 1 house
37	Willie Mark Baten	220	-	-	-	Jet	Well for 2 houses+
38	James Edwards	-	-	-	-	Submer-sible	Well
39	Ruby Martin	-	-	-	-	-	Well
40	Ella B. Martin	-	-	-	-	-	Well for 2 houses*
41	Jenkinsville Water Co. Well #2	355	42	-	86	Submer-sible/30	Well 6" diameter+

Well No.[1]	Name of Owner	Well Depth (Ft.)	Water Level ft. Depth	Water Level ft. Ele.	Casing Depth (Ft.)	Pump Type/ Yield (GPM)	Remarks[2]
42	Celese Cook	-	-	-	-	Submer-sible	Well for store and 1 house*
43	Alean Baten	65	22	417	-	Jet	Well
	W. G. Heron	120	-	345	-	Jet	Well* currently not operating
45	-	-	-	-	-	-	Spring currently not used
46	-	-	-	-	-	-	"

(1) Well numbers refer to locations on Figure 2.1-31.

(2) * = dwellings connected with Jenkinsville Water Co. having operable wells not in use at present
+ = wells for which S.C. Dept. of Health & Environmental Control, Div. of Radiological Health periodically monitors for gross Alpha-beta contact.

(3) Use to be terminated upon operation of the plant.

Source: Field Survey, April 1976.

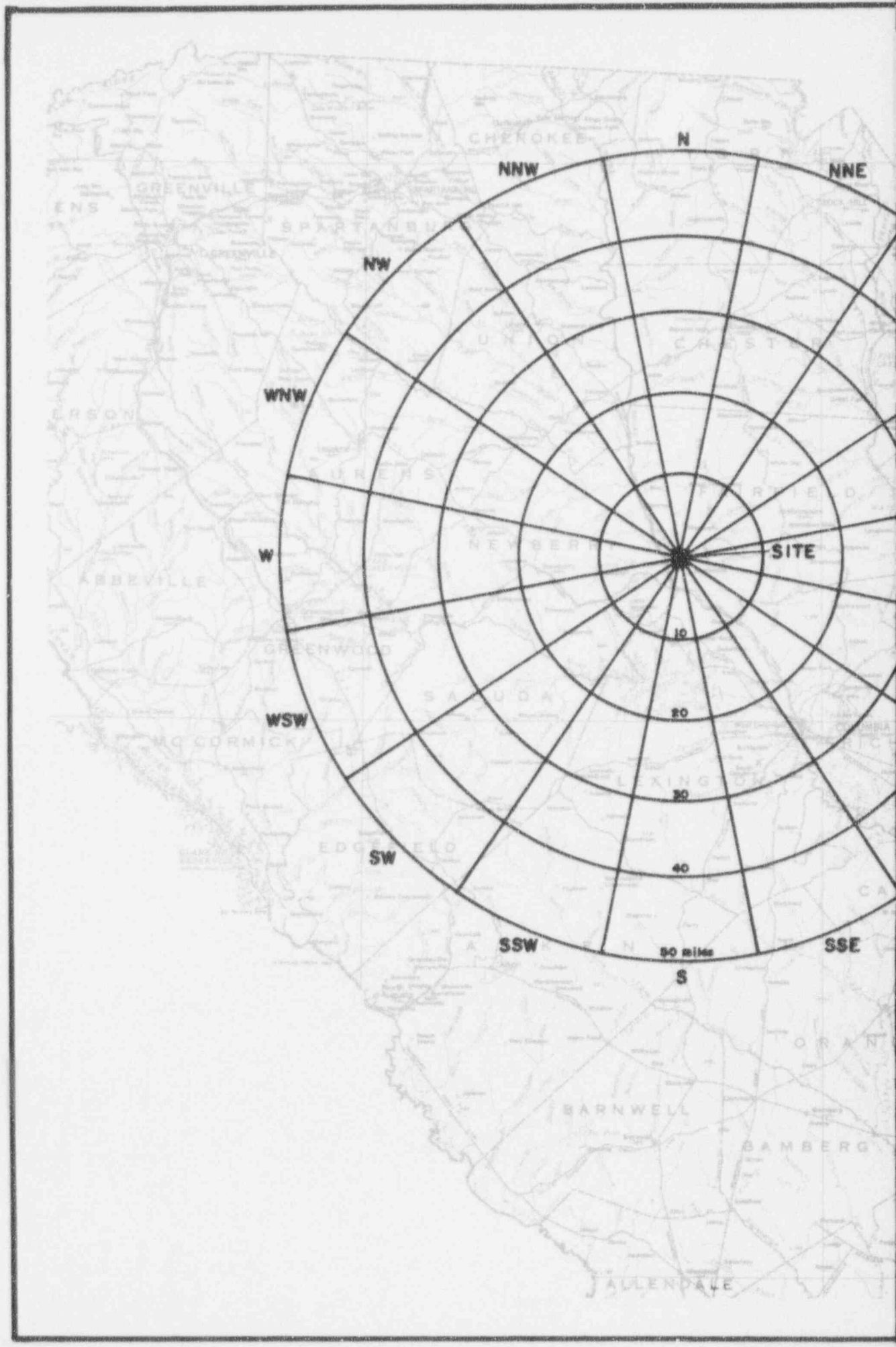
TABLE 2.1-13

SIGNIFICANT DOWNSTREAM SURFACE WATER USERS

Location Water User	Average Daily Use Drinking Water (MGD)	Population or Number of Employees	Source of Supply
Fairfield County, S. C.			
SCE&G Parr	.030		Broad River
Richland County, S. C.			
City of Columbia	27.0	228,456	Broad River, Saluda River
Lexington County, S. C.			
City of West Columbia	2.8	19,690	Saluda River
Calhoun County, S. C.			
Carolina Eastman Co.	.036	800	Congaree River
Berkeley County, S. C.			
Georgia Pacific	0.1		Lake Moultrie
Santee Wool Combing Co.	0.366		Santee River
City of Charleston	1.5		Back River Reservoir
Verona Div. Baychem Corp.	NS(1)		Back River Reservoir
The DuPont Co.	NS		Cooper River
SCE&G, Williams Station	.003	65	Cooper River
Amoco (Future Plant)	NS		Back River Reservoir
Georgetown County, S. C.			
Unknown User	NS		N. Santee River

(1) NS - Average daily use not specified for new, future, and unknown users.

Source. Reference 17.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ANSTEC
APERTURE
CARD

Also Available on
Aperture Card

REFERENCE:
THE BASE FOR THIS MAP WAS PREPARED FROM A PORTION OF USGS STATE OF SOUTH CAROLINA, 1970.

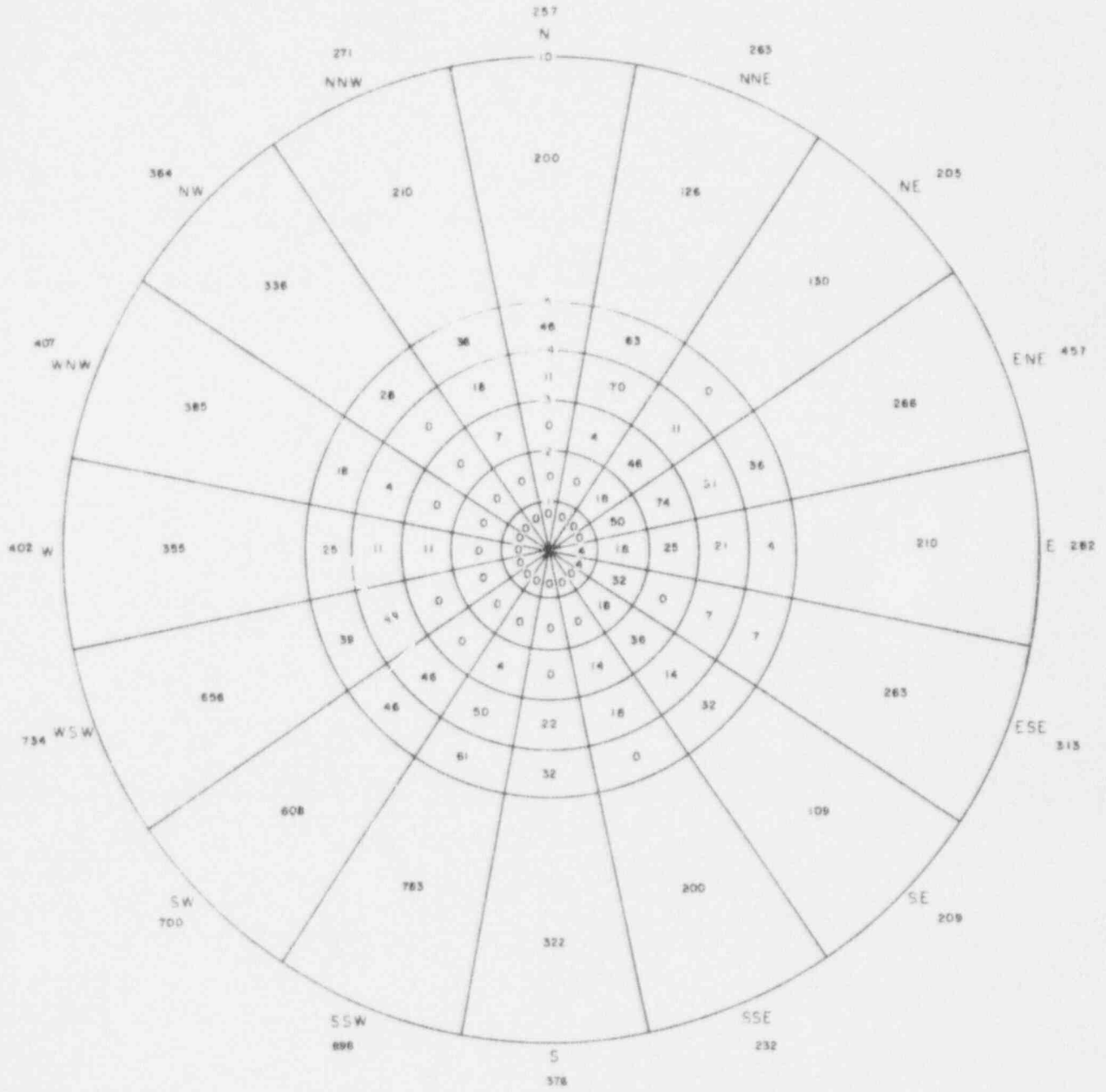
STATUTE MILES
0 5 10 20

9406090201 - //

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Regional Location Map

Figure 2.1-1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209
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200
S
378
322
SSW
896
783
SW
700
608
WSW
734
656
W
402
355
WNW
407
385
NW
364
336
NNW
271
210
200
126
63
70
0
11
36
46
74
50
18
25
21
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32
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14
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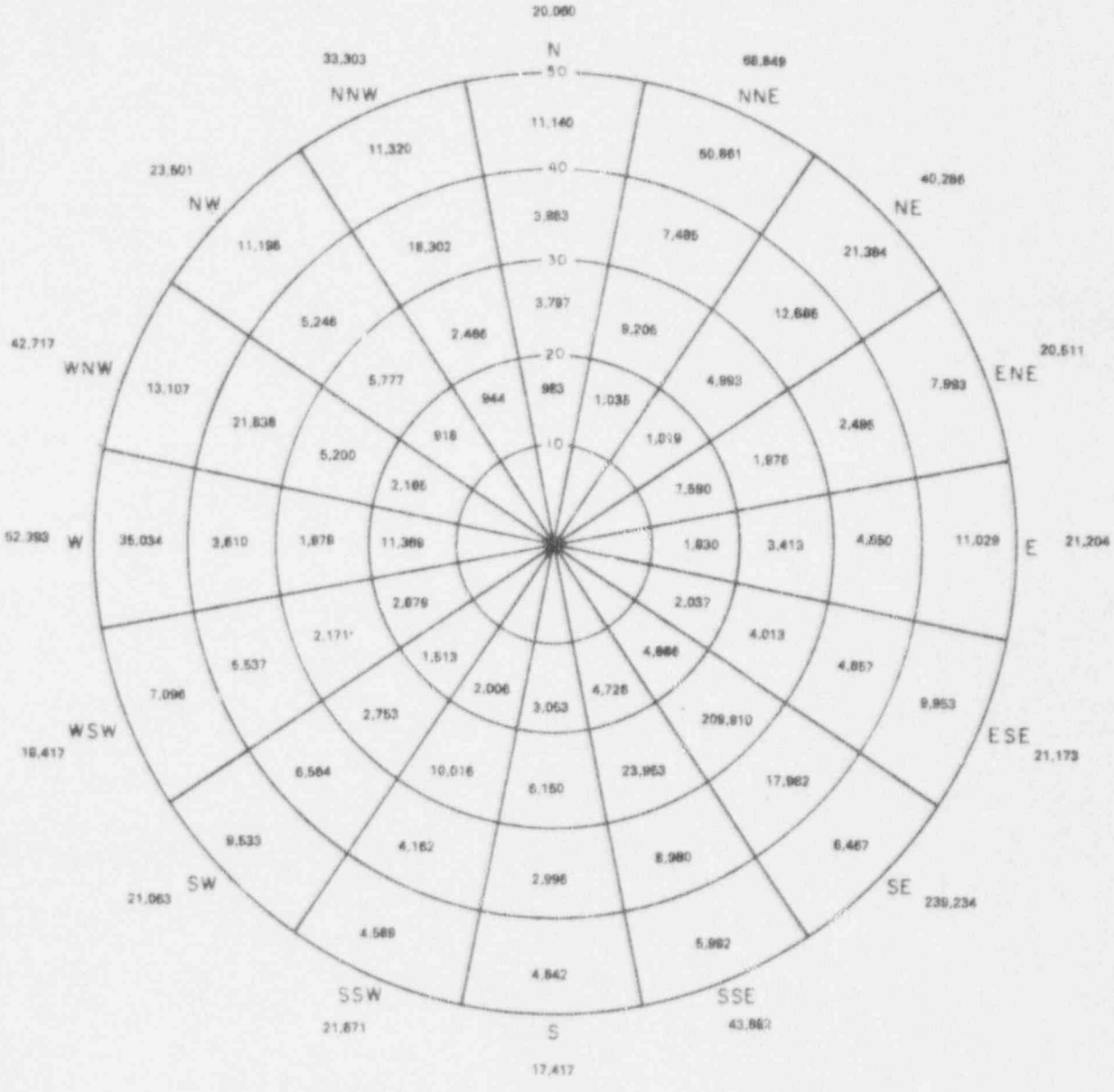


POPULATION BY ANNULAR RING

0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
6,370	48,733	297,771	131,272	221,536	699,312	705,682

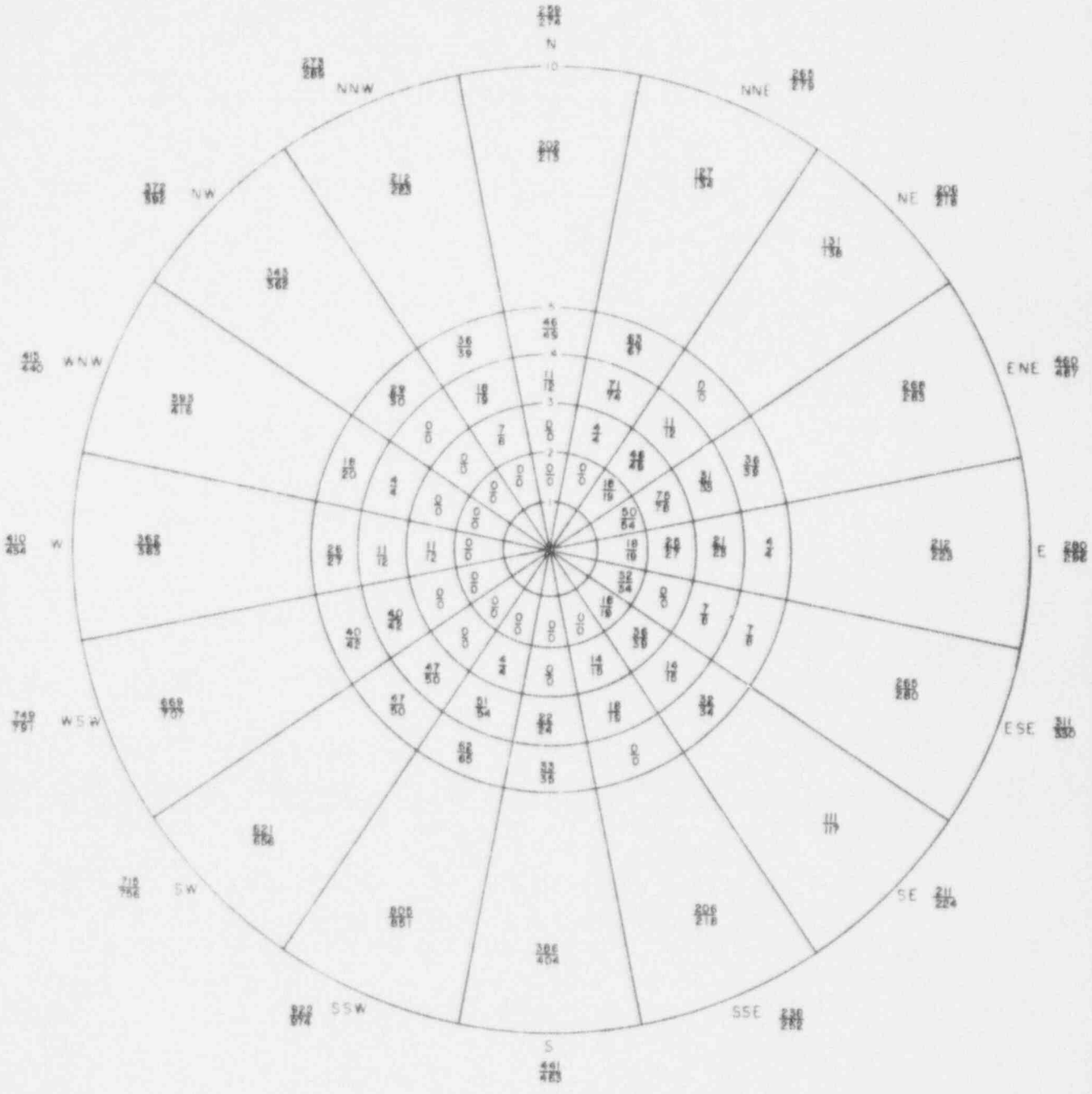
Sector Totals on Outer Circumference
0 to 10 mile populations are found on
0 to 10 mile rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Resident Population Distribution Between 10 and 50 Miles, 1970

Figure 2.1-5



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	136	222	377	479	5,313	6,527
HIGH	0	145	236	401	509	5,608	6,899

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

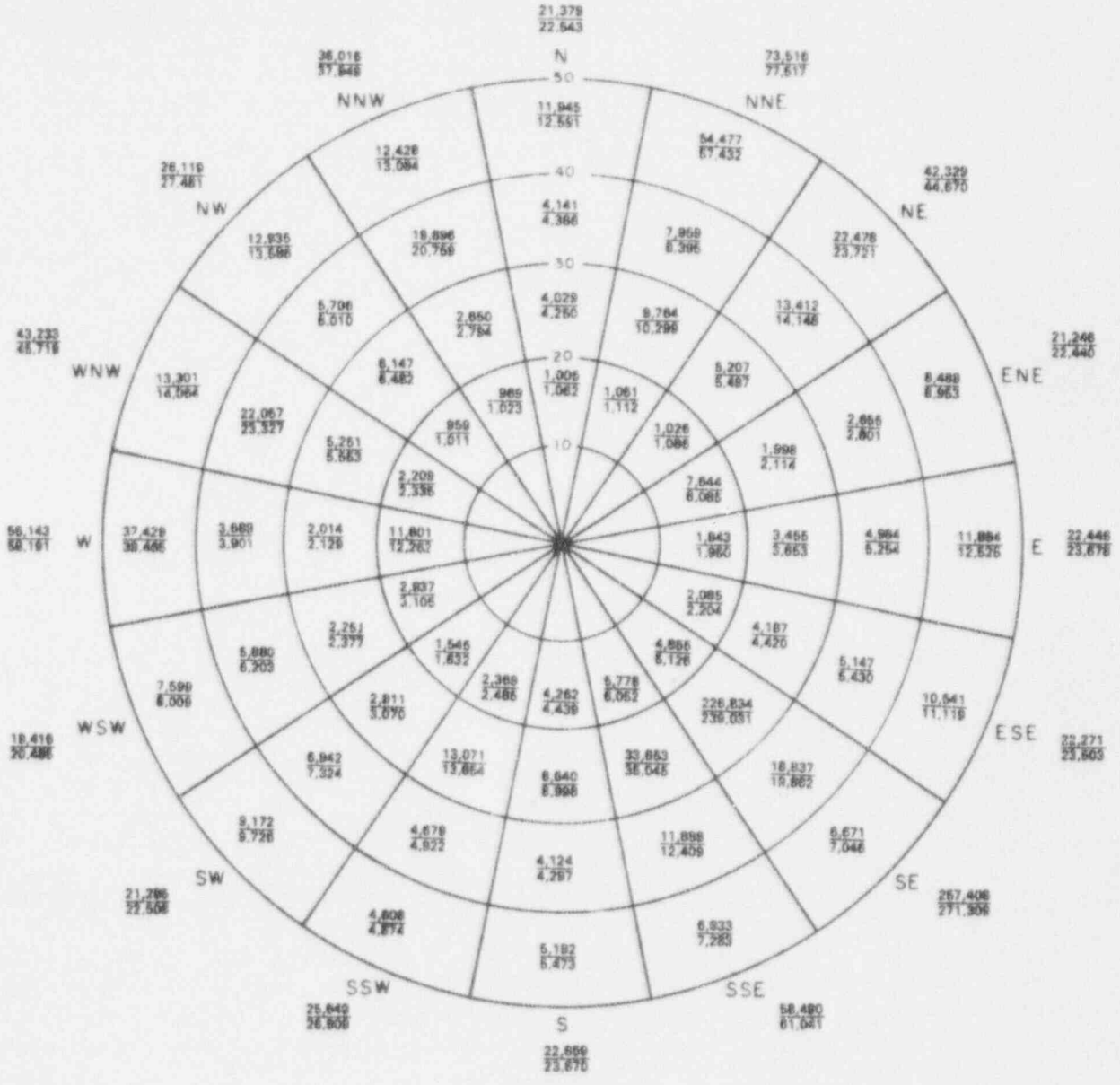
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected Resident Population Distribution up to 10 Miles, 1979

Figure 2.1-6



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	6,627	52,138	332,062	141,798	236,082	762,078	768,805
HIGH	6,889	54,989	348,386	149,428	248,951	802,714	809,613

Key:

805 = Low Projections (BEA Series E)
951 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

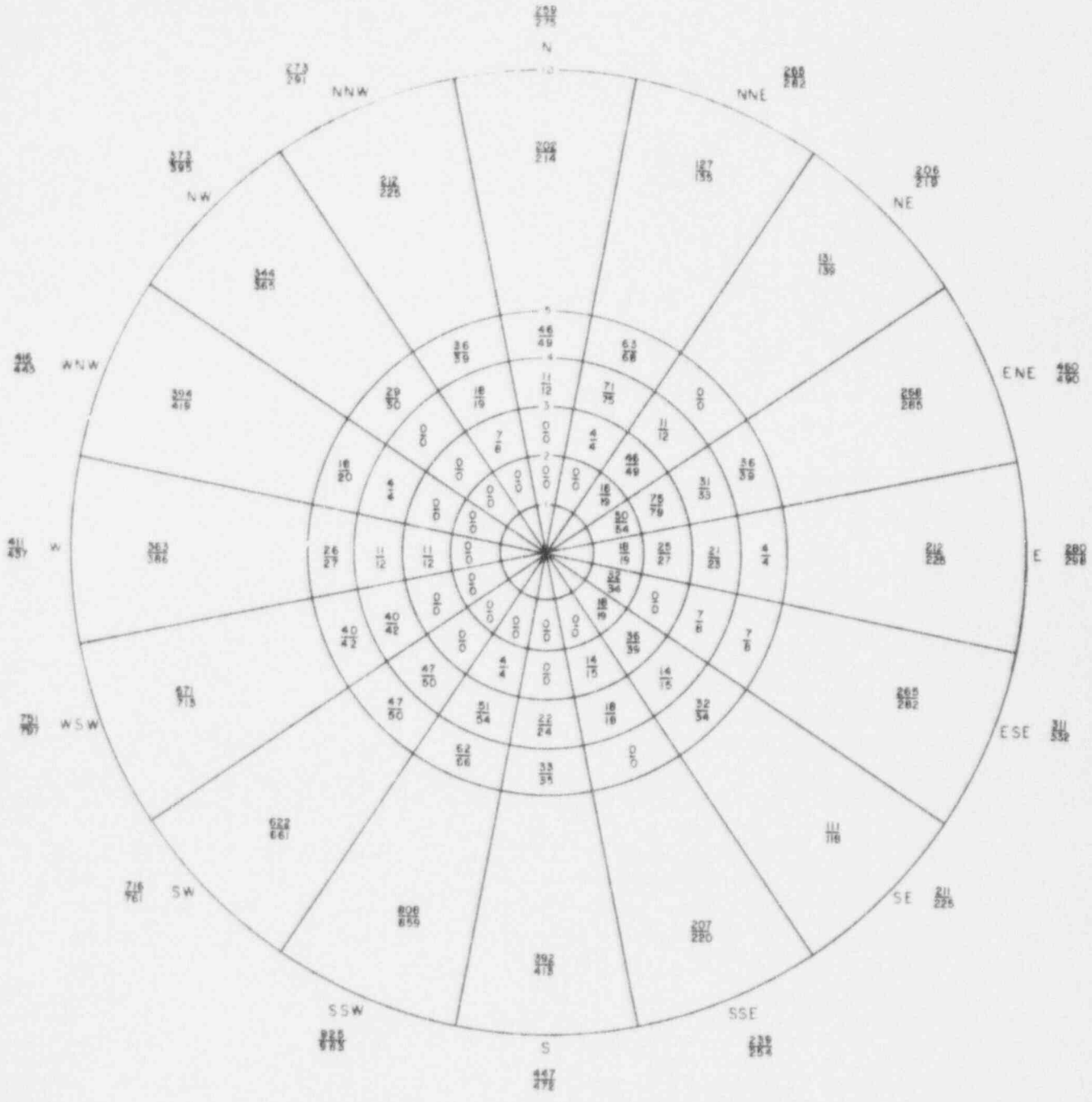
0 to 10 Mile Populations are found on 0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 1979

Figure 2.1-7



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	136	222	377	479	5,329	6,543
HIGH	0	145	237	402	511	5,659	6,954

Key:
805 = Low Projections (BEA Series E)
857 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

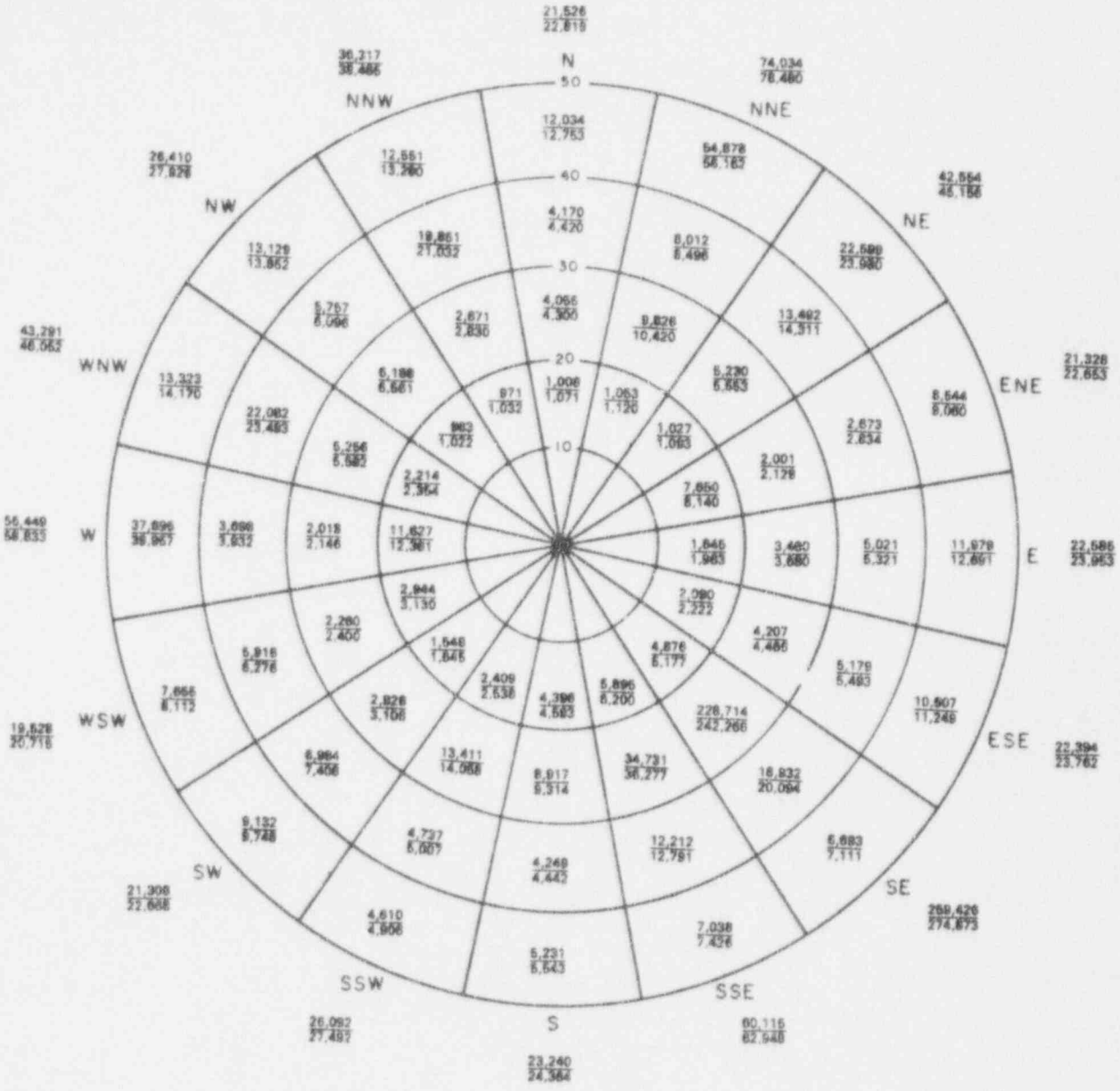
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 1980

Figure 2.1-8



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	6,543	62,616	335,873	142,967	237,696	769,054	775,597
HIGH	6,954	66,661	356,098	151,446	252,000	814,205	821,159

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

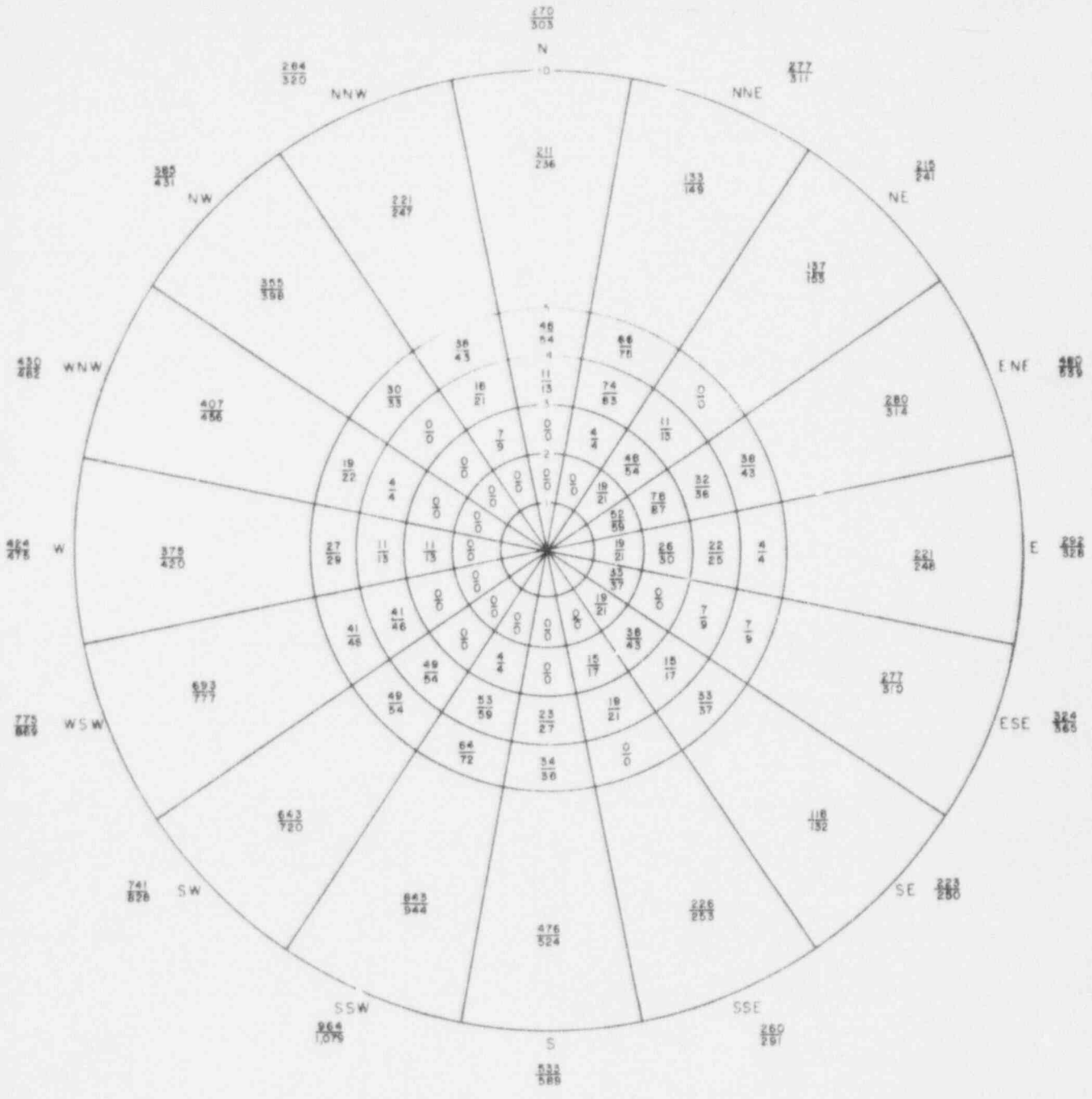
0 to 10 Mile Populations are found on
0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 1980

Figure 2.1-9



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	142	231	390	498	5616	6,877
HIGH	0	159	261	441	559	6281	7,701

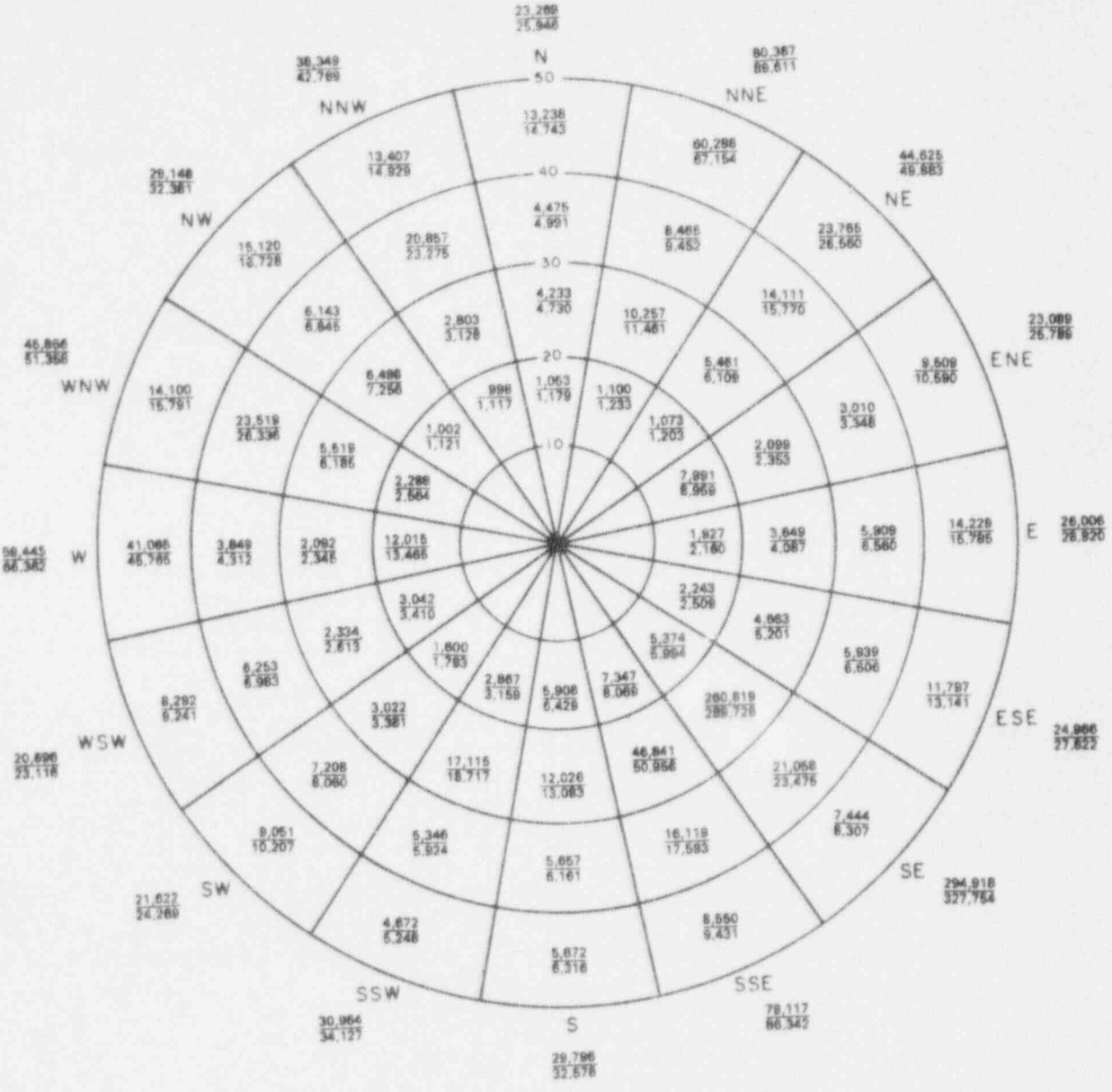
Key:
BOS = Low Projections (BEA Series E)
BST = High Projections (BEA Alternate Method)
Sector Totals on Outer Circumference
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 1990

Figure 2.1-10



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	6,877	57,828	389,431	157,918	260,199	865,376	872,253
HIGH	7,701	64,364	431,335	175,691	289,936	961,326	969,027

Key:
805 = Low Projections (BEA Series E)
857 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

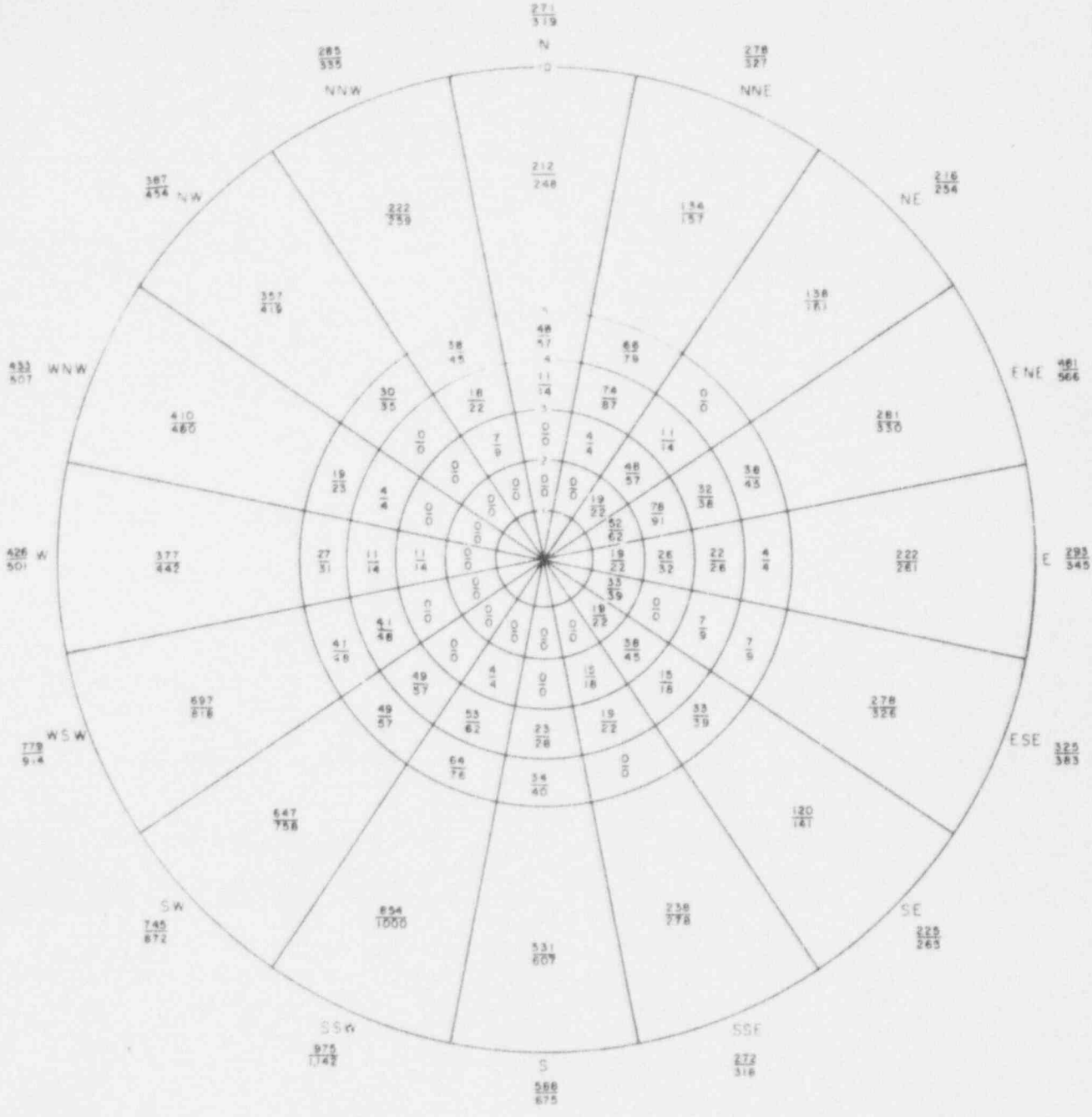
0 to 10 Mile Populations are found on
0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 1990

Figure 2.1-11



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	142	231	390	498	5,718	6,979
HIGH	0	167	274	463	588	6,685	8,177

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

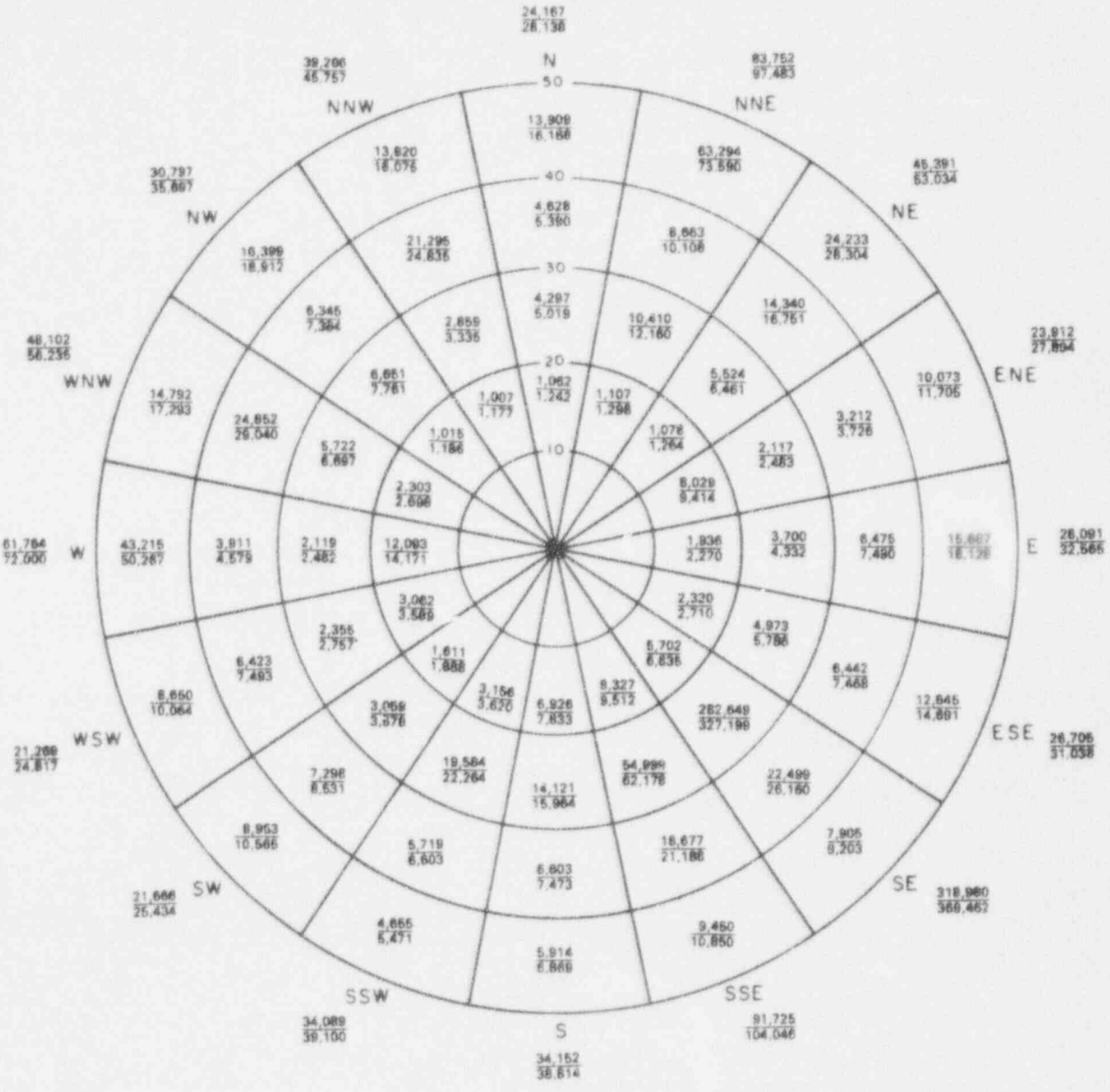
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 2000

Figure 2.1-12



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	6,979	80,734	425,139	167,382	273,594	926,849	933,828
HIGH	8,177	70,507	490,456	194,219	318,155	1,073,337	1,081,514

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

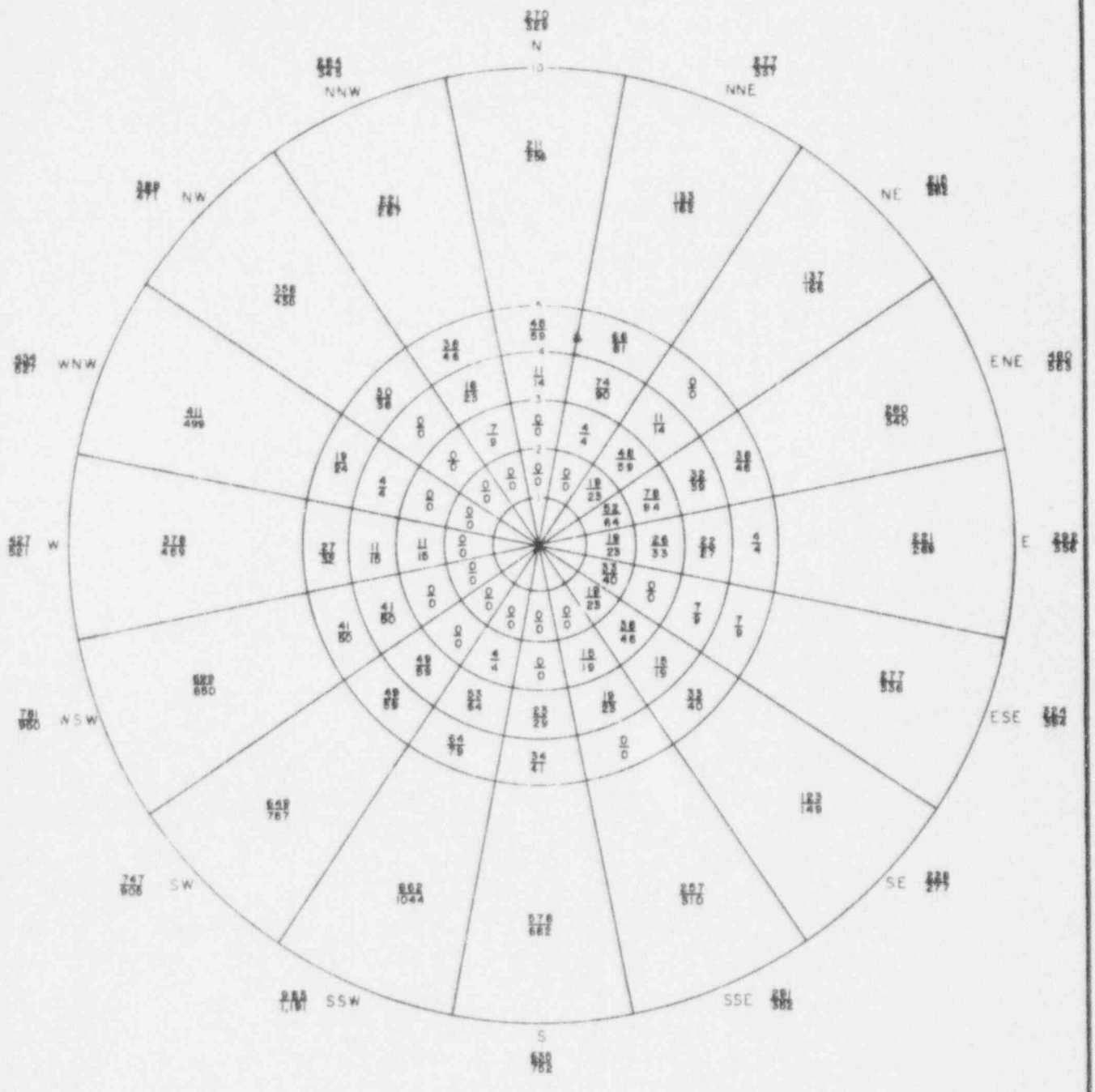
0 to 10 Mile Populations are found on
0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 2000

Figure 2.1-13



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	142	231	390	498	5,795	7,056
HIGH	0	173	283	479	606	7,011	8,552

Key:
805 = Low Projections (BEA Series E)
857 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

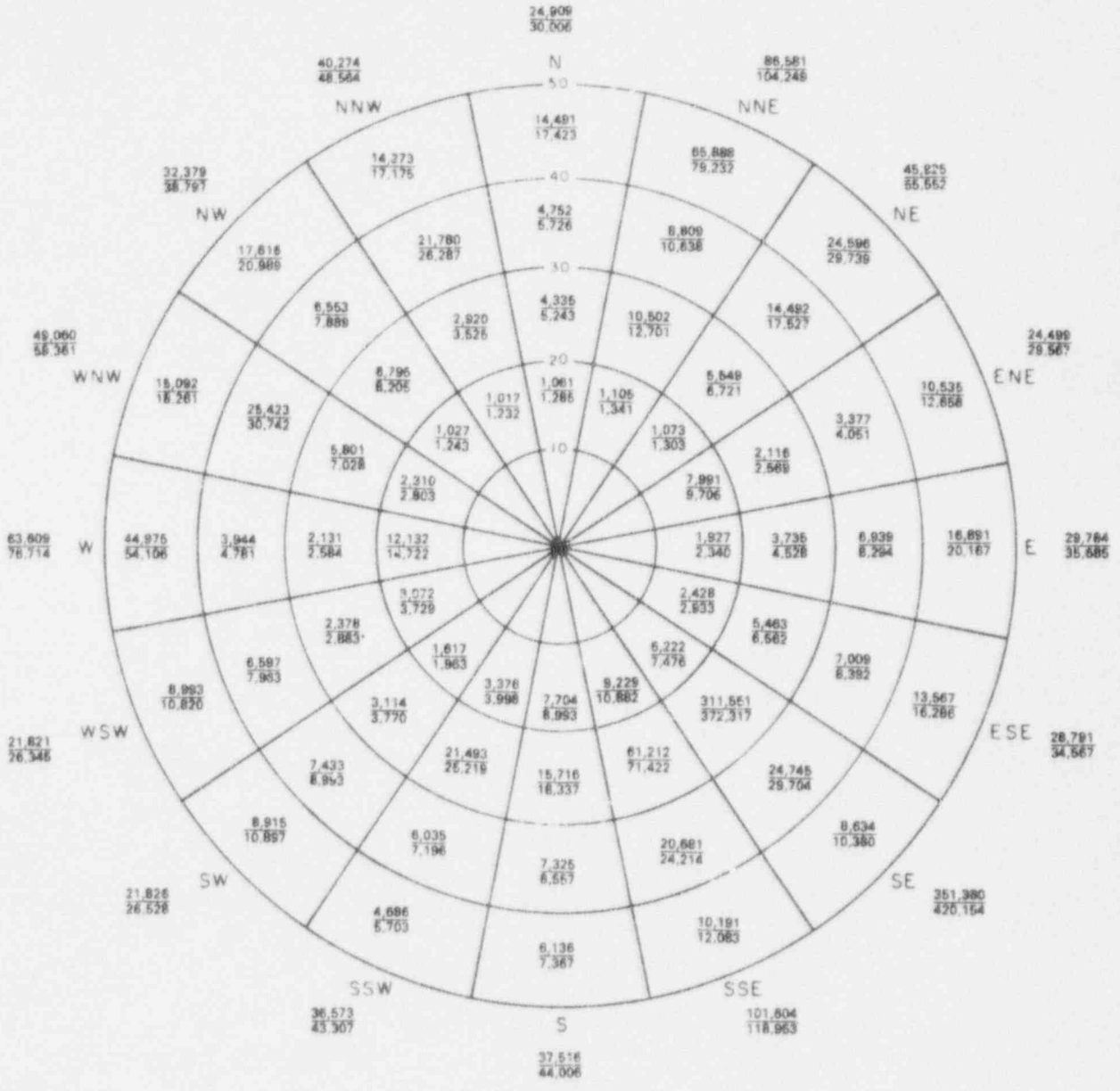
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 2010

Figure 2.1-14



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	7,056	83,291	464,811	175,894	285,479	989,475	996,531
HIGH	8,562	75,949	553,614	210,954	343,286	1,183,803	1,192,356

Key:

805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

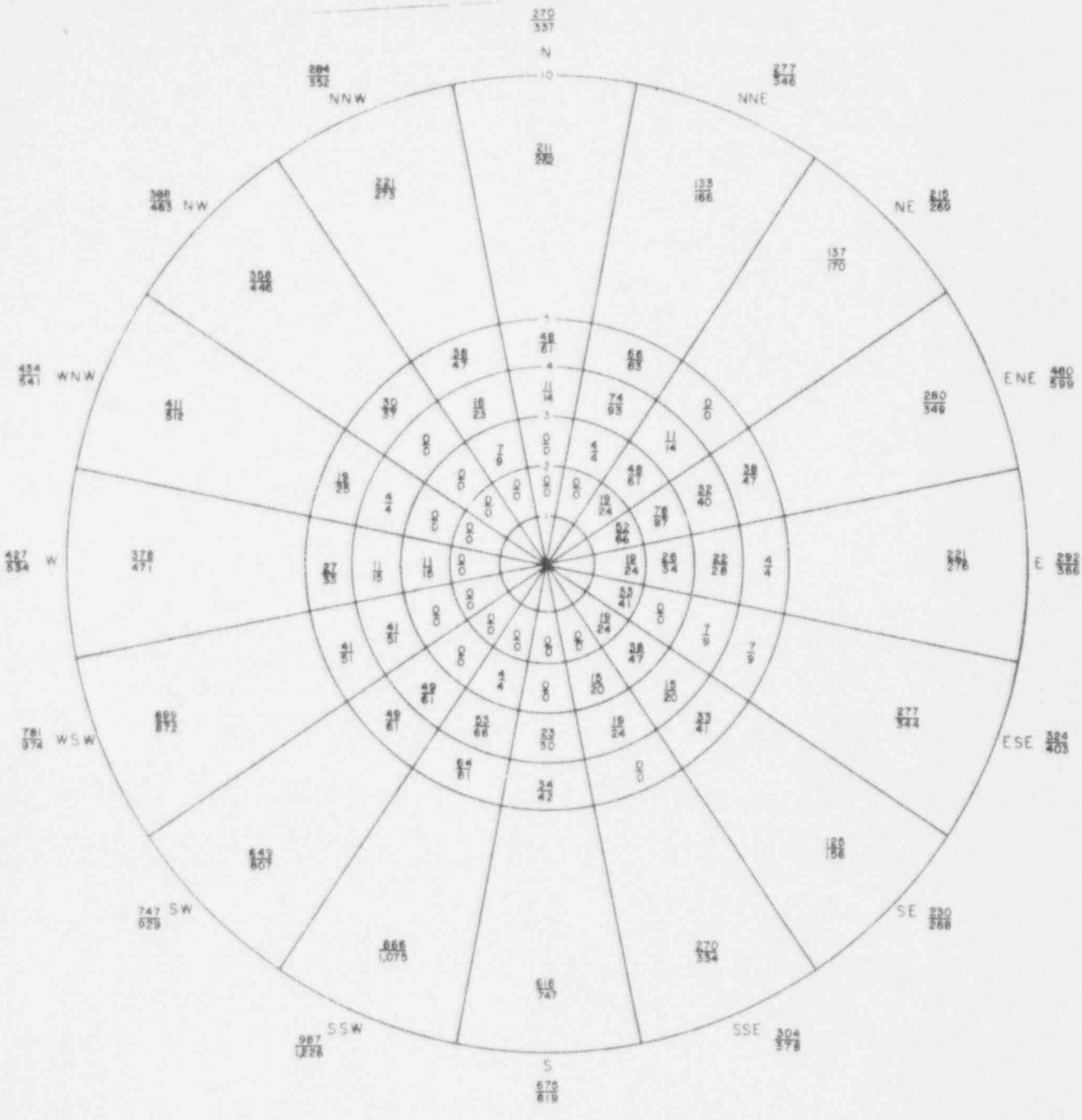
0 to 10 Mile Populations are found on 0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 2010

Figure 2.1-15



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	142	231	390	498	5,854	7,115
HIGH	0	179	291	492	622	7,260	8,844

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

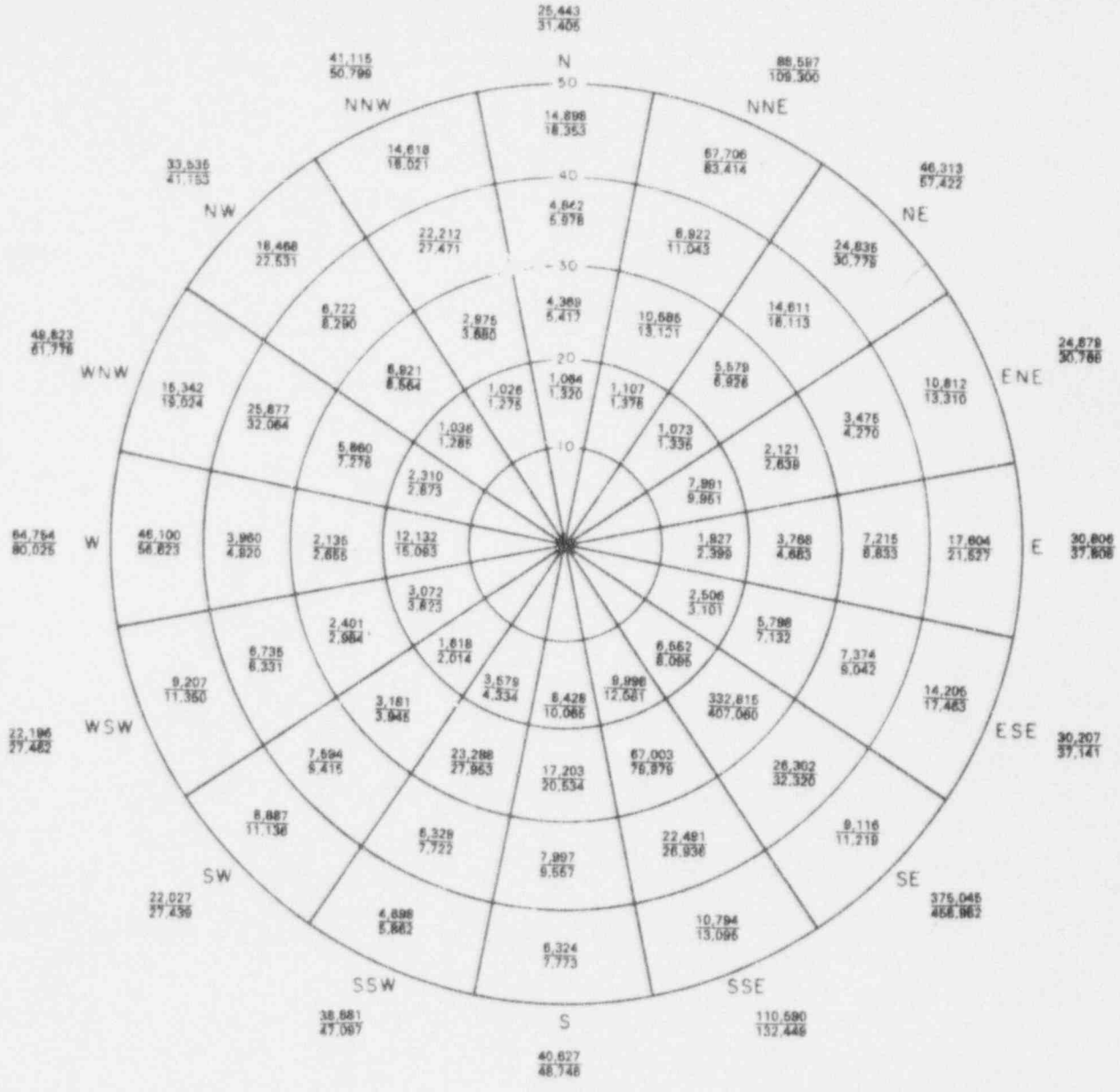
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 2019

Figure 2.1-16



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	7,116	66,449	496,002	182,658	293,614	1,037,723	1,044,838
HIGH	8,844	80,400	604,548	224,305	361,680	1,270,993	1,279,777

Key:

805 = Low Projections (BEA Series E)

851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

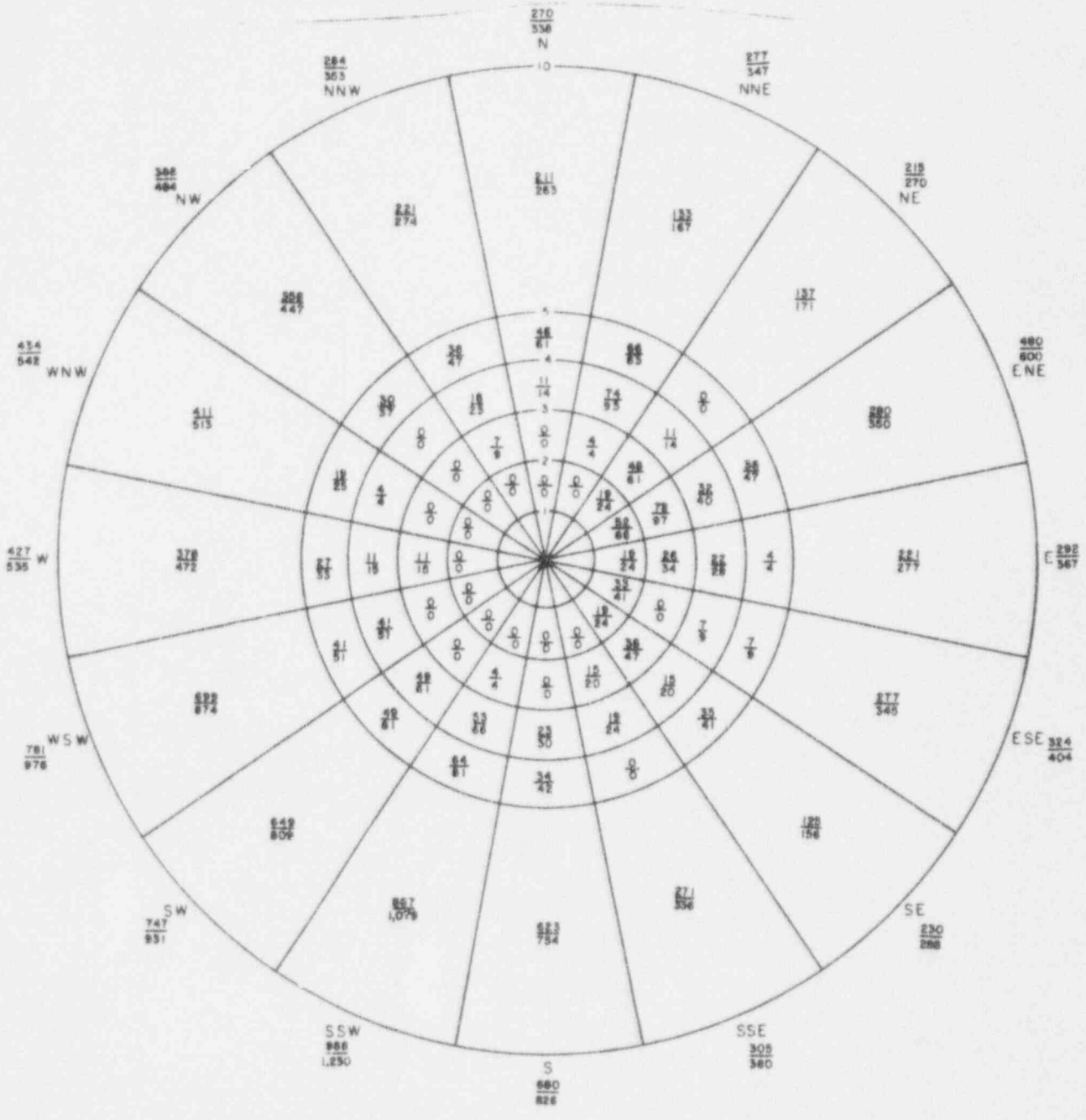
0 to 10 Mile Populations are found on 0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 2019

Figure 2.1-17



POPULATION BY ANNULAR RING

PROJECTION	0-1 MI	1-2 MI	2-3 MI	3-4 MI	4-5 MI	5-10 MI	0-10 MI TOTAL
LOW	0	142	231	390	498	5,861	7,122
HIGH	0	179	291	492	622	7,287	8,871

Key:
805 = Low Projections (BEA Series E)
857 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

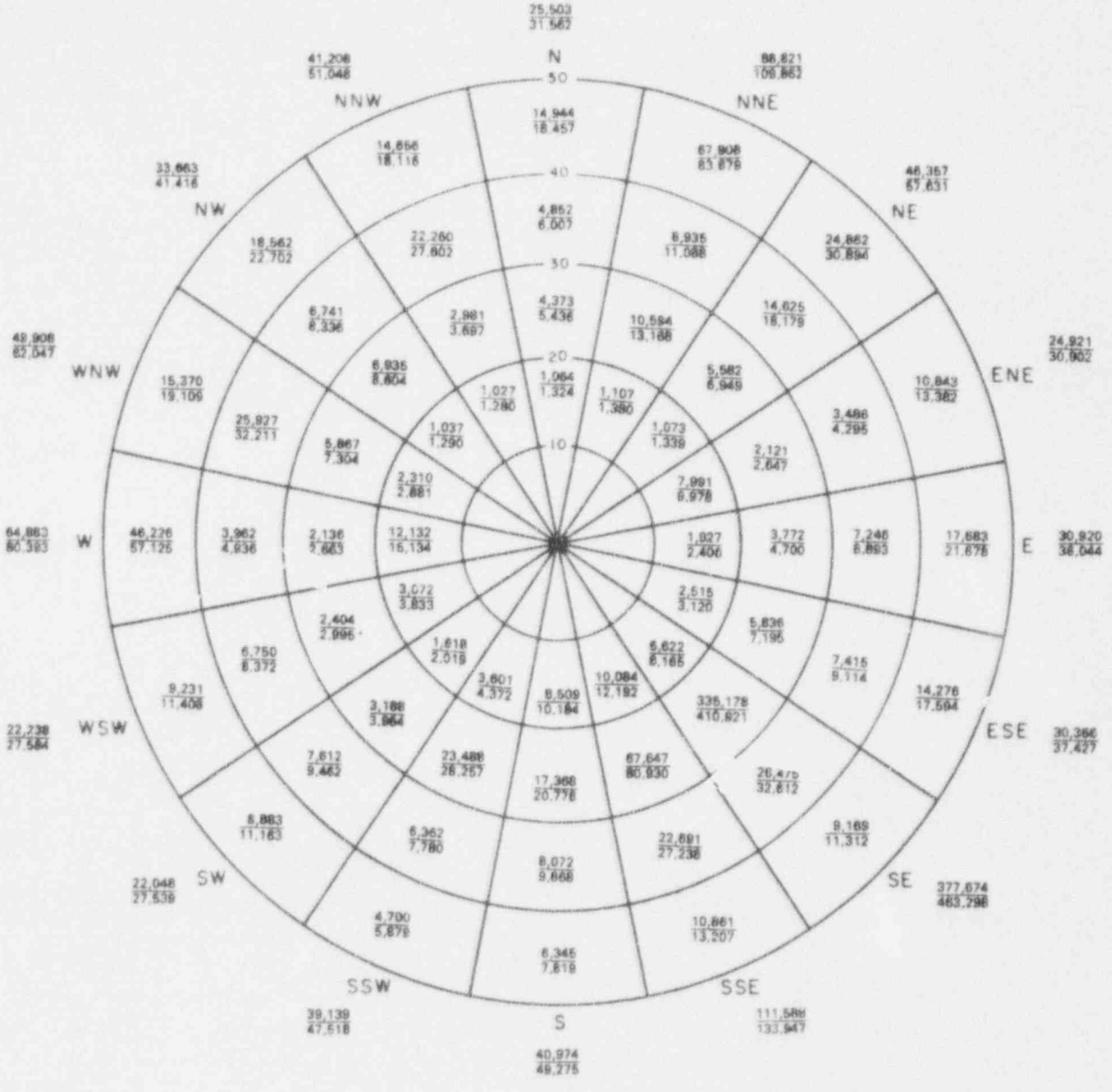
All 0-1 Mile Sectors Have Zero Population

Note: Population Annuli in Relation to Major Area Features are Shown on Figure 2.1-26.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
up to 10 Miles, 2020

Figure 2.1-18



POPULATION BY ANNULAR RING

PROJECTION	0-10 MI	10-20 MI	20-30 MI	30-40 MI	40-50 MI	10-50 MI	0-50 MI TOTAL
LOW	7,122	65,689	499,470	183,411	294,519	1,043,089	1,050,211
HIGH	8,871	80,897	610,208	225,793	363,724	1,280,622	1,289,493

Key:
805 = Low Projections (BEA Series E)
851 = High Projections (BEA Alternate Method)

Sector Totals on Outer Circumference

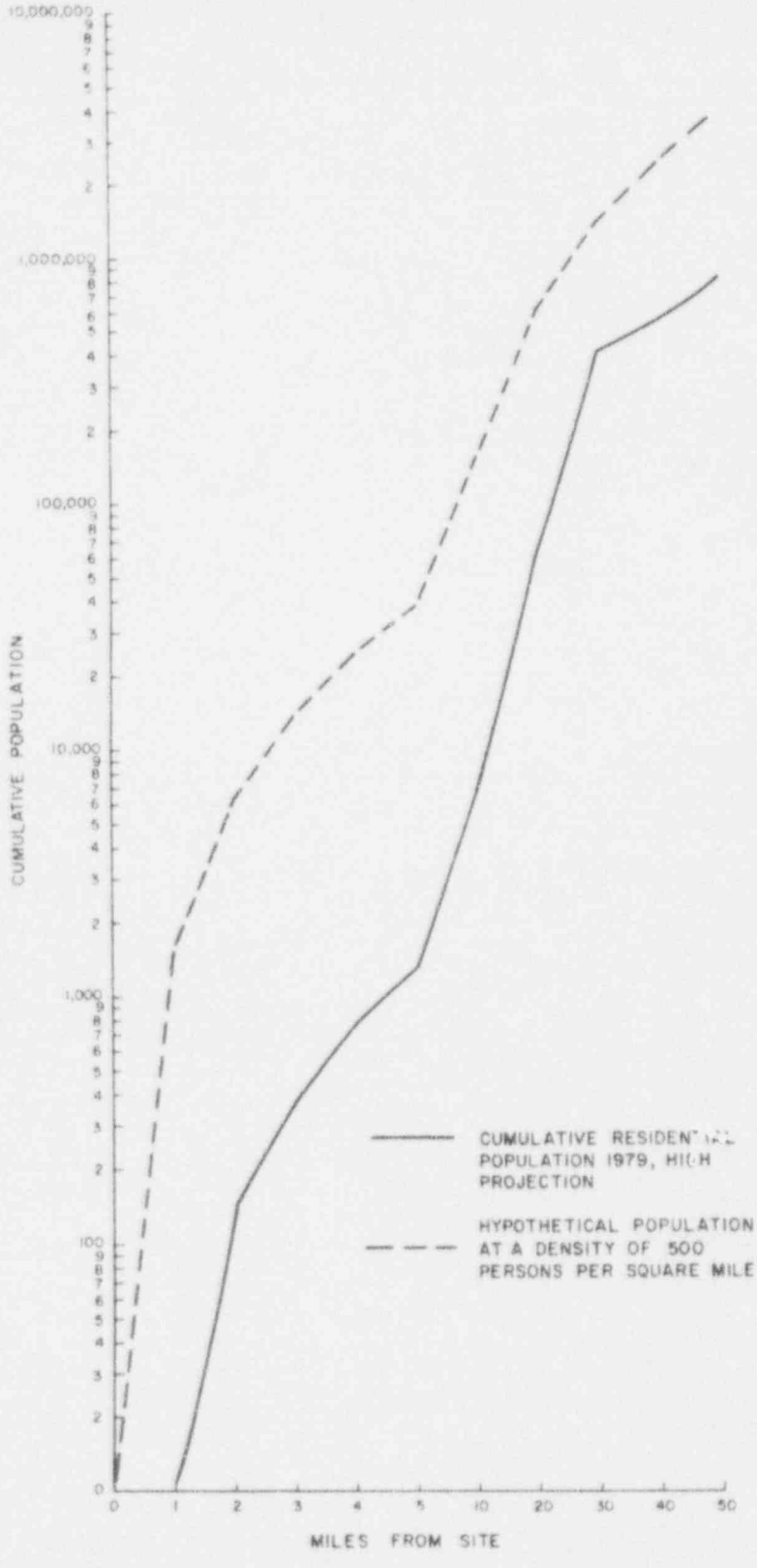
0 to 10 Mile Populations are found on 0 to 10 Mile Rose

Note: Population Annuli in Relation to Major Area Features are Shown in Figures 2.1-1 and 2.1-22.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected
Resident Population Distribution
Between 10 and 50 Miles, 2020

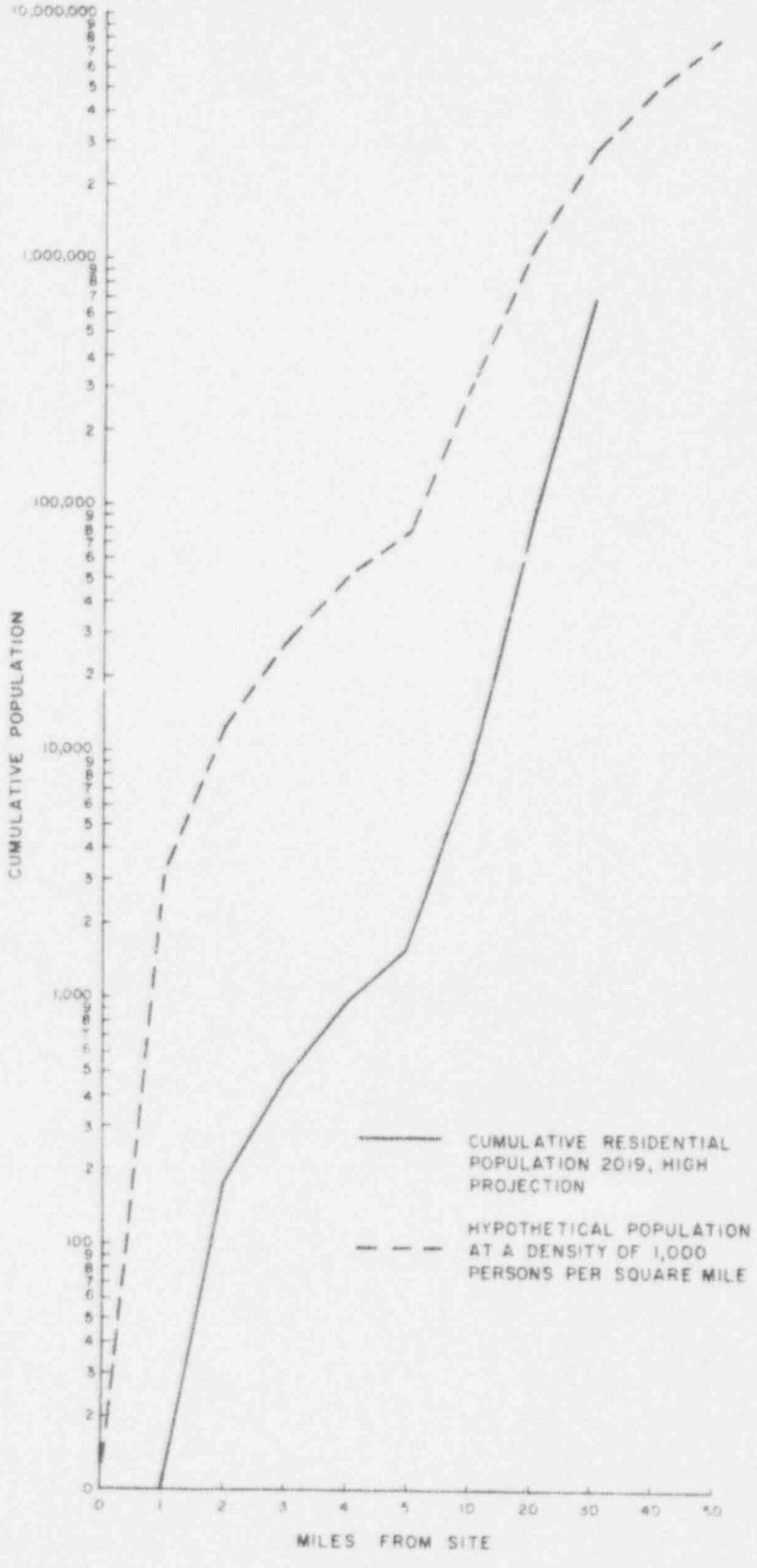
Figure 2.1-19



South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected Cumulative Residential Population - 1979

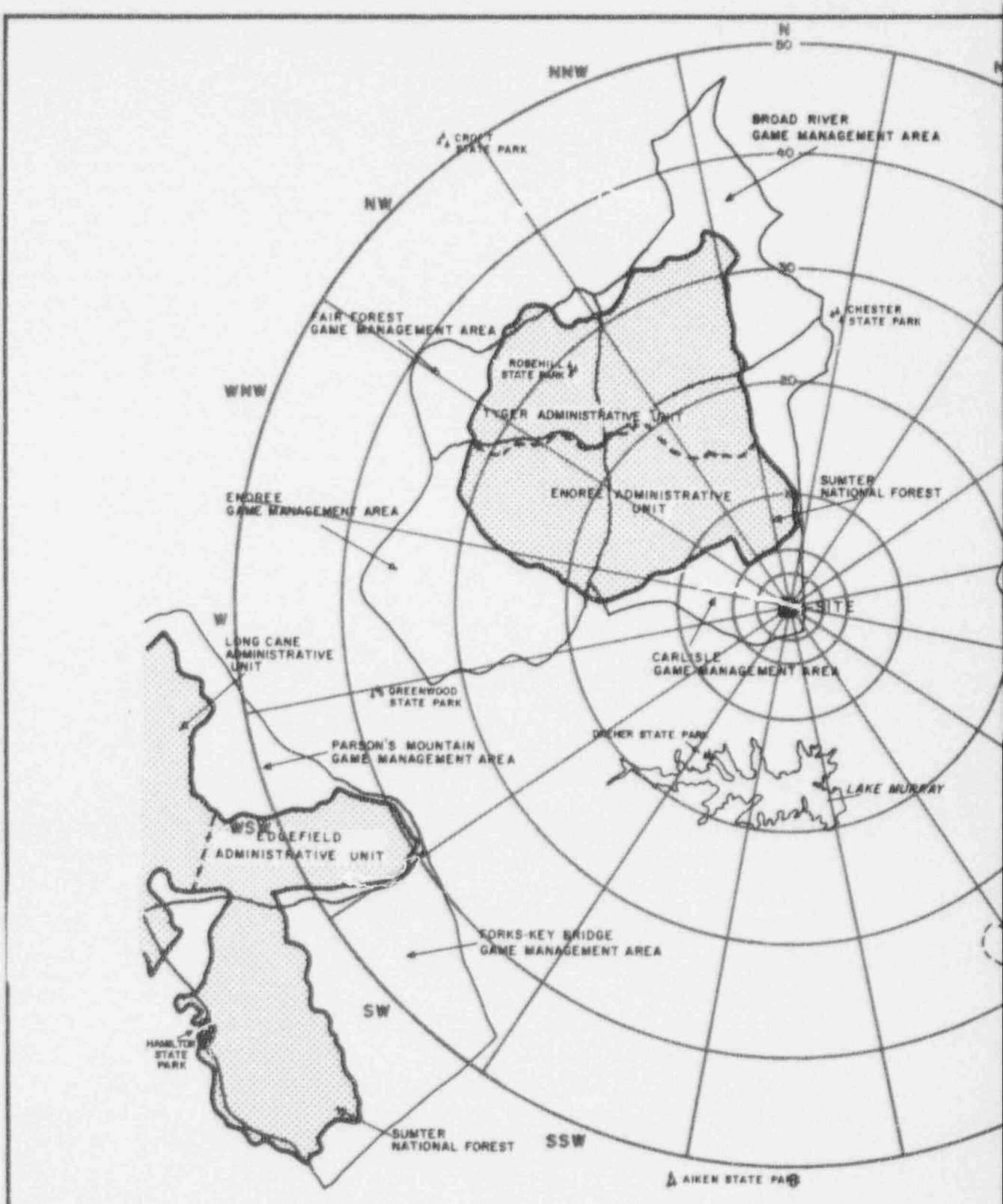
Figure 2.1-20



South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected Cumulative Residential Population - 2019

Figure 2.1-21



REFERENCE: BASE MAP FROM U.S.G.S. MAP, SOUTH CAROLINA, 1:500,000 1970. PARK FEATURES FROM SOUTH CAROLINA 1975 PRIMARY HIGHWAY SYSTEM MAP. NATIONAL FOREST FEATURES FROM U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, SUMTER NATIONAL FOREST MAP, 1964. GAME MANAGEMENT AREAS FROM U.S. ARMY CORP OF ENGINEERS, ENVIRONMENTAL RECONNAISSANCE INVENTORY OF THE CHARLESTON DISTRICT, 1973.

ANSTEC APERTURE CARD

Also Available on Aperture Card

LEGEND:

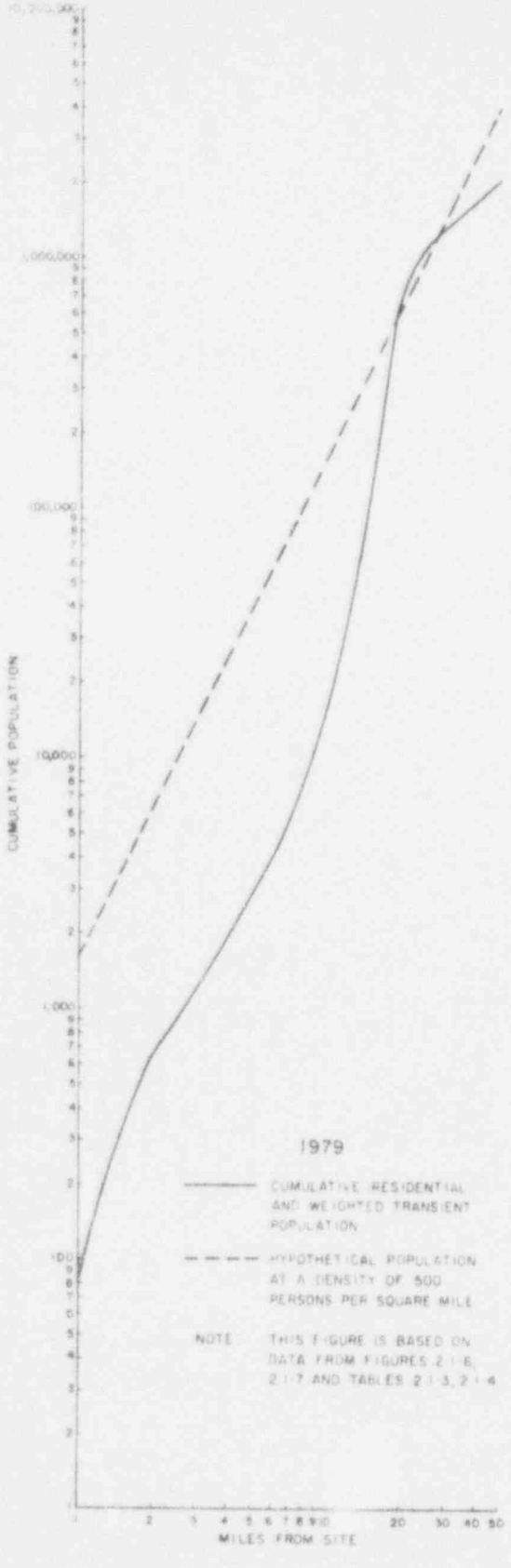
- STATE PARK
- GAME MANAGEMENT AREA
- ADMINISTRATIVE UNIT
- SUMTER NATIONAL FOREST

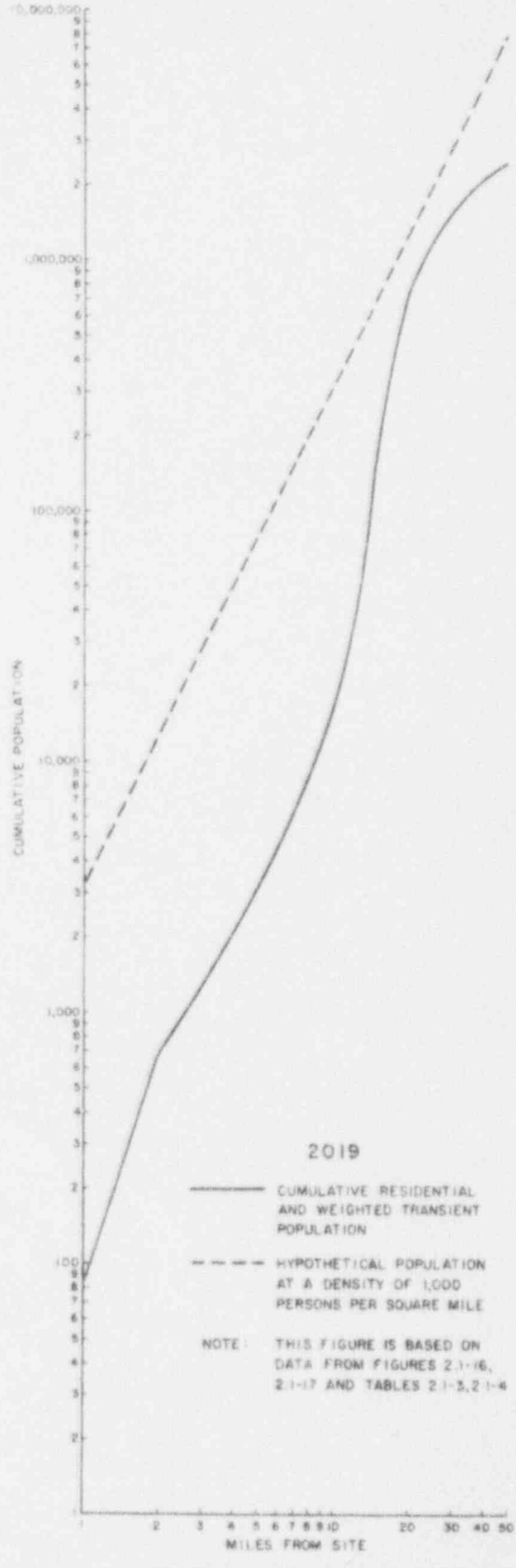
9406090201-12

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

National Forests, State Parks and Selected Recreation Areas within 50 Miles of the Site

Figure 2.1-22





South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Projected Cumulative Residential and Weighted Transient Population - 1979 and 2019

Figure 2.1-23

SUMTER
NATIONAL FOREST
MONTICELLO
RESERVOIR
VIRGIL C.
SUMMER
NUCLEAR
STATION
SITE AREA
BROAD
RIVER
Bellers Creek
Cannons Creek
5 miles

N

ANSTEC
APERTURE
CARD

Also Available on
Aperture Card

REFERENCE: THE BASE FOR THIS MAP IS FROM U.S.G.S. 7 1/2'
QUADRANGES: JENKINSVILLE (1969)
POMARIA (1969)
CHAPIN (1971)
RION (1969)
RICHTEX (1971)
LITTLE MOUNTAIN (1971)

STATUTE MILES

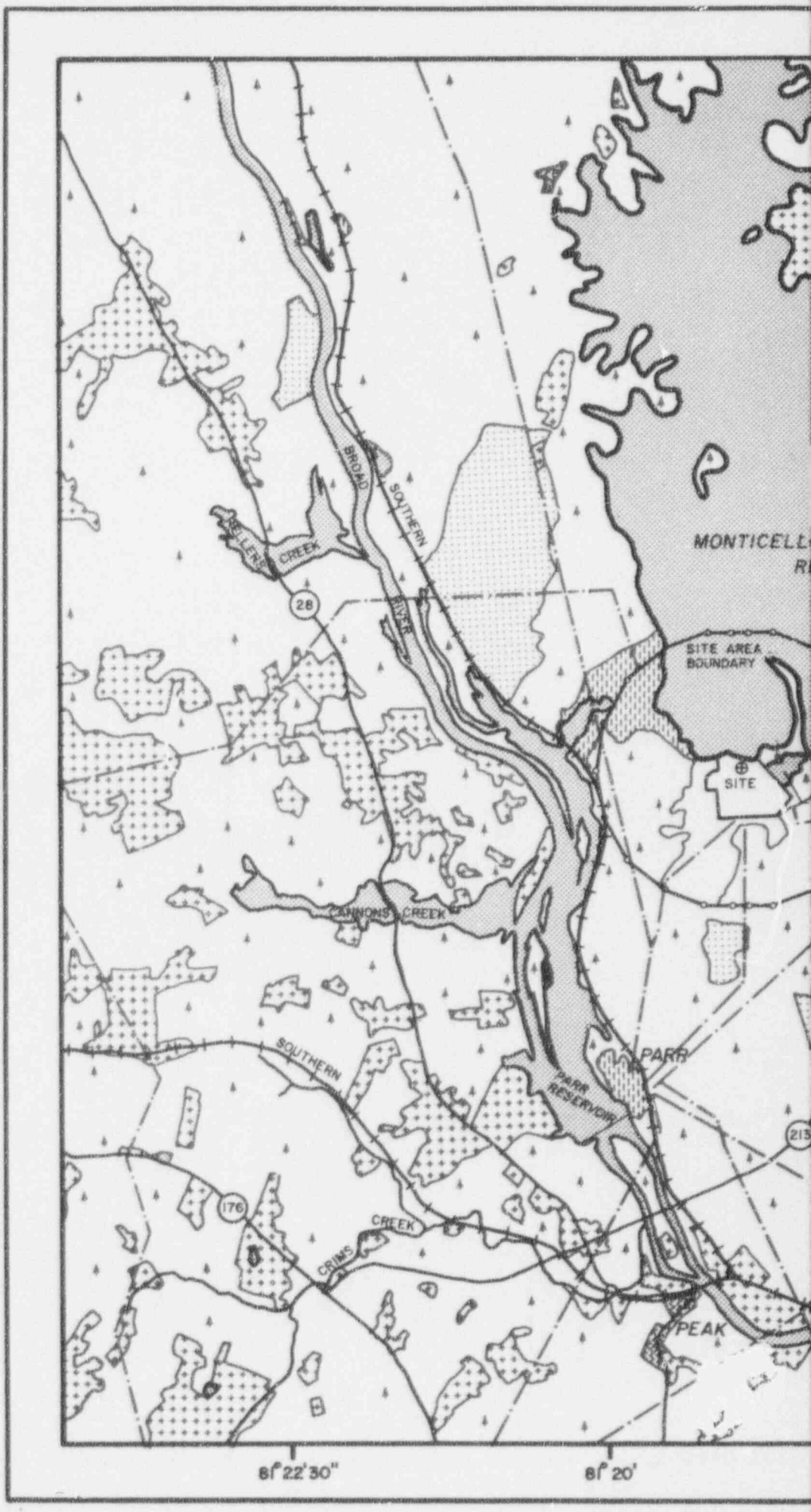
1 1/2 0 1 2

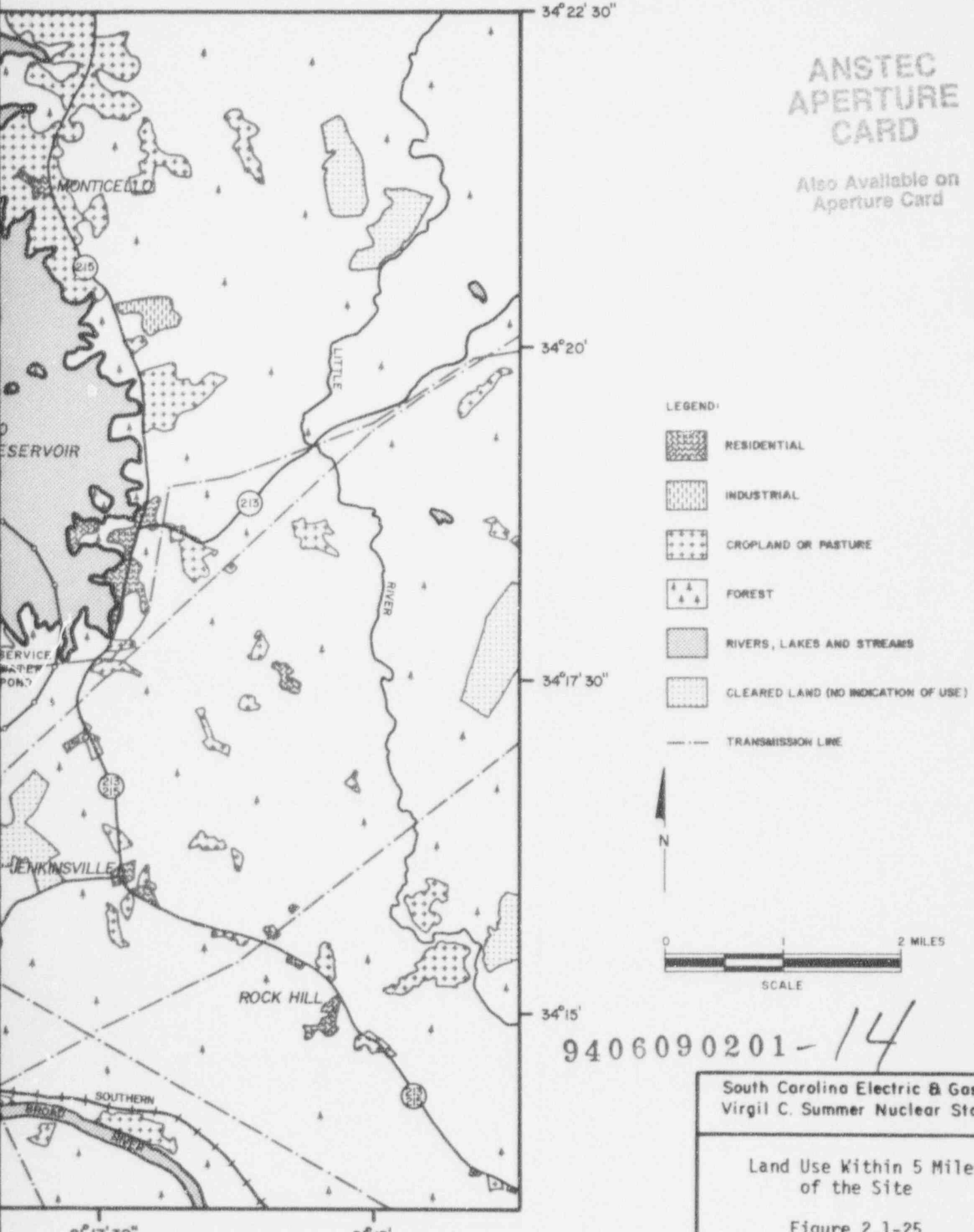
9406090201-13

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Topographic Features

Figure 2.1-24


BROAD
SOUTHERN
RIVER
CREEK
28
SITE AREA
BOUNDARY
SITE
CANNONS CREEK
SOUTHERN
PARR
PARR
RESERVOIR
176
CRIMS
CREEK
PEAK
81° 22' 30"
81° 20'



ANSTEC APERTURE CARD

Also Available on Aperture Card

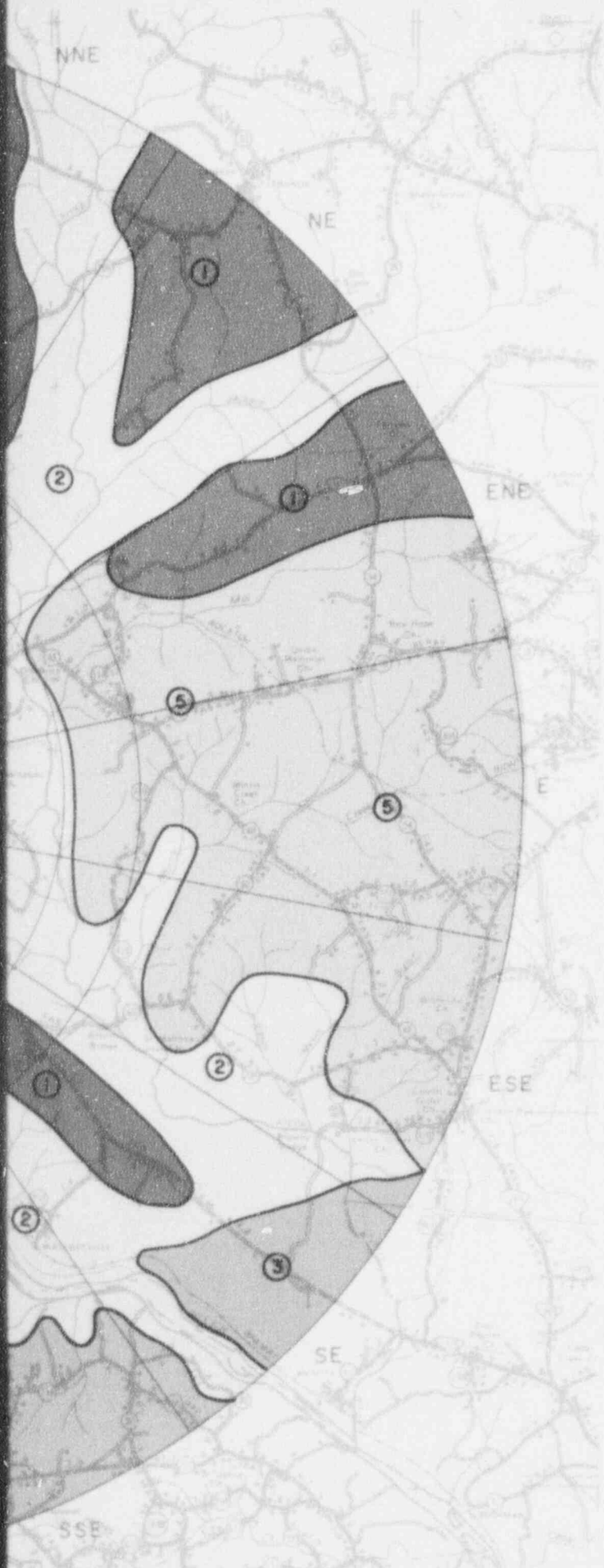
9406090201-14

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Land Use Within 5 Miles of the Site

Figure 2.1-25

N
NNW
NW
WNW
W
WSW
SW
SSW
S
SITE
1
2
3
4
5
6
1 mile
2 miles
3 miles
4 miles
10 miles



ANSTEC APERTURE CARD

Also Available on Aperture Card

N

LEGEND:

MAP UNIT	DESCRIPTION
①	LAND USE - ABOUT 70% WOODLAND, 20% PASTURE, AND 10% CROPLAND. TOPOGRAPHY - BROAD TO NARROW GENTLY SLOPING RIDGETOPS DISSECTED BY MANY SHALLOW DRAINS.
②	LAND USE - ABOUT 95% WOODLAND, 10% PASTURE, AND 5% CROPLAND. TOPOGRAPHY - DISSECTED SHORT, NARROW TO MEDIUM RIDGETOPS WITH STEEP SIDE SLOPES ADJACENT TO MANY MEDIUM-SIZED DRAINS AND A FEW MAJOR DRAINAGEWAYS.
③	LAND USE - ABOUT 80% WOODLAND, 10% PASTURE, 5% CROPLAND, AND 5% IN RESIDENTIAL DEVELOPMENT. TOPOGRAPHY - BROAD, GENTLY SLOPING TO NEARLY LEVEL RIDGETOPS WITH A FEW SMALL SHALLOW DRAINS.
④	LAND USE - ABOUT 75% CROPLAND, 20% WOODLAND, AND 5% PASTURE. TOPOGRAPHY - BROAD, GENTLY SLOPING RIDGETOPS CUT BY MANY SHALLOW DRAINS.
⑤	LAND USE - ABOUT 45% WOODLAND, 35% PASTURE, 15% CROPLAND, AND 5% IN RESIDENTIAL DEVELOPMENT TOPOGRAPHY - BROAD, MODERATELY DISSECTED RIDGETOPS.
⑥	LAND USE - ABOUT 75% WOODLAND, 20% PASTURE, AND 5% CROPLAND. TOPOGRAPHY - NEARLY LEVEL STREAM BOTTOMLAND AND ADJACENT SLOPING TERRACES.

REFERENCE:

THE BASE FOR THIS MAP WAS PREPARED FROM ENLARGED PORTIONS OF THE FOLLOWING SOUTH CAROLINA STATE HIGHWAY DEPARTMENT, GENERAL HIGHWAY MAPS: LEXINGTON COUNTY 1958, REVISED 1970, NEWBERRY COUNTY, 1961, REVISED 1970, FAIRFIELD COUNTY 1962, REVISED 1970, AND RICHLAND COUNTY 1963, REVISED 1969.

ADAPTED FROM GENERAL SOIL MAPS OF NEWBERRY, FAIRFIELD, AND RICHLAND COUNTIES, SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, CLEMSON UNIVERSITY IN COOPERATION WITH U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE, 1967, 1956, AND 1968, RESPECTIVELY.

STATUTE MILES

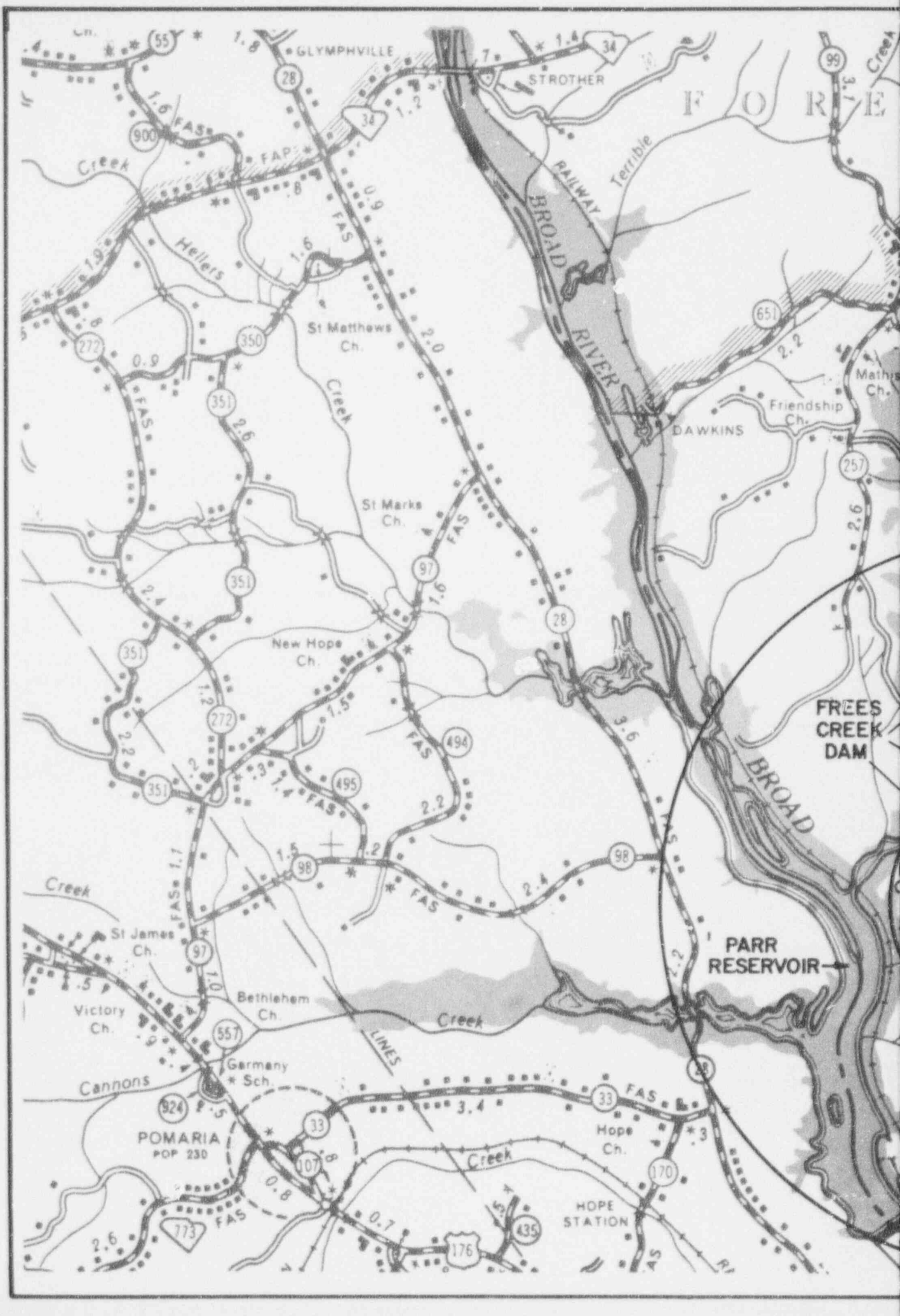
1 0 1 2

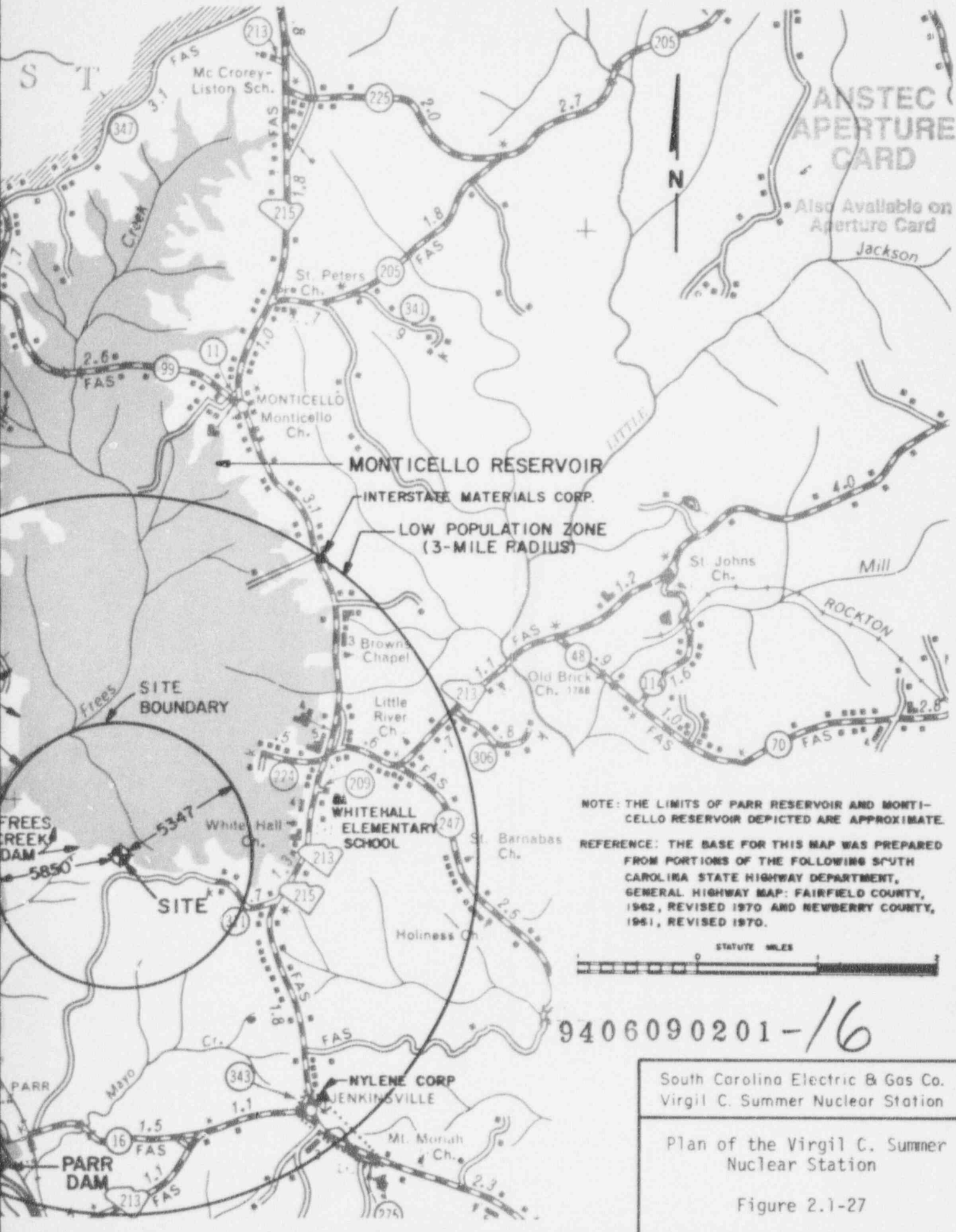
9406090201-15

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Land Use Within 10 Miles of the Site, 1966-1968

Figure 2.1-26


GLYMPHVILLE
STROTHER
F O R E
RAILWAY
Terrible
BROAD RIVER
Creek
Hellers
St Matthews Ch.
St Marks Ch.
New Hope Ch.
DAWKINS
Friendship Ch.
FREES CREEK DAM
BROAD
PARR RESERVOIR
St James Ch.
Victory Ch.
Bethlehem Ch.
Garmany Sch.
Cannons
POMARIA
POP 230
Hope Ch.
HOPE STATION
LINES
FAS
FAP



NOTE: THE LIMITS OF PARR RESERVOIR AND MONTICELLO RESERVOIR DEPICTED ARE APPROXIMATE.

REFERENCE: THE BASE FOR THIS MAP WAS PREPARED FROM PORTIONS OF THE FOLLOWING SOUTH CAROLINA STATE HIGHWAY DEPARTMENT, GENERAL HIGHWAY MAP: FAIRFIELD COUNTY, 1962, REVISED 1970 AND NEWBERRY COUNTY, 1961, REVISED 1970.

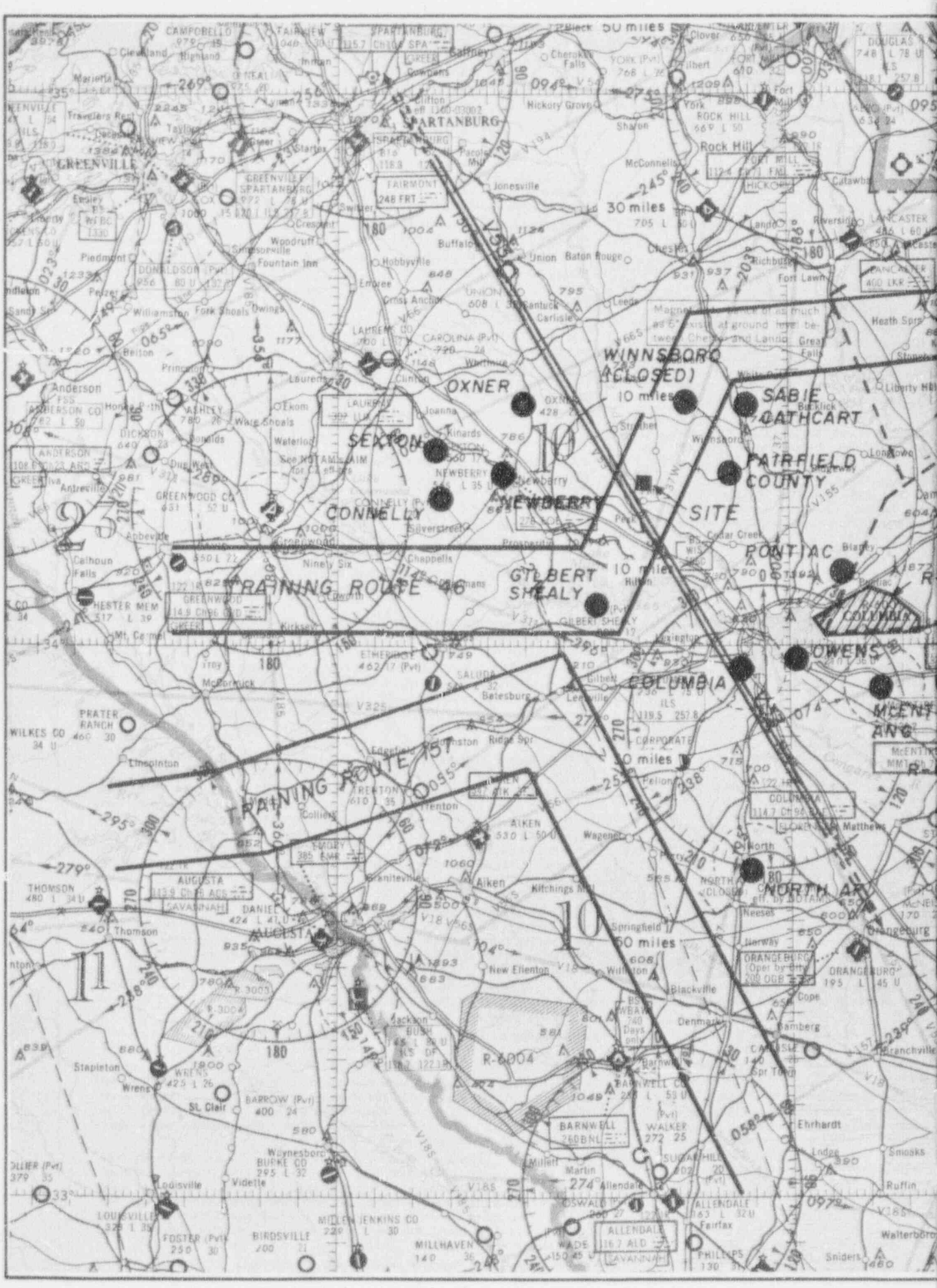
STATUTE MILES

9406090201-16

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Plan of the Virgil C. Summer Nuclear Station

Figure 2.1-27



WINNSBORO (CLOSED)
OXNER
SABIE
CATHCART
SEXTON
FAIRFIELD COUNTY
NEWBERRY
CONNELLY
SITE
PONTIAC
GILBERT SHEALY
TRAINING ROUTE 46
TRAINING ROUTE 157
OWENS
COLUMBIA
NORTH AR
AUGUSTA
GREENVILLE
SPARTANBURG
30 miles
10 miles
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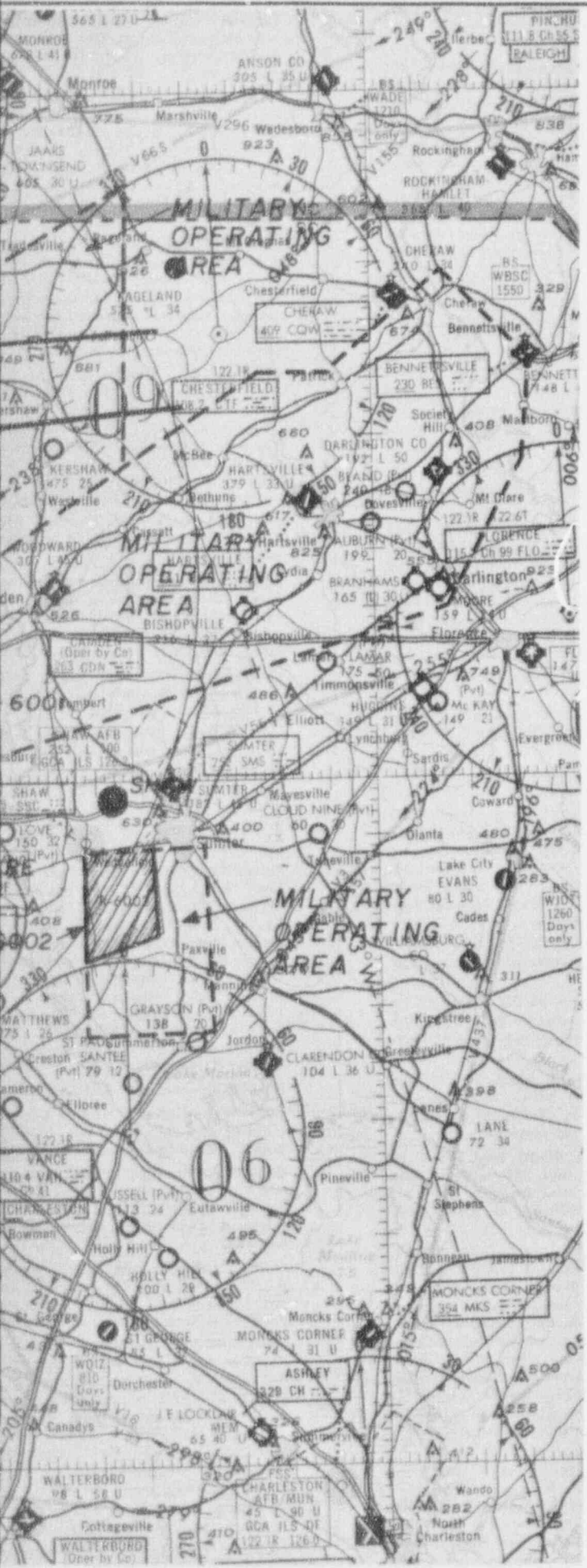
R-6004



ANSTEC APERTURE CARD

Also Available on Aperture Card

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STATUTE MILES

NOTE: TRAINING ROUTES AND MILITARY OPERATING AREAS PERTAIN TO SHAW AIR FORCE BASE.

LEGEND:

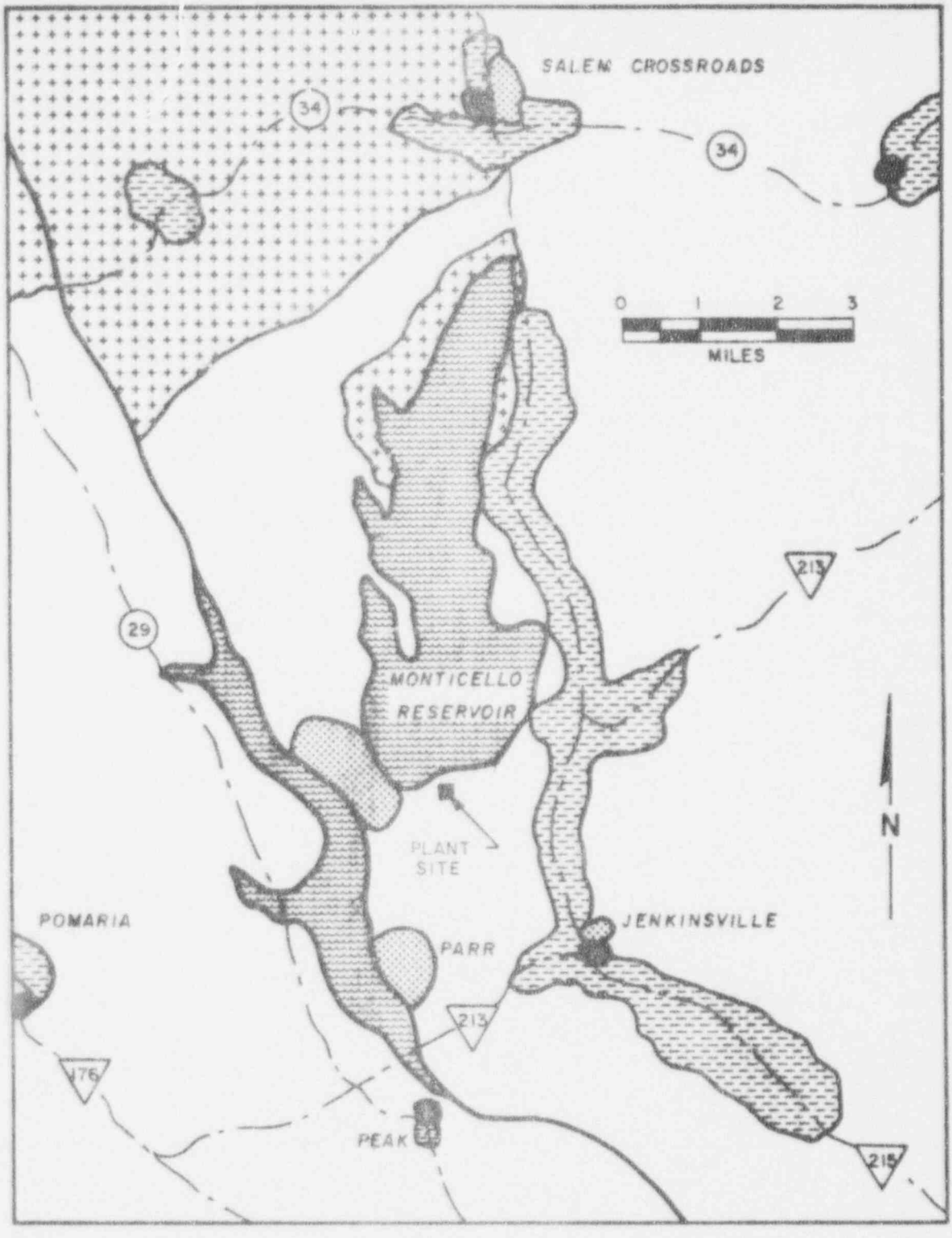
- AIRCRAFT FACILITIES DISCUSSED IN TEXT
- RESTRICTED AREAS

9406090201-17

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Airport Facilities Map

Figure 2.1-28



AGRICULTURAL OR FORESTRY

URBANIZED AREA

RESIDENTIAL

INDUSTRIAL

PUBLIC, INSTITUTIONAL & RECREATIONAL

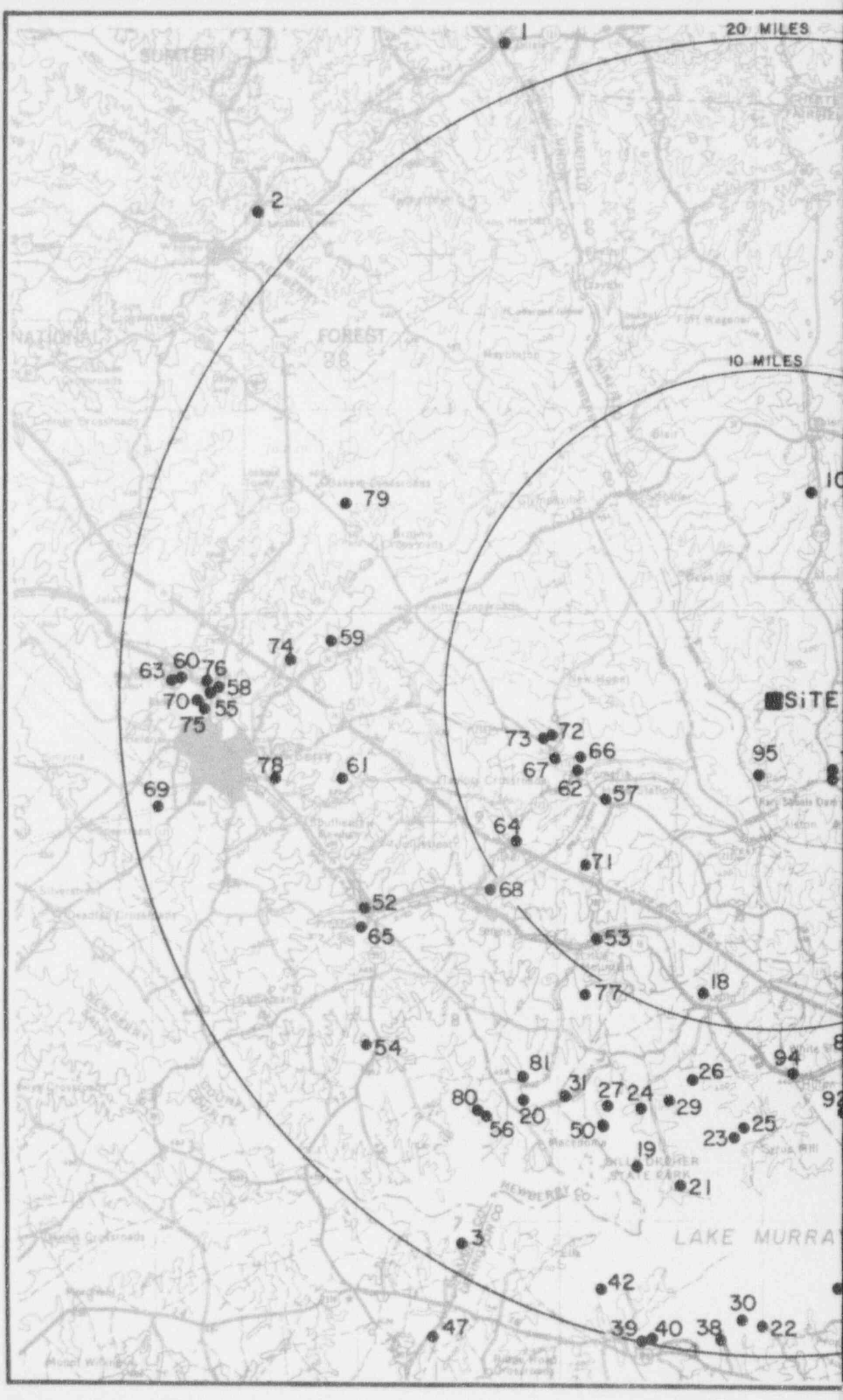
WATER

SOURCE: FUTURE LAND USE PLAN 1995. CENTRAL MIDLANDS REGIONAL PLANNING COUNCIL, 1974.
COMPREHENSIVE WATER & SEWER PLANNING STUDY, NEWBERRY CO. PLANNING BOARD, 1969

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Future Land Use Within Five Miles of the Site

Figure 2.1-29


20 MILES
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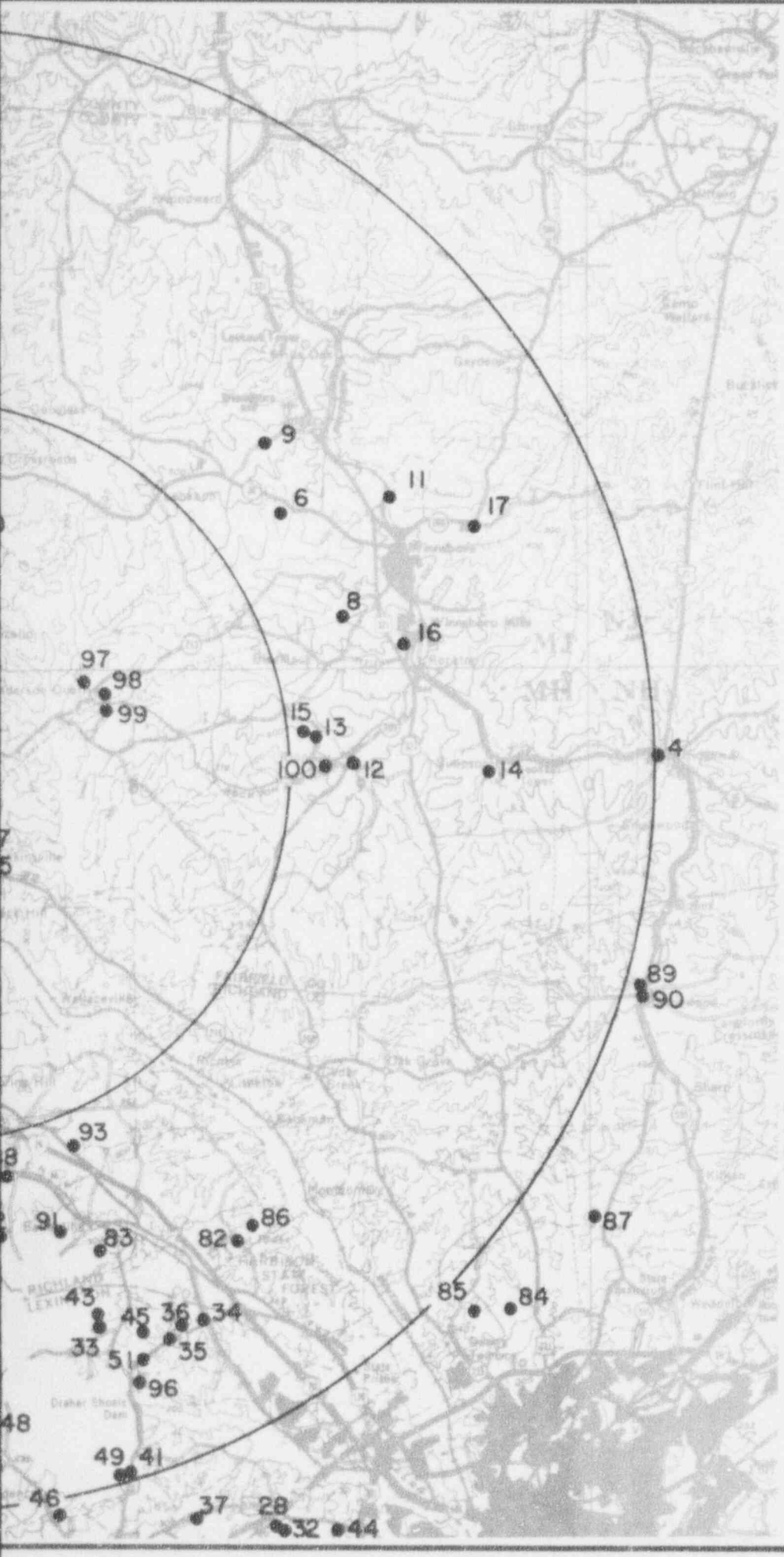

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STATUTE MILES

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REFERENCE:

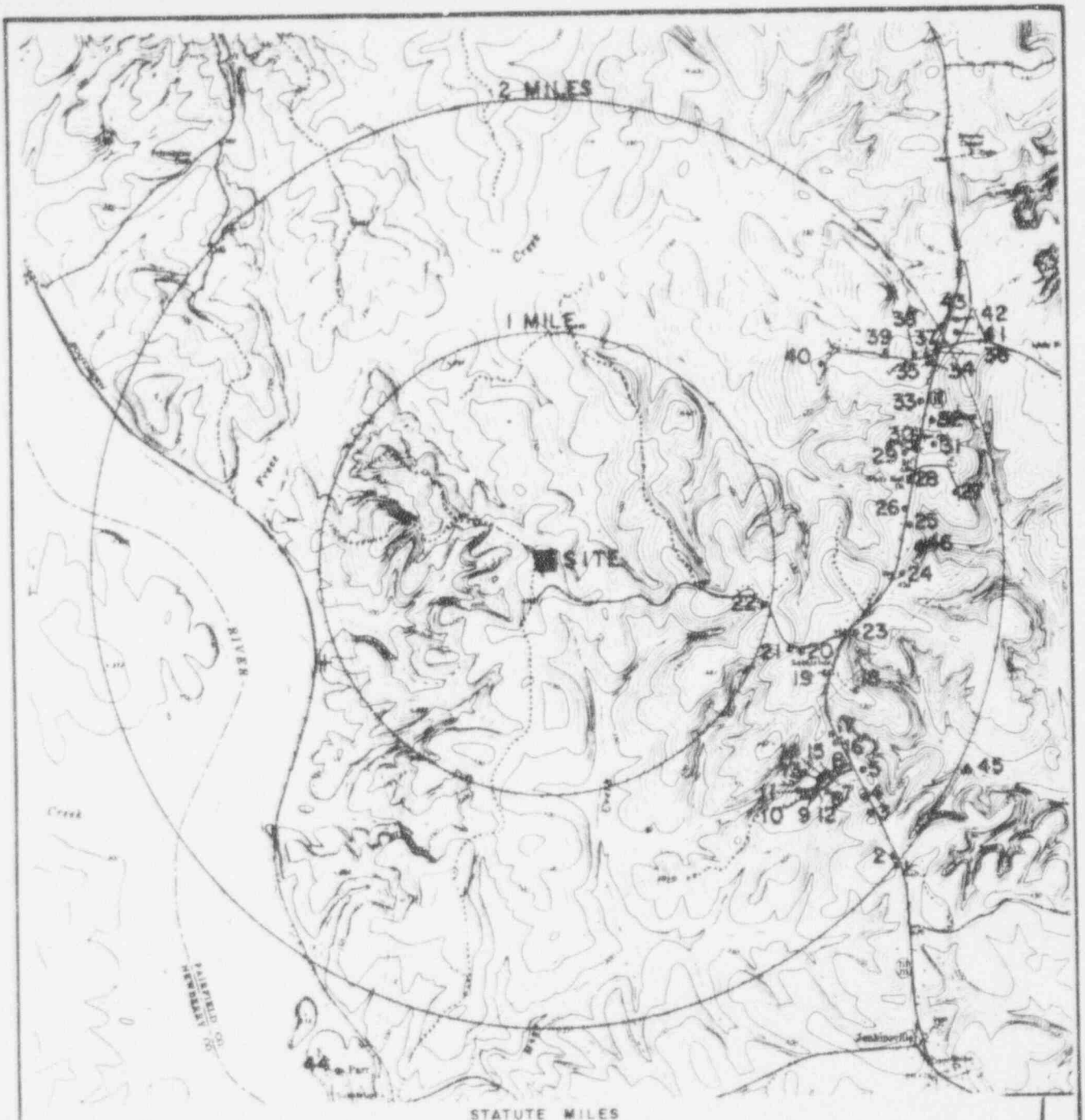
THE BASE FOR THIS MAP WAS PREPARED FROM A PORTION OF USGS TOPOGRAPHIC MAP SPARTANBURG, S.C.-N.C., 1955.

9406090201-18

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Reported Municipal, Industrial, and Domestic Well Locations
2-20 Miles

Figure 2.1-30



REFERENCE: THE BASE FOR THIS MAP WAS PREPARED FROM PORTIONS OF THE 7.5 JENKINSVILLE QUADRANGLE, 1969, U.S. GEOLOGICAL SURVEY

KEY:

- ● DOMESTIC WELL
- ▲ SPRING

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Domestic Well and Spring Locations: 0-2 Miles

Figure 2.1-31

2.2 ECOLOGY

2.2.1 TERRESTRIAL ECOLOGY

An extensive ecological monitoring program, sponsored by South Carolina Electric & Gas Company (SCE&G) and South Carolina Public Service Authority (SCPSA), at the site of the Virgil C. Summer Nuclear Station has been underway since early in 1971. The information summarized here is taken from detailed reports presenting results of these monitoring programs. These reports are included as Appendices 2A through 2D to this Environmental Report.

Domestic animals are not included in this section. A discussion of these forms is presented in Section 2.1.4.

2.2.1.1 Background

The site of the Virgil C. Summer Nuclear Station is to the east of the Broad River in the southwest corner of Fairfield County, S. C. The soils of the area are roughly separated into upland and bottomland soils. Some upland soils have steep slopes which are susceptible to erosion hazard. Proper vegetation cover and land management are necessary in these areas to reduce this hazard. Bottomland soils occur along the tributary creeks which flow into the Broad River. These soils are usually not as well drained as upland soils and have higher water and organic content. Section 2.4 of Appendix 2A gives a more detailed description of the soil classifications recognized in this region.

The vegetation associations of the area can be subdivided into four community types: pine, deciduous, mixed pine-hardwoods, and grassland. Loblolly pine, slash pine, and longleaf pine dominate the well-drained upland sites. Lowlands are at least 75 percent dominated by hardwoods;

major hardwood species are yellow poplar, oaks, and sycamore on well-drained sites, with willow, black gum, birch, water oak, and red maple occurring on the poorly drained flood plains. Mixed pine-hardwood communities are primarily found on slopes where the pine overstory has been removed through logging activities and the hardwood understory has come into prominence. Scattered mature pines and pine reproduction keeps these areas from being totally dominated by hardwoods. The grassland community type includes cultivated pasture and abandoned farmlands which are in early successional stages where broomsedge, three-awn grass, and little bluestem are the dominant grasses.

The site region has undergone various disturbances since early white settlement in 1752. While hardwood forest is the climax for the area, disturbances such as lumbering, natural and prescribed fires, and clear-cutting have kept the plant communities in a seral stage where loblolly pine is the dominant species. Loblolly pine is the most important economic plant species in the region and the act of planting, maintaining, and harvesting this species has done much to shape the ecology of this region.

A baseline biotic survey of the Broad River Study Area, Parr, South Carolina, was conducted during nine sampling periods between March 1971 and June 1973. The purpose of this study was to establish baseline characteristics of the ecosystems present in this area. The location of the study area is shown on the Vegetation Map in Appendix 2A. Information from these surveys will provide the basis for validating predictions regarding anticipated environmental impact as a result of the construction and operation of the Virgil C. Summer Nuclear Station and the Fairfield Pumped Storage Facility. Supplemental baseline data were gathered during five survey periods between August 1973 and September 1974. During this later period, monitoring sites were estab-

lished for the purpose of evaluating changes in the ecosystems due to construction activities. Construction monitoring has continued on a bi-annual basis from February 1975 to date.

2.2.1.2 Vegetation

Flora of the Summer Nuclear Station site consisted of 51 families represented by 99 genera and 108 identified species (Table 5.3.1, Appendix 2A).

The vegetative communities occurring on the study site may be divided as follows: pine, 47 percent; deciduous, 15 percent; mixed pine-deciduous, 26 percent; and grassland, 12 percent. Deciduous species occur as small scattered stands on the uplands and predominate on the river bottoms (Vegetation Map in Appendix 2A).

Red cedar (Juniperus virginianus), sweetgum (Liquidambar styraciflua), and several species of oak (Quercus spp.), hickory (Carya spp.), ash (Fraxinus spp.), and maple (Acer spp.) are of commercial importance in this area, but the loblolly pine (Pinus taeda) is by far the most important species. The wide occurrence of loblolly in pure stands and its abundance and versatility in use make this species the principal commercial pine in the southeastern United States. Forest statistics for 1974 show Fairfield County to be third in the state in pulpwood production (1). Recent clearing for the Monticello Reservoir has kept this county high on the list of pulpwood producing counties. Potential wood production on the study site is related to soil type, with the turnover rate for marketable timber running between 35 and 50 years. A discussion of productivity of loblolly on different soil types on the site is given in Section 5.3.4.2 of Appendix 2A.

Understory and ground-cover species were quite numerous on the site. Some of the more common species were honeysuckle (Lonicera japonica), Walter's smilax (Smilax cralteri), blackberry (Rubus allegheniensis), broomsedge (Andropogon virginicus), little bluestem (Schizachyrium scoparium), and Scribner's panicum (Panicum scribnerianum). The results of quantitative sampling on the site are given in Section 5.3.3.3 of Appendix 2A.

No plant species which could be classified as rare or endangered were collected or observed in the study area.

No evidence of disease or insect damage was observed on the site. Diseases which may occur in the area include rust diseases caused by the fungus Fusiformis, which is the most prevalent disease that affects the loblolly. Little leaf disease, a disease of shortleaf pine, can also affect loblolly but is usually a problem only when it is severe in shortleaf pine. Shortleaf pine is not very abundant on the site. The two main insect pests that can affect loblolly are the pine tip moth and the southern pine beetle. The pine beetle is one of the most damaging forest insects in the South, and the study area occurs on the edge of this beetle's distribution (2).

2.2.1.3 Birds

A total of 234 bird species may utilize the nuclear station area (3) (4) (5) (6). This includes 65 permanent residents, 50 winter residents, 43 summer residents, and 76 transient species. Of these, 127 species were observed on the site. These species are listed in Table 5.6.1 of Appendix 2A and Table 5.6.2a of Appendix 2B along with the time each species was observed and its residency status. A discussion of the diversity, abundance, distribution, and food habits of songbirds on the site is given in Section 5.6.4.2 of Appendix 2A.

There are several species of game birds that may be found on the site. These include the mourning dove, bobwhite, wild turkey, woodcock, and 12 species of ducks. The mourning dove (Zenaidura macroura), bobwhite (Colinus virginianus), eastern wild turkey (Meleagris gallopavo), and American woodcock (Philohela minor) are probably the best known terrestrial species.

The mourning dove is a permanent resident of South Carolina and is common in open woodlands and fields where it feeds on weed and grass seeds and grain. This bird is an important game species during the fall and winter when resident and migrant doves gather in flocks and provide sport for thousands of South Carolina sportsmen (6).

The bobwhite is perhaps the most highly regarded game bird in the south. It is a resident of all portions of South Carolina and is found in fields and open pinelands where it feeds on grass and weed seeds, grain, berries, and beetles, grasshoppers, and other insects. The dove and bobwhite have been censused on and off the site by use of the Game Bird Call Count used by the U. S. Fish and Wildlife Service. A description and results of this survey are given in Section 5.6.3.1.4 of Appendix 2A.

The eastern or wild turkey is an uncommon but permanent resident throughout the state. This large bird has been declining at an alarming rate in past years and has been the object of extensive repopulation efforts in South Carolina. In 1951, turkeys were introduced into the Sumter National Forest which borders the site on the north. Spring "gobbler" hunts have been held here each year since 1960. Sporadic sightings of turkeys have been made on Frees Creek and adjacent watersheds in the study area. It is not very abundant on the plant site. The turkey lives in deep woods and swamps where it can avoid its many enemies. It feeds on seeds, grain, acorns, and insects. Descriptions of the site's

suitability as turkey habitat are given in Section 5.6.4.3.2 of Appendix 2A and Section 5.6.3.5.1a of Appendix 2B.

The woodcock is not well represented on the site, as only one individual has been observed in the study area. This species resides in bottomland swamps where it probes the moist earth with its long bill in search of earthworms, grubs, and other insect food. It is doubtful that woodcock are hunted to any extent in the immediate vicinity, with the possible exception of the bottomland areas of the adjacent Sumter National Forest.

Several species of ducks utilize the Broad River and its tributaries and are of considerable importance as game birds in the area. The results of waterfowl surveys of the Broad River near the site are given in Section 5.6.3.3 of Appendix 2A and 5.6.3.4a of Appendix 2B. Twelve species of ducks were recorded in the site area. All of these, with one exception, are migratory and occur in South Carolina only during the fall and winter months. The wood duck (Aix sponsa) is the only duck species that is a permanent resident in the state. This duck is quite common along river swamps and wooded lakes. The wood duck prefers cavities in trees for constructing its nest. The nest does not have to be immediately adjacent to water but sufficient protective ground cover is necessary when the nests are far from water. A thorough assessment of wood duck breeding and brood rearing habitat in the site area is given in Sections 5.6.3.4.1 and 5.6.4.3.2 of Appendix 2A.

No federally listed endangered or threatened birds were found on the site. The American osprey has been observed sporadically along the Broad River. This species has been declining throughout portions of its range and is included on the National Audubon Society's "Blue List" (7). Other species observed on the site which may have declining populations and are on the "Blue List" include the double-crested cormorant,

black-crowned night heron, marsh hawk, red-shouldered hawk, Bewick's wren, and loggerhead shrike.

2.2.1.4 Amphibians and Reptiles

Amphibians and reptiles are often important links in terrestrial and aquatic food webs.

Twenty-three species of herpetofauna, including 5 amphibians, 8 turtles, 4 lizards, and 6 snakes were observed or collected in the vicinity of the nuclear plant site. Table 5.5.1 of Appendix 2A lists the species recorded on site.

No rare and endangered reptiles or amphibians were found on the site. Two species of particular interest, however, were a dusky salamander (Desmognathus sp.), which could represent a new species, and the pickerel frog (Rana palustris), which has not been previously reported from the Piedmont of South Carolina.

2.2.1.5 Mammals

The site contains several habitat types which can support many species of mammals. The site falls within the range of 43 species of mammals according to Burt and Grossenheider (8). The South Carolina Wildlife and Marine Resources Department lists six additional mammals which may occur in Fairfield County. Twenty species were observed on the site during field studies.

Some of the more common and well known mammals which occur on the site include whitetail deer, squirrels, rabbits, foxes, raccoons, and bobcats. The whitetail deer (Odocoileus virginianus) is generally considered the

most important big game animal in America (9). The state wildlife department reports that four separate subspecies of whitetail deer occur in Fairfield County. The whitetail is a very adaptable animal that can find food and cover in several habitats. Populations are usually higher in areas where hardwood habitat is present, as protective cover is very good here, and vines, twigs, buds and mast (acorns and seeds) are an abundant food source. Whitetail deer tracks and sign were a common sight over much of the area; however, the local wildlife biologist considers deer to occur in low numbers, therefore, they are not a significant sport resource on the site area (10).

Three species of squirrels may occur on the site. The gray squirrel (Sciurus carolinensis) and fox squirrel (Sciurus niger) are game species which are the most popular small game species in the south (11). Both squirrels feed on seeds, nuts, and mushrooms, but the gray squirrel prefers bottomland hardwoods, while the fox squirrel is found in more open pinelands. The flying squirrel (Glaucomys volans) is a small nocturnal creature that feeds primarily on seeds and nuts. It is not a game species. The gray squirrel was the only species observed on the site.

Another group of important small game species which may occur on the site are rabbits. The eastern cottontail (Sylvilagus floridanus) is probably the best known of the rabbits since it is frequently seen feeding along roadsides from early evening to late morning. It is found wherever there is heavy brush and seems to prefer areas where forests and swamps border fields. The swamp rabbit (S. aquaticus) is a large rabbit which is found in swamps, marshes, and wet bottomlands along with its smaller cousin, the marsh rabbit (S. palustris). These two species are more nocturnal than the cottontail and take to water readily. All three species are herbivorous, feeding on tender herbaceous plants when available and twigs and bark when more suitable forage is scarce.

The gray fox (Urocyon cinereoargenteus) and the red fox (Vulpes vulpes) are omnivores which may be found in the vicinity of the site. These foxes eat a varied diet but chiefly depend on rodents and the rabbits previously discussed. Other food items include birds, reptiles, insects, and fleshy fruits. They prefer habitats where forest land intermingles with open fields.

The raccoon is a well known omnivore which is found in all wooded areas of the site. It is found in all habitats but is especially fond of streams, where it hunts for crayfish, frogs, salamanders, and other aquatic life. The raccoon will also include other small vertebrates and large quantities of fleshy fruits, nuts, and crops in its diet as they become available.

The bobcat (Lynx rufus) is the only true carnivore that may be expected to occur on the site. The bobcat is very secretive and prefers to hunt at night when it preys on rodents, rabbits, and small birds. Prime habitat for this species is swamps and dense bottomland forests.

A detailed analysis of mammal populations sampled on the site is given in Section 5.7 of Appendix 2A. Fourteen species were collected during the trapping effort. These species are identified along with the number trapped and their sex ratio in Table 5.7.1 of Appendix 2A. Generally, more males were trapped than females.

The habitats sampled on the site were mature pine, second-growth pine, mixed pine-hardwood, and grassland. The habitat type containing the greatest number of species was the grassland habitat, which contained five species (Table 5.7.2, Appendix 2A). The mature pine habitat contained four species, while the second growth pine site was occupied by only one species. The mixed pine-hardwood site contained three species.

The season of greatest abundance was during the fall in all habitats except for the second growth pine site which produced animals only during the spring and summer (Table 5.7.7, Appendix 2A).

The cotton mouse (Peromyscus gossypinus) was the only species found in all habitats. This mouse occurs in a variety of habitats but seems to prefer wooded areas (12). The house mouse (Mus musculus) was the most abundant species at any one collection time. This mouse was found only in the grassland habitat and was collected only during the summer (4 mice) and fall (7 mice). This species has been introduced by man and is closely associated with man and his structures. The cotton rat (Sigmodon hispidus) was another abundant species in the grassland habitat. This species is perhaps the most abundant small mammal in the southeast (13). Preferred habitat is grassland or old field habitat.

Food habits of small mammals collected on the mature pine site (Table 5.7.5, Appendix 2A), the mixed pine-hardwood site (Table 5.7.4, Appendix 2A), and the grassland site (Table 5.7.3, Appendix 2A), were determined by analysis of stomach contents. Cotton mice on the mature pine site seemed to prefer insect matter over plant matter. Sorghum and lespedeza were the main plants found in the stomach analyses. Insect parts and hair were the most commonly occurring items in the stomach analyses of golden mice (Ochrotomys nuttalli) in the pine habitat. Insect parts were the only items in the stomach of the shorttail shrew Blarina brevicauda) from this habitat. This is understandable since shrews are highly voracious insectivores. The single pine vole (Microtus pinetorum) collected on this site had nothing in its stomach.

The cotton mice captured on the mixed pine-hardwood site fed on a diet of insects and various plant material which included lespedeza, an endosperm, and an unidentified dicot leaf. The single cotton rat cap-

tured here had fed entirely on insects, while the shorttail shrew contained insects, hair, and an unidentified nematode.

Cotton mice from the clear-cut site contained food items similar to those found on the other sites; that is, they fed on lespedeza and other leafy vegetation as well as insects. House mice also contained insects and a mixed diet of vegetation on this site. Cotton rats captured here had a wide variety of items in their stomachs, including insects, nematodes, fungus, blackberries, sorghum, lespedeza, and hair, among other items. It is interesting, although not significant, that the single cotton rat caught during the fall in the clear-cut area had eaten only insects and that the single cotton rat caught during the same season in the mixed pine-hardwood site also contained only insects.

Harvest mice (Reithrodontomys humulus) from this site contained a variety of foods during the winter but had fed on only insects during the spring survey. Shrews generally feed on insects and other invertebrates but do include plant materials in their diet (13). This was the case with the southeastern shrews (Sorex longirostris) and least shrews (Cryptotis parva) found in this habitat.

A discussion of population dynamics and interspecific relationships for small mammals on the site is given in Section 2.7.4.2 of Appendix 2A. Sections 2.7.4.3 and 2.7.4.4, of the same appendix, give similar discussions for the medium and large mammals, respectively.

Recreationally important species which occur in the site area include the whitetail deer, gray and fox squirrel, raccoon, bobcat, gray and red fox, and swamp, marsh, and cottontail rabbit. No rare and endangered mammals were observed on the site.

2.2.2 AQUATIC ECOLOGY

2.2.2.1 General Aquatic Ecology Description

Characterization of the aquatic ecology in the Broad River study area presented in this section has been largely based on a comprehensive program sponsored by SCE&G and SCPSA. The purpose of this program has been to develop baseline data and to monitor construction phases of the Fairfield Pumped Storage Facility (FPC Project No. 1894) and preoperational phases of the Virgil C. Summer Nuclear Station (AEC Docket No. 395).

Aquatic ecological studies have been conducted on the Broad River and Parr Reservoir on a quarterly basis since March 1971 and are continuing at the present time. The purpose of the baseline phase of these studies was to establish the characteristics of the ecosystems present in the Broad River study area, prior to construction and operation of the plant.

The results of the aquatic program to date provide an adequate background for characterization of the aquatic ecosystem of the site; a summary of the scope and results of these studies is presented in the following sections. A detailed discussion of the aquatic ecology programs is presented in Appendices 2A through 2D.

The Broad River originates in the mountainous region of western North Carolina and flows southeastward through South Carolina to its confluence with the Saluda River north of Columbia. It forms the boundary line separating Newberry County from Fairfield County, where the study area is located. The Broad River was dammed in 1914 at Parr, S. C., to form Parr Reservoir. In the site vicinity tributaries entering this system at Parr Reservoir include, on the west side, Cannons Creek,

Hellers Creek, and the Enoree River, and on the east side, Frees Creek and Terrible Creek. A detailed discussion of the hydrologic characteristics of the Broad River is presented in Section 2.4.

The Broad River in the study area is characterized by a high silt load and a relatively high flow rate, which results in the main portion of the reservoir having more lotic (flowing water) conditions than lentic (standing water). However, in the arms of the reservoir such as Cannons and Frees Creeks, more lentic conditions occur. The flow of water affects the distribution and abundance of aquatic organisms in various parts of the reservoir. For example, phytoplankton production appeared to be greatest in the areas characterized as lentic (Section 3.3, Appendix 2A) whereas benthic macroinvertebrate biomass was greatest in lotic areas (Section 3.5, Appendix 2A).

Vascular hydrophytes were observed mainly in protected areas near the dam. The predominant emergents were found throughout the reservoir although their abundance was usually low. Turbidity and fluctuating water levels appear to be the main limiting factors.

The diatom species are the dominant phytoplankton, numerically. Populations fluctuated widely throughout the study period. The phytoplankton are thought to contribute only a small amount to the productivity of the Broad River in the study area, due primarily to turbidity, which is suggested as the major limiting factor in primary productivity for most river systems (14). It is the hypothesis that most of the energy requirements for the Broad River biota are derived from allochthonous organic material.

The zooplankton population of the Broad River study area is dominated by rotifers. Four of the six most frequently collected species are

considered omnivores. Detritus is an important food source for these forms. Copepods and cladocerans were present in small numbers.

The benthic macroinvertebrate community is characterized by having relatively low diversity but high biomass in certain areas of the reservoir.

The fishes of the Broad River study area are represented by at least 50 species (Section 3.6, Appendix 2D). These are dominated numerically by the bluegill sunfish, an important sport and forage species. Gizzard shad is an important primary consumer and forage species which ranks second in numerical abundance. In terms of biomass, standing crop data suggest that bluegill sunfish, gizzard shad, redear sunfish, and largemouth bass predominate. The composition of fishes in the study area contrasts with other turbid reservoir systems where carp, river carpsucker, and white crappie predominate (15) (16). The low numbers of carp and carpsucker in the study area may be due to interspecific competition.

The occurrence of gizzard shad as the second most abundant species attests to its importance in the trophic structure of the aquatic community. Gizzard shad are known to be the most important fish forage organism in warm water reservoirs (17). In the study area this species is utilized as a food source mainly by largemouth bass, white and black crappie, catfish, and gar. In addition, gizzard shad are important as they are believed to directly utilize allochthonous organic detrital material as well as plankton as a food source.

2.2.2.2 Water Quality

The Broad River in the site area is a Class B stream as defined by South Carolina water quality standards; that is, water is suitable for domestic purposes after complete treatment (18). The main body of Monticello Reservoir will also be Class B because of the pumpage into the reservoir from Parr Reservoir through the Fairfield Pumped Storage Facility. The upper section of Monticello Reservoir will be reserved for recreational activities and will be maintained as Class A.

Information on water quality in the general vicinity of the site is available from published sources and from a monitoring program performed by SCE&G. This information is summarized in the following sections.

2.2.2.2.1 Published Records

The USGS maintains several water quality stations in the general area of the site. These include one 1 mile below Parr Dam established in October 1973; one at Carlisle, on the Broad River above the confluence of the Enoree and Tyger Rivers, which has been in operation since 1947; one on the Tyger, near Delta, S. C., established in November 1971; and one on the Enoree River at Whitmire, S. C., which was also established in 1971. Specific conductance, dissolved oxygen, temperature, and pH are monitored at these stations. Extremes of these parameters over the period for these stations are presented in Table 2.2-1.

Heavy metal determinations have been made by the S. C. Department of Health and Environmental Control in the vicinity of the Parr Reservoir (Table 2.2-2). Heavy metal accumulation is caused by settling of soil or silt particles to which heavy metals are adhering and by settling of dead planktonic organisms in which these heavy metals may concentrate.

Results of the study indicate that concentrations of mercury, copper, and cadmium are below levels which would be toxic to some aquatic organisms, but chromium and lead approach levels that could be harmful. Results of research on heavy metal toxicity to aquatic organisms have not provided conclusions that can be applied to all fresh water. Each case of suspected heavy metal concentration must be evaluated individually. Toxicity of heavy metals varies widely, dependent upon such factors as organism involved, temperature, dissolved oxygen, pH, valence of the metal, concentrations of other heavy metals, and resulting synergism and hardness of the water. No reported instances of mortality to aquatic organisms from heavy metals in the Broad River are known (19).

2.2.2.2.2 Monitoring Program Results

Since initiation of the on-site monitoring program in 1971, selected physical and chemical parameters have been measured at collecting stations along the transects in the Broad River study area (see Vegetation Map, Appendix 2A). The investigation provides basic information on existing abiotic conditions. The measured parameters exhibited seasonal variations, largely dependent upon several physical factors, i.e., temperature, precipitation, and runoff.

The on-site water quality monitoring program is discussed in detail in Section 3.2 of Appendix 2A, Section 3.2a of Appendix 2B, and Section 2.2 of Appendix 2C.

The temperatures observed varied from a maximum of 31.5°C to a minimum of 3.3°C. These results are similar to those recorded by the USGS stations (Table 2.2-1). The temperature data suggest more lentic conditions at Transects A (a backwater area of the Broad River), B (Frees Creek embayment), and C (Cannons Creek embayment), while more

lotic conditions exist at Transects D (above Parr Dam), and E (below Parr Dam). The lentic water conditions at Transects A, B, and C allow for rapid surface heating and the establishment of thermally related density gradients between the surface and bottom of the river. Turbulence and mixing, characteristic of lotic conditions at Transect D and E create general homothermous conditions.

Secchi disc readings in the Broad River study area were generally low regardless of the sampling date or location. This was attributed to silt and clay turbidity.

The sediment composition in the study area indicates that a distribution of finely divided materials occurs on the bottom. These materials are easily erodable and may shift and become redeposited with slight changes in stream velocity. The predominance of finely divided sediment likely limits the benthic fauna to species tolerant of silting conditions. In addition, it affects the entire water column by reducing light penetration.

Dissolved oxygen was near saturation levels during all of the sampling periods. In areas that are lentic there were greater surface concentrations of oxygen than other areas; this was probably due to photosynthetic activity.

Nutrients in the water of the Broad River study area are generally in high enough concentrations to support algae populations.

The analysis of heavy metals indicates that slightly higher concentrations occur in the reservoir than in the river. This is due in part to metals being precipitated as the velocity of the water is reduced within the reservoir.

A summary of results from physical and chemical characteristics is found in Section 3.2.3 of Appendix 2A, Section 3.2.3a of Appendix 2B, and Section 2.2.3 of Appendix 2C.

In summary, the water quality of the Broad River study area is considered to be good, with oxygen levels near or above saturation most of the time; there is a general low transparency due to high turbidity, but nutrients are sufficiently high to support large algae populations. Sediments from most areas were composed of finely divided materials, mainly silt and clay. Temperature conditions ranged from relative homothermy at the lotic transects to gradient-like conditions at the lentic transects.

2.2.2.3 Aquatic Flora

Plants are primary producers, that is, they form the base of the food chain in all ecosystems. Aquatic flora of significance in the study area include vascular hydrophytes (large aquatic plants) and phytoplankton (minute floating plants).

2.2.2.3.1 Vascular Hydrophytes

Vascular hydrophytes provide support, shelter, and oxygen to other organisms. In the site vicinity, vascular hydrophytes are utilized by birds, mammals, fish, and numerous invertebrates. Fruits and tubers of most of the species listed are important sources of food for waterfowl and other upland game birds. Other species such as marsh willow and cattail are a food source for beaver and muskrat. The objective of the baseline studies was to identify the important vascular hydrophytes present.

Many species of vascular hydrophytes afford shelter as well as food for species of fish. For example, rushes provide spawning grounds for fish, especially several species of centrarchids, that inhabit the littoral zone. Other species of vascular hydrophytes, including water milfoil and pondweeds, are extremely important in the aquatic ecosystem since they support an insect population fed upon by fish.

The surveys conducted in the Broad River area have resulted in the identification of a total of 22 species of vascular hydrophytes, including both emergent and submergent forms (Section 3.4.3, Appendix 2A and Section 3.4, Appendix 2B).

Cattail was the most abundant emergent species, occurring in dense colonies along the shoreline. Other important species include arrowhead, which was dispersed throughout the area, and marsh willow, which was found growing in shallow water and on moist banks in parts of the study area. Emergent species of vascular hydrophytes were confined to shallow water next to shore or the moist shoreline. Emergent species can survive water depths greater than 1.5 m, and the restriction of the plant populations in the study area to shallow water is probably due to the turbidity of the water.

The majority of the submergent species of vascular hydrophytes were observed in protected areas, such as Hellers and Cannons Creeks. These areas are not influenced directly by the Broad River and the silt load it carries. Only one species of submergent vascular hydrophyte was found in the Broad River in a quiet backwater area.

The increase of water level in the study area during construction may cause some shift in populations. For example, along moist shorelines, emergent vegetation may colonize the new areas and provide habitat and

food for some species of waterfowl. In addition, the upper section of Monticello Reservoir that will be removed from the daily water level fluctuation, will presumably have good water quality with a minimum amount of turbidity. In such areas there will be more light penetration, which is conducive to the growth of submergent vascular hydrophytes.

2.2.2.3.2 Phytoplankton

Phytoplankton are the minute photosynthetic organisms scattered throughout the limnetic zone. They are among the primary producers upon which all higher forms of aquatic life are ultimately dependent in any aquatic ecosystem, including the study area. Because they possess no powers of locomotion of their own, phytoplankton are subject to movement by physical forces of wind, current, and wave action which determine their distribution and stratification.

A total of 352 species of phytoplankton have been collected in the Broad River study area. The number of species in each major taxonomic group was: Chlorophyta (green algae) 76; Chrysophyta (golden algae) 247; Cyanophyta (blue-green algae) 17; Euglenophyta (euglenoids) 8; Pyrrophyta (dinoflagellates) 4.

The dominant group of phytoplankton (at most of the collection stations) is the golden algae, with diatoms the most abundant of the group. The diatoms comprised from about 30 percent of the total phytoplankton at one collecting station to almost 80 percent at the other collection stations. Diatoms typically dominate the phytoplankton of temperate rivers (20). In addition, most of the diatom species collected are considered to be pollution tolerant species (21).

The green algae, the next most abundant group, were most numerous during late summer and early fall when the warmer water temperatures were optimal for their development.

The cyanophytes were the next most abundant species of phytoplankton. The species found are typical of organically enriched waters (21). Other forms found during the sampling program were the euglenoids and the dinoflagellates. Documentation of results of the phytoplankton study are presented in Section 3.3.3.1 of Appendix 2A, Section 3.3.3.a of Appendix 2B, and Section 2.3.3.1 of Appendix 2C.

A comparison of the phytoplankton taxa collected throughout the study area indicates only minor differences within a particular sampling period. Some seasonal fluctuations in the total phytoplankton species have been noted during the study period, especially in the Cannons Creek area and just above Parr Dam.

The highest densities of phytoplankton occurred near the Frees Creek embayment, even though Secchi disc readings indicated the least amount of light penetration occurred there. Water quality data indicate that a supply of nutrients is entering the area from the watershed, thereby stimulating phytoplankton growth. This is supported by recent data which show an abundance of organisms indicative of eutrophic conditions.

2.2.2.4 Aquatic Fauna

The components of the aquatic fauna include zooplankton, benthic macroinvertebrates, and fish. Each of these components is important to the entire aquatic ecosystem. For example, the zooplankton abundance governs the phytoplankton population. The fish and larger invertebrates govern the zooplankton populations; the gizzard shad which is very abundant in

the Broad River study area is planktivorous. Largemouth bass and white and black crappie feed on the gizzard shad. Thus, each component plays a role in keeping the entire aquatic ecosystem in balance.

2.2.2.4.1 Zooplankton

Zooplankton are small animals scattered throughout the limnetic zone. As with the phytoplankton, they are subject to movement by physical forces of wind, current, and wave action because, for the most part, they possess no powers of locomotion.

The zooplankton are generally classified into several broad categories based on general anatomical features. The rotifers usually have one or more rings of cilia at the front part of the body. Crustaceans have hard outer shells and jointed appendages. The crustaceans tend to be more abundant in the littoral zone because they are less buoyant and do not float in the free limnetic zone. Those forms which do occur in the free limnetic zone are characterized by their density rather than species diversity. The species in this zone utilize phytoplankton as their chief nutrient.

The zooplankton population in the Broad River study area is composed mainly of rotifers, copepods, and cladocerans. A total of 50 species of zooplankton have been collected during the study period. Rotifers were the most abundant group, with no single species predominating during the entire study period. The densities of rotifer population were usually less than 50/liter regardless of where they were collected or what season. Some exceptions to this do occur; for example, collections of rotifers made at transects in the Frees Creek embayment and in the Cannons Creek embayment show that a few genera were collected in abundances of 73/liter to 190/liter. These areas are lentic in nature and are not influenced directly by the Broad River; thus environmental

conditions such as less turbidity and silt load and warmer water temperatures appear to periodically allow increases in population of several species of rotifers. Other transects do not experience these conditions, thus restricting the population to static levels. Zooplankton species found in the sampling program are presented in Table 3.3.4 of Appendix 2A, Table 3.3.4a of Appendix 2B, and Table 2.3.3 of Appendix 2C.

Observations by Williams (22) indicate that rotifers are intolerant of silty conditions and high turbidity levels such as exist in the study area. Other factors such as detrital and bacterial concentrations, and physical and chemical characteristics of the water influence zooplankton compositions and abundance. On the other hand, the pulses exhibited in some of the zooplankton populations could be in part due to high phytoplankton populations. Williams (22) found that stations with high phytoplankton populations generally have high rotifer populations, suggesting that there is a dependence of rotifers on phytoplankton for food.

In general, the zooplankton density in the study area is very low compared to similar systems throughout the United States. The low population densities are probably due to the high silt load and concomitant turbidity acting in concert with other limiting factors such as unfavorable detrital and bacterial levels and physical and chemical characteristics of the water.

2.2.2.4.2 Benthic Macroinvertebrates

The benthic macroinvertebrates are the group of aquatic organisms associated with the bottom substrates. They may be either sessile or burrowing forms (23). Some of these organisms spend their entire lives in the water (oligochaetes), while the majority have terrestrial

phases of their life cycles. Trichoptera (caddis flies), Ephemeroptera (mayflies), and Diptera (true flies) (24) (25) are members of the latter group of organisms. All of these serve as important links in the transfer of energy in the aquatic ecosystem.

Some of the macroinvertebrates such as stoneflies, mayflies, caddis flies, and midges convert detritus into forms usable by other animals in the food web. Others utilize algae growing on the substrate as food; these forms filter drifting heterogeneous material (26). Some of the dragonflies, stoneflies, beetles, and true bugs prey on other aquatic organisms or small fish, fry, or fingerlings (25). The benthos as a whole serve an important role in the diet of most species of fish (25) (27).

Generally, benthic forms may be categorized according to the type of habitat they occupy. In the broad sense there are two main habitats: swift currents, with rocks, stones, and gravel for a substrate; and static areas, which have a silt, sand, or mud bottom. Many microhabitats are found within each. The habitats that have flowing water generally have diversified fauna, with stoneflies, mayflies, and caddis flies dominating.

In the study area, the habitat tends to be more static, with a silt and mud bottom. Generally, there are fewer species in this type of habitat due to increased stresses such as turbidity, reduced light penetration, and substrates that are unstable.

The Asiatic clam, Corbicula manilensis, has recently invaded the study area and has since been found in high densities in the reservoir (Section 3.5, Appendix 2A). These pelecypods appear to serve as an important food source to certain species of centrarchids. The burrowing mayfly (Hexagenia limbata) occurs throughout the Broad River study area

and contributes significantly to the benthic invertebrate biomass. Other species of mayflies and tubificid worms are common and serve as important food sources to several fishes.

A total of 75 species of benthic macroinvertebrates have been collected from the Broad River study area. Most of the benthic organisms collected were insects, with dipterans, odonates, trichopterans, and ephemeropterans being most abundant. Other important benthic fauna include oligochaetes and pelecypods. A list of benthic organisms captured in the study area is found in Section 3.5.3 of Appendix 2A, Section 3.5.3a of Appendix 2B, Section 2.4.3 of Appendix 2C, and Appendix 2D.

Many of the organisms collected, especially the chironomids, are classified as facultative, with wide ranges of tolerance to environmental conditions; such species are considered to be pollution-tolerant organisms. According to Brinkhurst and others (28), the burrowing mayfly, which was found in great numbers, is an exception to this as it is not considered to be a facultative organism, although it is known to prefer soft, silty substrates (29).

The diversity and density of organisms changed with seasons as expected. Insect species have specific emergence patterns, with individual species emerging during a particular time of the year. Samples taken shortly after emergence of a particular species (or several species) would be expected to show few of these forms.

2.2.2.4.3 Fish

Fish are the most obvious component of the aquatic ecosystem, thus a knowledge of the species composition and certain aspects of their life history are important in characterizing the system. Species composition and relative abundance provide basic information about species

diversity of the fish fauna and their numerical status in the fish community.

A total of 50 species of fish have been collected in the study area. Bluegill sunfish was the most abundant species captured and was found in all areas that were sampled. This species, one of the primary sport fishes, is considered to be ubiquitous in the reservoir.

Gizzard shad was the next most abundant species. This species is also considered to be ubiquitous in the reservoir as it was collected at all of the transects. Gizzard shad is an important forage species in the study area since they are filter feeders and are planktivorous.

The white crappie was the third most abundant species found. This species was also collected at all of the transects. It is actively sought as a sport fish and probably also contributes to the forage base.

The largemouth bass was the fourth most abundant species captured in the study area. This fish was collected at all of the transects except one. The length-weight relationship of the largemouth bass collected and their abundance indicate that it is a major predator in the reservoir. It is also considered one of the important segments of the sport fishery.

The aforementioned species comprise about 75 percent of the fishes in the study area according to these studies. Checklists of all species captured and aspects of life history information including age and growth studies, length-weight relationships, standing crop estimates, sex ratios, gonad condition, food habits, condition factors, and parasitism are provided in Section 3.6.3 of Appendix 2A, Section 3.6.3a of Appendix 2B, and Section 2.5.3 of Appendix 2C.

There is no commercial fishing in the Broad River study area but there is an active sport fishery of two distinct types; several species which are important from a recreational aspect occur. In the Broad River fishing for catfish is the main sport. In Parr Reservoir the fish most sought are the centrarchids. Several species of this group are considered to be important, including: largemouth bass, white crappie, bluegill sunfish, black crappie, pumpkinseed, redear sunfish, and green sunfish.

No rare or endangered species of fish as designated by the United States Fish and Wildlife Service or the state of South Carolina (30) were found in the Broad River study area.

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TABLE 2.2-1

WATER QUALITY DATA FROM USGS STATIONS

	Specific Conductance	Dissolved Oxygen	Temperature	pH
Parr Dam				
Max	103 micromhos (Nov. 22, 1973)	12.7 mg/l (Dec. 24, 1973)	31.5°C (July 31, 1974)	7.3 units (Oct. 27 & 28, 1973)
Min	40 micromhos (July 8 & 9, 1974)	6.1 mg/l (July 31, 1974)	4.5°C (Dec. 23 & 24, 1973)	6.0 units (July 8, 1973)
Broad River at Carlisle, S. C.				
Max	90 micromhos (Nov. 21, 1973)	12.0 mg/l (Dec. 20, 1973)	30.0°C (Aug. 1, 1974)	7.8 units (Nov. 20, 1973)
Min	35 micromhos (Dec. 28, 1973)	5.5 mg/l (Sept. 3, 1974)	5.5°C (Dec. 18, 19, & 20, 1973)	6.4 units (Sept. 3, 1974)
Tyger River at Delta, S. C.				
Max	181 micromhos (Oct. 20, 1973)	12.3 mg/l (Feb. 26 & 27, 1974)	28.0°C (May 19, Aug. 29 & 30, 1974)	8.7 units (May 27, 1974)
Min	50 micromhos (April 7, 1974)	5.9 mg/l (Oct. 2, 1973)	3.5°C (Dec. 23, 1973)	6.2 units (April 5, 6, & 7, 1974)
Enoree River at Whitmire, S. C.				
Max	81 micromhos (Nov. 17, 18, & 19, 1973)	12.4 mg/l (Dec. 12, 1973)	28.0°C (July 18, 1974)	7.4 units (Jan. 27 & 28, 1974)
Min	32 micromhos (July 7 & 8, 1974)	5.2 mg/l (July 10, 1974)	3.5°C (Dec. 19, 1973)	6.3 units (Jan. 4, 1974)

Source: Reference 31.

TABLE 2.2-2

TOTAL CONCENTRATION OF CERTAIN HEAVY METALS
ABOVE AND BELOW PARR RESERVOIR

Above Parr Reservoir (S. C. 34)

Sampling Period	Cu (mg/1)	Cr (mg/1)	Pb (mg/1)	Hg (mg/1)	Cd (mg/1)
8/28/62	Min. 0.050	Min. 0.100	Min. 0.100	Min. 0.0002	Min. 0.005
	Avg. 0.050	Avg. 0.234	Avg. 0.157	Avg. 0.0004	Avg. 0.059
12/7/73	Max. 0.050	Max. 0.480	Max. 0.200	Max. 0.0005	Max. 0.100

Below Parr Reservoir (S. C. 213)

Sampling Period	Cu (mg/1)	Cr (mg/1)	Pb (mg/1)	Hg (mg/1)	Cd (mg/1)
6/25/70	Min. 0.050	Min. 0.100	Min. 0.034	Min. 0.0000	Min. 0.005
	Avg. 0.055	Avg. 0.358	Avg. 0.349	Avg. 0.0003	Avg. 0.056
12/7/73	Max. 0.070	Max. 1.090	Max. 1.210	Max. 0.0005	Max. 0.100

Source: Reference 19.

2.3 METEOROLOGY

2.3.1 GENERAL CLIMATE

Climatological conditions for the region in the area of the Virgil C. Summer Nuclear Station are described in this section. The site is in the Piedmont Physiographic Province near the Fall Line, which separates the Piedmont from the Coastal Plain. It is 26 miles northwest of Columbia, S.C. (Figure 2.1-1), near the center of the state, approximately 140 miles northwest of the Atlantic Ocean and 100 miles southeast of the Appalachian Mountains. The terrain consists of rolling hills; elevations range from 200' near Columbia to over 600' near Little Mountain. The Broad River is approximately 1 mile to the west, and Parr Dam is 3 miles south-southwest. Site elevation is approximately 435' above mean sea level.

The climate in this region is temperate, having long hot summers and cool winters. The Appalachian Mountain chain frequently retards the approach of cold fronts during the winter months.

In summer, the Bermuda High is the greatest single weather factor influencing the area. This semi-permanent high pressure system blocks the entry of cold fronts so that many stall before reaching central South Carolina. Also, the southwesterly flow around this system supplies moisture from the Gulf of Mexico for the many summer thunderstorms. Typically, summer has approximately 50 days with temperatures of 90°F or above and 6 days with temperatures of 100°F or above. Summer is the rainiest season of the year, contributing about 33 percent of the annual total. The summer rains are largely in the form of local thunderstorms, occurring on an average of 11 days per month during this season. About once or twice a year, effects of passing tropical storms are felt by

way of strong winds and heavy rains. The incidence of these storms is greatest in September, although they represent a possible threat from summer to late fall. Rainfall during the late fall (October and November) is at an annual minimum.

Winter weather in this region is largely made up of polar outbreaks that reach this area in a much modified form. On rare occasions, arctic air masses push through this region and cause some of the coldest temperatures. On the average, minimum temperature can be expected to drop to 32°F or lower on 45 to 50 days, and at or below 20°F on 5 days during this season. A day or more with snowfall is probable during 9 out of 11 winters. A day with more than 1 inch of snowfall is likely to occur in 1 out of 5 winters. Winter rainfall accounts for 22 percent of the annual total.

Spring is the most changeable season of the year in this area due to the alterating effects of polar and tropical air masses. Spring rainfall accounts for 25 percent of the annual total. While tornadoes are infrequent, those that do occur are most frequent during this season. Hailstorms are not common, but the annual incidence is at a maximum in spring and early summer (1).

The prevailing surface winds tend to be either from the northeast or southwest due to the presence and orientation of the Appalachian Mountains. The prevailing wind direction during the winter, spring, and summer seasons is southwest; northeast or north-northeast winds prevail during the fall (2) (3).

Annually, values of relative humidity of 90 percent or greater are recorded 25 percent of the time. Values of relative humidity in this range occur most frequently during the hours from 0000 to 0700 local time (3).

The mean percentage of possible sunshine in the state varies from a low of 59 percent in January to a high of 68 percent in April and October (1) (2) (4) (5).

2.3.2 SITE METEOROLOGY

Data summaries presented in this section are based on 1975 onsite meteorological measurements at the nuclear plant site, supplemented by long-term data from proximal National Weather Service Stations.

2.3.2.1 Temperature and Water Vapor

Monthly and annual diurnal distributions of temperature at the site during 1975 are shown in Tables 2.3-1 through 2.3-13 (6). Values of the mean, absolute maximum and minimum, and average daily maximum and minimum temperatures for each month are also presented. The annual mean temperature from Table 2.3-13 is 17.2°C. During 1975, the highest average daily maximum temperature, 31.8°C, occurred in August, while the lowest average daily minimum temperature, 1.5°C, occurred in December.

Long-term monthly and annual values of daily mean temperature, and average and extreme daily maximum and minimum temperatures are shown in Table 2.3-14, based on data records at Parr and Little Mountain (7). From Table 2.3-14, the annual mean temperature is approximately 63°F, which is equivalent to the onsite value of 17.2°C.

The monthly and annual diurnal distributions of dewpoint temperature and relative humidity at the site during 1975 are also shown in Tables 2.3-1 through 2.3-13 (6). Values of the mean, absolute maximum and minimum, and average daily maximum and minimum for both parameters are included in these tables. The annual average relative humidity from

Table 2.3-13 is 69 percent and the annual average dewpoint temperature is 10.9°C. The highest average daily maximum dewpoint temperature, 22.2°C, occurs in August.

Long-term monthly and annual values of relative humidity for four different times of day, based on 7 years of record (1967-1973) at Columbia, are given in Table 2.3-15 (1). From these data, the annual average relative humidity is estimated to be about 73 percent, or slightly higher than the onsite average of 69 percent.

Long-term monthly and annual average dewpoint temperatures and extreme maximum and minimum dewpoint temperatures are shown in Table 2.3-16. These values are based on 1971-1975 data from Columbia (8). The annual average dewpoint temperature from these data is 53°F, which is slightly higher than the 1975 onsite value of 10.9°C.

2.3.2.2 Wind Characteristics

Monthly and annual wind roses for each stability class (and all classes combined) for the 1975 period of record at the Virgil C. Summer Nuclear Station are presented in Tables 2.3-17 through 2.3-42 (6). Tables 2.3-17 through 2.3-29 are based on wind distributions at the 10.5 meter level, while Tables 2.3-30 through 2.3-42 are based on wind distributions at the 61.5 meter level. Stability was determined from the 10-61 meter delta temperature measurements onsite and the class intervals specified in Regulatory Guide 1.23. The maximum frequency of surface wind on an annual basis is from the southwest, 9.4 percent, and the annual average wind speed is just over 6 mph (Table 2.3-29). At the 61.5 meter level, the maximum annual frequency of winds, 11.7 percent, is also from the southwest, but the average wind speed at this level is almost 10 mph (Table 2.3-42).

During the period from 1951 to 1960 at Columbia, the maximum frequency of surface wind on an annual basis was 10.1 percent from the southwest and the annual average wind speed was 7.0 mph (9). These values compare favorably with the 1975 onsite data at the 10.5 meter level.

2.3.2.3 Precipitation

Long-term monthly precipitation normals and mean number of days with precipitation equal to or greater than 0.5 inches, presented in Table 2.3-43, are based on data from Little Mountain, Santuck, and Winnsboro, S.C. (7). These data indicate that the rainfall is fairly well distributed throughout the year, with an annual average of about 45 inches. Monthly maximum precipitation as recorded at Columbia and Greenville-Spartanburg is also presented in Table 2.3-43 (1) (11). The maximum monthly value, 16.72 inches, occurred during August 1949, at Columbia.

Monthly and annual average snowfall expected at the site is given in Table 2.3-44, based on data from Little Mountain, Santuck, and Winnsboro (7). These data give an annual expectancy of 2.4 inches of snow in the site area. Monthly maximum snowfall amounts at selected stations in the region are also presented in Table 2.3-44 (1) (7) (11) (12).

2.3.2.4 Storms

2.3.2.4.1 Thunderstorms

The largest number of thunderstorms occur in late spring and summer, with a minimum during the winter months. The most severe thunderstorms accompany the squall lines and active cold fronts of spring. There is an average of 50 to 60 thunderstorms per year in this area of South Carolina. The monthly and seasonal distributions at several cities around the site are displayed in Table 2.3-45 (1) (11) (12).

2.3.2.4.2 Tornadoes

From 1955, through 1967, a total of 12 tornadoes occurred within the square containing the site (13). This gives a mean annual frequency of 0.92. The probability of a tornado hitting a point in a given year is:

$$P = (2.8209\ \bar{t}/A)$$

where A is the area in square miles of a 1° square centered on the point, and $\bar{t}$ is the mean annual frequency of tornadoes in the area (14). The return period is the reciprocal of P. For the plant site, $\bar{t}$ is 0.92 and A is approximately 3,930 square miles. Therefore, the probability of a tornado hitting the site in any given year is 0.00066, with a return frequency of once every 1,514 years.

2.3.2.4.3 Hurricanes

Tropical cyclones, including hurricanes, lose strength rapidly as they move over land so the greatest concern inland is potential damage from excessive rainfall. The tropical cyclone season for South Carolina extends from June to October, with the peak months August and September. Occurrences outside this period are extremely rare. The average frequency of tropical storms that affected the state from 1931 to 1960 is approximately 2 per year; of these about 1 in 6 were of hurricane intensity with winds of 74 mph or greater (15).

2.3.2.4.4 Wind Storms

From 1955 through 1967, a total of 22 wind storms with wind speeds of 50 knots or greater occurred within the 1° latitude-longitude square containing the site (13).

The "fastest mile" of record at Columbia and Greenville-Spartanburg for each month is presented in Table 2.3-46 (1) (11). Fastest mile

winds are sustained winds, normalized to 30 feet above ground and include all meteorological phenomena except tornadoes.

2.3.3 AIR POLLUTION

Air quality data from Newberry, S.C., the closest representative air sampling station, indicates that the site area is relatively unpolluted (16). At this station, suspended particulates are measured using a high-volume sampler, and sulfur dioxide and nitrogen dioxide are sampled using the "bubbler" method. Sampling is conducted every 6 days for a 24-hour period.

Data during 1975 for the pollutants measured at Newberry are summarized as follows:

Pollutant	South Carolina Air Quality Standards		24-Hour Value		Annual Mean
	24-Hour	Annual	Highest	2nd Highest	
Total Suspended Particulates	250	60	83	75	38.6
Sulfur Dioxide	365(1)	80	15	13	2.9
Oxides of Nitrogen	None	100	61	60	21.6

(1) Not to be exceeded more than once per year.

All values given above are in micrograms per cubic meter. The annual mean for particulates is a geometric mean rather than an arithmetic. Comparing the values at Newberry to the South Carolina ambient air quality standards indicates that air pollution levels in the area are quite low. Existing levels of air pollution are not expected to have any effect on plant operation.

2.3.4 REGIONAL COMPARISON

Generally, the 1975 onsite data and the long-term (regional) data summaries presented in Section 2.3.1 compare favorably. One notable exception is the low 1975 precipitation total onsite compared to the norm for this region. On the other hand, annual averages of temperature, dewpoint, and humidity compare favorably as do the annual wind frequency distributions.

2.3.5 TOPOGRAPHIC EFFECTS

Terrain in the area consists of rolling hills. Elevations range from 200' near Columbia to over 600' near Little Mountain. Site elevation is approximately 435'.

Variable terrain has a potential to influence local diffusion characteristics. One possible influence, drainage wind conditions in the Broad River Valley, has been investigated using the CVNPA tower data. This valley is oriented north-northwest to south-southeast, and the tower stands on a bluff next to the river, with its base lower than the nearby valley ridge lines.

When measured over three sectors (67.5°), the 23 foot level winds on the CVNPA tower show a primary directional frequency in those sectors centered on west (17). The secondary frequency maximum is in the three sectors centered on east-northeast. These wind directions cross, rather than parallel, the Broad River Valley. Similar wind distributions are observed at Charlotte, Columbia, and Greenville, with bimodel maxima near the west and east-northeast sectors (18). It is evident that these frequency maxima are not local conditions caused by terrain influences.

The three wind sectors centered on north-northwest include all down-valley winds, and the three sectors centered on south-southeast include all up-valley winds. A comparison of winds falling within these six sectors at the 23 foot level with those at the 193 foot level reveals up-valley and down-valley winds almost twice as frequent at the higher tower height as at the lower (17). Since this is the reverse of what would be expected if drainage winds were occurring, such winds are, therefore, quite infrequent or non-existent in that portion of the Broad River Valley occupied by Parr Reservoir.

An examination of the terrain near the plant shows that if valley drainage winds do occur occasionally over the Parr Reservoir, or in the Little River Valley tributary to the east of the plant, the plant and condenser-warmed Monticello Reservoir would be above and to the side of cool air circulation fields. It is concluded that any valley drainage winds will not influence the diffusion climate of the Virgil C. Summer Nuclear Station.

An evaluation of the impact of Monticello Reservoir upon meteorological conditions in the area is presented in Section 5.1.4.

2.3.6 REFERENCES

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TABLE 2.3-1

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: JANUARY 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: JANUARY 1, 1975 TO JANUARY 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00 DEG C	DEW POINT 10.00 DEG C	REL HUMID 10.00 PCT	WIND SPEED 10.50 M/SEC	WIND DIR 10.50 DEG	WIND SPEED 61.50 M/SEC	WIND DIR 61.50 DEG	DELTA TEMP 10.00-61.00 DEG C	STAR CLASS 10.00-61.00
1	8.3	7.9	70.8	2.8	216	5.7	228	.7	E
2	7.8	7.8	72.9	2.7	232	5.0	234	.7	E
3	7.4	7.9	74.8	2.5	212	4.7	233	.7	E
4	7.1	7.9	76.1	2.5	212	4.9	222	.7	E
5	6.9	8.0	77.8	2.4	221	4.8	237	.7	E
6	6.6	8.0	79.3	2.3	226	4.6	228	.9	E
7	6.4	8.0	80.8	2.4	236	4.6	231	.9	E
8	6.2	8.2	81.4	2.4	256	4.5	251	.8	E
9	6.2	8.3	82.0	2.5	246	4.6	246	.7	E
10	6.9	8.8	81.7	2.5	249	4.4	234	.4	E
11	7.8	8.6	77.2	2.8	253	4.0	238	-.2	E
12	9.2	8.4	70.1	3.3	265	4.3	252	-.5	D
13	10.5	8.6	64.2	3.5	270	4.5	253	-.6	D
14	11.7	8.7	60.6	3.6	269	4.5	260	-.6	D
15	12.5	8.9	58.0	3.9	267	4.8	261	-.6	D
16	13.1	9.3	59.1	3.9	244	4.9	241	-.6	D
17	13.4	9.2	56.6	3.9	242	4.9	244	-.5	D
18	13.2	9.2	58.1	3.6	237	4.7	240	-.4	D
19	12.5	9.1	59.6	2.9	215	4.3	224	-.1	E
20	11.7	9.0	62.0	2.6	193	4.6	208	.2	E
21	10.9	9.0	64.6	2.8	204	5.1	212	.6	E
22	10.2	8.7	65.6	2.9	183	5.1	195	.7	F
23	9.6	8.5	66.9	2.9	211	5.1	207	.8	F
24	9.0	8.4	69.6	3.2	217	5.6	227	.8	F
ABSOLUTE MAX	25.8	17.8	98.6	9.1		11.7			
AVG DAILY MAX	14.4	7.7	86.8	5.2		7.5			
MEAN	9.4	8.5	69.3	3.0	236	4.7	234	.3	E
CLIMATIC MEAN	9.6	8.5	68.3	3.0		4.8			
AVG DAILY MIN	4.9	-.6	49.9	.9		2.2			
ABSOLUTE MIN	-3.7	-10.5	16.2	0.0		.4			
STANDARD DEV	6.2	6.6	20.8	1.7		2.3			
VALID OBS	743	707	707	743	743	735	733	742	742
INVALID OBS	1	37	37	1	1	9	11	2	2
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	99.9	95.0	95.0	99.9	99.9	98.8	98.5	99.7	99.7

TABLE 2.3-2

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: FEBRUARY 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: FEBRUARY 1, 1975 TO FEBRUARY 28, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00	DEW POINT 10.00	REL HUMID 10.00	WIND SPEED 10.50	WIND DIR 10.50	WIND SPEED 61.50	WIND DIR 61.50	DELTA TEMP 10.00-61.00	STAB CLASS 10.00-61.00
	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	9.4	3.8	69.1	3.0	165	5.6	187	.7	F
2	8.9	3.8	71.0	2.8	159	5.5	173	.8	F
3	8.4	3.6	72.2	3.0	148	5.5	170	.8	E
4	8.0	3.6	73.8	2.8	154	5.3	166	.7	E
5	7.5	3.4	75.5	2.9	142	5.4	166	.8	F
6	7.0	3.5	78.3	2.9	132	5.3	146	.9	F
7	6.5	3.3	79.4	2.6	207	5.1	180	.9	F
8	6.2	3.0	79.8	2.5	217	5.1	181	.8	F
9	6.0	2.9	80.5	2.4	181	5.0	186	.8	F
10	6.6	3.2	79.0	2.7	189	4.6	201	.5	F
11	8.3	3.3	72.2	3.0	185	4.1	189	-.3	D
12	10.3	3.6	65.6	3.4	228	4.2	214	-.5	D
13	11.3	3.6	62.5	3.4	228	4.2	222	-.6	D
14	12.4	3.5	58.1	3.5	246	4.4	237	-.6	D
15	13.3	3.7	56.0	3.7	250	4.6	243	-.6	D
16	13.7	3.6	54.3	3.5	245	4.4	236	-.5	D
17	14.2	3.7	53.3	3.6	234	4.5	228	-.5	D
18	14.2	3.6	52.9	3.6	230	4.7	226	-.4	D
19	13.6	3.9	55.3	3.4	209	4.8	210	-.2	E
20	12.7	3.9	57.9	3.1	206	5.0	206	.0	E
21	11.7	3.9	60.9	3.2	186	5.5	189	.3	E
22	11.0	3.9	63.3	3.2	200	5.6	186	.5	E
23	10.2	3.7	65.4	3.2	186	5.6	184	.7	E
24	9.7	3.8	67.9	3.1	185	5.7	191	.7	E
ABSOLUTE MAX	24.1	18.7	96.8	7.2		9.7			
AVG DAILY MAX	15.3	7.0	84.1	5.0		7.7			
MEAN	10.0	3.6	66.9	3.1	207	5.0	201	.2	E
CLIMATIC MEAN	10.1	3.5	66.3	3.2		5.2			
AVG DAILY MIN	4.9	-.1	48.6	1.4		2.6			
ABSOLUTE MIN	-2.7	-9.1	18.3	0.0		0.0			
STANDARD DEV	4.0	4.4	21.1	1.4		1.9			
VALID OBS	671	671	671	665	665	641	641	672	672
INVALID OBS	1	1	1	7	7	31	31	0	0
TOTAL OBS	672	672	672	672	672	672	672	672	672
DATA RECOVERY	99.9	99.9	99.9	99.0	99.0	95.4	95.4	100.0	100.0

TABLE 2.3-3

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: MARCH 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: MARCH 1, 1975 TO MARCH MARCH 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

	DRY BULB	DEW POINT	REL HUMID	WIND SPEED	WIND DIR	WIND SPEED	WIND DIR	DELTA TEMP 10.00 61.00	STAB CLASS 10.00 61.00
	10.00	10.00	10.00	10.50	10.50	61.50	61.50		
HOUR	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	10.2	3.4	64.5	3.7	218	6.2	218	.4	E
2	9.6	3.6	67.2	3.4	221	5.8	220	.4	E
3	9.1	3.5	68.6	3.3	233	5.7	232	.5	E
4	8.5	3.2	69.3	3.2	225	5.4	228	.5	E
5	8.1	3.0	70.1	3.0	256	5.1	254	.7	E
6	7.8	2.9	70.8	2.9	241	5.1	260	.7	E
7	7.5	2.8	71.6	3.0	229	5.2	250	.8	F
8	7.1	2.7	73.4	2.9	224	4.9	250	.9	F
9	7.3	2.8	72.9	3.0	239	4.9	261	.5	F
10	8.9	3.4	69.2	3.4	234	4.7	234	-.2	E
11	10.2	2.6	60.6	3.9	260	5.0	244	-.5	D
12	12.0	2.7	55.3	4.3	239	5.3	237	-.6	D
13	13.2	2.6	51.8	4.6	243	5.6	240	-.6	D
14	14.0	2.7	50.6	4.5	249	5.6	247	-.6	D
15	14.8	3.0	49.8	4.6	261	5.7	256	-.6	D
16	15.3	3.1	48.6	4.5	251	5.5	250	-.6	D
17	15.6	3.2	48.6	4.4	244	5.6	242	-.6	D
18	15.5	2.7	47.2	4.4	254	5.5	246	-.5	D
19	14.9	2.7	48.1	4.1	256	5.3	250	-.3	D
20	13.8	3.1	52.9	3.7	270	5.4	253	-.0	E
21	12.7	3.0	55.7	3.8	254	5.9	236	.3	E
22	11.8	2.8	57.5	3.7	203	6.3	204	.5	F
23	11.2	3.1	60.2	3.6	186	6.2	192	.5	E
24	10.6	3.3	62.7	3.5	187	6.1	191	.4	E
ABSOLUTE MAX	26.5	18.3	96.2	11.1		15.2			
AVG DAILY MAX	16.7	7.6	82.3	6.2		8.7			
MEAN	11.2	3.0	60.3	3.7	241	5.5	239	.1	F
CLIMATIC MEAN	11.2	3.3	61.6	4.0		5.8			
AVG DAILY MIN	5.8	-1.0	40.9	1.8		2.9			
ABSOLUTE MIN	-4.2	-12.6	13.5	.5		.4			
STANDARD DEV	6.7	8.3	23.8	1.9		2.6			
VALID OBS	741	738	738	742	742	738	738	742	742
INVALID OBS	3	6	6	2	2	6	6	2	2
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	99.6	99.2	99.2	99.7	99.7	99.2	99.2	99.7	99.7

TABLE 2.3-4

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: APRIL 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: APRIL 1,1975 TO APRIL 30, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR,SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00 DEG C	DEW POINT 10.00 DEG C	REL HUMID 10.00 PCT	WIND SPEED 10.50 M/SEC	WIND DIR 10.50 DEG	WIND SPEED 61.50 M/SEC	WIND DIR 61.50 DEG	DELTA TEMP 10.00 - 61.00 DEG C	STAB CLASS 10.00 - 61.00
1	14.8	6.9	60.8	3.2	193	5.6	204	.9	F
2	14.3	7.0	63.1	3.1	201	5.8	208	1.0	F
3	13.8	7.0	65.8	3.0	205	5.5	214	1.0	F
4	13.0	7.1	68.9	2.8	203	5.3	226	1.0	F
5	12.4	7.1	71.0	2.6	227	5.1	265	1.1	F
6	11.9	7.3	74.5	2.4	245	4.7	275	1.2	F
7	11.6	7.0	74.2	2.4	261	4.8	283	1.1	F
8	11.3	7.0	75.3	2.5	251	4.9	277	1.2	F
9	12.2	7.4	72.8	2.9	259	4.7	263	.4	F
10	14.3	7.0	63.0	3.6	269	4.8	265	-.5	D
11	15.1	6.5	55.7	4.2	276	5.1	271	-.7	D
12	17.6	6.4	51.0	4.1	257	4.8	252	-.7	D
13	18.8	6.5	47.6	4.1	261	4.8	249	-.8	D
14	19.8	6.2	44.3	4.1	256	4.8	249	-.8	D
15	20.6	6.1	42.3	4.2	254	5.1	252	-.7	D
16	21.1	6.0	41.1	4.4	257	5.2	252	-.7	D
17	21.4	5.9	40.3	4.4	258	5.2	249	-.7	D
18	21.6	5.9	40.0	4.3	251	5.2	242	-.6	D
19	21.0	6.0	41.2	4.0	244	5.1	242	-.4	D
20	20.0	6.3	44.4	3.6	227	5.2	230	-.1	F
21	18.7	6.6	48.4	3.4	196	5.5	206	.3	F
22	17.6	6.8	52.1	3.5	190	6.0	197	.7	E
23	16.6	7.0	55.6	3.3	190	5.8	199	.7	E
24	15.9	7.2	58.4	3.3	189	5.9	202	.8	F
ABSOLUTE MAX	30.5	19.2	95.4	10.2		13.4			
AVG DAILY MAX	22.0	10.1	80.3	5.7		8.1			
MEAN	16.5	6.7	56.4	3.5	234	5.2	237	.2	F
CLIMATIC MEAN	14.3	4.7	57.4	3.6		5.4			
AVG DAILY MIN	10.7	3.2	35.5	1.6		2.7			
ABSOLUTE MIN	1.4	-10.6	11.1	0.0		.5			
STANDARD DEV	5.1	4.2	23.2	1.9		2.3			
VALID OBS	719	714	714	720	720	709	708	720	720
INVALID OBS	1	6	6	0	0	11	12	0	0
TOTAL OBS	720	720	720	720	720	720	720	720	720
DATA RECOVERY	99.9	99.2	99.2	100.0	100.0	98.5	98.3	100.0	100.0

TABLE 2.3-5

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: MAY 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: MAY 1,1975 TO MAY 31,1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/04/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR,SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-04

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

	DRY BULB	DEW POINT	REL HUMID	WIND SPEED	WIND DIR	WIND SPEED	WIND DIR	DELTA TEMP 10.00 61.00	STAB CLASS 10.00 61.00
	10.00	10.00	10.00	10.50	10.50	61.50	61.50		
HOUR	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	20.1	14.6	80.5	2.3	142	4.7	144	1.1	F
2	19.6	18.3	91.5	2.2	124	4.7	145	1.1	F
3	19.1	18.1	93.1	2.1	143	4.5	170	1.0	F
4	18.8	15.9	83.3	2.1	145	4.2	182	1.0	F
5	18.5	15.7	84.4	2.1	137	4.1	172	.9	F
6	18.1	15.7	86.3	1.8	137	3.6	173	.9	F
7	17.8	1 .7	87.7	1.7	140	3.6	175	.9	F
8	17.9	16.8	88.2	1.7	97	3.3	104	.6	E
9	19.1	16.5	84.5	2.1	88	3.1	95	-.1	F
10	20.9	14.9	74.3	2.3	317	2.6	24	-.5	D
11	22.6	17.2	72.3	2.6	223	2.7	203	-.7	D
12	24.1	17.3	66.7	2.5	261	2.8	249	-.8	C
13	24.2	17.0	61.7	2.7	278	3.1	208	-.8	C
14	24.0	16.8	57.5	2.8	229	3.0	219	-.8	C
15	24.7	16.3	54.2	2.9	212	3.3	207	-.8	C
16	24.9	16.3	52.7	3.2	213	3.6	211	-.7	D
17	24.9	16.4	53.7	3.5	207	4.0	206	-.7	D
18	24.2	16.4	56.5	3.3	203	3.9	204	-.6	D
19	23.6	16.7	59.6	3.0	172	3.8	181	-.4	D
20	24.3	17.0	65.3	2.8	147	4.2	162	-.2	F
21	23.0	17.0	70.1	2.6	140	4.5	157	.2	F
22	22.1	17.1	73.9	2.5	143	4.7	155	.4	E
23	21.4	17.0	76.8	2.6	155	5.0	163	1.0	F
24	20.7	16.4	74.3	2.5	155	5.0	171	1.1	F
ABSOLUTE MAX	33.7	23.1	97.6	8.2		11.7			
AVG DAILY MAX	27.5	18.6	90.7	4.7		6.9			
MEAN	22.1	16.5	72.5	2.5	168	3.8	178	.1	E
CLIMATIC MEAN	22.5	16.5	70.2	2.8		4.2			
AVG DAILY MIN	17.5	14.5	64.8	.4		1.8			
ABSOLUTE MIN	11.7	6.5	33.1	0.0		0.0			
STANDARD DEV	4.6	3.1	17.7	1.2		1.7			
VALID OBS	742	742	741	744	744	742	742	744	744
INVALID OBS	2	2	3	0	0	2	2	0	0
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	99.7	99.7	99.6	100.0	100.0	99.7	99.7	100.0	100.0

TABLE 2.3-6

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: JUNE 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: JUNE 1,1975 TO JUNE 30, 1975

DATA SOURCE: ON-SITE
TAPE GENERATED: 08/05/76, 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR,SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	HGY HEAT 10.00	DEW POINT 10.00	REL HUMID 10.00	WIND SPEED 10.50	WIND DIR 10.50	WIND SPEED 61.50	WIND DIR 61.50	DELTA TEMP 10.00 61.00	STAB CLASS 10.00 61.00
	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	22.4	18.1	77.2	2.5	156	5.1	174	.9	F
2	21.8	18.2	79.9	2.2	161	4.6	179	.9	F
3	21.6	18.0	81.5	2.2	165	4.4	185	.9	F
4	21.9	17.9	82.9	2.1	212	4.3	210	.8	F
5	21.6	17.8	84.2	2.1	246	4.0	272	.9	F
6	21.1	17.4	84.7	2.1	289	4.2	11	.9	F
7	19.8	17.2	85.3	2.0	321	4.0	20	.9	F
8	20.3	17.4	83.8	2.2	356	3.7	31	.4	F
9	21.9	17.8	77.7	2.6	14	3.2	43	-.4	D
10	23.9	18.1	70.0	3.0	28	3.4	50	-.7	D
11	25.7	17.8	62.2	3.3	17	3.6	38	-.8	C
12	27.0	17.3	55.6	3.5	20	4.0	43	-.8	C
13	28.0	16.9	51.6	3.7	46	4.3	102	-.9	C
14	28.8	16.6	48.1	3.6	335	4.1	144	-.9	B
15	29.4	16.6	46.4	3.9	325	4.4	135	-.9	C
16	29.6	16.8	46.6	3.9	273	4.5	231	-.8	C
17	29.6	16.9	46.5	4.1	221	4.6	185	-.8	C
18	29.2	16.9	48.1	4.0	193	4.8	186	-.7	D
19	28.5	17.0	50.7	3.7	142	4.5	146	-.6	D
20	27.5	17.5	55.5	3.2	117	4.3	132	-.4	D
21	26.0	17.8	61.2	3.1	121	4.8	142	.0	E
22	26.8	18.0	66.2	2.8	136	4.8	147	.5	E
23	24.8	17.9	69.4	2.5	142	4.7	152	.7	E
24	23.2	18.0	72.7	2.3	172	4.8	179	1.0	F
ABSOLUTE MAX	34.2	23.0	95.0	9.7		12.3			
AVG DAILY MAX	31.1	19.8	88.4	5.1		8.9			
MEAN	24.8	17.5	66.2	2.9	133	4.3	148	.0	E
CLIMATIC MEAN	24.8	17.5	65.0	3.1		4.5			
AVG DAILY MIN	19.6	15.3	43.1	1.1		2.1			
ABSOLUTE MIN	14.3	9.2	31.6	0.0		0.0			
STANDARD DEV	1.4	2.5	18.5	1.3		1.6			
VALID OBS	719	719	719	720	720	719	719	720	720
INVALID OBS	1	1	1	0	0	1	1	0	0
TOTAL OBS	720	720	720	720	720	720	720	720	720
DATA RECOVERY	99.9	99.9	99.9	100.0	100.0	99.9	99.9	100.0	100.0

TABLE 2.3-7

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: JULY 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: JULY 1, 1975 TO JULY 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-073-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00 DEG C	DEW POINT 10.00 DEG C	REL HUMID 10.00 PCT	WIND SPEED 10.50 M/SEC	WIND DIR 10.50 DEG	WIND SPEED 61.50 M/SEC	WIND DIR 61.50 DEG	DELTA TEMP 10.00 61.00 DEG C	STAB CLASS 10.00 61.00
1	23.0	20.5	86.4	2.3	181	4.4	189	.5	F
2	22.8	20.4	87.5	2.3	184	4.4	195	.5	F
3	22.3	20.3	88.7	1.9	183	3.8	198	.6	F
4	22.0	20.2	89.4	1.9	176	3.7	191	.5	E
5	21.7	20.1	90.2	1.9	175	3.6	191	.5	F
6	21.4	20.0	91.2	1.6	176	3.4	189	.6	F
7	21.2	20.0	92.4	1.6	176	3.4	194	.6	F
8	21.5	20.2	92.4	1.7	181	3.1	197	.4	E
9	22.4	20.6	88.3	1.9	197	2.7	209	.1	F
10	24.9	19.7	83.5	2.3	192	2.8	199	-.0	F
11	25.2	21.1	77.8	2.4	185	2.6	168	-.0	E
12	26.4	20.9	71.8	2.6	195	3.0	181	-.0	F
13	27.4	20.7	67.6	2.8	202	3.2	193	.1	F
14	27.9	20.7	65.6	2.9	200	3.4	199	-.0	F
15	28.4	20.2	62.1	3.1	199	3.6	205	-.2	F
16	28.4	20.0	61.6	3.4	199	4.0	194	.0	F
17	28.3	19.9	61.7	3.7	199	4.3	207	-.1	F
18	28.0	19.8	62.4	3.4	161	4.2	170	-.1	F
19	27.1	20.0	66.9	3.4	156	4.5	165	-.2	F
20	26.3	20.3	71.2	2.9	169	3.9	172	-.1	E
21	25.4	20.5	75.3	2.4	162	4.0	173	.1	F
22	24.7	20.5	78.6	2.3	153	4.1	170	.4	E
23	24.1	20.6	81.5	2.4	155	4.3	171	.6	F
24	23.5	20.6	84.0	2.4	163	4.7	178	.6	E
ABSOLUTE MAX	33.5	25.2	100.0	9.8		12.4			
AVG DAILY MAX	29.4	21.8	93.7	4.9		6.7			
MEAN	24.7	20.3	78.3	2.5	177	3.7	188	.2	F
CLIMATIC MEAN	25.2	19.8	75.3	2.8		4.2			
AVG DAILY MIN	21.1	17.8	56.8	.8		1.7			
ABSOLUTE MIN	18.4	-17.3	35.3	0.0		0.0			
STANDARD DEV	3.4	2.3	16.3	1.2		1.5			
VALID OBS	736	733	732	741	741	643	643	741	741
INVALID OBS	8	11	12	3	3	101	101	3	3
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	98.9	98.5	98.4	99.6	99.6	86.4	86.4	99.6	99.6

TABLE 2.3-8

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: AUGUST 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: AUGUST 1, 1975 TO AUGUST 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5382-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00 DEG C	DEW POINT 10.00 DEG C	REL HUMID 10.00 PCT	WIND SPEED 10.50 M/SEC	WIND DIR 10.50 DEG	WIND SPEED 61.50 M/SEC	WIND DIR 61.50 DEG	DELTA TEMP 10.00-61.00 DEG C	STAB CLASS 10.00-61.00
1	24.4	21.1	81.8	1.4	183	4.0	192	.8	F
2	23.8	21.1	84.5	1.2	194	3.8	207	.7	F
3	23.5	21.0	85.7	1.3	204	3.8	214	.7	E
4	23.1	20.9	87.2	1.2	207	3.7	221	.7	E
5	22.6	20.8	89.1	1.2	223	3.7	235	.8	F
6	22.4	20.6	89.8	1.1	228	3.7	244	.8	F
7	22.0	20.5	90.8	1.1	238	3.6	242	.8	F
8	22.0	20.5	91.0	1.0	236	3.4	261	.6	E
9	23.1	21.0	87.6	1.4	246	2.7	245	-.1	E
10	25.2	21.5	79.4	1.7	264	2.5	243	-.7	D
11	27.3	21.5	70.4	2.0	276	2.9	242	-.8	C
12	28.8	21.3	63.5	2.2	266	3.1	235	-.8	C
13	29.9	20.6	57.2	2.5	243	3.5	219	-.9	B
14	30.7	20.1	53.0	2.5	239	3.4	215	-.9	B
15	31.3	19.7	49.9	2.6	226	3.4	201	-.9	B
16	31.2	19.4	49.1	2.8	212	3.9	195	-.8	C
17	31.0	19.5	50.2	2.7	202	3.9	191	-.7	D
18	30.8	19.5	51.0	2.5	203	3.5	195	-.6	D
19	30.2	19.8	54.1	2.3	189	3.6	182	-.6	D
20	28.9	20.5	60.8	1.9	164	3.7	171	-.2	E
21	27.5	20.9	67.3	1.8	157	4.1	165	.3	E
22	26.4	21.1	72.4	1.6	162	4.4	171	.6	E
23	25.6	21.0	76.0	1.5	170	4.1	180	.7	F
24	24.9	21.1	79.2	1.4	184	3.9	189	.7	E
ABSOLUTE MAX	34.5	23.9	96.3	5.5		10.3			
AVG DAILY MAX	31.8	22.2	91.8	3.2		5.9			
MEAN	26.5	20.6	71.7	1.8	207	3.6	204	.0	E
CLIMATIC MEAN	26.8	20.5	69.3	1.9		3.8			
AVG DAILY MIN	21.9	18.9	46.7	.7		1.6			
ABSOLUTE MIN	18.9	14.6	31.1	0.0		0.0			
STANDARD DEV	3.9	1.5	17.0	.8		1.5			
VALID OBS	744	744	744	744	744	744	744	744	744
INVALID OBS	0	0	0	0	0	0	0	0	0
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 2.3-9

STATISTICS AND DIURNAL VARIATION OF
METEOROLOGICAL PARAMETERS: SEPTEMBER 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: SEPTEMBER 1, 1975 TO SEPTEMBER 30, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76, 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

	DRY BULB	DEW POINT	REL HUMID	WIND SPEED	WIND DIR	WIND SPEED	WIND DIR	DELTA TEMP	STAB CLASS
	10.00	10.00	10.00	10.50	10.50	61.50	61.50	10.00 61.00	10.00 61.00
HOUR	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	20.9	18.2	84.7	2.3	136	4.6	133	.5	F
2	20.6	18.0	85.4	2.2	96	4.3	131	.5	E
3	20.2	17.9	86.3	2.2	74	4.1	100	.3	F
4	19.9	17.5	86.5	2.3	56	4.3	67	.3	E
5	19.5	17.3	86.9	2.3	54	4.2	56	.3	F
6	19.3	17.2	87.4	2.2	51	3.9	35	.3	E
7	19.1	17.1	87.8	2.2	50	3.8	23	.3	E
8	19.0	17.0	88.1	2.3	58	4.0	49	.2	F
9	19.3	17.1	86.8	2.4	45	3.6	45	-.2	E
10	20.5	17.4	82.5	2.9	51	3.7	56	-.5	D
11	22.0	17.7	76.7	3.2	61	3.8	67	-.6	D
12	23.5	17.9	71.6	3.0	74	3.6	79	-.8	D
13	24.8	18.1	67.2	3.1	67	3.7	73	-.8	C
14	25.6	17.9	63.3	3.3	81	3.8	92	-.8	C
15	26.3	17.9	60.7	3.3	98	4.0	117	-.8	C
16	26.6	17.7	59.2	3.4	81	4.1	118	-.7	D
17	26.7	17.6	58.7	3.2	101	4.0	120	-.7	D
18	26.1	17.6	60.5	3.2	86	4.0	107	-.6	D
19	25.1	17.8	65.1	2.8	88	4.0	97	-.3	D
20	23.9	18.1	70.5	2.7	85	4.3	80	-.0	F
21	23.0	18.2	75.0	2.7	111	4.8	108	.3	F
22	22.2	18.2	78.4	2.5	121	4.9	115	.7	E
23	21.7	18.1	80.5	2.3	111	4.8	112	.7	E
24	21.1	18.1	83.0	2.4	121	4.8	117	.6	E
ABSOLUTE MAX	35.7	24.1	98.1	10.1		12.4			
AVG DAILY MAX	27.1	19.9	91.4	4.6		6.8			
MEAN	22.4	17.7	76.4	2.7	81	4.1	92	-.1	E
CLIMATIC MEAN	22.8	17.9	74.1	2.9		4.5			
AVG DAILY MIN	18.4	15.9	56.8	1.2		2.2			
ABSOLUTE MIN	10.4	5.1	34.4	0.0		0.0			
STANDARD DEV	4.7	4.3	15.6	1.5		1.8			
VALID OBS	719	719	719	717	717	717	714	715	715
INVALID OBS	1	1	1	3	3	3	6	5	5
TOTAL OBS	720	720	720	720	720	720	720	720	720
DATA RECOVERY	99.9	99.9	99.9	99.6	99.6	99.6	99.2	99.3	99.3

TABLE 2.3-10

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: OCTOBER 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: OCTOBER 1, 1975 TO OCTOBER 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76. 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00	DEW POINT 10.00	REL HUMID 10.00	WIND SPEED 10.50	WIND DIR 10.50	WIND SPEED 61.50	WIND DIR 61.50	DELTA TEMP 10.00-61.00	STAB CLASS 10.00-61.00
	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	16.2	12.9	81.0	2.1	38	4.7	113	2.0	F
2	15.8	12.7	82.2	2.2	36	4.5	124	1.7	F
3	15.4	12.5	83.0	2.1	43	4.4	120	1.6	F
4	14.9	12.4	86.9	2.1	6	4.3	49	1.5	F
5	14.4	12.1	86.4	2.0	349	4.2	9	1.5	F
6	14.0	11.9	87.4	2.0	1	4.3	35R	1.4	F
7	13.8	11.7	87.2	2.0	351	4.3	35R	1.4	F
8	13.6	11.5	87.3	2.1	10	4.3	10	1.3	F
9	14.0	11.8	86.6	2.2	18	4.0	2R	.9	F
10	15.6	12.2	80.8	2.7	40	3.7	40	.0	F
11	17.7	12.9	74.2	3.1	42	3.7	45	-.4	D
12	19.7	13.0	66.7	3.1	45	3.6	49	-.6	D
13	21.4	12.8	59.5	3.2	44	3.5	50	-.7	D
14	22.7	12.8	53.5	3.4	3	3.7	1R	-.8	D
15	23.4	12.4	50.6	3.5	71	4.0	142	-.7	D
16	23.8	12.4	49.7	3.5	31	4.0	294	-.7	D
17	23.8	12.3	49.7	3.5	72	4.0	74	-.6	D
18	23.1	12.4	52.0	3.0	91	3.8	99	-.4	D
19	21.9	12.9	57.7	2.6	113	4.1	121	.0	F
20	20.6	13.0	62.3	2.5	100	4.6	79	.6	F
21	19.3	13.0	67.8	2.5	100	4.9	91	1.3	F
22	18.1	12.9	72.0	2.4	120	5.0	122	1.8	F
23	17.2	12.7	75.3	2.2	66	4.8	115	1.9	F
24	16.4	12.5	77.9	2.1	77	4.8	120	2.0	F
ABSOLUTE MAX	24.8	22.0	94.3	10.4		13.1			
AVG DAILY MAX	24.0	15.1	98.0	4.4		6.7			
MEAN	18.2	12.5	71.7	2.6	44	4.2	5R	.7	E
CLIMATIC MEAN	14.5	12.5	88.4	2.8		4.4			
AVG DAILY MIN	13.0	9.4	47.4	1.1		2.1			
ABSOLUTE MIN	3.3	-4.6	19.8	.4		0.0			
STANDARD DEV	5.3	5.4	14.6	1.5		2.1			
VALID OBS	738	732	732	743	743	737	738	744	744
INVALID OBS	6	12	12	1	1	7	R	0	0
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	99.2	98.4	98.4	99.9	99.9	99.1	98.9	100.0	100.0

TABLE 2.3-11

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: NOVEMBER 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: NOVEMBER 1,1975 TO NOVEMBER 30, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76, 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00 DEG C	DEW POINT 10.00 DEG C	REL HUMID 10.00 PCT	WIND SPEED 10.50 M/SEC	WIND DIR 10.50 DEG	WIND SPEED 61.50 M/SEC	WIND DIR 61.50 DEG	DELTA TEMP 10.00-61.00 DEG C	STAB CLASS 10.00-61.00
1	10.9	6.6	75.0	2.1	189	4.7	184	2.3	G
2	10.3	6.6	77.7	1.9	187	4.4	191	2.4	G
3	9.8	6.5	80.0	1.9	196	4.3	195	2.4	G
4	9.5	6.5	81.4	1.9	189	4.2	195	2.4	G
5	9.0	6.2	81.9	2.0	208	4.0	208	2.4	G
6	8.9	6.0	82.0	1.9	208	4.0	235	2.2	G
7	8.4	5.9	83.9	1.7	234	3.9	271	2.2	G
8	8.1	5.9	85.6	1.7	206	3.9	305	2.2	G
9	8.2	6.2	87.2	2.0	218	4.1	352	2.2	G
10	9.2	6.8	84.5	2.2	292	3.6	328	1.3	F
11	11.5	7.4	76.1	2.4	296	3.2	304	.1	E
12	14.1	7.6	66.0	2.6	280	3.1	254	-.5	D
13	16.0	7.5	58.2	2.8	261	3.2	253	-.7	D
14	17.0	7.3	54.9	2.9	260	3.4	254	-.7	D
15	17.9	7.0	50.9	3.2	239	3.7	238	-.7	D
16	18.3	6.9	49.3	3.3	247	3.8	240	-.6	D
17	18.2	6.8	49.2	3.0	224	3.6	225	-.5	D
18	17.7	6.9	50.9	2.5	222	3.3	220	-.3	D
19	16.7	6.9	53.8	2.3	189	3.5	196	.1	E
20	15.6	7.2	58.5	2.4	162	4.1	186	.8	F
21	14.4	7.3	63.0	2.4	173	4.7	187	1.6	F
22	13.3	7.4	67.6	2.4	179	4.9	186	2.1	G
23	12.4	7.3	71.5	2.3	167	4.9	182	2.2	G
24	11.9	7.2	73.2	2.2	172	4.9	181	2.1	G
ABSOLUTE MAX	26.1	20.4	100.0	7.7		9.8			
AVG DAILY MAX	18.8	10.3	89.9	4.1		6.8			
MEAN	12.8	6.8	69.3	2.3	217	4.0	211	1.1	F
CLIMATIC MEAN	13.0	6.8	67.9	2.6		4.2			
AVG DAILY MIN	7.1	3.4	45.8	1.0		1.6			
ABSOLUTE MIN	-1.4	-7.5	23.4	.4		0.0			
STANDARD DEV	7.1	7.7	19.6	1.5		2.2			
VALID OBS	719	719	719	720	720	719	719	720	720
INVALID OBS	1	1	1	0	0	1	1	0	0
TOTAL OBS	720	720	720	720	720	720	720	720	720
DATA RECOVERY	99.9	99.9	99.9	100.0	100.0	99.9	99.9	100.0	100.0

TABLE 2.3-12

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS: DECEMBER 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: DECEMBER 1, 1975 TO DECEMBER 31, 1975

DATA SOURCE: ON-SITE
TABLE GENERATED: 08/05/76, 21.30.47.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00	DEW POINT 10.00	REL HUMID 10.00	WIND SPEED 10.50	WIND DIR 10.50	WIND SPEED 61.50	WIND DIR 61.50	DELTA TEMP 10.00-61.00	STAB CLASS 10.00-61.00
	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	5.1	.9	69.0	2.2	186	5.3	211	1.5	F
2	5.5	.7	71.2	2.0	226	4.9	221	1.5	F
3	5.0	.5	72.1	2.0	263	4.6	224	1.5	F
4	4.7	.4	73.4	2.0	141	4.5	232	1.5	F
	4.3	.5	75.6	1.8	25	4.2	249	1.5	F
	4.9	.4	77.3	1.8	307	4.0	268	1.7	F
7	3.5	.4	79.1	1.9	232	4.1	253	1.8	F
8	3.3	.5	80.5	1.8	218	4.1	243	1.9	F
9	3.2	.5	80.9	1.9	260	3.9	268	1.8	F
10	3.7	.8	79.7	2.0	278	3.9	277	1.5	F
11	5.3	1.4	75.1	2.2	279	3.5	272	.4	F
12	7.5	1.9	68.1	2.6	270	3.3	242	-.3	D
13	9.2	2.0	61.8	2.8	276	3.4	266	-.5	D
14	10.1	1.1	56.1	3.0	285	3.4	277	-.6	D
15	11.2	1.4	54.4	3.2	275	3.8	269	-.6	D
16	11.5	1.4	53.5	3.3	277	3.9	278	-.6	D
17	11.7	1.2	52.1	3..	277	3.8	274	-.5	D
18	11.2	1.0	52.9	2.8	281	3.7	276	-.3	D
19	10.3	1.0	55.2	2.6	242	4.0	255	.1	E
20	9.3	.8	57.4	2.8	232	4.7	252	.5	F
21	8.2	.4	61.2	2.5	221	4.8	244	1.0	F
22	7.4	.4	63.4	2.4	203	5.0	219	1.4	F
23	6.8	.7	65.6	2.4	154	5.0	202	1.5	F
24	6.4	.7	67.3	2.4	176	5.3	204	1.4	F
ABSOLUTE MAX	21.9	16.9	96.6	9.1		12.7			
AVG DAILY MAX	12.7	4.5	84.3	4.3		7.2			
MEAN	7.1	.9	66.8	2.4	264	4.2	251	.8	F
CLIMATIC MEAN	7.1	.8	65.3	2.7		4.4			
AVG DAILY MIN	1.5	-2.0	46.3	1.0		1.6			
ABSOLUTE MIN	-4.4	-15.8	14.6	.4		0.0			
STANDARD DEV	4.3	3.5	21.3	1.5		2.3			
VALID OBS	742	742	742	744	744	742	742	744	744
INVALID OBS	2	2	2	0	0	2	2	0	0
TOTAL OBS	744	744	744	744	744	744	744	744	744
DATA RECOVERY	99.7	99.7	99.7	100.0	100.0	99.7	99.7	100.0	100.0

TABLE 2.3-13

STATISTICS AND DIURNAL VARIATION OF
METEOROLOGICAL PARAMETERS: JANUARY TO DECEMBER, 1975

STATISTICS AND DIURNAL VARIATION OF METEOROLOGICAL PARAMETERS
DATA PERIOD: JANUARY 1, 1975 0100 EST TO DECEMBER 31, 1975 2400

DATA SOURCE: ON-SITE
TABLE GENERATED: 04/05/76. 10.49.58.

VIRGIL C SUMMER NUCLEAR STATION
PARR, SOUTH CAROLINA
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
DAMES AND MOORE JOB NO: 5182-070-09

METEOROLOGICAL PARAMETERS (HEIGHTS IN METERS)

HOUR	DRY BULB 10.00	DEW POINT 10.00	REL HUMID 10.00	WIND SPEED 10.50	WIND DIR 10.50	WIND SPEED 61.50	WIND DIR 61.50	DELTA TEMP 10.00 61.00	STAB CLASS 10.00 61.00
	DEG C	DEG C	PCT	M/SEC	DEG	M/SEC	DEG	DEG C	
1	15.6	11.1	75.1	2.5	178	5.0	188	1.0	F
2	15.1	11.0	77.1	2.4	179	4.8	195	1.0	F
3	14.6	10.9	78.6	2.3	180	4.6	200	1.0	F
4	14.2	10.8	79.8	2.2	185	4.5	205	1.0	F
5	14.0	10.7	81.1	2.2	203	4.4	224	1.0	F
6	13.6	10.6	82.5	2.1	222	4.2	244	1.0	F
7	13.2	10.5	83.4	2.0	242	4.2	257	1.1	F
8	13.1	10.5	83.9	2.1	236	4.1	263	.9	F
9	13.6	10.7	82.3	2.3	252	3.9	263	.6	F
10	15.0	11.0	77.6	2.6	243	3.7	263	.1	F
11	15.7	11.2	76.8	2.9	302	3.7	252	-.4	D
12	16.4	11.2	68.3	3.1	258	3.8	234	-.6	D
13	19.7	11.1	59.3	3.3	253	3.9	234	-.6	D
14	20.6	10.8	55.4	3.3	251	4.1	237	-.7	D
15	21.3	10.8	53.0	3.5	247	4.2	238	-.7	D
16	21.7	10.7	52.1	3.5	243	4.3	234	-.6	D
17	21.7	10.7	51.7	3.6	230	4.4	227	-.6	D
18	21.4	10.6	52.7	3.4	220	4.3	219	-.5	D
19	20.7	10.8	55.6	3.1	198	4.3	207	-.3	D
20	19.6	11.0	59.9	2.9	173	4.5	189	.1	E
21	18.8	11.2	64.2	2.8	160	4.9	178	.5	F
22	17.5	11.2	67.7	2.7	159	5.1	171	.9	F
23	16.8	11.1	70.4	2.6	161	5.0	173	1.0	F
24	16.1	11.1	73.0	2.6	170	5.1	181	1.0	F
ABSOLUTE MAX	36.5	25.2	100.0	11.1		15.2			
AVG DAILY MAX	23.5	13.8	87.9	4.8		7.2			
MEAN	17.2	10.9	68.8	2.7	209	4.4	207	.3	E
CLIMATIC MEAN	17.4	10.8	67.6	3.0		4.5			
AVG DAILY MIN	12.2	7.9	47.3	1.1		2.1			
ABSOLUTE MIN	-4.4	-17.3	11.3	0.0		0.0			
STANDARD DEV	4.8	4.3	20.5	1.6		2.1			
VALID OBS	8733	8686	8678	8743	8743	8586	8574	8742	8742
INVALID OBS	27	74	82	17	17	174	181	12	12
TOTAL OBS	8760	8760	8760	8760	8760	8760	8760	8760	8760
DATA RECOVERY	99.7	99.1	99.1	99.8	99.8	98.0	97.9	99.9	99.9

TABLE 2.3-14

VALUES OF MEAN, AVERAGE AND EXTREME DAILY MAXIMUM, AND AVERAGE AND EXTREME DAILY MINIMUM SURFACE TEMPERATURES (°F) IN THE SITE AREA

Month	Mean[1]	Average Daily Maximum[1]	Extreme Maximum	Average Daily Minimum[1]	Extreme Minimum[2]
January	46.5	59.4	84	33.5	5
February	48.1	61.3	82	35.0	-4
March	52.5	65.6	92	39.3	9
April	63.2	77.1	97	49.2	23
May	70.7	84.0	102	57.4	35
June	77.4	90.5	107	64.3	43
July	79.9	92.0	108	67.8	52
August	79.1	91.3	107	67.0	50
September	73.3	85.4	106	61.1	39
October	63.5	76.8	103	50.1	21
November	52.8	66.8	89	38.7	13
December	45.5	58.9	81	32.1	4
Annual	62.7	75.8	108	49.6	-4

(1) Based on 13-14 years of record (1947-1960) at Parr.

(2) Based on 1893-1960 period of record at Little Mountain and the 1947-1960 period of record at Parr. Value in table is extreme monthly temperature using both records.

Source: Reference 7.

TABLE 2.3-15

MONTHLY AND ANNUAL AVERAGE RELATIVE HUMIDITY (%) AT COLUMBIA (1967-1973)

Month	Hour (Local Standard Time) 0100	0700	1300	1900
January	80	83	55	66
February	74	80	48	57
March	74	83	48	54
April	77	84	45	50
May	84	88	49	61
June	88	90	54	64
July	89	91	57	72
August	91	93	59	74
September	92	94	56	75
October	89	92	54	76
November	84	88	49	71
December	80	85	55	71
Annual	84	88	53	66

Source: Reference 1.

TABLE 2.3-16

MONTHLY AND ANNUAL MEAN, AND
EXTREME MAXIMUM AND MINIMUM DEWPOINT
TEMPERATURES (°F) AT COLUMBIA, S.C. (1971-1975)

Month	Mean	Extreme Maximum	Extreme Minimum
January	41	68	-06
February	36	69	01
March	43	68	09
April	48	72	17
May	60	74	28
June	66	76	39
July	71	79	52
August	71	77	57
September	67	78	41
October	54	75	17
November	44	72	09
December	41	71	02
Annual	53	79	-06

Source: Reference 8.

TABLE 2.3-17

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: JANUARY 1975

PASQUILL A&B (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	0	0	1	0	2	6.35
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	1	0	0	0	0	0	0	0	0	0	1	2.15
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	2	0	0	0	0	0	0	0	0	0	2	2.35
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													1	2.15
TOTAL	0	0	4	0	0	0	0	0	0	0	1	0	4	3.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL B&C (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
NE	0	0	0	0	0	0	0	0	0	1	0	0	1	9.40
ENE	0	0	0	1	1	0	0	0	0	0	0	0	2	5.45
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	1	0	0	0	0	0	0	0	0	0	1	3.45
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	1	1	0	0	0	0	1	0	0	4	4.48

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL C&D (FROM AEC/DELTA-T CRITERIA [illegible] METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	1	0	0	0	0	0	0	1	4.80
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	1	0	0	0	0	0	0	1	8.73
SE	0	0	0	0	0	0	1	0	0	0	0	0	1	10.50
SSE	0	0	0	0	0	0	1	0	0	0	0	0	1	6.30
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.80
SW	0	0	0	0	0	0	0	0	0	0	1	0	1	13.20
WSW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.30
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	1	0	1	10.70
NW	0	0	0	0	0	1	1	0	0	0	0	0	2	6.85
NNW	0	0	2	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	1	0	0	1	9.90
CALM													0	0.
TOTAL	0	0	1	1	1	2	3	1	1	3	4	1	18	7.84

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL D&E (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	1	1	0	2	0	3	0	1	4	13	8.73
NE	1	0	3	3	2	1	1	0	0	1	0	0	12	4.50
ENE	0	0	1	1	3	3	2	1	3	2	0	0	16	5.20
E	0	0	1	1	0	4	1	2	3	1	0	1	14	6.60
ESE	0	0	0	2	3	0	2	3	2	2	0	0	14	6.45
SE	0	0	0	0	1	1	1	0	0	0	0	4	8	9.80
SSE	0	0	0	0	0	2	2	0	0	0	0	0	4	5.10
S	0	0	0	0	0	0	0	0	0	0	2	1	2	12.15
SSW	0	0	0	1	0	0	0	0	0	1	0	2	4	11.60
SW	0	0	2	3	1	1	1	1	4	0	2	2	17	7.80
WSW	0	0	1	2	1	1	0	3	6	5	7	11	37	10.28
W	0	0	2	3	2	5	3	3	3	1	3	17	42	10.34
WNW	0	1	3	4	3	3	5	4	1	0	0	0	24	5.17
NW	0	1	1	5	10	2	1	2	1	2	2	0	27	5.67
NNW	0	0	3	3	1	3	3	0	1	2	0	2	18	6.39
N	0	2	0	0	5	0	1	1	2	0	0	0	11	5.36
CALM													0	0.
TOTAL	1	4	18	30	35	26	23	20	29	21	16	52	275	7.79

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-17 (Continued)

PASQUILL WEA (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	6	1	3	3	2	2	1	2	0	0	0	14	5.29
NE	0	6	0	1	4	1	4	2	2	0	0	0	16	4.94
ENE	0	1	6	3	3	7	1	0	0	0	0	0	15	4.30
E	0	0	3	3	0	3	5	1	0	0	0	0	15	5.07
ESE	0	0	0	2	1	3	0	0	0	0	0	0	6	4.47
SE	0	0	0	1	1	0	1	0	1	0	0	1	5	7.64
SSE	0	0	1	0	1	2	7	4	2	0	1	6	24	8.43
S	0	0	0	2	1	2	1	3	2	0	5	2	3	21
SSW	0	1	1	3	2	3	2	0	2	5	1	3	25	7.12
SW	0	1	2	3	1	2	2	3	1	9	1	8	33	8.68
WSW	0	0	2	5	1	1	2	2	1	2	4	4	24	7.70
W	0	0	0	0	1	4	2	3	2	0	1	2	17	7.23
WNW	0	1	1	3	1	2	1	1	1	0	0	0	13	5.15
NW	0	1	1	2	1	2	1	0	0	0	0	1	9	6.56
NNW	0	0	2	3	1	0	0	0	0	0	0	3	11	7.45
N	1	0	2	5	1	0	2	0	1	2	0	1	15	6.42
CALM													2	.43
TOTAL	1	5	26	39	29	41	39	19	13	24	11	32	263	6.94

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	1	2	0	0	0	0	0	0	5	3.80
NE	0	1	0	1	4	0	0	0	0	0	0	0	6	3.98
ENE	1	0	1	2	1	2	0	0	0	0	0	0	7	4.16
E	0	1	0	0	2	1	0	0	0	0	0	0	4	3.80
ESE	0	2	0	0	1	0	1	0	0	0	0	0	5	4.14
SE	0	0	0	0	0	1	1	1	1	0	0	0	4	7.25
SSE	0	1	1	1	1	2	1	5	2	1	1	0	16	6.56
S	0	1	0	0	1	1	1	0	0	0	0	0	4	4.75
SSW	0	0	1	1	2	3	1	5	0	0	0	0	13	6.01
SW	1	1	0	0	5	4	5	1	0	0	0	0	16	5.31
WSW	0	0	0	3	4	5	0	0	0	0	0	0	12	4.74
W	0	0	1	0	0	2	0	0	0	0	0	0	3	4.57
WNW	0	1	1	0	1	0	0	0	0	0	0	0	3	2.70
NW	0	0	0	2	0	1	1	0	1	0	0	0	5	5.50
NNW	0	3	1	1	0	0	0	0	0	0	0	0	5	2.92
N	1	2	1	0	1	0	0	0	0	0	0	0	4	2.45
CALM													1	.47
TOTAL	2	14	8	11	24	23	15	15	4	1	1	0	119	4.63

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	1	0	2	0	0	0	0	0	4	3.87
NE	1	0	0	0	2	0	0	0	0	0	0	0	1	1.05
ENE	0	1	1	0	1	1	0	0	0	0	0	0	4	3.77
E	0	1	2	0	0	0	1	1	0	0	0	0	5	4.07
ESE	1	1	0	0	0	1	2	0	0	0	0	0	5	4.06
SE	0	0	0	1	0	1	0	0	0	0	0	0	2	4.65
SSE	0	0	0	0	1	0	1	1	1	0	0	0	6	5.77
S	0	1	0	0	0	0	0	0	0	0	0	0	1	2.23
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.70
WSW	0	0	1	0	1	0	0	0	0	0	0	0	2	3.30
W	0	0	1	0	0	0	1	0	0	0	0	0	2	2.60
WNW	0	0	1	0	0	0	0	0	0	0	0	0	1	3.37
NW	1	1	0	1	0	1	0	0	0	0	0	0	4	2.82
NNW	0	1	1	0	0	0	0	0	0	0	0	0	2	2.05
N	0	1	0	1	0	0	0	0	0	0	0	0	2	3.07
CALM													5	.42
TOTAL	3	8	14	4	5	4	4	2	1	0	0	0	55	3.28

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	4	7	4	4	1	5	1	2	4	30	5.75
NE	2	1	3	5	10	2	6	2	2	2	0	0	35	4.58
ENE	1	2	4	7	9	13	5	2	4	4	2	0	53	5.04
E	0	2	5	4	2	8	7	4	3	1	1	1	39	5.65
ESE	1	3	0	4	5	4	6	4	2	2	0	0	31	5.64
SE	0	0	0	4	2	3	3	2	2	0	0	5	21	7.74
SSE	0	1	2	3	5	6	9	10	5	1	2	6	50	7.88
S	0	2	5	1	3	2	4	2	0	7	3	5	34	7.67
SSW	0	1	5	5	4	6	5	5	2	8	1	12	54	7.79
SW	1	3	4	6	7	7	8	7	5	9	3	11	71	7.25
WSW	0	0	5	10	8	7	2	5	7	7	11	15	77	8.34
W	0	0	4	4	5	9	6	5	3	2	5	10	43	9.11
WNW	0	3	6	10	5	5	8	5	2	3	1	0	49	4.98
NW	1	3	4	10	11	7	4	2	2	2	2	1	49	6.24
NNW	0	4	7	7	4	3	3	0	1	2	0	5	36	5.64
N	1	5	5	6	9	0	3	1	3	3	0	1	37	4.65
CALM													8	.41
TOTAL	7	31	67	90	97	86	83	57	48	50	33	86	763	6.61

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: FEBRUARY 1975

PASQUILL #AB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	1	1	0	0	0	0	0	0	0	2	3.50
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.00
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	2	1	0	0	0	0	0	0	0	3	3.33

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 432

PASQUILL #AB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	1	0	1	0	0	0	0	0	2	5.45
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	1	0	0	0	0	0	0	0	0	1	3.00
SE	0	0	0	0	0	1	0	0	0	0	0	0	1	4.50
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	1	0	1	11.00
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
NNW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.50
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	2	2	1	1	0	0	0	1	0	8	5.13

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 432

PASQUILL #CB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
ENE	0	0	0	0	0	0	1	0	1	0	0	0	2	7.35
E	0	0	0	0	0	1	0	0	0	0	0	0	1	5.10
ESE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.70
SE	0	0	0	1	0	0	0	1	0	0	0	0	2	5.50
SSE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.20
S	0	0	0	0	1	0	2	0	0	0	0	0	3	5.83
SSW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.00
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	2	3	3	1	1	0	0	0	11	5.64

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 432

PASQUILL #CB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	2	1	2	4	1	1	0	0	11	6.45
NE	0	0	2	1	3	4	4	4	4	11	4	4	41	8.24
ENE	0	0	1	1	2	4	2	7	2	0	1	0	20	6.80
E	0	0	1	1	1	1	2	4	5	1	0	0	16	6.94
ESE	0	0	0	1	1	0	1	0	0	0	0	0	3	5.03
SE	0	0	0	1	0	2	1	1	0	0	0	0	5	6.20
SSE	0	0	0	1	1	0	1	1	1	0	1	1	7	7.41
S	0	1	1	2	0	1	2	2	1	1	0	2	13	6.78
SSW	0	0	0	1	1	1	3	3	1	2	2	4	18	8.72
SW	0	0	0	0	1	2	2	7	2	5	4	11	45	9.38
WSW	0	1	0	0	1	1	2	3	1	4	3	14	30	10.90
W	1	0	0	0	1	0	1	3	2	4	4	3	21	8.86
WNW	0	0	0	1	0	1	1	3	2	2	0	2	12	8.46
NW	0	1	0	1	1	0	2	0	0	2	0	1	8	6.71
NNW	0	0	1	0	0	1	0	1	0	1	2	0	6	7.43
N	0	0	0	0	1	2	4	1	2	2	0	0	12	7.09
CALM													1	0.
TOTAL	1	3	7	12	17	21	35	44	26	39	21	42	379	8.29

NUMBER OF INVALID OBSERVATIONS = 7
TOTAL NUMBER OF OBSERVATIONS = 432

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	2	2	7	2	2	0	5	0	0	16	5.29
NE	0	0	0	2	2	4	3	2	2	0	0	0	15	6.74
ENE	0	0	1	1	1	1	0	1	0	0	0	0	5	4.80
E	0	0	0	0	2	1	3	0	0	0	0	0	6	5.83
ESE	0	0	0	2	0	0	1	0	0	0	0	0	3	4.83
SE	0	0	0	0	1	2	2	0	0	2	2	0	9	7.67
SSE	0	0	0	0	2	2	4	0	0	2	1	12	23	10.72
S	0	0	0	0	4	5	1	2	3	2	3	1	21	7.60
SSW	0	0	0	0	1	2	4	4	0	0	0	4	15	8.21
SW	0	0	0	0	6	2	4	4	6	5	5	5	37	8.38
WSW	0	1	0	1	2	5	3	4	1	2	2	1	22	8.07
W	0	0	0	0	2	5	1	2	0	0	0	0	10	5.24
WNW	0	0	0	1	0	2	0	0	0	0	0	0	3	4.97
NW	0	2	1	0	0	0	1	0	0	0	1	0	5	4.34
NNW	0	0	2	0	2	3	0	1	0	1	0	0	9	5.34
N	0	0	0	0	0	2	1	2	0	0	0	1	6	7.45
CALM													1	.00
TOTAL	0	3	5	9	27	43	30	24	12	14	14	26	206	7.33

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	2	2	1	0	0	0	0	0	0	5	4.29
NE	0	1	0	4	4	1	0	0	0	0	0	0	10	4.94
ENE	0	0	1	4	1	0	0	0	0	0	0	0	6	3.63
E	0	0	2	1	0	2	2	1	0	0	0	0	8	5.15
ESE	0	1	0	1	1	3	0	4	1	2	0	0	13	6.35
SE	0	0	0	0	0	1	0	1	1	1	1	0	5	7.44
SSE	0	0	2	0	1	5	1	0	0	0	0	0	9	5.00
S	0	0	0	0	1	1	1	0	0	1	0	0	4	6.62
SSW	0	0	0	1	0	2	1	0	0	0	0	0	4	5.38
SW	0	1	0	3	0	2	0	0	0	0	0	0	6	4.03
WSW	0	1	0	1	2	1	0	0	0	0	0	0	5	4.13
W	0	0	0	1	1	1	0	2	1	0	0	0	6	5.17
WNW	0	0	0	0	1	1	0	0	0	0	0	0	2	3.75
NW	0	0	1	1	2	0	0	0	0	0	0	0	4	3.88
NNW	0	0	0	1	1	0	0	0	0	0	0	0	2	3.50
N	0	1	0	2	0	0	0	0	0	0	0	0	3	3.13
CALM													2	.00
TOTAL	0	5	7	23	18	18	6	11	2	4	1	0	99	4.94

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	0	0	0	0	1	3.00
NE	0	0	2	0	1	0	0	0	0	0	0	0	3	3.67
ENE	0	0	0	0	2	1	0	0	0	0	0	0	3	3.44
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	1	1	0	1	0	0	0	3	7.07
SE	0	0	0	0	0	0	1	2	0	0	0	0	3	7.20
SSE	0	0	0	0	0	0	0	2	0	1	0	0	3	8.33
S	0	0	0	0	0	0	1	0	0	0	0	0	1	5.10
SSW	0	1	0	1	2	0	1	0	0	0	0	0	5	4.96
SW	0	0	1	2	0	2	0	0	0	0	0	0	5	4.82
WSW	0	0	1	1	1	0	0	1	0	0	0	0	3	4.47
W	0	2	1	2	0	0	0	0	0	0	0	0	5	2.48
WNW	0	0	2	0	0	0	0	0	0	0	0	0	2	2.95
NW	0	0	3	1	0	0	0	0	0	0	0	0	4	2.97
NNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.40
N	0	0	1	0	0	0	0	0	0	0	0	0	1	2.20
CALM													4	.00
TOTAL	0	3	12	8	7	3	3	3	1	0	1	0	51	4.01

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	3	4	6	9	4	6	0	1	0	0	33	5.45
NE	0	1	4	7	13	9	7	11	6	11	9	4	82	6.99
ENE	0	2	3	6	7	6	4	8	2	0	1	0	40	5.63
E	0	0	3	2	3	5	7	5	5	1	0	0	31	6.17
ESE	0	1	0	5	2	5	3	4	2	2	0	0	24	5.83
SE	0	0	0	3	3	5	5	9	1	3	3	0	32	6.97
SSE	0	0	2	1	4	8	6	3	1	2	3	13	43	8.70
S	0	1	1	2	6	8	4	4	4	4	4	3	41	7.24
SSW	0	1	0	3	4	6	9	7	1	2	2	8	43	7.44
SW	0	1	1	6	4	8	11	6	11	11	14	16	93	9.24
WSW	0	3	1	3	6	7	5	8	2	6	5	15	61	8.56
W	1	2	2	3	4	5	4	6	2	6	4	3	42	6.85
WNW	0	0	2	3	2	3	1	3	2	2	0	2	20	4.69
NW	0	3	5	6	4	0	3	1	1	2	1	1	27	4.94
NNW	0	0	4	4	3	4	0	2	0	2	2	0	21	5.40
N	0	1	1	2	1	4	5	3	2	2	0	1	22	6.69
CALM													8	.00
TOTAL	1	16	32	60	76	92	80	86	43	57	48	66	665	6.97

NUMBER OF INVALID OBSERVATIONS = 7
TOTAL NUMBER OF OBSERVATIONS = 672

TABLE 2.3-19

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: MARCH 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.40
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.40
W	0	0	1	0	0	0	0	0	0	0	0	0	1	2.90
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	1	0	0	0	0	1	0	0	0	3	4.07

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #BB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	0	0	0	1	4.70
NE	0	0	0	0	0	0	0	0	0	1	0	0	1	9.10
ENE	0	0	0	0	0	1	0	0	0	0	0	0	1	4.00
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.40
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	1	0	0	0	0	0	0	1	4.10
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	1	1	17.00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	1	1	1	1	0	1	0	1	6	8.34

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #CC (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	1	0	1	0	0	0	0	3	4.87
NE	0	0	0	0	0	0	1	1	2	0	0	0	5	8.36
ENE	0	0	0	0	0	0	0	2	1	0	0	0	3	8.03
E	0	0	0	0	0	0	1	1	1	0	0	0	3	7.48
ESE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.40
SE	0	0	0	0	1	2	0	0	0	0	0	0	3	5.17
SSE	0	0	0	0	0	0	1	0	0	0	0	0	1	4.30
S	0	0	1	0	0	0	0	0	0	0	0	0	1	2.40
SSW	0	0	0	0	1	0	1	0	0	0	0	0	2	5.90
SW	0	0	0	1	0	0	0	0	1	0	0	0	2	5.80
WSW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
W	0	0	0	0	0	2	0	0	0	0	0	0	2	6.70
WNW	0	0	0	0	0	2	0	0	0	0	0	1	3	7.33
NW	0	0	0	0	1	0	0	0	0	0	1	4	6	11.33
NNW	0	0	0	0	0	0	0	1	0	0	0	0	1	7.20
N	0	0	0	0	1	0	0	1	0	0	0	0	2	6.30
CALM													0	0.
TOTAL	0	0	1	1	4	4	3	5	2	1	1	5	39	7.34

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #DD (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	1	1	1	1	2	0	0	0	0	9	4.87
NE	0	1	0	1	1	3	3	0	0	0	0	0	12	4.32
ENE	0	0	0	1	1	0	5	5	6	3	3	0	24	7.08
E	0	0	0	0	2	4	2	2	2	2	0	1	17	6.94
ESE	0	0	0	0	3	0	0	1	3	0	0	1	9	7.21
SE	0	0	0	0	0	0	1	1	0	0	0	2	4	9.47
SSE	0	0	0	0	1	0	0	1	0	3	0	2	7	9.36
S	0	0	0	0	0	0	3	1	2	3	2	2	5	19	10.32
SSW	0	0	0	0	1	1	1	5	1	3	2	5	16	35	10.40
SW	0	1	0	0	1	0	0	0	1	5	2	4	10	24	11.13
WSW	0	0	0	0	0	2	1	1	1	3	0	2	22	32	11.40
W	0	0	0	0	0	1	4	2	0	1	2	3	33	46	14.56
WNW	0	0	0	1	0	1	1	0	1	5	2	1	1	19	9.77
NW	0	1	0	1	1	0	2	2	2	1	1	10	21	10.43
NNW	0	0	2	2	2	1	3	0	0	0	0	8	18	8.67
N	0	0	0	0	2	4	3	6	4	0	0	3	22	8.08
CALM													0	0.
TOTAL	0	4	5	14	17	21	30	28	36	19	23	120	317	10.12

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL =B= (FROM AEC/DELTA-T CRITERIA 10-M) METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	2	1	1	0	1	1	1	0	0	10	5.14
NE	0	0	0	3	3	0	2	0	0	0	0	0	8	4.88
ENE	0	0	1	1	1	1	4	3	0	0	0	1	14	6.14
E	0	0	0	1	1	4	5	0	1	0	0	0	12	5.50
ESE	0	1	0	1	2	3	2	1	0	0	0	1	11	4.27
SE	0	0	0	0	0	1	0	1	1	1	0	0	4	10.34
SSE	0	0	0	0	0	1	1	2	3	1	4	1	13	9.97
S	0	0	0	0	0	2	2	2	2	3	0	5	11	10.82
SSW	0	0	0	0	0	1	0	5	1	1	1	2	11	9.32
SW	0	0	0	0	2	3	1	1	2	1	1	0	2	13	7.35
WSW	0	0	0	0	0	1	1	1	2	2	3	0	2	12	8.27
W	0	0	0	0	2	2	2	1	4	2	3	3	1	2	25	7.43
WNW	0	0	0	1	1	1	0	2	1	1	1	4	0	1	12	7.50
NW	0	0	0	1	4	2	2	1	3	4	2	1	5	24	7.88
NNW	0	0	0	1	4	1	4	2	3	0	1	3	3	24	7.04
N	0	0	0	0	1	4	2	1	0	0	1	0	0	14	5.14
CALM														0	0.
TOTAL	0	1	2	24	29	33	36	32	29	20	25	43	265	7.77

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL =C= (FROM AEC/DELTA-T CRITERIA 10-M) METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	5	0	0	0	1	0	0	0	0	0	0	0	1	4.77
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.35
ENE	0	2	0	0	3	0	2	1	1	0	0	0	9	5.06
E	0	0	0	0	1	1	1	1	0	0	0	0	4	5.20
ESE	0	1	0	1	0	0	1	1	0	0	0	0	4	4.47
SE	0	0	0	0	0	0	0	0	0	2	1	1	0	4	9.82
SSE	0	0	0	0	0	0	0	1	3	2	2	0	8	9.23
S	0	0	1	0	0	1	1	1	0	0	0	3	7	8.53
SSW	0	0	0	0	0	0	2	1	1	0	0	0	0	5.84
SW	0	0	0	3	2	0	0	0	0	0	0	0	5	4.37
WSW	0	0	1	0	2	2	0	0	0	0	0	0	5	4.71
W	0	0	2	0	1	1	2	0	0	0	0	0	4	4.41
WNW	0	1	1	0	1	0	0	0	0	0	0	0	3	2.47
NW	0	0	0	2	1	0	0	0	0	0	0	0	3	3.40
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	1	0	1	0	0	0	0	0	0	0	0	2	2.24
CALM													0	0.
TOTAL	0	5	5	7	20	5	11	6	7	3	3	3	75	5.81

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL =D= (FROM AEC/DELTA-T CRITERIA 10-M) METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.30
NE	0	2	1	1	0	0	0	0	0	0	0	0	4	2.48
ENE	0	0	0	0	2	0	0	0	0	0	0	0	2	4.90
E	0	0	0	2	0	0	0	0	0	0	0	0	2	3.35
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.55
SSE	0	0	0	2	1	0	1	0	1	0	0	0	5	5.20
S	0	0	0	0	1	0	0	0	0	0	0	0	5	3.92
SSW	0	1	0	1	0	0	0	0	0	0	0	0	2	2.55
SW	0	1	1	0	2	0	0	0	0	0	0	0	4	3.20
WSW	0	0	3	0	1	1	0	0	0	0	0	0	5	3.76
W	0	0	0	1	1	0	0	0	0	0	0	0	2	3.65
WNW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.68
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	2	0	1	0	0	0	0	0	0	0	3	3.17
CALM													0	0.
TOTAL	0	4	10	10	10	1	1	0	1	0	0	0	37	3.54

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	5	1	4	3	4	3	2	4	1	1	0	0	28	5.01
NE	0	3	1	5	5	2	4	4	5	1	0	0	32	5.83
ENE	0	2	1	2	9	2	11	11	8	3	3	1	53	6.86
E	0	0	0	7	8	7	11	6	6	2	0	1	68	6.28
ESE	0	2	0	5	2	3	6	1	0	1	2	2	26	6.64
SE	0	0	1	0	1	4	1	1	3	4	1	6	22	8.80
SSE	0	0	0	2	1	5	4	8	6	3	8	0	40	9.82
S	0	0	2	3	5	6	4	5	6	11	7	10	68	9.22
SSW	0	1	0	2	10	1	13	3	5	3	7	22	67	9.35
SW	0	2	1	7	7	1	1	3	7	3	4	12	48	8.48
WSW	0	0	4	1	6	6	3	3	6	7	6	23	66	9.67
W	0	0	3	3	7	6	8	7	4	6	4	35	82	11.09
WNW	0	1	4	1	4	3	2	1	2	0	2	0	30	8.10
NW	0	1	1	7	5	2	3	5	5	7	3	20	55	9.18
NNW	0	0	3	6	3	7	5	4	0	1	2	11	43	7.65
N	0	1	2	2	8	11	4	7	4	1	0	3	43	6.68
CALM													0	0.
TOTAL	0	14	29	57	86	65	81	72	69	55	62	172	762	9.34

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-20

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: APRIL 1975

PASQUILL #A# (FROM AEC/DELTA-T CRITERIA 10-A) METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.50
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	1	0	0	0	0	0	1	4.10
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	1	0	1	0	0	0	0	2	6.50
S	0	0	0	0	0	1	0	0	0	0	0	0	1	4.10
SSW	0	0	0	0	0	1	0	0	1	0	0	0	2	6.30
SW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.70
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	1	1	0	0	0	0	0	0	2	4.70
N	0	0	0	0	0	0	0	0	0	0	1	0	1	10.40
CALM													0	0.
TOTAL	0	0	0	1	1	4	1	2	1	0	1	0	11	5.60

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #B# (FROM AEC/DELTA-T CRITERIA 10-A) METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	1	1	11.30
ENE	0	0	0	0	0	2	0	0	0	0	0	0	2	5.65
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	0	0	1	0	0	0	2	4	9.90
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	1	1	0	0	0	0	0	2	6.15
WSW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.30
W	0	0	0	0	0	1	0	0	0	0	0	0	1	5.10
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	1	0	0	1	0	0	4	12.75
NNW	0	0	0	0	0	0	0	0	0	2	0	1	3	11.20
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	1	4	2	1	0	3	0	3	20	9.65

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #C# (FROM AEC/DELTA-T CRITERIA 10-A) METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.30
ENE	0	0	0	0	0	0	0	1	1	0	0	0	2	7.80
E	0	0	0	0	0	0	0	1	0	0	0	0	1	6.70
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	1	1	0	0	0	0	0	0	2	5.10
S	0	0	0	0	2	2	0	1	0	0	0	2	7	7.99
SSW	0	0	0	0	0	1	1	0	2	1	0	3	9	10.27
SW	0	0	0	1	0	0	1	0	1	0	0	0	3	6.47
WSW	0	0	1	0	1	0	1	0	0	0	0	0	3	6.70
W	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
WNW	0	0	0	0	0	0	0	1	0	0	0	0	2	12.20
NW	0	0	0	0	1	0	1	3	3	2	1	10	21	11.81
NNW	0	0	0	0	0	0	0	0	2	0	1	4	7	14.17
N	0	0	0	0	0	0	0	0	0	0	1	1	2	10.75
CALM													0	0.
TOTAL	0	0	1	1	4	5	5	6	10	3	3	22	62	10.14

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #D# (FROM AEC/DELTA-T CRITERIA 10-A) METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	2	1	0	0	0	0	0	4	5.13
NE	0	0	0	0	0	0	0	0	0	1	0	0	1	9.20
ENE	0	0	0	2	1	2	1	2	3	2	1	1	15	7.39
E	0	0	1	0	0	1	0	2	1	1	1	0	7	7.66
ESE	0	0	0	0	1	2	1	0	0	0	1	0	5	6.38
SE	0	0	0	0	2	3	2	1	1	1	1	0	11	5.87
SSE	0	0	0	0	3	2	2	1	0	1	1	0	11	5.87
S	0	0	0	1	1	0	2	1	0	1	1	0	7	6.68
SSW	0	0	0	1	1	1	0	0	2	0	1	0	6	6.38
SW	0	0	1	1	1	0	0	2	2	4	1	1	13	8.48
WSW	0	0	1	1	0	2	2	4	0	5	2	0	17	8.47
W	0	0	1	1	2	2	3	2	4	0	0	4	19	8.41
WNW	0	0	0	2	3	2	3	3	1	2	1	4	21	8.73
NW	0	0	0	1	1	2	1	3	2	1	1	9	21	10.29
NNW	0	0	1	0	0	3	1	3	4	3	1	7	23	10.85
N	0	0	0	0	0	1	1	0	0	1	1	0	4	8.38
CALM													1	.40
TOTAL	0	1	7	14	22	28	22	20	31	24	10	76	256	9.13

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	1	0	2	0	0	0	0	0	4	5.17
NE	0	3	0	4	0	2	1	1	0	0	0	0	11	3.99
ENE	0	0	1	0	0	1	1	0	0	1	1	0	4	6.82
E	0	0	1	1	2	1	1	0	0	0	0	0	6	4.42
ESE	0	0	0	1	1	0	0	0	0	1	0	0	3	5.00
SE	0	0	1	1	2	1	0	2	0	0	0	0	7	4.80
SSE	0	0	0	1	2	4	2	2	0	3	3	2	23	7.55
S	0	0	0	2	5	1	5	5	4	1	1	13	37	9.35
SSW	0	1	1	1	7	0	0	1	3	0	3	9	36	8.14
SW	0	0	0	2	4	1	6	4	2	10	2	2	1	34
WSW	0	0	0	1	0	2	1	3	1	0	0	0	8	4.17
W	0	0	0	0	2	2	2	6	2	1	0	1	2	18
WNW	0	0	0	1	1	0	1	1	0	0	0	0	4	5.50
NW	0	1	0	0	1	1	0	3	0	1	1	5	13	8.50
NNW	0	0	0	0	1	1	1	2	1	2	1	5	14	8.64
N	0	1	1	2	1	1	1	0	1	0	0	0	8	4.50
CALM													2	.40
TOTAL	0	5	8	21	33	27	26	34	21	19	15	37	229	7.54

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	1	0	0	0	0	0	2	4.45
NE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.70
ENE	0	0	0	1	0	0	0	0	0	0	0	0	1	5.00
E	0	0	1	0	0	0	1	0	0	0	0	0	2	4.85
ESE	0	1	0	0	0	1	2	1	0	0	0	0	5	5.44
SE	0	0	1	0	1	0	1	2	1	0	0	0	6	4.37
SSE	0	0	1	1	2	1	0	2	2	4	3	0	16	7.74
S	0	0	0	0	0	0	1	0	0	0	0	0	1	6.10
SSW	0	0	0	1	2	3	2	0	0	0	0	0	8	5.64
SW	0	0	0	1	1	0	1	0	0	0	0	0	3	4.97
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	2	1	0	1	0	0	0	0	5	5.14
WNW	0	1	0	2	3	2	2	1	1	0	0	0	12	5.39
NW	0	0	0	1	1	1	0	0	0	0	0	0	3	4.47
NNW	0	0	0	1	2	1	0	0	0	0	1	0	5	5.02
N	0	0	1	0	0	2	0	0	0	0	0	0	3	4.50
CALM													0	0.
TOTAL	0	2	6	9	14	12	10	8	4	4	4	0	73	5.91

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	2	1	0	1	0	0	0	0	0	5	4.58
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.60
ENE	0	1	0	0	1	0	0	0	0	0	0	0	2	2.85
E	0	1	0	0	0	2	0	0	0	0	0	0	3	4.10
ESE	0	1	0	2	0	0	0	0	0	0	0	0	3	2.80
SE	1	0	2	3	1	1	0	0	0	0	0	0	7	3.60
SSE	0	1	0	1	0	0	1	0	0	0	0	0	3	3.63
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	1	1	1	0	1	0	0	0	0	0	0	0	3	2.98
SW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.10
WSW	0	2	1	0	0	0	0	0	0	0	0	0	3	1.90
W	1	0	1	0	1	0	0	0	0	0	0	0	3	2.63
WNW	1	1	2	0	0	0	0	0	0	0	0	0	3	2.37
NW	0	0	0	3	1	0	0	0	0	0	0	0	4	3.37
NNW	1	1	4	1	2	0	0	0	0	0	0	0	12	2.87
N	0	1	1	0	1	2	0	0	0	0	0	0	4	3.97
CALM													2	.40
TOTAL	1	11	17	14	14	5	2	0	0	0	0	0	66	3.21

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	3	2	2	2	5	1	0	0	0	0	16	4.09
NE	0	3	1	4	2	2	1	1	0	1	0	1	16	4.74
ENE	0	1	1	3	2	5	2	3	4	1	2	1	27	4.71
E	0	1	3	1	2	4	3	3	1	1	1	0	20	5.47
ESE	0	2	0	3	2	3	3	1	0	1	1	0	16	5.37
SE	0	0	4	5	7	5	2	5	2	1	0	0	33	5.22
SSE	0	1	1	5	8	12	4	4	3	5	5	0	41	7.41
S	0	0	1	3	12	5	7	8	5	4	1	24	70	8.83
SSW	0	2	3	3	10	4	3	3	8	13	4	27	80	9.39
SW	0	1	3	6	6	10	8	4	17	4	4	17	80	8.44
WSW	0	2	3	3	3	4	8	3	6	2	0	8	42	7.21
W	1	0	2	4	7	7	9	5	5	0	1	6	47	7.38
WNW	0	2	2	5	7	4	6	5	2	2	1	4	43	7.25
NW	0	1	2	6	6	4	3	9	5	5	3	26	72	9.22
NNW	0	1	7	4	5	5	2	5	7	7	7	17	67	8.85
N	0	2	3	2	3	8	2	0	1	1	2	1	25	5.67
CALM													5	.69
TOTAL	1	20	39	61	84	84	68	62	66	53	33	144	720	7.09

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-21

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: MAY 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	1	0	0	0	0	0	2	5.45
NE	0	0	0	0	0	2	3	1	1	0	0	0	7	6.74
ENE	0	0	0	0	2	1	1	0	0	0	0	0	4	5.35
E	0	0	0	0	0	0	1	0	0	0	0	0	1	4.50
ESE	0	0	0	0	0	1	0	1	0	0	0	0	2	6.65
SE	0	1	0	0	0	0	0	0	0	0	0	1	2	10.00
SSE	0	0	0	1	1	0	0	1	0	0	1	0	4	6.42
S	0	0	0	1	0	0	1	1	2	0	1	1	7	8.14
SSW	0	0	0	1	1	1	0	1	0	0	0	0	4	5.00
SW	0	0	0	0	0	0	1	0	0	0	0	0	1	5.00
WSW	0	0	0	0	0	2	0	0	0	0	0	0	2	5.50
W	0	0	0	0	0	1	0	0	0	0	0	0	1	4.50
WNW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.35
NW	0	0	0	0	0	2	0	0	0	0	0	0	2	6.75
NNW	2	1	1	0	0	0	0	0	0	0	0	0	2	2.45
N	0	0	0	0	1	1	0	0	0	0	0	0	2	6.65
CALM													0	0.
TOTAL	0	2	1	3	6	10	7	5	3	1	2	2	44	6.23

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #BB (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
SE	0	0	0	0	0	2	0	0	1	0	0	0	3	5.45
SSE	0	0	0	0	0	0	1	1	0	0	1	0	3	8.23
S	0	0	0	0	0	0	0	0	0	0	1	0	1	10.50
SSW	0	0	0	1	0	0	0	0	0	0	0	1	2	7.45
SW	0	0	0	0	0	0	2	0	0	0	0	0	2	6.50
WSW	0	0	0	0	0	1	1	0	0	0	0	0	2	6.50
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
NW	0	0	0	0	1	0	2	0	1	0	0	0	4	5.87
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	2	4	5	4	1	0	0	2	1	21	6.63

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #CC (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	1	0	0	0	0	0	0	2	5.25
NE	0	0	1	0	0	1	0	0	0	0	0	0	2	4.25
ENE	0	0	0	0	2	0	0	0	1	1	1	0	5	7.44
E	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	1	0	0	0	1	2	10.00
SSE	0	0	0	0	0	1	0	0	0	0	0	2	3	10.17
S	0	0	0	0	0	1	0	0	0	0	0	0	1	4.50
SSW	0	0	0	0	1	2	0	2	0	1	2	0	8	6.63
SW	0	0	0	0	0	1	1	1	1	1	0	0	7	6.64
WSW	0	0	0	0	1	1	2	4	1	1	1	0	11	6.45
W	0	0	0	0	0	1	2	1	0	0	0	0	4	5.50
WNW	0	0	0	0	0	2	0	0	1	1	0	0	4	6.25
NW	0	0	0	0	0	2	1	0	0	0	0	0	3	4.65
NNW	0	0	0	0	1	1	0	0	0	0	0	0	4	4.50
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	3	10	10	8	4	5	4	1	3	57	6.36

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #DD (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	4	3	1	3	0	0	0	0	0	1	13	4.27
NE	0	2	2	3	3	3	4	4	1	0	1	0	23	5.61
ENE	0	0	2	2	3	5	7	1	2	2	0	0	24	5.96
E	0	0	1	2	3	3	1	2	1	2	0	0	15	5.81
ESE	0	0	1	1	1	1	4	0	0	0	1	1	12	6.83
SE	0	0	1	3	2	1	2	2	2	2	3	2	25	7.32
SSE	0	0	0	0	0	2	1	3	2	2	5	7	22	9.83
S	0	0	1	0	1	1	4	0	1	0	0	0	14	6.45
SSW	0	0	1	1	3	3	3	5	0	1	1	1	19	6.59
SW	0	0	0	0	5	5	1	2	5	1	0	0	19	6.53
WSW	0	0	1	1	4	2	2	4	2	0	0	0	28	6.48
W	0	1	0	5	1	5	1	4	2	2	1	4	27	7.01
WNW	0	0	0	1	1	2	2	1	4	0	1	0	12	7.07
NW	0	0	0	1	0	4	0	2	1	1	1	0	10	6.07
NNW	0	0	0	2	4	1	1	0	0	0	0	0	8	4.81
N	0	1	0	1	0	1	0	2	0	0	1	0	6	6.15
CALM													1	.69
TOTAL	0	5	14	27	34	42	33	30	25	15	15	16	265	6.56

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM ΔEC/ΔΘ+T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	1	5	2	0	0	0	0	0	0	0	10	3.13
NE	0	0	1	5	1	1	1	0	0	0	0	0	9	4.56
ENE	0	0	2	1	4	1	0	0	1	1	0	1	11	5.69
E	0	0	3	3	2	0	1	1	0	1	1	1	14	5.53
ESE	1	0	0	2	1	4	3	2	1	0	0	1	15	5.00
SE	0	0	1	1	0	4	7	3	2	0	0	0	18	4.39
SSE	0	1	1	1	3	4	3	4	2	2	0	1	22	6.41
S	0	0	0	0	4	2	4	3	1	1	1	0	16	6.31
SSW	1	0	1	0	2	1	4	1	2	2	0	0	14	6.21
SW	0	0	0	2	0	1	2	3	1	0	0	0	9	6.23
WSW	0	1	2	3	0	0	2	0	0	0	1	1	10	5.75
W	0	0	1	2	0	2	0	1	0	0	0	0	6	6.87
WNW	2	1	1	0	2	3	0	0	0	0	0	0	9	3.68
NW	0	1	2	4	2	1	1	1	0	0	0	0	12	4.08
NNW	0	0	2	2	0	1	0	0	0	0	0	0	5	3.44
N	1	2	0	2	0	0	0	1	0	0	0	0	6	3.13
CALM													3	.67
TOTAL	5	8	18	33	23	31	29	20	11	5	3	5	194	5.14

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM ΔEC/ΔΘ+T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	1	0	0	0	0	0	0	0	3	2.77
NE	0	1	4	3	2	1	0	0	0	0	0	1	12	4.12
ENE	0	2	0	2	1	2	0	0	0	0	0	0	7	3.00
E	1	1	0	1	0	1	0	0	0	0	0	0	4	2.04
ESE	0	0	1	2	1	4	1	1	0	0	0	0	10	4.08
SE	0	0	0	0	0	3	4	4	0	0	0	0	11	6.64
SSE	0	0	1	4	1	2	0	2	0	0	0	0	10	4.75
S	0	0	2	4	1	4	2	0	0	0	0	0	13	4.81
SSW	0	2	1	3	1	1	0	2	2	0	0	0	12	5.07
SW	0	3	1	1	1	0	0	0	0	0	0	0	6	3.43
WSW	0	0	1	0	2	1	0	0	0	0	0	0	4	4.15
W	0	2	0	1	0	0	0	0	0	0	0	0	3	2.40
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	4.00
NW	0	0	0	3	1	0	1	0	0	0	0	0	5	4.22
NNW	0	1	0	0	1	0	0	0	0	0	0	0	2	3.20
N	0	0	0	2	0	1	0	0	0	0	0	0	3	3.67
CALM													4	.67
TOTAL	1	13	14	25	14	19	8	9	2	0	0	1	110	4.24

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM ΔEC/ΔΘ+T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	0	0	0	0	0	0	0	0	2	2.15
NE	2	0	0	2	0	0	0	0	0	0	0	0	4	2.25
ENE	1	1	0	0	0	0	0	0	0	0	0	0	2	1.35
E	0	1	0	0	0	0	0	0	0	0	0	0	1	1.29
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	2	0	0	0	0	2	7.30
SSE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.65
S	0	1	0	0	0	0	1	0	0	0	0	0	2	3.75
SSW	0	1	2	1	0	0	0	0	0	0	0	0	4	2.65
SW	0	0	2	5	1	0	0	0	0	0	0	0	8	3.55
WSW	0	0	3	4	0	0	0	0	0	0	0	0	7	3.07
W	0	0	1	0	1	0	0	0	0	0	0	0	2	4.00
WNW	1	0	1	0	0	0	0	0	0	0	0	0	2	1.80
NW	0	1	1	1	2	0	0	0	0	0	0	0	5	3.32
NNW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.10
N	0	0	0	1	0	0	0	0	0	0	0	0	1	3.70
CALM													9	.62
TOTAL	4	6	12	14	4	1	1	2	0	0	0	0	53	2.77

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM ΔEC/ΔΘ+T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	5	7	8	6	5	1	0	0	0	0	1	33	3.80
NE	2	3	8	13	6	8	6	5	2	0	1	1	47	4.47
ENE	1	3	4	5	12	10	8	1	4	4	1	1	54	5.65
E	1	2	4	4	6	10	3	3	2	2	1	1	41	5.29
ESE	1	0	2	5	6	10	9	4	1	0	1	2	40	5.76
SE	0	1	2	4	4	8	13	13	4	2	3	4	58	6.66
SSE	0	1	3	6	6	8	5	11	4	4	7	10	65	7.56
S	0	1	3	5	7	7	12	10	4	1	3	1	54	6.30
SSW	1	3	5	8	9	6	4	9	5	5	1	2	63	5.90
SW	0	3	3	8	8	10	6	6	7	1	0	0	52	5.49
WSW	0	1	7	9	7	8	9	5	5	3	1	1	56	5.71
W	0	3	2	9	4	9	2	5	2	2	1	4	43	6.07
WNW	3	1	2	2	6	6	2	2	5	0	1	0	30	5.24
NW	0	2	3	10	9	8	2	4	1	1	1	0	41	4.93
NNW	0	2	3	5	9	3	1	0	0	0	0	0	22	4.13
N	1	3	2	4	2	2	0	3	0	0	1	0	18	4.42
CALM													17	.42
TOTAL	10	34	48	107	106	118	89	81	46	25	23	29	744	5.59

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-22

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: JUNE 1975

PASQUILL #A# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	5	2	4	11	10.43
NE	0	0	0	0	1	1	2	0	1	0	1	9	14	10.43
ENE	0	0	0	0	0	2	1	0	0	1	0	0	4	7.82
E	0	0	0	0	0	1	0	0	0	0	1	1	3	8.68
ESE	0	0	0	0	0	0	0	1	1	0	0	0	2	8.18
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	1	0	0	2	0	0	0	3	7.77
S	0	0	0	0	0	1	0	0	0	0	0	0	1	6.20
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	13.40
SW	0	0	0	1	0	0	0	0	0	0	0	1	2	8.60
WSW	0	0	0	0	1	1	1	0	0	0	0	0	3	5.60
W	0	0	0	0	1	3	2	1	0	0	0	0	7	5.91
WNW	0	0	0	0	1	0	2	0	0	0	0	0	3	6.47
NW	0	0	0	0	0	0	0	1	0	0	0	0	1	7.00
NNW	0	0	0	0	0	0	0	1	0	0	0	0	1	6.80
N	0	0	0	0	0	1	1	1	0	1	1	0	5	8.02
CALM													0	0.
TOTAL	0	0	0	1	5	13	11	4	4	7	5	15	65	8.45

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #B# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.80
NE	0	0	0	0	0	0	0	2	0	2	0	3	7	11.46
ENE	0	0	0	0	0	1	1	1	0	0	0	0	3	7.33
E	0	0	0	0	1	0	1	1	0	1	2	0	6	9.35
ESE	0	0	0	0	0	0	0	1	0	0	0	0	1	8.00
SE	0	0	0	0	0	0	0	0	0	0	0	1	1	11.20
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	17.60
SW	0	0	0	0	2	1	1	0	1	0	0	0	5	5.56
WSW	0	0	0	1	1	0	0	0	0	0	0	0	2	4.45
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	1	0	0	0	1	8.10
NNW	0	0	0	0	0	0	0	0	0	1	0	0	1	6.60
N	0	0	0	0	0	0	1	0	0	0	0	0	1	6.60
CALM													0	0.
TOTAL	0	0	0	1	4	1	4	5	3	3	2	5	30	8.60

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #C# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	2	1	1	1	1	1	0	1	8	7.82
ENE	0	0	0	0	0	0	0	0	0	1	1	2	4	12.75
E	0	0	0	0	0	0	0	0	4	4	2	3	13	9.92
ESE	0	0	0	0	0	0	0	0	1	0	1	0	2	9.85
SE	0	0	0	0	0	0	0	0	1	0	1	0	2	9.40
SSE	0	0	0	0	0	0	1	0	0	0	0	0	1	6.70
S	0	0	0	0	0	0	1	1	0	0	0	1	3	8.53
SSW	0	0	0	0	0	1	0	2	0	0	0	0	3	7.10
SW	0	0	1	0	1	1	1	0	0	0	0	0	4	6.80
WSW	0	0	0	0	0	5	3	2	1	1	0	2	14	7.66
W	0	0	0	0	0	0	2	1	1	0	0	0	4	6.10
WNW	0	0	0	1	1	0	1	0	0	0	0	0	3	6.93
NW	0	0	0	0	1	0	1	0	0	0	0	0	2	5.90
NNW	0	0	0	0	1	0	1	0	0	0	1	0	3	7.37
N	1	0	0	0	0	0	1	1	0	0	0	0	2	6.95
CALM													0	0.
TOTAL	0	0	1	1	6	12	12	8	8	7	6	9	72	7.78

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #D# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	2	1	1	1	1	9	10.41
NE	0	0	1	0	0	1	3	4	1	2	1	0	13	6.04
ENE	0	0	0	0	3	2	7	6	5	2	2	2	29	7.79
E	0	0	0	0	2	1	2	2	1	0	2	1	11	7.64
ESE	0	0	0	0	0	0	1	4	4	2	2	3	16	9.34
SE	0	0	0	0	0	1	1	0	0	1	2	3	8	10.31
SSE	0	0	0	1	0	0	0	3	2	0	1	1	8	7.07
S	0	0	0	0	0	2	1	2	1	1	0	3	10	8.85
SSW	0	0	0	1	2	1	4	1	0	1	0	3	13	7.58
SW	0	0	0	0	2	0	4	2	5	3	1	2	20	8.28
WSW	0	0	0	1	5	4	5	4	3	0	2	5	35	7.66
W	0	0	0	1	1	5	2	5	2	3	2	5	26	8.17
WNW	0	0	1	0	1	5	1	1	0	1	0	1	11	6.37
NW	0	0	0	1	1	3	4	1	1	0	0	0	12	6.34
NNW	0	0	0	0	1	1	1	1	0	1	0	0	5	6.60
N	0	0	0	0	2	3	3	1	0	1	0	1	11	6.75
CALM													0	0.
TOTAL	0	0	2	5	24	29	44	41	27	20	16	34	242	7.93

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-22 (Continued)

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA [0-61 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	3	3	1	0	0	3	0	0	0	0	11	4.55
NE	0	0	1	0	7	4	3	3	1	0	0	0	19	5.68
ENE	0	0	2	1	1	1	4	2	1	2	0	0	14	4.21
E	0	0	0	0	0	4	0	2	1	0	0	0	7	5.71
ESE	0	0	0	1	1	3	3	2	0	0	0	0	10	5.04
SE	0	0	2	0	1	2	0	0	0	0	0	0	5	4.12
SSE	0	0	1	6	4	5	3	4	0	0	0	1	24	4.17
S	0	1	1	2	1	2	3	0	2	0	2	0	14	5.04
SSW	0	0	1	1	1	4	2	1	0	0	0	0	10	5.14
SW	0	0	2	2	6	4	1	0	0	0	0	0	16	4.94
WSW	0	0	0	0	4	4	3	0	0	2	0	0	13	5.48
W	0	0	0	2	2	3	0	1	0	0	0	0	8	5.14
WNW	1	0	0	0	0	3	0	0	0	0	0	0	4	4.60
NW	0	0	0	1	2	1	1	0	0	1	0	0	6	5.17
NNW	0	1	0	0	1	1	1	0	0	0	0	0	4	4.53
N	1	1	2	4	2	1	1	0	0	0	0	0	12	3.41
CALM													1	0.00
TOTAL	2	4	15	17	42	42	27	17	4	5	2	1	179	5.31

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA [0-61 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00
NE	0	1	1	1	0	1	0	0	0	0	0	0	4	3.12
ENE	0	1	0	1	2	2	3	0	0	0	0	0	9	4.10
E	0	1	0	1	1	1	0	0	0	0	0	0	4	3.49
ESE	1	0	1	0	1	0	1	1	0	0	0	0	7	4.58
SE	0	1	1	0	0	0	1	1	0	0	0	0	4	4.55
SSE	0	0	2	0	0	0	0	0	0	0	0	0	2	2.48
S	0	0	1	0	1	0	1	2	1	0	0	0	6	4.15
SSW	1	0	0	1	3	2	3	0	0	0	0	0	10	4.08
SW	0	0	1	2	2	2	0	0	0	0	0	0	7	4.37
WSW	0	0	2	2	1	2	0	0	0	0	0	0	7	4.06
W	0	1	1	0	1	0	0	0	0	0	0	0	3	3.33
WNW	0	1	0	1	0	1	0	0	0	0	0	0	3	3.43
NW	0	1	0	1	2	1	0	0	0	0	0	0	5	4.04
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
N	1	1	1	1	1	0	0	0	0	0	0	0	4	2.12
CALM													0	0.00
TOTAL	2	9	11	10	15	12	9	4	1	0	0	0	91	4.06

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA [0-61 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	2	1	0	0	0	0	0	0	0	0	3	2.97
NE	1	1	1	2	0	0	0	0	0	0	0	0	5	2.44
ENE	0	1	0	2	0	0	0	0	0	0	0	0	3	2.77
E	0	0	1	0	0	0	0	0	0	0	0	0	1	2.13
ESE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
SE	0	0	1	0	0	1	0	0	0	0	0	0	2	4.35
SSE	0	0	0	0	1	0	2	0	0	0	0	0	3	4.17
S	0	0	0	1	0	0	0	0	0	0	0	1	1	3.80
SSW	0	2	1	1	3	3	0	1	0	0	0	0	11	4.40
SW	0	0	2	0	2	1	0	0	0	0	0	0	5	4.18
WSW	0	1	0	1	2	0	0	0	0	0	0	0	4	3.67
W	0	1	1	0	0	0	0	0	0	0	0	0	2	2.15
WNW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.20
NW	1	0	1	0	0	0	0	0	0	0	0	0	2	1.70
NNW	0	2	1	0	0	0	0	0	0	0	0	0	3	1.77
N	0	0	0	0	1	0	0	0	0	0	0	0	1	4.30
CALM													3	0.00
TOTAL	2	8	11	8	10	6	2	1	0	0	0	0	51	3.43

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA [0-61 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	5	4	1	0	1	5	2	6	1	7	34	7.74
NE	1	2	4	3	14	8	4	12	6	5	2	12	75	7.21
ENE	0	2	2	4	6	7	13	4	7	4	3	6	63	7.09
E	0	1	1	1	4	3	5	4	5	5	7	5	45	7.69
ESE	1	0	1	1	2	4	7	5	6	2	3	3	33	7.42
SE	0	1	4	0	1	5	2	1	3	1	3	4	25	7.33
SSE	0	0	3	1	5	6	6	7	2	0	1	2	33	6.76
S	0	1	2	3	2	4	6	5	4	1	2	5	35	7.10
SSW	1	2	2	5	11	13	9	5	0	1	0	5	54	6.02
SW	0	0	4	4	10	13	8	2	7	1	1	2	46	5.87
WSW	0	1	2	5	17	10	17	7	4	3	2	4	65	6.83
W	0	2	2	4	5	10	5	7	2	1	2	4	51	6.39
WNW	1	1	1	2	4	11	2	2	0	1	0	1	26	5.69
NW	1	1	1	3	5	5	7	1	2	2	2	0	30	5.86
NNW	0	3	1	0	1	2	4	1	1	1	1	0	17	5.41
N	1	2	3	5	6	5	7	3	0	2	1	1	36	5.19
CALM													7	0.00
TOTAL	6	21	48	49	104	115	108	80	49	42	41	66	720	6.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-23

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: JULY 1975

PASQUILL #A# (FROM AEC/DELTA-T CRITERIA 0-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	0	0	0	1	5.45
NE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.40
ENE	0	0	0	1	0	0	0	0	0	0	0	0	1	4.85
E	0	0	0	0	0	0	2	1	0	0	0	0	3	5.45
ESE	0	0	0	0	1	1	0	0	0	0	1	0	3	5.93
SE	0	0	0	1	0	0	1	1	0	0	0	0	3	4.77
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	2	0	0	1	1	0	1	5	8.96
SSW	0	0	0	0	0	1	0	1	0	0	0	1	3	7.47
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	1	0	0	0	0	0	1	5.40
W	0	0	0	0	0	0	1	0	0	0	0	0	1	5.85
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	1	0	0	0	1	0	0	0	1	0	0	3	4.87
NNW	0	0	0	0	0	0	1	0	1	0	0	0	2	6.55
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	1	2	1	6	4	3	2	1	1	1	27	6.04

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #B# (FROM AEC/DELTA-T CRITERIA 0-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	1	0	1	10.40
ENE	0	0	0	1	2	0	0	0	0	1	0	0	4	5.47
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	1	0	0	2	0	0	0	0	0	3	5.43
SE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.35
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
SSW	0	0	0	1	0	0	0	1	0	0	2	0	4	7.47
SW	0	0	0	0	0	1	0	0	0	1	0	1	3	9.80
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	1	0	0	0	1	0	0	2	6.90
WNW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
NW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.40
NNW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.40
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	3	2	5	2	2	0	2	3	1	22	6.75

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #C# (FROM AEC/DELTA-T CRITERIA 1-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	1	0	0	0	0	0	0	0	0	1	3.30
ENE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.40
E	0	0	0	0	0	0	0	1	1	0	0	0	2	7.85
ESE	0	0	0	0	1	1	0	0	0	1	0	0	3	5.43
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.40
S	0	0	0	0	0	0	1	1	1	0	1	0	4	8.42
SSW	0	0	0	1	0	0	0	0	1	1	0	0	3	6.50
SW	0	0	0	0	0	0	1	1	0	2	0	0	4	7.90
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	1	0	1	0	0	0	0	0	3	4.60
WNW	0	0	0	0	1	1	0	1	0	0	0	0	3	6.03
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	1	1	22.10
CALM													0	0.
TOTAL	0	0	1	3	4	2	3	3	3	3	1	1	28	7.14

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #D# (FROM AEC/DELTA-T CRITERIA 1-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.40
NE	1	0	1	0	0	0	0	0	0	0	0	0	2	1.45
ENE	0	1	1	1	0	1	0	0	0	0	0	0	4	3.22
E	0	0	0	0	0	2	0	0	1	0	0	0	3	6.63
ESE	0	0	0	0	1	0	0	0	0	0	1	0	2	7.40
SE	0	0	0	1	0	2	0	2	2	1	0	3	11	8.61
SSE	0	0	0	0	0	2	6	3	1	0	5	3	20	8.56
S	0	0	1	1	2	1	3	7	2	5	1	4	27	8.17
SSW	0	1	0	1	3	2	5	7	3	2	2	0	26	6.99
SW	0	0	2	0	3	1	7	8	2	1	0	2	26	6.91
WSW	0	0	1	0	1	3	4	5	2	0	1	1	18	7.05
W	0	0	0	2	3	1	3	2	3	0	2	0	16	6.75
WNW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.20
NW	0	1	0	2	0	0	1	0	0	0	1	0	5	4.24
NNW	0	0	1	1	0	1	0	0	0	0	0	0	3	3.80
N	0	1	0	1	1	0	0	0	0	0	0	0	3	2.87
CALM													0	0.
TOTAL	1	4	7	10	15	17	29	34	16	9	13	13	168	7.54

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #E# (FROM ΔEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	3	4	1	0	0	0	1	0	0	0	0	9	3.89
NE	0	1	1	7	1	3	4	1	2	0	0	1	21	5.43
ENE	0	2	3	3	1	1	1	0	0	0	0	0	11	3.66
E	0	1	2	5	3	2	0	0	0	0	0	0	13	3.73
ESE	0	0	1	4	2	1	3	2	2	2	0	1	18	5.35
SE	0	1	1	8	8	5	6	5	1	2	0	0	37	5.44
SSE	0	0	2	5	4	4	8	5	1	1	2	2	34	6.37
S	1	3	4	4	4	13	13	4	1	0	0	0	51	5.00
SSW	0	1	2	1	12	8	9	7	2	1	0	1	44	6.11
SW	0	3	2	4	7	7	9	5	2	0	0	0	41	5.29
WSW	0	0	1	3	4	5	0	2	1	0	0	0	20	5.01
W	1	0	1	0	2	1	0	1	0	0	0	0	6	4.33
WNW	0	0	0	4	1	0	0	1	0	0	0	0	6	4.33
NW	0	1	3	3	1	2	0	1	0	0	1	1	13	5.15
NNW	0	2	3	0	0	2	0	0	0	0	0	0	7	3.00
N	0	1	0	4	0	0	1	0	2	0	0	0	10	4.13
CALM													2	.63
TOTAL	2	21	38	60	58	64	64	35	14	6	3	6	360	5.14

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM ΔEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	1	2	3	1	2	0	0	0	0	0	0	0	9	2.74
NE	0	1	3	1	1	1	2	0	0	0	0	0	9	3.02
ENE	0	0	2	2	1	2	2	2	3	3	2	6	25	4.88
E	0	0	2	1	2	1	2	1	0	0	0	0	9	4.34
ESE	1	0	0	3	1	1	1	1	0	0	0	0	8	4.45
SE	0	1	1	1	3	4	2	0	0	0	0	0	14	4.77
SSE	0	1	1	2	4	1	0	1	1	0	0	0	11	4.32
S	0	2	4	2	2	0	0	0	0	0	0	0	10	3.45
SSW	0	0	1	0	3	1	0	0	0	0	0	0	5	4.34
SW	0	0	4	0	1	0	0	0	0	0	0	0	5	3.03
WSW	0	0	0	0	4	1	0	0	0	0	0	0	5	4.87
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	1	0	0	0	0	0	0	0	0	1	0	2	6.34
NW	0	1	4	0	0	0	0	0	0	0	0	0	5	3.35
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	1	1	0	0	0	0	0	0	0	0	2	2.66
CALM													3	.63
TOTAL	2	9	26	14	24	14	9	5	4	3	3	6	119	4.38

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM ΔEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	5	1	0	0	0	0	0	0	0	0	0	1	2.40
NE	0	0	2	0	0	0	0	0	0	0	0	0	2	2.70
ENE	1	1	0	5	1	1	0	0	0	0	0	0	9	3.24
E	0	0	0	0	5	1	2	0	0	0	0	0	8	5.21
ESE	0	0	0	0	0	0	1	0	0	0	0	0	1	4.80
SE	0	2	0	0	0	0	0	0	0	0	0	0	2	1.95
SSE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.70
S	0	0	0	0	1	0	0	0	0	0	0	0	1	4.60
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.60
NW	0	0	0	0	1	0	0	0	0	0	0	0	1	3.80
NNW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.30
N	0	0	0	0	1	0	0	0	0	0	0	0	1	3.60
CALM													1	.48
TOTAL	1	3	3	8	9	2	3	0	0	0	0	0	30	3.83

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM ΔEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	1	5	8	2	2	1	1	1	0	0	0	0	21	3.19
NE	1	2	7	9	2	4	5	2	2	0	1	1	37	4.24
ENE	1	4	6	13	6	5	3	2	3	4	2	0	49	4.04
E	0	1	4	6	10	8	5	2	2	0	0	0	38	4.00
ESE	1	0	1	9	6	3	7	3	2	4	1	1	38	5.03
SE	0	4	3	10	11	14	9	8	3	3	0	3	68	5.68
SSE	0	1	4	7	9	7	14	9	3	1	7	5	67	6.47
S	1	5	9	9	13	15	17	13	5	5	3	4	99	5.94
SSW	0	2	3	4	19	11	15	16	6	3	4	2	85	6.41
SW	0	3	8	6	11	9	17	11	4	4	0	3	81	6.00
WSW	0	0	2	3	13	10	4	7	3	0	1	1	44	5.81
W	1	0	1	3	7	3	4	3	3	1	2	0	28	5.96
WNW	0	1	0	5	5	2	0	2	0	0	1	0	16	4.94
NW	0	4	7	4	3	2	1	1	1	0	2	1	26	4.81
NNW	0	2	4	1	2	4	0	1	0	0	0	0	14	3.90
N	0	4	1	7	1	0	1	0	2	0	0	1	17	4.74
CALM													11	.42
TOTAL	6	38	68	108	120	98	104	86	39	25	24	22	741	5.54

NUMBER OF INVALID OBSERVATIONS = 3
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-24

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: AUGUST 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	3	1	0	0	0	0	0	0	5	4.40
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	5.80
ENE	0	0	0	2	1	4	2	0	0	0	0	0	9	5.08
E	0	0	1	1	1	2	2	0	0	0	0	0	7	4.91
ESE	0	0	0	0	1	0	3	0	0	0	0	0	4	6.10
SE	0	0	1	0	2	0	0	0	0	0	0	0	3	3.87
SSE	0	0	0	1	0	0	0	0	0	0	0	0	1	3.90
S	0	0	0	1	1	2	0	0	0	0	0	0	4	4.70
SSW	0	0	0	0	1	2	1	1	3	3	0	0	11	7.69
SW	0	0	0	3	4	3	3	1	2	1	0	0	21	5.67
WSW	0	0	2	0	4	2	2	0	0	0	0	0	10	4.41
W	0	0	1	0	1	0	0	0	0	0	0	0	4	3.72
WNW	0	0	0	2	0	1	0	0	0	0	0	0	3	4.17
NW	0	0	1	2	2	0	0	0	0	0	0	0	5	3.94
NNW	0	0	2	2	2	0	0	0	0	0	0	0	6	3.30
N	0	0	0	0	2	0	0	0	0	0	0	0	2	4.40
CALM													0	0.
TOTAL	0	0	10	15	30	17	13	2	5	4	0	0	96	5.10

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #BB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	1	0	0	0	0	0	0	2	5.10
NE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.20
ENE	0	0	0	1	0	0	1	0	0	0	0	0	2	5.10
E	0	0	0	0	1	0	1	0	0	0	0	0	2	5.20
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	1	0	0	0	0	0	0	0	0	1	3.20
SSW	0	0	1	0	0	1	0	0	2	0	0	0	4	6.27
SW	0	0	0	0	0	3	1	1	2	1	1	0	9	7.07
WSW	0	0	0	1	0	0	0	0	0	0	0	0	1	4.80
W	0	0	0	0	1	0	0	0	0	0	0	0	1	4.10
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	1	1	0	0	0	0	0	0	0	0	2	3.35
NNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	2	5	4	5	3	1	4	1	1	0	26	5.61

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #CB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	0	0	0	0	0	0	0	0	1	3.30
NE	0	0	1	0	0	0	1	0	0	0	0	0	2	4.40
ENE	0	0	0	0	0	1	7	0	0	0	0	0	8	6.55
E	0	0	0	1	0	0	0	0	0	0	0	0	1	3.20
ESE	0	0	0	0	2	0	0	0	0	0	0	0	2	4.90
SE	0	0	1	0	1	0	0	0	0	0	0	0	2	3.30
SSE	0	0	0	0	1	1	0	0	0	0	0	0	2	5.10
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	2	1	1	0	0	0	0	4	7.65
SW	0	0	0	0	1	1	4	1	1	2	0	0	14	6.74
WSW	0	0	0	2	1	2	1	0	0	0	0	0	8	4.84
W	0	0	1	0	0	0	0	0	0	0	0	0	1	3.00
WNW	0	0	1	2	2	0	0	0	0	0	0	0	5	4.06
NW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.40
NNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.80
N	0	0	0	1	0	0	0	0	0	0	0	0	1	3.80
CALM													0	0.
TOTAL	0	0	4	8	11	9	15	3	1	4	0	0	55	5.41

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #DA (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	3	1	1	0	1	0	0	0	0	0	6	3.67
NE	0	0	7	5	2	5	3	0	1	0	0	0	23	4.65
ENE	0	2	3	1	7	5	2	0	0	0	0	0	20	4.41
E	0		1	2	5	1	0	0	0	0	0	0	9	4.19
ESE	0		1	3	1	1	0	0	0	0	0	0	6	3.75
SE	0	0	1	2	0	0	0	0	0	0	0	0	3	3.43
SSE	0	0	0	3	0	2	0	0	0	0	0	0	5	4.20
S	0	1	1	2	4	1	0	1	0	0	0	0	10	4.13
SSW	0	0	0	2	0	6	2	2	0	0	0	0	21	5.20
SW	0	1	1	7	9	7	4	2	3	0	0	0	36	5.14
WSW	0	0	4	6	3	4	10	5	2	0	0	0	34	5.57
W	0	0	2	3	1	4	3	1	1	0	0	0	15	5.26
WNW	0	1	3	1	0	1	0	0	0	0	0	0	6	3.25
NW	0	0	6	8	1	2	0	0	0	0	0	0	17	3.59
NNW	0	0	3	0	0	0	0	0	0	0	0	0	3	2.77
N	0	0	1	1	2	0	0	1	0	0	0	0	5	4.42
CALM													0	0.
TOTAL	0	5	37	47	45	39	25	12	7	0	0	0	217	4.44

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	7	1	0	0	0	0	0	0	0	0	10	2.44
NE	0	0	10	0	0	0	0	0	0	0	0	0	10	2.47
ENE	0	0	9	2	0	0	0	0	0	0	0	0	11	2.45
E	0	0	7	5	0	0	0	1	0	0	0	0	13	3.00
ESE	0	0	2	3	0	0	0	0	0	0	0	0	5	3.20
SE	0	1	0	1	0	1	1	0	0	0	0	0	4	4.13
SSE	0	0	0	3	3	1	2	0	0	0	0	0	9	4.84
S	0	2	11	9	13	4	0	0	0	0	0	0	39	3.75
SSW	0	4	6	14	20	3	0	0	0	0	0	0	47	3.00
SW	0	3	12	8	2	0	0	0	0	0	0	0	25	2.48
WSW	1	1	1	1	1	0	0	0	0	0	0	0	5	2.73
W	0	3	4	1	0	0	0	0	0	0	0	0	8	2.17
WNW	1	1	3	0	0	0	0	0	0	0	0	0	5	2.14
NW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.00
NNW	1	2	1	0	0	0	0	0	0	0	0	0	4	1.45
N	0	1	4	0	0	0	0	0	0	0	0	0	5	2.24
CALM													6	.43
TOTAL	3	20	70	48	39	9	3	1	0	0	0	1	200	3.30

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	3	0	0	0	0	0	0	0	0	0	5	2.04
NE	0	4	1	2	0	0	0	0	0	0	0	0	7	2.21
ENE	0	3	2	3	0	0	0	0	0	0	0	0	8	2.46
E	0	1	1	0	0	0	0	0	0	0	0	0	2	2.65
ESE	1	0	1	0	0	0	0	0	0	0	0	0	2	1.65
SE	0	3	1	2	1	0	0	0	0	0	0	0	7	2.21
SSE	0	0	3	4	1	1	0	0	0	0	0	0	11	2.64
S	0	7	6	1	8	2	0	0	0	0	0	0	22	2.34
SSW	0	0	7	1	4	0	0	0	0	0	0	0	12	2.29
SW	0	2	5	2	0	0	0	0	0	0	0	0	9	2.19
WSW	0	3	5	1	0	0	0	0	0	0	0	0	9	2.21
W	0	1	1	0	0	0	0	0	0	0	0	0	2	2.00
WNW	0	1	1	0	0	0	0	0	0	0	0	0	2	1.70
NW	1	2	1	0	0	0	0	0	0	0	0	0	4	1.77
NNW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.45
N	1	3	2	0	0	0	0	0	0	0	0	0	6	1.67
CALM													4	.43
TOTAL	3	33	38	16	18	3	0	0	0	0	0	0	111	2.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	4	0	0	0	0	0	0	0	0	0	0	4	1.77
NE	0	2	1	0	0	0	0	0	0	0	0	0	3	1.73
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	1	0	0	0	0	0	0	0	0	0	1	2.10
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	1	0	0	1	1	0	0	0	0	0	0	3	4.00
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	3	1	0	0	0	0	0	0	0	0	0	4	2.25
SSW	0	1	3	0	0	0	0	0	0	0	0	0	4	2.32
SW	0	0	4	0	0	0	0	0	0	0	0	0	4	2.32
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	2	0	0	0	0	0	0	0	0	0	0	2	1.65
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	2	1	0	0	0	0	0	0	0	0	0	3	1.77
NNW	2	0	0	0	0	0	0	0	0	0	0	0	2	.85
N	0	1	1	0	0	0	0	0	0	0	0	0	2	2.00
CALM													3	.43
TOTAL	2	16	12	0	1	1	0	0	0	0	0	0	35	2.00

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	8	13	4	5	2	1	0	0	0	0	0	33	3.03
NE	0	5	20	7	4	5	3	1	1	0	0	0	47	3.57
ENE	0	5	9	9	8	10	12	0	0	0	0	1	54	4.54
E	0	1	6	9	7	3	3	1	0	0	0	0	30	4.17
ESE	1	0	4	6	4	1	3	0	0	0	0	0	19	4.08
SE	0	5	4	5	7	2	1	0	0	0	0	0	24	3.66
SSE	0	0	3	11	7	5	2	0	0	0	0	0	28	4.21
S	0	13	17	14	24	9	0	1	0	0	0	0	78	3.65
SSW	0	5	17	17	34	14	4	4	5	5	0	0	105	4.71
SW	0	8	22	20	20	16	14	5	8	4	1	0	118	4.83
WSW	1	4	14	11	11	4	13	5	2	0	0	0	69	4.49
W	0	6	11	4	3	4	3	1	1	0	0	0	33	3.73
WNW	1	3	8	5	2	2	0	0	0	0	0	0	21	3.14
NW	1	4	11	11	4	2	0	0	0	0	0	0	33	3.25
NNW	3	3	6	4	2	0	0	0	0	0	0	0	18	2.53
N	1	5	8	2	4	0	0	1	0	0	0	0	21	2.06
CALM													13	.43
TOTAL	8	74	173	139	148	83	59	19	17	9	1	1	744	4.52

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-25

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: SEPTEMBER 1975

PASQUILL AAA (FROM DEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	0	0	1	0	0	1	0	0	3	6.50
NE	0	0	0	1	0	0	1	0	0	0	0	0	2	4.00
ENE	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
SE	0	0	0	0	2	0	0	0	0	0	0	0	2	4.50
SSE	0	0	0	0	0	1	0	0	0	1	0	0	2	7.50
S	0	0	0	0	0	2	1	1	1	1	0	0	6	7.17
SSW	0	0	0	1	0	1	2	0	0	0	0	0	4	6.50
SW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.00
WSW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	2	0	0	0	0	0	0	0	2	3.50
NW	0	0	0	0	2	1	3	1	0	0	0	0	7	6.64
NNW	0	0	0	0	2	2	0	0	0	0	0	0	4	6.00
N	0	0	0	0	1	2	1	2	0	0	0	0	6	7.17
CALM													0	0.
TOTAL	0	0	1	10	7	8	9	4	1	3	0	0	42	5.74

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL BBB (FROM DEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	2	0	0	0	0	0	0	3	5.33
NE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
ENE	0	0	0	0	0	0	0	0	1	0	0	0	1	9.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	1	0	0	0	0	0	1	7.50
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	1	0	0	0	1	0	0	2	8.50
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	24.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	1	0	0	0	0	0	0	0	1	6.50
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	1	0	0	0	0	0	1	6.50
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	1	1	0	0	0	0	0	0	0	2	5.50
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	2	3	2	0	0	1	0	0	13	6.81

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL CCC (FROM DEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	1	2	0	0	0	2	1	1	0	5	8.20
NE	0	0	0	1	0	0	0	0	0	0	1	1	3	6.67
ENE	0	0	1	0	0	0	0	1	2	0	1	0	5	9.73
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	1	0	0	1	0	0	0	2	6.50
SSE	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
S	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
SSW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
SW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
WSW	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
W	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	1	2	2	6	0	1	5	1	2	1	22	7.20

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL DDD (FROM DEC/DELTA-T CRITERIA 1?-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	5	3	1	5	1	4	8	3	1	2	37	6.67
NE	0	2	6	4	1	3	5	6	3	5	3	12	50	8.14
ENE	0	2	6	3	4	4	3	4	3	4	6	7	43	7.11
E	0	0	0	0	3	2	1	1	5	4	2	1	19	8.03
ESE	0	0	0	1	1	0	0	1	3	0	0	0	6	6.04
SE	0	1	0	0	0	2	2	3	2	1	1	3	15	9.46
SSE	0	0	0	0	0	0	2	1	1	3	0	3	10	12.15
S	0	0	0	1	0	0	1	2	3	2	2	0	11	9.27
SSW	0	0	0	0	0	2	2	4	1	2	0	2	20	7.36
SW	0	0	0	0	0	3	1	2	2	0	2	1	15	8.57
WSW	0	0	1	0	0	4	4	1	1	0	1	0	12	5.08
W	0	0	0	3	0	3	1	2	3	0	0	0	12	6.01
WNW	0	0	0	0	2	1	1	0	2	1	0	0	7	6.01
NW	0	0	0	2	2	0	1	0	1	0	0	0	6	6.10
NNW	0	0	0	1	1	1	0	0	1	0	0	0	4	6.63
N	0	0	0	3	0	3	1	2	2	0	0	0	11	6.00
CALM													1	0.
TOTAL	0	8	28	19	27	38	25	43	46	25	18	40	301	7.38

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-M) METEOR
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	3	1	2	0	3	7	1	0	0	0	19	5.63
NE	0	2	1	4	3	1	4	3	3	1	2	1	34	6.94
ENE	0	1	5	3	3	1	2	0	0	0	0	0	15	3.70
E	0	1	2	2	2	3	0	0	0	0	1	0	11	4.61
ESE	0	0	0	1	2	1	0	0	2	1	1	0	8	7.04
SE	0	0	2	1	1	2	4	1	1	4	2	0	22	6.93
SSE	0	1	1	2	4	1	3	0	6	1	0	0	21	5.48
S	1	0	0	5	5	2	1	2	0	0	0	1	17	5.88
SSW	0	2	4	1	2	1	3	3	2	1	0	0	19	5.24
SW	0	2	1	1	0	1	0	1	0	0	0	0	6	3.68
WSW	0	0	0	1	1	2	2	0	0	0	0	0	6	5.28
W	0	1	1	0	2	3	0	0	0	0	0	0	7	4.29
WNW	0	2	1	4	4	0	1	2	0	0	0	0	14	4.24
NW	1	1	5	0	2	4	0	1	0	0	0	0	14	3.60
NNW	0	0	3	1	1	0	1	0	0	0	0	0	6	4.00
N	1	1	2	3	0	0	0	0	0	0	0	0	7	2.64
CALM													4	.45
TOTAL	3	16	31	34	41	28	28	20	15	8	6	2	242	5.21

NUMBER OF INVALID OBSERVATIONS = 6
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-M) METEOR
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	1	0	0	0	1	0	0	0	0	3	4.41
NE	0	0	0	0	3	5	2	1	1	0	0	0	12	5.41
ENE	0	0	1	1	0	1	0	0	0	0	0	0	3	3.47
E	0	2	2	0	0	2	0	0	0	0	0	0	4	3.47
ESE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.47
SE	0	1	1	1	2	1	0	1	0	1	0	0	8	4.93
SSE	0	1	0	2	0	1	0	0	0	0	0	0	4	3.43
S	0	0	0	2	1	2	0	1	0	0	0	0	6	4.17
SSW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.40
SW	1	1	3	1	0	0	0	0	0	0	0	0	6	2.93
WSW	0	0	2	1	0	0	0	0	0	0	0	0	3	2.47
W	0	1	1	1	0	0	0	0	0	0	0	0	3	2.47
WNW	1	1	0	0	1	1	0	0	0	0	0	0	4	3.19
NW	0	1	0	0	2	0	0	0	0	0	0	0	3	3.27
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													1	.69
TOTAL	2	7	15	9	10	11	2	4	1	1	0	0	66	3.64

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-M) METEOR
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	1	1	0	0	0	0	0	0	0	2	3.85
ENE	0	1	0	1	0	0	0	0	0	0	0	0	2	2.49
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	1	0	0	0	0	0	0	0	0	0	0	1	1.30
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.35
SW	0	2	0	0	0	0	0	0	0	0	0	0	2	1.40
WSW	0	1	1	1	0	0	0	0	0	0	0	0	3	2.23
W	0	3	1	0	0	0	0	0	0	0	0	0	4	2.10
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.79
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	1	0	0	0	0	0	0	0	0	0	0	0	1	.98
CALM													7	.48
TOTAL	1	8	3	3	1	0	0	0	0	0	0	0	24	1.83

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METEOR
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	6	3	9	7	4	5	5	17	11	5	2	2	70	4.39
NE	0	4	7	11	4	14	12	10	7	4	5	14	106	7.34
ENE	5	4	13	9	7	7	5	6	7	4	2	11	77	4.69
E	0	3	4	2	5	7	1	1	5	4	4	1	37	4.31
ESE	0	0	1	2	4	1	0	3	5	1	1	0	19	4.58
SE	0	3	3	2	6	5	11	6	3	7	3	7	56	7.41
SSE	6	2	1	4	5	3	5	1	7	4	1	0	37	7.68
S	1	0	3	6	9	5	4	7	5	1	0	5	46	6.83
SSW	0	2	4	2	4	9	8	2	3	1	0	2	47	5.11
SW	1	5	5	2	4	2	2	3	0	2	1	4	31	5.66
WSW	0	1	4	4	7	10	3	1	0	1	1	0	33	4.73
W	0	5	4	5	6	4	2	3	0	0	1	0	31	4.39
WNW	1	3	2	11	11	2	2	4	1	0	0	0	35	3.99
NW	1	2	7	5	5	8	1	2	0	0	0	0	37	4.19
NNW	0	0	5	5	4	0	1	1	0	0	0	0	16	4.03
N	2	1	4	5	5	2	4	2	1	1	0	0	29	4.41
CALM													13	.62
TOTAL	6	38	82	86	94	86	66	75	55	42	18	54	717	6.53

NUMBER OF INVALID OBSERVATIONS = 3
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-26

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: OCTOBER 1975

PASQUILL AAA (FROM AEC/DELTA-T CRITERIA 10-41 METER)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	1	0	0	0	0	0	2	4	11.48
NE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.75
ENE	0	0	0	0	0	0	1	1	0	0	0	0	2	7.88
E	0	0	0	0	0	0	0	1	0	0	0	0	1	7.48
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	1	0	0	0	0	0	0	0	0	1	4.50
SW	0	0	0	1	0	0	0	0	0	0	0	0	1	5.00
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.50
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	2	2	0	1	1	2	1	0	0	2	11	7.23

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL BBB (FROM AEC/DELTA-T CRITERIA 10-41 METER)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	0	0	0	0	2	3	14.17
NE	0	0	0	0	0	0	0	0	0	1	0	0	1	9.10
ENE	0	0	0	0	0	0	1	1	1	0	0	0	3	7.67
E	0	0	0	0	0	0	0	1	0	0	0	0	1	6.50
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
CALM													0	0.
TOTAL	0	0	0	0	1	2	1	2	1	1	0	2	10	9.60

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL CCC (FROM AEC/DELTA-T CRITERIA 10-41 METER)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	1	1	0	0	1	4	9.52
NE	0	0	0	0	2	2	0	0	1	1	1	0	7	6.01
ENE	0	0	0	0	0	0	4	1	0	2	0	0	7	7.65
E	0	0	0	1	0	0	1	0	0	0	0	0	2	5.25
ESE	0	0	0	0	0	1	1	0	0	0	0	0	2	6.10
SE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
SSE	0	0	0	0	0	0	0	0	0	0	1	0	1	10.00
S	0	0	0	0	1	1	0	0	1	0	0	0	3	5.10
SSW	0	0	0	1	0	0	2	1	0	0	0	0	4	5.25
SW	0	0	0	1	0	0	1	1	0	1	0	0	4	5.63
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
NW	0	0	0	0	0	0	1	0	1	0	0	1	3	7.00
NNW	0	0	0	1	1	1	1	0	1	0	0	1	6	6.75
N	0	0	0	1	0	0	0	0	0	0	0	1	1	3.50
CALM													0	0.
TOTAL	0	0	0	5	5	5	10	4	4	3	3	7	46	6.66

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL DDD (FROM AEC/DELTA-T CRITERIA 10-41 METER)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	1	0	6	6	5	1	1	1	4	26	8.02
NE	0	0	1	5	2	2	0	5	3	4	1	2	26	9.38
ENE	0	0	0	0	2	5	1	2	5	0	1	3	19	7.84
E	0	0	0	1	1	5	3	0	0	0	1	1	12	5.47
ESE	0	0	0	1	4	2	0	0	0	0	0	0	7	4.01
SE	0	0	0	1	0	0	1	0	0	0	1	1	4	9.38
SSE	0	0	0	0	0	1	1	1	0	0	1	1	6	10.47
S	0	0	1	0	0	0	0	0	0	0	0	2	3	14.67
SSW	0	0	0	2	2	3	1	1	0	0	0	0	9	5.89
SW	0	0	0	3	0	5	4	5	4	1	4	1	30	7.55
WSW	0	1	0	1	4	1	3	2	1	2	3	1	19	6.83
W	0	0	0	2	2	1	2	2	1	1	1	0	11	6.28
WNW	0	0	1	1	0	3	1	1	0	0	0	0	7	5.13
NW	0	1	0	3	1	4	3	5	1	1	0	0	24	5.11
NNW	0	0	1	1	1	1	4	2	2	1	0	1	14	6.05
N	0	0	1	1	2	1	1	0	0	0	0	0	7	4.64
CALM													0	0.
TOTAL	0	2	4	19	21	41	31	31	23	13	13	23	221	7.35

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	3	5	2	3	0	4	1	2	4	20	7.97
NE	0	1	2	4	4	5	5	3	4	3	0	0	36	5.67
ENE	0	1	0	1	1	1	2	0	0	0	0	0	6	4.77
E	0	0	1	2	2	0	2	0	0	0	0	0	7	4.48
ESE	0	0	0	0	4	1	3	0	2	1	0	0	11	6.47
SE	0	0	0	0	1	2	1	3	1	0	0	4	12	9.33
SSE	0	0	1	0	1	1	0	0	0	0	0	3	6	12.27
S	0	0	1	2	0	1	1	0	1	0	0	2	8	8.15
SSW	0	0	1	2	2	2	4	2	3	0	0	0	16	6.14
SW	0	0	1	3	3	0	3	3	1	1	0	1	16	6.27
WSW	0	1	2	0	0	1	5	0	1	0	1	0	11	4.45
W	0	1	2	1	2	1	4	1	0	0	0	0	12	4.91
WNW	0	0	1	1	1	2	0	0	0	0	0	0	5	4.39
NW	0	1	1	2	2	1	1	0	0	0	0	0	10	3.75
NNW	0	1	5	2	1	2	0	0	0	0	0	0	13	3.54
N	0	0	1	5	1	1	1	1	0	0	0	0	12	4.57
CALM													0	0.
TOTAL	0	8	22	30	24	24	35	21	17	6	3	16	209	6.20

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	2	2	3	1	0	0	0	0	0	10	4.85
NE	0	0	3	1	5	2	4	2	2	2	0	0	21	5.77
ENE	0	0	2	2	4	1	1	0	0	0	0	0	10	4.37
E	0	0	2	0	0	1	1	0	0	0	0	0	4	4.45
ESE	0	1	2	0	1	2	2	0	0	0	0	0	8	4.17
SE	0	0	1	0	0	2	4	5	1	0	0	0	13	6.69
SSE	0	1	0	1	1	2	0	1	0	0	0	0	6	4.57
S	0	0	0	0	1	4	2	0	0	0	0	0	7	5.61
SSW	0	0	3	1	0	4	2	0	0	0	0	0	10	4.54
SW	0	0	0	0	1	1	1	0	0	0	0	0	5	5.15
WSW	0	1	1	0	0	2	0	0	0	0	0	0	4	3.57
W	0	1	0	0	0	1	0	0	0	0	0	0	2	3.74
WNW	0	2	1	2	0	0	0	0	0	0	0	0	5	3.52
NW	0	1	5	0	0	1	0	0	0	0	0	0	7	2.47
NNW	0	1	1	0	0	0	0	0	0	0	0	0	2	2.05
N	0	2	2	1	1	2	0	1	0	0	0	0	9	3.47
CALM													0	0.
TOTAL	0	11	24	10	17	28	18	9	3	2	0	0	129	4.73

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	8	1	0	0	0	0	0	0	0	0	11	2.34
NE	0	4	1	1	0	0	0	0	0	0	0	0	6	2.28
ENE	0	0	1	1	1	0	0	0	0	0	0	0	3	3.57
E	0	0	0	0	0	1	1	0	0	0	0	0	2	4.90
ESE	0	1	0	0	1	0	0	0	0	0	0	0	2	2.80
SE	0	2	1	0	1	0	1	0	0	0	0	0	5	3.50
SSE	0	4	2	0	0	0	0	1	0	0	0	0	7	2.83
S	0	1	3	0	0	1	0	0	0	0	0	0	5	3.14
SSW	0	4	3	2	2	1	1	0	0	0	0	0	14	3.00
SW	0	5	4	1	1	0	0	0	0	0	0	0	11	2.35
WSW	0	2	1	0	0	0	0	0	0	0	0	0	3	2.10
W	1	3	2	0	0	0	0	0	0	0	0	0	6	1.83
WNW	0	7	1	1	0	0	0	0	0	0	0	0	11	2.19
NW	0	9	8	2	1	0	0	0	0	0	0	0	20	2.23
NNW	1	4	4	1	0	0	0	0	0	0	0	0	10	2.17
N	1	4	3	1	0	0	0	0	0	0	0	0	9	1.93
CALM													0	0.
TOTAL	3	52	44	11	8	3	2	1	0	0	0	0	124	2.49

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METERS
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	3	12	7	7	7	11	4	6	2	3	13	77	7.44
NE	0	4	7	8	14	14	9	10	11	11	1	0	97	6.40
ENE	0	1	3	4	4	8	10	5	6	2	0	3	56	4.27
E	0	0	3	4	6	7	7	2	0	0	0	0	29	4.23
ESE	0	2	2	1	10	6	6	0	2	1	0	0	30	5.38
SE	0	2	2	1	4	4	7	8	2	0	1	5		7.22
SSE	0	5	3	1	2	4	1	3	0	2	2	5	36	7.66
S	0	1	5	3	2	8	3	1	1	0	0	4	28	6.04
SSW	0	5	8	8	6	12	9	3	3	0	0	0	54	4.77
SW	0	5	6	8	7	7	9	8	8	2	4	1	67	6.04
WSW	0	5	4	1	4	4	8	10	2	2	4	0	44	5.17
W	1	5	4	3	4	3	6	3	1	1	0	0	31	4.22
WNW	0	9	6	6	1	5	1	1	0	0	0	0	29	3.44
NW	0	12	16	7	4	11	4	6	1	1	2	0	64	4.25
NNW	1	6	12	5	5	6	5	2	3	1	0	2	48	4.72
N	1	8	7	9	5	5	2	2	0	0	0	1	38	3.04
CALM													0	0.
TOTAL	3	71	100	74	83	109	98	70	44	25	19	43	743	5.78

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-27

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: NOVEMBER 1975

PASQUILL ADW (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.40
NW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.10
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	1	0	0	0	0	0	0	0	0	0	2	1.75

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ADW (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.40
SSE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.40
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	1	0	0	0	0	0	0	0	0	0	1	3.80
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	0	0	0	0	0	0	0	0	1	4.80
WNW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.40
NW	0	0	0	2	0	0	0	0	0	0	0	0	2	3.45
NNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.30
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	3	4	0	1	0	0	0	0	0	0	8	3.88

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ADW (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	1	0	0	0	0	2	4.44
NE	0	0	0	0	0	2	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	1	1	1	1	0	0	0	4	8.05
SE	0	0	0	0	0	2	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	1	1	1	1	0	0	0	0	4	6.15
S	0	0	2	0	0	0	0	0	0	1	0	0	3	5.27
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	1	1	0	0	0	0	0	0	0	2	4.20
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	1	0	0	0	0	0	0	0	3	3.23
WNW	0	0	0	0	0	0	0	0	0	0	0	0	2	2.75
NW	0	0	1	0	0	0	0	0	0	0	0	0	1	4	3.82
NNW	0	0	1	1	0	0	0	0	0	0	0	0	2	3.15
N	0	1	0	0	1	0	0	0	1	0	0	0	3	5.20
CALM													0	0.
TOTAL	0	1	4	3	3	2	2	3	1	2	1	1	29	5.49

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ADW (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	0	0	3	1	0	0	0	0	0	5	4.64
NE	0	0	0	1	0	1	4	1	0	0	0	0	7	5.99
ENE	0	0	0	0	0	3	2	5	1	0	0	0	11	6.88
E	0	0	0	2	0	1	0	1	2	1	0	0	7	5.69
ESE	0	0	0	1	1	1	0	1	0	0	0	0	4	5.27
SE	0	0	0	2	0	1	2	1	1	3	0	2	12	7.87
SSE	0	0	1	1	2	0	1	1	5	0	3	0	14	7.43
S	0	0	2	0	1	1	1	3	2	2	2	5	19	8.54
SSW	0	0	2	0	0	1	0	1	4	2	0	2	12	8.07
SW	0	0	0	2	1	3	0	0	1	2	0	0	9	6.13
WSW	0	1	1	2	11	4	3	0	0	1	2	2	32	7.29
W	0	0	1	4	3	5	2	6	3	0	0	2	26	6.65
WNW	0	0	4	2	0	0	2	3	1	0	0	0	12	4.00
NW	0	0	3	1	2	5	1	1	0	1	0	15	29	9.59
NNW	0	2	2	6	3	8	2	3	3	1	0	2	32	5.71
N	0	0	0	2	2	2	0	1	0	0	0	0	7	4.93
CALM													0	0.
TOTAL	0	4	16	26	26	39	21	28	23	16	7	35	241	7.09

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-27 (Continued)

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-M METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	3	0	0	2	0	0	0	0	0	0	5	3,60
NE	0	1	3	2	3	1	1	0	0	0	0	0	11	3,89
ENE	0	6	0	2	3	4	1	0	0	0	0	0	16	5,25
E	0	1	3	0	0	1	0	0	0	0	0	0	5	2,60
ESE	0	0	0	0	3	0	2	0	0	1	0	0	6	6,17
SE	0	0	0	1	4	3	1	3	1	4	2	3	22	7,41
SSE	0	0	1	0	3	2	3	4	2	1	2	4	22	8,14
S	0	0	0	1	2	1	3	2	0	3	0	4	16	8,74
SSW	0	0	2	0	2	4	1	2	1	2	1	2	17	8,64
SW	0	1	2	3	4	0	0	1	0	0	0	0	13	6,04
WSW	0	1	1	2	2	2	1	0	0	0	0	0	9	6,41
W	0	1	1	4	4	1	1	0	0	1	0	1	14	5,82
WNW	0	1	1	0	0	1	0	2	0	0	1	0	6	5,97
NW	0	1	3	0	2	0	0	0	0	1	0	0	7	3,88
NNW	0	3	1	3	1	2	1	1	0	0	0	0	12	3,67
N	0	1	0	1	1	0	0	0	0	0	0	0	3	3,20
CALM													0	0.
TOTAL	0	11	21	19	36	24	15	15	4	13	6	14	178	5,92

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-M METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	4	3	0	0	0	0	0	0	0	0	0	7	2,14
NE	0	1	4	1	1	0	0	0	0	0	0	0	7	2,00
ENE	0	2	1	2	1	0	0	0	0	0	0	0	6	2,33
E	0	3	0	1	0	1	0	0	0	0	0	0	5	2,70
ESE	0	1	2	0	0	0	0	0	0	0	0	0	3	2,37
SE	0	1	3	1	1	0	1	0	0	0	0	0	7	3,56
SSE	0	0	0	1	0	1	0	0	0	0	0	0	2	4,70
S	0	1	1	0	1	0	0	0	0	0	0	0	3	3,00
SSW	0	3	4	1	1	0	0	0	0	0	0	0	9	2,62
SW	0	2	4	1	4	0	0	0	0	0	0	0	11	3,18
WSW	0	5	5	1	0	1	0	0	0	0	0	0	12	2,17
W	0	3	7	0	0	0	0	0	0	0	0	0	10	2,34
WNW	0	13	10	3	0	3	0	0	0	0	0	0	26	2,14
NW	2	14	7	1	0	0	0	0	0	0	0	0	24	1,81
NNW	0	13	2	0	0	0	0	0	0	0	0	0	15	1,59
N	1	12	4	0	0	0	0	0	0	0	0	0	17	1,73
CALM													0	0.
TOTAL	3	78	67	13	9	5	1	0	0	0	0	0	144	2,29

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	4	9	2	0	6	1	1	0	0	0	0	24	3,41
NE	0	3	7	8	4	3	4	1	0	0	0	0	32	4,11
ENE	0	3	4	6	4	8	5	0	1	0	0	0	36	4,01
E	0	5	4	3	0	4	1	1	2	1	0	0	21	4,29
ESE	0	1	3	1	7	4	4	2	2	2	0	0	27	5,67
SE	0	1	4	5	7	8	9	5	3	7	2	6	57	6,65
SSE	0	0	5	2	7	9	5	4	9	4	5	4	53	7,17
S	0	1	5	1	4	2	4	5	2	5	3	9	41	7,98
SSW	0	3	9	1	5	6	1	3	5	4	1	4	42	6,74
SW	0	3	9	7	14	5	1	1	1	2	0	0	44	4,38
WSW	0	11	9	5	11	8	4	0	0	1	2	7	60	5,24
W	0	5	11	12	7	6	3	0	1	1	0	3	57	4,04
WNW	0	19	18	5	0	1	2	5	1	3	1	0	55	3,42
NW	2	17	17	5	4	5	1	1	0	2	0	16	72	5,53
NNW	0	20	6	11	4	10	3	4	3	1	0	2	64	4,14
N	1	15	7	3	4	2	0	1	0	1	0	0	34	2,87
CALM													0	0.
TOTAL	3	113	127	77	87	84	50	47	32	34	15	51	720	5,21

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-28

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: DECEMBER 1975

PASQUILL AAA (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.25
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	0	0	0	0	0	0	0	0	0	1	2.25

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL BBB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	1	0	1	0	0	0	0	0	0	0	0	2	2.75
SW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.75
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	0	1	1	0	0	0	0	0	0	0	3	3.42

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL CCC (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	1	0	0	0	0	0	1	5.50
E	0	0	0	0	0	1	0	0	0	0	0	0	1	5.00
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	0	0	0	0	0	0	0	1	4.00
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	1	2	1	0	0	0	0	0	0	0	0	4	2.35
NW	0	0	0	0	0	0	0	0	1	0	0	0	1	8.20
NNW	0	0	0	0	0	0	0	0	0	1	0	4	5	12.40
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	2	1	2	1	0	0	1	1	0	4	13	7.40

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL DDD (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	4	5	7	4	5	0	0	0	2	28	6.00
NE	0	0	1	5	9	11	11	1	0	1	0	3	42	5.99
ENE	0	0	1	1	2	3	2	4	0	0	0	0	13	5.46
E	0	0	1	0	2	0	3	1	0	0	0	0	7	5.50
ESE	0	0	1	0	0	2	0	0	1	0	0	0	4	5.13
SE	0	0	0	1	0	1	1	1	1	0	0	0	5	6.40
SSE	0	0	0	0	1	0	0	0	0	0	0	2	3	10.20
S	0	0	2	2	0	1	0	0	0	0	0	0	5	3.54
SSW	0	0	2	1	0	4	4	1	0	1	0	0	13	5.78
SW	0	0	0	1	1	0	1	5	3	2	2	10	25	10.33
WSW	0	0	3	1	3	1	2	2	2	0	0	14	28	10.13
W	0	1	3	2	3	2	2	1	0	0	0	0	14	6.43
WNW	0	2	0	5	6	4	1	1	0	0	0	0	20	6.75
NW	0	0	4	4	3	5	5	3	2	3	4	2	35	6.77
NNW	0	0	4	5	3	4	1	2	1	2	2	2	26	6.15
N	0	0	0	0	1	1	3	0	0	1	0	4	10	8.71
CALM													0	0.
TOTAL	0	3	23	32	39	46	40	27	11	10	8	39	278	6.82

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #B (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	3	1	2	4	2	1	0	0	0	0	0	15	3,80
NE	0	1	2	1	3	2	1	1	0	0	0	0	11	4,47
ENE	0	0	0	1	4	7	4	0	0	0	0	0	16	5,33
E	0	0	0	0	3	3	2	0	0	1	0	0	9	5,00
ESE	0	0	0	0	2	2	3	1	0	0	0	0	8	4,95
SE	0	0	0	0	0	0	1	2	0	0	0	0	3	6,33
SSE	0	0	1	0	0	2	3	0	0	0	1	0	7	6,43
S	0	0	1	0	0	3	1	2	0	0	1	2	10	7,50
SSW	0	0	1	0	0	3	3	4	2	0	0	0	13	7,00
SW	0	0	2	0	0	4	3	4	2	0	0	0	15	7,00
WSW	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
W	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
WNW	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
NW	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
NNW	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
N	0	0	2	0	0	3	3	4	2	0	0	0	14	7,07
CALM													0	0,
TOTAL	0	4	19	4	16	46	40	34	16	1	2	0	228	6,46

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #C (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	2	0	0	0	0	0	0	0	0	3	3,67
NE	0	1	0	0	1	2	0	0	0	0	0	1	4	6,25
ENE	0	0	0	0	1	1	0	0	0	0	0	0	2	5,25
E	0	0	0	1	1	0	1	0	0	0	0	0	3	4,67
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SE	0	0	0	0	0	0	2	1	0	0	1	0	4	7,50
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
S	0	0	2	5	2	1	0	0	1	0	0	0	11	4,18
SSW	0	0	1	0	0	1	0	2	1	0	0	0	5	6,60
SW	0	0	1	0	1	1	0	0	0	0	0	0	3	3,67
WSW	0	1	0	0	1	0	0	0	0	0	0	0	2	3,50
W	0	1	1	0	0	1	0	0	0	0	0	0	3	3,33
WNW	0	0	0	2	0	0	0	0	0	0	0	0	2	3,50
NW	0	2	0	4	0	0	0	0	0	0	0	0	6	3,67
NNW	0	1	2	0	0	0	0	0	0	0	0	0	3	2,67
N	0	0	1	1	0	0	0	0	0	0	0	0	2	2,50
CALM													0	0,
TOTAL	0	6	10	15	6	6	3	3	2	0	1	1	53	4,32

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #D (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	6	4	0	2	0	0	0	0	0	0	0	13	2,31
NE	0	6	6	4	0	2	0	0	0	0	0	0	14	2,43
ENE	0	3	0	1	0	0	0	0	0	0	0	0	3	2,00
E	0	2	1	2	0	0	0	0	0	0	0	0	5	2,40
ESE	0	0	4	2	2	0	0	0	0	0	0	0	8	3,25
SE	0	3	1	1	1	1	2	0	0	0	0	0	9	3,44
SSE	0	0	1	2	1	1	1	0	0	0	0	0	6	4,04
S	0	2	3	1	0	2	0	0	0	0	0	0	8	3,10
SSW	1	2	3	4	2	0	0	0	0	0	0	0	12	3,04
SW	1	1	0	6	2	1	0	0	0	0	0	0	11	3,52
WSW	0	5	2	3	0	0	0	0	0	0	0	0	10	2,47
W	1	5	4	1	1	0	0	0	0	0	0	0	12	2,36
WNW	0	2	1	0	0	0	0	0	0	0	0	0	3	1,73
NW	2	7	2	0	0	0	0	0	0	0	0	0	11	1,69
NNW	0	3	1	1	0	0	0	0	0	0	0	0	5	2,22
N	0	8	1	0	0	0	0	0	0	0	0	0	9	1,61
CALM													0	0,
TOTAL	5	56	35	28	11	11	3	0	0	0	0	0	145	2,72

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	9	8	8	13	9	5	5	0	0	0	2	59	4,54
NE	0	8	9	10	13	17	12	2	0	1	0	3	75	4,89
ENE	0	2	1	3	4	12	6	4	0	0	0	0	37	5,24
E	0	2	3	3	6	4	5	1	0	1	0	0	25	4,80
ESE	0	0	5	4	4	5	1	0	1	0	0	0	20	4,34
SE	0	3	1	2	1	5	5	4	1	0	1	0	23	5,41
SSE	0	0	2	2	4	6	1	0	0	1	2	4	22	6,00
S	0	2	8	13	6	5	2	3	4	1	1	4	51	5,54
SSW	1	3	7	10	5	8	8	5	1	5	4	2	59	5,89
SW	1	3	4	13	8	9	1	6	5	3	2	15	73	7,23
WSW	0	8	9	7	11	4	2	2	2	0	0	14	59	6,63
W	3	9	11	7	5	4	3	1	1	0	0	0	44	3,48
WNW	0	5	7	10	8	5	1	1	1	0	0	0	38	3,89
NW	2	16	9	13	8	5	7	3	3	3	5	2	76	4,75
NNW	0	4	11	8	5	6	2	4	1	3	4	5	52	5,67
N	0	10	6	1	8	1	3	0	0	1	1	4	31	4,77
CALM													0	0,
TOTAL	7	84	99	114	112	103	64	44	20	23	20	56	744	5,36

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
10.5 METER LEVEL: ANNUAL 1975

PASQUILL ##A (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	3	9	2	2	4	2	3	1	0	4	3	4	29	8,39
NE	6	9	5	1	2	3	6	2	4	0	1	8	27	8,44
ENE	0	0	0	4	3	7	5	1	0	1	0	0	21	5,95
E	0	0	1	1	1	5	5	1	0	0	1	1	16	6,17
ESE	0	0	0	1	3	1	3	2	1	1	0	0	12	6,35
SE	0	1	2	1	4	3	1	1	2	0	0	1	17	5,82
SSE	0	0	0	2	2	2	0	1	0	1	1	0	9	6,28
S	0	0	1	2	4	4	2	4	1	2	3	3	27	7,17
SSW	0	0	0	4	4	4	4	2	3	3	0	2	26	6,65
SW	0	0	1	4	9	5	4	1	2	1	0	0	27	5,85
WSW	0	0	2	2	5	8	4	1	0	0	0	0	22	5,13
W	0	0	4	0	3	1	2	0	0	0	0	0	10	4,41
WNW	0	1	0	4	1	4	0	1	0	0	0	0	11	4,68
NW	0	1	4	5	7	3	2	0	1	0	0	0	23	4,34
NNW	5	1	5	5	4	1	1	1	0	0	1	0	19	4,13
N	0	0	0	1	5	5	3	1	0	1	1	0	17	5,06
CALM													1	0,0
TOTAL	5	4	22	39	62	58	45	20	17	14	10	21	314	6,13

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL ##B (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	5	1	0	1	0	0	2	10	7,09
NE	0	0	0	0	1	1	0	2	0	5	1	4	14	9,96
ENE	0	0	0	3	4	4	4	2	3	1	0	0	21	6,04
E	0	0	0	0	2	0	2	2	0	1	2	0	9	7,72
ESE	0	0	0	2	1	0	2	2	0	0	0	0	9	5,80
SE	0	0	0	0	3	2	1	2	0	0	0	2	10	6,87
SSE	0	0	1	0	0	0	1	1	0	0	1	0	4	6,50
S	0	0	0	1	3	1	0	1	1	0	2	2	11	7,46
SSW	0	1	1	2	0	1	0	1	2	0	2	2	13	6,61
SW	0	0	1	0	3	4	5	1	3	2	1	1	21	6,07
WSW	0	0	1	3	3	1	1	0	0	0	0	0	9	4,83
W	0	0	0	1	2	1	0	0	1	0	0	0	5	5,40
WNW	0	0	1	0	1	1	1	0	0	0	0	0	4	4,75
NW	0	0	1	5	1	2	1	1	1	1	0	0	13	4,38
NNW	0	0	2	3	1	0	0	0	1	2	0	1	10	6,32
N	0	0	0	0	0	1	1	0	2	1	0	0	5	6,80
CALM													0	0,
TOTAL	0	1	8	21	29	26	20	15	12	13	9	14	172	7,09

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL ##C (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	2	2	3	1	3	3	1	1	1	17	7,34
NE	0	0	2	2	7	4	3	3	3	4	1	2	31	6,55
ENE	0	0	1	0	4	3	12	5	7	6	5	4	49	8,29
E	0	0	0	2	2	1	3	2	4	4	3	3	26	8,14
ESE	0	0	0	0	3	3	3	1	3	2	1	0	16	7,11
SE	0	0	1	2	4	2	0	3	1	1	1	2	18	6,85
SSE	0	0	1	0	4	4	3	1	0	0	1	2	16	6,66
S	0	0	3	1	1	2	4	4	2	0	2	3	28	6,71
SSW	0	0	2	2	3	1	1	4	5	5	0	3	35	7,33
SW	0	0	2	3	1	10	11	5	5	4	0	1	49	6,31
WSW	0	0	1	3	1	10	4	3	2	2	0	2	30	6,29
W	0	0	1	4	5	1	3	1	0	0	0	0	19	4,87
WNW	0	1	0	1	4	1	1	3	1	0	1	3	33	5,48
NW	0	0	1	3	4	3	3	4	5	2	3	15	49	8,17
NNW	0	0	1	5	4	1	2	1	3	1	2	9	30	8,79
N	0	1	1	3	2	0	1	2	1	3	1	2	17	7,64
CALM													0	0,
TOTAL	0	2	23	39	70	49	66	47	47	36	22	56	474	7,21

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL ##D (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	4	13	14	12	21	28	27	13	6	4	16	158	6,76
NE	2	5	24	23	26	33	36	35	16	25	14	28	347	8,06
ENE	0	5	15	13	28	39	34	38	30	14	7	13	239	6,76
E	0	0	6	11	23	23	15	17	21	12	5	4	137	6,44
ESE	0	0	3	13	16	9	10	14	10	4	4	5	98	6,43
SE	0	1	2	14	6	14	13	11	9	8	7	22	107	8,01
SSE	0	0	1	10	8	11	14	13	14	8	14	27	124	8,26
S	0	2	11	8	8	14	15	26	13	14	8	33	152	8,36
SSW	0	1	6	12	24	29	29	28	14	20	11	52	228	8,32
SW	0	3	5	18	31	28	32	32	48	22	27	57	401	8,33
WSW	0	3	13	15	42	32	43	30	29	17	20	43	327	8,46
W	1	2	12	27	23	35	26	32	22	15	15	48	278	8,48
WNW	0	4	13	19	17	23	17	19	12	13	4	14	155	6,69
NW	0	5	14	30	21	32	20	26	15	13	11	37	215	7,26
NNW	0	2	19	21	16	26	16	13	11	11	5	22	162	6,82
N	0	4	9	6	21	18	14	14	6	5	2	9	109	6,67
CALM													6	0,0
TOTAL	3	41	170	254	324	385	358	370	280	211	168	490	3050	7,61

NUMBER OF INVALID OBSERVATIONS = 9
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL REP (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	8	13	29	23	18	16	13	15	4	2	2	4	143	4.91
NE	5	9	21	35	31	33	29	16	14	4	2	7	201	5.63
ENE	8	5	19	19	26	26	20	6	2	4	1	3	131	5.07
E	5	3	17	24	21	24	21	4	2	1	2	1	126	4.91
ESE	1	1	3	19	19	19	16	7	7	4	1	3	104	5.48
SE	0	2	7	14	19	24	29	18	8	15	6	12	156	6.82
SSE	0	2	9	12	32	34	37	26	14	15	12	39	232	7.81
S	2	6	20	33	47	35	38	25	18	24	15	39	302	8.07
SSW	1	9	29	27	55	33	38	16	16	24	11	27	287	6.52
SW	6	12	27	40	38	32	26	29	24	19	8	22	276	6.24
WSW	1	7	15	20	29	27	21	21	8	6	10	7	172	6.00
W	3	8	13	24	23	22	20	17	5	5	4	7	151	5.66
WNW	4	6	13	17	19	16	6	8	2	4	1	1	97	4.71
NW	1	14	23	21	20	14	8	9	3	5	5	12	137	5.40
NNW	1	9	23	17	15	18	7	9	1	4	8	11	123	5.48
N	4	12	14	27	17	17	9	4	4	3	1	2	108	4.39
CALM													24	.43
TOTAL	58	128	279	372	429	345	339	237	136	141	89	197	2744	5.97

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL REP (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	1	4	15	10	4	6	2	1	0	0	0	0	53	3.45
NE	0	11	13	17	21	14	9	3	3	2	0	1	94	4.45
ENE	1	9	12	20	14	11	9	3	4	3	2	0	88	4.42
E	1	7	12	5	8	12	9	4	6	0	0	0	56	4.40
ESE	3	6	7	7	10	14	12	10	2	2	0	0	73	5.01
SE	0	6	7	5	12	16	21	23	7	3	1	1	104	5.66
SSE	0	4	13	15	14	16	2	12	10	10	7	0	103	5.44
S	0	10	16	13	19	14	9	4	2	1	0	3	91	4.59
SSW	1	2	16	9	22	18	13	10	4	0	0	0	96	5.03
SW	2	8	17	13	18	13	5	3	0	0	0	0	82	4.30
WSW	0	10	14	8	16	15	0	0	0	0	0	0	63	3.73
W	0	8	10	9	5	6	4	2	0	0	0	0	64	3.87
WNW	1	13	4	9	7	4	2	1	1	0	1	0	43	3.41
NW	1	10	13	15	9	4	2	0	1	0	0	0	55	3.45
NNW	0	9	4	3	4	1	0	0	0	0	1	0	27	3.22
N	1	11	14	7	3	4	0	1	0	0	0	0	41	2.95
CALM													18	.41
TOTAL	12	133	187	165	191	168	102	77	34	21	14	5	1127	4.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL #6# (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	18	25	4	4	0	1	0	0	0	0	0	52	2.52
NE	4	15	18	12	6	2	0	0	0	0	0	0	57	2.48
ENE	2	12	3	12	9	3	0	0	0	0	0	0	41	3.11
E	0	8	5	5	6	5	3	1	0	0	0	0	33	3.48
ESE	1	4	6	4	3	3	4	0	1	0	0	0	26	3.87
SE	0	10	9	6	5	7	3	4	5	0	0	0	44	3.97
SSE	0	5	4	8	5	4	6	4	2	0	1	0	39	4.26
S	0	5	10	5	7	4	1	0	0	0	0	0	36	3.31
SSW	1	17	18	11	11	4	2	1	0	0	0	0	65	3.19
SW	1	12	19	15	12	4	0	0	0	0	0	0	63	3.14
WSW	0	16	18	11	4	2	0	1	0	0	0	0	52	2.88
W	3	19	19	4	4	0	0	0	0	0	0	0	49	2.34
WNW	1	23	21	9	1	0	0	0	0	0	0	0	55	2.35
NW	4	34	25	10	4	1	0	0	0	0	0	0	78	2.21
NNW	3	24	15	6	3	1	0	0	0	0	0	0	52	2.23
N	3	27	15	4	6	2	0	0	0	0	0	0	57	2.30
CALM													34	.61
TOTAL	25	253	238	126	90	42	20	11	5	0	1	0	835	2.82

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 10.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	1	44	98	55	52	53	41	47	25	15	10	29	462	5.68
NE	6	60	78	98	94	98	83	61	40	40	19	56	691	5.93
ENE	3	31	51	71	87	93	84	56	47	32	16	22	593	5.87
E	1	18	41	48	63	70	58	31	29	18	14	9	400	5.66
ESE	5	11	19	46	55	49	52	36	24	15	8	8	328	5.81
SE	0	26	28	42	54	68	68	63	27	28	17	40	455	6.68
SSE	0	11	29	47	65	71	63	58	42	34	30	68	527	7.35
S	2	27	41	63	95	74	69	64	45	42	27	83	647	6.74
SSW	3	30	65	68	121	96	93	71	44	52	24	86	753	6.66
SW	3	35	72	93	118	98	86	70	80	48	36	81	820	6.55
WSW	1	36	64	62	106	95	78	56	39	25	35	92	684	6.68
W	7	37	59	69	65	70	55	52	27	21	19	75	556	6.68
WNW	6	48	58	65	55	69	27	32	16	17	7	18	398	5.10
NW	8	66	83	89	71	49	36	35	21	21	19	69	577	5.82
NNW	4	45	69	60	44	48	26	24	16	14	17	43	418	5.73
N	8	55	69	48	54	40	31	23	13	12	5	13	351	4.77
CALM													83	.67
TOTAL	58	554	916	1016	1203	1123	950	779	536	438	307	788	8743	6.14

NUMBER OF INVALID OBSERVATIONS = 17
TOTAL NUMBER OF OBSERVATIONS = 8760

TABLE 2.3-30

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: JANUARY 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	1	1	12.00
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	1	0	0	0	0	0	0	0	0	0	1	2.00
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	1	0	0	0	0	0	0	0	0	0	1	2.10
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.30
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00
WNW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	3	2	0	0	0	0	0	0	0	0	1	4	3.40

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #BB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
NE	0	0	0	0	0	0	0	0	0	0	1	0	1	11.50
ENE	0	0	0	1	0	1	0	0	0	0	0	0	2	4.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.77
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	0	1	1	1	0	0	0	0	0	0	4	5.67

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #CC (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	1	0	0	1	2	8.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	1	0	0	0	0	0	1	7.00
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.00
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.40
SW	0	0	0	0	1	0	0	0	0	0	0	1	2	12.00
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	1	0	0	0	0	1	2	9.45
NW	0	0	0	0	0	0	0	1	0	0	0	0	1	6.60
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	1	1	12.00
CALM													0	0.
TOTAL	0	0	1	1	1	0	1	1	1	0	0	1	8	9.44

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #DD (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	0	1	2	0	0	2	5	4	15	10.43
NE	1	0	0	1	0	2	1	1	0	1	1	1	9	7.17
ENE	0	0	0	2	2	1	2	1	1	1	1	4	17	8.14
E	0	0	2	1	1	1	2	2	1	2	1	1	14	7.96
ESE	3	0	0	0	2	0	1	1	1	1	0	0	9	6.13
SE	0	0	0	0	2	2	0	1	1	1	1	5	14	11.29
SSE	0	0	0	0	2	1	1	0	0	0	0	0	4	5.00
S	0	0	0	0	0	0	0	0	0	2	2	2	4	12.15
SSW	0	0	0	1	0	0	0	0	0	2	1	11	13	14.04
SW	0	0	1	1	4	2	2	0	1	2	1	6	22	9.19
WSW	0	0	0	0	1	4	1	0	0	0	4	28	38	14.07
W	0	1	1	1	1	2	0	1	0	1	2	22	33	15.11
WNW	0	1	3	0	4	5	4	5	3	3	3	3	34	9.99
NW	0	0	0	3	5	4	1	0	2	1	3	3	22	8.45
NNW	0	0	0	2	1	1	2	1	2	1	1	1	13	8.69
N	0	0	0	0	1	0	2	2	0	1	0	1	7	7.86
CALM													0	0.
TOTAL	1	3	8	12	26	24	26	15	11	20	22	101	247	10.21

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #A# (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	2	1	0	2	0	4	10	9.57
NE	0	0	0	0	1	0	5	1	1	3	2	10	23	10.13
ENE	0	0	1	0	0	2	0	0	1	2	3	1	10	8.49
E	0	0	0	0	0	1	2	4	1	2	6	8	24	10.01
ESE	0	0	0	0	0	1	0	0	2	0	0	0	3	7.79
SE	0	0	0	0	0	0	1	2	0	1	1	0	7	9.30
SSE	0	0	0	0	1	2	1	0	1	0	2	0	10	17	13.43
S	0	0	1	0	0	0	0	0	0	1	4	11	17	12.91
SSW	0	0	1	0	0	0	0	1	2	0	2	20	26	13.38
SW	0	0	1	2	1	2	1	1	5	4	1	21	39	12.75
WSW	0	0	0	1	0	1	2	2	2	0	1	23	32	14.06
W	0	0	0	0	4	0	1	1	3	2	1	5	17	9.35
WNW	0	0	0	0	0	1	2	1	3	1	3	2	13	8.97
NW	0	0	1	1	1	0	1	1	0	0	0	1	6	8.08
NNW	0	0	0	0	1	0	0	1	0	0	0	4	6	16.05
N	0	0	0	0	1	0	1	1	1	2	1	4	11	10.32
CALM													0	0.
TOTAL	0	1	4	5	17	10	19	16	22	22	24	126	261	11.54

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #B# (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	0	0	0	0	0	1	1	0	4	8.80
NE	0	0	0	0	0	0	0	1	1	0	1	3	6	10.44
ENE	0	1	0	0	0	0	1	1	0	2	1	5	11	10.04
E	0	0	0	0	0	0	0	1	0	2	0	1	4	9.43
ESE	0	0	0	1	0	1	0	0	0	0	1	2	5	9.80
SE	0	0	0	0	0	0	0	0	0	0	0	5	5	14.42
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	4	4	14.01
SSW	0	0	0	0	0	0	0	0	0	0	1	5	6	13.52
SW	0	1	1	0	0	0	0	1	1	2	1	23	30	12.62
WSW	0	0	2	1	0	0	0	1	0	1	1	10	16	10.66
W	0	0	0	0	1	0	1	0	0	0	0	3	5	10.44
WNW	0	0	0	0	0	1	0	1	1	2	2	2	9	9.61
NW	0	1	0	0	0	1	0	0	0	0	0	0	2	3.23
NNW	1	0	0	0	0	0	1	0	0	1	0	1	4	7.76
N	0	0	0	1	0	0	0	0	0	0	1	0	2	7.26
CALM													0	0.
TOTAL	1	4	4	3	1	3	3	5	3	11	12	66	119	11.08

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #C# (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	1	0	0	0	2	5.95
NE	0	0	0	0	0	0	1	1	0	1	0	1	4	9.87
ENE	0	0	0	1	0	1	0	1	0	0	1	1	5	8.04
E	0	0	0	0	0	0	0	1	0	0	0	0	1	7.50
ESE	0	0	0	0	0	0	0	0	0	1	0	0	1	6	14.88
SE	0	0	0	0	0	0	0	0	0	0	0	0	2	2	13.75
SSE	0	0	1	0	0	0	0	0	0	1	2	1	0	5	8.32
S	0	0	1	1	2	0	2	0	2	1	1	2	12	7.78
SSW	0	1	0	0	0	0	0	1	0	0	0	0	2	4.50
SW	0	0	0	0	0	0	1	1	0	0	1	0	2	5	9.22
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	1	0	0	0	0	0	1	5.60
WNW	0	0	0	0	0	1	0	0	1	0	0	3	5	10.18
NW	0	0	0	1	1	0	0	0	0	0	1	0	3	6.29
NNW	0	0	0	0	0	0	0	0	0	0	0	1	1	12.08
N	0	0	0	0	0	1	0	0	0	0	0	0	1	5.80
CALM													0	0.
TOTAL	0	1	3	3	3	3	4	4	4	3	4	17	55	9.01

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	3	0	2	1	4	1	1	5	1	13	33	9.65
NE	1	0	0	1	1	2	7	4	4	5	4	16	45	9.43
ENE	0	1	1	4	2	5	3	4	2	5	9	16	52	8.87
E	0	0	3	1	1	2	4	8	2	4	4	11	44	8.87
ESE	0	0	0	1	2	2	2	1	4	1	4	7	24	10.88
SE	0	0	1	0	2	3	2	1	2	2	1	16	30	11.33
SSE	0	0	2	1	4	2	1	1	4	1	1	19	27	11.00
S	0	1	2	1	2	0	2	0	2	2	1	23	42	11.25
SSW	0	1	1	2	0	0	0	2	2	0	4	34	48	12.00
SW	0	2	3	3	6	5	4	2	7	9	2	54	99	11.47
WSW	0	0	2	2	1	5	3	3	2	1	4	61	88	13.39
W	0	2	1	1	4	1	4	1	4	7	2	28	57	12.59
WNW	0	2	3	0	4	8	7	7	8	4	8	11	64	8.80
NW	0	1	1	5	7	5	6	2	0	2	1	4	34	6.59
NNW	1	1	0	2	2	1	3	2	2	1	1	9	25	10.34
N	0	0	0	1	2	1	3	3	1	2	2	4	21	9.19
CALM													0	0.
TOTAL	2	13	23	25	44	43	55	42	44	58	41	323	733	10.43

NUMBER OF INVALID OBSERVATIONS = 11
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-31

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: FEBRUARY 1975

PASQUILL #AA (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.30
SE	0	0	0	1	1	0	0	0	0	0	0	0	2	3.85
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	1	1	0	0	0	0	0	0	3	4.33

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 672

PASQUILL #BB (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	1	0	1	0	0	0	0	2	6.15
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	1	0	1	0	1	0	0	0	0	0	3	4.67
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	1	1	12.00
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.66
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.40
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	1	2	1	1	1	0	0	0	1	8	5.88

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 672

PASQUILL #CC (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	1	0	0	0	0	0	1	6.10
ENE	0	0	0	0	0	0	0	1	0	1	0	0	2	8.50
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	1	1	0	0	0	0	0	2	6.25
SE	0	0	0	0	1	0	0	0	1	0	0	0	2	6.25
SSE	0	0	0	0	0	3	0	0	0	0	0	0	0	0.
S	0	0	0	0	3	1	1	1	0	0	0	0	4	6.87
SSW	0	0	0	0	0	0	1	0	0	0	0	0	1	6.90
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.50
NW	0	0	0	1	1	0	0	1	1	0	0	0	4	6.72
NNW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.10
N	0	0	0	0	1	0	0	0	0	0	0	0	1	4.60
CALM													0	0.
TOTAL	0	0	0	2	4	5	4	3	2	1	0	0	19	6.17

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 672

PASQUILL #DD (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	0	1	1	1	4	9.77
NE	0	0	0	0	1	1	1	2	3	3	6	26	43	11.61
ENE	0	0	1	0	1	1	2	2	2	4	5	2	21	8.86
E	0	0	1	1	1	1	1	0	1	4	4	2	18	8.43
ESE	0	0	0	1	1	0	0	0	1	0	0	0	3	5.63
SE	0	0	0	0	0	2	0	0	1	2	0	0	5	7.84
SSE	0	0	0	1	0	0	2	0	1	1	0	2	7	8.89
S	0	2	0	0	1	1	1	2	0	1	1	3	12	8.34
SSW	0	1	1	1	1	3	1	1	1	0	0	8	19	8.82
SW	0	0	0	0	0	0	1	3	5	3	3	35	50	13.12
WSW	0	1	1	0	0	1	1	0	0	1	1	24	30	14.41
W	0	0	0	0	0	0	2	0	0	1	0	16	19	12.53
WNW	0	0	0	0	1	0	1	1	0	2	2	5	12	10.84
NW	0	0	1	0	0	0	0	1	1	1	0	0	4	6.97
NNW	0	0	0	0	1	2	1	1	1	1	0	2	9	8.58
N	0	0	0	0	0	0	0	0	0	0	1	0	1	10.80
CALM													0	0.
TOTAL	0	4	6	4	8	12	14	13	17	27	24	126	255	11.61

NUMBER OF INVALID OBSERVATIONS = 31
TOTAL NUMBER OF OBSERVATIONS = 672

PASQUILL #B (FROM AEC/DELTA-T CRITERIA 10-M) METEOR 1
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	1	2	3	7	10.57
NE	0	1	1	0	0	0	1	2	0	2	4	12	23	10.11
ENE	0	0	0	0	0	0	0	0	1	1	0	3	5	10.54
E	0	0	0	0	0	2	0	1	1	0	1	2	5	9.82
ESE	0	0	0	0	0	0	1	1	0	0	1	2	5	9.14
SE	0	0	0	0	0	0	1	0	0	0	2	2	5	11.93
SSE	0	0	0	0	0	1	0	0	0	2	2	16	21	15.75
S	0	0	0	0	0	0	0	2	2	4	2	6	16	13.69
SSW	0	0	0	0	0	0	0	2	3	1	0	12	20	12.66
SW	0	1	1	0	0	0	0	2	4	3	3	36	44	12.73
WSW	0	0	0	0	0	0	1	0	2	4	1	14	23	13.33
W	0	0	0	0	0	0	1	1	0	1	2	0	4	9 10.43
WNW	0	0	0	0	0	0	0	0	0	0	1	0	1	2 10.75
NW	0	0	0	0	0	1	0	0	0	0	1	0	1	3 8.67
NNW	0	0	0	0	0	1	0	0	0	0	0	2	3	6 14.67
N	0	0	0	0	0	0	0	0	0	0	1	3	4	9 11.72
CALM														0 0.
TOTAL	0	2	2	0	2	5	10	6	13	24	23	119	206	12.73

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL #C (FROM AEC/DELTA-T CRITERIA 10-M) METEOR 1
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	1	0	0	2	7.50
NE	0	0	0	0	0	0	1	1	0	1	1	3	6	10.14
ENE	0	0	0	0	0	0	0	0	0	1	0	5	6	11.84
E	0	0	0	0	0	0	-	0	0	0	1	3	4	11.94
ESE	0	0	0	0	0	0	0	0	1	1	1	0	14	17 14.68
SE	0	0	0	0	0	0	0	1	0	0	0	5	6	12.50
SSE	0	0	0	0	0	1	0	0	0	1	0	4	6	12.50
S	0	0	0	0	0	0	0	1	0	0	1	4	6	17.92
SSW	0	0	0	0	0	0	0	1	1	0	0	1	3	8.33
SW	0	0	0	0	0	0	0	0	0	0	1	4	7	12.71
WSW	0	0	0	0	0	0	0	1	0	2	1	1	10	10.75
W	0	0	0	0	0	0	0	0	0	0	0	3	3	14.17
WNW	0	0	0	0	0	1	0	0	0	0	1	2	4	10.63
NW	0	0	0	0	0	1	0	0	1	1	1	1	5	8.47
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	1	0	0	0	0	0	1	4.75
CALM													2	2.
TOTAL	0	0	0	0	2	3	4	4	4	7	10	44	68	11.75

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL #D (FROM AEC/DELTA-T CRITERIA 10-M) METEOR 1
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	2	2	0	1	3	4	13	9.21
NE	0	2	1	0	1	1	4	5	4	6	12	41	77	10.97
ENE	0	0	1	1	1	3	2	5	3	6	5	12	41	9.43
E	0	0	1	1	2	3	2	1	3	5	10	11	39	9.42
ESE	0	1	0	1	1	3	3	1	3	2	1	16	36	11.56
SE	1	0	2	1	1	2	3	0	2	4	2	10	30	9.23
SSE	0	0	0	2	2	1	2	0	2	3	3	28	43	13.27
S	0	2	1	0	2	3	2	5	2	5	4	15	41	9.91
SSW	0	1	1	1	1	3	4	4	4	2	0	22	45	10.60
SW	0	1	1	0	1	0	1	5	9	6	4	36	108	12.84
WSW	0	1	1	0	0	1	1	1	4	5	3	48	67	13.45
W	0	0	0	0	0	0	1	3	0	1	3	0	23	31 12.87
WNW	0	0	0	0	2	2	0	1	1	0	4	3	9	22 10.86
NW	0	0	1	1	1	0	0	3	1	5	2	2	20	9.14
NNW	0	0	0	0	0	2	3	2	2	1	2	2	5	19 9.63
N	0	0	0	0	0	1	0	0	1	0	1	4	4	10 10.97
CALM														2 .50
TOTAL	1	8	11	10	22	24	36	33	40	46	62	128	441	11.17

NUMBER OF INVALID OBSERVATIONS = 31
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL #E (FROM AEC/DELTA-T CRITERIA 10-M) METEOR 1
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	6	0	0	0	0	0	0	0	0	0	0	6	0.
NE	0	1	0	0	0	0	0	0	0	0	1	0	2	6.50
ENE	0	0	0	1	0	1	0	1	0	0	0	2	5	9.74
E	0	0	0	0	0	1	2	0	0	1	0	2	5	9.40
ESE	0	1	0	0	0	0	0	0	0	1	1	2	5	11.74
SE	1	0	1	0	0	0	0	0	0	0	0	1	3	5 8.42
SSE	0	0	0	1	0	0	0	0	0	0	0	0	2	5 8.74
S	0	0	0	1	0	0	0	0	0	0	0	1	2	9.75
SSW	0	0	0	0	0	0	1	0	0	0	0	1	2	11.75
SW	0	0	0	0	0	0	0	0	0	0	1	5	6	13.27
WSW	0	0	0	0	0	0	0	1	0	0	0	3	4	13.97
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	1	0	1	2	10.50
NW	0	0	0	0	0	0	0	0	0	0	1	1	2	12.15
NNW	0	0	0	0	0	0	0	1	0	1	0	0	2	8.80
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	1	9	2	2	0	2	3	3	0	3	4	19	48	10.48

NUMBER OF INVALID OBSERVATIONS = 8
TOTAL NUMBER OF OBSERVATIONS = 472

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METEOR 1
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	2	2	0	1	3	4	13	9.21
NE	0	2	1	0	1	1	4	5	4	6	12	41	77	10.97
ENE	0	0	1	1	1	3	2	5	3	6	5	12	41	9.43
E	0	0	1	1	2	3	2	1	3	5	10	11	39	9.42
ESE	0	1	0	1	1	3	3	1	3	2	1	16	36	11.56
SE	1	0	2	1	1	2	3	0	2	4	2	10	30	9.23
SSE	0	0	0	2	2	1	2	0	2	3	3	28	43	13.27
S	0	2	1	0	2	3	2	5	2	5	4	15	41	9.91
SSW	0	1	1	1	1	3	4	4	4	2	0	22	45	10.60
SW	0	1	1	0	1	0	1	5	9	6	4	36	108	12.84
WSW	0	1	1	0	0	1	1	1	4	5	3	48	67	13.45
W	0	0	0	0	0	0	1	3	0	1	3	0	23	31 12.87
WNW	0	0	0	0	2	2	0	1	1	0	4	3	9	22 10.86
NW	0	0	1	1	1	0	0	3	1	5	2	2	20	9.14
NNW	0	0	0	0	0	2	3	2	2	1	2	2	5	19 9.63
N	0	0	0	0	0	1	0	0	1	0	1	4	4	10 10.97
CALM														2 .50
TOTAL	1	8	11	10	22	24	36	33	40	46	62	128	441	11.17

NUMBER OF INVALID OBSERVATIONS = 31
TOTAL NUMBER OF OBSERVATIONS = 472

TABLE 2.3-32

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: MARCH 1975

PASQUILL WDR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	1	0	0	0	1	10.20
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	1	0	0	0	0	0	0	0	0	1	1.60
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.30
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	1	0	0	0	0	0	0	0	0	2	5.77

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WDR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.30
NE	0	0	0	0	0	0	1	0	0	0	1	0	2	11.65
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	1	0	0	0	1	9.70
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	1	0	0	0	0	0	0	0	1	6.50
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	1	1	19.60
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	1	0	1	1	1	0	1	1	4	4.72

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WDR (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	1	1	1	0	0	0	4	7.35
NE	0	0	0	0	0	0	0	0	1	1	0	2	4	10.20
ENE	0	0	0	0	0	0	0	0	0	1	2	1	4	9.77
E	0	0	0	0	0	0	0	1	0	1	0	0	2	8.70
ESE	0	0	0	0	0	0	1	0	1	0	0	0	2	8.55
SE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.70
SSE	0	0	1	0	0	1	0	0	0	0	0	0	2	4.80
S	0	0	0	0	0	0	0	2	0	0	0	0	2	7.25
SSW	0	0	0	0	0	0	0	0	0	1	0	0	1	9.20
SW	0	0	1	0	0	0	0	0	0	0	0	0	1	2.50
WSW	0	0	0	0	1	1	0	0	0	0	0	0	2	5.85
W	0	0	0	1	0	1	0	0	0	0	0	0	2	6.45
WNW	0	0	0	0	1	0	0	0	0	0	0	1	2	9.30
NW	0	0	0	1	1	0	0	0	0	0	0	5	7	11.60
NNW	0	0	0	0	0	1	0	1	0	0	0	0	2	6.40
N	0	0	0	0	0	0	0	0	1	0	0	0	1	8.80
CALM													0	0.
TOTAL	0	0	2	2	4	5	2	5	4	4	3	9	70	8.22

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WDR (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	0	3	0	0	0	2	2	1	1	10	7.34
NE	1	0	0	1	1	0	0	1	2	2	4	1	13	8.22
ENE	0	0	0	0	1	1	0	1	2	8	3	11	27	10.67
E	0	0	0	0	3	0	2	1	3	0	1	5	15	9.35
ESE	0	0	0	0	2	3	1	0	0	1	5	3	15	9.84
SE	0	0	0	0	0	0	0	2	0	0	0	2	4	10.87
SSE	0	0	0	0	0	0	1	0	0	1	2	4	4	12.87
S	0	0	0	0	1	0	1	1	0	1	3	2	8	17	12.35
SSW	0	0	0	0	0	1	3	4	2	1	4	24	39	17.78
SW	0	0	0	0	1	1	0	1	0	1	3	19	26	15.22
WSW	0	0	0	0	1	0	0	2	0	1	2	31	37	16.68
W	0	0	0	0	1	0	1	2	1	0	1	32	39	19.48
WNW	0	0	1	0	0	0	0	0	1	0	3	13	18	17.53
NW	0	0	0	0	0	1	0	1	0	0	2	15	19	13.08
NNW	0	1	1	2	0	2	0	4	1	0	0	7	18	10.58
N	0	0	1	0	3	1	2	1	3	4	1	4	20	8.77
CALM													0	0.
TOTAL	1	2	3	5	15	12	11	20	19	23	29	178	319	13.87

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-32 (Continued)

PASQUILL WEEK (FROM DEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	1	0	1	2	1	6	9.67
NE	0	0	0	0	1	1	4	1	0	0	1	4	14	8.61
ENE	0	0	0	0	0	2	2	1	0	0	0	0	5	10	9.58
E	0	0	0	0	0	0	1	1	0	1	1	10	14	12.42
ESE	0	0	0	0	0	1	1	1	1	2	2	7	17	10.84
SE	0	0	0	0	0	0	0	0	0	0	0	8	8	15.07
SSE	0	0	0	0	0	1	1	0	1	0	1	6	11	14.64
S	0	0	0	0	0	0	1	1	1	0	1	2	27	33	14.64
SSW	0	0	0	1	0	0	0	1	1	1	0	2	26	32	13.17
SW	0	0	0	0	1	0	0	0	0	0	0	1	11	13	13.62
WSW	0	0	0	0	1	0	0	1	0	1	0	2	10	15	12.98
W	0	0	0	0	0	1	0	1	1	1	0	0	21	25	13.41
WNW	0	0	0	0	0	0	0	1	0	0	0	0	8	9	13.06
NW	0	0	0	1	0	0	0	0	1	0	0	4	16	22	12.74
NNW	0	0	0	0	0	0	0	1	0	2	2	1	9	15	12.71
N	0	0	0	0	0	0	2	2	1	0	1	3	6	15	9.34
CALM													0	0.
TOTAL	0	0	1	3	4	9	15	11	11	12	23	172	243	12.55

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEEK (FROM DEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	0	1	0	0	2	4.00
NE	0	0	0	0	0	0	0	0	0	0	1	1	2	11.75
ENE	0	0	0	0	0	0	0	0	1	1	2	3	7	11.43
E	0	0	0	1	0	0	0	0	0	0	2	8	11	13.35
ESE	0	0	0	0	0	0	0	0	0	0	0	3	3	13.00
SE	0	0	0	0	0	1	0	0	0	0	0	3	4	14.75
SSE	0	0	0	0	0	1	0	0	0	0	0	3	4	14.25
S	0	0	0	0	0	0	0	0	0	0	0	5	5	16.20
SSW	0	0	0	0	0	0	0	0	0	0	1	2	3	15.33
SW	0	0	0	0	0	0	1	0	0	0	0	1	2	12.50
WSW	0	0	0	0	0	0	1	0	0	0	0	1	2	12.50
W	0	0	0	0	0	0	0	0	0	1	0	0	1	12.20
WNW	0	0	0	0	0	0	1	1	0	0	0	2	4	14.00
NW	0	0	0	0	0	0	0	0	0	0	0	1	1	11.67
NNW	0	0	0	0	0	0	0	1	1	0	1	0	3	12.00
N	0	0	0	0	0	0	0	1	0	0	0	1	2	9.00
CALM													0	0.
TOTAL	0	0	1	1	1	2	2	2	2	4	5	43	74	12.74

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEEK (FROM DEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	1	1	15.20
E	0	1	0	0	0	0	0	0	1	0	1	1	4	8.95
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	1	1	4.00
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	5	5	13.84
SSW	0	0	3	0	0	0	0	0	0	1	0	1	5	5.60
SW	0	0	0	1	0	0	0	0	0	0	0	1	2	7.85
WSW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.80
W	0	1	0	1	0	0	0	1	0	0	1	1	5	7.24
WNW	0	0	0	0	0	1	0	0	1	0	1	1	4	8.95
NW	0	0	0	0	0	0	0	0	1	1	0	1	3	9.97
NNW	0	0	0	1	0	2	0	0	0	0	0	0	3	5.07
N	0	0	0	1	0	1	0	0	0	0	0	0	2	6.55
CALM													0	0.
TOTAL	0	2	3	4	2	4	0	2	2	3	2	12	36	8.38

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM DEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	3	1	2	3	3	4	3	2	23	7.80
NE	1	0	0	1	2	1	5	2	3	3	4	8	30	8.93
ENE	0	0	0	0	1	3	2	2	4	11	4	20	49	10.55
E	0	1	0	2	3	0	3	3	4	2	5	24	47	10.47
ESE	0	0	0	0	3	4	3	1	3	4	2	13	33	9.48
SE	0	0	0	0	2	0	0	2	0	0	0	12	16	13.40
SSE	0	0	1	0	2	3	1	1	0	1	1	21	31	13.48
S	0	0	0	1	0	2	2	3	1	4	4	45	62	14.04
SSW	0	0	3	1	2	1	3	5	3	4	6	47	75	12.67
SW	0	0	1	2	1	1	1	1	0	3	5	42	57	13.63
WSW	0	0	1	1	2	2	1	2	1	2	4	42	58	14.64
W	0	1	0	3	1	2	2	4	3	0	2	60	78	15.87
WNW	0	0	1	0	3	2	0	1	1	1	3	25	37	12.54
NW	0	0	1	1	1	1	0	2	5	1	4	39	55	12.61
NNW	0	1	1	3	0	5	2	4	3	3	1	14	41	10.66
N	0	0	1	1	3	4	4	3	4	7	4	8	39	9.73
CALM													0	0.
TOTAL	1	4	11	16	29	32	31	41	38	50	51	424	738	12.31

NUMBER OF INVALID OBSERVATIONS = 6
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-33

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: APRIL 1975

PASQUILL WKR (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.45
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	1	0	0	0	0	1	8.45
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	1	1	0	0	0	2	8.45
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	2	0	0	0	1	0	0	1	8.45
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	1	0	0	0	0	0	1	8.45
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	1	0	0	0	0	0	0	1	8.45
NNW	0	0	0	0	0	0	0	0	0	0	0	1	1	11.30
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	1	2	1	2	0	0	2	11	9.63

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WKR (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	1	1	14.10
ENE	0	0	0	0	0	0	1	1	0	0	0	0	2	8.17
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	1	0	1	0	0	0	1	3	9.40
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	15.10
SW	0	0	0	1	0	1	0	1	0	0	0	0	3	9.33
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	1	0	0	0	0	0	1	2	9.40
WNW	0	0	0	0	0	0	1	0	0	0	0	0	1	9.30
NW	0	0	0	0	0	0	0	0	0	0	1	2	3	14.33
NNW	0	0	0	0	0	0	0	0	0	0	1	0	1	14.60
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	0	4	2	2	0	1	2	6	20	10.76

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WKR (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WKR (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	0	0	0	1	0	0	0	2	9.40
NE	0	0	0	0	0	0	0	0	0	1	0	3	4	15.47
ENE	0	0	0	0	0	1	0	0	2	1	2	4	10	10.71
E	0	0	0	1	1	1	0	0	1	1	0	1	8	8.77
ESE	0	0	0	0	0	2	3	0	0	0	0	1	6	6.98
SE	0	0	0	0	1	2	3	0	1	0	1	1	9	8.38
SSE	0	0	0	0	3	1	1	3	0	1	0	0	15	6.26
S	0	1	0	0	3	1	1	0	1	0	1	1	9	10.05
SSW	0	0	0	0	1	1	1	0	0	1	0	3	17	24	13.82
SW	0	1	0	0	0	2	3	2	3	0	1	4	29	14	14.33
WSW	0	0	0	1	2	3	1	0	1	1	2	3	11	25	10.76
W	0	0	0	0	0	1	0	3	1	5	2	0	7	19	11.77
WNW	0	0	0	0	1	1	1	1	1	2	1	2	7	17	12.24
NW	0	0	0	0	0	1	2	2	1	4	1	1	8	20	11.43
NNW	0	0	0	1	1	0	1	0	2	0	3	3	11	22	11.50
N	0	0	0	0	0	0	0	0	1	1	0	1	2	5	10.46
CALM													0	0.
TOTAL	0	2	1	3	13	14	18	14	12	20	15	23	115	249	11.47

NUMBER OF INVALID OBSERVATIONS = 7
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-33 (Continued)

PASQUILL WIND (FROM AEC/DELTA-T CRITERIA [DAY] METERS)
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WIND (FROM AEC/DELTA-T CRITERIA [DAY] METERS)
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WIND (FROM SEC/DELTA-T CRITERIA [DAY] METERS)
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA [DAY] METERS)
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	1	0	0	1	2	0	1	12	18	19.34
NE	0	1	0	0	2	0	0	1	2	3	1	11	21	19.44
ENE	0	0	0	1	0	1	3	1	4	1	4	4	29	9.09
E	0	0	1	2	2	1	2	1	3	4	1	4	21	9.24
ESE	0	1	0	1	0	2	4	1	0	2	4	6	21	9.64
SE	0	0	1	1	4	3	2	2	1	0	2	6	24	8.79
SSE	0	0	0	0	4	3	4	4	2	3	2	23	48	10.88
S	0	1	1	4	3	5	3	8	5	2	1	39	72	11.44
SSW	0	0	0	1	4	3	4	5	5	0	4	67	98	13.01
SW	0	1	0	1	3	6	5	5	4	5	6	52	90	12.41
WSW	0	0	2	2	3	1	2	4	2	3	3	21	43	11.46
W	0	0	0	0	1	1	7	1	5	2	0	20	38	11.31
WNW	0	1	0	1	1	2	3	2	2	0	3	11	29	11.14
NW	0	0	0	0	1	2	2	4	6	7	5	41	73	13.19
NNW	0	0	2	1	0	2	1	3	3	0	3	35	63	12.44
N	0	0	1	0	2	0	0	1	4	1	4	13	26	10.54
CALM													0	0.
TOTAL	0	5	9	19	32	36	42	48	50	40	47	365	708	11.46

NUMBER OF INVALID OBSERVATIONS = 12
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-34

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: MAY 1975

PASQUILL A&B (FROM ΔEC/ΔELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	1	1	0	0	0	0	0	0	2	4,50
NE	0	0	1	0	0	1	3	1	0	2	0	0	0	8	6,88
ENE	0	0	0	0	0	0	0	1	1	0	0	0	0	2	7,50
E	0	0	0	0	0	1	1	0	1	1	0	0	0	4	8,37
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SE	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3,00
SSE	0	0	0	0	0	1	0	0	0	0	0	0	1	1	9,00
S	0	0	0	0	0	0	0	0	1	0	1	0	0	2	9,50
SSW	0	0	0	0	1	1	0	0	1	2	1	0	0	6	8,17
SW	0	0	0	0	1	0	2	1	0	0	0	0	0	4	6,50
WSW	0	0	0	0	0	1	0	0	0	0	0	0	0	1	5,00
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
WNW	0	0	0	0	0	1	1	0	0	0	0	0	0	2	5,50
NW	0	0	0	0	2	0	0	0	0	0	0	0	0	2	4,00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
N	0	0	0	0	0	0	1	0	0	0	0	0	0	1	5,75
CALM													0	0,	
TOTAL	0	0	2	6	7	7	9	5	4	3	2	4	63	6,75	

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL A&B (FROM ΔEC/ΔELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	0	0	0	1	4,00
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
ENE	0	0	0	0	0	0	1	0	0	0	0	0	1	4,50
E	0	0	0	0	1	0	0	0	0	0	0	0	1	4,00
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SE	0	0	0	1	0	0	0	0	0	0	0	0	1	3,00
SSE	0	0	0	0	0	0	0	1	0	0	0	0	1	8,00
S	0	0	0	0	0	0	0	0	0	0	0	1	1	12,00
SSW	0	0	0	0	0	0	0	0	1	0	0	1	2	9,75
SW	0	0	0	0	1	0	0	1	1	0	0	0	3	5,33
WSW	0	0	0	0	0	0	0	1	0	0	0	0	1	7,00
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
WNW	0	0	0	0	0	0	1	0	0	0	0	0	1	6,00
NW	0	0	0	0	0	1	0	1	0	0	0	0	2	6,50
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
CALM													0	0,	
TOTAL	0	0	0	1	2	1	2	3	2	0	0	2	13	7,23

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL A&B (FROM ΔEC/ΔELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	1	0	0	0	0	0	2	5,75
NE	0	0	2	0	0	0	0	0	0	0	0	0	2	2,00
ENE	0	0	0	0	1	0	0	0	0	0	1	2	4	9,75
E	0	0	0	1	1	0	1	0	0	0	0	0	3	5,00
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SE	0	0	0	0	1	0	0	0	1	0	0	1	3	9,25
SSE	0	0	0	0	0	2	0	0	1	0	0	2	4	9,00
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SSW	0	0	0	0	1	1	0	0	2	0	1	1	7	7,14
SW	0	0	0	1	0	1	1	0	2	0	1	0	6	6,25
WSW	0	0	0	1	1	0	3	3	1	1	1	0	11	7,36
W	0	0	0	0	1	1	2	0	1	0	0	0	5	5,50
WNW	0	0	0	0	0	0	0	0	2	0	0	0	2	8,75
NW	0	0	0	2	0	0	0	0	0	0	0	0	2	3,80
NNW	0	0	1	0	1	0	0	0	0	0	0	0	2	4,75
N	0	0	0	1	1	0	0	0	0	0	0	0	2	4,25
CALM													0	0,	
TOTAL	0	0	3	5	12	6	8	3	6	3	3	6	57	6,89

NUMBER OF INVALID OBSERVATIONS = 6
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL A&B (FROM ΔEC/ΔELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	2	1	0	4	0	0	0	0	1	11	5,45
NE	0	0	1	3	2	3	1	1	4	3	1	2	21	7,17
ENE	0	0	0	2	1	1	4	1	3	2	2	2	18	7,78
E	0	0	2	1	1	3	4	2	1	2	2	2	20	7,33
ESE	0	0	2	0	3	2	2	0	0	0	1	0	10	5,53
SE	0	0	0	1	2	2	0	1	2	3	2	4	21	9,42
SSE	0	0	0	1	0	3	3	1	1	0	5	13	27	11,26
S	0	0	0	0	2	1	1	4	3	0	1	3	15	9,35
SSW	0	0	0	1	2	3	1	0	2	1	1	2	13	7,79
SW	0	0	0	1	0	1	5	1	0	3	3	3	17	9,44
WSW	0	1	1	0	3	1	3	4	2	1	0	3	25	7,02
W	0	1	0	3	4	2	2	1	1	1	2	7	24	8,73
WNW	0	0	0	1	1	1	1	1	1	2	1	1	10	7,70
NW	0	0	0	1	1	0	1	1	3	0	2	1	10	9,13
NNW	0	0	0	1	0	3	0	1	0	1	0	0	6	6,27
N	0	0	1	1	1	1	1	0	0	1	0	1	7	6,50
CALM													1	,50	
TOTAL	0	2	8	19	26	27	33	25	25	20	29	49	264	8,14

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-34 (Continued)

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-A) METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	1	2	2	0	1	0	1	2	11	7.91
NE	0	1	5	2	0	0	2	1	1	2	0	0	9	6.33
ENE	0	0	0	1	0	0	0	0	0	0	0	1	1	7.88
E	0	0	0	0	1	2	1	2	2	4	1	7	20	10.64
ESE	0	0	0	1	1	0	1	0	0	3	2	5	13	10.35
SE	0	2	1	0	1	1	0	1	1	1	5	11	24	9.75
SSE	0	0	0	1	1	1	1	2	1	1	1	5	17	10.42
S	0	0	0	0	1	0	0	3	2	2	2	9	19	11.47
SSW	0	0	0	0	0	0	0	2	1	2	1	10	16	11.92
SW	0	1	0	0	1	1	2	1	1	3	2	9	21	9.80
WSW	0	0	0	0	1	0	1	0	1	1	0	1	5	11.20
W	0	0	0	0	0	1	0	2	0	3	0	1	7	8.97
WNW	0	0	1	1	1	0	0	1	2	2	0	1	9	7.24
NW	0	1	0	0	0	0	0	1	2	0	1	0	5	7.44
NNW	0	0	0	0	0	2	0	1	0	1	0	0	4	7.10
N	0	0	1	0	1	1	2	0	0	0	0	0	5	5.17
CALM													1	.70
TOTAL	0	4	9	6	9	11	12	21		29	16	85	194	9.51

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F# (FROM AEC/DELTA-T CRITERIA 10-A) METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	0	0	0	0	1	8.50
NE	0	0	1	1	0	1	0	0	5	1	0	0	9	10.61
ENE	0	1	0	0	0	0	0	0	1	1	0	3	6	9.47
E	0	1	1	0	1	0	0	0	0	0	0	0	3	2.20
ESE	0	0	0	1	0	0	0	0	0	0	0	0	1	12.11
SE	0	0	0	0	0	1	0	0	0	0	0	0	1	13.44
SSE	0	0	0	0	1	0	0	1	1	0	0	0	3	11.74
S	0	0	2	0	0	0	0	0	2	0	0	0	4	11.00
SSW	0	0	0	1	0	3	0	0	2	2	1	4	13	10.49
SW	0	1	0	0	2	1	0	0	1	1	1	2	9	9.91
WSW	1	0	0	0	1	1	0	0	1	1	0	0	5	9.20
W	0	0	0	1	0	1	2	0	1	1	0	1	7	7.14
WNW	0	0	0	0	0	0	0	1	0	0	0	1	2	7.10
NW	0	0	0	0	1	0	0	0	0	1	0	2	4	10.35
NNW	0	0	0	1	1	1	0	1	0	1	0	0	5	6.14
N	0	0	0	1	0	0	0	0	2	1	0	0	4	7.45
CALM													0	0.
TOTAL	1	3	4	6	7	9	2	4	9	13	2	13	110	9.74

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-A) METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	1	2	0	0	0	4	6.65
NE	0	0	0	0	0	0	1	0	0	0	0	1	2	9.20
ENE	0	0	1	0	0	0	0	0	0	0	0	0	1	7.30
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	1	0	0	0	0	0	0	0	0	1	2	7.60
SSE	0	0	0	0	0	0	0	0	0	0	0	1	1	17.50
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	1	0	0	0	0	0	1	0	0	0	2	5.30
SW	0	0	0	0	0	0	1	0	0	0	1	1	4	9.25
WSW	0	0	0	0	0	0	0	0	1	2	0	1	4	10.18
W	0	0	0	0	0	0	0	0	2	0	4	2	8	10.11
WNW	0	0	0	0	0	0	0	0	0	0	0	1	1	11.75
NW	0	1	0	0	0	0	0	0	1	0	1	1	4	8.55
NNW	0	0	0	1	0	0	0	0	2	0	1	3	7	10.49
N	0	0	0	0	1	0	0	0	0	0	0	0	1	4.20
CALM													2	.50
TOTAL	0	1	3	1	1	2	3	6	4	6	7	17	53	8.87

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-A) METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	2	5	5	9	3	1	0	1	3	32	6.56
NE	0	1	5	5	2	5	7	3	7	4	1	8	53	7.65
ENE	0	1	1	3	2	1	6	7	5	5	3	8	43	8.16
E	0	1	3	2	5	6	6	5	4	5	3	9	51	8.17
ESE	0	0	2	2	4	2	3	0	0	3	3	10	29	9.10
SE	0	2	3	2	5	4	0	3	4	4	7	30	65	9.84
SSE	0	0	1	2	4	4	5	4	5	1	5	33	65	10.79
S	0	0	2	2	2	3	1	6	7	5	3	21	57	9.65
SSW	0	0	1	4	4	4	1	12	6	6	4	20	64	9.76
SW	0	2	1	3	4	9	9	5	2	9	7	15	66	8.24
WSW	1	1	1	1	7	2	8	10	5	4	9	14	63	8.49
W	0	1	0	5	5	6	4	6	2	9	4	12	54	8.55
WNW	0	0	1	4	3	3	1	3	5	4	1	3	28	7.18
NW	0	2	0	5	2	1	1	3	6	1	4	4	29	7.40
NNW	0	0	0	3	3	6	0	3	2	3	1	3	24	7.69
N	0	0	2	3	4	3	3	0	2	2	0	1	20	5.08
CALM													4	.55
TOTAL	1	12	25	49	63	64	66	75	63	71	57	194	742	8.57

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-35

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: JUNE 1975

PASQUILL #A# (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	1	0	1	0	3	8,33
NE	0	0	0	1	0	0	0	1	0	0	4	12	18	11,74
ENE	0	0	0	0	0	0	1	1	0	1	0	6	9	12,67
E	0	0	0	0	0	0	1	1	1	0	0	0	3	6,67
ESE	0	0	0	0	0	0	0	0	0	0	2	0	2	11,17
SE	0	0	0	0	0	0	1	0	0	1	1	0	3	9,29
SSE	0	0	0	0	0	0	0	0	0	0	0	0	1	6,60
S	0	0	0	0	0	0	0	0	0	0	0	1	1	14,50
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	15,00
SW	0	0	1	0	0	3	2	0	0	0	0	0	6	5,38
WSW	0	0	0	0	1	0	1	2	0	0	0	0	4	6,67
W	0	0	0	0	1	2	2	0	0	0	0	0	5	5,80
WNW	0	0	0	0	0	0	1	1	0	0	0	0	2	7,00
NW	0	0	0	0	1	0	0	0	1	0	0	0	2	6,15
NNW	0	0	0	0	0	0	0	0	1	0	0	0	1	7,40
N	0	0	0	0	0	0	1	0	0	0	0	0	1	5,75
CALM													0	0,
TOTAL	0	0	1	1	3	4	9	6	3	4	8	22	66	9,45

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #B# (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	0	2	0	0	3	8,91
NE	0	0	0	0	0	1	0	0	0	2	0	0	3	8,50
ENE	0	0	0	0	0	0	0	1	1	0	1	3	6	11,42
E	0	0	0	0	0	0	1	0	0	1	0	0	2	8,85
ESE	0	0	0	0	0	0	0	0	1	0	2	1	4	11,77
SE	0	0	0	0	0	0	0	0	0	0	0	1	1	12,00
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	14,10
SW	0	0	0	0	1	0	1	0	0	1	0	0	3	8,83
WSW	0	0	0	1	2	0	1	0	0	0	0	0	4	6,97
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
NW	0	0	0	0	0	0	0	0	1	0	0	0	1	8,40
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
CALM													0	0,
TOTAL	0	0	0	1	3	1	3	2	4	5	3	6	30	9,54

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #C# (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	1	0	0	0	0	1	8,00
NE	0	0	0	0	2	0	1	0	0	1	1	0	5	7,18
ENE	0	0	0	0	0	1	0	0	0	0	0	3	4	13,42
E	0	0	0	0	0	0	0	1	0	1	5	4	11	10,83
ESE	0	0	0	0	0	0	0	0	0	0	1	1	2	10,65
SE	0	0	0	0	0	0	0	0	0	1	0	1	2	10,65
SSE	0	0	0	0	0	0	1	1	0	0	0	0	2	7,30
S	0	0	0	0	0	0	1	0	1	0	0	0	1	8,70
SSW	0	0	0	0	0	0	1	0	0	2	0	0	3	7,33
SW	0	0	0	0	0	1	2	2	0	0	0	0	5	5,64
WSW	0	0	1	0	0	4	2	2	0	1	0	3	13	8,32
W	0	0	0	0	0	2	2	2	0	0	0	0	6	6,50
WNW	0	0	0	0	0	0	1	0	0	0	0	0	1	6,70
NW	0	0	0	1	3	1	0	1	0	0	0	0	5	5,18
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0,
N	0	0	0	0	0	0	1	2	0	0	0	1	4	8,50
CALM													0	0,
TOTAL	0	0	1	1	5	12	10	11	2	5	7	18	72	8,74

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #D# (FROM SEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	1	0	1	1	0	0	4	7,63
NE	0	0	0	0	0	1	4	2	3	3	1	5	19	10,00
ENE	0	0	1	0	0	3	0	6	6	7	1	0	32	9,09
E	0	0	0	0	0	1	3	2	2	2	2	2	14	8,64
ESE	0	0	0	0	0	0	0	0	3	1	5	7	16	11,88
SE	0	0	0	0	0	0	1	1	0	1	1	0	4	10	11,72
SSE	0	0	0	0	0	0	0	1	0	1	2	1	4	9	11,47
S	0	0	0	0	0	0	0	1	2	2	0	1	3	9	10,56
SSW	0	0	0	0	0	0	3	0	1	0	2	2	5	13	11,15
SW	0	0	0	0	0	0	1	1	1	2	3	3	9	20	11,21
WSW	0	0	0	0	0	1	5	2	3	6	4	3	12	34	10,14
W	0	0	0	0	0	0	2	0	1	6	1	3	3	16	9,56
WNW	0	0	0	0	0	1	1	2	1	1	0	1	4	11	9,19
NW	0	0	0	0	0	1	1	2	2	3	1	0	2	12	8,27
NNW	0	0	0	0	1	1	3	0	3	1	2	0	1	12	7,29
N	0	0	0	0	1	1	2	0	1	2	0	0	2	9	7,82
CALM													0	0,
TOTAL	0	0	1	2	5	25	18	25	40	30	23	73	242	9,89

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-35 (Continued)

PASQUILL B&R (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	1	0	1	0	2	4	8.75
NE	0	0	1	1	0	0	1	1	2	1	3	1	11	8.39
ENE	0	0	0	1	1	1	1	4	4	4	1	10	27	9.99
E	0	0	2	0	1	0	1	2	1	3	2	7	19	9.67
ESE	0	0	0	0	0	0	1	1	0	2	2	2	8	10.34
SE	0	0	0	0	0	1	0	0	1	2	0	4	8	10.58
SSE	0	0	0	0	0	0	1	0	1	2	2	4	10	10.81
S	0	0	0	0	0	0	0	1	1	1	1	5	9	11.79
SSW	0	0	0	1	0	0	1	2	4	1	2	7	18	9.96
SW	0	0	0	0	0	1	1	0	1	2	3	4	12	9.77
WSW	0	0	0	0	0	0	0	0	1	1	0	2	4	11.50
W	0	0	0	0	0	0	0	2	2	3	1	1	9	11.42
WNW	0	0	1	0	0	0	0	3	1	0	1	1	7	8.84
NW	0	0	0	0	0	0	0	3	1	0	1	1	6	8.85
NNW	0	0	1	0	0	0	0	2	2	0	1	1	7	7.91
N	0	0	0	1	0	0	0	2	0	2	0	1	6	7.42
CALM													1	.79
TOTAL	0	0	5	4	4	3	12	21	24	34	20	60	179	9.67

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL C&D (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	1	1	1	0	0	0	0	0	0	3	4.71
ENE	0	0	0	0	0	2	0	0	1	2	0	0	5	7.44
E	0	0	0	0	0	1	0	0	1	1	1	3	7	10.70
ESE	0	0	0	0	0	0	1	0	0	0	0	4	5	11.40
SE	0	0	0	0	0	1	0	0	1	1	2	2	7	10.71
SSE	0	0	0	0	0	0	1	0	0	2	0	1	4	10.47
S	0	0	0	0	0	0	0	0	0	0	0	1	1	16.10
SSW	0	0	0	0	0	0	0	0	2	0	0	4	6	11.82
SW	0	0	0	0	0	1	2	0	0	2	0	9	14	12.54
WSW	0	0	0	0	0	1	0	0	0	1	0	2	4	10.30
W	0	0	0	0	1	0	0	0	1	1	0	2	4	9.77
WNW	0	0	0	0	0	0	0	2	0	0	0	1	3	9.10
NW	0	0	0	0	1	1	1	1	4	1	1	1	11	8.45
NNW	0	0	1	0	0	0	0	2	0	0	0	1	4	7.30
N	0	0	0	0	0	0	1	0	0	0	0	0	1	4.40
CALM													0	0.
TOTAL	0	0	1	1	4	9	4	3	14	10	4	31	81	9.93

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL E&W (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	1	1	0	0	3	7.49
NE	0	0	0	0	0	0	0	2	1	0	0	2	5	10.38
ENE	0	0	0	0	0	0	0	0	0	0	0	1	1	12.10
E	0	0	0	0	0	0	0	0	2	1	0	1	4	10.88
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	1	0	0	1	0	0	0	2	6.15
SSE	0	0	0	0	0	0	0	0	0	1	0	1	2	11.30
S	0	0	0	0	0	0	1	0	0	0	0	3	4	10.99
SSW	0	0	0	0	0	0	0	0	0	0	0	2	2	14.85
SW	0	0	0	0	0	0	0	0	0	1	1	4	6	12.15
WSW	0	0	0	0	0	1	0	0	0	0	0	2	3	10.48
W	0	0	1	1	0	0	0	0	0	0	1	2	5	10.48
WNW	0	0	0	0	0	0	0	1	0	0	0	0	2	2.88
NW	0	0	0	0	1	1	1	0	1	0	0	1	4	9.47
NNW	0	0	1	0	0	1	0	0	1	0	0	1	4	8.75
N	0	0	0	0	1	1	0	0	1	0	0	0	3	6.33
CALM													6	0.
TOTAL	0	0	2	2	4	5	2	4	7	4	3	17	51	9.29

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-A1 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	6	0	0	0	1	2	1	4	3	5	1	2	19	8.61
NE	0	0	1	3	1	3	5	4	4	4	11	20	66	9.73
ENE	0	0	1	1	1	7	2	12	14	14	3	31	86	10.22
E	0	0	2	0	1	3	5	4	6	9	10	17	60	9.44
ESE	0	0	0	0	0	0	2	1	3	7	5	23	44	11.62
SE	0	0	0	0	0	2	3	1	2	4	5	2	14	33	10.54
SSE	0	0	0	0	0	0	0	5	1	3	4	3	10	28	10.41
S	0	0	0	0	0	0	2	1	4	3	1	2	14	27	11.18
SSW	0	0	0	0	1	0	4	1	3	4	3	4	20	44	10.82
SW	0	0	1	0	4	9	6	2	4	4	3	4	27	71	9.69
WSW	0	0	1	1	5	10	6	8	8	6	4	28	78	9.71
W	0	0	1	1	2	6	6	5	10	4	4	6	45	8.28
WNW	0	0	1	0	1	1	5	8	2	1	1	7	27	8.39
NW	0	0	0	2	6	5	5	5	9	7	1	4	44	7.69
NNW	0	0	3	1	1	4	2	4	5	3	1	3	27	7.33
N	0	0	0	2	2	4	2	3	4	0	0	3	20	7.37
CALM													1	.79
TOTAL	0	0	11	12	29	63	57	74	94	84	65	229	719	9.63

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: JULY 1975

PASQUILL #AB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	1	0	0	0	1	0	0	0	2	6.70
E	0	0	0	1	0	0	1	2	0	0	0	0	4	6.17
ESE	0	0	0	0	1	2	0	0	0	0	0	1	4	8.72
SE	0	0	0	0	0	0	0	1	0	0	0	0	1	7.20
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	2	0	0	0	1	0	1	5	7.20
SSW	0	0	0	0	0	0	0	0	0	0	0	1	1	12.40
SW	0	1	0	0	0	0	0	1	0	0	0	0	2	4.50
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	2	0	0	0	0	0	2	5.45
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	1	1	0	0	2	8.65
N	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
CALM													0	0.
TOTAL	0	1	0	1	4	7	1	4	2	2	0	3	25	6.75

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #BB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	0	0	0	0	0	1	4.50
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	1	0	1	1	0	0	0	1	0	4	6.67
E	0	0	0	0	1	0	0	0	0	0	0	1	2	8.10
ESE	0	0	0	0	0	0	0	0	1	1	0	0	2	8.95
SE	0	0	0	0	0	0	0	0	1	0	0	0	1	9.00
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	1	0	0	0	0	0	0	2	5.25
SSW	0	0	0	0	0	0	0	0	1	0	0	2	3	10.43
SW	0	0	0	0	0	1	0	0	0	0	0	2	3	10.47
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	1	0	1	9.50
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	6	3	1	0	3	2	1	5	22	7.45

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #CB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	1	1	24.30
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	1	1	0	0	0	0	0	0	2	4.60
E	0	0	0	0	0	0	0	1	0	1	0	0	2	8.90
ESE	0	0	0	0	0	1	0	1	0	0	0	0	2	8.90
SE	0	0	0	0	0	0	0	0	0	0	1	0	1	10.70
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	2	0	1	0	1	4	8.90
SSW	0	0	0	1	0	0	0	1	0	1	0	0	3	7.13
SW	0	0	0	0	0	0	0	1	2	1	1	1	6	9.23
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	0	0	0	1	0	0	0	0	2	5.40
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	1	0	1	0	0	0	0	0	2	5.25
NNW	0	0	0	1	0	0	0	1	0	0	0	0	2	5.75
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	3	2	2	1	7	3	4	2	3	27	8.34

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #DB (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.50
NE	0	1	2	0	0	0	0	0	0	0	0	0	3	2.03
ENE	0	0	0	0	0	0	1	0	0	0	0	0	1	7.10
E	0	0	0	2	0	0	1	1	0	1	0	0	5	5.98
ESE	0	0	1	0	0	1	0	1	0	0	0	0	3	4.93
SE	0	0	0	0	0	0	0	2	2	2	0	5	11	10.41
SSE	0	0	0	0	0	1	0	1	2	2	1	8	15	11.71
S	0	0	0	0	0	2	1	4	6	4	2	8	27	9.88
SSW	0	0	0	2	0	2	2	4	4	5	3	2	24	8.30
SW	0	0	1	1	1	0	4	2	1	5	4	5	24	9.10
WSW	0	0	1	0	0	2	2	4	2	7	2	4	24	8.66
W	0	0	0	0	1	1	1	2	2	1	0	2	10	8.81
WNW	0	0	1	0	1	0	0	0	0	0	0	2	4	8.20
NW	0	0	0	2	0	0	1	0	0	0	0	1	4	8.72
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	1	1	0	0	0	0	0	0	0	2	3.50
CALM													0	0.
TOTAL	0	1	7	8	3	10	12	22	19	27	12	39	160	8.91

NUMBER OF INVALID OBSERVATIONS = 8
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	1	1	2	0	0	0	0	0	0	5	4.27
NE	0	0	1	0	4	2	1	3	3	1	2	1	20	6.60
ENE	0	0	0	3	2	2	2	1	0	1	2	1	15	7.12
E	0	1	0	1	1	1	1	1	0	3	1	1	11	7.69
ESE	0	0	0	0	2	0	1	0	4	3	1	4	17	9.34
SE	0	0	0	1	3	3	1	2	2	3	0	4	19	7.87
SSE	0	0	0	1	3	3	1	2	3	3	5	13	34	9.74
S	0	0	0	1	2	5	4	2	2	3	2	12	33	9.27
SSW	0	3	0	0	5	5	3	5	5	2	5	10	45	8.14
SW	0	0	1	0	4	5	3	4	6	3	5	20	51	8.62
WSW	0	0	0	1	0	2	1	3	3	3	6	3	22	9.13
W	0	0	0	0	0	1	1	0	0	1	0	1	4	8.75
WNW	0	0	0	1	0	0	0	0	1	0	0	0	2	5.00
NW	0	0	0	0	0	0	1	1	1	1	0	2	6	10.79
NNW	0	0	0	1	0	1	0	0	1	2	0	1	6	8.33
N	0	1	0	0	1	1	0	1	1	1	1	0	7	6.07
CALM													1	.60
TOTAL	0	5	3	11	30	36	28	27	35	35	39	73	382	8.44

NUMBER OF INVALID OBSERVATIONS = 62
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	3	0	0	0	0	0	0	1	5	7.40
NE	0	0	2	1	9	1	1	0	0	0	0	0	14	6.15
ENE	0	0	1	1	2	2	5	2	1	1	0	2	18	6.85
E	0	5	0	1	0	0	0	1	1	0	2	2	12	9.00
ESE	0	0	0	0	0	0	1	2	1	2	0	0	6	8.67
SE	0	0	0	0	0	1	0	1	0	0	0	1	3	9.33
SSE	0	0	1	1	0	0	0	0	0	1	1	4	10	12.70
S	0	1	3	1	0	0	2	1	1	0	1	4	14	7.11
SSW	0	1	0	0	1	0	0	1	1	1	2	0	7	7.29
SW	0	0	0	2	2	1	0	0	0	1	1	0	7	6.57
WSW	0	1	1	0	0	2	1	0	0	0	0	0	5	4.10
W	0	0	0	1	1	0	1	0	0	0	0	0	3	4.00
WNW	0	0	0	0	0	0	0	1	0	0	0	0	1	4.80
NW	0	0	1	1	0	0	0	0	0	0	0	0	2	5.00
NNW	0	0	1	1	0	0	0	0	0	0	0	0	2	5.00
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	3	9	10	7	7	15	11	5	6	7	14	96	7.15

NUMBER OF INVALID OBSERVATIONS = 20
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #6W (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	1	0	0	1	0	0	0	2	7.00
E	0	0	0	0	0	1	0	0	1	0	0	0	2	6.80
ESE	0	0	1	0	0	0	1	0	0	0	0	0	2	6.40
SE	0	0	0	0	0	0	0	0	0	1	0	1	2	10.35
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	0	0	0	0	0	0	1	2	8.65
SSW	0	0	0	0	0	0	0	0	1	1	0	0	2	9.85
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	1	0	0	0	0	0	0	0	0	1	4.00
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	1	1	0	0	0	0	0	0	0	2	3.00
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	2	1	1	1	0	3	2	0	2	15	6.00

NUMBER OF INVALID OBSERVATIONS = 15
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	2	3	3	0	0	0	0	0	2	11	7.25
NE	0	1	5	1	5	3	2	3	3	1	2	1	27	5.49
ENE	0	0	1	5	6	7	8	5	3	1	2	4	42	6.77
E	0	1	0	5	3	1	3	4	4	5	3	4	35	7.46
ESE	0	0	2	0	3	4	3	4	4	4	1	5	36	8.08
SE	0	0	0	1	3	4	1	4	5	4	1	11	38	8.96
SSE	0	0	1	2	3	4	1	3	5	4	7	25	59	10.27
S	0	1	3	2	4	10	7	9	9	9	5	26	87	8.85
SSW	0	4	0	3	4	4	9	14	11	10	10	15	90	8.17
SW	0	1	2	3	7	7	7	8	9	10	11	28	93	9.04
WSW	0	1	2	2	0	6	4	7	5	10	8	7	52	8.38
W	0	0	0	2	2	4	3	3	2	5	0	3	24	7.79
WNW	0	0	1	2	5	0	0	1	1	0	0	2	12	6.28
NW	0	0	0	2	1	0	3	1	1	0	0	5	13	8.79
NNW	0	0	1	3	0	1	0	0	3	3	0	1	12	7.17
N	0	1	1	1	1	2	0	1	1	1	1	0	10	6.13
CALM													1	.43
TOTAL	0	10	20	36	55	64	51	71	70	75	51	139	443	8.30

NUMBER OF INVALID OBSERVATIONS = 101
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-37

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: AUGUST 1975

PASQUILL ABA (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	1	0	0	0	0	0	0	1	6.50
ENE	0	0	0	0	1	1	5	3	2	2	1	0	15	7.17
E	0	0	1	0	2	0	2	2	1	1	1	0	10	6.75
ESE	0	0	0	0	1	2	1	1	0	0	1	0	7	7.17
SE	0	0	0	0	0	1	1	0	0	0	0	0	2	6.00
SSE	0	0	0	1	2	2	0	0	0	0	0	0	5	5.70
S	0	0	0	0	1	1	0	1	2	0	0	0	5	5.54
SSW	0	0	0	1	1	1	0	0	0	2	0	0	5	5.54
SW	0	0	0	0	3	0	11	4	2	2	0	1	23	7.09
WSW	0	0	0	0	1	1	2	0	1	1	0	0	6	5.00
W	0	0	0	1	1	1	1	0	0	0	0	0	4	3.71
WNW	0	0	0	1	1	1	2	0	0	0	0	0	5	4.00
NW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	5	12	12	14	11	8	8	3	1	94	6.61

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ABB (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	0	0	0	0	1	4.50
NE	0	0	0	0	0	1	0	1	0	0	0	0	2	6.50
ENE	0	0	0	0	0	1	1	5	0	1	0	0	8	7.25
E	0	0	0	0	0	0	0	0	1	1	0	0	2	9.50
ESE	0	0	0	0	1	0	1	0	0	0	0	0	2	5.75
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	1	0	0	0	0	0	0	0	1	5.50
SSW	0	0	0	0	0	0	0	1	0	0	0	0	1	5.50
SW	0	0	0	0	0	1	0	2	1	1	0	0	4	6.50
WSW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.75
W	0	0	0	1	0	0	0	0	0	0	0	0	1	2.50
WNW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.50
NW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.50
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	1	2	2	5	2	9	2	2	0	0	24	7.27

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ACA (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	1	0	1	2	11.17
ENE	0	0	0	0	0	0	1	0	0	0	1	1	3	9.87
E	0	0	0	0	0	0	0	0	1	0	0	0	1	7.20
ESE	0	0	0	0	0	0	0	1	0	0	0	0	1	6.50
SE	0	0	0	1	0	1	0	0	0	0	0	0	2	6.50
SSE	0	0	0	0	1	0	0	0	0	1	0	0	2	6.15
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	1	0	0	2	0	0	1	3	7	9.43
SW	0	0	0	0	0	0	1	2	4	4	1	0	13	8.77
WSW	0	1	0	0	1	1	3	0	2	0	0	0	7	5.64
W	0	0	0	0	1	1	0	0	0	0	0	0	2	3.85
WNW	0	0	0	1	0	1	0	0	0	0	0	0	2	4.00
NW	0	0	0	0	0	1	1	0	0	0	0	0	2	5.00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	2	3	7	8	3	9	5	5	2	10	55	7.67

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ADA (FROM ΔEC/ΔDELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	1	0	1	0	1	0	3	8.50
NE	0	0	0	0	0	1	2	4	3	5	4	1	24	9.96
ENE	0	0	2	0	0	0	0	4	6	2	1	3	18	8.44
E	0	0	2	1	1	0	3	1	1	1	0	1	11	6.40
ESE	0	0	0	1	0	1	2	0	0	1	2	0	7	7.43
SE	0	5	1	2	2	0	0	0	0	0	0	0	4	3.63
SSE	0	0	0	1	0	0	0	1	0	0	0	1	4	7.88
S	0	0	0	0	0	2	1	1	1	1	2	0	8	9.13
SSW	0	0	0	0	1	2	2	3	2	4	1	2	14	8.69
SW	0	1	0	3	3	2	2	5	3	4	5	12	40	8.89
WSW	0	0	1	1	2	3	4	3	7	4	4	5	34	8.74
W	0	0	0	1	2	1	2	4	2	1	1	1	15	7.40
WNW	0	0	1	0	1	1	2	3	0	0	0	0	9	6.11
NW	0	0	1	2	1	2	1	1	2	0	0	1	11	6.14
NNW	0	0	0	1	0	1	1	0	1	0	0	0	4	6.13
N	0	0	0	0	0	0	0	0	1	0	0	0	1	8.50
CALM													0	0.
TOTAL	0	1	8	13	13	16	23	32	30	31	21	29	217	8.04

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METEOROLOGY
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	0	1	1	1	0	1	4	6.44
NE	0	0	1	0	0	1	1	2	2	4	0	0	11	7.14
ENE	0	0	0	0	1	1	0	4	0	1	2	1	10	8.28
E	0	0	0	0	0	0	1	2	3	0	2	0	8	9.19
ESE	0	0	0	0	1	1	0	0	0	1	0	0	3	8.58
SE	0	0	1	0	0	1	0	0	0	2	0	0	4	8.77
SSE	0	0	0	1	1	0	0	0	1	0	0	0	3	8.17
S	0	0	1	1	0	1	1	2	1	2	0	1	10	11.47
SSW	1	0	0	0	0	1	1	2	1	2	0	1	9	9.76
SW	0	0	1	0	0	2	1	5	7	3	5	20	44	10.13
WSW	0	0	1	0	0	2	2	2	3	4	1	4	19	10.23
W	0	1	0	0	0	2	1	1	1	4	1	1	12	7.85
WNW	0	0	0	0	1	0	0	2	1	1	1	0	6	7.14
NW	0	0	1	0	1	1	0	0	0	0	0	0	3	4.24
NNW	0	0	0	0	1	1	0	0	0	0	0	0	2	4.11
N	0	0	0	0	0	0	0	0	1	0	0	0	1	8.75
CALM													1	.50
TOTAL	1	0	4	2	5	16	12	23	27	26	12	29	166	8.11

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METEOROLOGY
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	2	1	2	1	1	1	9	8.63
NE	0	0	1	0	0	0	1	0	0	0	0	0	2	2.40
ENE	0	0	2	0	0	0	0	0	0	0	0	0	2	2.40
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	1	0	0	1	11.27
SSE	0	0	0	0	1	0	0	0	0	1	0	0	2	7.96
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	1	0	0	0	1	0	0	0	0	2	8.55
SW	0	0	0	1	0	0	0	1	0	0	0	0	2	7.43
WSW	0	0	0	0	0	0	0	1	0	0	0	0	1	8.83
W	0	0	0	0	0	0	0	1	0	0	0	0	1	7.15
WNW	0	0	0	0	0	1	1	1	0	0	0	0	3	8.67
NW	0	0	0	0	0	1	0	1	0	0	0	0	2	8.60
NNW	0	0	0	0	0	0	0	0	0	1	0	0	1	8.85
N	0	0	0	0	0	0	1	0	0	1	0	0	2	8.85
CALM													1	.50
TOTAL	0	0	4	1	2	3	4	1	3	4	0	4	35	8.91

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-M) METEOROLOGY
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	1	2	1	2	1	1	1	9	8.63
NE	0	0	1	0	0	0	1	0	0	0	0	0	2	2.40
ENE	0	0	2	0	0	0	0	0	0	0	0	0	2	2.40
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	1	0	0	1	11.27
SSE	0	0	0	0	1	0	0	0	0	1	0	0	2	7.96
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	1	0	0	0	1	0	0	0	0	2	8.55
SW	0	0	0	1	0	0	0	1	0	0	0	0	2	7.43
WSW	0	0	0	0	0	0	0	1	0	0	0	0	1	8.83
W	0	0	0	0	0	0	0	1	0	0	0	0	1	7.15
WNW	0	0	0	0	0	1	1	1	0	0	0	0	3	8.67
NW	0	0	0	0	0	1	0	1	0	0	0	0	2	8.60
NNW	0	0	0	0	0	0	0	0	0	1	0	0	1	8.85
N	0	0	0	0	0	0	1	0	0	1	0	0	2	8.85
CALM													1	.50
TOTAL	0	0	4	1	2	3	4	1	3	4	0	4	35	8.91

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: SEPTEMBER 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #AB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #AC (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #AD (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	0	5	3	2	2	5	3	4	10	36	9.69
NE	0	0	0	1	3	6	5	5	6	4	6	18	54	10.36
ENE	0	1	0	1	1	3	4	2	8	5	1	10	36	9.44
E	0	0	0	1	1	2	4	2	2	2	4	10	28	9.34
ESE	0	0	0	0	1	0	0	0	3	1	1	0	6	8.10
SE	0	0	0	0	1	1	0	0	2	2	2	9	17	12.35
SSE	0	0	0	0	0	0	0	0	2	1	3	5	11	14.73
S	0	0	0	0	0	0	2	4	1	0	1	4	12	11.83
SSW	0	0	0	0	0	1	2	4	0	3	3	2	15	9.60
SW	0	0	0	0	1	3	2	3	0	2	0	7	18	10.17
WSW	0	1	2		3	7	2	0	1	0	0	1	17	5.59
W	0	1	2		1	2	1	4	1	0	1	0	15	5.41
WNW	0	0	0		1	0	1	1	1	0	1	1	6	8.67
NW	0	0	0		0	2	0	0	0	0	2	0	4	5.22
NNW	0	0	0	0	0	0	1	1	1	1	0	0	4	7.00
N	0	0	0	0	0	2	2	1	1	0	2	0	6	8.00
CALM													1	.69
TOTAL	0	4	5	5	13	31	30	28	36	27	32	80	292	9.54

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL WEA (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	2	0	0	1	0	0	0	0	1	4	10.11
NE	0	0	0	0	0	1	2	4	0	4	4	16	34	10.94
ENE	0	0	1		0	0	2	2	3	3	1	5	17	9.89
E	0	1	0		0	2	1	0	4	2	2	1	3	14	8.68
ESE	0	0	0	0	1	0	0	0	0	2	0	1	4	9	11.44
SE	0	2	0	0	0	1	0	0	1	2	3	1	10	20	10.31
SSE	0	0	0	0	0	0	0	0	2	3	3	4	8	20	11.45
S	0	0	0	0	0	0	0	0	0	2	2	1	5	12	10.83
SSW	0	1	0	0	0	0	0	0	0	0	0	0	1	2	9.47
SW	0	1	0	0	0	0	0	0	0	0	0	0	1	2	9.47
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0	0.
TOTAL	0	4	0	14	10	10	11	26	23	33	25	56	242	6.37

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 726

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	3	1	0	0	0	0	0	0	0	1	2	9.49
NE	0	0	0	0	1	0	0	0	0	0	0	10	11	13.79
ENE	0	0	0	0	0	0	0	0	0	0	2	2	4	11.15
E	0	0	0	0	0	1	0	0	0	0	0	2	3	13.47
ESE	0	0	0	0	0	0	0	0	1	1	0	0	2	9.47
SE	0	0	0	0	0	1	0	0	0	0	1	0	2	7.15
SSE	0	0	0	0	0	0	0	1	0	0	1	3	5	13.00
S	0	0	0	0	1	0	1	0	0	0	0	5	7	11.17
SSW	0	0	0	0	0	0	0	1	0	0	1	0	2	9.47
SW	0	0	0	0	0	0	0	0	0	1	0	2	3	10.49
WSW	0	0	0	0	0	0	0	0	1	2	1	1	5	9.78
W	0	0	0	0	0	0	0	0	1	0	0	1	2	9.15
WNW	0	0	0	0	0	0	1	2	0	0	0	0	3	6.47
NW	0	0	0	1	0	0	0	1	0	0	1	0	3	7.13
NNW	0	0	0	0	0	0	0	0	0	0	0	2	2	9.47
N	0	0	0	0	1	0	0	0	0	0	0	0	1	5.00
CALM													0	0.
TOTAL	0	0	0	3	3	3	8	5	3	4	6	27	66	9.99

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 726

PASQUILL WEB (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	1	0	0	0	0	0	0	0	0	1	2.96
SSW	0	0	0	0	0	0	0	1	0	0	0	0	1	6.50
SW	0	0	0	0	0	0	0	1	0	0	0	0	1	5.25
WSW	0	0	0	0	0	0	0	1	0	1	0	0	2	7.75
W	0	0	0	0	0	0	0	1	0	1	0	0	2	8.53
WNW	0	0	0	0	0	0	0	1	1	2	0	0	4	7.99
NW	0	0	0	0	0	0	0	0	0	1	1	0	2	9.10
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	1	0	0	0	4	2	4	2	1	3	24	7.57

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 726

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METEOR
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	3	0	3	4	3	7	4	12	20	62	9.69
NE	0	0	0	0	1	7	10	10	6	9	12	47	104	10.85
ENE	0	1	1	1	2	3	4	4	11	11	5	23	70	9.93
E	0	1	1	2	4	5	4	7	4	2	5	16	61	8.91
ESE	0	0	0	0	2	1	0	1	4	1	3	5	19	9.72
SE	0	2	0	2	5	2	5	3	5	5	4	23	56	10.01
SSE	0	0	0	2	0	0	1	4	5	3	9	17	41	11.71
S	0	0	0	1	2	1	1	5	3	4	3	16	37	10.37
SSW	0	1	1	1	1	5	4	5	4	10	4	16	58	9.04
SW	0	1	0	1	4	7	3	4	0	5	0	12	41	8.48
WSW	0	1	2	3	1	7	3	1	3	2	2	2	29	6.69
W	0	1	3	5	4	4	3	4	2	1	2	3	36	6.37
WNW	0	0	2	3	4	4	5	7	10	2	4	2	43	7.31
NW	0	0	1	2	3	3	3	4	2	4	1	0	27	6.83
NNW	0	0	2	0	2	0	1	1	2	1	1	1	14	7.70
N	0	0	0	1	3	0	2	1	1	2	1	0	13	7.63
CALM													1	.69
TOTAL	0	9	16	34	38	53	65	72	73	78	70	203	714	9.24

NUMBER OF INVALID OBSERVATIONS = 6
TOTAL NUMBER OF OBSERVATIONS = 726

TABLE 2.3-39

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: OCTOBER 1975

PASQUILL #6B (FROM AEC/DELTA-T CRITERIA 10-61 METERS :
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	2	2	23,50
NE	0	0	0	0	0	1	0	0	0	1	0	0	2	7,75
ENE	0	0	0	0	0	0	0	1	0	0	0	0	1	8,75
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	1	0	0	0	0	0	0	0	1	5,00
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	1	0	0	0	0	0	0	0	1	5,00
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	0	0	0	0	0	0	0	0	1	5,00
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	1	0	0	0	0	0	0	0	0	0	0	1	1,00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	1	2	0	1	0	0	1	1	0	2	9	9,22

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #6A (FROM AEC/DELTA-T CRITERIA 10-61 METERS :
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	2	2	23,50
NE	0	0	0	0	0	0	0	1	0	0	1	0	2	8,50
ENE	0	0	0	0	0	0	0	0	1	0	1	0	2	9,25
E	0	0	0	0	0	0	0	0	1	0	0	0	1	8,75
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	1	0	0	0	0	0	0	0	1	5,00
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	1	0	0	1	1	0	1	2	10	19,70

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #6B (FROM AEC/DELTA-T CRITERIA 10-61 METERS :
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	0	1	0	0	1	0	1	1	5	14,60
NE	0	0	0	1	0	1	0	0	0	0	0	0	2	6,00
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	2	1	0	2	0	0	1	0	1	1	8	10,25

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #6A (FROM AEC/DELTA-T CRITERIA 10-61 METERS :
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	0	1	0	2	2	5	4	8	23	11,60
NE	0	0	0	0	2	0	1	1	3	4	1	2	20	10,40
ENE	0	0	1	0	3	2	4	3	2	4	1	4	24	8,92
E	0	0	0	0	1	2	3	1	1	0	0	0	8	6,60
ESE	0	0	0	0	2	2	2	1	0	0	0	0	7	5,41
SE	0	0	0	1	0	0	0	1	0	0	0	3	5	17,14
SSE	0	0	1	0	0	1	0	0	2	0	0	3	7	8,43
S	0	1	0	2	0	0	0	0	0	0	0	3	6	14,75
SSW	0	0	0	1	0	3	1	0	1	0	0	0	6	5,83
SW	0	0	2	0	1	2	3	4	5	4	5	4	35	9,23
WSW	0	0	0	0	2	2	1	0	0	3	1	5	15	9,21
W	0	0	0	2	1	0	1	3	0	0	0	2	9	7,67
WNW	0	0	0	1	1	2	1	1	0	0	0	0	7	5,07
NW	0	0	0	0	2	4	3	5	2	0	1	1	18	7,00
NNW	0	0	2	2	1	1	2	3	2	5	0	2	20	7,47
N	0	0	0	1	1	2	0	1	1	0	0	1	7	7,00
CALM													0	0.
TOTAL	0	1	6	11	17	24	22	27	22	25	13	49	217	8,78

NUMBER OF INVALID OBSERVATIONS = 4
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-39 (Continued)

PASQUILL #E8 (FROM AEC/DELTA-T CRITERIA [D-A] METEOR
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH)													MEAN SPEED
	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	
NNE	0	0	0	1	2	1	5	4	1	5	2	15	36	11.32
NE	0	0	1	0	1	1	3	3	4	5	7	14	38	10.66
ENE	0	0	0	1	0	0	0	0	3	0	2	2	8	9.31
E	0	0	1	0	2	2	2	0	0	0	0	1	8	5.80
ESE	0	0	0	0	0	0	3	1	0	0	1	7	12	12.54
SE	0	0	0	0	0	0	1	0	0	0	1	11	13	14.69
SSE	0	0	0	0	0	0	0	0	0	0	0	3	3	15.33
S	0	0	0	0	1	1	0	0	0	0	1	2	5	13.00
SSW	0	0	0	0	0	2	0	0	0	1	2	6	11	11.42
SW	0	0	0	0	1	1	3	1	1	2	1	17	27	10.74
WSW	0	0	0	0	1	0	1	0	1	0	1	14	18	11.89
W	0	1	2	1	1	0	1	0	1	0	1	10	18	9.48
WNW	0	0	0	0	2	0	0	1	0	0	1	0	4	6.77
NW	0	0	0	1	1	1	0	1	1	0	0	0	7	5.81
NNW	0	1	0	0	2	1	0	1	0	1	0	0	6	5.67
N	0	1	0	0	2	0	1	2	2	0	2	0	10	7.01
CALM													0	0.
TOTAL	0	3	5	4	14	9	14	14	17	9	22	97	209	10.58

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #F8 (FROM AEC/DELTA-T CRITERIA [D-A] METEOR
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH)													MEAN SPEED
	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	
NNE	0	0	1	0	0	1	0	0	0	0	0	0	2	10.50
NE	0	0	0	1	0	1	0	5	1	1	2	11	22	12.09
ENE	0	0	1	0	0	0	0	1	0	1	4	4	11	10.45
E	0	0	0	1	0	0	0	0	2	0	1	4	8	10.48
ESE	0	0	0	0	0	1	0	1	1	0	2	4	9	11.91
SE	0	0	0	1	0	1	0	0	0	0	0	4	6	13.33
SSE	0	0	0	0	0	0	0	0	0	0	1	4	5	14.60
S	1	0	0	0	0	0	0	0	0	0	0	1	2	4.77
SSW	0	0	0	0	0	0	0	1	0	0	2	7	10	11.44
SW	0	0	1	0	0	0	0	0	1	0	0	8	10	12.43
WSW	0	0	1	0	0	0	0	0	0	0	2	0	2	10.48
W	0	0	0	0	1	0	1	1	0	0	0	7	7	9.14
WNW	0	0	0	0	0	0	1	0	1	0	0	1	3	8.00
NW	0	0	0	0	0	0	0	0	1	0	0	0	1	4.00
NNW	0	0	1	0	1	0	1	0	0	1	0	1	5	9.00
N	0	0	0	0	0	1	1	0	0	0	0	0	2	5.00
CALM													0	0.
TOTAL	1	0	4	3	2	4	4	9	6	3	12	52	122	11.17

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G8 (FROM AEC/DELTA-T CRITERIA [D-A] METEOR
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH)													MEAN SPEED
	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	
NNE	0	0	3	0	0	0	0	0	0	2	1	2	8	7.34
NE	0	0	3	1	2	1	0	1	0	1	1	4	14	7.67
ENE	0	1	1	1	2	1	0	0	0	0	0	2	10	6.68
E	0	1	2	0	0	0	0	0	0	0	1	1	4	9.51
ESE	0	0	1	0	0	0	0	0	0	0	0	0	1	2.80
SE	0	0	0	0	0	0	1	0	0	0	0	4	5	12.52
SSE	0	1	0	1	0	0	0	0	0	0	1	1	4	6.63
S	0	1	1	0	0	0	1	0	0	1	0	0	4	5.29
SSW	0	0	0	1	1	0	0	0	0	0	0	1	3	6.23
SW	0	0	0	0	0	0	2	0	0	3	1	9	7	15	9.89
WSW	0	0	0	0	0	0	1	0	0	2	4	2	4	16	8.74
W	0	0	0	0	0	0	0	1	1	2	0	0	2	9	7.73
WNW	0	0	1	1	0	0	0	1	0	0	0	0	0	3	4.10
NW	0	0	0	0	1	0	0	1	0	0	1	0	0	3	5.98
NNW	0	0	0	0	1	1	0	0	2	0	1	0	0	5	5.80
N	0	0	0	2	2	0	0	1	0	0	1	2	0	10	6.70
CALM													1	.70
TOTAL	0	4	14	14	9	4	9	7	13	13	8	31	124	7.71

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA [D-A] METEOR
WINDS AT 41.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH)													MEAN SPEED
	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	
NNE	0	0	5	2	2	4	2	7	1	4	7	38	76	11.24
NE	0	0	4	3	5	4	5	9	12	13	44	164	263	10.61
ENE	0	1	3	2	4	4	4	7	9	4	12	43	93	9.65
E	0	1	3	1	3	5	5	2	5	1	3	9	38	8.17
ESE	0	0	1	0	2	2	3	2	1	1	4	12	31	9.94
SE	0	0	0	2	2	0	3	1	0	0	1	24	35	12.90
SSE	0	1	1	1	0	1	0	0	2	0	1	13	20	11.48
S	1	2	1	1	2	1	1	0	1	1	1	4	16	10.14
SSW	0	0	0	1	1	0	0	1	0	1	1	4	9	9.92
SW	0	0	0	0	1	0	1	1	2	1	1	14	21	12.00
WSW	0	0	0	0	0	0	0	0	0	0	0	1	1	10.00
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	1	5	18	13	22	21	24	30	33	25	74	344	620	10.58

NUMBER OF INVALID OBSERVATIONS = 124
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-40

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: NOVEMBER 1975

PASQUILL AAA (FROM RECIRCULATION CRITERIA [DELTA-T] WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	3	0	0	0	0	0	0	3	6.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.50
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													1	0.
TOTAL	0	1	0	0	0	3	0	0	0	0	0	0	5	1.50

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL AAB (FROM RECIRCULATION CRITERIA [DELTA-T] WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ACA (FROM RECIRCULATION CRITERIA [DELTA-T] WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	1	0	0	0	1	8.60
NE	1	0	0	0	0	0	0	0	0	0	0	0	1	1.00
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	1	1	0	0	0	1	2	0	0	0	5	6.20
SSE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.00
S	2	0	0	0	0	0	0	0	0	0	0	0	2	2.50
SSW	0	1	0	1	0	0	0	0	0	0	0	0	2	3.50
SW	0	0	0	0	0	1	0	0	0	0	0	0	1	4.00
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	1	0	0	0	0	0	0	0	0	1	3.00
WNW	0	0	0	1	0	0	0	0	0	0	0	0	1	3.00
NW	0	0	1	1	0	1	0	0	0	0	0	0	3	5.00
NNW	0	1	0	0	0	0	0	0	0	0	0	1	2	7.50
N	0	1	0	1	1	0	1	0	0	0	1	0	5	5.20
CALM													0	0.
TOTAL	3	3	3	5	1	2	1	1	3	1	1	3	28	4.68

NUMBER OF INVALID OBSERVATIONS = 1
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ACB (FROM RECIRCULATION CRITERIA [DELTA-T] WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	1	1	0	0	1	0	0	2	1	7	7.14
NE	0	0	0	1	1	2	0	1	2	0	1	2	10	8.00
ENE	0	0	0	0	0	1	1	1	2	1	1	0	7	8.29
E	0	0	1	1	0	1	2	0	2	0	0	3	10	7.85
ESE	0	0	0	0	0	2	1	0	0	1	0	0	4	6.40
SE	0	0	0	0	0	2	1	0	0	1	1	4	10	9.20
SSE	0	1	0	0	1	1	1	2	1	4	0	3	14	6.50
S	0	0	0	0	0	0	0	0	1	0	0	0	1	4.00
SSW	1	0	0	0	0	0	1	1	1	2	2	11	19	12.74
SW	0	2	1	0	1	4	1	1	1	1	0	2	15	6.73
WSW	1	2	1	0	2	2	2	0	1	2	1	10	29	10.19
W	1	1	4	0	1	3	1	1	1	2	2	10	28	9.43
WNW	0	0	2	1	0	1	1	0	0	1	1	11	18	10.61
NW	0	3	2	0	4	0	0	0	1	2	2	14	28	11.43
NNW	0	0	4	2	0	1	1	2	1	4	4	7	26	9.20
N	0	3	1	0	1	1	0	0	0	0	0	1	9	6.33
CALM													3	.00
TOTAL	3	12	17	5	14	22	12	10	13	24	21	28	241	9.33

NUMBER OF INVALID OBSERVATIONS = 6
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #F# (FROM ΔEC/ΔΘ+Δ-T CRITERIA 10-41 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	2	0	0	0	1	3	8.87
NE	0	0	0	0	0	2	2	0	0	3	0	0	7	10.35
ENE	0	1	0	0	0	0	0	1	3	1	1	0	6	7.23
E	0	0	0	0	1	0	0	1	0	1	1	1	5	8.33
ESE	1	0	1	0	0	0	0	0	1	1	1	2	7	9.11
SE	0	1	0	0	1	0	0	1	1	0	0	0	4	5.45
SSE	0	0	0	0	0	0	1	1	0	0	0	0	2	6.00
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
VAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
CALM													0	.00
TOTAL	1	4	1	0	2	2	3	6	5	6	3	4	37	7.61

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #G# (FROM ΔEC/ΔΘ+Δ-T CRITERIA 10-41 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	1	0	0	1	0	0	0	0	2	4.50
NE	0	0	0	2	0	0	0	1	0	0	0	1	4	9.63
ENE	0	0	0	0	1	0	1	1	0	0	0	2	5	10.33
E	0	0	0	1	0	1	0	0	0	2	1	1	6	10.17
ESE	0	0	1	0	0	1	0	1	0	1	1	2	7	9.11
SE	0	0	0	1	1	0	1	0	0	1	0	14	18	17.61
SSE	0	1	0	0	1	1	2	1	1	1	0	4	12	11.14
S	0	1	0	0	0	0	0	0	0	0	0	1	2	9.50
SSW	0	0	1	0	0	1	0	0	0	0	0	0	2	4.50
SW	0	0	0	0	0	1	0	0	1	0	0	1	3	9.67
WSW	0	1	0	0	0	0	0	0	0	0	0	0	1	3.00
W	1	0	0	0	0	0	0	1	0	0	0	0	2	4.50
WNW	0	0	1	0	0	0	0	0	0	0	0	0	1	3.00
NW	0	1	0	0	0	0	0	1	0	1	1	0	4	7.50
NNW	0	0	0	0	1	0	0	0	0	1	0	0	2	7.00
VAR	0	0	0	0	0	0	0	0	1	0	0	0	1	6.00
CALM													1	.00
TOTAL	1	4	3	4	5	7	4	6	3	6	3	26	72	12.01

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL #F# (FROM ΔEC/ΔΘ+Δ-T CRITERIA 10-41 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	1	0	1	0	1	2	1	3	0	0	11	5.55
NE	0	0	1	1	0	1	0	1	2	0	1	1	16	7.69
ENE	0	0	0	0	0	0	0	0	1	0	0	0	2	7.23
E	0	1	0	0	0	0	0	1	1	1	0	1	5	9.38
ESE	0	0	0	1	0	0	0	0	1	1	0	0	6	8.05
SE	0	1	1	1	0	0	0	1	0	0	0	1	13	5.35
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
S	1	0	1	1	0	0	0	0	1	0	0	0	4	4.45
SSW	0	0	0	0	0	0	0	1	0	0	0	0	1	6.41
SW	0	1	0	1	0	0	0	0	0	1	0	0	3	4.82
WSW	0	1	0	0	0	0	0	0	1	0	0	0	2	5.50
W	0	1	0	0	0	0	0	0	1	0	0	0	2	5.50
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
VAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
CALM													0	.00
TOTAL	2	11	4	11	11	23	11	16	12	12	5	38	166	6.07

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM ΔEC/ΔΘ+Δ-T CRITERIA 10-41 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	1	2	2	1	4	2	3	2	2	24	7.79
NE	1	0	1	3	1	1	0	3	3	2	2	4	29	8.26
ENE	0	1	0	0	1	2	3	5	4	4	1	3	28	8.68
E	0	1	1	1	1	2	4	1	4	4	3	13	43	8.98
ESE	1	0	2	1	0	1	1	4	2	5	3	6	32	8.46
SE	0	2	2	3	0	3	3	4	0	2	1	31	57	10.14
SSE	0	2	0	2	4	3	5	2	5	6	4	23	56	10.36
S	1	1	1	1	0	3	0	2	1	1	0	24	41	11.91
SSW	1	3	1	3	0	2	2	2	2	2	0	15	30	9.31
SW	1	3	1	1	2	2	1	2	3	1	1	18	43	8.56
WSW	3	0	1	1	3	0	1	2	2	2	2	31	44	10.07
W	2	3	2	1	0	1	3	2	2	0	0	23	43	9.17
WNW	0	0	0	0	1	0	1	2	2	2	2	15	25	8.30
NW	0	1	3	3	0	3	1	1	0	0	0	0	12	3.17
NNW	1	3	2	3	2	2	1	2	0	0	0	0	16	3.06
VAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
CALM													0	.00
TOTAL	11	21	15	21	16	25	26	37	32	34	21	208	477	8.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

PASQUILL ALL (FROM ΔEC/ΔΘ+Δ-T CRITERIA 10-41 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	1	2	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	1	2	2	1	4	2	3	2	2	24	7.79
NE	1	0	1	3	1	1	0	3	3	2	2	4	29	8.26
ENE	0	1	0	0	1	2	3	5	4	4	1	3	28	8.68
E	0	1	1	1	1	2	4	1	4	4	3	13	43	8.98
ESE	1	0	2	1	0	1	1	4	2	5	3	6	32	8.46
SE	0	2	2	3	0	3	3	4	0	2	1	31	57	10.14
SSE	0	2	0	2	4	3	5	2	5	6	4	23	56	10.36
S	1	1	1	1	0	3	0	2	1	1	0	24	41	11.91
SSW	1	3	1	3	0	2	2	2	2	2	0	15	30	9.31
SW	1	3	1	1	2	2	1	2	3	1	1	18	43	8.56
WSW	3	0	1	1	3	0	1	2	2	2	2	31	44	10.07
W	2	3	2	1	0	1	3	2	2	0	0	23	43	9.17
WNW	0	0	0	0	1	0	1	2	2	2	2	15	25	8.30
NW	0	1	3	3	0	3	1	1	0	0	0	0	12	3.17
NNW	1	3	2	3	2	2	1	2	0	0	0	0	16	3.06
VAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
CALM													0	.00
TOTAL	11	21	15	21	16	25	26	37	32	34	21	208	477	8.47

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 720

TABLE 2.3-41

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: DECEMBER 1975

PASQUILL #AA (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #AB (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00
SSW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.00
SW	0	0	0	0	0	1	0	0	0	0	0	0	1	5.00
WSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	0	0	1	1	0	0	0	0	0	0	3	4.67

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #AC (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NE	1	0	0	0	0	0	0	0	0	0	0	0	1	.80
ENE	0	0	0	0	0	1	0	0	0	0	0	0	1	5.10
E	0	0	0	0	1	0	0	0	0	0	0	0	1	4.60
ESE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
SSW	0	0	0	0	1	0	0	0	0	0	0	0	1	4.00
SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
WSW	0	1	0	0	0	0	0	0	0	0	0	0	1	1.10
W	0	1	0	0	0	0	0	0	0	0	0	0	1	2.00
WNW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NW	0	0	0	0	0	0	0	0	1	0	1	0	2	9.40
NNW	0	0	0	0	0	0	0	0	0	0	0	4	4	17.55
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													1	.40
TOTAL	1	2	0	0	2	1	0	0	1	0	1	4	13	8.34

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #AD (FROM AEC/DELTA-T CRITERIA 10-41 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	1	1	3	1	1	1	2	2	8	24	9.19
NE	0	1	0	2	3	4	4	2	5	5	5	4	40	7.94
ENE	0	0	1	0	1	3	2	1	0	4	2	4	18	8.67
E	0	1	0	1	0	1	3	0	0	2	0	0	8	6.14
ESE	0	0	1	1	0	2	0	0	0	1	0	0	5	5.60
SE	0	0	0	0	0	1	0	1	1	1	0	0	5	7.24
SSE	0	0	0	0	1	0	0	0	0	0	0	1	2	10.15
S	0	2	2	1	0	1	0	0	0	0	0	0	6	2.84
SSW	0	1	2	0	2	1	0	2	2	1	0	0	11	5.77
SW	0	1	2	1	1	0	0	1	4	2	2	14	30	12.33
WSW	0	0	0	1	1	1	0	0	3	2	1	17	26	15.35
W	0	0	1	1	4	2	2	0	1	0	2	1	14	6.43
WNW	0	2	2	2	0	2	5	2	1	2	0	1	19	5.96
NW	0	3	0	1	0	2	1	3	2	2	3	15	32	10.87
NNW	0	3	0	0	2	0	1	1	0	1	1	9	18	10.03
N	0	2	0	1	0	0	3	1	2	1	0	5	15	8.96
CALM													3	.67
TOTAL	0	16	11	13	19	27	23	15	24	24	18	81	274	9.11

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METER
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	5	6	1	0	3	1	1	2	1	0	0	19	6.53
NE	0	0	0	0	0	1	2	2	3	4	1	4	17	9.82
ENE	0	0	1	2	0	0	2	1	2	4	1	4	19	9.65
E	0	1	0	0	0	0	0	5	1	2	0	6	15	9.87
ESE	1	0	0	0	0	1	0	0	1	0	0	1	4	9.24
SE	0	0	2	0	0	0	1	1	0	0	0	2	6	11.15
SSE	0	0	0	0	0	0	1	2	0	0	0	5	8	12.17
S	0	0	2	0	0	0	0	0	0	0	0	0	2	7.50
SSW	0	0	0	0	0	1	1	0	0	0	1	3	6	12.14
SW	0	0	0	0	0	1	0	1	1	0	0	2	5	12.40
WSW	0	0	0	0	0	0	2	0	0	1	0	0	3	8.33
W	0	0	0	1	0	0	0	0	1	0	0	0	2	7.50
WNW	0	0	0	0	0	0	1	0	1	1	1	2	7	14.36
NW	0	0	0	0	3	0	1	2	0	2	0	0	8	10.25
NNW	0	0	0	0	1	1	1	0	1	1	0	0	5	9.80
N	0	0	0	1	0	0	1	0	1	0	0	0	3	5.83
CALM													8	.52
TOTAL	1	5	11	7	4	14	12	22	24	22	10	111	246	15.37

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #E# (FROM AEC/DELTA-T CRITERIA 10-41 METER
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	0	0	0	1	0	0	1	8.00
NE	0	0	0	0	0	1	0	0	0	1	0	1	3	12.33
ENE	0	0	0	0	0	0	0	0	0	0	0	1	1	14.70
E	0	0	0	0	0	1	0	1	0	0	1	2	5	9.74
ESE	0	1	0	0	0	0	0	1	0	0	0	0	2	5.00
SE	0	0	0	0	0	0	0	0	0	0	0	1	1	13.40
SSE	0	0	0	0	0	0	0	0	0	0	0	1	1	14.20
S	0	0	0	0	0	0	1	0	0	0	0	1	2	11.00
SSW	0	0	0	0	0	0	0	0	0	0	1	0	1	11.70
SW	0	0	0	0	0	0	0	0	0	0	0	1	1	11.35
WSW	0	0	0	0	0	0	0	0	0	0	1	0	1	12.20
W	0	0	0	0	0	0	0	0	0	1	0	0	1	9.00
WNW	0	0	0	0	0	0	0	0	0	1	0	0	1	9.70
NW	0	0	0	0	0	0	0	0	0	0	0	1	1	13.10
NNW	0	0	0	0	0	0	0	0	0	0	0	1	1	8.00
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
CALM													0	0.
TOTAL	0	1	0	0	0	2	1	2	0	4	2	9	21	11.25

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL #G# (FROM AEC/DELTA-T CRITERIA 10-41 METER
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	0	0	0	0	0	0	0	0	0	1	1.10
NE	0	1	1	1	0	0	0	0	0	0	0	0	3	3.13
ENE	0	0	0	0	1	0	1	0	0	0	0	0	2	4.11
E	0	0	0	0	0	0	0	2	2	1	0	1	6	8.83
ESE	0	2	0	0	1	0	1	1	1	0	1	5	12	8.94
SE	0	1	1	0	1	0	1	1	3	2	0	4	14	8.44
SSE	0	0	0	0	0	0	0	0	0	0	0	3	3	13.67
S	0	0	1	1	0	0	0	0	0	0	0	10	14	10.40
SSW	0	0	0	0	0	0	1	1	0	2	0	5	11	9.85
SW	0	1	0	0	1	1	0	1	1	0	0	5	12	9.91
WSW	0	1	0	0	0	0	0	1	1	4	3	12	24	10.66
W	0	0	0	0	0	0	0	0	0	1	0	0	5	8.17
WNW	1	0	0	0	0	0	0	1	0	2	1	2	7	8.79
NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
NNW	1	0	0	0	0	1	0	0	0	2	0	0	4	5.57
N	0	0	0	0	0	1	0	0	0	0	0	1	2	8.60
CALM													20	.62
TOTAL	2	7	3	3	10	3	4	8	11	12	5	53	145	8.37

NUMBER OF INVALID OBSERVATIONS = 0
TOTAL NUMBER OF OBSERVATIONS = 744

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-41 METER
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	0	2	1	4	4	2	4	3	2	8	30	8.74
NE	1	2	1	3	1	11	5	4	6	5	4	15	49	8.54
ENE	0	0	2	2	2	4	5	2	2	10	3	11	43	9.20
E	0	2	0	1	2	1	4	7	3	4	1	9	34	8.65
ESE	1	3	1	1	1	3	1	1	4	1	1	4	26	8.08
SE	0	1	1	0	2	0	3	3	4	3	0	6	26	9.25
SSE	0	0	0	0	1	0	1	2	0	2	0	12	18	12.61
S	0	0	3	2	1	0	1	1	0	0	1	14	23	9.57
SSW	0	1	2	0	2	1	1	3	2	4	4	32	52	10.56
SW	0	2	2	2	2	3	1	1	0	4	4	44	63	12.01
WSW	0	2	0	1	3	3	0	1	0	4	7	45	75	12.28
W	0	1	2	1	4	2	4	1	0	3	6	4	32	7.73
WNW	1	3	2	2	0	1	5	4	3	4	5	4	37	7.32
NW	0	3	0	4	0	1	3	3	5	3	7	33	66	10.23
NNW	1	3	1	1	4	1	2	5	3	3	1	17	42	9.65
N	0	2	1	1	1	1	3	2	2	1	0	6	20	8.36
CALM													37	.69
TOTAL	4	31	18	29	37	42	44	45	41	47	40	278	742	9.45

NUMBER OF INVALID OBSERVATIONS = 2
TOTAL NUMBER OF OBSERVATIONS = 744

TABLE 2.3-42

WIND FREQUENCY DISTRIBUTIONS
VIRGIL C. SUMMER NUCLEAR STATION
61.5 METER LEVEL: ANNUAL 1975

PASQUILL XBR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	2	1	1	2	4	1	2	3	16	10,81
NE	0	2	1	1	0	3	3	2	0	3	5	12	32	9,40
ENE	0	0	0	1	2	0	5	4	4	2	0	8	26	9,27
E	0	0	0	2	2	4	1	5	6	2	1	0	23	6,14
ESE	0	0	0	1	1	1	1	0	0	1	3	3	11	8,09
SE	0	0	0	1	2	3	3	2	3	1	1	0	17	6,74
SSE	0	0	1	3	1	0	1	0	1	0	1	2	14	6,29
S	0	0	0	1	3	0	2	1	4	3	4	11	33	7,43
SSW	0	0	0	2	0	4	0	2	3	0	2	5	22	7,40
SW	0	0	2	1	5	0	17	7	3	2	0	1	4	42
WSW	0	1	1	2	3	2	1	3	2	0	1	0	16	5,37
W	0	0	2	2	1	2	4	3	1	0	0	0	17	4,76
WNW	0	2	1	2	3	4	1	1	0	0	0	0	14	4,50
NW	0	1	0	2	4	0	2	2	1	0	0	0	12	5,42
NNW	0	0	0	0	0	0	0	1	1	1	0	1	4	9,22
N	0	0	0	0	0	1	0	0	0	0	0	0	1	4,43
CALM													0	0,
TOTAL	0	6	13	31	34	27	35	34	23	15	18	43	304	7,17

NUMBER OF INVALID OBSERVATIONS = 11
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL XBR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	0	0	0	0	2	2	2	0	0	2	8	10,63
NE	0	0	0	0	0	2	3	2	0	3	4	2	13	9,69
ENE	0	0	0	2	0	5	3	2	4	1	1	3	25	8,80
E	0	0	0	0	2	0	1	1	2	2	0	1	9	7,56
ESE	0	0	0	1	0	1	0	0	2	2	0	3	9	9,33
SE	0	0	1	1	1	0	1	2	1	0	0	2	11	7,64
SSE	0	0	0	0	1	0	1	1	0	0	0	1	4	7,70
S	0	1	0	1	1	2	0	1	0	0	0	4	10	7,47
SSW	0	0	0	0	1	0	2	1	2	0	2	5	13	8,96
SW	0	0	0	1	3	3	4	3	1	1	0	0	26	7,04
WSW	1	1	0	1	1	1	0	1	1	0	0	0	6	6,23
W	0	0	1	0	1	1	0	0	0	1	0	0	4	5,65
WNW	0	0	1	1	5	4	1	1	0	1	0	0	14	6,50
NW	0	0	1	1	1	1	0	1	1	1	2	4	13	11,45
NNW	0	1	0	0	0	0	0	0	0	0	0	1	2	9,45
N	0	0	0	0	0	2	0	0	0	0	0	0	2	5,48
CALM													0	0,
TOTAL	1	3	3	15	22	18	19	17	16	10	11	35	175	8,11

NUMBER OF INVALID OBSERVATIONS = 3
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL XBR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	0	1	0	1	1	4	3	2	3	1	4	21	9,43
NE	2	0	2	1	3	1	3	1	4	3	2	7	28	7,91
ENE	0	0	0	0	4	5	0	5	1	4	4	16	47	9,79
E	0	0	0	0	2	2	3	1	4	1	3	5	4	25	8,64
ESE	0	0	0	0	0	1	1	1	0	3	1	6	19	9,31
SE	0	0	0	2	2	4	2	2	1	4	1	1	5	26	7,31
SSE	0	0	0	2	2	1	1	3	1	2	0	0	3	18	6,86
S	0	0	0	0	2	2	4	4	6	2	2	0	5	27	7,78
SSW	0	1	1	5	1	1	3	7	4	4	3	7	39	8,26
SW	0	0	2	0	4	1	5	7	7	5	1	5	45	7,44
WSW	0	2	2	1	3	2	5	4	1	2	1	3	36	6,94
W	0	1	1	5	4	5	2	4	0	0	0	0	22	5,16
WNW	0	0	2	2	4	1	2	1	2	0	0	0	14	7,77
NW	0	0	1	4	4	1	2	4	5	1	3	17	52	9,80
NNW	0	1	0	1	2	4	3	2	3	1	0	4	25	9,05
N	0	1	0	2	1	1	2	2	1	1	2	4	18	7,80
CALM													1	,60
TOTAL	2	6	16	33	51	42	43	58	41	39	26	100	468	8,27

NUMBER OF INVALID OBSERVATIONS = 7
TOTAL NUMBER OF OBSERVATIONS = 8767

PASQUILL XDR (FROM AEC/DELTA-T CRITERIA 10-61 METERS)
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	3	5	5	10	10	11	6	15	26	17	38	140	9,19
NE	2	2	3	8	10	25	19	21	33	37	32	72	264	9,48
ENE	0	1	6	5	10	17	19	23	34	40	22	52	229	9,63
E	0	1	9	10	10	13	28	12	15	17	13	30	158	7,99
ESE	0	0	4	3	11	15	12	3	8	7	12	11	86	7,88
SE	0	0	1	5	12	12	2	9	11	14	7	43	116	10,00
SSE	0	1	1	4	5	8	12	9	10	9	11	48	120	10,44
S	0	4	2	7	4	9	8	19	15	10	10	53	151	10,24
SSW	1	2	3	7	8	21	15	22	19	22	19	61	220	10,25
SW	0	5	7	7	15	19	21	25	22	31	32	155	341	11,17
WSW	1	5	8	4	19	34	18	18	23	25	24	151	338	11,36
W	1	4	8	11	15	11	18	19	21	14	13	101	237	11,46
WNW	0	3	10	6	12	14	19	16	11	11	14	48	164	8,42
NW	0	4	4	9	17	18	15	15	17	8	11	43	124	9,46
NNW	0	4	8	12	6	15	9	19	10	14	9	42	152	9,07
N	0	5	4	5	8	7	10	8	11	8	6	17	88	7,93
CALM													8	,67
TOTAL	5	48	83	110	173	248	238	244	278	295	264	1065	2096	9,91

NUMBER OF INVALID OBSERVATIONS = 63
TOTAL NUMBER OF OBSERVATIONS = 8760

TABLE 2.3-42 (Continued)

PASQUILL #A (FROM AEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	2	5	7	9	10	11	5	6	11	38	105	9.30
NE	3	3	6	8	4	9	22	21	16	24	27	67	213	9.60
ENE	5	1	3	9	4	9	11	23	14	21	11	39	150	9.07
E	5	3	4	2	6	8	12	23	8	20	14	48	155	9.44
ESE	2	1	1	3	5	6	10	6	14	15	16	39	121	9.89
SE	0	4	2	1	8	5	7	6	14	12	10	68	139	10.79
SSE	0	0	2	4	9	7	5	12	11	14	21	99	184	12.28
S	0	4	1	1	5	9	9	14	14	17	22	117	213	12.04
SSW	1	4	1	2	10	19	12	24	24	25	24	180	324	11.37
SW	1	3	4	3	11	17	15	18	32	34	28	186	352	11.26
WSW	1	1	0	6	4	6	16	16	19	11	19	108	195	11.15
W	0	2	4	4	9	3	15	9	14	25	8	66	154	10.17
WNW	0	2	3	7	4	7	4	13	15	4	9	20	94	8.48
NW	0	2	6	7	6	3	9	11	11	4	11	49	121	9.83
NNW	0	1	4	2	7	5	3	8	9	13	7	39	98	10.64
N	0	4	5	3	4	5	4	4	5	9	10	13	77	7.91
CALM													14	.55
TOTAL	5	38	47	87	117	125	162	214	237	254	260	1178	2768	10.52

NUMBER OF INVALID OBSERVATIONS = 56
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL #B (FROM AEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	3	2	1	1	1	2	3	4	1	10	29	8.58
NE	0	0	3	4	3	6	2	4	5	4	4	44	81	10.17
ENE	0	3	2	1	3	4	7	5	3	13	11	30	82	9.66
E	0	1	1	4	2	3	2	2	6	7	12	11	71	10.47
ESE	0	1	1	2	1	2	3	5	4	5	6	37	68	11.57
SE	0	0	0	2	5	3	6	2	3	2	4	52	79	11.61
SSE	0	2	1	4	2	5	5	5	5	6	4	46	85	11.76
S	1	3	4	3	3	3	3	3	3	5	5	47	85	10.92
SSW	0	1	1	1	1	6	10	10	6	7	7	40	100	10.83
SW	0	4	2	3	7	6	2	9	7	10	9	70	128	10.65
WSW	1	2	4	1	1	4	2	1	4	7	3	32	62	10.18
W	1	1	1	3	4	1	6	3	6	2	2	25	55	9.35
WNW	0	0	1	1	3	3	7	6	5	4	7	8	45	8.58
NW	0	2	0	3	3	2	1	5	7	12	4	14	53	9.35
NNW	1	1	4	4	4	2	5	3	2	9	3	7	47	7.17
N	0	1	0	2	1	3	2	3	3	1	2	5	23	8.22
CALM													4	.55
TOTAL	4	23	30	42	43	54	64	68	72	98	87	518	1107	10.31

NUMBER OF INVALID OBSERVATIONS = 20
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL #C (FROM AEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	2	5	0	0	4	2	5	3	6	2	10	39	8.20
NE	0	2	6	3	2	5	2	5	4	3	3	19	53	8.79
ENE	0	1	4	3	3	5	2	2	4	0	3	11	38	8.22
E	0	3	2	1	2	2	1	10	10	6	6	16	59	9.16
ESE	0	3	2	1	1	3	2	2	4	1	1	14	34	9.77
SE	1	2	4	1	0	2	3	4	4	3	0	20	52	8.48
SSE	0	1	1	4	2	1	0	1	4	4	2	15	37	9.20
S	1	1	2	4	3	4	3	3	4	2	1	25	60	8.76
SSW	0	3	4	4	3	1	5	2	4	2	1	12	48	7.65
SW	0	2	1	4	3	5	5	2	3	6	2	30	70	9.57
WSW	0	2	2	4	4	3	4	6	7	9	8	36	83	10.07
W	0	1	3	3	4	4	5	5	5	8	5	9	54	7.91
WNW	1	0	2	2	3	2	2	4	3	5	1	9	45	7.55
NW	0	3	2	4	4	4	0	0	4	5	3	3	32	7.14
NNW	2	2	1	3	4	4	3	2	8	5	4	4	47	7.09
N	0	2	2	3	3	5	4	1	4	4	4	4	36	7.54
CALM													32	.54
TOTAL	5	29	45	48	51	66	48	54	79	74	51	237	819	8.26

NUMBER OF INVALID OBSERVATIONS = 16
TOTAL NUMBER OF OBSERVATIONS = 8760

PASQUILL ALL (FROM AEC/DELTA-T CRITERIA 10-61 METERS
WINDS AT 61.5 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	7	16	12	22	28	31	31	32	41	34	105	359	9.14
NE	4	7	19	27	27	51	54	55	62	77	77	223	683	9.61
ENE	0	6	15	21	25	45	47	64	73	85	56	159	597	9.17
E	0	8	10	21	30	30	50	60	66	56	51	131	499	8.84
ESE	2	5	8	11	20	31	33	17	37	36	39	113	352	9.58
SE	1	8	12	14	45	27	23	27	38	33	22	192	442	10.03
SSE	0	4	8	27	25	23	27	29	33	35	39	224	474	11.05
S	2	15	17	21	24	35	30	49	41	40	48	257	579	10.55
SSW	2	11	13	24	30	48	47	70	64	65	60	340	769	10.42
SW	1	16	17	27	45	74	61	67	74	87	77	456	1002	10.56
WSW	4	14	15	19	37	57	41	47	55	58	66	330	743	10.79
W	2	11	20	27	42	31	49	41	46	45	28	201	543	10.08
WNW	1	7	21	25	35	37	41	41	37	28	31	90	394	8.26
NW	0	14	11	32	43	31	29	39	48	35	34	151	467	9.38
NNW	3	10	17	24	23	35	20	35	33	47	20	103	370	9.11
N	0	11	11	15	24	25	26	20	26	23	23	43	247	7.80
CALM													59	.54
TOTAL	22	154	238	347	498	608	609	692	743	786	725	3118	8579	9.77

NUMBER OF INVALID OBSERVATIONS = 181
TOTAL NUMBER OF OBSERVATIONS = 8760

TABLE 2.3-43

MONTHLY AND ANNUAL PRECIPITATION
MEANS AND EXTREMES IN THE SITE AREA
(in inches)

Month	Mean[1]	Mean No. of Days >0.5 Inch[2]	Maximum Precipitation[3] Columbia (1948-1973)	Maximum Precipitation[3] Greenville-Spartanburg (1963-1973)
January	3.79	3	7.62 (1972)	6.14 (1972)
February	3.78	3	8.68 (1961)	7.43 (1971)
March	4.45	4	10.89 (1973)	9.66 (1963)
April	3.81	2	5.89 (1958)	11.30 (1964)
May	3.29	2	8.85 (1967)	8.89 (1972)
June	3.29	2	14.81 (1973)	9.59 (1969)
July	5.35	3	13.87 (1959)	7.44 (1964)
August	4.91	3	16.72 (1949)	7.51 (1967)
September	3.63	3	8.78 (1953)	7.98 (1966)
October	2.61	2	12.09 (1959)	10.24 (1964)
November	2.54	1	7.20 (1957)	5.31 (1972)
December	3.59	2	7.43 (1953)	7.55 (1973)
Annual	45.04	30		

(1) Based on 30 years of record (1931-1960) at Little Mountain, Santuck, and Winnsboro.

(2) Based on 10 years of record (1951-1960) at Little Mountain, Santuck, and Winnsboro.

(3) Year of occurrence is given in parentheses.

Source: References 1, 7, 11.

TABLE 2.3-44

MONTHLY AND ANNUAL AVERAGE SNOWFALL FOR THE SITE AREA AND EXTREMES FOR SELECTED STATIONS

(in inches)

		Maximum Snowfall[3]		
Month	Mean[1]	Columbia (1884-1930; 1948-1973)[2]	Greenville (1884-1930)[2]	Greenville-Spartanburg (1963-1973)
January	0.6	5.9 (1912)	12.9 (1893)	9.1 (1966)
February	0.9	16.0 (1973)	15.0 (1902)	6.9 (1969)
March	0.4	3.2 (1960)	9.7 (1927)	6.6 (1971)
April	T[4]	T	T	0.0
May	T	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0
October	T	0.0	T	0.0
November	0.1	3.3 (1901)	0.3 (1918)	1.9 (1968)
December	0.4	9.3 (1958)	14.4 (1930)	11.4 (1971)
Annual	2.4			

---

(1) Based on 68 years of record (1893-1960) at Little Mountain, 65 years of record (1896-1900) at Santuck and 64 years of record (1897-1960) at Winnsboro.

(2) Monthly extremes that occurred in 1930 or before are based on greatest amount in 24 hours and greatest snow depth of record.

(3) Year of occurrence is given in parentheses.

(4) T = trace, an amount too small to measure.

Source: References 1, 7, 11, 12.

TABLE 2.3-45

MEAN NUMBER OF THUNDERSTORM DAYS[1]
AT SELECTED STATIONS IN THE REGION

Period	Columbia (1948-1973)	Greenville (1884-1930)	Greenville-Spartanburg Airport (1963-1973)
January	1	*[2]	*
February	1	1	*
March	3	3	3
April	4	4	3
May	6	8	6
June	9	9	6
July	13	13	12
August	10	9	7
September	4	6	3
October	1	1	1
November	1	1	1
December	*	1	1
Winter	2	2	1
Spring	13	15	12
Summer	32	31	25
Autumn	6	8	5
Annual	54	56	43

(1) Defined as a day on which thunder is heard at the station.

(2) * = less than one half.

Source: References 1, 11, 12.

TABLE 2.3-46

MONTHLY VARIATION OF
EXTREME "FASTEST MILE" WINDS
AT COLUMBIA AND GREENVILLE-SPARTANBURG

Month	Columbia (1954-1973) Speed(mph)	Direction	Year	Greenville-Spartanburg (1963-1973) Speed(mph)	Direction(1)	Year
January	46	W	1964	44	SW	1967
February	40	SSW	1966(2)	44	SW	1966
March	60	W	1954	38	W	1963
April	40	W	1961	44	SW	1970
May	46	SW	1958	36	SW	1967
June	40	SW	1957	35	NW	1969
July	40	N	1965	52	NE	1966
August	44	SSE	1961	34	N	1973(2)
September	38	ESE	1959	31	NE	1964
October	27	SSW	1968(2)	31	NE	1964(2)
November	35	N	1967	32	S	1968
December	30	WNW	1954	47	NE	1963
Year	60	W	1954	52	NE	1966

(1) Direction recorded to 8 compass points only.

(2) Record also occurred in earlier year(s)

Source: References 1, 11.

2.4 HYDROLOGY

The South Carolina Electric & Gas Company (SCE&G) Virgil C. Summer Nuclear Station is located in Fairfield County, S. C., approximately 1 mile east of the Broad River and 3 miles north-northeast of Parr Dam. The site is situated on a hilltop at elevation 435' above mean sea level (MSL), or about 180 feet above the Broad River floodplain.

The following sections describe the site and its regional setting for both surface and ground water regimes. Water usage in the plant environs is discussed in Section 2.1.4.2. Information on water quality is presented in Section 2.2.2.2.

2.4.1 SURFACE WATER

2.4.1.1 Rivers and Streams

A network of small streams and a few major rivers, including the Enoree, the Tyger, and the Pacolet, drain the rolling, low-profile terrain into the Broad River. The Broad River is the major stream in the vicinity, draining an area of about 4,550 square miles above the site. Its headwaters are about 100 miles northeast of the site in North Carolina; to the south, at Columbia, it joins the Saluda River to form the Congaree River.

In addition to the major rivers, many small streams provide inflow into the system from surface runoff and ground water drainage. The average annual precipitation is 45 inches with a runoff of about 17 inches; this constitutes a runoff volume of 4.3 million acre-feet per year for the drainage basin above Parr Dam.

elevation 425.0'. For generating purposes, maximum daily withdrawal will be 29,000 acre-feet, which will lower the pool elevation to 420.5' and reduce the surface area to approximately 6,500 acres. Pumping operations during periods of off peak power demand will refill the reservoir. Figure 2.4-2 presents area and capacity curves for Monticello Reservoir.

Parr Reservoir lies about 1 mile west of the Virgil C. Summer Nuclear Station on the Broad River and will constitute the lower pool of the Fairfield Pumped Storage Facility (Figure 2.4-1). The reservoir is formed by Parr Dam, owned by SCE&G, about 3 miles south-southwest of the site. Parr Reservoir originally had a surface area of 1,850 acres, with normal surface elevation of 257.0', extending about 8.5 miles upstream from the dam. The dam crest has since been raised approximately 9 feet by the installation of spillway crest gates so that normal maximum elevation is 266.0'. The reservoir now extends approximately 13 miles upstream, with a usable storage capacity of 29,000 acre-feet and a surface area of approximately 4,400 acres. At normal minimum pool elevation of 256.0', the surface area is about 1,400 acres and the volume about 2,500 acre-feet. The operating drawdown of the pool will be about 10 feet. Figure 2.4-3 shows area and storage capacity curves for Parr Reservoir.

The only other reservoir within a radius of 50 miles from the site which may receive waterborne plant radionuclides is Columbia Reservoir. This reservoir is small, having a maximum surface area of only 265 acres. Columbia Dam, which forms the reservoir, is approximately 28 miles downstream of the Virgil C. Summer Nuclear Station on the Broad River and 2 miles upstream of the confluence of the Congaree River.

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In the site vicinity, the Broad River is about 2,000 feet wide and as much as 15 feet deep. It is, in general, shallow, with many rapids and very turbid so that it is used very little for recreation.

Drainage gradients on the Broad River and its tributaries are gentle, approximately 4 to 8 feet per mile below elevation 800'. Gradients steepen considerably above this elevation, to about 65 feet per mile near the Blue Ridge Mountains.

2.4.1.2 Lakes and Reservoirs

The nearest body of water to the site is Monticello Reservoir, currently under construction and expected to be filled by June of 1977. This reservoir, the upper pool of the Fairfield Pumped Storage Facility and the source of cooling water for the Virgil C. Summer Nuclear Station, has a drainage area of about 17 square miles. The reservoir is formed by the Frees Creek Dams (Figure 2.4-1). Due to the size of these dams, Frees Creek channel will be submerged to an average depth of 70 feet in the site vicinity. The main dam has a maximum height of 180 feet and a crest length of 5,000 feet. Three smaller saddle dams have lengths of 3,400 feet, 1,700 feet, and 900 feet. Maximum heights are from 50 to 90 feet and crest elevations are 434.0' (1). The dams are to be of earth-fill construction with appropriate riprap protection. Figure 2.1-3 shows the small portion of Monticello Reservoir which is isolated by additional small dams to form the service water pond. A small recreational area in the northern portion of Monticello Reservoir is also isolated, by S. C. 99 roadway dam, and is not subject to water level fluctuations.

The surface area of Monticello Reservoir is about 6,800 acres, and total volume is about 400,000 acre-feet at normal high water surface

elevation 425.0'. For generating purposes, maximum daily withdrawal will be 29,000 acre-feet, which will lower the pool elevation to 420.5' and reduce the surface area to approximately 6,500 acres. Pumping operations during periods of off peak power demand will refill the reservoir. Figure 2.4-2 presents area and capacity curves for Monticello Reservoir.

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2.4.1.3 Flow Characteristics

The nearest USGS streamflow gaging station to the site on the Broad River is gage 1615 at Richtex, S. C. This station, which is about 10 miles downstream from Parr Dam, has a contributing drainage area of approximately 4,850 square miles. Streamflow measurements began in October 1925. An average discharge of over 6,000 cubic feet per second (cfs) has been observed over the period of record (2). A map of the Broad River drainage basin at the Richtex gaging station is shown on Figure 2.4-4.

Gage 1565 on the Broad River near Carlisle, S. C. is about 21 miles upstream of the site (Figure 2.4-4). Streamflow measurements began in October 1938, and an average discharge of almost 4,000 cfs has been recorded over the period of record. This station is upstream of the confluence of the Tyger and Enoree Rivers and has a contributing drainage area of approximately 2,790 square miles, about 40 percent less than that at the site (2).

The Richtex gage provides the more suitable data from which to estimate flow characteristics at the site, because the drainage area is closer to the size of the drainage area at the site - only about 7 percent greater - and the period of record at Richtex is longer than at Carlisle.

2.4.1.3.1 Floods

Data from the Richtex gage indicate that there are two flood seasons, one from January to April and the other from July to October. Floods in the latter period have always been associated with hurricanes and have usually been of greater magnitude than those occurring from January to April (3). The peak discharge of the flood of record at Rich-

tex is 228,000 cfs, which occurred on October 3, 1929. Table 2.4-1 presents a summary of the major historical floods at Richtex, their peak discharge rates, and maximum water-surface elevations. Also included is an estimate of the corresponding discharges and elevations at Parr Dam. The discharge estimates at Parr were obtained by multiplying the values at Richtex by the ratio of the two drainage areas. Elevations were estimated using the weir equation, with Parr Dam having a 2,000 foot crest at the original elevation 257.0'. A weir discharge coefficient of 3.97 was adopted for the spillway section (4). Backwater losses have not been included, since the site is only a short distance upstream from the dam and such losses would be minor when the river is in flood stage.

On a frequency basis, the 228,000 cfs flood of record at Richtex has a corresponding return period of between 100 and 200 years. A complete tabulation of flood magnitudes at Richtex, based on a Log-Pearson Type III frequency analysis over the years 1926 to 1975, is shown in Table 2.4-2. Flood magnitudes having return periods from 1.01 to 500 years have been included.

2.4 1.3.2 Low Flow

Information on historic low flows is also available at the Richtex gaging station. The lowest observed average daily flow has been 149 cfs, which occurred on October 13, 1935 and on September 2, 1957 (2). The lowest average flow over a period of seven consecutive days has been 593 cfs, which occurred in 1954. In contrast, the seven day once-in-ten-year low flow is estimated to be 860 cfs (5). Other average low-flow statistics at Richtex for 7 to 274 consecutive days and 2 to 40 year return periods are presented in Table 2.4-3.

2.4.1.3.3 Storage Adequacy

Inflow to Monticello Reservoir will consist of rainfall intercepted on the pool surface, runoff from the Frees Creek drainage basin, and pumpage through the Fairfield Pumped Storage Facility. The average annual rainfall of 45 inches falling into Monticello Reservoir corresponds to an average natural inflow rate of about 35 cfs. Since Monticello Reservoir will inundate nearly 70 percent of the total Frees Creek drainage basin, runoff into Monticello Reservoir from the remainder of the catchment area will be greatly decreased and has been neglected in the water balance. Ambient evaporation from Monticello Reservoir has been estimated at 33 cfs, with an additional 13 cfs latent evaporation from condenser water. The total evaporation rate, 46 cfs, will produce a net flow deficit of about 11 cfs, which must be provided by pumpage through the Fairfield Pumped Storage Facility to maintain a long-term water balance.

As was discussed in Section 2.4.1.2, Monticello and Parr Reservoirs are to be interconnected by means of the Fairfield Pumped Storage Facility. The average pumpage rate during a 9 to 10 hour period at night will be 40,000 cfs. During the day, power generation takes place during an 8- to 9 hour period at a rate of about 44,000 cfs. These two volumes of water are equivalent and result in no net gain or loss of water from Monticello and Parr Reservoirs.

Sources of net inflow to Parr Reservoir consist of rainfall interception on the pool surface and the natural streamflow from the Broad River. The average annual rainfall over Parr Reservoir corresponds to an inflow rate of about 23 cfs. Ambient evaporation from Parr Reservoir has been estimated as 10 cfs, for a net local surplus of 13 cfs. This amount alone is more than enough to provide the 11 cfs makeup required by Monticello Reservoir.

An additional water surplus will be obtained from inflow from the Broad River. The average daily flow of the Broad River at Parr Reservoir is 5,600 cfs. This value, reduced by the 149 cfs minimum release rate at Parr Dam, results in a net inflow surplus of 5,451 cfs. Including the net local surplus of 13 cfs as calculated above, a total net surplus under "average" conditions of 5,464 cfs will be obtained. Even during the seven day once-in-ten-year low flow, discussed in Section 2.4.1.3.2, the Broad River streamflow is about 860 cfs. Under these conservative conditions, the net flow surplus is computed to be about 724 cfs.

2.4.2 GROUND WATER

Ground water at and around the site occurs under water table conditions in bedrock fractures and the lower zone of overburden soils. There is no artesian aquifer at the site, and ground water at the site does not recharge any artesian aquifer.

Depth to the water table at the site (prior to filling Monticello Reservoir) ranges from elevation 350' to 420', as shown in Figure 2.4-5. Lenses of perched water occur locally. Recharge of ground water at the site is by infiltrating precipitation at and near the site.

Data obtained from on-site observation wells show that the principal direction of flow prior to filling Monticello Reservoir is northeast in the direction of the sloping land surface into Frees Creek, a tributary of Broad River (Figure 2.4-5). The water table gradient is quite flat at the site, ranging from .005 to .07 feet/foot. Laboratory permeability tests, indicative of vertical permeability, performed on selected samples ranged from 33.5×10^{-2} to 4.8×10^{-4} feet per day for silty sand and sandy silts to 6.8×10^{-2} feet per day for clayey sands (Table 2.4-4). Typical field permeabilities, considered to represent

horizontal permeability, measured in soil and rock at the site are presented in Table 2.4-5. Representative ground water quality data are presented in Table 2.4-6. These data were obtained from on-site borings prior to filling of Monticello Reservoir.

After impoundment of Monticello Reservoir to elevation 425', ground water elevations and gradients at the site and around the reservoir are expected to change. After filling, the reservoir elevation of 425' will be higher than the existing water table at the plant site. It is estimated that the water table will ultimately rise from its present level and will approach elevation 420' at the plant site. Wells near the reservoir with water levels below elevation 420' will likely experience an increase in water level. The amount of the increase will depend on the original well water elevation and its distance from the reservoir. At the plant site, the ground water flow direction will probably be reversed from northeast to the south and west in the direction of the Broad River as a result of the impoundment. There are no domestic or industrial wells down gradient of this predicted flow.

2.4.3 REFERENCES

1. Federal Power Commission, "Final Environmental Impact Statement, Parr Project, No. 1894 - South Carolina," March 1974.

2. U. S. Geological Survey, "Surface Water Records of South Carolina," annual publication, water years 1961 - 1974.

3. U. S. Geological Survey, "Magnitude and Frequency of Floods in the United States," Water Supply Paper 1673 Part 2-A, 1964.

4. Henderson, F. M., "Open Channel Flow," MacMillan and Company, 1966.

5. U. S. Geological Survey, "South Carolina Streamflow Characteristics: Low-Flow Frequency and Flow Duration," 1967.

TABLE 2.4-1

MAJOR HISTORICAL FLOODS AND AVERAGE FLOW ON THE BROAD RIVER

Date	Observed at Richtex Gaging Station		Estimated at Parr Dam	
	Peak Discharge (cfs)	Water Elevation (Feet, msl)	Peak Discharge (cfs)	Water Elevation (Feet, msl)
October 3, 1929	228,000	215.54	214,000	266.0
August 17, 1928	222,000	214.94	208,000	265.8
April 8, 1936	157,000	209.80	147,000	264.0
August 16, 1940	120,000	205.92	113,000	262.9
October 18, 1964	102,000	204.09	96,000	262.3
Average Flow	6,000	185.20	5,600	257.8

TABLE 2.4-2

FLOOD FREQUENCY AT RICHTEX, SOUTH CAROLINA

Return Period (Year)	Theoretical Peak Flood Discharge (cfs)
1.01	22720
1.05	29550
1.11	34272
1.25	41329
2.00	60572
5.00	91710
10.00	115437
25.00	149056
50.00	176819
100.00	206979
200.00	239841
500.00	287927

TABLE 2.4-3

LOW FLOW FREQUENCY AND DURATION AT
RICHTEX, SOUTH CAROLINA

Low Flow Duration (Consecutive Days)	Lowest Average Flow (cfs) For Indicated Return Period (Years)				
	2	5	10	20	40
7	1,650	1,110	860	680	540
30	2,010	1,360	1,060	825	650
60	2,330	1,590	1,240	990	790
120	2,960	2,030	1,610	1,300	1,060
274	4,360	3,250	2,700	2,300	1,970

TABLE 2.4-4

LABORATORY PERMEABILITY TEST DATA -
MAJOR PLANT STRUCTURE AREA

Soil Description	Boring	Depth (Feet)	Permeability (ft/day)	Permeability (cm/sec)
Micaceous fine sandy silt	N-19	65	4.8×10^{-4}	1.7×10^{-7}
Micaceous silty fine to medium sand	N-22	40	4.0×10^{-2}	1.4×10^{-5}
Micaceous silty fine to medium sand	3-2	40	13.6×10^{-2}	4.8×10^{-5}
Silty fine to medium sand	3-3	60.5	17.0×10^{-2}	6.0×10^{-5}
Sandy silty clay	3-5	5.5	6.8×10^{-2}	2.4×10^{-5}
Micaceous silty fine to medium sand	3-9	75.5	33.5×10^{-2}	11.8×10^{-5}
Micaceous silty fine to medium sand	3-17	30	16.8×10^{-2}	5.9×10^{-5}

TABLE 2.4-5

FIELD PERMEABILITY TEST DATA - SERVICE WATER POND AREA

Horizon	Boring No.	Depth Range of Tests(ft.)	Average Permeability ($cm/sec \times 10^{-5}$)
Colluvium/ Residual Soils	SD- 5b	5.0- 14.5	0.18
	SD- 8b	6.4- 16.0	0.48
	ED- 4	5.5- 10.0	1.1
	SS- 3	4.0- 7.0	0.62
Saprolite	ND- 7	8.0- 15.0	2.3
	ND-13	4.0- 27.0	0.70
		27.0- 30.0	7.6
		30.0- 33.0	150.0+
	ND-11a	14.0- 15.5	29.0++
		19.0- 25.5	6.4
	ND-20	13.0- 24.5	3.7
	ND-23	9.0- 25.0	0.96
	ND-25	9.0- 14.0	0.18
		14.0- 29.0	2.2
	SD- 6	4.2- 8.2	0.34
		14.6- 18.0	1.2
	ED- 4	14.6- 37.0	3.0
	SS- 3	7.0- 37.0	5.9
Decomposed Rock	ND- 7	15.0-136.0	0.94
	ND- 9	4.0- 20.0	0.55
	ND- 9a	20.5- 35.0	0.54
		35.0- 45.0	1.8
		45.0- 70.0	0.46
	ND-20	25.0- 38.8	0.60
	ND-22a	4.0- 30.0	0.77
	ND-23	25.0- 40.0	1.8
		40.0- 54.0	2.5
	ND-24	4.0- 29.0	0.64
	SD- 5b	14.5- 18.0	0.54
		18.0- 20.8	3.6
	SD- 6	18.0- 38.0	2.5
	SD- 8b	19.2- 25.0	4.1
	ED- 4	37.0- 40.0	1.7
Fractured Rock	ND-13	33.0- 34.0	1000.0 (est)
	ND-25	29.0- 30.0	320.0
	SD- 5	35.5- 44.0	33.0
	SD- 8	42.0- 55.0	25.0
Intact Rock	ND- 1	21.0- 38.5	5.6
	ND-11a	40.0-146.5	4.5
	ND-21	29.5-146.5	0.60
	SD- 5	44.0-146.0	4.2
	SD- 6	38.0- 52.0	2.6
	ED- 4	40.0- 48.5	2.4

\+ Influenced by fractured rock at 34 feet

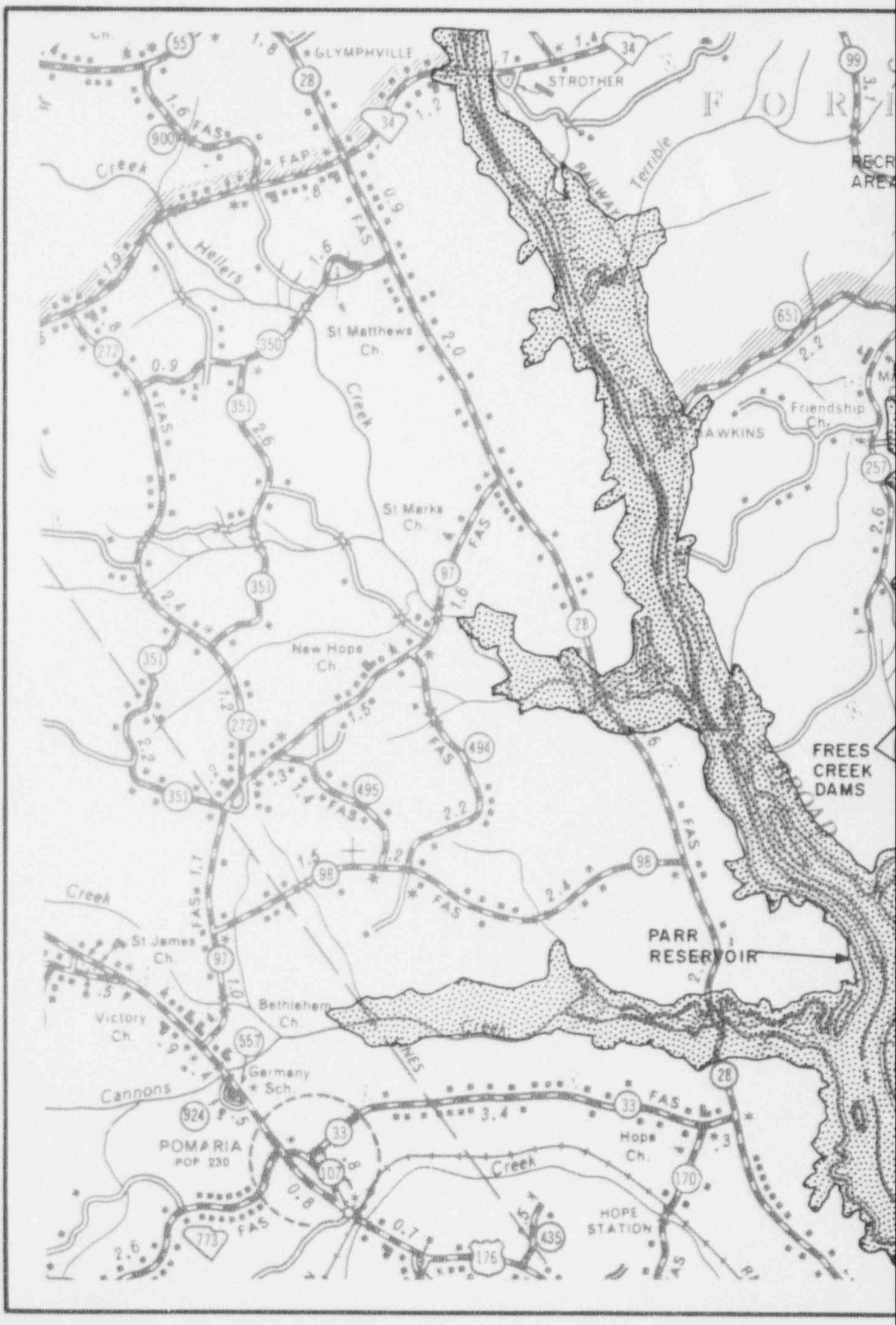
++ Influenced by very loose alluvium at 13.5 feet.

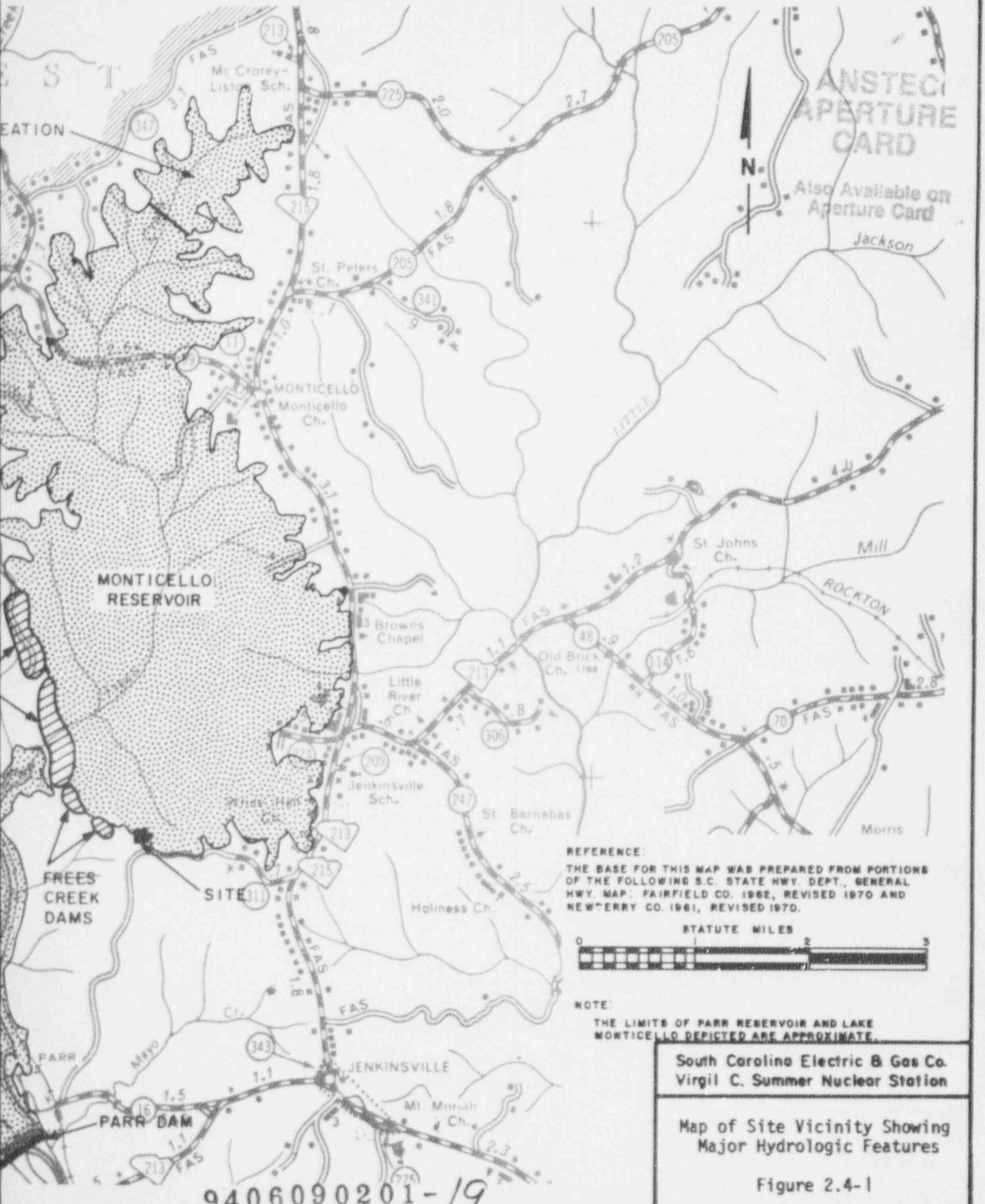
TABLE 2.4-6

GROUND WATER QUALITY RESULTS

	Boring N-23	Boring 3-14	Boring 3-2
pH	6.6	6.7	7.0
Alkalinity (phenolphthalein)	0 ppm	0 ppm	0 ppm
Alkalinity (methyl orange)	29 ppm	50 ppm	45 ppm
Sodium Chloride	7.37 ppm	10.36 ppm	5.38 ppm
Total Hardness	16 ppm	42 ppm	28 ppm
Calcium Hardness	12 ppm	30 ppm	16 ppm
Magnesium Hardness	4 ppm	12 ppm	12 ppm
Conductivity	60 µmhos	140 µmhos	100 µmhos
Dissolved Solids	50 ppm	608 ppm	332 ppm
Silica	4.7 ppm	22.5 ppm	16.5 ppm
Iron	2.6 ppm	2.7 ppm	4.9 ppm
Copper	0.8 ppm	0.7 ppm	1.0 ppm

ppm = parts per million
µmhos = micromhos


GLYMPHVILLE
STROTHER
Terrible
RAILWAY
Creek
Hellers
St Matthews Ch.
St Marks Ch.
New Hope Ch.
DAWKINS
Friendship Ch.
FREES CREEK DAMS
PARR RESERVOIR
St James Ch.
Victory Ch.
Bethlehem Ch.
Germany Sch.
Cannons
POMARIA
POP 230
Hope Ch.
HOPE STATION
FAS
FAP



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Virgil C. Summer Nuclear Station

Map of Site Vicinity Showing Major Hydrologic Features

Figure 2.4-1

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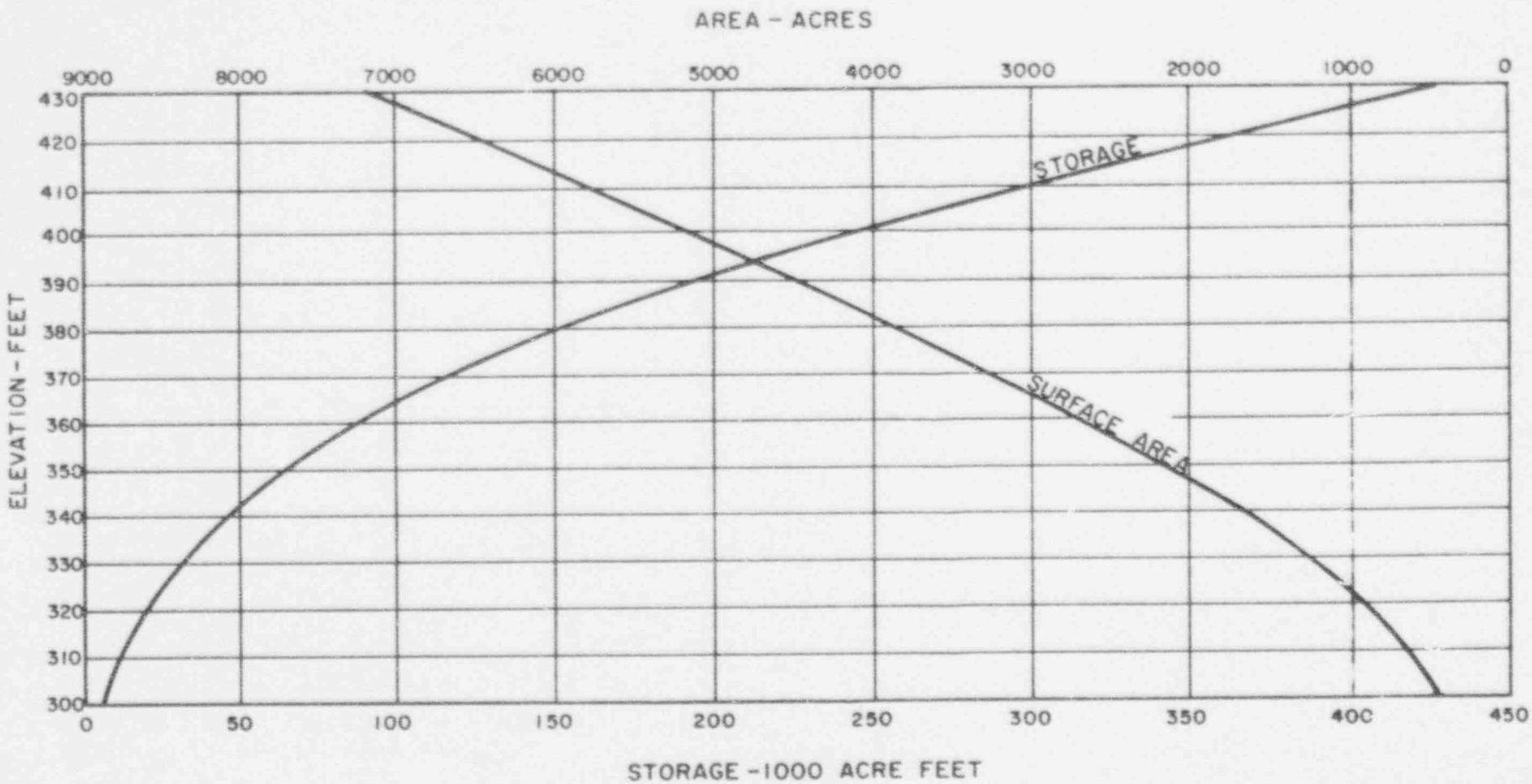

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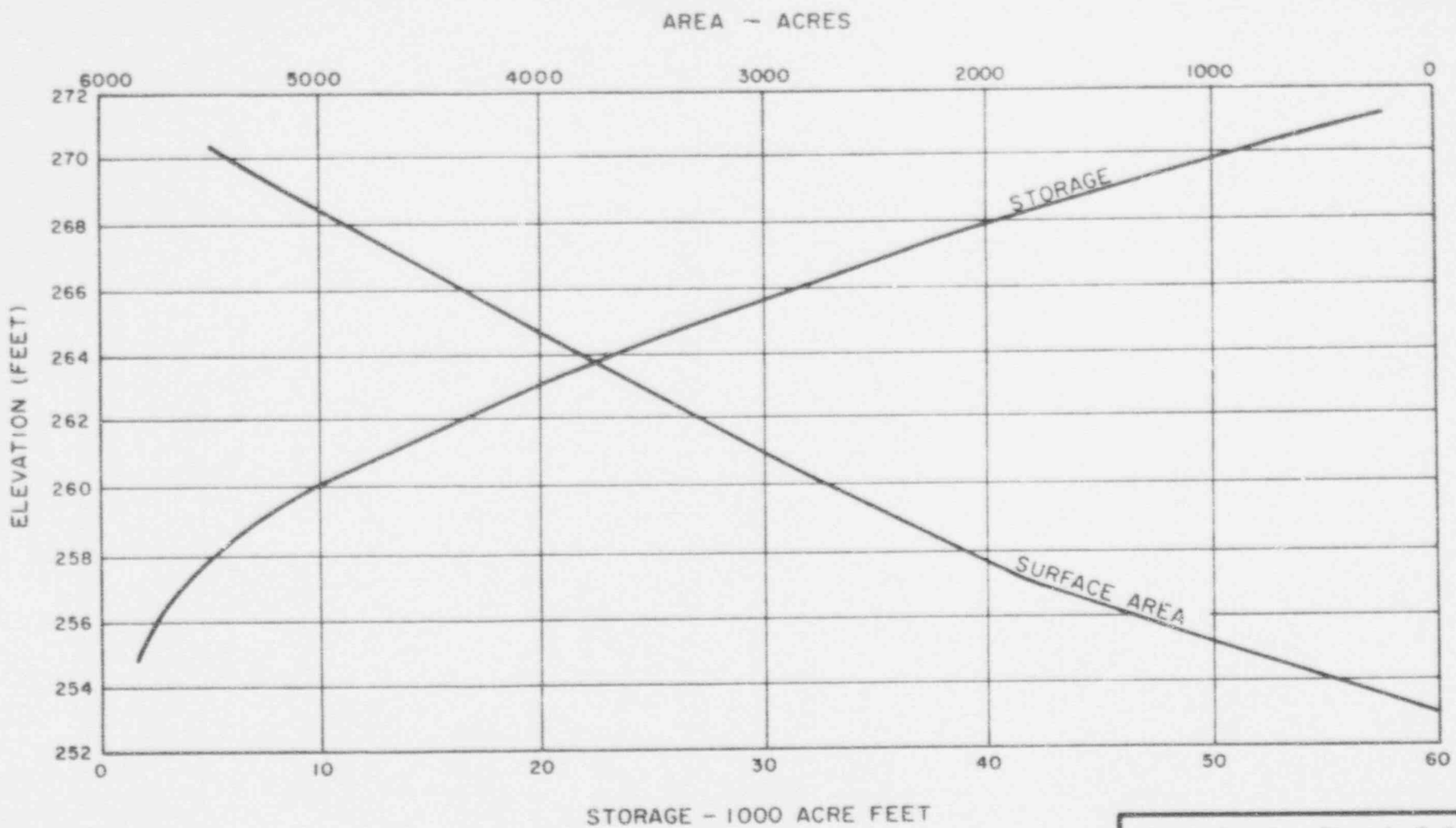
Virgil C. Summer Nuclear Station

Monticello Reservoir Area and Capacity Curves

Figure 2.4-2



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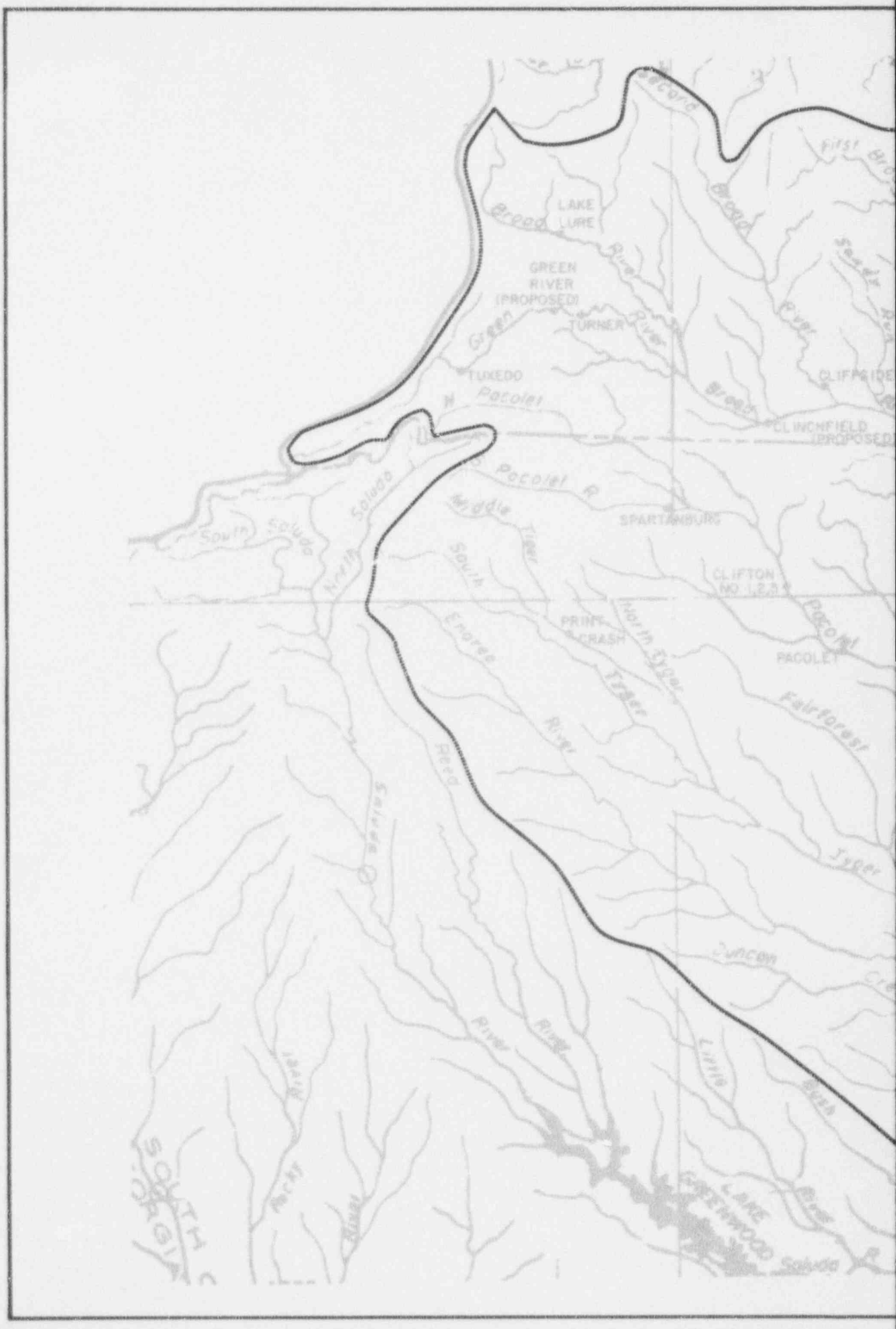
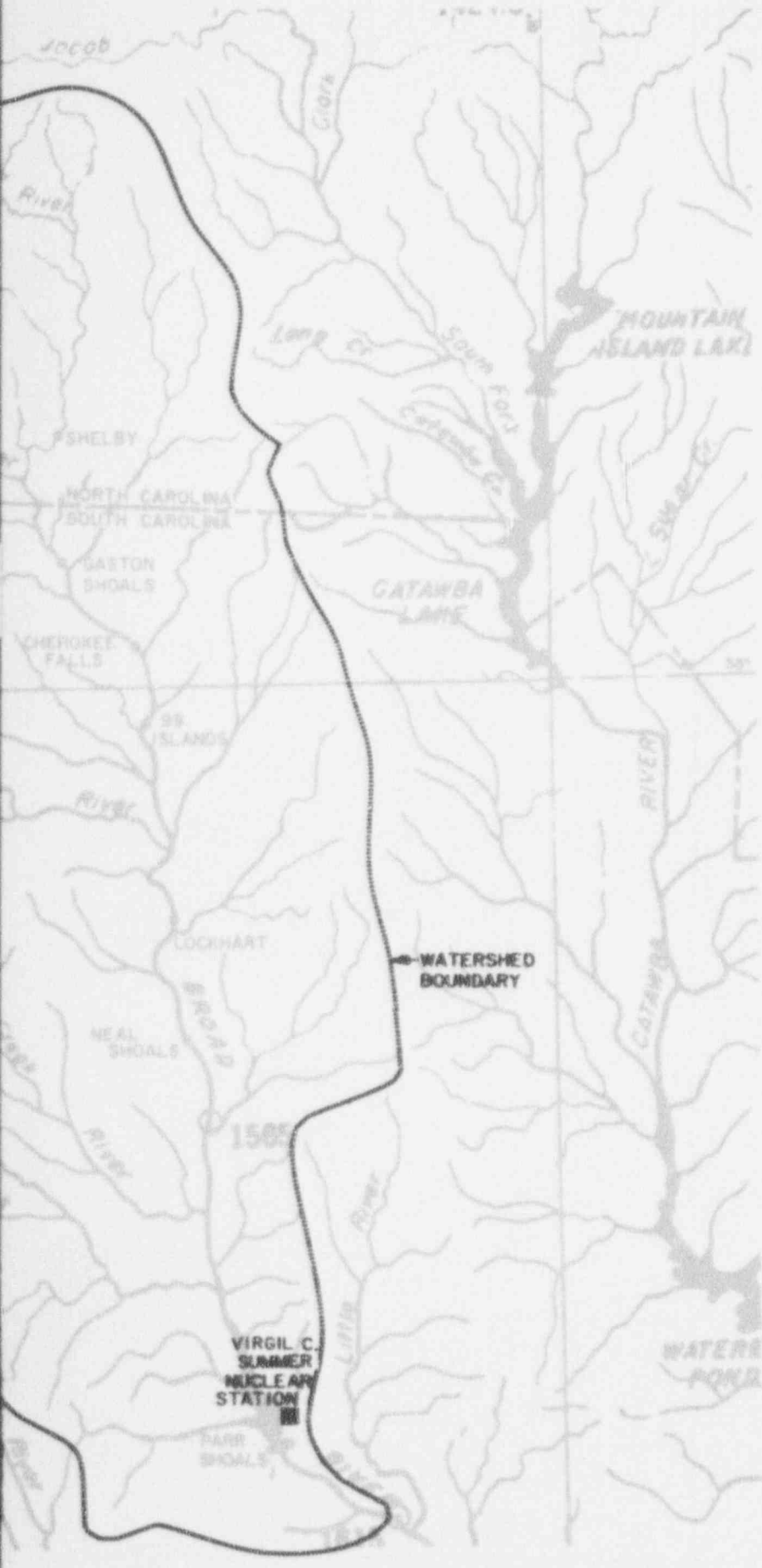
Parr Reservoir Area
and Capacity Curves

Figure 2.4-3


LAKE LURE
GREEN RIVER (PROPOSED)
TURNER
TUXEDO
N Pacolet
S Pacolet R
SPARTANBURG
CLIFTON NO 1,2,3
PACOLET
PRINT CRASH
CLINCHFIELD (PROPOSED)
CLIFFSIDE
Broad River
Green River
Middle Tyger
South Tyger
North Tyger
Enoree River
Fairforest
Tyger
Duncan
Little
Bush
Reed
Saluda
South Saluda
North Saluda
Pacolet
Saluda R
LAKE GREENWOOD
SOUTH



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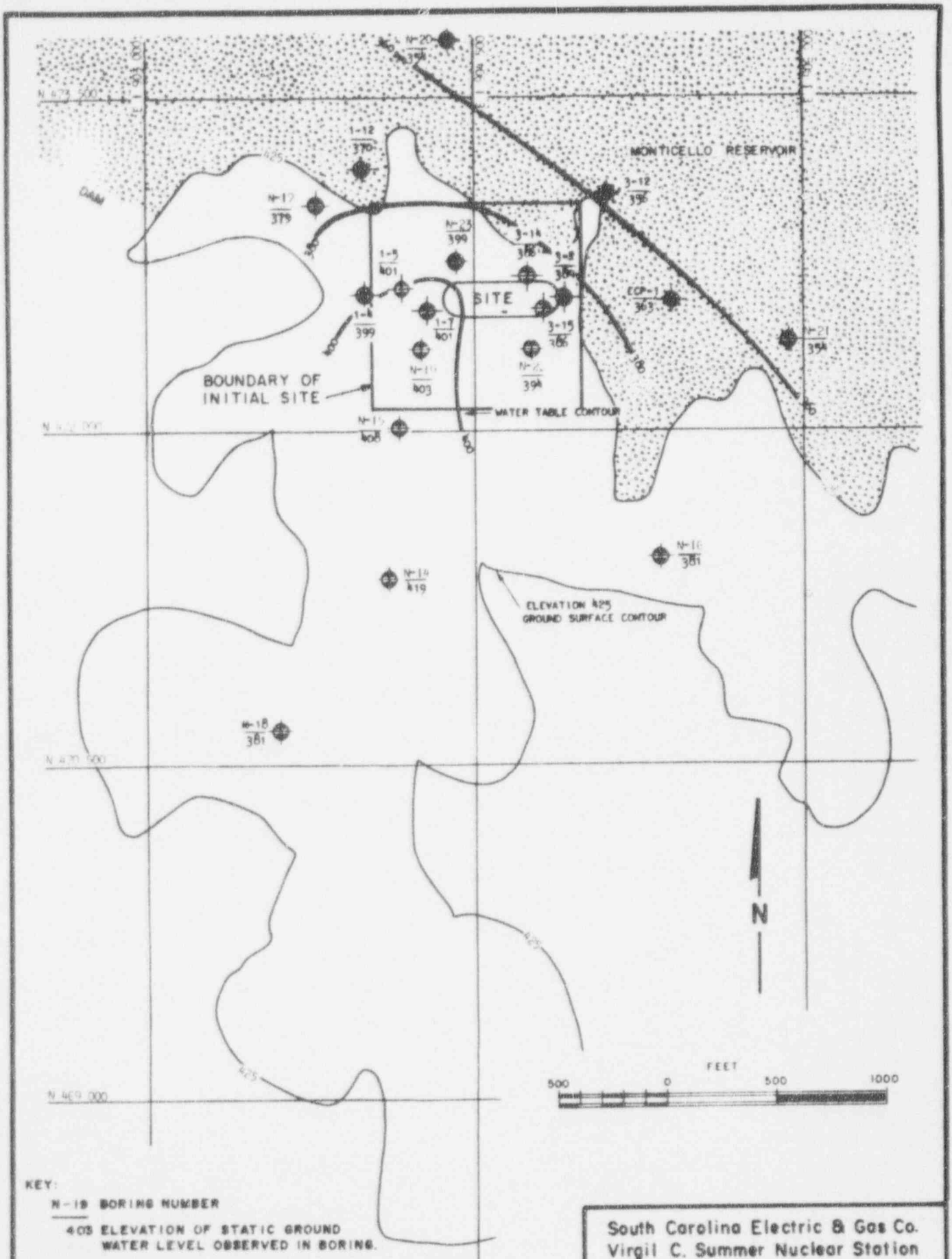
The Broad River Watershed at Richtex, S.C. Including Significant Existing and Proposed Dams

Figure 2.4-4



KEY:

N-19 BORING NUMBER

403 ELEVATION OF STATIC GROUND WATER LEVEL OBSERVED IN BORING.

NOTE:

CONTOURS OF WATER TABLE EVALUATED FROM WATER OBSERVATIONS ON BORINGS PRIOR TO FILLING OF MONTICELLO RESERVOIR. ONLY BORINGS IN WHICH WATER LEVELS WERE TAKEN ARE SHOWN.

N-24 / 333

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Site Water Table

Figure 2.4-5

2.5 GEOLOGY

The site is within the Piedmont Physiographic Province (shown in Figure 2.5-1), which is characterized by rolling hills. The immediate site area is characterized by gently to steeply rolling hills and generally well-drained mature valleys which empty into the Broad River. Maximum topographic relief across the area is approximately 250 feet.

A series of northeast-southwest trending belts of metamorphic and plutonic rocks characterize the bedrock within the Southern Piedmont. In South Carolina, six belts are recognized (Figure 2.5-2); these are the Carolina State Belt, Charlotte Belt (within which the site generally lies), Kings Mountain Belt, Inner Piedmont Belt, Brevard Belt, and the Blue Ridge Belt. It is generally thought that these rocks were formed 250 to 600 millions of years ago (1). The latest tectonic movements at the site were dated radiometrically to have occurred most probably 150 to 300 millions of years ago, but at least 45 millions of years ago at the latest.

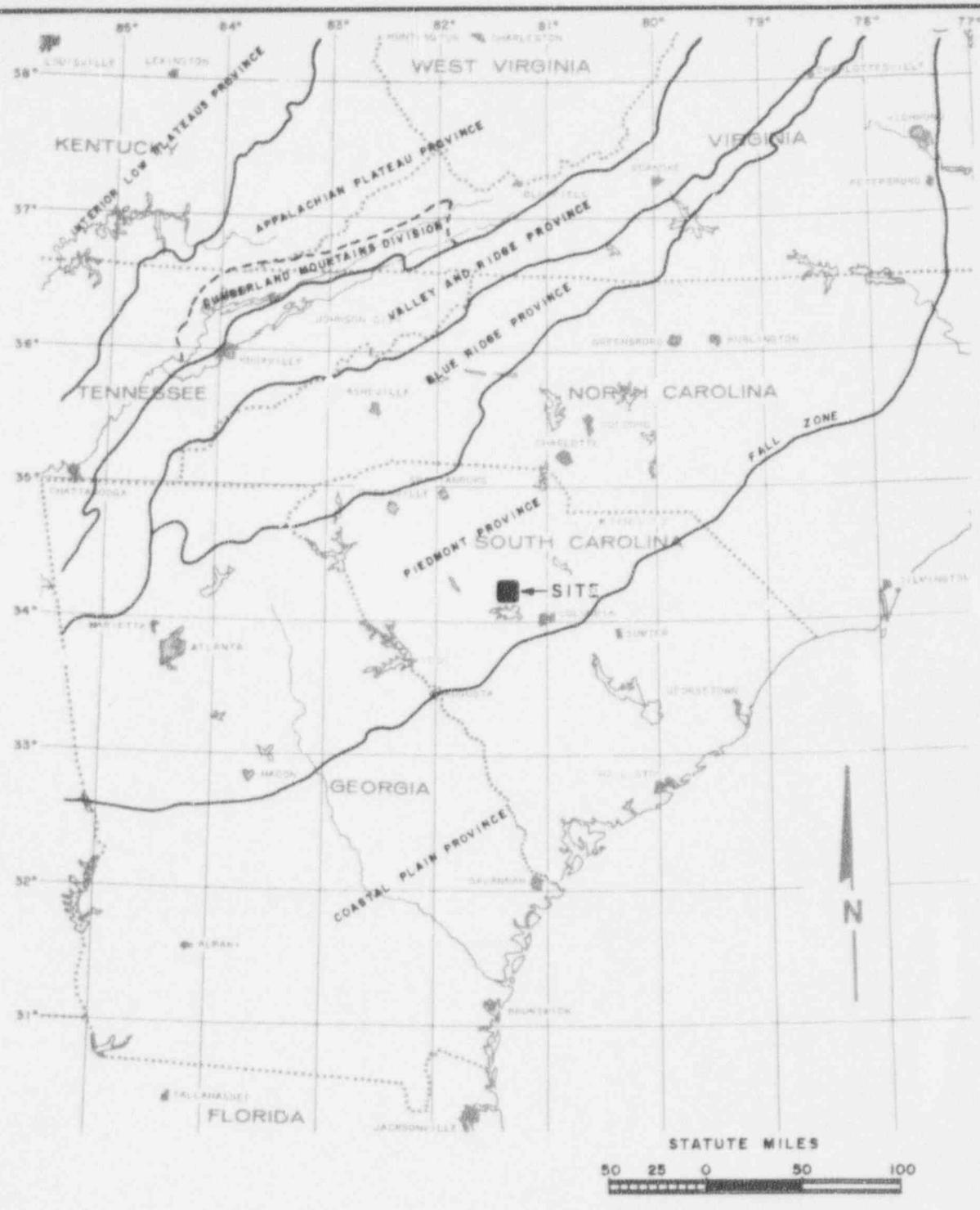
Bedrock at the site consists of a complex series of almandine-amphibolite facies metamorphic rocks of the Charlotte Belt lithologies. These rocks consist of interlayered and folded hornblende-plagioclase gneiss, quartz-feldspar gneiss, amphibolite gneiss, amphibolite, biotite gneiss, and biotite-muscovite schists, all of which have been intruded by granite/granodiorite plutons. Migmatites, most of which were formed during placement of the plutons, generally occur gradationally between the plutons and surrounding country rock. Greenschist facies metamorphic rocks of the Carolina Slate Belt are present generally in the southernmost portion of the site area. These consist of quartz-feldspar-muscovite/biotite schist, amphibolites, and quartzites. The geology of the site area is presented on Figure 2.5-3.

The site overburden is typical of the Piedmont Physiographic Province. Residual soil ranging in thickness from about 40 to 85 feet overlies the parent bedrock. The soil generally grades from a clayey and silty material near the ground surface, where the weathering has been greatest, to a dense sandy silt and silty sand (saprolite) at depth. The saprolite in turn grades with depth to weathered rock and then to unweathered rock. Alluvial and colluvial soils overlie residual soils in the small valley which contains the service water pond. These transported soils were removed where encountered at locations of the north dam, south dam, and west embankment in order to properly prepare foundations for these embankments.

Microseismic events could result from initial filling and reservoir loading fluctuations of Monticello Reservoir. However, the maximum activity would be expected to occur shortly after filling, with a gradual reduction in activity afterwards in adjustment to the imposed pore pressures. The weight of water surcharge on the reservoir bottom would be negligible (on the order of 60 to 70 psi); therefore, deformation of the substrata in the magnitude to produce stresses capable of inducing macroseismic activity (> Intensity II MM) is highly unlikely. Potential microseismic events should have no effect upon the safe operation of the facility. In an effort to identify and quantify potential microseismic events, a microseismic monitoring program is currently being implemented.

2.5.1 REFERENCES

1. Fisher, G. W., Ed., "Studies of Appalachian Geology: Central and Southern New York," Interscience Publishers, 1970.



REFERENCE:

THE BASE FOR THIS MAP WAS PREPARED FROM A PORTION OF THE U.S.G.S. "IFR WALL PLANNING CHART, EAST AND WEST, 1967."

PHYSIOGRAPHIC DIVISIONS TAKEN FROM PHYSIOGRAPHY OF EASTERN UNITED STATES BY N. M. FENNEMAN, 1938.

South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Regional Physiographic Map

Figure 2.5-1

The site overburden is typical of the Piedmont Physiographic Province. Residual soil ranging in thickness from about 40 to 85 feet overlies the parent bedrock. The soil generally grades from a clayey and silty material near the ground surface, where the weathering has been greatest, to a dense sandy silt and silty sand (saprolite) at depth. The saprolite in turn grades with depth to weathered rock and then to unweathered rock. Alluvial and colluvial soils overlie residual soils in the small valley which contains the service water pond. These transported soils were removed where encountered at locations of the north dam, south dam, and west embankment in order to properly prepare foundations for these embankments.

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2.5.1 REFERENCES

1. Fisher, G. W., Ed., "Studies of Appalachian Geology: Central and Southern New York," Interscience Publishers, 1970.

2.6 REGIONAL HISTORIC, SCENIC, CULTURAL, AND NATURAL FEATURES

Sites of historic, scenic, cultural, or natural significance within 5 miles of the Virgil C. Summer Nuclear Station are identified in Figure 2.6-1. In Fairfield County there are 10 sites; these include 6 in the National Register of Historic Places, and 4 which are listed by the Central Midlands Historic Preservation Survey (1). The Survey also lists two sites which are in Newberry County across the Broad River from the plant.

The sites listed in the National Register are: 1) Ebenezer Associate Reformed Presbyterian Church (Old Brick Church), 2) Kincaid-Anderson Home (Fairfield or Heyward Hall), 3) Little River Baptist Church, 4) Davis Plantation (Davis-Robinson Plantation), 5) Blair Mound, and 6) McMeekin Rock Shelter.

Those from the Central Midlands Survey are: Monticello Methodist Church, White Hall African Methodist Episcopal Church, the Chappell Place, and Mayfair, in Fairfield County and the Summer Huggins House and St. John's Lutheran Church in Newberry County.

Initially it may be possible to see the plant from three historic buildings: the Monticello Methodist Church, the White Hall African Methodist Episcopal Church, and the Davis-Robinson Plantation. The 425' contour which marks the high water line of the reservoir is about 1,000 feet from the plantation.

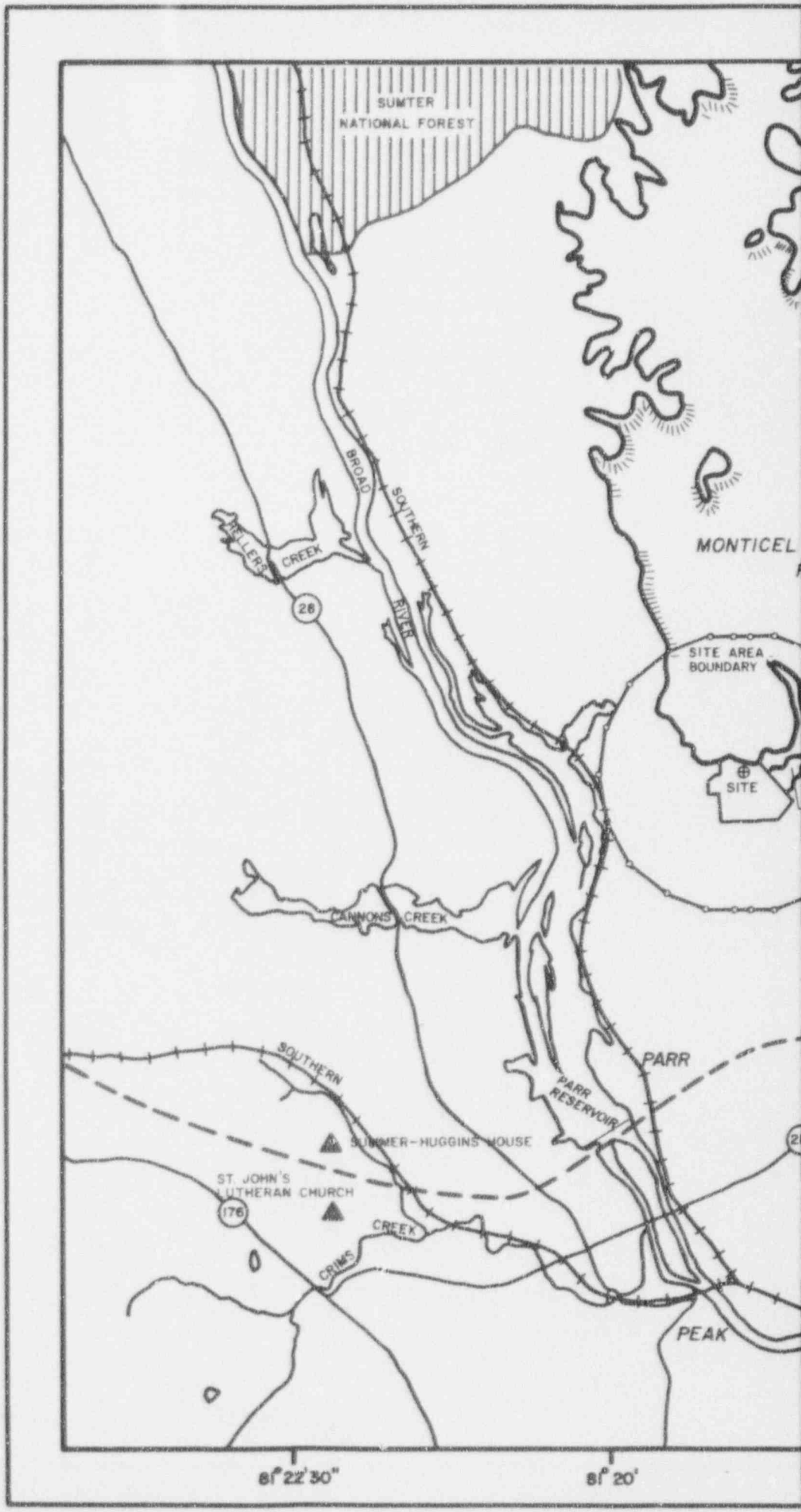
Drawings applicable to the possible visual impact of the plant are found in Section 3.1. Discussions of transmission facility impacts on these resources are given in Section 3.9.

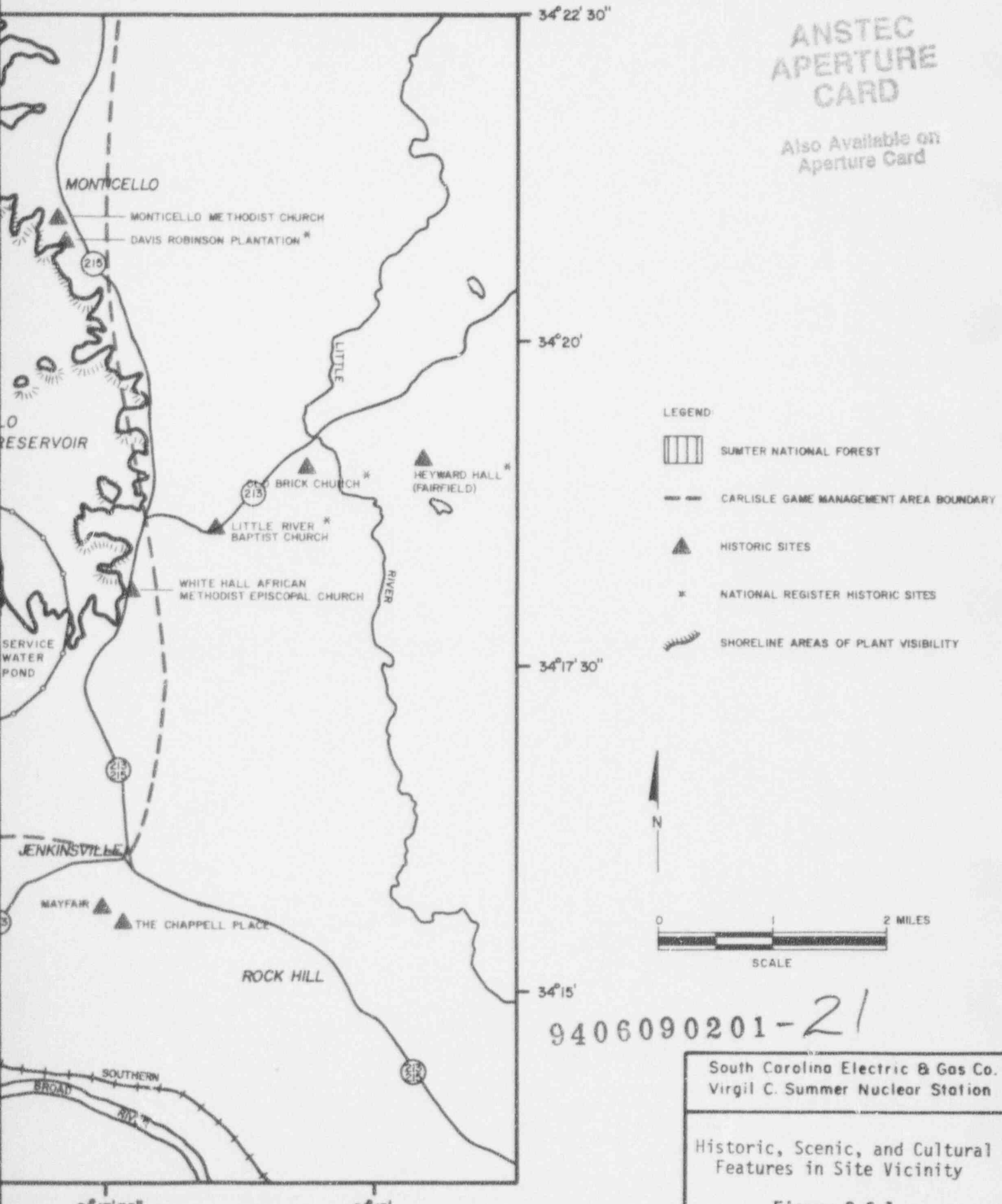
A copy of the comments concerning the effect of the project on historic, archeological, and cultural resources of the area by the State Historic Preservation Officer follows this section.

South Carolina Electric & Gas Company and South Carolina Public Service Authority have sponsored a survey by George Teague of the Institute of Archeology and Anthropology, University of South Carolina. The results of the survey are unknown at this time. Conversation with Robert L. Stevenson, director and state archeologist, revealed that 38FA41 and 38FA48, along with numerous other archeological sites, will be inundated by Parr and Monticello Reservoirs. Fairfield County sites listed by the Central Midlands Historic Preservation Survey which will probably be flooded by the Fairfield Pumped Storage Facility are 38FA37 through 38FA48 and 38FA50 through 38FA52. Locations of these archeological sites are not given on Figure 2.6-1 because, in order to preserve the sites, details as to location are not made public (1).

2.6.1 REFERENCES

1. Central Midlands Regional Planning Council, "An Inventory and Plan for the Preservation of Historical Properties in the Central Midlands Region," Prepared for the South Carolina Department of Archives and History, Central Midlands Regional Planning Council, Columbia, South Carolina, June 1974.


SUMTER
NATIONAL FOREST
BROAD
SOUTHERN
RIVER
MILLERS CREEK
28
MONTICEL
SITE AREA
BOUNDARY
SITE
CANNONS CREEK
SOUTHERN
PARR
PARR
RESERVOIR
SUMMER-HUGGINS HOUSE
ST. JOHN'S
LUTHERAN CHURCH
176
CREEK
CRIMS
PEAK
81° 22' 30"
81° 20'



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Historic, Scenic, and Cultural Features in Site Vicinity

Figure 2.6-1

TABLE OF CONTENTS (Continued)

Section	Title	Page
3.6.3	Steam Generator Blowdown	3.6-6
3.6.4	Ion Exchange Regenerant Wastes	3.6-6
3.6.5	Startup Wastes	3.6-7
3.6.6	Condensate Polishing Wastes	3.6-8
3.6.7	Concentrations in Circulating Water Discharge	3.6-8
3.6.8	References	3.6-8
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1
3.7.1	Sanitary Treatment Facilities	3.7-1
3.7.2	Storm Drainage	3.7-2
3.7.3	Non-Radioactive Gaseous Effluents	3.7-3
3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1
3.9	TRANSMISSION FACILITIES	3.9-1
3.9.1	South Carolina Electric & Gas Company Tranmission Lines	3.9-1
3.9.1.1	Lines Proximal to the Virgil C. Summer Nuclear Station	3.9-1
3.9.1.2	Summer-Graniteville 230 kV Line	3.9-5
3.9.1.3	Pineland-Summer-Denny Terrace Lines	3.9-8
3.9.1.4	Structure of Lines Outside the Project Area	3.9-11
3.9.2	South Carolina Public Service Authority Transmission Lines for the Virgil C. Summer Nuclear Station	3.9-12
3.9.2.1	Summer-Newberry Line	3.9-12
3.9.2.2	Summer-Blythewood Transmission Line	3.9-15
3.9.2.3	Auxiliary Facilities	3.9-18
3.9.2.4	Impact from Noise and Electromagnetic Radiation	3.9-20
3.9.3	References	3.9-20

4

LIST OF TABLES

Table	Title	Page
3.1-1	Stack Release Information	3.1-4
3.2-1	Turbine Heat Rate Variation with Back Pressure and Load	3.2-2
3.3-1	Flow Rates	3.3-2
3.4-1	Average Monthly Data	3.4-15
3.4-2	Thermal Performance Study - Summary of Meteorological Data Used in LOCA Studies	3.4-16
3.4-3	SWP Thermal Performance Studies - Maximum Service Water Intake and Discharge Temperature	3.4-17
3.5-1	Specific Activities in Principal Fluid Steams - Gale Code Model	3.5-36
3.5-2	Tritium Production	3.5-40
3.5-3	Calculated Releases of Radioactive Materials in Gaseous Effluents from Virgil C. Summer Nuclear Station	3.5-41
3.5-4	Calculated Releases of Radioactive Materials in Liquid Effluents from the Boron Recycle System	3.5-42
3.5-5	Calculated Releases of Radioactive Materials in Liquid Effluents from the Liquid Waste Processing System	3.5-43

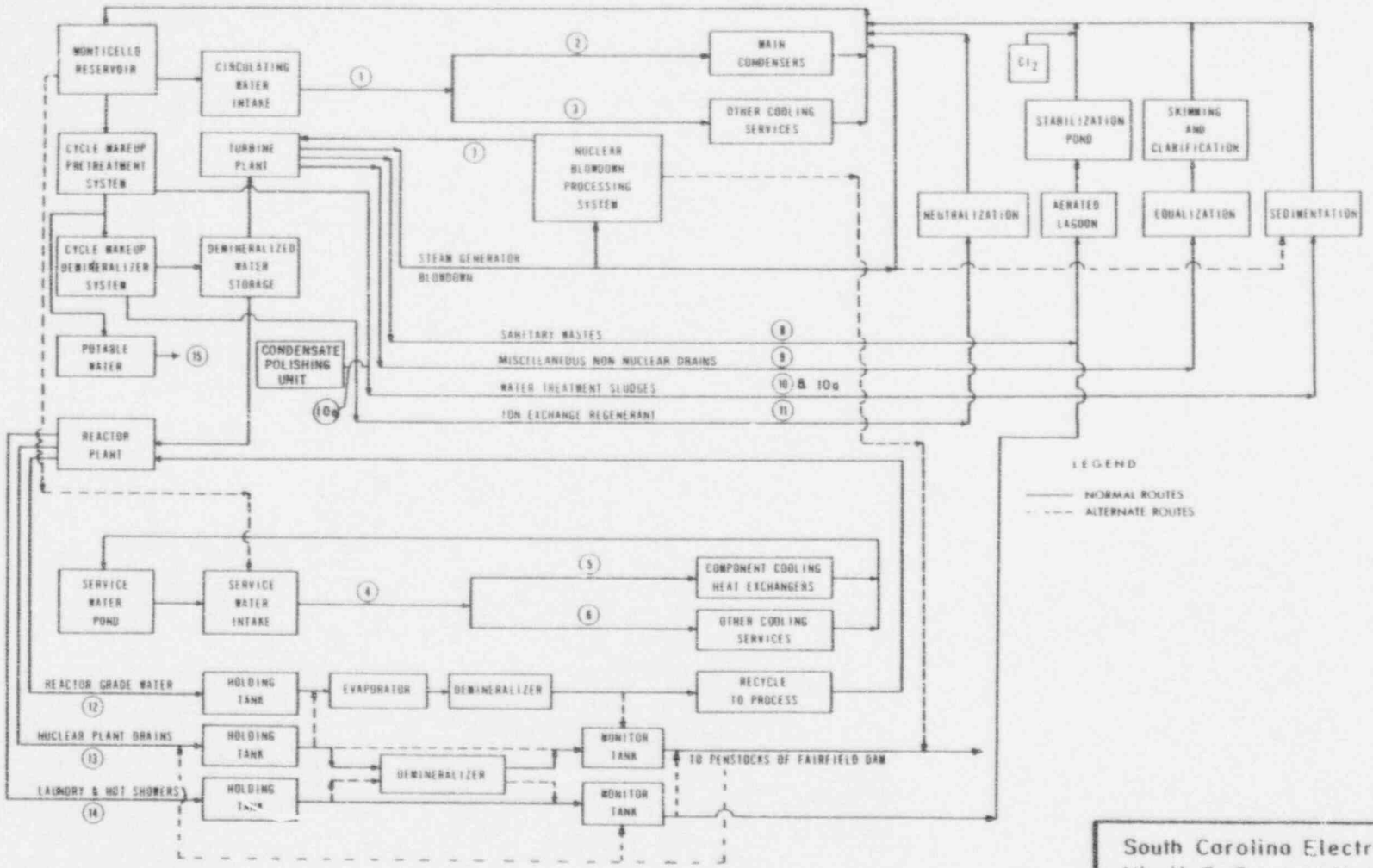
3

TABLE 3.3-1

FLOW RATES (GPM)

Item[1]	Maximum Power Operation	Minimum Anticipated Power Operation	Temporary Shutdown
1. Circulating Water (total)	534,000	400,000	400,000
2. Main Condensers	(480,000)	(366,000)	(366,000)
3. Other Cooling Services	(54,000)	(34,000)	(34,000)
4. Service Water (total)	12,000	12,000	12,000
5. Component Cooling Heat Exchangers	(9,000)	(9,000)	(9,000)
6. Other Cooling Services	(3,000)	(3,000)	(3,000)
7. Steam Generator	250.0	30.0	30.0
8. Sanitary Wastes	15.6	8.0	8.0
9. Miscellaneous Non-Nuclear Drains	66.0	10.5	10.5
10. Water Treatment Sludges	20.0	2.1	2.1
10a. Condensate Polishing Wastes	340.	2.17	2.17 | 4
11. Ion Exchange Regenerant	11.1	2.1	2.1
12. Reactor Grade Water	0.14	0.14	0.14
13. Nuclear Plant Drains	0.93	0.93	0.93
14. Laundry and Hot Showers	0.31	0.31	0.31
15. Potable Water Usage	15.6	15.6	15.6

(1) Numbers refer to Figure 3.3-1.



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Water Use Diagram

Figure 3.3-1

AMENDMENT 4
JANUARY 1979

7.	Non-biodegradable organic	Negligible
8.	Surfactants	Negligible
9.	Phosphorus and nitrogen	Negligible
10.	Toxic compounds	Negligible

The amount of waste generated is estimated from the following dosage levels and raw water conditions:

1.	Clay	2 grains/gal.
2.	Soda ash	2 grains/gal.
3.	Alum	4 grains/gal.
4.	Suspended solids in raw water	50 mg/liter

These levels are based on experience relative to performance of similar operations.

The water treatment plant wastes are treated to remove suspended solids. By removing the suspended solids, the BOD concentrated in the clarifier sludge is removed also. The method of treatment is to provide two lagoons that are operated on a batch basis. These lagoons are provided with variable level discharge facilities to allow decantation of the supernatant as the lagoon is filled. It is assumed that after two to five years of filling the lagoon, it will be retired from service and the sludge allowed to compact. After sufficient compaction has taken place, the sludge will be removed to a landfill site. These lagoons are also to be used to treat the plant startup wastes and condensate polishing waste. The suspended solids and BOD levels of the lagoon treated effluent are based on operation of a similar facility (Shormont, N.Y., Water Treatment Lagoon) (1). 4

Average effluent values were:

1.	BOD_5	16 mg/liter
2.	Suspended solids	24 mg/liter
3.	Settlable solids	Trace

The settled solids ranged from 1.5 to 15 percent in suspended solids content.

3.6.3 STEAM GENERATOR BLOWDOWN

The Steam Generator Blowdown System continuously purges the steam generators of concentrated impurities, thereby maintaining secondary side water chemistry. The steam generator blowdown is essentially demineralized water with small amounts of chemicals added to act as oxygen scavengers and to maintain the water quality within specifications. The cooled steam generator blowdown can be directed to either the circulating water discharge or the Nuclear Blowdown Processing System (NBPS). Effluent from the NBPS is recycled to the main condenser hotwell, an alternate path being to the penstock of the Fairfield Pumped Storage Facility. The characteristics of the cooled blowdown fluid are tabulated in Table 3.6-1.

3.6.4 ION EXCHANGE REGENERANT WASTES

The ion exchange demineralizers used to treat makeup water for purified water to the steam generators and the primary coolant for the reactor are regenerated with sodium hydroxide and sulfuric acid. The sodium hydroxide and sulfuric acid regenerant waste are combined and the pH adjusted between 6 and 9. The neutralized wastes are discharged at 250 gpm to the circulating water discharge with a rate ranging from about 11,000 to 16,000 gpd. The pH of the neutralized waste is continuously monitored. Discharge is automatically terminated if the pH value exceeds the specified range of 6 to 9. Characteristics of the neutralized wastes discharged are shown in Table 3.6-2.

Seasonal and operational variations in the discharge are minimal. Regeneration frequency is not expected to vary. Constituents in the neutral-

ized wastes could vary slightly with seasonal changes in ground water quality, but changes are not expected to be significant.

3.6.5 STARTUP WASTES

Prior to the startup of the nuclear station, the plant equipment, piping, etc., is cleaned to remove rust, mill scale, welding rods, and debris resulting from construction. The cleaning operation consists of the following approximate water volumes:

1.	Water flush	10 million gallons
2.	Alkaline phosphate detergent flush	200,000 gallons
3.	Final water rinse	600,000 gallons.

The characteristics of the plant startup wastes are given in Table 3.6-3.

All of the plant startup wastes are pumped to the lagoons that normally are used for the water treatment plant wastes. During the initial plain water flush, the lagoons operate as sedimentation basins for removal of trash and suspended solids. At the completion of the plain water flush, the lagoons are decanted to the debris layer. The detergent phosphate wash and the final rinse are then accumulated in the lagoons and treated on a batch basis.

Treatment consists of pH adjustment, phosphate precipitation with alum, and possible oil removal. The treatment continues until analyses indicate that the waste is treated to a quality acceptable for discharge to the Monticello Reservoir. After treatment, the supernatant is decanted off to the Monticello Reservoir. The sludge accumulation, if significant, is allowed to dewater to a condition acceptable for disposal at a sanitary landfill.

3.6.6 CONDENSATE POLISHING WASTES

The Condensate Polishing System is operated during startup, shutdown, and as required during condenser leakage to maintain acceptable water chemistry purity levels. The polishing system consists of powdered resin filter/demineralizers. System waste is normally discharged to one of two lagoons for settling prior to ultimate discharge into Monticello Reservoir (refer to Section 3.6.2).

3.6.7 CONCENTRATIONS IN CIRCULATING WATER DISCHARGE

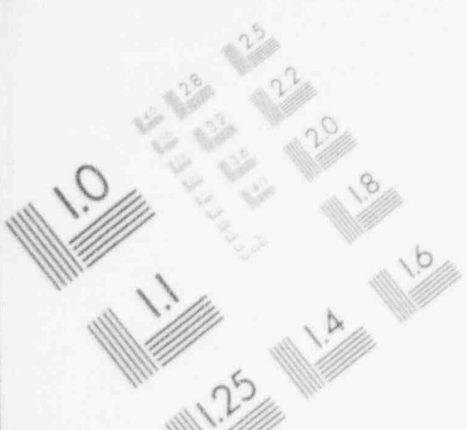
Expected increases in concentrations in the circulating water discharge as a result of passage through the plant are shown in Table 3.6-4.

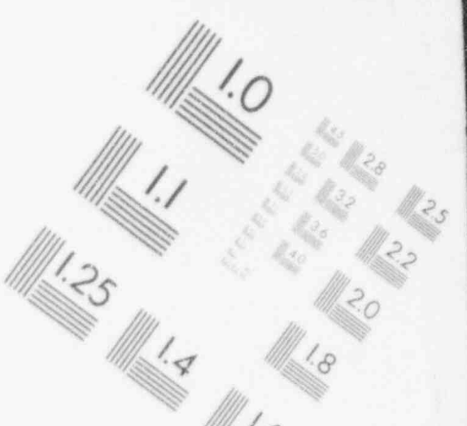
3.6.8 REFERENCES

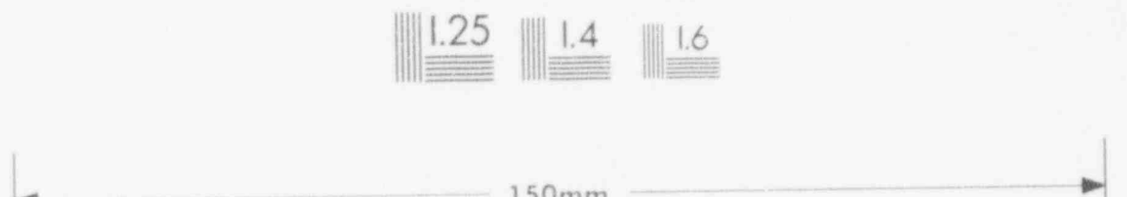
1. O'Brien & Gere, "Waste Alum Sludge Characteristics and Treatment," New York State Department of Health, Research Report No. 15, December 1966.

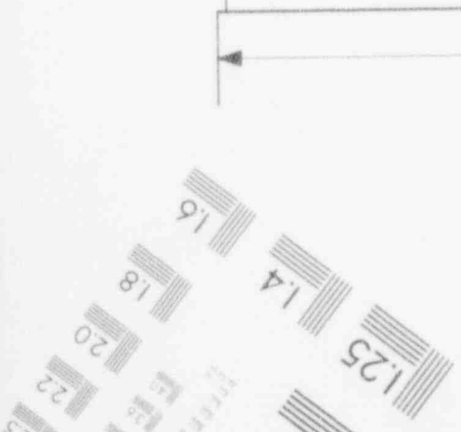
1

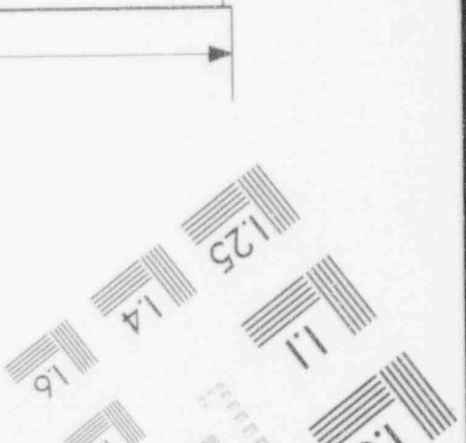
IMAGE EVALUATION TEST TARGET (MT-3)











and construction phase surveys and will form the basis for assessing the impacts of operation of the Virgil C. Summer Nuclear Station. Changes in bird populations will be determined primarily through comparison of indicator species populations. Indicator species used to assess results collected by auto survey and strip census techniques will include the mockingbird, loggerhead shrike, eastern meadowlark cardinal, pine warbler, rufous-sided towhee, Carolina chickadee, and mourning dove. The great blue heron, belted kingfisher, and wood duck will serve as indicator species in evaluating results of the waterfowl survey data. 1

A standard Chi-square test will be applied to each set of data. The results of this statistical analysis may show whether any significant differences in bird populations exist between control and test populations and whether any significant changes may have occurred during the period just prior to operation of the nuclear plant.

6.1.5 RADIOLOGICAL MONITORING

The environmental radiological monitoring program for the Virgil C. Summer Nuclear Station is designed to: 1) analyze selected samples in important anticipated pathways for the qualification and quantification of radionuclides released to the surrounding environment and 2) to establish correlations between levels of environmental radioactivity and radioactive effluent from plant operation. This program utilizes the concepts of control-indicator and preoperational-operational intercomparisons in order to establish the adequacy of source control and to realistically verify the assessment of environmental levels and resultant human radiation dose as demonstrated by both the in-plant effluent monitoring program and the environmental monitoring program. Significant upgrading of program scope and sensitivity has occurred as a result of the review of more comprehensive site-specific baseline environmental and land use data which had been unavailable at the construction permit stage.

The sample types, criteria for selection, collection frequencies, locations, and analyses which are performed are presented in Table 6.1-15 and Figures 6.1-4 and 6.1-5. Site related dispersion characteristics, demography, hydrology, land use, anticipated source terms, and critical pathways have been considered in the selection of sample media, sampling and analysis frequencies, sample locations, and types of analyses (see Chapters 2 and 5). The corresponding individual program elements set forth in Table 6.1-15 are indicated on Figures 5.2-3 and 5.2-4, as are normalized anticipated percentages of dose commitment by the particular pathways. Detailed examination of possible critical pathways and site related specific dose estimates are presented in Section 5.2. The results of this analysis assure that reasonably conceivable pathways to man and the environment are monitored with frequencies justified on the basis of potential dose. Locations are selected on the basis of site specific characteristics. Anticipated maximum lower limits of detection for the analyses are presented in Table 6.1-16. 1

The radiological monitoring program implemented in the preoperational phase assures that the minimum amount of baseline data acquired describes the samples of interest for those time periods reflected in Table 6.1-17. Preoperational sampling and sample measurements indicate the existent fluctuating background levels of radioactivity due to naturally occurring and manmade radionuclides. The methodology and frequency of sampling and analyses has been reviewed and optimized (as necessary) during the preoperational phase to obtain a realistic qualitative and quantitative estimate of the radiological environment. Experience gained through the use of analytical procedures and quality control reviews provides the basis for appropriate analytical modifications. Annual reviews of site specific existent exposure pathways provide a basis for the evaluation of possible changes in sampling and sample site selections (see Section 6.2.4). 1

The laboratories of the licensee and licensee's contractors which perform analyses shall participate in the Environmental Protection Agency's (EPA's) 4

Environmental Radioactivity Laboratory Intercomparisons Studies (Crosscheck) Program or equivalent program. This participation shall include all of the determinations (sample medium-radionuclide combination) that are offered by EPA and that also are included in the monitoring program. The results of analysis of these crosscheck samples shall be included in the annual report.

If the results of a determination in the EPA crosscheck program (or equivalent program) are outside the specified control limits, the laboratory shall investigate the cause of the problem and take steps to correct it. The results of this investigation and corrective action shall be included in the annual report. 4

The requirement for the participation in the EPA crosscheck program, or similar program, is based on the need for independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices as part of the quality assurance program for envrionmental monitoring in order to demonstrate that the results are reasonably valid.

The operational phase of the radiological monitoring program will be an extension of the preoperational phase. Raw data is analyzed and presented

TABLE 6.1-15

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
VIRGIL C. SUMMER NUCLEAR STATION

Exposure Pathway and/or Sample		Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Mi/Dir	Type and Frequency of Analysis
AIRBORNE						
I. Particulates	A	3 Indicator samples to be taken at locations (in different sectors) beyond but as close to the exclusion boundary as practicable where the highest offsite sectoral ground level concentrations are anticipated.(2)	Continuous sampler operation with weekly collection.	2 5 10	1.1 SW 1.3 SE 2.4 NNE	Gross beta following filter change; Monthly composite (by location) for gamma isotopic.
	B	1 Indicator sample to be taken in the sector beyond but as close to the exclusion boundary as practicable corresponding to the residence having the highest anticipated offsite ground level concentration or dose.(2)		6	1.1 ESE	
	C	1 Indicator sample to be taken at the location of one of the dairies most likely to be affected.(2) (4)		14(4)	5.2 W	

1 1 4

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
AIRBORNE, (continued)	D 2 Control samples to be taken at locations at least 10 air miles from the site and not in the most prevalent wind directions.(2)		17 16	24.7 SE 28.0 W		1
II. Radioiodine	A 3 Indicator samples to be taken at two locations as given in I.A above.	Continuous sampler operation with weekly cannister collection.	2 5 10	1.1 SW 1.3 SE 2.4 NNE	Gamma isotopic screening of all five indicators with conjunctive screening of the two controls. If screening is positive, each sample will be subjected to isotopic analysis for iodine.	
	B 1 Indicator sample to be taken at the location as given in I.B above.		6	1.1 ESE		
	C 1 Indicator sample to be taken at the location as given in I.C above.		14	5.2 W		1 | 4
	D 2 Control samples to be taken at locations similar in nature to A-C above.		17 16	24.7 SE 28.0 W		1

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
AIRBORNE, (continued)						
III. Direct	A 5 Indicator samples to be taken at the locations as given in I.A through D above.	Monthly exchange.(5) Two or more dosimeters at each location.	#'s 2, 5, 6, 10, and 14.		Gamma dose monthly(5)	4
	B 3 Additional indicator samples to be taken in sectors different from III.A above, beyond but as close to the exclusion boundary as practicable.		1 4 8	1.3 S 1.2 NW 1.3 ENE		
	C Control samples to be taken at the locations as given in I.D above.		16 17	28.0 W 24.7 SE		1
	D 1 Additional control sample to be taken at a location as set forth in I.D above.		18	16.5 S		
WATERBORNE						
IV. Surface Water	A 1 Indicator sample to be taken at a location which allows for mixing and dilution in the ultimate receiving river.	Time composite samples with collection every month (corresponds to USGS continuous sampling site).(5)	21(3) (6)	2.7 SSE	Gamma isotopic with quarterly composite (by location) to be analyzed for tritium.(7)	4 4

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations: Location[1]	Sample Locations: Mi/Dir	Type and Frequency of Analysis		
WATERBORNE, (continued)	B 1 Control sample to be taken at a location on the receiving river, sufficiently far upstream such that no effects of pumped storage operation are anticipated.		22[3]	12-15 NNW		1	
	C 1 Indicator sample to be taken in the upper reservoir of the pumped storage facility.	Grab sampling monthly[5]	23[3]	<1 E	As in V above.	1	4
	D 1 Indicator sample to be taken in the upper reservoir's non-fluctuating recreational area.		24[3]	4.7 N		1	
	E 1 Control sample to be taken at a location on a separated unaffected watershed reservoir.		18[3]	16.5 S		1	
V. Ground Water	A 2 Indicator samples to be taken within the exclusion boundary and in the direction of potentially affected ground water supplies.	Quarterly grab sampling.[7]	26 27	Onsite Onsite	Gamma isotopic and tritium analyses quarterly.[7]	1	4
	B 1 Control sample from an unaffected location.		16	28.0 W		1	

Exposure Pathway and/or Sample		Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations: Location[1]	Sample Locations: Mi/Dir	Type and Frequency of Analysis	
WATERBORNE, (continued)							
VI. Drinking Water	A	1 Indicator sample from nearby public ground water supply source.	Monthly grab sampling[5]	28	1.3 ESE	Monthly[5] gamma isotopic and gross Beta analyses and quarterly[7] tritium analyses	1, 4
	B	1 Indicator sample from a location immediately upstream of the nearest downstream municipal water supply.	Time composite sample[6] with monthly collection[5]	17	24.7 S		1
INGESTION							
VII. Milk[5]	A	1 Indicator sample to be taken at the location of one of the dairies most likely to be affected. [2] [5]	Semi-monthly when animals are on pasture,[8] monthly other times.[5]	14[4]	5.2 W	Gamma isotopic and I-131 analysis semimonthly[8] when animals are on pasture; monthly[5] at other times	1, 4
	B	1 Control sample to be taken at the location of a dairy 10-20 miles distant and not in the most prevalent wind direction.[2]		16	28.0 W		1
	C	1 Indicator grass (forage) sample to be taken at one of the locations beyond but as close to the exclusion boundary as practicable where the highest offsite sectoral ground level concentrations are anticipated.[2]	Monthly when available[5]	6	1.1 ESE	Gamma Isotopic	1, 4

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location[1]	Sample Locations Mi/Dir	Type and Frequency of Analysis	
INGESTION, (continued)	D 1 Indicator grass (forage) sample to be taken at the location of VIII.A above when animals are on pasture.		14[4]	5.2 W		4
	E 1 Control grass (forage) sample to be taken at the location of VIII.B above.		16	28.0 W		
VIII. Food Products	A 1 Indicator sample to be taken at a nearby garden likely to be affected.	Annually at the approximate median harvest time for the area. Samples, if available, will include: green leafy, fruit, and grain.	6	1.1 ESE	Gamma isotopic on edible portion. Radioiodine on green leafy vegetables.	1
						4
	B 1 Control sample for the same foods taken at a location at least 10 miles distant and not in the most prevalent wind direction.		18[3]	16.5 S		
IX. Fish	A 1 Indicator sample to be taken at a location in the upper reservoir.	Semi-annual[9] collection of the following specie types if available: bass, bream, crappie; catfish, carp; forage fish (shad).	23[3]	0.3-5	Gamma isotopic on edible portions semi-annually	1
						4

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations: Location[1]	Sample Locations: Mi/Dir	Type and Frequency of Analysis	
INGESTION, (continued)	B 1 Indicator sample to be taken at a location in the lower reservoir		21[3]	1-3		1
	C 1 Indicator sample to be taken at a location in the upper reservoir's non-fluctuating recreational area.		24[3]	4-5 N		1
						1
	D 1 Control sample to be taken at a location on the receiving river, sufficiently far up-stream such that no effects of pumped storage operation are anticipated.		22[3]	12-15 NNW		1
AQUATIC						
X. Sediment	A 1 Indicator sample to be taken at a location in the upper reservoir.	Semi-annual grab sample[9]	23[3]	0.3-4	Gamma isotopic[3]	1

4

4

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations		Type and Frequency of Analysis	
			Location(1)	Mi/Dir		
AQUATIC (continued)	B 1 Indicator sample to be taken in the upper reservoir's non-fluctuating recreational area.		24(3)	4-5 N		1
	C 1 Indicator sample to be taken on the shoreline of the lower reservoir.		21(3)	1-3		1
	D 1 Control sample to be taken in receiving river, sufficiently far upstream such that no effects of pumped storage operation are anticipated.		22(3)	12-15		1
						1 4

(1) Location numbers refer to Figures 6.1-3 and 6.1-4.

(2) Sample site locations are based on the meteorological analysis for the period of record as presented in Chapters 5 and 6.

(3) Though generalized areas are noted for simplicity of sample site enumeration, airborne, water and sediment sampling is done at the same location whereas biological sampling sites are generalized areas in order to reasonably assure availability of samples. 1

(4) Milking animal and garden survey results will be analyzed annually. Should the survey indicate new dairying activity of a significant nature (5 or more cows milking) in a quadrant(s) other than W or NW and closer than 5-7 miles, the owners shall be contacted with regard to a contract for supplying sufficient samples. If contractural arrangements can be made, the site(s) will be added for additional milk sampling. 4

(5) Not to exceed 35 days.

(6) Time composite samples are samples which are collected with equipment capable of collecting an aliquot at time intervals which are short (e.g. hourly) relative to the compositing period.

(7) At least once per 100 days.

(8) At least once per 18 days.

(9) At least once per 200 days.

NOTE: Deviations from this sampling schedule may occasionally be necessary if sample media are unobtainable due to hazardous conditions, seasonal unavailability, insufficient sample size, malfunctions of automatic sampling or analysis equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. Deviations from sampling-analyses schedule will be described in the annual report. 4

TABLE 6.1-16

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS
MEDIA/DETECTION CAPABILITIES

	Lower Limit of Detection (LLD)[1]					
Analysis	Water (pCi/l)	Airborne Particulate of Gas (pCi/m^3)	Fish, Meat or Poultry (pCi/kg,wet)	Milk (pCi/l)	Vegetation (pCi/kg,wet)	Sediment (pCi/kg,dry)
gross beta	2[2]	(1×10^{-2})				
^{3}H	2000 (1000)[2]					
^{54}Mn	15		130			
^{59}Fe	30		260			
$^{58,60}Co$	15		130			
^{65}Zn	30		260			
^{95}Zr-Nb	15					
^{131}I	1[2]	(7×10^{-2})		1	60[3]	
$^{134,137}Cs$	15(10)[2], 18	(1×10^{-2})	130	15	80	150
^{140}Ba-La	15			15		

Direct TLD measurements should have detection sensitivities approaching 10 mrem/yr.

(1) The nominal lower limit of detection is defined in HASL 300 (Rev. 8/74), pp. D-08-01, 02, 03 at the 95% confidence level. The LLD levels are decay corrected to the end of the total sampling period. The LLD for radionuclides analyzed by gamma spectrometry will vary according to the number of radionuclides encountered in environmental samples. These LLD levels will be used as minimum criteria for objectives for instrumentation and analytical procedure selection.

(2) LLD for Drinking Water

(3) LLD for Green Leafy Vegetables

4

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

May 22, 1978

Submitted January 1979

1. As stated in Subsection 2.1.1 the personnel of the Fairfield Pumped Storage Facility are located inside of the Summer Nuclear Station's exclusion area boundary. These workers are employees of SCE&G and subject to administrative controls of the company. If you do not intend to implement the requirements of 10 CFR Part 20 for these workers, we will have to consider them members of the general public. Under these conditions, the workers would be subject to the requirements of 10 CFR Part 50, Appendix I and we would require the following information:

   a. Locations (distances and directions) which will be occupied by the workers of the Fairfield Pumped Storage Facility inside the exclusion area boundary, and

   b. Annual occupancy (number of hours per year) of a worker at each location described in item (a) above.

   Approximate distance and direction of major components of the Fairfield Pumped Storage Facility (FPSF) from the centerline of the nuclear plant containment building are listed in Table 1. Table 2 lists estimated annual occupancy of various worker classifications at each of the points identified in Table 1.

   In addition, doses to a FPSF worker conservatively assumed to spend full time on a dam located in the west-northwest sector at a distance of 0.5 mile from the containment building were calculated. Plume, ground deposition, and air inhalation pathways were investigated. Methodology utilized was that specified in Regulatory Guides 1.109 and 1.111 for dose and meteorological calculations, respectively. No credit for building shielding was taken. Results were as follows:

Total Body Dose (Plume & Ground Pathways)	0.26 mrem/yr
Skin Dose (Plume & Ground Pathways)	0.69 mrem/yr
Thyroid Dose (Air Inhalation Pathway)	0.18 mrem/yr

   Thus, these results indicate the design of the Virgil C. Summer Nuclear Station conforms to the guidelines set forth in 10 CFR 50, Appendix I, when FPSF workers are considered members of the general public.

2. Table 2.1.7 does not contain any information on the locations of the nearest meat animals. However, in Subsection 5.2.4.2, statement is made that exposure from consumption of meat was evaluated at the same location as that for cow milk. Please confirm whether the

TABLE 1

FPSF Component	Direction Sector	Approximate Distance (miles)
Powerhouse	WNW	1.0
Intake Structure	WNW	0.8
Nearest Dam	WNW	0.4
Dam Near Intake Structure	WNW	0.7
Frees Creek Dam	NW	1.1

TABLE 2

		Hours per year spent at indicated component of Fairfield Pumped Storage Facility		
Worker Type	Number	Power-house	Intake Structure	Dams Within Exclusion Area Boundary
Utility Men	3	2000	0	0
Operators	5	2000	0	0
Clerk	1	2000	0	0
Supervisor*	1	1500	0	40
Assistant Supervisor*	1	1500	0	40
Ground Supervisor*	1	100	0	150
Ground Utility Man*	6	30	0	150
Electricians	2	1950	30	0
Mechanics	2	1950	50	0
Instruction Technicans	2	1950	50	0

*Note: All remaining time spent outside the exclusion area.

implication of this, that there are no meat animals at closer locations than the nearest cow locations given in Tables 2.1-7, is true.

An additional survey to locate vegetable gardens and meat and milk animals was conducted in January of 1978. The results of this survey supercede those presented in the OLER and are presented in the attached table (Table 3).

3. For the purposes of independence checks and quality assurance of Radiological Environmental Monitoring Program, the Branch Technical Position (March 1978), An Acceptable Radiological Environmental Monitoring Program, of the Radiological Assessment Branch requires that the laboratories of the licensee or licensee's contractors which perform analyses shall participate in the EPA's Environmental Radioactivity Laboratory Intercomparison Studies Program or equivalent program. Please describe your plans for such participation.

See Amendment 4, Section 6.1.5, pages 6.1-34 and 6.1-34a of the OLER.

4. Please define "Time composite sample with monthly collection" stated under the column heading Sampling and Collection Frequency in Table 6.1-15 item VI.B. Staff would require drinking water samples to be composite samples collected with equiment which are capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to the compositing period (e.g., monthly).

See revised Table 6.1-15, page 9 of 9, page 6.1-60 of Amendment 4 of the OLER.

Monthly gross Beta analysis also should be performed for drinking water.

See revised Table 6.1-15, page 5 of 9, page 6.1-56 of Amendment 4 of the OLER.

5. Staff would require frequency of milk sample collection and analysis of I-131 in milk semi-monthly when the milk animals are on pasture. This should be included in Table 6.1-15.

See revised Table 6.1-15, page 5 of 9, page 6.1-56 of Amendment 4 of the OLER.

6. Since gross Beta analysis would be performed for drinking water, please include the LLD for gross Beta in drinking water in Table 6.1-16.

See revised Table 6.1-16, page 6.1-61 of Amendment 4 of the OLER.

TABLE 3

VEGETABLE GARDEN, MILK AND MEAT ANIMAL SURVEY

CENSUS COMPLETED JANUARY 4 - JANUARY 10, 1978

SECTOR	GARDEN	BEEF CATTLE		MILKING ANIMAL (Cows)	
	Distance* (in miles)	Distance* (in miles)	Total Number	Distance* (in miles)	Total Number
NORTH	4.2				
NNE	3.5	3.7	20	4.5	3 (3)
NE	1.9	3.5	6		
ENE	1.7	3.7	20		
EAST	1.2				
ESE	1.5	5.0	1		
SE	2.7	2.2	20	5.5	1 (4)
SSE	2.5			5.7	1 (3)
SOUTH	3.7				
SSW	3.7				
SW	2.6	2.6	45		
WSW	2.7	5.0	20		
WEST	2.2	2.2	12		
WNW	4.0	4.0	5		
NW	4.2	4.2	5		
NNW	2.8	2.8	13		

* Distance scaled from map as estimated from centerline of reactor building.

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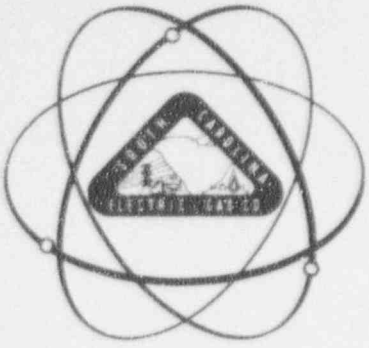

south carolina
electric & gas
company

VIRGIL C. SUMMER NUCLEAR STATION

operating license environmental report

VOLUME II

INSPECTION ... ENT FILES
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APPENDIX 2A

REPORT ON THE BASELINE BIOTIC SURVEY
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA
MARCH 1971 TO MAY 1973
FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY

Dames & Moore
Project No. 5182-046-17

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

SUITE 200, 455 EAST PACES FERRY ROAD · ATLANTA, GEORGIA 30305 · (404) 262-2915
CABLE: DAMEMORE TWX: 810-751-8218

February 11, 1974

South Carolina Electric & Gas Company
Post Office Box 764
Columbia, South Carolina 29218

Attn: Mr. E. H. Crews, Jr.
Mr. H. T. Babb
Mr. W. E. Moore
Mr. W. R. Baehr

Gentlemen:

We are pleased to transmit herewith our report entitled "Report on the Baseline Biotic Survey, Broad River Study Area, Parr, South Carolina, March 1971 to May 1973, for South Carolina Electric & Gas Company."

The report presents the results of a comprehensive biotic study performed in connection with the proposed Virgil C. Summer Nuclear Station project and Parr Hydroelectric Project to be constructed near Parr, South Carolina. The baseline characteristics of the ecosystems present in the area of the proposed projects are described in the report.

We have enjoyed preparing this report on your behalf and look forward to being of continuing service.

Yours very truly,

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TABLE OF CONTENTS

		Page
1.0	SCOPE OF WORK	1.0-1
2.0	INTRODUCTION	2.1-1
2.1	GEOGRAPHIC LOCATION	2.2-1
2.2	CLIMATOLOGY	2.2-1
2.2.1	PRECIPITATION	2.2-1
2.2.2	RIVER STAGE	2.2-2
2.3	TOPOGRAPHY OF THE BROAD RIVER WATERSHED	2.3-1
2.4	CLASSIFICATION OF SOILS IN NEWBERRY AND FAIRFIELD COUNTIES	2.4-1
2.5	VEGETATION ASSOCIATIONS	2.5-1
2.6	THE HISTORICAL AND PRESENT INFLUENCE OF MAN	2.6-1
2.7	REFERENCES	2.7-1
3.0	AQUATIC SURVEY	3.1-1
3.1	DESCRIPTION OF SAMPLING STATIONS	3.1-1
3.2	PHYSICAL AND CHEMICAL CHARACTERISTICS	3.2-1
3.2.1	INTRODUCTION	3.2-1
3.2.2	METHODS AND MATERIALS	3.2-1
3.2.3	FINDINGS	3.2-3
3.2.3.1	Temperature	3.2-3
3.2.3.2	Transparency	3.2-3
3.2.3.3	Sediment	3.2-6
3.2.3.4	Sediment Chemistry	3.2-8
3.2.3.5	Dissolved Oxygen	3.2-10
3.2.3.6	pH	3.2-10
3.2.3.7	Other Water Quality Parameters	3.2-14
3.2.4	DISCUSSION	3.2-14
3.2.5	SUMMARY	3.2-19
3.2.6	REFERENCES	3.2-21
3.3	PLANKTON	3.3-1
3.3.1	INTRODUCTION	3.3-1
3.3.2	METHODS AND MATERIALS	3.3-1
3.3.3	FINDINGS	3.3-2
3.3.3.1	Phytoplankton	3.3-2
3.3.3.1.1	Qualitative Analysis	3.3-2
3.3.3.1.2	Quantitative Analysis	3.3-11

TABLE OF CONTENTS (Continued)

		Page
3.3.3.2	Zooplankton	3.3-14
3.3.3.2.1	Qualitative Analysis	3.3-14
3.3.3.2.2	Quantitative Analysis	3.3-17
3.3.3.3	Net Plankton Biomass	3.3-20
3.3.4	DISCUSSION	3.3-20
3.3.4.1	Phytoplankton	3.3-20
3.3.4.2	Zooplankton	3.3-25
3.3.4.3	Net Plankton Biomass	3.3-26
3.3.5	SUMMARY	3.3-28
3.3.5.1	Phytoplankton	3.3-28
3.3.5.2	Zooplankton	3.3-29
3.3.5.3	Net Plankton Biomass	3.3-30
3.3.6	REFERENCES	3.3-31
3.4	VASCULAR HYDROPHYTES	3.4-1
3.4.1	INTRODUCTION	3.4-1
3.4.2	METHODS	3.4-1
3.4.3	FINDINGS	3.4-1
3.4.4	DISCUSSION	3.4-4
3.4.5	SUMMARY	3.4-5
3.4.6	REFERENCES	3.4-6
3.5	BENTHOS	3.5-1
3.5.1	INTRODUCTION	3.5-1
3.5.2	METHODS AND MATERIALS	3.5-1
3.5.3	FINDINGS	3.5-3
3.5.3.1	Insects	3.5-3
3.5.3.1.1	Qualitative Analysis	3.5-3
3.5.3.1.2	Quantitative Analysis	3.5-16
3.5.3.2	Other Benthic Macroinvertebrates	3.5-17
3.5.3.2.1	Qualitative Analysis	3.5-17
3.5.3.2.2	Quantitative Analysis	3.5-18
3.5.3.3	Biomass	3.5-18
3.5.4	DISCUSSION	3.5-25
3.5.5	SUMMARY	3.5-26
3.5.5.1	Insects	3.5-26
3.5.5.2	Other Benthic Macroinvertebrates	3.5-27
3.5.5.3	Biomass	3.5-28
3.5.6	LITTORAL ZONE BENTHOS (QUALITATIVE)	3.5-29
3.5.6.1	Introduction	3.5-29
3.5.6.2	Methods and Materials	3.5-29
3.5.6.3	Findings	3.5-31
3.5.6.4	Discussion	3.5-40
3.5.6.5	Summary	3.5-45
3.5.7	REFERENCES	3.5-46

TABLE OF CONTENTS (Continued)

		Page
3.6	FISH	3.6-1
3.6.1	INTRODUCTION	3.6-1
3.6.2	METHODS AND MATERIALS	3.6-1
3.6.2.1	Collection	3.6-1
3.6.2.2	Age and Growth	3.6-2
3.6.2.3	Length-Weight Relationships	3.6-3
3.6.2.4	Condition Factor	3.6-4
3.6.2.5	Sex Ratio and Gonad Condition	3.6-4
3.6.2.6	Standing Crop Estimate	3.6-4
3.6.2.7	Food Habits and Parasites	3.6-7
3.6.3	FINDINGS AND DISCUSSION	3.6-9
3.6.3.1	Species Composition and Relative Abundance	3.6-9
3.6.3.2	Age and Growth	3.6-18
3.6.3.3	Length-Weight Relationship	3.6-18
3.6.3.4	Condition Factors	3.6-23
3.6.3.5	Sex Ratios	3.6-26
3.6.3.6	Gonad Condition	3.6-26
3.6.3.7	Standing Crop	3.6-30
3.6.3.8	Food Habits	3.6-34
3.6.3.9	Parasites	3.6-45
3.6.4	SUMMARY	3.6-53
3.6.5	REFERENCES	3.6-55
3.7	PRODUCTIVITY	3.7-1
3.7.1	INTRODUCTION	3.7-1
3.7.2	METHODS AND MATERIALS	3.7-2
3.7.3	FINDINGS AND DISCUSSION	3.7-4
3.7.4	SUMMARY	3.7-16
3.7.5	REFERENCES	3.7-18
4.0	AQUATIC ECOLOGY OF THE BROAD RIVER STUDY AREA	4.0-1
4.1	REFERENCES	4.0-5
5.0	TERRESTRIAL SURVEY	5.1-1
5.1	DESCRIPTION OF SAMPLING STATIONS	5.1-1
5.1.1	STUDY SITES	5.1-1
5.1.2	WILDLIFE SURVEY ROUTES	5.1-4
5.1.3	WATERFOWL SURVEY	5.1-5
5.2	SOILS	5.2-1
5.2.1	INTRODUCTION	5.2-1
5.2.2	METHODS AND MATERIALS	5.2-1
5.2.3	FINDINGS	5.2-4
5.2.3.1	Soil Nutrient Status	5.2-4
5.2.3.2	Residual Pesticides in the Soil	5.2-6

TABLE OF CONTENTS (Continued)

		Page
5.2.3.3	Heavy Metal Concentration in the Soil	5.2-6
5.2.4	DISCUSSION	5.2-12
5.2.4.1	Areas to be Flooded	5.2-12
5.2.4.2	Upland Areas	5.2-13
5.2.4.3	Soil Nutrient Status	5.2-13
5.2.4.4	Native Wildlife	5.2-14
5.2.4.5	Residual Pesticides in the Soil	5.2-14
5.2.4.6	Heavy Metal Concentration in the Soil	5.2-14
5.2.4.7	Impounding of Water	5.2-16
5.2.5	SUMMARY	5.2-17
5.2.6	REFERENCES	5.2-19
5.3	VEGETATION	5.3-1
5.3.1	INTRODUCTION	5.3-1
5.3.2	METHODS AND MATERIALS	5.3-2
5.3.3	FINDINGS	5.3-4
5.3.3.1	Floristic Composition	5.3-4
5.3.3.2	Vegetative Communities	5.3-4
5.3.3.3	Study Site	5.3-13
5.3.3.3.1	Study Site 1	5.3-13
5.3.3.3.2	Study Site 2	5.3-18
5.3.3.3.3	Study Site 3A	5.3-20
5.3.3.3.4	Study Site 4	5.3-20
5.3.4	DISCUSSION	5.3-22
5.3.4.1	Habitat Description	5.3-22
5.3.4.2	Ecologically Important Species	5.3-25
5.3.4.3	Environmental Stresses and Ecological Succession	5.3-27
5.3.5	SUMMARY	5.3-30
5.3.6	REFERENCES	5.3-6
5.4	INSECTS AND OTHER ARTHROPODS	5.4-1
5.4.1	INTRODUCTION	5.4-1
5.4.2	METHODS AND MATERIALS	5.4-2
5.4.3	FINDINGS	5.4-3
5.4.3.1	Insect Infestation	5.4-5
5.4.4	DISCUSSION	5.4-7
5.4.4.1	Insect Infestations	5.4-9
5.4.5	SUMMARY	5.4-10
5.4.6	REFERENCES	5.4-11
5.5	AMPHIBIANS AND REPTILES	5.5-1
5 5.1	INTRODUCTION	5.5-1
5.5.2	METHODS AND MATERIALS	5.5-1
5.5.3	FINDINGS AND DISCUSSION	5.5-1

TABLE OF CONTENTS (Continued)

		Page
5.5.4	SUMMARY	5.5-7
5.5.5	REFERENCES	5.5-8
5.6	BIRDS	5.6-1
5.6.1	INTRODUCTION	5.6-1
5.6.2	METHODS AND MATERIALS	5.6-1
5.6.2.1	Survey Periods	5.6-1
5.6.2.2	Wildlife Auto Survey Route	5.6-1
5.6.2.3	Strip Census	5.6-3
5.6.2.4	Bird Census Transects	5.6-4
5.6.2.5	Waterfowl Survey	5.6-4
5.6.2.6	Additional Sources of Information	5.6-4
5.6.3	FINDINGS	5.6-4
5.6.3.1	Wildlife Survey Route	5.6-11
5.6.3.1.1	Abundance of Birds	5.6-11
5.6.3.1.2	Diversity of Birds	5.6-13
5.6.3.1.3	Fluctuations in Indicator Species	5.6-13
5.6.3.1.4	Game Bird Call Counts	5.6-15
5.6.3.2	Bird Census	5.6-16
5.6.3.3	Waterfowl Survey	5.6-21
5.6.3.4	Additional Findings	5.6-21
5.6.3.4.1	Suitable Wood Duck and Other Game Bird Habitat	5.6-21
5.6.3.4.2	Birds Inadvertently Snap Trapped	5.6-25
5.6.4	DISCUSSION	5.6-25
5.6.4.1	Endangered or Threatened Species	5.6-29
5.6.4.2	Song Birds	5.6-31
5.6.4.2.1	Diversity	5.6-31
5.6.4.2.2	Abundance	5.6-31
5.6.4.2.3	Distribution	5.6-33
5.6.4.3	Game Birds	5.6-35
5.6.4.3.1	Abundance and Distribution	5.6-35
5.6.5	SUMMARY	5.6-42
5.6.6	REFERENCES	5.6-44
5.7	MAMMALS	5.7-1
5.7.1	INTRODUCTION	5.7-1
5.7.2	METHODS AND MATERIALS	5.7-1
5.7.2.1	Sampling Locations	5.7-1
5.7.2.2	Snap Trapping	5.7-2
5.7.2.3	Pit Trapping	5.7-2
5.7.2.4	Live Trapping	5.7-2
5.7.2.5	Supplemental Collections and Observations	5.7-3
5.7.2.6	Density Estimates	5.7-4
5.7.2.7	Stomach Content Analysis	5.7-4
5.7.3	FINDINGS	5.7-5
5.7.3.1	Study Site 1A	5.7-5
5.7.3.2	Study Site 1B	5.7-5

TABLE OF CONTENTS (Continued)

		Page
5.7.3.3	Study Site 2	5.7-5
5.7.3.4	Study Site 3A	5.7-8
5.7.3.5	Study Site 4	5.7-8
5.7.3.6	Study Site Adjacent to Aquatic Transect G	5.7-8
5.7.3.7	Supplemental Collections and Observations	5.7-9
5.7.3.8	Stomach Content Items	5.7-10
5.7.3.9	Rare and Endangered Species	5.7-10
5.7.4	DISCUSSION	5.7-10
5.7.4.1	General Habitat Conditions	5.7-10
5.7.4.2	Small Mammal Populations	5.7-16
5.7.4.3	Medium-Sized Mammals	5.7-22
5.7.4.4	Large Mammal Populations	5.7-26
5.7.4.5	Rare and Endangered Species	5.7-27
5.7.5	SUMMARY	5.7-27
5.7.6	REFERENCES	5.7-30
6.0	TERRESTRIAL ECOLOGY OF THE BROAD RIVER STUDY AREA	6.0-1

LIST OF TABLES

Table		Page
2.5.1	Comparison of native vegetation found in 1971 and 1972 on soil types, Parr, South Carolina.	2.5-2
2.6.1	Comparison of acreage and yield of selected crops in South Carolina and Fairfield County, S. C. in 1970.	2.6-3
3.2.1	Water temperature at the surface (S) and bottom (B) at collection points along transects in the Broad River Study Area in 1971-73.	3.2-4
3.2.2	Secchi readings along the transects in the Broad River Study Area in 1971-73.	3.2-5
3.2.3	Percent of ash weight sediment components at stations on transects in the Broad River Study Area in February and May 1973.	3.2-7
3.2.4	Concentration of minerals in bottom sediment samples from the Broad River Study Area at Parr, South Carolina, February 1972.	3.2-9
3.2.5	Dissolved oxygen at the surface (S) and bottom (B) at collecting points along transects in the Broad River Study Area in 1971-73.	3.2-11
3.2.6	Estimated percent saturation of dissolved oxygen at collecting points along transects in the Broad River Study Area in 1971-73.	3.2-12
3.2.7	Measured pH at the surface (S) and bottom (B) at collecting points along transects in the Broad River Study Area in 1971-73.	3.2-13
3.2.8	Chemical analyses of the Broad River, Parr, South Carolina.	3.2-15
3.3.1	Species list of phytoplankton present (P) in quarterly surface (S) and vertical tow (VT) plankton samples between June 1971 and May 1973 on the Broad River Study Area.	3.3-3
3.3.2	Total phytoplankton species by phyla found on transects and stations on the Broad River Study Area between June 1971 and May 1973.	3.3-2
3.3.3	Mean density (number/millimeter) of major diatom species samples on Transects A to F on the Broad River Study Area between June 1971 and May 1973.	3.3-12

LIST OF TABLES (Continued)

Table		Page
3.3.4	Species list of zooplankton present (P) in quarterly surface (S) and vertical tow (VT) plankton samples between June 1971 and May 1973 on the Broad River Study Area.	3.3-15
3.3.5	Mean density (number/liter) of major zooplankton groups sampled on Transects A to F on the Broad River Study Area between June 1971 and May 1973.	3.3-18
3.3.6	Ash-free dry weight biomass in milligrams for 100 liters of plankton found in surface samples at stations on transects in the Broad River Study Area in 1972-73.	3.3-22
3.4.1	Vascular hydrophtes found during a shoreline survey of the Broad River Study Area.	3.4-2
3.5.1	Species list of benthic macroinvertebrates present (P) at sample periods between June 1971 and May 1973 on the Broad River Study Area.	3.5-4
3.5.2	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in June 1971.	3.5-10
3.5.3	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in September 1971.	3.5-11
3.5.4	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in January 1972.	3.5-12
3.5.5	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in March 1972.	3.5-13
3.5.6	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in November 1972.	3.5-14
3.5.7	Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in May 1973.	3.5-15
3.5.8	Quantitative comparison (number per square meter) of Pelecypod families Sphaeriidae and Corbiculidae at fourteen collection points along six transects in the Broad River Study Area between June 1971 and May 1973.	3.5-20

LIST OF TABLES (Continued)

Table		Page
3.5.9	Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transect B in the Broad River Study Area between November 1972 and May 1973.	3.5-22
3.5.10	Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transect D in the Broad River Study Area between November 1972 and May 1973.	3.5-23
3.5.11	Results from qualitative sampling of littoral and terrestrial invertebrates in the Broad River Study Area, June 1971, September 1971, January 1972, and March 1972.	3.5-32
3.5.12	Number of species collected in qualitative sampling, Broad River Study Area, 1971-72.	3.5-41
3.5.13	Functional habitat groupings and average annual coefficients of similarity based on littoral zone fauna.	3.5-42
3.6.1	The classification of maturity stages (gonadal condition) in fishes.	3.6-5
3.6.2	Species composition and relative abundance of all fishes collected from the Broad River Study Area from March 1971 through May 1973.	3.6-10
3.6.3	Mean back calculated total lengths and average growth increments of selected fishes from all Parr Reservoir transects (B, C, D), March 1971 - May 1973.	3.6-19
3.6.4	Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, November 1972.	3.6-21
3.6.5	Mean condition factors for all important species collected from the Broad River Study Area, March 1971 - May 1973.	3.6-24
3.6.6	Sex ratios of fishes collected from the Broad River Study Area, November 1972 and February and May 1973.	3.6-27
3.6.7	Mean gonadal condition of mature female fishes collected in the Broad River Study Area, February and May, 1973.	3.6-28
3.6.8	Standing crop estimates of the fishes from a shoreline rotenone sample of the Cannons Creek area of Parr Reservoir, South Carolina, November 9-10, 1972.	3.6-31

LIST OF TABLES (Continued)

Table		Page
3.6.9	Standing crop estimates of the fishes from a shoreline rotenone sample of the Frees Creek area of Parr Reservoir, South Carolina, November 11-13, 1972.	3.6-32
3.6.10	Parasites of fishes collected from five transects in the Broad River Study Area, November 1972.	3.6-46
3.6.11	Parasites of fishes collected from five transects in the Broad River Study Area, February - March 1973.	3.6-47
3.6.12	Parasites of fishes collected from five transects in the Broad River Study Area, May 1973.	3.6-48
3.7.1	Physicochemical data (average values in water column) at Transect B in Broad River and Frees Creek, 15 November 1972.	3.7-5
3.7.2	Physicochemical data (average values in water column) at Transect D in Broad River, 24 February 1973.	3.7-6
3.7.3	Physicochemical data (averaged values in water column) at Transect D in Broad River, 16 May 1973.	3.7-7
3.7.4	Gross production at Transect D and Frees Creek in the Broad River Study Area, 15 November 1972 - 6 May 1973.	3.7-17
5.2.1	Soil sample identification and soil test results.	5.2-5
5.2.2	Relative level of plant nutrients from soil test results.	5.2-7
5.2.3	Fertilizer recommendations for pine and hardwoods, wildlife habitats and bermuda grass for recreational areas.	5.2-8
5.2.4	Estimated productivity of soils under two levels of management and the adaptability of bermuda grass and bicolor lespedeza to soil types.	5.2-9
5.2.5	Concentration of residual pesticides in soil samples from South Carolina Electric & Gas Company project area at Parr, South Carolina.	5.2-10
5.2.6	Concentration of heavy metals in soil samples from South Carolina Electric & Gas Company project area at Parr, South Carolina.	5.2-11
5.3.1	Summary of flora identified in the environs of the Broad River Study Area.	5.3-5
5.3.2	Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 1A of the Broad River Study Area, June 1971.	5.3-14

LIST OF TABLES (Continued)

Table		Page
5.3.3	Frequency of occurrence (%) of understory, herbaceous, and woody plant species growing within pine, hardwood, mixed pine-hardwood, and grassland environs in the Broad River Study Area.	5.3-15
5.3.4	Mean litter pine production from the various sites within the Broad River Study Area.	5.3-17
5.3.5	Relative frequency, density, and dominance of the various grass species within a pine plantation (Site 2) in the Broad River Study Area.	5.3-19
5.3.6	Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 3A of the Broad River Study Area, June 1971.	5.3-21
5.3.7	Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 4 of the Broad River Study Area, June 1971.	5.3-23
5.4.1	Identified insects collected on Site 2, northwest shore of proposed Monticello impoundment, 22 and 24 March 1972.	5.4-4
5.4.2	Insects collected by blacklight trapping on the shore of Cannons Creek, Newberry County, South Carolina, 23 March 1972.	5.4-6
5.5.1	Occurrence of amphibians and reptiles by study site and sampling date.	5.5-2
5.6.1	Birds observed on the Broad River Study Area during six survey periods during 1971-1973.	5.6-5
5.6.2	Birds recorded by strip census and census transects in various habitats on the Broad River Study Area, March 1973.	5.6-17
5.6.3	Birds recorded by strip census and census transects in various habitats on the Broad River Study Area, May 1973.	5.6-19
5.6.4	Maximum waterfowl and shorebirds seen any one day along the boat survey route during four study periods.	5.6-22
5.6.5	Annual Christmas Bird Counts taken by National Audubon Society near Columbia, South Carolina in 1968, 1969, 1970, 1971, and 1972.	5.6-26
5.7.1	Number of each species and percent of males trapped during four survey periods.	5.7-6
5.7.2	Relative abundance of small mammals collected along traplines in Study Sites 1A, 2, 3A, and 4.	5.7-7

LIST OF TABLES (Continued)

Table		Page
5.7.3	Percent frequency of occurrence of stomach content items of small mammals from Study Site 2.	5.7-11
5.7.4	Percent frequency of occurrence of stomach content items of small mammals from Study Site 3A.	5.7-13
5.7.5	Percent frequency of stomach content items of small mammals from Study Site 4.	5.7-14
5.7.6	Trapping success of small mammals by habitat on the Broad River Study Area and Savannah River Project (SRP), all seasons combined; trapping success is one individual for number of trapnights.	5.7-20
5.7.7	Seasonal abundance of small mammals by habitat during the first four sampling periods.	5.7-21
5.7.8	Minimum body weight and/or total length of mammals considered to be adults.	5.7-23
5.7.9	Body measurements of adult mammals collected from study areas.	5.7-24

LIST OF FIGURES

Figure		Page
1.0.1	South Carolina physiographic regions and the location of the study area.	1.0-2
1.0.2	Plan of Virgil C. Summer Nuclear Station-Parr Hydroelectric project.	1.0-4
3.3.1	Total zooplankton taxa by transect (A-F) in the Broad River Study Area between June 1971 and May 1973.	3.3-18
3.3.2	Possible zooplankton food web for perennial species on the Broad River Study Area between June 1971 and March 1972.	3.3-27
3.5.1	Mean number of oligochaetes (Branchirua sowerbi and unidentified species) per square meter on transects (A-F) in the Broad River Study Area between June 1971 and May 1973.	3.5-19
3.6.1	Percent infection of Centrarchidae and all fishes by selected parasites and all parasites in the Broad River Study Area, 1972-1973.	3.6-50
3.7.1	Percent saturation of dissolved oxygen in Broad River, 15 November 1972.	3.7-19
3.7.2	Percent saturation of dissolved oxygen in Frees Creek, 15 November 1972.	3.7-20
3.7.3	Percent saturation of dissolved oxygen at Transect D in Broad River, 24 February 1973.	3.7-21
3.7.4	Percent saturation of dissolved oxygen at Transect D in Broad River, 16 May 1973.	3.7-22
3.7.5	Diurnal rate of change oxygen curve at Transect D in Broad River, 15 November 1972.	3.7-23
3.7.6	Diurnal rate of change oxygen curve in Frees Creek, 15 November 1972.	3.7-24
3.7.7	Diurnal rate of change oxygen curve at Transect D in Broad River, 24 February 1973.	3.7-25
3.7.8	Diurnal rate of change oxygen curve at Transect D in Broad River, 16 May 1973.	3.7-26
5.2.1	Soil survey sites.	5.2-3

1.0 SCOPE OF WORK

This report presents results of our baseline biotic survey of the Broad River Study Area, Parr, South Carolina, for South Carolina Electric & Gas Company. The study consisted of nine sampling periods between March, 1971, and June, 1973. The purpose of our study was to establish the baseline characteristics of the ecosystems present in the Broad River Study Area. The location of the Study Area is shown on Figure 1.0.1. This baseline information will provide the basis for validating predictions regarding anticipated environmental impact as a result of the construction and operation of the proposed Parr Hydroelectric Project (FPC Project No. 1894) and the proposed Virgil C. Summer Nuclear Station project (AEC Docket No. 50-395).

The proposed Parr Hydroelectric Project and Virgil C. Summer Nuclear Station project are integral parts of a planned electric power generating northwest of Columbia, the state capital. The most important feature of the Parr Hydroelectric Project is the Fairfield Pumped Storage Hydro Facility which will have a total capacity of 480 MWs. The nuclear station will have a generating capacity of approximately 900 MWs.

To provide the necessary lower reservoir capacity for the pumped storage plant, the existing Parr Dam will be raised approximately nine feet to Elevation 266 feet by means of Bascule gates. This will result in an increase in surface area of Parr Reservoir from 1,850 acres to about 4,400 acres and extend the reservoir about 13 miles upstream of Parr Dam. The upper impoundment (Monticello) of the pumped storage plant will be created by constructing four earthen dams (Frees Creek Dam) with a crest elevation of 434 feet across Frees Creek, a tributary of the Broad River. The 6800-acre Monticello Impoundment will also provide cooling water for the nuclear station, which will be constructed along the southern shoreline of the reservoir.

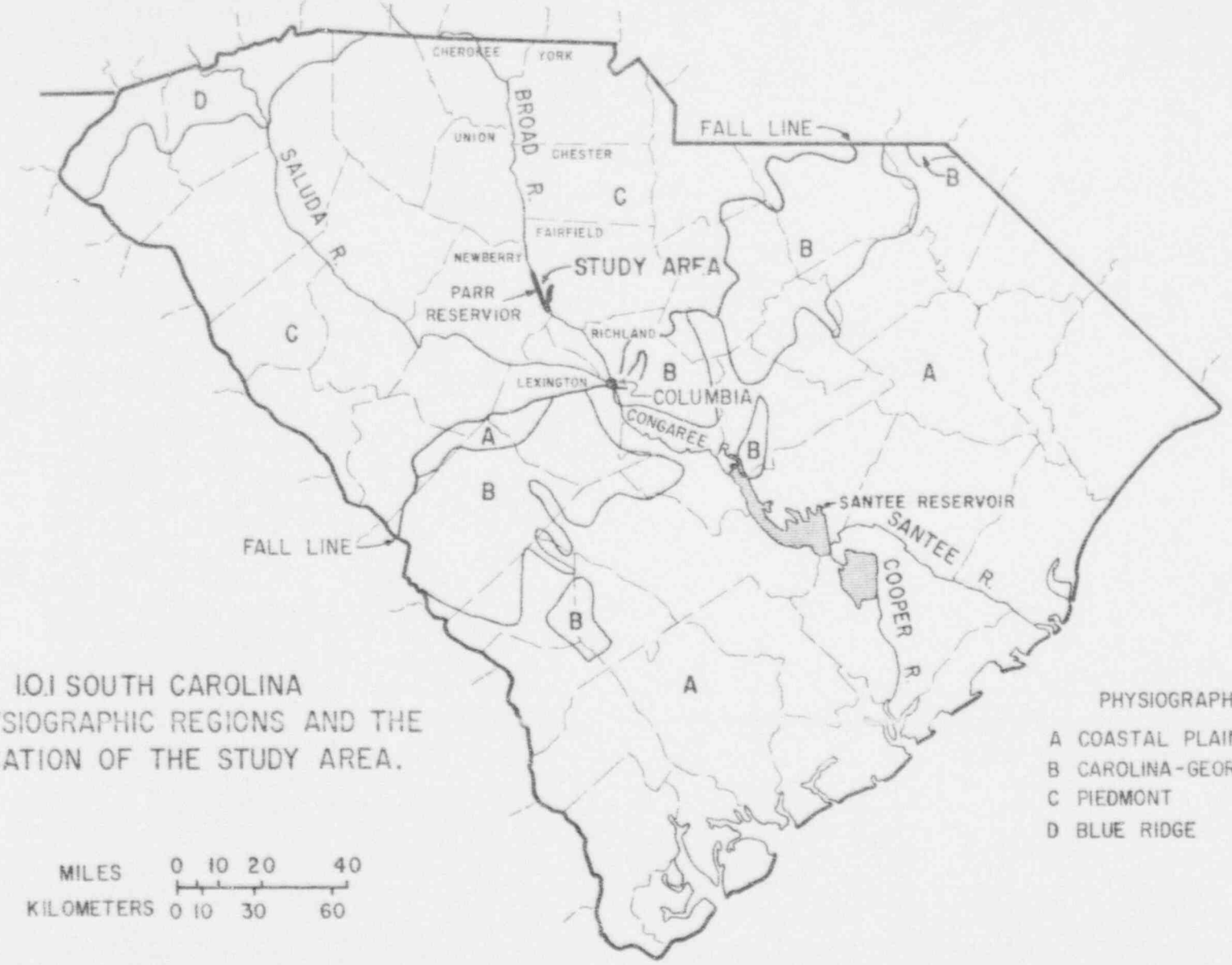


FIGURE 1.0.1 SOUTH CAROLINA PHYSIOGRAPHIC REGIONS AND THE LOCATION OF THE STUDY AREA.

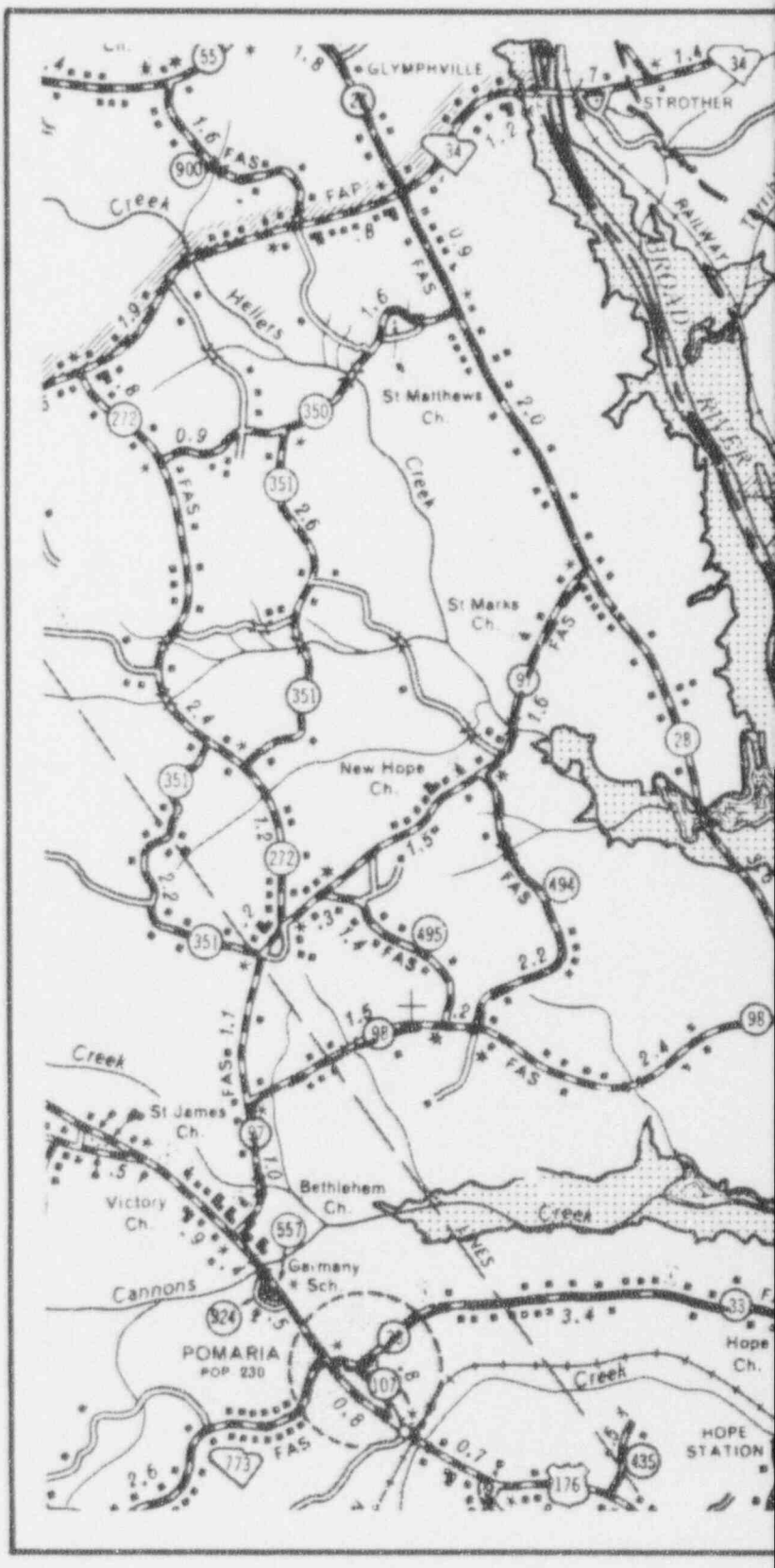
ADAPTED FROM ELLERBE AND SMITH (1964:2)

Monticello Impoundment will have a maximum operating pool level of Elevation 425 feet. During normal pumped storage operations, Monticello Impoundment will fluctuate from Elevation 425 to 420.5 feet, and Parr Reservoir from Elevation 256 to 266 feet. Important features of the proposed projects are shown on Figure 1.0.2.

As outlined in our proposal dated 19 March 1971, our study is to be conducted in two phases, preoperational and operational. The objectives of the preoperational program are: (1) Collect baseline information on aquatic and terrestrial organisms present in the study area; (2) Evaluate ecological relationships and assess key species in evaluating environmental change; (3) Develop programs to determine the effects of construction and operation of the proposed projects on the environment.

Although the baseline studies ended when the construction of the Virgil C. Summer Nuclear Station began last year, baseline information will still be collected in those areas unaffected by construction activities. This additional baseline information will aid in identifying natural population variations within the system.

This report has been divided into aquatic and terrestrial ecosystems. The terrestrial system includes studies on soil, vegetation, insects, birds, and mammals while the aquatic system includes information on water quality, plankton, periphyton, benthos, vascular hydrophytes, and fishes. Specific information on each of these groups are presented in the subsequent sections. A summary of the aquatic and terrestrial ecology appears in Sections 4.0 and 6.0, respectively.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New Hope Ch.
St James Ch.
Victory Ch.
Bethlehem Ch.
Germany Sch.
Cannons
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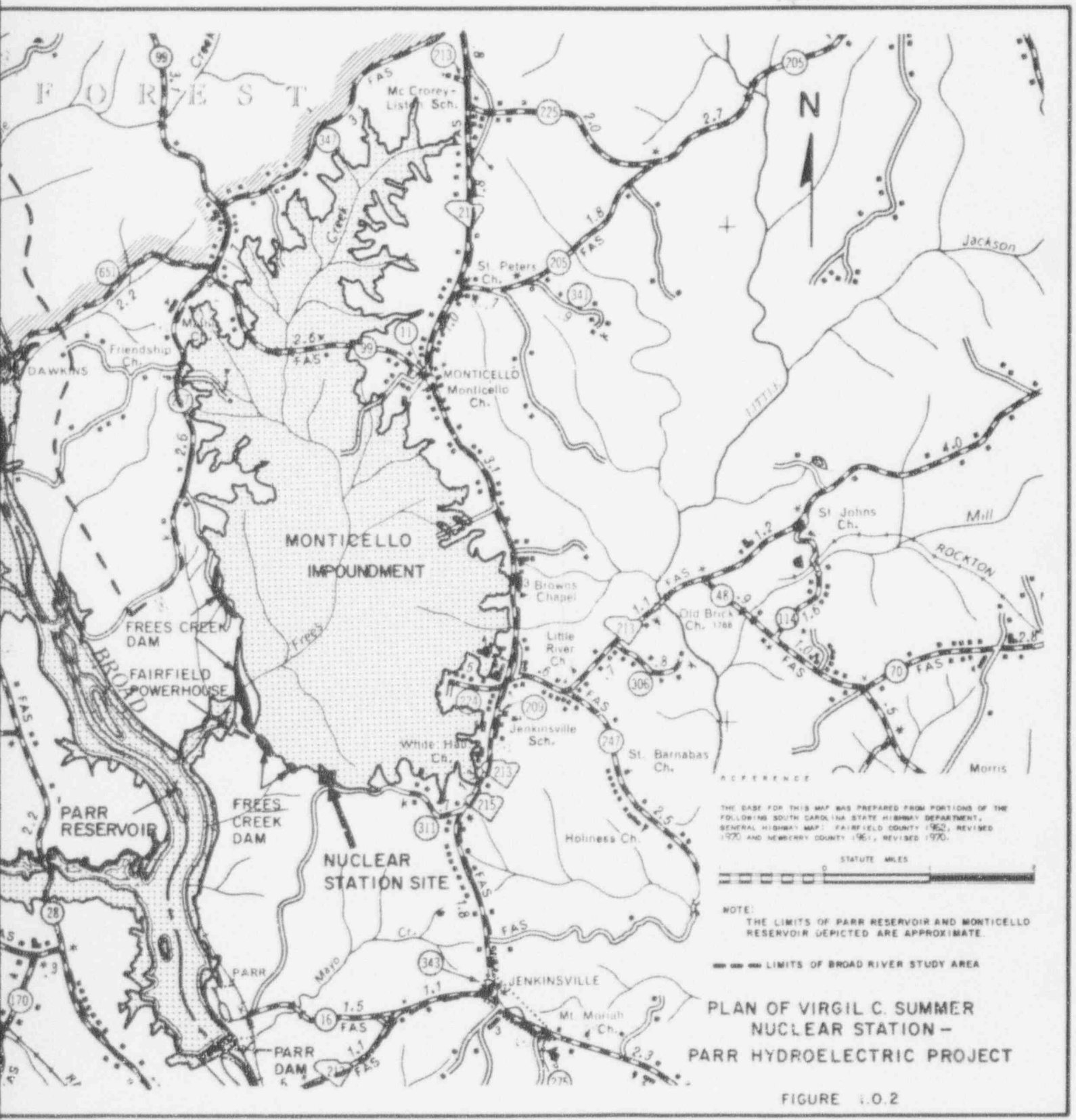

PLAN OF VIRGIL C. SUMMER
NUCLEAR STATION –
PARR HYDROELECTRIC PROJECT

FIGURE 1.0.2

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2.0 INTRODUCTION

2.1 GEOGRAPHIC LOCATION

South Carolina is bordered on the east by the Atlantic Ocean and on the north by North Carolina. The Savannah River separates the state's southwestern border from Georgia.

Five major river systems dissect South Carolina: the Savannah, the Combahee, the Edisto, the Congaree-Santee-Cooper, and the Pee Dee-Bleak. The Broad River, located approximately in the middle of the state, is a tributary of the Congaree-Santee-Cooper River System (Figure 1.0.1). The Congaree-Santee-Cooper River System lies within two of the three physiographic regions in South Carolina; the Piedmont, Carolina-Georgia Sandhills, and the Coastal Plains. The third region, the Blue Ridge Mountains, is northwest of the system (Figure 1.0.1).

The Piedmont ranges in elevation from 61 m (about 200 ft) in the southeast to nearly 457 m (1,500 ft) in the northwest and is separated from the Carolina-Georgia Sandhills and the Coastal Plain by the Fall Line (Kirk 1970).

The Broad River originates in the mountainous region of western North Carolina. It separates six counties in South Carolina including Newberry and Fairfield, where the study area is located. Approximately 32 km (20 miles) downstream from the southern junction of the two counties, the Broad River is joined by the Saluda River in Columbia to form the Congaree River, which then flows into the Santee Reservoir. The Santee and Cooper Rivers emerge from the Santee Reservoir and flow to the Atlantic Ocean (Figure 1.0.1).

The Broad River was dammed in 1914 at Parr, South Carolina to form Parr Reservoir. Tributaries entering this system at Parr Reservoir include, on the west side, Cannons Creek, Hellers Creek and the Enoree

River, and on the east side, Frees Creek and Terrible Creek. The study area is centered around this system and is approximately 15 airline miles southeast of Winnsboro and Newberry.

2.2 CLIMATOLOGY

The Piedmont of South Carolina has a continental climate with periods of warm, humid weather during the summer months. A U.S. Geological Survey (USGS) weather station was installed at Parr, South Carolina in 1947. This station has recorded temperatures and precipitation for 25 years. This information is assumed to be the best approximation of the norm and the monthly temperature changes in the vicinity of Frees Creek and Parr Reservoir.

Spring days are warm with cool nights, while late spring and summers are hot. The Bermuda high pressure system is the major factor influencing the summers of South Carolina (USDC 1971b). The warmest month, July, averaged 81°F from 1969 to 1971 while the coolest month, January, averaged 44°F during the past four years. The area may experience temperatures below freezing once out of two or three days during the winter (USDC 1971b). The Blue Ridge Mountains, about 160 km (100 miles) northwest of Parr (Figure 1.0.1), modify the polar air outbreaks that reach this area during the winter. These outbreaks have caused temperatures to fall below zero on rare occasions and contribute to the infrequent occurrence of snow fall (USDC 1971b). Snow was not recorded at Parr in 1969 or 1972 but an average of 5.08 cm (2.0 in) water equivalent was recorded in December 1970 and 1971. Unusual climatic conditions produced 16.5 cm (6.5 in) of snow on 25 March 1971. The soil seldom freezes to a depth of more than 6.4 cm (2.5 in) and then only for three or four days (Dames & Moore 1972).

2.2.1 PRECIPITATION

The average annual precipitation is 116 cm (45.7 in) at Parr based on three years of measurements and 131 cm (51.6 in) at Little Mountain (10 km from Parr). The maximum variation in annual precipitation between Parr and Little Mountain of 25.4 cm (10.0 in) occurred in 1970 (Dames & Moore 1972).

Precipitation at four recording locations show two peaks of accumulation; one in the spring (March) and the other during late summer and autumn (July, August, September, and October). The latter peak coincides with a peak in the frequency of thunderstorms during July. Thunderstorms may occur about one day out of three during the late summer. The moisture is supplied by southwesterlies that flow around the semi-permanent offshore Bermuda high pressure system. The incidence of tropical storms and hurricanes may affect the area about once every two years. Precipitation associated with these tropical storms ranged from 19.1 cm (7.5 in) to over 53.3 cm (21 in) in a calendar month (Dames & Moore 1971).

The incidence of passing tropical storms is greatest in September (USDC 1971b), their intensity being related to the distance from the coast.

2.2.2 RIVER STAGE

Stream flow data from a USGS gage at Richtex, South Carolina, were presented in the Preliminary Safety Analysis Report for the Virgil C. Summer Nuclear Station. Historical floods recorded at Richtex indicate two flood seasons; one from January to April and the other from July to October.

The monthly river stage (depth) from January 1969 through March 1972 pertinent to the Broad River and Parr Reservoir was obtained for Blair (USDC 1969, 1970, 1971a; pers. comm.). The river stage at Blair reflect the monthly trend in flow rate that may influence the biota in and along the Broad River.

The maximum peaks occurred in April 1969 at 6.64 m (21.8 ft), August 1971 at 6.55 m (21.5 ft), February and October 1971 at 6.37 m (20.9 ft) each, December 1971 at 6.43 m (21.1 ft), January 1972 at 6.67 m (21.9 ft), and June 1972 at 7.77 m (25.5 ft). The months with frequent river levels above flood stage include January, February, March, August, and October.

2.3 TOPOGRAPHY OF THE BROAD RIVER WATERSHED

The topography of the Broad River watershed in the Piedmont region is a mature plain containing numerous youthful streams, rolling, hilly terrain with few actual rock outcrops. The surface of this peneplain has been dissected by stream rejuvenation forming a dendritic pattern. Although the tributary streams of the Broad River are generally in a youthful stage of stream valley development, the Broad River is in the early maturity stage. The valley is deeply incised with a relatively narrow flood plain, part of which was impounded by Parr Reservoir.

A topographic map of the area surrounding Parr Reservoir and Frees Creek is located inside of the back cover. Surface elevations range from 76 to 152 m (400-500 ft) above mean sea level (msl). Frees Creek ranges in elevation from 122 m (400 ft) at its source to 76 m (250 ft) where it enters the Broad River. The existing Parr Reservoir varies from 82 m (270 ft) elevation south of Henderson Island to 78 m (257 ft) at Parr Dam.

2.4 CLASSIFICATION OF SOILS IN NEWBERRY AND FAIRFIELD COUNTIES

Soil classification depends on the interaction of the soil forming factors; parent materials, climate, topography, organic material, and time. These factors create the distinct horizons which develop during the formation of soils.

The soils of Newberry and Fairfield Counties were formed from the weathering of igneous, metamorphic and migmatitic rocks; generally hornblende, quartz-biotite gneiss, schists, and granite (Johnson 1964). The degree of weathering and depth to bedrock is variable throughout the study area. The surface in the area is relatively free of boulders and smaller stones.

The bottomland soils consist of recently deposited alluvium washed from the uplands and deposited on new flood plains. Deposits of alluvium occurring on old, high terraces were part of the old flood plain now incised by stream erosion and subsequently, have been left above the present flood plain.

Soil classifications recognized in Fairfield and Newberry Counties in the vicinity of the project area include:

Upland Soil

Major Series: Cecil, Davidson, Enon, Wilkes, and Appling.

Minor Series: Helena, Mecklenburg, Vance, Iredell, and Catawba.

Bottomland Soil

Dominant Series: Congaree, Chewacla, and Mixed Alluvial.

Cecil, Davidson, Appling, and Wilkes are the more abundant soil series, occurring primarily on upland ridge tops and moderate to steep slopes in Fairfield County (Craddock and Ellerbe 1966). The major series on uplands in Newberry County include Cecil and Enon soils (Camp, et al. 1960; Craddock and Ellerbe 1967).

Cecil soil is one of the dominant and widely distributed series in both counties. Cecil, Enon, and Davidson soils are deep, well-drained, with a gentle to steep slope, and acid soils. The soils are formed from parent material of igneous (granite, gabbro, and diorite) and metamorphic (gneiss and schist) rocks. Surface soils usually range in color from reddish-brown to brown on the level ridge tops to olive-yellow on the slopes. The subsoils range in color from yellowish-brown to dark red.

The texture of soils on the uplands and side slopes varies from gravelly-sandy loam to clay. Clay loam and clay textured soils occur where the original surface soil has been removed by accelerated erosion. The gravelly soils in these series contain fragments of quartz, gneiss, or granite that may interfere with cultivation (Camp, et al. 1960).

The upland soils are suitable for agriculture for the commonly grown crops such as cotton, corn, sorgum, small grains, legumes, and grasses used for hay and pasture. Applications of lime and fertilizer are required for moderate yields.

The major series that characterize the uplands are variable in slope and consequently the erosion hazard may be variable. The slopes must be managed for forest or pasture and grazing controlled to reduce the erosion hazard. As the slope increases, the rate of runoff will increase. Sheet and gully erosion will occur without proper management.

In contrast to the Cecil, Davidson, Enon, and Appling soils, the Wilkes soil occur primarily on uneven terrain and steep side slopes in Fairfield County (Craddock and Ellerbe 1966). This soil is best suited for timber production and the production of food plants for wildlife and are not suited to cultivation.

The bottomland soils of Fairfield and Newberry Counties consist

of Congaree and Chewacla soils and mixed alluvial land (Craddock and Ellerbe 1966 and 1967). These soils are along the major and minor tributaries to the river and are formed by the deposition of alluvium and colluvium. The soils are usually acidic. They are poorly drained to moderately well drained soils. The surface soils are not defineable as horizons. The colors range from light brown to dark yellowish brown. Their texture is sandy loam to silty clay loam. The soils are better suited for agriculture because their organic content and water retaining capacity is better than the upland soils.

2.5 VEGETATION ASSOCIATIONS

The present vegetation in the Broad River watershed includes four vegetative communities; pine, deciduous, mixed, and grassland. Vegetation growth is a result of the interaction between vegetation and the principal environmental factors, climate and soil. The mild and temperate climate is conducive for growth of both coniferous and deciduous trees. The winters are cold enough, however, that hardwoods shed their leaves in the fall.

The major soil association in the Frees Creek drainage is Cecil-Davidson-Wilkes, with Cecil being the major type (Section 2.4). Table 2.5.1 shows the "native vegetation" for the soil types.

Similar vegetation should be expected to be growing on the same soil types when undisturbed. However, clearing of the land for agricultural purposes has altered the composition of natural vegetation. Abandonment of farmlands resulted in stands of loblolly pine (about 75%) on the gentle upper slopes) with a very sparse understory of hardwoods. No hardwood control is necessary for a pure pine stand on the upper slopes (Ellerbe and Smith 1964). The bottomland vegetation is predominately deciduous (about 80%) with scattered pine making up the remainder.

Table 2.5.1 Comparison of native vegetation found in 1971 and 1972 on soil types, Parr, South Carolina.

Soil Type	Oak	Hickory	Dogwood	Beech	Sourwood	Cedar	Elder	Holly	Gum	Poplar	Red Cedar	Red Maple	Pine	Elm	Birch	Cottonwood	Ash	Sycamore	Persimmon	Yellow Poplar	Hop Hornbeam	Hornbeam	Basswood	Redbud	Black Cherry
Upland																									
Major Soils																									
Cecil	X	X	X	O	X	X	O	O	X	X	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Davidson	X	X	X	O	O	O	O	X	O	O	X	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Wilkes	X	O	O	O	O	X	O	O	O	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Appling	X	X	O	O	O	O	O	O	X	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Minor Soils																									
Catawba	O	X	O	O	O	X	O	O	X	O	O	O	X	X	O	O	O	X	O	O	O	O	O	O	O
Helena	X	O	O	O	O	O	O	O	X	O	O	O	X	X	O	O	O	O	O	O	O	O	O	O	O
Enon	X	X	X	O	O	X	O	O	X	O	O	O	X	X	O	O	O	O	X	O	O	O	O	O	O
Mecklenberg	X	X	X	O	O	X	O	O	O	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Iredell	X	X	X	O	O	O	O	X	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Hiwasee	X	X	X	O	X	X	O	X	O	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Site 1*	O	O	X	O	O	O	O	O	X	O	X	X	X	O	O	O	O	O	O	X	X	O	O	O	O
Site 2*	O	O	O	O	O	O	O	O	X	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Site 4*	X	O	X	O	O	O	O	X	X	O	X	X	X	O	O	O	O	O	O	O	X	O	O	O	O
Bottomland																									
Congaree	X	X	O	X	O	O	X	O	X	O	O	O	O	O	X	O	O	O	O	O	O	O	O	O	O
Chewacla	X	X	O	O	O	O	O	O	X	O	O	O	O	O	X	X	X	X	O	O	O	O	O	O	O
Alluvium	X	X	O	O	O	O	O	O	X	X	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
Site 3*	X	X	X	O	O	O	O	O	O	O	X	X	X	O	O	O	O	O	O	O	X	X	X	X	X

* Terrestrial Study Areas

2.6 THE HISTORICAL AND PRESENT INFLUENCE OF MAN

The area surrounding the project area was occupied by man long before the advent of the Europeans. The Cherokee Indian nation extended to the Broad River; the area between the Broad River and the Catawba River provided excellent hunting grounds for the Cherokee and Catawba Indians. Four archeological sites are known to exist in the vicinity of the project (pers. comm., R. L. Stephenson, Director & State Archeologist, Univ. of S. C., Columbia).

Land clearing by the Europeans was well underway in the Piedmont by 1770. The virgin forest of primarily hardwoods grew on the more productive soils and, therefore, were removed to be replaced by agricultural crops. When crop yields declined, the farmer either cleared adjacent woodland or moved to more productive land. This cycle was in evidence by: (1) a land clearing boom about 1800, following the invention of the cotton gin which stimulated cotton farming, and (2) two major periods of abandonment, one following the Civil War and the other following the appearance of the boll weevil in 1921 (Ellerbe and Smith 1964). The abandoned farmlands followed a natural pattern of succession of vegetation (Oosting 1956). The secondary hardwoods, however, were inferior in quality to the original forest (Ellerbe and Smith 1964).

Farming methods have changed considerably from its early beginning. Family farms of small size were common in South Carolina by 1770 (Ellerbe and Smith 1964). In 1930, 4.7 million hectares (11.5 million acres) were under cultivation in the state, however, by 1970 this decreased to 3.3 million hectares (8.2 million acres). A similar decline also occurred in Fairfield County. The area cultivated for wheat, corn, oats, barley, and hay had decreased in the county from 7,340 hectares (18,140 acres) in 1955, to 4,900 hectares (12,100 acres) in 1960, to 2,030 hectares (5,020 acres) in 1970 (Farrar and

Garrison 1962; Wiley and Garrison 1967, and 1971a). Much of the abandoned farmland reverted to forest land (Knight and McClure 1969).

Aerial photographs taken in 1970 indicate that nearly two-thirds of the cleared land in the Frees Creek watershed is idle or in pasture, and the remainder is in cropland. This land may have accounted for as much as eight percent of the county's total acreage used for the 1970 production of corn, oats, wheat, barley, and hay, or about 0.05 percent of the total land acreage in the state for the production of these crops. Yields per acre in Fairfield County are lower than in most other counties in the state (Table 2.6.1; Wiley and Garrison 1971a).

The number of beef cattle in Fairfield County declined from a maximum of 17,880 in 1956 to 10,400 in 1970. This represents a 42 percent reduction in beef production. Dairy cows also declined from 3,000 to 600 during the same period (Wiley and Garrison 1967; 1971b). Approximately 150 cattle of all types were observed in the immediate vicinity of the proposed Monticello Impoundment during the March 1972 sampling period.

In 1967, 86 percent of the land in Fairfield County was commercial forest (Haines 1967). Of this, 20 percent is owned by forest industries, 75 percent is owned by farmers and private individuals and the remainder is national forest land or under corporate and county or municipal ownership.

Within the area to be affected by the enlargment of Parr Reservoir and construction of Monticello Impoundment, the Forest Service owns 10 percent, the forest industries own 14 percent, and the remainder is owned primarily by private individuals. This forested area represents two percent of the county's resource. Approximately 54 percent of the forest in Fairfield County (Haines 1967) is commercial saw and pole timber.

Only minor commercial cutting occurred up to 1968, when about

Table 2.6.1 Comparison of acreage and yield of five selected crops in South Carolina and Fairfield County, S. C. in 1970 (Wiley and Garrison 1971a).

Corn	Acreage		County Rank*	Yield per Acre		County Rank*
	State	County		State	County	
Corn						
Grain	402,000	750	41	27 bu	20 bu	35
Silage	27,000	---		9 T	---	
Wheat	81,000	200	46	35 bu	28 bu	45
Oats	83,000	220	40	38 bu	33 bu	39
Barley	21,000	50	42	42 bu	36 bu	33
Hay	218,000	3,800	24	1.7 T	1 T	45

* Forty-six Counties in South Carolina.

700 acres were cleared by the Champion Paper Company (John White, Forester, Champion Paper Company, pers. comm.). SCE&G purchased or has optioned most of the land in the Frees Creek area for Monticello Impoundment and granted the timber rights to each former owner or tenant. The removal of commercial timber was occurring in the area during the March 1972 Biological Survey.

The Broad River was dammed in 1914 at Parr, South Carolina to form the Parr Reservoir. The reservoir functioned for flood control as well as an energy source for the production of electricity. The dam inundated an estimated 600 acres of bottomland along the Broad River and its tributaries. Based upon the present vegetation associations adjacent to the reservoir, it is estimated that the area was predominantly deciduous forest. Most game species of wildlife prevalent now, except wild turkey, were probably present when the dam was constructed.

No major fires have occurred in the vegetative cover in the environs of Parr Reservoir in more than 20 years. However, burning of scrub wood is done to clear areas after the commercially useful timber has been removed (Walter Schrader, State Game Biologist, Rock Hill, S. C., pers. comm.).

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3.0 AQUATIC SURVEY

3.1 DESCRIPTION OF SAMPLING STATIONS

Seven transects with a total of 15 collecting points were selected for study of the aquatic environs of the Broad River Study Area. Four of these transects were located within the Parr Reservoir, one above the reservoir, one below Parr Dam, and one in upper Frees Creek (map, back cover).

Collecting points were chosen along each transect according to their depth, substrate type, and general habitat conditions. Their locations and characteristics are given as follows:

Transect A and A' Transect A represents the main stream habitat of the Broad River upstream from the influence of Frees Creek and Cannons Creek watersheds. However, during the initial location of the transect, unfamiliarity with the area resulted in the sampling location being located in an impounded area and not in the main stream. This was designated Transect A' on the map (back cover). Transect A' is 5.5 km (3.4 miles) upstream from Parr Dam on the northeast side of the central peninsula of the reservoir. It is 150 m (492 ft) in length and varied in depth from 0 to 1.2 m (3.9 ft). The bottom substrate is composed of silt and muck.

By January 1972, it was determined that the original ecological reasons for location of this transect were not met and it was relocated to the position indicated as "A". It is located 7.0 km (4.3 miles) upstream from Parr Dam in the main river channel and is 150 m (492 ft) long. Transect A has a silt bottom and its depth varies from 0 to 5.5 m (18.0 ft).

Transect B is located in the Frees Creek embayment. The transect is 75 m (246 ft) upstream from the railroad bridge and parallel to it. Transect B is 230 m (755 ft) in length and has three collecting points whose depth varies from 1.0 to 2.0 m (3.3 to 6.5 ft). It has a silt and muck bottom substrate.

This embayment was selected because it will be subjected to dredging during construction and to strong water movements during pumping and drawdowns after plant operations begin.

Transect C is located 460 m (1590 ft) upstream from the Route 28 bridge in Cannons Creek embayment, a major embayment of the west side of the Broad River. Transect C is 230 m (755 ft) in length and has three collecting points whose depth varies from 0.5 to 2.0 m (1.6 to 6.5 ft). It has a silt and muck bottom substrate. Transect C was established to sample an embayment which will be influenced by daily water level fluctuation, however, would not be subjected to water movements as great as expected in Frees Creek (Transect B).

Transect D is located upstream from Parr Dam in the main body of Parr Reservoir. The west end of the transect is 305 m (1000 ft) and the east end is 535 m (1755 ft) upstream from the dam. Transect D is 760 m (2494 ft) in length and has three collecting points whose depth varies from 1.25 to 4.75 m (4.1 to 15.6 ft) with a bottom substrate of silt, sand, and muck. Some samples were also taken from the east shore of the mid-river island just upstream of Transect D. This transect was chosen to represent the open reservoir habitat which would be influenced by water level fluctuations and some water movements.

Transect E is located below Parr Dam in the east channel of the river. The length of this transect is 220 m (722 ft) from the east bank to the tip of the island and has two collecting points whose depths are about one meter. The bottom substrate is detritus, muck, and coarse gravel. This area was selected because it will not be subjected to water level fluctuations as projected in Parr Reservoir. It will, however, receive water from the project operations, thus a monitoring program was necessary for comparative purposes.

Transect F was established in September 1971 approximately 23 km (14.3 miles) upstream from Parr Dam. Transect F is 635 m (2083 ft) downstream

from the southern tip of Henderson Island and is a perpendicular extension to the east bank of the river. The width of the transect is approximately 125 m (410 ft). The river bed is fairly uniform along the transect and is characterized by a riffle habitat. The area selected is in the upper limits of the proposed area that will be subjected to impoundment fluctuations and will provide data on the upstream effects of the proposed project.

Transect G was also established in September 1971 in upper Frees Creek, an area which is not currently impounded. The northern limit of this station is approximately 100 m (328 ft) north of the bridge on State Highway 99 and the southern limit extends 400 m (1312 ft) south of the bridge. The substrate is primarily very coarse sand. Many granite rocks, up to 35 cm (13.8 in) in diameter, have washed into the creek from the road bridge riprap. The creek at this location is less than 4 m (13 ft) wide. The effects of the existing impoundment can be assessed by comparing fauna in the upper part of the creek with that of the impounded area at Transect B.

3.2 PHYSICAL AND CHEMICAL CHARACTERISTICS

3.2.1 INTRODUCTION

Water quality can influence species composition or diversity of biota and determine to some degree the population densities of specific organisms. Therefore, a knowledge of physical and chemical characteristics is fundamental to a baseline biological analysis in the study area.

Selected physical and chemical parameters were measured at points along transects in the Broad River Study Area at intervals between June 1971 and May 1973. This investigation was to provide basic information on existing abiotic conditions during the biotic sampling periods.

3.2.2 METHODS AND MATERIALS

Water temperature was measured with a Yellow Springs Instrument Company telethermometer (Model 47). The thermistor probe was lowered to the bottom and allowed to stabilize prior to recording the temperature to the nearest 0.5 degree centigrade (C). Temperatures were then recorded at 0.25 m intervals with the final measurement taken one centimeter below the water surface.

A Secchi disc (20 cm [7.9 in] diameter) was employed to measure light penetration in the water. The maximum water depth at which the disc was visible was determined to the nearest 0.05 m (2 in) at each station.

Substrate grab samples were collected with an Ekman dredge for sediment analysis (see Section 3.5.2). In the laboratory, the sediment from each grab was washed into a container, mixed thoroughly by stirring, and allowed to settle for two or more days. When the sample was completely settled, a random core was removed, placed in a sieve series, and washed with distilled water until separation was complete. The sieve series allowed designation of sediment components according to millimeter diameter ranges as follows: pebble, 4 to 64;

granule, 2 to 4; very coarse sand, 1 to 2; coarse sand, 0.5 to 1.0; medium sand, 0.25 to 0.50; fine sand, 0.125 to 0.250; very fine sand, 0.062 to 0.125; and silt-clay, 0.004 to 0.062. Each sediment type from a sample was washed from the retaining sieve into a crucible of known weight, dried at 60°C and ashed at 500°C to constant weight. An analytical balance was used to weigh samples to the nearest 0.01 mg.

Bottom sediment samples used for heavy metals and pesticide analyses were collected from all aquatic transects in February, 1973. Samples, obtained with an Ekman dredge, were placed in glass jars that had previously been washed with petroleum ether, rinsed with acetone, and air dried. The jar opening was covered with aluminum foil before closing with a screw lid. The sample was later air dried and sent to the Environmental Science and Engineering Corporation at Mt. Juliet, Tennessee for analysis of heavy metals and residual chlorinated hydrocarbon pesticides. A hot 6N hydrochloric acid was used to extract heavy metals from the sediments.

Water for dissolved oxygen analysis was collected with a 1.2 liter Kemmerer water sampler. Artificial aeration of the sample was prevented by placing the rubber emptying tube at the bottom of a ground-glass stoppered bottle and allowing water to fill and overflow the bottle volume. Dissolved oxygen was measured to the nearest part per million with a Hach Model OX-2-P test kit.

Water was also collected with the Kemmerer sampler for pH determinations. A Hach portable colorimetric pH test kit was used to measure pH to the nearest 0.1 unit.

Other water quality parameters were supplied by SCE&G from samples obtained from the Broad River.

3.2.3 FINDINGS

3.2.3.1 Temperature

Water temperature data were recorded at six collection points between June 1971 and May 1973 (Table 3.2.1). Collection points on Transects A and B were relocated beginning with the November 1972 sample period in order to correspond with revised biological sampling points. Other parameters discussed later follow the same site revision described above.

Maximum surface temperature of 31.5°C was recorded at Station A-1 in June 1971, while a minimum of 7.0°C was recorded at Station F-1 in January 1972. Seasonal surface temperatures at stations ranged as follows for combined 1971 to 1973 data: winter (January and February), 7.0 to 12.0°C; early spring (March), 12.5 to 17.0°C; late spring (May), 20.0°C at all stations; early summer (June), 27.0 to 31.5°C; early fall (September), 22.0 to 27.5°C; and late fall (November), 14.5 to 15.0°C. Maximum variation in surface temperatures between stations occurred during September 1971, when Station B-2 was 5.5°C warmer than Station D-1.

Differences were also noted between surface and bottom temperatures at some stations. Stations A-1, A-2, B-2, B-3, and C-3 usually exhibited lower temperatures at the bottom than at the surface. Surface temperatures at these sites were also generally higher than at Stations D-1 and E-1. Differences between surface and bottom temperatures at D-1 and E-1 were almost non-existent regardless of sampling period.

3.2.3.2 Transparency

Secchi disc visibility determinations were conducted at six collection points between June 1971 and May 1973 (Table 3.2.2). Light penetration, as measured using the limit of Secchi disc visibility, varied by season. Seasonal Secchi disc visibility readings ranged as follows for combined

Table 3.2.1 Water temperature at the surface (S) and bottom (B) at collection points along transects in the Broad River Study Area in 1971-73.

Date (1971-72)	Sample	Collecting Points*					
		A-1	B-2	C-3	D-1	E-1	F-1
June	S	31.5	30.0	30.0	27.0	28.5	NS***
	B	27.0	21.0	23.0	26.0	28.5	NS
September	S	25.5**	27.5	27.0	22.0	24.0	24.0
	B	23.0**	21.5	23.0	22.0	NS	NS
January	S	10.0	9.0	12.0	9.0	7.5	7.0
	B	10.0	9.0	11.0	9.0	7.5	NS
March	S	17.0	12.5	17.0	14.5	14.0	16.0
	B	15.0	10.0	16.0	14.0	14.0	NS

Date (1972-73)		A-2	B-3	C-3	D-1	E-1	F-1
November	S	NS	15.0	14.5	14.5	14.5	14.5
	B	NS	14.0	14.0	14.5	NS	NS
February	S	10.0	10.0	10.0	9.5	9.5	9.5
	B	9.0	NS	9.0	9.5	NS	NS
May	S	NS	20.0	20.0	NS	20.0	NS
	B	NS	NS	NS	NS	NS	NS

* Letter denotes transect, numeral denotes station.
** Temperature at Station 2 for this date.
*** Not sampled.

Table 3.2.2 Secchi readings along the transects in the Broad River Study Area in 1971-73.

Date (1971-72)	Collecting Points					
	A-1	B-2	C-3	D-1	E-1	F-1*
June	0.20	0.25	0.60	0.25	0.15	NS**
September	0.15***	0.25	0.35	0.10	0.20	NS
January	0.70	0.50	0.30	0.40	0.40	0.40
March	0.20***	0.30	0.50	0.10	0.50	NS
Date (1972-73)	**A-2**	**B-3**	**C-3**	**D-1**	**E-1**	**F-1**
November	0.35	0.45	0.35	0.25	0.35	NS
February	0.60	0.25	0.60	0.60	0.60	NS
May	NS	0.20	0.60	0.15	NS	NS
Mean	0.36	0.31	0.47	0.26	0.37	---

* Current velocity usually too great for reading at this site.
** Not Sampled
*** Secchi at Station 2 for this date.

1971 to 1973 data: winter (January and February), 0.25 to 0.70 m (0.8 to 2.3 ft); early spring (March), 0.10 to 0.50 m (0.3 to 1.6 ft); late spring (May), 0.15 to 0.60 m (0.5 to 2.0 ft); early summer (June), 0.15 to 0.60 m (0.5 to 2.0 ft); early fall (September), 0.10 to 0.35 m (0.3 to 1.2 ft); and late fall (November), 0.25 to 0.45 m (0.8 to 1.5 ft). The maximum light penetration of 0.70 m (2.3 ft) Secchi depth occurred in January 1972 at Station A- while least penetration of 0.10 m (0.8 ft) occurred in September 1971 and March 1972 at Station D-1. Winter (January and February) Secchi disc readings were slightly greater than those recorded on other dates.

Mean Secchi disc visibility readings for the more lentic (static water or lake-like) conditions present at Transects A, B, and C ranged from means of 0.31 to 0.47 m (1.0 to 1.6 ft) while means for the more lotic (running water or river-like) conditions at Transects D and E ranged from 0.26 to 0.37 m (0.8 to 1.2 ft). Secchi disc readings were lowest at Transect D and highest at Transect C. Differences, however, were usually small and light penetration at all sites was restricted by silt and clay turbidity.

3.2.3.3 Sediment

Sediment samples were collected at selected stations during February and May 1973 (Table 3.2.3). The bottom sediments of Stations B-3, C-3, D-1, and D-3 were the most homogeneous of all sample sites on the study area. Silt and clay comprised from about 65 to 98 percent of the sediment from these stations. Station D-3, however, had pebbles present in small quantities.

Coarse and medium sand made up from about 69 to 89 percent of the sediment from Stations A-1 and F-1. Silt and clay were also important at the F-1 station and comprised about 15 percent of the total. The substrate composition of these stations makes them moderately homogeneous when compared with the predominately silt and clay stations discussed above

Table 3.2.3 Percent of ash weight sediment components* at stations on transects in the Broad River Area in February and May 1973.

Transect & Station	Date	Pebble	Granule	Very Course Sand	Course Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt-Clay
A-1 (Shallow)	May	0.0	0.0	6.7	35.2	53.4	3.5	0.4	0.9
B-1 (Shallow)	Feb.	0.4	2.6	4.3	13.0	25.6	20.6	13.2	20.2
	May	0.0	0.0	1.1	3.1	20.9	26.6	19.8	28.5
B-3 (Deep)	Feb.	0.0	0.0	0.0	0.3	0.2	1.3	8.5	89.7
	May	0.0	0.0	0.2	0.1	0.1	0.4	1.4	97.7
C-1 (Shallow)	May	0.0	2.2	11.2	22.0	29.3	21.4	9.1	4.7
C-3 (Deep)	May	0.0	0.0	0.1	0.1	0.2	0.7	2.4	96.5
D-3 (Shallow)	Feb.	1.5	0.0	3.0	1.0	0.8	3.4	24.5	65.8
	May	11.6	0.0	0.4	0.9	0.5	1.9	20.0	64.7
D-1 (Deep)	Feb.	0.0	0.0	0.0	0.0	0.0	1.9	1.5	96.5
	May	0.0	0.0	0.0	1.3	2.5	14.3	12.3	69.7
F-1 (Shallow)	May	0.0	0.0	9.0	43.7	25.4	3.7	3.4	14.6

*See 3.2.2 for description of diameter size classes of designated components

The sediment composition at Stations B-1 and C-1 was moderately heterogeneous. The C-1 station had four components, each comprising over 10 percent of the sample; very course sand, coarse sand, medium sand, and fine sand. Station B-1 had four components each comprising over 10 percent of the May sample; medium sand, fine sand, very fine sand, and silt and clay. In February, coarse sand also constituted over 10 percent of the sample at Station B-1. The four substrate constiuents in May accounted for over 98 percent of the total while in February the five components accounted for about 80 percent.

3.2.3.4 Sediment Chemistry

Concentrations of DDE, DDD, and DDT from all samples were generally very low and were often below the detectable limits of 0.005 ppm. No other pesticides were detected in the bottom sediments. Similar findings were made for surface soils of the surrounding study area, although the frequency occurrence of samples containing no pesticide residue was greater (see Section 5.2). Concentrations (in ppm) of pesticides found in the bottom sediments are as follows:

Transect	DDE	DDD	DDT
A	<0.005	0.005	0.005
B	0.009	0.007	0.012
C	0.007	<0.005	<0.005
D	0.007	0.007	0.009
E	0.005	0.008	0.009
F	<0.005	<0.005	<0.005

Polychlorinated bi-phenyls (PBCs) were present in moderate concentrations ranging from 0.010 to 0.044 ppm. The highest concentration was found at Transect E, directly below Parr Dam.

Boron was present in the highest concentration (100-194 ppm) of the minerals measured in bottom sediments (Table 3.2.4). Concentrations of all other minerals measured were low. Lithium and zinc concentrations were generally low, but in all cases higher than those in the surrounding topsoil.

Table 3.2.4 Concentration of minerals in bottom sediment samples from the Broad River Study Area at Parr, South Carolina, February 1972. All values are in parts per million.

Transect	Arsenic	Copper	Zinc	Lead	Mercury	Boron	Chromium	Lithium
A	0.020	6.96	27.0	6.24	0.008	100	22.80	3.92
B	0.020	13.90	30.2	18.40	0.042	142	36.50	2.80
C	0.020	21.70	30.3	20.20	0.033	160	25.20	2.32
D	0.027	25.20	30.4	14.60	0.038	174	35.40	3.64
E	0.160	10.70	36.9	8.83	0.017	168	24.60	8.28
F	0.107	5.40	24.9	5.42	0.021	108	20.40	4.20

With the exception of lithium, mineral concentrations were highest in and below the reservoir. Lithium, zinc, and arsenic concentrations were greatest at Transect E, directly below Parr Dam.

3.2.3.5 Dissolved Oxygen

Dissolved oxygen analyses were conducted at six collection points between June 1971 and May 1973 (Table 3.2.5). Seasonal variations in surface samples for 1971 to 1973 data were as follows: winter (January and February), 6 to 13 ppm; early spring (March), stable at 9 ppm; late spring (May), 9 to 11 ppm; early summer (June), 9 to 11 ppm; early fall (September), 7 to 10 ppm; and late fall (November), 9 to 11 ppm. Daytime dissolved oxygen levels near Parr Dam throughout August, 1972, reached a minimum concentration of 4.8 ppm (SCE&G Water Quality Program 1972). Nighttime levels may well have been even lower.

Percent saturation of dissolved oxygen, which corrects for temperature effects, was near or above 100 percent at the surface except in the January 1971 and August 1972 samples (Table 3.2.6). During the mid-winter period, saturation ranged from about 50 to 80 percent in both surface and bottom samples. Saturation values during August 1972 ranged from 51 to 90 percent. Percent saturation of dissolved oxygen in bottom water samples never exceeded surface values.

3.2.3.6 pH

Analyses for pH were also conducted routinely between June 1971 and May 1973 at six collecting points (Table 3.2.7). Seasonal pH values for 1971 to 1973 at all stations and depths ranged from 6.9 to 8.0. Mean pH values, however, ranged from 7.0 to 7.2 for combined surface and bottom samples. Values for pH at the surface were slightly greater than bottom values for several sample sites; particularly in early summer (June) and early fall (September) 1971.

Table 3.2.5 Dissolved oxygen at the surface (S) and bottom (B) at collecting points along transects in the Broad River Study Area in 1971-73.

Date (1971-72)	Sample	Collecting Points A-1	B-2	C-3	D-1	E-1	F-1
		ppm of Dissolved Oxygen ± 1.0 ppm					
June	S	10	11	10	9	9	NS**
	B	8	6	7	7	NS	NS
September	S	10*	10	7	7	9	NS
	B	8*	8	7	7	NS	NS
January	S	6	6	9	7	6	7
	B	6	6	9	6	6	7
March	S	9	9	9	9	9	9
	B	9	9	9	9	NS	NS

Date (1972-73)		A-2	B-3	C-3	D-1	E-1	F-1
November	S	9	10	10	10	10	11
	B	NS	NS	NS	NS	NS	NS
February	S	13	11	13	13	11	12
	B	13	NS	12	12	NS	NS
May	S	NS	11	11	NS	9	NS
	B	NS	NS	NS	NS	NS	NS

* Dissolved oxygen at Station 2 for this date

** Not Sampled

Table 3.2.6 Estimated percent saturation of dissolved oxygen at collecting points along transects in the Broad River Study Area in 1971-73.

Date (1971-72)	Sample	Percent Saturation*					
		A-1	B-2	C-3	D-1	E-1	F-1
June	S	135	145	132	112	115	NS***
	B	100	67	80	85	NS	NS
September	S	120**	125	87	79	106	NS
	B	93**	90	80	79	NS	NS
January	S	52	54	83	60	50	57
	B	52	54	80	54	50	NS
March	S	92**	84	93	87	86	90
	B	89**	79	90	86	NS	NS

Date (1972-73)		A-2	B-3	C-3	D-1	E-1	F-1
November	S	NS	98	97	97	97	106
	B	NS	NS	NS	NS	NS	NS
February	S	114	96	114	112	95	105
	B	111	NS	105	105	NS	NS
May	S	NS	120	120	NS	97	NS
	B	NS	NS	NS	NS	NS	NS

* Estimated from nomograph on oxygen saturation present in Welch (1948)

** Percent saturation at Station 2 for this date

*** Not Sampled

Table 3.2.7 Measured pH at the surface (S) and bottom (B) at collecting points along transects in the Broad River Study Area in 1971-73.

Date (1971-72)	Sample	pH* A-1	B-2	C-3	D-1	E-1	F-1
June	S	7.5	7.7	7.7	7.0	7.0	NS***
	B	7.0	6.9	7.0	NS	NS	NS
September	S	7.0**	7.5	7.5	7.0	7.0	7.0
	B	7.0**	7.0	7.0	7.0	NS	NS
January	S	7.0	7.0	7.0	7.0	7.0	7.0
	B	7.0	7.0	7.0	7.0	7.0	7.0
March	S	7.0**	7.0	7.5	7.0	7.0	8.0
	B	7.0**	7.0	7.0	7.0	NS	NS
Date (1972-73)		A-2	B-3	C-3	D-1	E-1	F-1
November	S	7.0	7.3	7.1	7.0	7.0	7.0
	B	NS	NS	NS	NS	NS	NS
February	S	7.2	7.0	7.0	7.0	7.0	6.9
	B	7.2	NS	7.0	7.0	NS	NS
May	S	NS	7.0	7.5	NS	7.0	NS
	B	NS	NS	NS	NS	NS	NS
Mean		7.1	7.1	7.2	7.0	7.0	7.2

* Measured to the nearest 0.1 pH unit

** pH at Station 2 for this date

*** Not Sampled

3.2.3.7 Other Water Quality Parameters

Chemical analyses of the Broad River at Parr indicate that the river is very low in dissolved solids (Table 3.2.8). The water is soft and has a low buffering capacity. Silica and nitrogen concentrations are high while phosphates are present only in trace quantities. Biological oxygen demand (BOD) is generally low but has been recorded as high as 13 ppm (John Foley pers. comm.).[1] Chemical oxygen demand (COD) measurements are usually high and range from 1.9 to 46.9 ppm with a mean value of 16.8 ppm.

3.2.4 DISCUSSION

Seasonal water temperature changes on the Broad River Study Area are typical of lotic waters strongly influenced by air temperature. The temperature data suggest a more lentic condition at Transects A, B, and C while a more lotic condition exists at Transects D and E. Undoubtedly the lentic water conditions at A-1, A-2, B-2, B-3, and C-3 allow for rapid surface heating and the establishment of thermally related density gradients between the surface and bottom of the river. Turbulence and mixing, characteristic of lotic conditions at D-1 just above Parr Dam and E-1 just below, create general homothermous conditions.

Secchi disc visibility readings in the Broad River Study Area, regardless of sample date or transect, were low. Low readings were related to silt and clay turbidity.

An indication of the depth to which major photosynthesis will occur may be obtained with Secchi readings since Secchi disc transparency represents the depth at which about 95 percent of solar radiation is absorbed (Odum 1971). Minimum and maximum Secchi readings on the study area were 0.10 and 0.70

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[1] John Foley, University of South Carolina, Belle Baruch Institute

Table 3.2.8 Chemical analyses of the Broad River, Parr, South Carolina.*

	Average	Minimum	Maximum
Total Dissolved Solids	71 ppm	36	178
Conductivity	63 µmhos	43	92
Total Alkalinity	24 ppm	15	33
Total Hardness	17 ppm	12	24
Calcium Hardness	12 ppm	6	18
Magnesium Hardness	5 ppm	2	8
Chlorides	6 ppm	4	9
Sulfates	4 ppm	2	13
Soluble SiO_2	12 ppm	7	24
Nitrates	0.8 ppm	0.55	1.0
Phosphate	Trace	Trace	Trace
Chemical Oxygen Demand	16.8 ppm	1.9	46.9

*From SCE&G Broad River Sampling Program; mean of 21 samples from 8 June 1971 to 8 August 1972.

(0.3 to 2.3 ft) respectively, and mean Secchi readings by site ranged from 0.26 to 0.47 (0.8 to 1.5 ft). Autotrophic production by primary producers (planktonic algae) is therefore generally restricted to near-surface water where light intensity is sufficient for phytosynthesis.

The sediment composition of the study area in general reflects the distribution of finely divided materials deposited in relation to changes in stream velocity. These materials are easily erodable and may shift and be redeposited with periodic changes in stream velocity. Smaller particles are usually a characteristic of river substrates as the distance downstream from the source increases (Hynes 1972).

The predominance of finely divided sediment likely limits the benthic fauna to species tolerant of silting conditions. Silt is known to inhibit development of certain insect and mollusc species (Van der Schalie and Van der Schalie 1950; Lauff and Cummins 1964; Scott 1958). However, species such as the mayfly, Hexagenia limbata, an important component of the benthic fauna in the study area, are known to prefer a soft silty substrate (Swanson 1967). Although the number of species in the typical silt-sand substrate of the study area is restricted, Hynes (1972) indicates that this substrate type is capable of supporting considerable biomass of benthic forms.

The dectectable but low concentrations of residual DDE, DDD, and DDT in bottom sediments indicate a low level of insecticide contamination. Although sediment samples were taken in February, the low concentrations of these basically refractory compounds suggests the absence of chronic contamination from topsoil applications and subsequent runoff.

Minerals in the bottom sediments are within the range of concentrations found in the surrounding watershed, with the exception of lithium, zinc, and copper, which were generally higher. The higher levels of lithium,

zinc, and copper reflect a combination of differential solubility during leaching from the soil, differential adsorption to seston[1], and precipitation and concentration in the bottom sediments. With the exception of lithium, all heavy metals analyzed were found in slightly higher concentrations in the reservoir than in the river. This is due, in part, to adsorbed metals being precipitated with the seston as the terminal water velocity is reduced within the reservoir.

Polychlorinated bi-phenyls (PCBs) are persistant, ubiquitous environmental contaminants that are used in industrial and agricultural applications. The source of PCB contamination in the bottom sediments of the Broad River is unknown.

Seasonal dissolved oxygen concentrations were near or above saturation during the sampling periods except in January 1971 and August 1972. Photosynthetic activity during June and September 1971 probably accounts for greater surface concentrations of dissolved oxygen especially at the lentic-like Stations A-1 and B-2 where saturation was 120 percent or greater. Surface and bottom concentrations were more similar at C-3 than at A-1 and B-2, and typical lotic oxygen conditions (homogeneous mixing) occurred at the D-1, E-1, and F-1 sites. A reduction in oxygen saturation was evident in January 1971 and August 1972 at all sites and ranged from about 50 to 90 percent. In addition, dissolved oxygen was lower in bottom samples on several sample dates. The lowered dissolved oxygen levels observed were probably the result of oxygen consumption for decomposition coupled with reduced phytosynthetic activity. Although dissolved oxygen levels near the bottom were sometimes lower than

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[1]all material, both inorganic and organic, suspended in the waterway

those at the surface, the relatively high levels indicate that the bottom sediments have only moderate oxygen demand.

The differences in surface and bottom pH values in early summer and early fall (June and September 1971) at the more lentic-like sites (A, B, and C) are probably related to increased phytosynthetic activity near the surface and increased CO_2 production in bottom sediments.

Nutrients in the water of the Broad River are generally in high enough concentrations to support large algae populations. Phosphorus, though found in trace quantities in the Broad River, is not expected to be a limiting nutrient, as very low quantities (one part per billion) are known to support large algae blooms. The low calcium hardness of the water may be an important factor limiting the density of plankton crops. All other factors being equal, streams with higher calcium hardness produce appreciably higher standing crops (Williams 1964). Other dissolved solids are present in low concentrations as evidenced by the low specific conductivity as well as the low level of total dissolved solids. In addition, the low buffering capacity of the water may allow the pH to decrease somewhat in localized areas in response to runoff from the surrounding acid soils.

The high levels of COD with concurrently high DO levels appear to be related to the presence of allochthonous materials such as cellulose that have undergone partial biological degredation, and hence exert a low BOD. There is also a possibility that certain organic materials leached from the surrounding watershed are adsorbed on colloidal clay particles where they become more resistant to biological degredation. In addition, the occurrence of moderate levels of PCBs in the bottom sediments as well as high COD levels suggest the possibility of upstream industrial contamination of the water.

3.2.5 SUMMARY

Selected physical and chemical characteristics of water on the Broad River Study Area were examined between June 1971 and May 1973. The purpose of this investigation was to provide information on seasonal abiotic conditions existing during periods of biotic sampling.

Temperatures for the periods measured ranged from a maximum of 31.5°C to a minimum of 7.0°C. Vertical temperature gradients at Transects A, B, and C were related to the more lentic-like conditions existing at these sites. Relative homothermy, found at Transects D, E, and F, was typical of more lotic-like conditions.

Water transparency was low and light penetration was restricted due to silt and clay turbidity. Minor differences in transparency occur with season and site. Photosynthetic activity is probably restricted to near surface waters because of low transparency.

Sediments from most sites examined were homogeneous to moderately homogeneous compositions of finely divided materials, mainly silt, clay, and coarse to medium sand. Only sediments from Stations B-1 and C-1 were moderately heterogeneous, usually composed of coarse sand, medium sand, fine sand, very fine sand, and silt and clay. Larger particles such as pebbles and granules were generally lacking with the exception of Station D-3 where pebbles comprised about 12 percent of the sediment in May. The homogeneous nature of finely divided materials in the substrate probably is a major factor in limiting diversity of the benthic fauna although substrates of this type may be capable of supporting considerable biomass.

Data on bottom sediment chemistry indicated a low level of DDD, DDE, and DDT contamination and moderate concentration of PCBs. Minerals and heavy metals were present in concentrations that reflected differential

solubility and adsorption to soil particles and subsequent deposition in bottom sediments.

Seasonal dissolved oxygen concentrations were usually near or above saturation at all transects. A period of lowered dissolved oxygen in mid-winter, 1971, and late summer, 1972, was probably related to decomposition and reduced photosynthesis. Elevated dissolved oxygen levels in June and September, 1971, on Transects A, B, and C were probably due to the more lentic-like conditions and photosynthetic activity.

The pH values recorded were usually near 7.0 regardless of season or station. Slightly elevated pH levels at the surface on Transects A, B, and C in June and September, 1971 were likely produced by elevated photosynthetic activity in the more lentic-like conditions.

The Broad River at the study area is low in dissolved solids and has a low buffering capacity. Nutrient levels are probably high enough to support large algae populations under conditions of low turbidity. High levels of biologically degredated allochthonous materials probably account for most of the observed high COD levels although the possibility of upstream industrial contamination is not discounted.

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3.3 PLANKTON

3.3.1 INTRODUCTION

Photoplankton and zooplankton analyses are fundamental to the examination of trophic relationships existing in the Broad River Study Area. In addition, they are important biological indicators of environmental conditions. Pre-operational examination of the plankton community is essential to subsequent post-operational analyses to determine any impact of the project.

Phytoplankton and zooplankton populations in the Broad River Study Area were examined qualitatively and quantitatively between June 1971 and May 1973. The purpose of these analyses was to provide basic information on species composition, density, diversity, and biomass of the plankton.

A detailed examination of the phytoplankton in the project area was conducted for SCE&G by John Foley, a graduate student from the University of South Carolina, Belle W. Baruch Coastal Research Institute. Some of his preliminary work appears in this report.

3.3.2 METHODS AND MATERIALS

A modified Wisconsin tow net with a diameter of 12 cm (4.7 in) and a length of 55 cm (21.8 in) was used for all plankton sampling. The net frame and detachable bucket were fitted with No. 20 nylon bolting cloth with a mesh size of about 76 microns.

Plankton samples for qualitative and quantitative analyses were collected using two methods. The first method involved sampling surface waters by dipping to a depth of about 25 cm (9.8 in) with a bucket and pouring 100 liters of water through the plankton net. The second method involved sampling the water column from the bottom to the surface by lowering the plankton net into the water until the bottom of the net mouth touched the substrate whereupon the net was retrieved steadily at a rate of approximately 0.5 m/sec. The remainder

of the procedure for both methods involved washing the inside of the net with filtered water to concentrate all organisms in the net bucket, rinsing the plankton concentrate into small jars, and preserving the labeled samples with about 10 percent formalin for later laboratory analysis.

In the laboratory, bottles containing plankton samples were filled to a volume of 50 ml. A one milliliter aliquot was taken from each thoroughly mixed sample with a Hensen-Stemple pipette and placed in a Sedgwick-Rafter counting chamber. All organisms in the chamber were examined microscopically under 200X magnification and enumerated. Slides were prepared as necessary for diatom identification using procedures outlined by Weber (1970). Appropriate computations were made to convert the sample into organisms or cells per liter. Plankton were identified by using Patrick and Reimer (1966), Pennak (1953 and 1963), Prescott (1962), Smith (1950), Ward and Whipple (1959), Weber (1971), and Whitford and Schumacher (1969).

Beginning in November 1972, plankton biomass was estimated from surface samples concentrated with a plankton net as previously described. After enumeration of organisms, the sample was collected on a Millipore HA filter of known weight using a standard Millipore apparatus. The samples were dried to constant weight at 60°C, ashed at 600°C for one hour, reweighed, and the ash-free dry weight computed. All weights were determined with an analytical balance to the nearest 0.01 mg.

3.3.3 FINDINGS

3.3.3.1 Phytoplankton

3.3.3.1.1 Qualitative Analysis

A total of 102 phytoplankton taxa were collected on the Broad River Study Area between June 1971 and May 1973 in surface samples and vertical plankton net tows (Table 3.3.1). The number of species in each major taxonomic

Table 3.3.1 Species list of phytoplankton present (P) in quarterly surface (S) and vertical tow (VT) plankton samples between June 1971 and May 1973 on the Broad River Study Area.

	1971				1972					1973	
	June		Sept.		Jan.		March		Nov.	Feb.	May
Taxa	S	VT	S	VT	S	VT	S	VT	S	S	S
Chlorophyta											
Actinastrum sp.	P	P	P	P	P	P	P	0	P	0	0
Ankistrodesmus sp.	0	0	0	0	0	0	0	0	P	P	P
Ankistrodesmus falcatus	P	0	P	0	0	0	0	0	0	0	P
Arthrodesmus sp.	0	0	0	0	0	0	0	0	0	P	0
Chlamydomonas sp.	0	0	0	0	0	0	0	C	0	P	0
Chlorella sp.	0	0	0	0	0	0	P	0	P	0	0
Cladophora sp.	0	0	0	0	0	0	0	0	0	0	P
Closterium sp.	0	P	P	0	P	0	P	P	P	0	0
Closterium pronum	0	0	0	0	0	0	0	0	0	P	0
Cosmarium sp.	0	0	0	0	0	0	P	0	P	P	P
Eudorina sp.	P	P	P	P	P	P	P	P	0	0	0
Gloeocapsa sp.	0	0	0	0	0	0	0	0	0	0	P
Gloeocystis gigas	0	0	0	0	0	0	0	0	0	0	P
Golen[illegible] sp.	0	0	0	0	0	0	0	0	0	0	P
[illegible] sp.	0	0	0	0	0	0	P	0	0	0	0
Micrasterias sp.	0	0	P	0	0	0	0	0	0	0	0
Mougeotia sp.	0	0	0	0	0	0	0	0	0	P	P
Onychonema sp.	0	0	0	0	0	0	P	0	P	0	0
Pachycladon sp.	0	P	P	0	0	0	P	0	0	0	0
Pachycladon umbrinus	0	0	0	0	0	0	0	0	0	P	0
Pediastrum sp.	P	P	P	P	P	0	P	P	P	0	0
Pediastrum boryanum	0	0	0	0	0	0	0	0	0	0	P
Pediastrum duplex	0	0	0	0	0	0	0	0	0	0	P
Penium sp.	0	0	0	0	0	0	P	0	0	0	0
Scenedesmus sp.	P	P	P	P	0	0	P	P	P	P	P
Scenedesmus dimorphus	0	0	0	0	0	0	0	0	0	0	P

Table 3.3.1 (Continued)

Taxa	1971 June S	1971 June VT	1971 Sept. S	1971 Sept. VT	1972 Jan. S	1972 Jan. VT	1972 March S	1972 March VT	1972 Nov. S	1973 Feb. S	1973 May S
Scenedesmus protuberans	0	0	0	0	0	0	0	0	0	0	P
Scenedesmus quadricauda	0	0	0	0	0	0	0	0	0	P	P
Salenastrum sp.	0	0	0	0	0	0	0	0	0	0	P
Sphaerocystis schroeteri	0	0	0	0	0	0	0	0	0	0	P
Staurastrum sp.	0	0	P	P	P	0	P	0	0	P	0
Staurastrum quadricuspidatum	0	0	0	0	0	0	0	0	0	P	0
Tetraedron sp.	0	0	0	0	0	0	0	0	P	P	0
Tetraspora sp.	0	0	0	0	0	0	0	0	0	0	P
Treubaria crassispina	0	0	0	0	0	0	0	0	0	0	P
Ulothrix sp.	0	0	0	0	0	0	0	0	0	P	0
Volvox sp.	0	0	0	0	P	0	P	P	P	0	0
Total Chlorophyta	5	6	9	5	6	2	13	5	10	13	18
Chrysophyta											
Achnanthes sp.	0	0	0	0	0	0	0	0	0	P	0
Achnanthes lanceolata	0	0	0	0	0	0	0	0	0	P	0
Asterionella sp.	P	P	P	P	P	P	P	P	P	0	0
Asterionella formosa	0	0	0	0	0	0	0	0	0	P	P
Cyclotella sp.	0	0	0	0	0	0	0	0	0	0	P
Cyclotella menghiniana	0	0	0	0	0	0	0	0	0	P	0
Cyclotella stelligera	0	0	0	0	0	0	0	0	0	P	0
Cymbella sp.	0	0	0	0	0	0	0	0	P	P	P
Dinobryon sp.	P	P	P	P	P	P	P	P	P	0	P
Dinobryon cylindricum	0	0	0	0	0	0	0	0	0	P	0
Dinobryon sociale	0	0	0	0	0	0	0	0	0	0	P
Epithema sp.	0	0	0	0	0	0	0	0	0	P	0
Eunotia sp.	0	0	0	0	0	0	0	0	0	P	0
Eunotia curvata	0	0	0	0	0	0	0	0	0	P	0
Fragilaria sp.	P	P	P	P	P	P	P	P	P	P	0

Table 3.3.1 (Continued)

Taxa	1971 June S	1971 June VT	1971 Sept. S	1971 Sept. VT	1972 Jan. S	1972 Jan. VT	1972 March S	1972 March VT	1972 Nov. S	1973 Feb. S	1973 May S
Fragilaria crotonesis	0	0	0	0	0	0	0	0	0	P	P
Frustulia vulgaris	0	0	0	0	0	0	0	0	0	P	0
Gomphonema sp.	0	0	P	P	P	P	P	P	P	0	0
Gyrosigma sp.	0	0	0	0	0	0	0	0	0	0	P
Gyrosigma obtusatum	0	0	0	0	0	0	0	0	0	P	0
Melosira distans	0	0	0	0	0	0	0	0	0	P	P
Melosira granulata*	P	P	P	P	P	P	P	P	P	P	P
Melosira varians*	P	P	P	P	P	P	P	P	P	P	P
Meridinion sp.	0	0	0	0	0	0	0	0	0	0	P
Meridinion circulare	0	0	0	0	0	0	0	0	0	P	0
Navicula sp.	P	0	P	P	P	P	P	P	P	P	P
Navicula mutica	0	0	0	0	0	0	0	0	0	P	0
Nedium sp.	0	0	0	0	0	0	0	0	0	0	P
Nitzschia sp.	0	0	0	0	0	0	0	0	0	P	P
Nitzschia acicularis	0	0	0	0	0	0	0	0	0	P	P
Nitzschia palea	0	0	0	0	0	0	0	0	0	P	0
Pinnularia sp.	0	0	0	0	0	0	0	0	0	P	P
Pleurosigma sp.	P	P	P	0	P	P	P	P	P	0	0
Rhizosolenia eriensis	0	0	0	0	0	0	0	0	0	0	P
Stauroneis sp.	0	0	0	0	0	0	0	0	0	0	P
Stephanodiscus	0	0	0	0	0	0	0	0	0	0	P
Surrirella sp.	0	0	0	0	0	0	0	0	0	0	P
Synedra sp.	P	P	P	P	P	P	P	P	P	P	P
Synedra puchella	0	0	0	0	0	0	0	0	0	P	0
Synedra ulna	0	0	0	0	0	0	0	0	0	P	0
Tabellaria sp.	P	P	P	P	P	P	P	P	P	0	0
Tabellaria fenestrata	0	0	0	0	0	0	0	0	0	P	P
Total Chrysophyta	9	5	10	9	10	10	10	10	11	28	22

*Melosira granulata designated Melosira "A" and Melosira varians designated Melosira "B" in previous reports.

Table 3.3.1 (Continued)

Taxa	1971 June S	1971 June VT	1971 Sept. S	1971 Sept. VT	1972 Jan. S	1972 Jan. VT	1972 March S	1972 March VT	1972 Nov. S	1973 Feb. S	1973 May S
Cyanophyta											
Anabena sp.	P	P	P	P	P	0	P	0	P	P	P
Aphanocapsa sp.	0	0	0	0	0	0	0	0	0	0	P
Arthrospira sp.	0	0	0	0	P	P	P	0	0	0	0
Chroococcus sp.	P	P	P	P	P	0	P	0	P	P	0
Coelosphaerium sp.	0	0	0	0	0	0	0	0	P	0	0
Gloeocapsa sp.	0	0	P	0	0	0	0	0	P	0	0
Gomphosphaerium sp.	0	0	P	0	0	0	0	0	0	0	0
Merismopedia sp.	0	0	0	0	0	0	0	0	0	P	0
Microcystis sp.	P	P	P	P	P	0	P	P	P	0	0
Oscillatoria sp.	0	0	0	0	0	0	0	0	0	P	P
Oscillatoria "A"	P	P	P	P	P	P	P	P	P	0	0
Oscillatoria "B"	P	P	P	P	P	P	P	P	P	0	0
Phormidium sp.	0	0	0	P	0	0	0	0	0	0	0
Spirulina sp.	P	P	P	P	0	0	0	0	P	0	0
Spirulina princeps	0	0	0	0	0	0	0	0	0	P	0
Total Cyanophyta	6	6	8	7	6	3	6	3	8	5	3
Euglenophyta											
Euglena sp.	0	0	0	0	0	0	P	P	P	P	0
Phacus sp.	0	0	0	0	0	0	P	0	0	0	0
Trachelomonas sp.	0	0	0	0	0	0	0	0	P	P	0
Trachelomonas hispida	0	0	0	0	0	0	0	0	0	P	0
Trachelomonas armata	0	0	0	0	0	0	0	0	0	P	0
Total Euglenophyta	0	0	0	0	0	0	2	1	2	4	0

Table 3.3.1 (Continued)

Taxa	1971				1972					1973	
	June		Sept.		Jan.		March		Nov.	Feb.	May
	S	VT	S	VT	S	VT	S	VT	S	S	S
Pyrrophyta											
Ceratium sp.	0	P	0	0	0	0	P	0	0	0	0
Ceratium hirundinella	0	0	0	0	0	0	0	0	0	0	P
Peridinium sp.	0	0	0	0	0	0	0	0	0	0	P
Total Pyrrophyta	0	1	0	0	0	0	1	0	0	0	2
Total Taxa	20	21	27	21	22	15	32	19	31	50	45

Table 3.3.2 Total phytoplankton species by phyla found on transects and stations on the Broad River Study Area between June 1971 and May 1973

	A*		B			C			D			E		F
	1	2	1	2	3	1	2	3	1	2	3	1	2	1
June 1971														
Chlorophyta	3	3	2	1	0	1	0	0	3	3	6	4	4	NS**
Chrysophyta	5	4	4	2	1	1	0	0	6	6	5	8	4	NS
Cyanophyta	4	4	2	3	3	0	0	0	4	4	5	3	3	NS
Total/Station	12	11	8	6	4	2	0	0	13	13	16	15	11	NS
Total/Transect	13		10			2			18			17		
September 1971														
Chlorophyta	4	1	4	3	4	0	1	2	0	0	1	4	3	6
Chrysophyta	5	5	4	4	3	2	2	3	5	2	4	8	8	9
Cyanophyta	6	4	3	6	4	2	2	2	1	1	3	4	4	5
Total/Station	15	10	11	13	11	4	5	7	6	3	8	16	15	20
Total/Transect	16			18			13			11			17	20
January 1972														
Chlorophyta	2	2	1	1	1	2	1	0	2	2	2	1	3	1
Chrysophyta	9	9	6	7	6	7	7	2	9	8	9	10	10	10
Cyanophyta	5	0	2	1	1	3	1	1	1	2	3	4	4	2
Total/Station	16	11	9	9	8	12	9	3	12	12	14	15	17	13
Total/Transect	16			10			15			15			17	13
March 1972														
Chlorophyta	4	8	2	2	5	2	0	1	9	6	4	6	3	8
Chrysophyta	10	10	5	7	8	10	8	8	10	10	10	10	10	10
Cyanophyta	2	3	2	3	3	5	2	1	4	5	1	3	2	4
Euglenophyta	0	2	0	0	0	1	0	0	0	0	1	1	0	1
Pyrrhophyta	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Total/Station	16	24	9	13	16	19	10	10	23	21	17	20	15	23
Total/Transect	24			19			20			29			20	23

* June & September samples are from Transect A'

** Not sampled

Table 3.3.2 (Continued)

	A		B			C			D			E		F
	1	2	1	2	3	1	2	3	1	2	3	1	2	1
November 1972														
Chlorophyta	3	NS	5	NS	NS	6	NS	6	2	NS	3	4	NS	2
Chrysophyta	7	NS	5	NS	NS	9	NS	10	10	NS	9	8	NS	7
Cyanophyta	3	NS	1	NS	NS	2	NS	3	2	NS	2	2	NS	1
Euglenophyta	1	NS	2	NS	NS	2	NS	1	1	NS	0	1	NS	1
Total/Station	14		13			19		20	15		14	15		11
Total/Transect	14		13			30			18			15		11
February 1973														
Chlorophyta	2	NS	4	NS	NS	3	NS	1	2	NS	4	4	NS	0
Chrysophyta	11	NS	13	NS	NS	14	NS	4	10	NS	5	4	NS	6
Cyanophyta	3	NS	3	NS	NS	0	NS	0	1	NS	0	1	NS	0
Euglenophyta	0	NS	0	NS	NS	1	NS	0	0	NS	2	0	NS	1
Total/Station	16		20			18		5	13		10	9		7
Total/Transect	16		20			20			19			9		7
May 1973														
Chlorophyta	4	NS	6	NS	2	2	NS	3	2	NS	1	2	NS	5
Chrysophyta	12	NS	10	NS	8	6	NS	8	4	NS	7	7	NS	9
Cyanophyta	2	NS	0	NS	0	0	NS	0	0	NS	0	0	NS	1
Pyrrophyta	0	NS	1	NS	0	1	NS	0	0	NS	0	0	NS	1
Total/Station	18		17		10	9		11	8		8	9		16
Total/Transect	13		19			17			12			9		16

* June & September samples are from Transect A

** Not sampled.

group was: Chlorophyta, 37; Chrysophyta, 42; Cyanophyta, 15; Euglenophyta, 5; and Pyrrhophyta, 3. Foley (1972), in his in-depth examination of phytoplankton in the Broad River Study Area between August and December 1971, found a total of 151 species. The species composition in major taxonomic groups was: Chlorophyta, 51; Chrysophyta (including Bacillariophyta), 70; Cyanophyta, 22; Euglenophyta, 7; and Pyrrhophyta, 1.

The number of phytoplankton taxa collected between June 1971 and March 1972 in surface samples was equal to or greater than the number of taxa in vertical tow plankton net samples (Table 3.3.1). Evaluation of phytoplankton species is therefore restricted to surface samples.

A comparison of the total phytoplankton taxa collected from Transects A through F reveals minor differences within a particular sample period (Table 3.3.2). The number of taxa collected from each transect between June 1971 and May 1973 ranged from 7 to 20 with two exceptions. Transect C taxa ranged from 2 to 30 during this period and all transects had taxa ranging from 19 to 29 during March 1972. The general increase in taxa during March was due primarily to a pulse of chlorophyte and chrysophyte species.

Seasonal fluctuations in the total phytoplankton species between June 1971 and May 1973 were as follows by transect: A', 13 to 16; A, 16 to 24; B, 10 to 20; C, 2 to 30; D, 11 to 29; E, 12 to 20; and F, 7 to 23 (Table 3.3.2). Significant seasonal changes in number of species occurred on Transect C and Transect D just above Parr Dam in the reservoir. In all cases the greatest phytoplankton species complex occurred in March.

The following phytoplankton are considered common on the Broad River Study Area because they occurred in at least five of seven surface samples between June 1971 and May 1973: Chlorophyta Actinastrum sp., Pediastrum spp., and Scenedesmus spp.; Chrysophyta Asterionella spp., Dinobryon spp.,

Fragilaria spp., Melosira granulata, M. Varians, Navicula spp., Pleurosigma sp., Synedra spp., and Tabellaria spp; Cyanophyta - Anabaena sp., Chroococcus sp., Microcystis sp., and Oscillatoria spp., (Table 3.3.1). Melosira granulata and M. varians were designated As species "A" and "B", respectively, in previous reports.

3.3.3.1.2 Quantitative Analysis

The examination of surface phytoplankton populations sampled from 1971 to 1973 revealed that the chrysophyte flora, including Asterionella spp., Fragilaria spp., Melosira granulata, M. varians, and Tabellaria spp., were the only species in consistently high enough numbers for evaluation. These were the only species present in at least one sample collected on each transect with a density of 100/liter or more. Seven species of desmids were collected throughout the study period but population densities were always low. The abundance of cyanophytes was also very low, however, density estimates are minimal since some loss of organisms probably occurred because of the plankton net mesh size.

The density of the predominant chrysophytes varied among transects but no definite trends were evident (Table 3.3.3). Transect C, however, did show a reduction in the number of chrysophytes during the June and September collections.

Seasonal changes in abundance were evident for Asterionella sp., Fragilaria sp., Melosira varians, and Tabellaria sp. Melosira granulata did not show consistent seasonal changes in abundance (Table 3.3.3).

Asterionella sp. appeared to peak in February and March. The greatest sample density occurred during March on Transect E when over 1550/liter were found. Less than 100/liter were found at other times.

Large populations of Fragilaria spp. occurred during February,

TABLE 3.3.3 Mean density (number/milliliter) of major diatom species sampled on Transects A to F on the Broad River Study Area between June 1971 and May 1973.

	A*	B	C	D	E	F
June 1971						
Asterionella sp.	0	0	0	50	50	NS**
Fragilaria sp.	450	50	0	2000	2000	NS
*Melosira granulata***	225	55	0	145	140	NS
*Melosira varians****	100	100	0	150	150	NS
Tabellaria sp.	20	0	0	20	20	NS
September 1971						
Asterionella sp.	0	0	0	25	25	25
Fragilaria sp.	50	50	50	50	575	50
Melosira granulata	40	55	5	5	130	55
Melosira varians	150	150	0	150	150	100
Tabellaria sp.	0	20	0	0	30	50
January 1972						
Asterionella sp.	50	50	50	50	50	25
Fragilaria sp.	50	50	0	50	50	50
Melosira granulata	10	390	35	35	115	10
Melosira varians	900	150	100	800	100	600
Tabellaria sp.	25	50	15	80	20	15
March 1972						
Asterionella sp.	150	75	100	75	1550	350
Fragilaria sp.	300	100	200	200	1050	150
Melosira granulata	55	160	125	135	260	50
Melosira varians	4500	100	100	1200	2350	7000
Tabellaria sp.	265	95	315	175	315	180

* Transect A' for June and September, 1971.

** Not sampled.

*** *Melosira granulata* designated *Melosira* "A" and *Melosira varians* designated *Melosira* "B" in previous reports.

Table 3.3.3 (Continued)

	A	B	C	D	E	F
November 1972						
Asteriorella sp.	21	15	39	18	0	0
Fragilaria sp.	0	0	2	2	3	0
Melosira granulata	9	361	316	9	3	36
Melosiran varians	37	0	8	19	109	277
Tabellaria sp.	20	0	1	14	0	9
February 1973						
Asterionella sp.	382	106	0	135	0	255
Fragilaria sp.	170	2110	10	106	0	552
Melosira granulata	0	0	69	0	107	0
Melosira varians	255	4175	199	0	77	128
Tabellaria sp.	524	0	0	156	50	113
May 1973						
Asterionella sp.	83	0	0	22	42	22
Fragilaria sp.	52	4	0	8	0	9
Melosira granulata	63	57	13	0	0	0
Melosira varians	4	0	26	4	4	8
Tabellaria sp.	21	0	4	0	0	0

March, and June. The greatest density occurred at Transect B in February and Transects D and E in June when about 2000/liter were present. Populations of Fragilaria spp. were usually below 100/liter during other sample periods.

Consistent changes in population density of Melosira granulata were not evident. Concentrations ranged between 0 and about 400/liter but were usually lower than 200/liter.

The highest measured density of Melosira varians about 7000/liter, occurred in March on Transect F, however, the population appeared to be expanding in January when concentrations ranged from 100 to 900/liter. Population levels during other periods were usually less than 200/liter.

The density for Tabellaria spp. peaked during February and March at all transects in the study area. The maximum numbers recorded were only about 300/liter but populations were usually 50/liter or less.

3.3.3.2 Zooplankton

3.3.3.2.1 Qualitative Analysis

A total of 35 zooplankton species were collected in surface samples and vertical plankton net tows on the Broad River Study Area between June 1971 and May 1973 (Table 3.3.4). An equal or greater number of taxa were collected in surface samples compared with vertical plankton net tows between June 1971 and March 1972. The composition for major taxonomic groups was as follows: Protozoa, 4; Rotifera, 21; Copepoda, 2; and Cladocera, 8.

The following zooplankters are considered common in the Broad River Study Area because they occurred in at least five of seven surface samples between June 1971 and May 1973: Rotifera - Asplanchna sp., Brachionus sp., Filinia spp., Keratella spp., Polyarthra sp., and Trichocera sp.; and Copepoda - Cyclops spp. (Table 3.3.4). No single cladoceran species occurred in all sample periods and no cladoceran species were collected during January and February.

TABLE 3.3.4 Species list of zooplankton present (P) in quarterly surface (S) and vertical tow (VT) plankton samples between June 1971 and May 1973 on the Broad River Study Area.

Taxa	1971				1972					1973	
	June		Sept.		Jan.		March		Nov.	Feb.	May
	S	VT	S	VT	S	VT	S	VT	S	S	S
Rotifera											
Asplanchna sp.	P	P	P	P	P	P	P	P	P	0	P
Brachionus sp.	P	P	P	P	P	0	P	P	P	0	P
Chonochiloides sp.	0	0	P	P	P	P	P	P	P	0	0
Chonochilus sp.	0	0	P	P	P	P	0	0	P	0	0
Filinia sp.	P	P	P	P	P	P	P	P	0	0	0
Filinia longiseta	0	0	0	0	0	0	0	0	0	0	P
Gastropus sp.	0	0	0	0	0	0	P	P	0	P	P
Kellicottia sp.	0	0	0	0	0	0	P	P	0	0	0
Kellicottia bostoniensis	0	0	0	0	0	0	0	0	0	P	0
Kellicottia longispina	0	0	0	0	0	0	0	0	0	0	P
Keratella sp.	P	P	P	P	P	P	P	P	P	0	0
Keratella cochlearis	0	0	0	0	0	0	0	0	0	P	P
Lecane sp.	0	0	0	0	0	0	P	P	0	0	0
Lepadella sp.	0	0	0	0	0	0	P	0	P	0	0
Monostyla sp.	0	0	0	0	0	0	P	P	P	P	P
Notholca sp.	0	0	0	0	0	0	P	P	P	P	0
Philodina sp.	0	0	0	0	0	0	0	0	0	P	0
Polyarthra sp.	P	P	P	P	P	P	P	P	P	0	P
Rotaria sp.	0	0	0	0	0	0	0	0	0	P	0
Synchaeta sp.	0	0	P	P	P	0	P	P	P	0	0
Trichocera sp.	0	0	P	P	P	P	P	P	P	P	P
Total Rotifera	5	5	9	9	9	7	14	13	11	8	9
Copepoda											
Cyclops sp.	P	P	P	P	P	P	P	P	P	0	0
Diaptomus sp.	P	P	P	0	0	0	0	0	0	0	P
Total Copepoda	2	2	2	1	1	1	1	1	1	0	1

TABLE 3.3.4 (Continued)

Taxa	1971 June S	1971 June VT	1971 Sept. S	1971 Sept. VT	1972 Jan. S	1972 Jan. VT	1972 March S	1972 March VT	1972 Nov. S	1973 Feb. S	1973 May S
Cladocera											
Acantholeberis sp.	0	0	0	0	0	0	P	0	0	0	0
Acantholeberis curvirostris	0	0	0	0	0	0	0	0	P	0	0
Alonella sp.	0	0	0	0	0	0	0	0	P	0	0
Bosmina sp.	0	0	0	0	0	0	P	0		0	P
Bosmina longirostris	0	0	0	0	0	0	0	0		0	P
Daphnia sp.	0	0	P	P	0	0	0	0	∪	0	P
Pseudosida sp.	P	P	P	P	0	0	P	0	0	0	0
Scaphelebris sp.	P	0	0	0	0	0	0	0	0	0	0
Total Cladocera	2	1	2	2	0	0	3	0	2	0	3
Protozoa											
Astrameba radiosa	0	0	0	0	0	0	0	0	0	0	P
Centropuxis aculeata	0	0	0	0	0	0	0	0	0	P	0
Codonella crotera	0	0	0	0	0	0	0	0	0	P	0
Difflugia sp.	0	0	P	P	P	P	P	P	0	P	0
Total Protozoa	0	0	1	1	1	1	1	1	0	3	1
Total Taxa	9	8	14	13	11	9	19	15	14	11	13

A comparison of the total zooplankton taxa reveals minor differences within particular sampling periods (Figure 3.3.1). Taxa numbers were lowest in June and ranged from 5 to 8 species. The number of taxa present in September and January was slightly greater than June and ranged from 6 to 13 with the exception of Transect F in September when only two taxa were collected. The greatest number of taxa occurred during March on Transects A and E and ranged from 11 to 18. Transect F was again lower than the others and only eight species were found. November samples showed greatest variability. The number of taxa ranged from 6 to 14 on Transects B, C, and D while only one was present on F, and none on A and E. The number of taxa in May was similar to June levels and ranged from 5 to 9, except on Transect E where only two were collected.

The range of zooplankton species occurring at each transect between June 1971 and May 1973 was as follows: A', 6 to 8; A, 6 to 13; B, 6 to 18; C, 7 to 16; D, 5 to 17; E, 0 to 11; and F, 0 to 8 (Figure 3.3.1). The number of taxa on Transect C was usually greater than other transects, regardless of period. Transects E and F usually had fewer taxa than other transects during periods sampled.

3.3.3.2.2 Quantitative Analysis

The zooplankton population on the Broad River Study Area was composed mainly of rotifers, copepods, and cladocerans. Densities from surface samples were generally low regardless of transect or season (Table 3.3.5).

Rotifers were the most abundant group of zooplankters with no single species predominating. The mean density was usually fewer than 50/liter regardless of transect or season. Exceptions to this generally low density level did not appear to follow a pattern, although all exceptions occurred on Transects B and C. The rotifer genera which were most numerous, the sample period, and transects having a density greater than 50/liter were: September

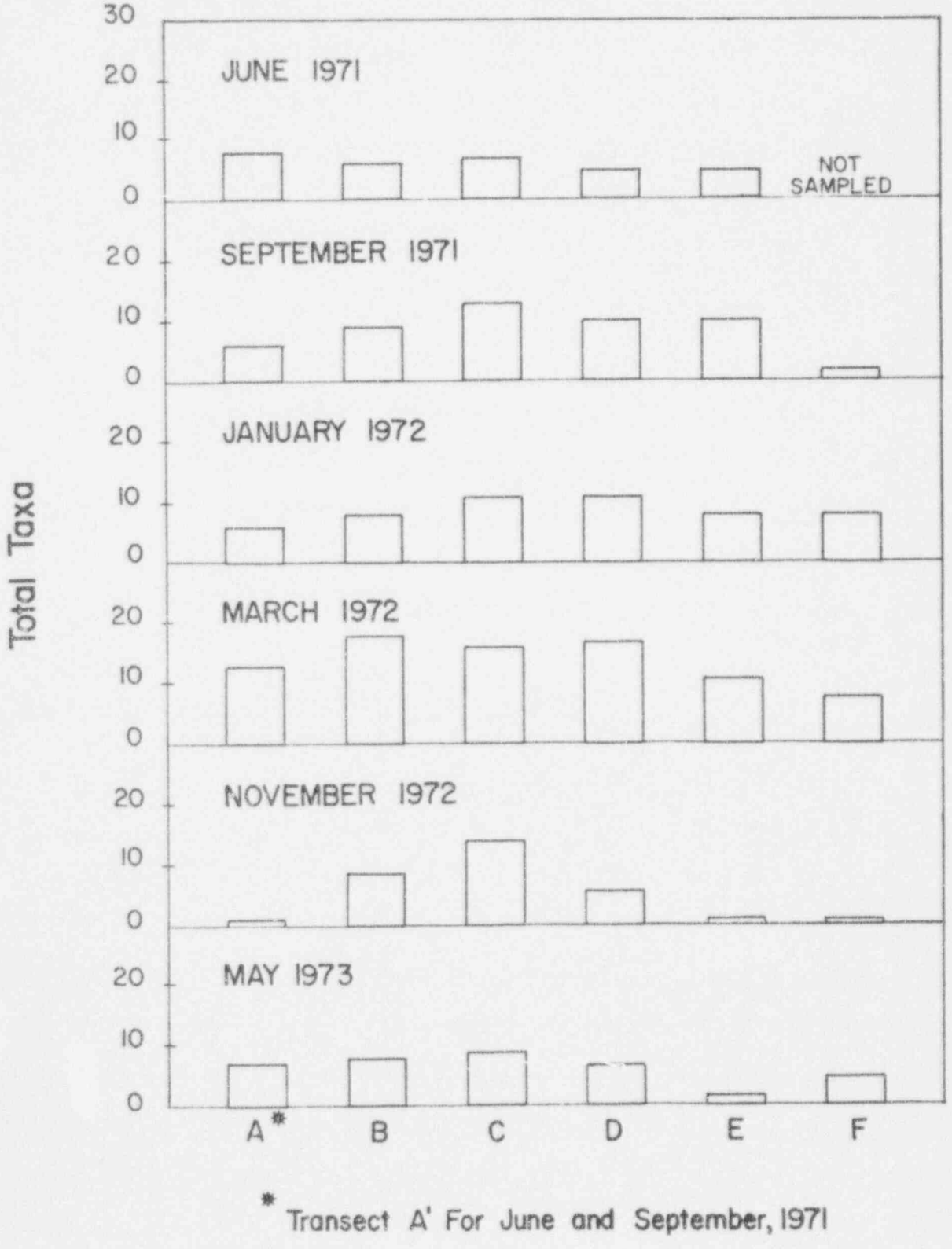

Figure 3.3.1 Total zooplankton taxa by Transect (A-F) in the Broad River Study Area between June 1971 and May 1973.

Table 3.3.5 Mean density (number/liter) of major zooplankton groups sampled on Transects A to F on the Broad River Study Area between June 1971 and May 1973.

	A*	B	C	D	E	F
June 1971						
Rotifers	20	20	10	10	10	NS**
Copepoid nauplii	2	3	1	3	1	NS
Cladocerans	2	1	1	0	1	NS
September 1971						
Rotifers	10	30	190	10	10	10
Copepoid nauplii	2	3	1	1	1	0
Cladocerans	2	2	1	1	1	0
January 1972						
Rotifers	10	240	25	15	20	10
Copepoid nauplii	0	1	2	1	2	1
Cladocerans	0	0	0	0	0	0
March 1972						
Rotifers	15	65	35	20	15	15
Capepoid nauplii	2***	1	2	3	1	2
Cladocerans	0	1	0	2	1	0
November 1972						
Rotifers	0	34	73	4	0	1
Copepoid nauplii	0	3	2	1	0	0
Cladocerans	0	0	1	0	0	0
February 1973						
Rotifers	1	7	11	2	1	2
Copepoid nauplii	0	1	3	0	0	0
Cladocerans	0	2	0	0	0	0

* Transect A' for June and September, 1971
** Not Sampled
*** Adults

Table 3.3.5 (Continued)

	A	B	C	D	E	F
May 1973						
Rotifera	10	170	99	1	1	4
Capepoid nauplii	0	0	4	0	0	0
Cladocerans	0	0	2	1	0	0

at C (190/liter), Brachionus; January at B (240/liter), Polyarthra and Keratella; March at B (65/liter), Brachionus; November at C (73/liter), Asplanchna, Chonochilus, and Polyarthra; and May at B and C (170 and 99/liter, respectively), Filinia, Keratella, and Polyarthra. Environmental conditions of Transects B and C appear to periodically allow the pulses noted for several species, particularly Brachionus, Keratella and Polyarthra, while on other transects the populations are restricted to low static levels.

The copepod populations were very low regardless of season and did not exceed a mean density of 4/liter (Table 3.3.5). Cyclopoid nauplii (probably Cyclops spp.) predominated over all other instar stages, including adults. No seasonal or transect trends in population density were evident.

The cladoceran populations were also very low regardless of season or transect and did not exceed a mean of 4/liter (Table 3.3.4). No species predominated although Pseudosida sp. occurred most frequently. In January, Cladocera were not collected at any station.

3.3.3.3 Net Plankton Biomass

Plankton standing crop ranged from 0.3 to 22.8 milligrams ash-free dry weight per 100 liters for sampling periods in November 1972 and February and May 1973 (Table 3.3.6). The biomass was greater in February than either November or May regardless of transect or station. The mean biomass values for November, February, and May were 2.1, 10.2, and 5.5 mg/100 liters, respectively.

3.3.4 DISCUSSION

3.3.4.1 Phytoplankton

Diatoms predominated on the Broad River Study Area both quantitatively and qualitatively. Certain diatom genera occurred with great regularity regardless of season. The diatoms Asterionella, Fragilaria, Melosira, and Tabellaria, found here, are among the most frequently encountered diatoms in

Table 3.3.6 Ash-free dry weight biomass in milligrams for 100 liters of plankton found in surface samples at stations on transects in the Broad River Study Area in 1972-73.

Transect and Station	1972	1973	
	November	February	May
A - 1 (Shallow)	1.2	11.8	9.2
B - 1 (Shallow)	1.5	11.6	4.3
C - 1 (Shallow)	2.6	7.1	0.1
C - 3 (Deep)	0.3	8.2	3.4
D - 3 (Shallow)	2.0	6.9	0.1
D - 1 (Deep)	4.8	5.5	3.9
E - 1 (Shallow)	1.6	14.5	0.1
F - 1 (Shallow)	2.9	16.2	22.8
Mean	2.1	10.2	5.5

large rivers and are considered true plankters (Hynes 1972). Nutrient enrichment is indicated by the dominant diatoms, Asterionella formosa, Fragilaria crotonensis, and Melosira granulata (Hutchinson 1967).

Asterionella sp. populations showed maxima in spring as expected. Spring maxima for Asterionella sp. are common and seem to be influenced by light, nutrients, and temperature (Hutchinson 1967). Asterionella formosa was identified in February and May 1973 samples and was likely the predominant species in 1971 and 1972 samples also. Asterionella spp. is strictly a planktonic form (Hynes 1972).

Fragilaria crotoninsis, a typical planktonic form (Hynes 1972), commonly has temperature related spring and fall maxima in lakes (Hutchinson 1967). However, only spring maxima occurred in the study area. The species noted above was identified in February and May 1973 samples on the study area and was likely predominant in earlier 1971 and 1972 samples.

Melosira granulata, a dominant diatom on the study area possibly has both spring and fall population pulses limited by temperature. This species showed some trend to spring and fall peaks but there were numerous exceptions. Late winter and early spring population peaks of some species of Melosira in lakes are associated with cold water and increasing light (Meier 1927; Schuurman 1932; Lund 1954, 1955). Seasonal changes in turbulence are also known to limit population levels in some Melosira species (Lund 1954).

The two dominant Melosira species on the study area, M. granulata and M. varians, are typical of two different zones in the ecosystem. M. granulata is a typical free-water zone (euplanktonic) diatom (Hustedt 1945). M. varians is a typical inhabitant of the silt substrate (epipelic) (Hynes 1972). The latter species is sluffed or lost from the bottom silt in proportion to population levels present, but flooding or scouring may influence densities

(Hynes 1972). The population trends of M. varians noted on the study area are probably influenced by sluffing rate in relation to actual benthic population levels.

Tabellaria fenestrata was identified in February and May 1973 samples and probably was the main species in 1971 and 1972 samples. This species is also typically planktonic (Hutchinson 1967). Strong spring peaks and weak fall peaks, common for Tabellaria sp. in lakes (Birge and Juday 1922; Chandler 1944), were not observed in the study area.

The genera Synedra, Nitzschia, Navicula, and Surirella, common benthic diatoms (Williams 1964; Hynes 1972), were found only in low numbers in the study area. Seven desmid species were collected although their abundance was also low. Desmids are a common alga of soft waters (Prescott 1968). Foley (1972) collected 25 species of desmids from the Broad River in the fall of 1971.

Phytoplankton populations are dependent on a number of environmental factors including temperature, light, turbulence, inorganic and organic substances, parasitism, predation, and competition. These factors regulate existance and density of species in a particular body of water.

Foley (1972), reported a greater number of algae species for the Broad River than those collected for this study. The difference is primarily due to methods of collection. Foley concentrated the phytoplankton from four liters of sample water to 200 ml by settling the organisms and removing the upper volume of water. Few organisms would be lost using his method and many species he reported obviously were not retained by the No. 20 bolting cloth net used in the present study. Foley's preparation time, procedure, and analytical time in examining samples in depth was many times that of the present study. Further, the objective of this investigation was to find predominant

species of phytoplankton as retained by the No. 20 bolting cloth net and thus provide a general overview of the phytoplankton.

Patrick and Reimer (1966) point out that diatom flora in muddy rivers may be limited when compared to a clear river or stream. Turbid waters and resultant low light penetration in the Broad River system limit primary production. Studies on high-nutrient reservoirs in eastern Nebraska (Hergenrader et al. 1972) reveal effects of persistent clay turbidities. Turbid reservoirs had higher nutrient levels, lower primary production, and lower standing crops of phytoplankton, zooplankton, and benthos than clear reservoirs. Diatoms were also found to be a major contributor to the phytoplankton population in these systems while primary production rates were two to three times lower. It appears that a similar reduction in primary production may occur in the Broad River system.

Nutrient analysis of the Broad River indicates phosphorus could be a limiting factor, although other features suggest the system is not nutrient limited. For example, blue-green algae species, such as those identified from the study area, are typical of organically enriched waters (Palmer 1962). Also, the periodic occurrence of abnormally high river B.O.D. (See Chapter 3.2) in conjunction with somewhat reduced dissolved oxygen concentration during the winter, implies that this sytem is organically rich. The occurrence of blue-green algae species in each sample period may be important as indicators of nutrient load. If turbidity conditions associated with currents in the Parr Reservoir and Broad River remain as they are presently, there probably will not be great changes in primary production levels or species composition and density. If, however, conditions are created where currents and associated turbidity decline, primary production will probably increase. A potential problem would then exist

because the nutrient level of the river in combination with seasonal high temperatures may allow expansion of undesirable blue-green algae. If currents and turbidity increase, primary production will probably decline.

3.3.4.2 Zooplankton

The common zooplankton species collected in the Broad River Study Area are wide spread limnetic plankters found in a variety of physical and chemical conditions (Edmondson 1959; Hutchinson 1967). The dominance of rotifers in the Broad River is a characteristic of large rivers (Williams 1966; Hynes 1972). The genera Keratella, Polyarthra, Brachionus, and Trichocerca are four of the five most widely distributed and dominant rotifers in the U.S. (Williams 1966). Crustaceans, normally dominant in reservoir systems, were only of secondary importance in the study area. The low storage ratio of Parr Reservoir and high flow rates likely limit abundance of crustecans, as they are unable to maintain themselves against flows greater than a few millimeters per second (Hynes 1972).

The distribution of zooplankton within the study area reflect the influence of water velocity. The more lentic areas of the reservoir contained somewhat greater numbers of taxa and higher population densities than the more lotic areas. The low number of taxa collected at Transect F is probably representative of upstream river zooplankton fauna.

Zooplankton as well as phytoplankton taxa were present in greatest abundance in March. Increased spring phytoplankton abundance may play a role in the maintenance of increased zooplankton diversity in the system. Cladoceran absence in January is related in part, to a typical lack of winter reproduction and an extremely low population of overwintering adults (Hutchinson 1967; Pennak 1953).

Zooplankton densities in the Broad River Study Area were very low in comparison to the mean values reported for U.S. rivers by Williams (1966).

Observations by Williams indicated that small rotifer populations were probably a result of their intolerance to turbulence and silt. Williams also found that stations with high phytoplankton populations generally have high rotifer populations, while low rotifer populations were found with low phytoplankton population. These findings suggested a dependence of rotifers on phytoplankton for food, or upon other factors that also favor phytoplankton growth. The low zooplankton densities found in the study area may be the result of prevailing turbid conditions and limited primary productivity, although zooplankton production may be characteristically low in lotic situations (Odum 1959). Other factors such as detrital and bacterial concentrations, and physical and chemical characteristics of the water influence zooplankton composition and abundance.

A possible food web was constructed for the seven species common in surface samples during each sample period (Figure 3.3.2). Cyclops spp. is a well known predator (Pennak 1953; McQueen 1969) and it probably preys on Keratella sp. (McQueen 1969), nauplius larvae (Anderson 1970), and other rotifers of appropriate size. Asplanchna sp. and Trichocera sp. are the other prominent predators in the food web probably feeding on algae, Keratella spp., other rotifers, and small crustacea (Hutchinson 1967). The genera Brachionus, Filinia, Keratella (Pennak 1953), and Polyarthra (Hutchinson 1967) are typical omnivorous rotifers feeding upon all organic particles of appropriate size.

3.3.4.3 Net Plankton Biomass

Standing crop biomass of plankton is an index of the overall productive capacity of an ecosystem. It will vary by season in relation to population fluctuations of phytoplankton and zooplankton. A common, simple method of biomass measurement is ash-free dry weight which accounts only for organic biomass present and therefore serves as an index to organic biosynthesis and true population growth.

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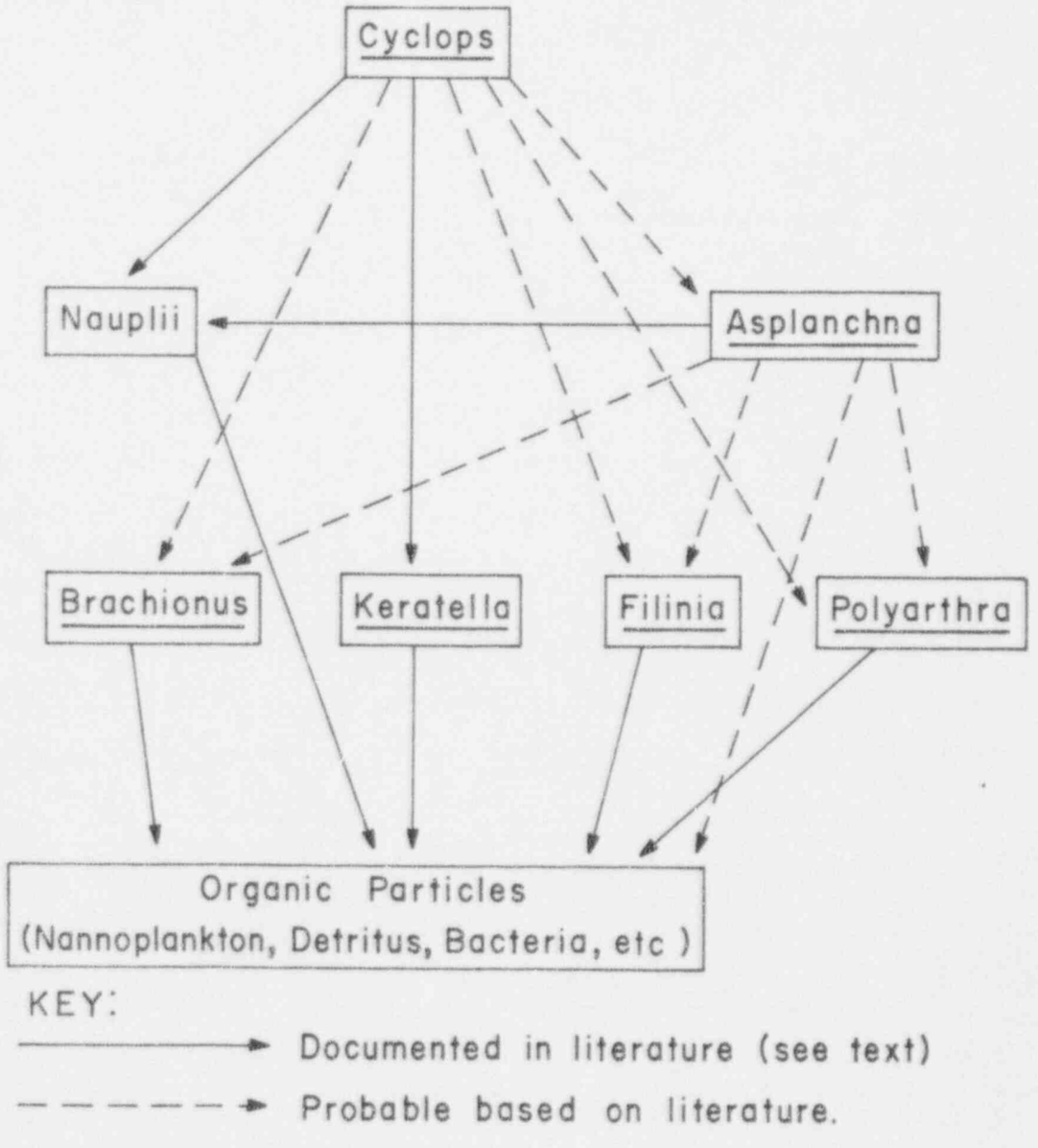

FIGURE 3.3.2 Possible Zooplankton Food Web for Perennial Species on the Broad River Study Area between June 1971 and March 1972.

Plankton standing crop ranged from 0.3 to 22.8 milligrams ash-free dry weight per 100 liters for sample periods in November 1972 and February and May, 1973 (Table 3.3.6). The mean biomass values for November, February, and May were 2.1, 10.2, and 5.5 mg/100 liters, respectively.

Biomass standing crop on the study area was low during the three measurement periods in 1972 and 1973; a direct reflection of the restricted productive capacity of the ecosystem. Standing crop showed the influence of a February bloom when the mean biomass was two to five times greater than in May or November, respectively.

Considerable variability was noted within each sample date making interpretation of results difficult. Some of the variability may be due to the extremely small organic mass present as plankton in 100 liters of water. Because biomass was so low, the reliability of measurement with existing analytical procedures is questionable. Another important source of variability is the organic debris (detritus) in samples not of planktonic origin, e.g., higher plant particles, insect fragments, etc. The reported values should therefore be considered only as an indication of ash-free biomass of plankton standing crop subject to the limitations noted above as well as the selective concentration of organisms with the plankton net.

3.3.5 SUMMARY

3.3.5.1 Phytoplankton

A total of 102 phytoplankton taxa were collected on the Broad River Study Area between June 1971 and May 1973 in surface samples and vertical plankton net tows. The species composition in major taxonomic groups were: Chlorophyta, 37; Chrysophyta, 42; Cyanophyta, 15; Euglenophyta, 5; and Pyrrhophyta, 3.

Diatoms predominated both quantitatively and qualitatively, though

all species were low in abundance. The planktonic genera Asterionella, Fragilaria, Melosira, and Tabellaria found in the study area are common in many river systems. Several common benthic algae were found, but only in low numbers. Desmids, common in soft waters, were represented by several species whose density was always low.

The phytoplankton data reported are representative of net phytoplankton and not total phytoplankton as reported by Foley (1972). The methods used in this study are considered adequate to meet the objectives of defining and detecting changes in the predominant species, and providing an overview of population structure.

3.3.5.2 Zooplankton

A total of 35 zooplankton species were collected in the Broad River Study Area between June 1971 and May 1973 in surface samples and vertical plankton net tows. The species composition by major taxonomic groups was as follows: Protozoa, 4; Rotifera, 21; Copepoda, 2; and Cladocera, 8.

Net zooplankton of the Broad River Study Area are dominated by rotifers, a characteristic common to many U.S. river systems. Four of the five most common and widely distributed rotifer genera were collected in the Broad River. Crustaceans, normally dominant in reservoirs, were only of secondary importance in the study area. Crustacean abundance is undoubtedly limited by the high flow rates and low storage ratio of Parr Reservoir as well as the high silt turbidity.

Distribution of zooplankton within the study area reflects the influence of water velocity on population levels. The more lentic areas had higher zooplankton densities. Also, the abundance of zooplankton appeared to be directly related to the abundance of phytoplankton.

Densities of all net zooplankters was much lower than those reported

for other U.S. river systems. These low population levels are probably due mainly to the high silt turbidity. Other influencing factors are detrital and bacterial levels, and physical and chemical characteristics of the water. A hypothetical food web was constructed to show possible trophic relationships among zooplankters.

3.3.5.3 Net Plankton Biomass

Although problems were encountered in the analysis of plankton biomass, the low values are an indication of the restricted productive capacity of the ecosystem.

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3.4 VASCULAR HYDROPHYTES

3.4.1 INTRODUCTION

Vascular hydrophytes play an important role in the aquatic ecosystem of the Broad River Study Area since they are utilized by birds, mammals, fish, and numerous invertebrates (Fassett 1966). Therefore, proposed water level fluctuations will have an impact on the plant-animal relationship within the area. The objective of this study was to identify important vascular hydrophytic species to be influenced by the proposed action.

3.4.2 METHODS

A survey of vascular hydrophytes of the Broad River Study Area was conducted by boat in March 1972 and May 1973. Included were the east and west banks of Parr Reservoir, the mouth areas of Frees Creek and Cannons Creek, and along the Broad River above the dam to the Highway 34 bridge (see map in back).

Specimens of emergent and submergent vegetation were collected, pressed, and identified. Emergent hydrophytes were defined as plants attached to the substrate and occurring on exposed or submerged soils, from where the water table is 50 cm (19.7 in) or more beneath the soil surface to where the soil is covered by 150 cm (59.1 in) or more of water. Submerged hydrophytes are plants attached to the substrate and occurring on submerged soils at all water depths to about 10 m (32.8 ft). These plants are characterized by foliage that is completely submerged (Sculthorpe 1967).

3.4.3 FINDINGS

A total of 18 species of vascular hydrophytes were identified growing on the Broad River Study Area (Table 3.4.1). Fifteen species were classified as emergent and three species were submergent hydrophytes.

Cattail (Typha latifolia) was the predominant emergent species

Table 3.4.1 Vascular hydrophytes found during a shoreline survey of the Broad River Study Area.

*Family Scientific Name Common Name	Growth Form	Location
Typhaceae		
Typha sp. Cattail	Emergent	Broad River
Najadaceae		
Potamogeton foliosus Leafy pondweed	Submergent	Broad River
Potamogeton sp. Pondweed	Submergent	Heliers Creek
Alismataceae		
Sagittaria latifolia Arrowhead	Emergent	Broad River Hellers Creek
Cyperaceae		
Carex lupulina Hop sedge	Emergent	Broad River Cannons Creek
Cyperus sp. Sedge	Emergent	Broad River Cannons Creek
Scirpus sp. Bulrush	Emergent	Broad River
Araceae		
Peltandra virginica Arrow arum	Emergent	Cannons Creek
Pontederiaceae		
Pontederia cordata Pickerelweed	Emergent	Cannons Creek
Juncaceae		
Juncus effusus Soft rush	Emergent	Broad River Cannons Creek
Juncus pelocarpus Bog rush	Emergent	Broad River Cannons Creek
Saururaceae		
Saururus cernuus Water-dragon	Emergent	Frees Creek
Salicaceae		
Salix nigra Marsh willow	Emergent	Broad River Cannons Creek Frees Creek

Table 3.4.1 (Continued)

*Family Scientific Name Common Name	Growth Form	Location
Polygonaceae		
Polygonum sp. Smartweed	Emergent	Broad River
Hypericaceae		
Hypericum sp. St. John's Wort	Emergent	Hellers Creek
Haloragaceae		
Myriophyllum sp.		Cannons Creek
Water milfoil	Submergent	Hellers Creek
Umbelliferae		
Hydrocotyle umbellata		Cannons Creek
Water pennywort	Emergent	Frees Creek
Acanthaceae		
Dianthera americana		Cannons Creek
Water willow	Emergent	Frees Creek

*Nomenclature follows Hotchkiss (1967) and Fassett (1966)

occurring in dense colonies along the shoreline. Arrowhead Sagittaria latifolia) also was dispersed throughout the area. Marsh willow (Salix nigra) was an important woody hydrophyte growing in shallow water and on moist banks in parts of the study area.

The three submergent species were observed near the dam. The relative abundance of vascular hydrophytes within the study area was generally limited.

3.4.4 DISCUSSION

Most of the species listed are important sources of food for waterfowl and some upland game and song birds. Nutlets (fruits) and tubers are the most utilized portions of the plants. Arrowhead is probably the most favored plant species of waterfowl as a food plant. Marsh willow attracts waterfowl and song birds as a nesting tree. Muskrat and beaver utilize many of these species as a food source (Fassett 1966).

Several species of hydrophytes provide shade and shelter for various fish species. Rush species (Juncus spp.) are spawning grounds for species of fish. Water milfoil (Myriophyllum sp.) and pondweeds (Potamogeton spp.) are extremely important in the aquatic ecosystem since they support an insect population fed upon by fish (Fassett 1966).

Emergent species were confined to shallow water next to shore or the moist shoreline. While emergents can survive water depths greater than 1.5 m (4.9 ft), plant populations are probably limited because of the turbidity of the water. While considerable volumes of soil have been deposited in these rivers from erosion, soils of the Broad River Study Area are low in nutrients (see Section 5.2), and thus, contribute little to the aquatic ecosystem's nutrient supply.

Submergent species were observed growing in protected areas.

Therefore, distribution of these species is probably influenced by stream flow as well as turbidity of the water.

Emergent hydrophytes are capable of surviving a range of water depths. Many are capable of surviving long periods of being totally submerged. These effects usually involve morphological and anatomical changes. This includes changes in the shape and size of leaves and the degree of development of various tissues. Prolonged submergence may result in population shifts to less shallow waters. The effect of periodic water level fluctuations on the emergent species is not well known.

Turbidity limits light penetration in the water which is probably the limiting factor in the growth of submergent vegetation. Some population shifts might occur in response to increased water levels. However, the submergent vegetation should not be significantly altered if physical and chemical conditions of the water are not altered by the proposed facility. Submergent vegetation might become more abundant if water turbidity decreases, allowing greater light penetration.

3.4.5 SUMMARY

Eighteen species of vascular hydrophytes have been observed growing on the Broad River Study Area. Emergent types predominated in shallow waters along the shoreline and moist banks. Cattail was the most common species. Three species of submergent hydrophytes were found growing in areas where water flow was greately reduced.

The planned increased water levels on the study area will inundate many existing emergent types, however, new colonization by emergents will likely occur near the shorelines.

3.4.6 REFERENCES

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3.5 BENTHOS

3.5.1 INTRODUCTION

Benthic macroinvertebrate populations were examined qualitatively and quantitatively at specific sample stations in the Broad River Study Area between June 1971 and May 1973. The purpose of these investigations was to provide basic information on species composition, density, diversity, and biomass of the macrobenthic fauna.

Benthic macroinvertebrates are important biological indicators of conditions within an aquatic system (Kolkwitz and Marsson 1908, 1909; Richardson 1928; Bartsch 1948; Ingram 1957; Hynes 1960). Their analysis is fundamental to the examination of trophic relationships and the understanding of the aquatic system.

3.5.2 METHODS AND MATERIAL.

Benthos samples were collected from Transects A through D and F with a 15 cm (6 in) square Ekman dredge. Two (June and September, 1971), three (January and March, 1972), and five (November, 1972, and February and May, 1973) dredge samples were taken at each station using the method outlined by Welch (1948). Several different dredges are available for benthos sampling but the Ekman was selected because recent work by Hudson (1970) and Howmiller (1971) snow it is the best sampler available for use in soft, silty substrates characteristic of the study area. Benthos samples from rocky Transect E, below Parr Dam in the swift tailwater current, were collected with a standard Surber sampler having a 30.5 cm (12 in) square frame. Two (June and September, 1971), three (January and March, 1972), and five (November, 1972, and February and May, 1973) samples were taken at each station using the procedure outlined by Welch (1948). Ekman dredge samples were washed with a fine spray of filtered water in a U.S. Standard No. 30 wire mesh sieve. Organisms collected in dredge

and Surber samples were placed in jars and preserved in about 10 percent formalin.

Macroinvertebrates were hand picked in the laboratory from gridded petri dishes under a 10X dissecting microscope and enumerated using appropriate magnification. Identification was according to: Berner 1959, Brinkhurst 1971, Burks 1953, Herrington 1962, Johannsen 1970, Mason 1968, Needham and Westfall 1955, Pennak 1953, Ross 1944, Roback 1957, Usinger 1971, and Ward and Whipple 1959. The mean number of organisms in samples from a station was computed and quantitative data were reported in numbers per square meter.

In January and March, 1972, the number of Ekman dredge samples taken at each station was increased from two to three as an effort to improve population estimation, increase the probability of collecting those species present in low numbers, and allow the computation of the standard deviation statistic to examine sampling variability. After instituting triplicate sampling it was obvious that variability between samples at individual stations was great, especially when only a few organisms were found. As a result of an analysis comparing the efficiency of 15 cm (6 in) square Ekman versus the 23 cm (9.1 in) square Ekman, and information provided by Kajak (1963), the number of samples collected with a 15 cm square Ekman was increased to five beginning in November 1972.

Biomass analyses of each of the five samples collected at each station was initiated beginning in November 1972. After enumeration, organisms were dried to a constant weight at 60°C (usually 24 hours), then weighed to the nearest 0.1 mg on an analytical balance, and ashed at 600°C in a muffle furnace. Ash-free dry weight was used as the estimate of biomass and was expressed in mean grams per square meter. Direct biomass determinations were not conducted on chironomids because identification required placing whole specimens on permanent slides. Biomass for chironomids was indirectly estimated

with a mathematical model constructed using chironomid data from extra Ekman grab samples. A linear length, ash-free dry weight relationship was computed resulting in the following model:

$$\text{Log ash-free Dry weight (g)} = -9.45110+1.29935 \log \text{length (mm)}$$

The correlation coefficient (r) of the model was 0.876 which was significant at the 0.001 level. The procedure for use of the model involved counting all chironomids for each 0.25 mm size class and multiplying by the ash-free dry weight for that particular group as determined indirectly from the regression formula. Biomass weights were determined for the total Chironomidae and expressed as mean grams per square meter.

3.5.3 FINDINGS

3.5.3.1 Insects

3.5.3.1.1 Qualitative Analysis

A total of 54 insect species were identified at least to genus, with an additional 11 identified to family and one identified to order for a total of 66 taxa collected on the Broad River Study Area between June 1971 and May 1973 (Table 3.5.1). The species composition by major taxonomic groups was as follows: Coleoptera, 5; Diptera, 31; Ephemeroptera, 7; Hemiptera, 4; Neuroptera, 1; Odonata, 10; Plecoptera, 1; and Trichoptera, 7.

The range in numbers of total insect taxa during each sampling period was as follows: June, 7-21; September, 5-16; January, 0-10; March, 8-17; November, 6-17; and May, 1-14 (Tables 3.5.2 to 3.5.7). The ranges of total taxa in all months sampled were comparable except in January when a decline was evident.

The seasonal range of total insect species from individual transects was as follows: A', 7-11; A, 1-15; B, 10-17; C, 10-16; D, 8-17;

Table 3.5.1 Species list of benthic macroinvertebrates present (P) at sample periods between June 1971 and May 1973 on the Broad River Study Area.

Taxa	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Insecta						
Coleoptera						
Chrysomelidae						
Donacia sp.	0	0	0	0	P	0
Dytiscidae						
Unidentified*	0	P	0	0	0	0
Elmidae						
Stenelmis sp.	P	P	0	0	0	0
Gyrinidae						
Dineutus sp.	0	0	0	0	0	P
Hydrophilidae						
Berosus sp.	P	0	0	0	0	0
Coleoptera Total	2	2	0	0	1	1
Diptera						
Ceratopogonidae						
Palpomyia sp.	P	P	P	P	P	0
Unidentified	0	0	0	0	P	P
Chironomidae						
Ablabesmia sp.	P	P	P	P	P	P
Brillia sp.	0	P	0	0	0	0
Chironomus sp.	P	P	P	P	P	P
Coelotanypus sp.	P	P	P	P	P	P
Cricotopus sp.	0	P	0	P	P	0
Cryptochironomus sp.	P	P	P	P	P	P
Dicrotendipes sp.	0	0	0	0	P	0
Diplocladius sp.	0	0	0	0	P	0
Glyptotendipes sp.	P	P	0	P	0	P
Harnishia sp.	P	0	0	0	P	P
Heterotrissocladius sp.	0	0	0	P	0	0

Table 3.5.1 (Continued)

	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Hydrobaenus sp. I	0	0	0	0	P	0
Hydrobaenus sp. II	0	0	0	0	P	0
Metriocnemus sp.	0	0	0	0	0	P
Micropsectra sp.	0	0	0	0	P	0
Orthocladius sp.	0	0	0	P	0	0
Paracladopelma sp.	P	0	0	P	0	P
Paralauterborniella sp.	0	0	0	0	P	0
Paratendipes sp.	0	0	0	P	0	0
Pentaneura sp.	P	0	0	0	?	0
Polypedilum sp.	P	P	P	P	P	0
Procladius sp.	P	P	P	P	P	P
Psectrocladius sp.	P	0	0	P	0	P
Pseudochironomus sp.	P	0	0	0	0	P
Smittia sp.	P	0	0	P	0	0
Tanypus sp.	0	P	P	P	0	0
Tanytarsus sp.	P	P	P	P	P	P
Unidentified*	P	P	P	P	P	P
Culicidae						
Chaoborus punctipennis	P	P	P	P	P	P
Diptera Total	17	14	11	19	19	15
Ephemeroptera						
Baetidae						
Ephemerella sp.	0	0	P	0	0	0
Unidentified*	0	0	0	0	0	P
Caenidae						
Tricorythodes sp.	P	P	0	0	0	0
Tricorythodes albilineatus	0	0	0	0	0	P
Ephemeridae						
Hexagenia limbata	P	P	P	P	P	P
Heptageniidae						
Stenonema sp.	P	P	0	P	0	P
Stenonema sp. (pulchellum gr.)	0	0	0	0	0	P
Ephemeroptera Total	3	3	2	2	1	5

Table 3.5.1 (Continued)

	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Hemiptera						
Corixidae						
Neocorixa sp.	0	0	0	0	P	0
Unidentified*	P	0	0	0	P	0
Notonectidae						
Notonecta sp.	P	0	0	0	0	0
Veliidae						
Unidentified*	P	0	0	P	0	0
Hemiptera Total	3	0	0	1	2	0
Neuroptera						
Sialidae						
Sialis sp.	P	P	P	P	P	P
Neuroptera Total	1	1	1	1	1	1
Odonata						
Calopterygidae						
Calopteryx sp.	0	P	0	0	0	0
Hetaerina sp.	0	0	P	0	0	0
Coenagrionidae						
Hyponeura sp.	P	P	0	0	0	0
Gomphidae						
Dromogomphus sp.	0	0	0	P	0	0
Gomphus sp.	P	P	P	0	P	0
Unidentified*	0	0	0	P	P	0
Libellulidae						
Perithemis sp.	0	0	0	0	P	0
Somatochlora sp.	0	0	0	0	P	0
Macromiidae						
Macromia sp.	0	0	0	0	P	0
Unidentified*	0	0	0	0	0	P
Odonata Total	2	3	2	2	5	1

Table 3.5.1 (Continued)

	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Plecoptera						
Perlodidae						
Isoperla sp.	0	0	P	0	0	0
Plecoptera Total	0	0	1	0	0	0
Trichoptera						
Hydropsychidae						
Hydropsyche sp.	P	P	P	0	P	0
Hydroptilidae						
Unidentified*	0	0	0	0	P	0
Psychomiidae						
Phylocentropus sp.	0	0	0	0	P	P
Unidentified*	P	0	0	0	0	P
Rhyacophilidae						
Rhyacophila sp.	0	0	0	0	P	0
Unidentified*	0	0	0	0	P	0
Unidentified*	0	0	0	0	0	P
Trichoptera Total	2	1	1	0	5	3
Insecta Total	30	24	18	25	34	26
Crustacea						
Amphipoda						
Talitridae						
Hyallela azteca	0	0	0	0	P	0
Decapoda						
Palaemonidae						
Palaemonetes sp.	0	0	0	0	P	0
Isopoda						
Asellus sp.	P	0	0	P	0	0
Crustacea Total	1	0	0	1	2	0

Table 3.5.1 (Continued)

	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Archnoidea						
Hydracarina						
Unidentified*	P	P	P	P	P	0
Archnoidea Total	1	1	1	1	1	0
Hirudinea						
Unidentified*	P	0	0	0	P	0
Hirudinea Total	1	0	0	0	1	0
Oligochaeta						
Naididae						
Stylaria fossularis	0	0	0	0	0	P
Unidentified*	0	0	0	0	0	P
Tubificidae						
Branchiura sowerbyii	P	P	P	P	P	P
Unidentified*	0	0	0	0	0	P
Unidentified*	P	P	P	P	P	P
Oligochaeta Total	2	2	2	2	2	5
Nematoda						
Unidentified*	P	P	0	0	P	P
Nematoda Total	1	1	0	0	1	1
Mollusca						
Gastropoda						
Physidae						
Physa sp.	P	P	P	P	P	0
Planorbidae						
Gyraulis sp.	0	0	0	0	P	0
Unidentified*	P	P	0	0	0	0
Lymnaeidae						
Lymnaea sp.	0	0	0	0	P	0
Gastropoda Total	2	2	1	1	3	0

Table 3.5.1 (Continued)

	1971		1972			1973
	June	Sept.	Jan.	March	Nov.	May
Pelecypoda						
Corbiculidae						
Corbicula manilensis	P	P	P	P	P	P
Sphaeriidae						
Pisidium sp.	0	0	0	0	0	P
Sphaerium transversum	0	0	0	0	0	P
Sphaerium sp.	P	P	P	P	P	0
Unidentified*	0	0	0	0	0	P
Unionidae						
Unidentified*	P	0	0	0	P	P
Pelecypoda Total	3	2	2	2	3	5
Mollusca Total	5	4	3	3	6	5
Taxa Total	41	32	24	32	47	37

*Species unknown, may be more than one species but considered here as one.

Table 3.5.2 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in June 1971.

	A	B	C	D	E
Insecta					
Coleoptera	0 (0)	0 (0)	0 (0)	0 (0)	2 (52)
Diptera	6 (657)	13 (2611)	8 (3427)	12 (267)	12 (399)
Ephemeroptera	1 (11)	1 (14)	1 (308)	2 (208)	3 (1148)
Hemiptera	0 (0)	1 (15)	1 (7)	0 (0)	0 (0)
Neuroptera	0 (0)	1 (50)	1 (7)	0 (0)	0 (7)
Odonata	0 (0)	0 (0)	1 (7)	1 (14)	1 (7)
Trichoptera	0 (0)	1 (22)	1 (7)	0 (0)	2 (43)
Total Taxa Mean No./m^2	7 (668)	17 (2712)	13 (3763)	15 (489)	21 (1656)

Table 3.5.3 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in September 1971.

	A	B	C	D	E
Insecta					
Coleoptera	0 (0)	0 (0)	0 (0)	1 (5)	1 (3)
Diptera	9 (785)	11 (492)	13 (1811)	7 (202)	1 (14)
Ephemeroptera	2 (97)	1 (25)	1 (232)	1 (2008)	2 (19)
Neuroptera	0 (0)	1 (12)	1 (30)	0 (0)	0 (0)
Odonata	0 (0)	0 (0)	1 (5)	1 (15)	1 (6)
Trichoptera	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)
Total Taxa Mean No. /m^2	11 (882)	13 (529)	16 (2078)	10 (2230)	5 (45)

Table 3.5.4 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in January 1972.

	A	B	C	D	E	F
Insecta						
Diptera	3 (37)	8 (829)	9 (1174)	6 (54)	0 (0)	1 (7)
Ephemeroptera	1 (193)	1 (5)	1 (148)	1 (444)	0 (0)	1 (22)
Neuroptera	0 (0)	1 (10)	0 (0)	0 (0)	0 (0)	0 (0)
Odonata	1 (15)	0 (0)	0 (0)	1 (5)	0 (0)	1 (4)
Plecoptera	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)
Trichoptera	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (7)
Total Taxa	5	10	10	8	0	5
Mean No. /m^2	(245)	(844)	(1322)	(503)	(0)	(44)

Table 3.5.5 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in March 1972.

	A	B	C	D	E
Insecta					
Diptera	7 (274)	9 (922)	10 (824)	14 (355)	7 (209)
Ephemeroptera	1 (49)	0 (0)	1 (64)	1 (148)	1 (118)
Hemiptera	0 (0)	1 (5)	1 (5)	1 (5)	0 (0)
Neuroptera	0 (0)	1 (10)	0 (0)	0 (0)	0 (0)
Odonata	0 (0)	0 (0)	0 (0)	1 (20)	2 (11)
Total Taxa	8	11	12	17	10
Mean No./m^2	(323)	(938)	(893)	(528)	(338)

Table 3.5.6 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in November 1972.

	A	B	C	D	E	F
Insecta						
Coleoptera	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Diptera	9 (3023)	12 (2929)	11 (2590)	9 (682)	6 (2370)	6 (1630)
Ephemeroptera	1 (740)	0 (0)	1 (444)	1 (1155)	0 (0)	0 (0)
Hemiptera	0 (0)	0 (0)	1 (8)	1 (156)	0 (0)	0 (0)
Neuroptera	0 (0)	1 (52)	1 (45)	1 (30)	0 (0)	0 (0)
Odonata	4 (52)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)
Trichoptera	0 (0)	4 (37)	0 (0)	1 (45)	2 (37)	0 (0)
Total Taxa	15	17	14	14	8	6
Mean No./m^2	(3845)	(3018)	(3087)	(2076)	(2407)	(1630)

Table 3.5.7 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in May 1973.

	A	B	C	D	E	F
Insecta						
Coleoptera	0 (0)	0 (0)	0 (0)	1 (11)	0 (0)	0 (0)
Diptera	1 (43)	9 (592)	10 (401)	4 (56)	0 (0)	0 (0)
Ephemeroptera	0 (0)	1 (7)	2 (48)	1 (376)	3 (29)	0 (0)
Neuroptera	0 (0)	1 (4)	1 (11)	0 (0)	1 (4)	0 (0)
Odonata	0 (0)	0 (0)	0 (0)	1 (6)	0 (0)	0 (0)
Trichoptera	0 (0)	3 (32)	1 (11)	1 (6)	0 (0)	0 (0)
Total Taxa	1	14	14	8	4	0
Mean No. /m^2	(43)	(635)	(471)	(455)	(33)	(0)

E, 0-21; and F, 0-16 (Tables 3.5.2 to 3.5.7). The greatest seasonal fluctuations in number of taxa occurred at Transect E, below Parr Dam, while seasonal fluctuations at the other transects were less intense. The number of taxa from Transect A', A, and F was usually less than those from B, C, or D regardless of sample date, while Transect F consistently had fewer taxa than all other transects.

The insect species found during all sample periods that are considered ubiquitous to the Broad River Study Area include: Diptera, (Chironomidae) Ablabesmia sp., Chironomus sp., Coelotanypus sp., Cryptochironomus sp., Procladius sp., Tanytarsus sp.; (Culicidae) Chaoborus punctipennis; Ephemeroptera, (Ephemeridae) Hexagenia limbata; and Neuroptera, (Sialidae) Sialis sp. (Table 3.5.1). Midges were the predominate insect fauna.

3.5.3.1.2 Quantitative Analysis

The orders Diptera and Ephemeroptera were numerically predominant in the Broad River Study Area during all seasons (Tables 3.5.2 to 3.5.7). The Diptera were accounted for primarily by chironomid larvae and phantom midges (Chaoborus punctipennis), while the Ephemeroptera consisted primarily of burrowing mayflies (Hexagenia limbata).

The density of insects varied by sample period (Tables 3.5.2 to 3.5.7). The density in mean number per square meter ranged as follows by transect: A', 668-882; A, 43-3845; B, 529-3018; C, 471-3763; D, 455-2230; E, 0-2407; and F, 0-1630. The densities on Transects B and C were generally greater than other transects.

Seasonal changes in insect density were evident (Tables 3.5.2 to 3.5.7) with the greatest overall density of insects occurring in June and November. The mean density (number per square meter) ranged as follows by sample period: June, 489-3763; September, 45-2230; January, 0-1322; March,

323-938; November, 1930-3845; and May, 0-635.

Seasonal density changes also occurred within the major taxa, midges (Diptera) and mayflies, mainly Hexagenia limbata (Ephemeroptera) (Tables 3.5.2 to 3.5.7). The density of midges was greatest in June and November, especially at Transects A, B, and C. In general, the midge density was greater than $400/m^2$ at the more lentic-like Transects B and C and usually lower than $400/m^2$ at the more lotic-like Transects D, E, and F. The midges comprised about 80 percent or more of the benthic community at Transects A', A, B, and C except at Transect A during January when they represented only 15 percent. At Transects D, E, and F they accounted for 67 percent or less of the community except at Transects E and F in November when they totaled 98 to 100 percent. Mayfly density was greatest during September. The most abundant populations occurred at Transect D where they ranged from 28 to 90 percent of the community.

A major emergence of Hexagenia limbata was underway in the vicinity of Transect D on 20 June 1971. Midge emergence patterns were not discernable, however, minor emergences were observed during spring, summer, and fall sampling periods.

3.5.3.2 Other Benthic Macroinvertebrates

3.5.3.2.1 Qualitative Analysis

In addition to the insects previously discussed, oligochaetes and molluscs also were important benthic fauna of the Broad River Study Area (Table 3.5.1). The species composition of the oligochaetes was not examined in detail, however, one species, Branchiura sowerbyi, was easily separated on the basis of unique characteristics. The remainder, listed as unidentified, are probably composed of a multiple species complex. The predominant species of

molluscs included: Gastropoda, (Physidae) Physa sp.; and Pelecypoda, (Corbiculidae) Corbicula manilensis and (Sphaeriidae) Sphaerium sp. Aquatic mites (Arachnoidea, Hydracarina) and Physa sp. were collected during each sample period except in May 1973, but their densities were low.

3.5.3.2.2 Quantitative Analysis

The density of oligochaetes varied by sample period and transect (Figure 3.5.1). The mean density at Transect A exceeded 400/m^2 only once in November 1972, while the density at Transect E was even lower and did not exceed 200/m^2. The mean oligochaete density at Transects B, C, and D was usually greater than 400/m^2 and was frequently near or in excess of 1000/m^2. Greatest oligochaete densities were found during January, March, and November although June populations from Transect D did exceed 1000/m^2. Branchiura sowerbyi comprised a significant proportion of the total oligochaete numbers at Transects B, C, and D regardless of season.

The density of pelecypod molluscs, represented by the exotic Asian clam, Corbicula manilensis, and fingernail clams, Sphaerium spp., was usually low except from Transect D which had densities ranging from about 500 to 2000/m^2 (Table 3.5.8). The C. manilensis population at Transect D expanded rapidly from June 1971 to November 1972, but a sharp decline was noted in May 1973. During the period of rapid population expansion, the density increased steadily from about 100/m^2 in June 1971 to over 1900/m^2 in November 1972. The May 1973 population level of about 350/m^2 approached the original density found in the June 1971 samples.

3.5.3.3 Biomass

Benthos standing crop was determined from shallow and deep stations of representative Transects B and D in November 1972 and February and May, 1973 (Tables 3.5.9 and 3.5.10). Total ash-free dry weight biomass for the periods

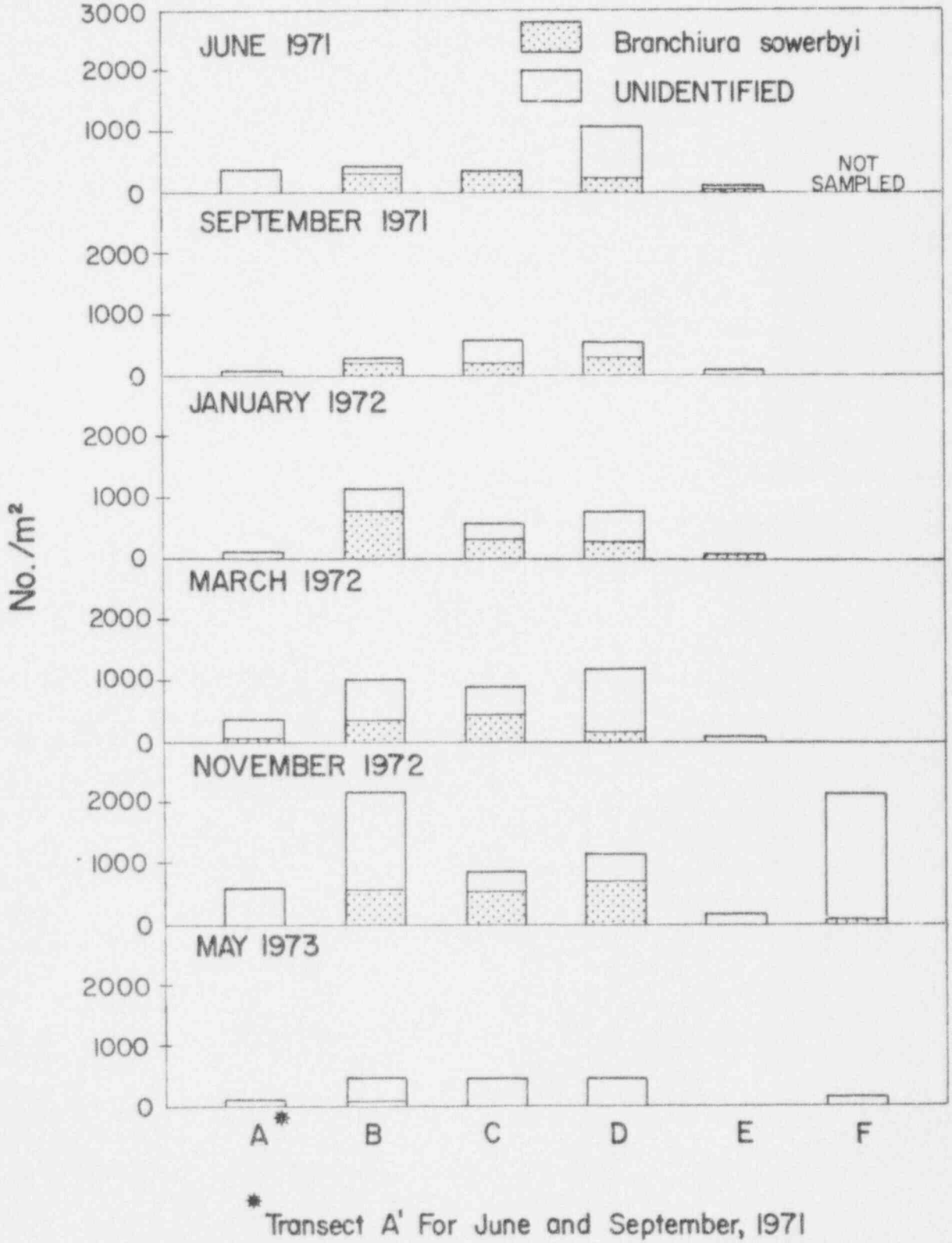

Figure 3.5.1 Mean Number of oligochaetes (Branchiura sowerbyi and unidentified species) per square meter on Transects (A-F) in the Broad River Study Area between June 1971 and May 1973.

Table 3.5.8 Quantitative comparison (number per square meter) of pelecypod families Sphaeriidae and Corbiculidae at fourteen collection points along six transects in the Broad River Study Area between June 1971 and May 1973.

	A*		B			C			D			E		F
	1	2	1	2	3	1	2	3	1	2	3	1	2	1
June 1971														
Sphaeriidae														
Sphaerium sp.	0	0	280	22	0	22	0	86	165	1254	1807	0	157	NS**
Corbiculidae														
Corbicula manilensis	0	0	0	0	0	0	0	0	117	15	264	235	15	NS
September 1971														
Sphaeriidae														
Sphaerium sp.	0	0	30	0	0	0	0	0	49	1260	635	NS	158	NS
Corbiculidae														
Corbicula manilensis	0	0	0	0	0	0	0	0	528	220	328	NS	40	NS
January 1972														
Sphaeriidae														
Sphaerium sp.	0	15	0	0	15	44	15	15	36	118	266	142	NS	0
Corbiculidae														
Corbicula manilensis	0	59	0	0	0	15	0	0	1266	0	74	0	NS	0

Table 3.5.8 (Continued)

	A		B			C			D			E		F
	1	2	1	2	3	1	2	3	1	2	3	1	2	1
March 1972														
Sphaeriidae														
Sphaerium sp.	15	0	15	0	0	59	29	15	0	1628	29	4	NS**	NS
Corbiculidae														
Corbicula manilensis	15	103	0	0	0	0	0	0	2057	1229	148	25	NS	NS
November 1972														
Sphaeriidae														
Sphaerium sp.	15	0	74	NS	15	59	NS	15	0	NS	0	0	NS	0
Corbiculidae														
Corbicula manilensis	15	873	29	NS	0	474	NS	0	1347	NS	2575	1983	NS	0
May 1973														
Sphaeriidae														
Sphaerium sp.	NS	0	0	NS	0	97	NS	0	0	NS	130	0	NS	0
Corbiculidae														
Corbicula manilensis	NS	413	50	NS	0	75	NS	26	344	NS	366	47	NS	0

*Transect A' for June and September, 1971

**Not sampled

Table 3.5.9 Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transect B in the Broad River Study Area between November 1972 and May 1973.

	B-1 (Shallow)			B-3 (Deep)		
	1972	1973		1972	1973	
	November	February	May	November	bruary	May
Insecta						
Coleoptera	-	0.536	-	-	-	-
Diptera						
Chironomidae	0.259	0.710	0.071	54	1.518	0.237
Others	-	0.671	0.012	058	0.955	0.104
Ephemeroptera						
Ephemeridae	-	0.595	0.731	-	-	-
Others	-	-	-	-	-	-
Hemiptera	-	-	-	-	-	-
Neuroptera	0.217	-	0.002	-	0.415	-
Odonata	-	-	-	-	0.212	-
Trichoptera	0.008	0.645	0.060	-	0.006	-
Crustacea	-	-	-	0.003	0.341	-
Arachnoidea	-	0.419	-	-	-	-
Hirudinea	-	-	-	0.031	0.016	-
Oligochaeta						
Tubificidae	0.583	-	0.223	0.207	-	0.753
Others	0.358	0.797	0.193	0.451	2.494	0.023
Nematoda	-	-	0.007	-	0.350	0.104
Mollusca						
Corbiculidae	0.369	-	0.295	-	-	-
Sphaeriidae	0.015	0.610	-	0.001	0.303	-
Others	-	-	-	-	-	-
TOTAL	1.809	4.983	1.594	0.985	6.610	1.221

Table 3.5.10 Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transect D in the Broad River Study Area between November 1972 and May 1973.

	D-3 (Shallow)			D-1 (Deep)		
	1972	1973		1972	1973	
	November	February	May	November	February	May
Insecta						
Coleoptera	-	-	0.010	-	-	-
Diptera						
Chironomidae	0.151	0.518	0.040	0.212	0.670	0.212
Others	T*	0.291	-	-	0.383	-
Ephemeroptera						
Ephemeridae	2.880	1.759	3.919	0.716	0.863	0.058
Others	-	0.162	-	-	-	-
Hemiptera	0.034	-	-	-	-	-
Neuroptera	0.305	0.123	-	-	-	-
Odonata	0.030	2.489	0.019	-	-	-
Trichoptera	0.130	0.604	0.043	-	-	-
Crustacea	0.063	-	-	-	-	-
Arachnoidea	T	0.750	-	-	-	-
Hirudinea	-	-	-	0.031	-	-
Oligochaeta						
Tubificidae	0.416	-	0.136	0.500	-	1.498
Others	0.053	0.690**	0.136	0.435	1.523**	0.180
Nematoda	T	-	-	-	-	-
Mollusca						
Corbiculidae	32.366	26.307	17.455	162.312	111.488	43.506
Sphaeriidae	-	-	0.082	-	-	-
Others	0.012	-	0.564	-	-	-
Total	36.440	33.693	22.404	164.115	114.927	45.454

*T indicates trace (<0.001g)
**Composite of all oligochaete species on this date only

ranged from 1.2 to 6.6 g/m^2 at lentic-like Transect B and from 22.4 to 164.1 g/m^2 at lotic-like Transect D. Biomass from shallow (B-1) and deep (B-3) stations at Transect B were similar during individual sample dates. At Transect D, however, biomass ranged from about two to five times more at the deep station (D-1) than at the shallow station (D-3).

Standing crop was greatest at Transect B in February when 4.9 and 6.6 g/m^2 occurred at the shallow and deep stations, respectively (Table 3.5.9). Ash-free dry weights from Transect B during November and May were similar and ranged from 0.9 to 1.8 g/m^2. Biomass from Transect D declined steadily between November and May (Table 3.5.10). Respective values for November, February, and May were as follows: Shallow - 35.4, 33.7, and 22.4 g/m^2; and Deep - 164.1, 114.9, and 45.5 g/m^2.

Insects, mainly chironomids, and oligochaetes accounted for about 80 to 95 percent of the ash-free dry weight from Transect B shallow and deep stations. The mayfly, Hexagenia limbata, contributed 12 percent to the biomass in February and 46 percent in May at the shallow B station but was unimportant during other periods at either B or D Transects. Other organisms made only small contributions to standing crop and are not discussed.

Molluscs, predominately Corbicula manilensis, comprised from 78 to 99 percent of the biomass at Transect D regardless of depth or date. Hexagenia limbata contributed from 5 to 18 percent to the total biomass measured at the shallow D station between November and May. Other organisms assumed lesser importance and contributed little to standing crop at Transect D.

3.5.4 DISCUSSION

Cryptochironomus sp., Chaoborus punctipennis, and Sialis sp. are provisionally classified as facultative organisms with wide ranges of tolerance to environmental conditions while Chironomus sp., Coelotanypus sp., and Procladius sp. are pollution tolerant (Mason, et al. 1971). Ablabesmia sp. and Hexagenia limbata are provisionally classified as pollution sensitive by the same authors. Tanytarsus sp. is also pollution sensitive according to Brinkhurst, et al. (1968). The insects found in the study area were predominantly facultative or pollution tolerant, although H. limbata was found in large numbers. The abundance of H. limbata at Transects C and D and certain times at A may be due to existing environmental conditions including substrate type since they are known to prefer soft, silty substrates (Swanson 1967). Both Corbicula manilensis and Sphaerium sp. are facultative organisms tolerant of wide ranges in environmental conditions. On the basis of indicator species and diversity, it appears that the study area is receiving waters moderately organically enriched.

Turbidity, currents, substrate types, and deposition of silt are a few environmental factors probably limiting insect diversity and density. These properties vary with location and tend to explain the differences in species composition and density among transects.

Seasonal differences in number of taxa (species composition) was expected. Insect species have specific emergence patterns with individual species emerging during a particular time of the year. If sampling occurred shortly after emergence of a particular species (or several species), they would be absent from the collection. Life cycles, therefore, help explain seasonal changes in species composition.

Density also changed with season. The lower January, March, and

May densities may be in part a reflection of lowered sieve efficiency since many small insects pass through a 0.59 mm screen opening. Many species over-winter as eggs and hatch during the spring. These species would, therefore, be absent from January samples and perhaps would not be retained by the sieve until they gained sufficient size later in the year.

Standing crop biomass varied considerably between the two transects examined. Factors previously mentioned as probably limiting species diversity and density also influence biomass. The standing crop was always much lower at lentic Transect B than at lotic Transect D regardless of depth. Habitat requirements probably explain the difference since insects (mainly chironomid larvae and mayfly nymphs, Hexagenia limbata) and oligochaetes were dominant at Transect B and molluscs (primarily Corbicula manilensis) and mayfly nymphs (H. limbata) were dominant at Transect D. Considerable variability in standing crop for benthos probably exists on the study area depending on local environmental characteristics.

3.5.5 SUMMARY

3.5.5.1 Insects

A total of 54 insect species were identified at least to genus, with an additional 11 identified to family, and one identified to order for a total of 66 taxa collected on the Broad River Study Area between June 1971 and May 1973.

Total taxa from all transects in June, September, March, November, and May ranged between 1 and 21 while the range in January was between 0 and 10. The January low may be attributed to certain species over-wintering as eggs or small, recently-hatched larvae capable of passing through the sieve screen, and winter mortality.

Diptera and Ephemeroptera species predominated samples during all seasons. The numerically dominant insect species were chironomid larvae, phantom midges (Chaoborus punctipennis), and burrowing mayflies (Hexagenia limbata).

The density of insects from individual transects varied by sample period and ranged from a minimum of $0/m^2$ to a maximum mean of $3763/m^2$. The greatest overall density of insects occurred in June ($489-3763/m^2$) and November ($1630-3845/m^2$).

3.5.5.2 Other Benthic Macroinvertebrates

Oligochaetes and molluscs (pelcypods) were also important components of the benthic fauna of the Broad River Study Area between June 1971 and May 1973. Although the species composition of oligochaetes was not examined in detail, Branchiura sowerbyi, was notably dominant while the remaining species were probably composed of a multiple species complex. The predominant pelecypod molluscs were Corbicula manilensis and Sphaerium sp.

The density of oligochaetes varied by sample period and transect. The mean density at Transects A and E was usually less than $400/m^2$ while the mean density of Transects B, C, and D was usually greater than $400/m^2$ and frequently near or in excess of $1000/m^2$. Branchiura sowerbyi comprised a significant proportion of the total oligochaete populations from Transects B, C, and D, regardless of season.

The density of the Asian clam, Corbicula manilensis and fingernail clams, Sphaerium sp., was usually low except at Transect D where the mean density ranged from about 500 to $2000/m^2$. The Asian clam population at Transect D increased at each sample period from June 1971 to November 1972 but a sharp decline approximating the June 1971 levels was noted in May 1973.

3.5.5.3 Biomass

Benthos standing crop was determined for shallow and deep stations from Transects B and D in November 1972 and February and May, 1973. Total ash-free dry weight for the periods ranged from 1.2 to 6.6 g/m^2 on lentic-like Transect B and from 22.4 to 164.1 g/m^2 on lotic-like Transect D. Biomass was similar at shallow and deep Transect B stations but at Transect D the biomass was about five times greater at the deep station than at the shallow station.

Insects, mainly chironomids, and oligochaetes accounted for about 80 to 95 percent of the Transect B biomass. The mayfly, Hexagenia limbata, contributed 12 and 46 percent, respectively, to March and May biomass at the shallow Transect B station but was not a biomass component in the deep Transect B station.

The mollusc, Corbicula manilensis, comprised from 78 to 99 percent of the biomass on Transect D. Hexagenia limbata contributed 5 and 18 percent to the ash-free dry weight biomass in November and May, respectively.

3.5.6 LITTORAL ZONE BENTHOS (QUALITATIVE)

3.5.6.1 Introduction

The purpose of qualitative benthic studies is primarily to catalogue the presence of species in Parr Reservoir and its tributaries. Often an indication of relative abundance of species can also be obtained from the collection. These qualitative studies are needed to confirm the presence of existing species which can be used to determine possible effects of the facility.

The littoral organisms in Parr Reservoir are important in food web relationships serving as potential prey for fish and other organisms. Since the water level fluctuations affect the littoral zone, the littoral zone organisms will be the most immediately and fundamentally impacted organisms in the reservoir.

The scope of this study is limited to the collection and taxonomic determination of the invertebrates, small fish, and incidental amphibians and reptiles living along selected parts of the shore of Parr Reservoir and its tributaries.

3.5.6.2 Methods and Materials

All specimens were collected by using aquatic D-frame nets and an apron net. Sediments were scooped up, washed, and the organisms picked out and immediately preserved in 85 percent ethanol. The specimens were taken to the lab for sorting and taxonomic identification, then were labeled, placed in vials, and stored in cabinets at the Cincinnati office of Dames & Moore. Taxonomy references include Arnett 1968; Borror and Delong 1971; Burks 1953; Kittrell 1969; Mackenthun and Ingram 1967; Needham and Needham 1962; Needham and Westfall 1955; Pennak 1953; Reid 1967; Ross 1944; Ward and Whipple 1959.

The littoral zone was sampled in the same areas as the benthic transects (Section 3.5) except as noted. At Transect A, both sides of the river

were sampled

At Transect B, Frees Creek, the southern shoreline was sampled. The littoral zone was fairly steep. In some places the vertical drop was almost 2 m (6.6 ft), indicating that a fairly swift current is present along the shore.

The littoral sampling in Cannons Creek, Transect C, was conducted along the shore about 300 m (985 ft) east of the benthic transect. This area included 80 m (263 ft) of shoreline on both sides of County Highway 28 bridge. By contrast with the littoral zone of Frees Creek, the gradient from the shore outward was very gentle. The greatest vertical drop at the shoreline was approximately 25 cm (10 in). There was a great deal of rooted aquatic vegetation in spots, as contrasted to none in Frees Creek. There was a small area, 15 by 10 m (4.9 by 3.3 ft), of very coarse sand.

Littoral sampling near Transect D took place on the east side of the large unnamed island immediately north of the transect proper. The substrate consisted of soft mud.

Littoral sampling near Transect E was confined to the east shore of the Broad River. It was necessary to begin sampling approximately 200 m (650 ft) downstream of the hydro plant tailrace because of the swiftness of the current. Sampling was along the shore for about 100 m (328 ft) and extending offshore for about 6 m (20 ft). The physical parameters below Parr Dam are completely different from those above the dam. The swift flowing shallow water and the rocky substrate all combine to create conditions suitable for a completely different fauna than that of the impounded Parr Reservoir.

The littoral sampling near Transect F was in close proximity to the transect area proper. The west bank and the riffles in the middle of the Broad River were sampled as well as riffle areas at the confluence of the Enoree and Broad Rivers.

The sampling area G, labeled Transect G, is on upper Frees Creek. It is approximately 30 m (98 ft) north of the State Highway 99 bridge over the creek. The creek at this point is about 3 to 4 m wide (9.6 to 12.8 ft), not usually over 50 cm (20 in) deep, and very clear. It is also a few degrees (3°-5°C) colder than the impounded portion of the creek.

The coefficient of similarity was calculated by the alogorithm, $S=2j/(a+b)$, where "a" is the number of species occurring in Area A, "b" is the number of species occurring in Area B, and "J" is the number of joint species in Areas A and B (Sorenson 1948, cited in Southwood 1966).

The coefficient of similarity is a numeric representation designed to evaluate similarities between the species composition of two ecological communities. Its values range from zero to one; zero indicating no common species and one representing two communities with all species identical. Thus, the coefficient of similarity accounts for differences in the number of species and species composition between communities.

3.5.6.3 FINDINGS

The cumulative number of species collected from the study area has increased greatly with each sampling period. Approximately 30 species were collected from four of the seven transects during the June 1971 survey. Nearly 70 different species were added from all seven transects during the September 1971 survey. Approximately 40 species previously unrecorded in the area were added during each of the January and March 1972 surveys.

The qualitative results from the 1971-1972 quarterly sampiing are presented in Table 3.5.11. The four sampling periods yielded 2,190 individuals representing 186 different species. The insects dominated the species list, as expected, with lesser quantities of crustaceans, mollusks, annelids, and vertebrates.

Table 3.5.11 Results from qualitative sampling of littoral and terrestrial invertebrates in the Broad River Study Area, June 1971, September 1971, January 1972, and March 1972.

Phylum	Arthropoda				Transect						
Class	Order	Family	Genus and Species	Author	A	B	C	D*	E	F	G
Subclass	Suborder	Subfamily									
Hexapoda	Ephemeroptera	Heptageniidae	Heptagenia marginalis	Banks	0	0	0	0	X	0	0
Pterygota			Stenonema ares	Burks	X	0	0	0	X	0	X
			Stenonema sp. 1	Traver	0	0	0	0	X	0	X
			Stenonema sp. 2		0	0	0	0	X	0	0
			Stenonema sp. 3		0	0	0	0	X	0	0
			Stenonema sp. 4		0	0	0	0	X	0	0
			Stenonema sp. 5		0	0	0	0	X	0	0
			Stenonema sp. 6		0	0	0	0	X	0	0
			Genus sp.		0	0	0	0	0	X	0
		Baetidae									
		Baetinae	Neocleon alamance	Traver	0	0	0	0	0	0	X
			Pseudocleon sp.		0	0	0	0	X	0	0
		Siphlonuridae									
		Isonychiinae	Isonychia sp.	Eaton	0	0	0	0	X	0	X
		Siphlonurinae	Ameletus sp.	Eaton	X	0	0	0	0	0	0
		Tricorythidae	Tricorythodes sp.	McDunnough	0	0	0	0	X	0	0
		Neoephemeridae	Neoephemera purpurea	(Traver)	0	0	0	X	0	0	0
		Leptophlebiidae	Leptophlebia sp.	Westwood	0	0	0	0	0	0	X
			Genus sp.		0	X	0	0	0	0	0
		Ephemeridae	Hexagenia limbata	Serville	X	X	X	X	0	0	0
		Ephemerellidae	Ephemerella frisoni	McDunnough	0	0	0	0	0	0	X
			Ephemerella sp.	Walsh	0	0	0	0	0	0	X
			Ephemerella rotunda	Morgan	0	0	0	0	X	0	0
			Ephemerella temporalis	McDunnough	0	0	0	0	X	0	0
	Trichoptera	Hydropsychidae	Hydropsyche sp.	Pictet	0	0	0	0	X	0	X
			Cheumatopsyche sp.	Wallenger	0	0	0	0	X	0	X
			Macronemum carolina	Banks	0	0	0	0	X	0	0
			Macronemum sp.	Burmeister	0	X	0	0	X	0	0

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Hexapoda Pterygota	Trichoptera	Psychomyiidae	Psychomyia nomade**		0	0	0	0	X	0	0
			Phylocentropus placidus	(Banks)	0	0	0	X	0	0	0
		Hydroptilidae	Dibusa angata	Ross	0	0	0	0	X	0	0
		Hydropsychidae	Potamyia flava	(Hagen)	0	0	0	0	X	0	0
		Leptoceridae	Leptocella sp.	Banks	0	0	X	0	0	0	0
			Genus sp.		0	0	X	0	0	0	0
			Athripsodes silutus	(Hagen)	0	0	0	0	X	0	0
		Philopotamidae	Chimmarra sp.	Stephens	0	0	0	0	0	0	X
		Family	Genus sp.		0	0	0	X	0	0	0
	Neuroptera	Cordalidae	Corydalus sp.	Latreille	0	0	0	0	X	0	0
			Niaronia sp.	Banks	0	0	0	0	0	0	X
		Sialidae	Sialis sp.	Latreille	X	0	0	0	0	0	X
	Plecoptera	Perlidae	Acroneuria sp.	Pictet	0	0	0	0	X	0	X
			Perlesta placida	(Hagen)	0	0	0	0	X	0	X
		Pteronarcidae	Pteronarcys pteronarcys dorsata	Say	0	0	0	0	X	0	0
		Nemouridae									
		Leuctrinae	Paraleuctra sara**	Claassen	0	0	0	0	X	0	0
		Capniinae	Nemocapnia sp.	Banks	X	0	0	0	0	0	0
		Nemourinae	Nemoura sp.	Pictet	0	0	0	0	0	0	X
		Perlodidae	Isoperla sp.	Banks	0	0	0	0	0	0	X
	Lepidoptera	Family	Genus sp.		0	0	0	0	0	0	X
	Hemiptera	Gerridae	Genus sp.		0	X	0	0	X	0	X
			Metrobates sp.		0	X	0	0	0	0	0
		Corixidae	Genus sp.		X	0	0	X	0	0	0
			Trichocorixa sp.	Kirkaldy	X	0	0	X	0	0	0
		Schizopteridae	Genus sp.		0	0	X	0	0	0	0
		Coreida	Genus sp.		X	0	0	0	0	0	0
		Nepidae	Ranatra sp.	Fabricus	0	0	X	0	0	0	0

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Hexapoda	Hemiptera	Veliidae	Microvelia	Westwood	0	0	0	0	0	0	X
Pterygota	Homoptera	Cercopidae	Genus sp.		0	0	X	0	0	0	0
	Ondonata	Gomphidae	Progomphus zephyrus	Needham	0	0	0	0	0	0	X
	Anisoptera		Progomphus sp.		0	0	0	0	0	X	0
			Ophiogomphus mainensis	Packard	0	0	0	0	0	0	X
			Dromogomphus spoliatus	Hagen	0	X	X	0	0	0	0
			Dromogomphus spinosus	Selys	0	0	0	0	X	0	0
			Dromogomphus armatus	Selys	0	X	X	0	0	0	0
			Erpetogomphus sp.	Selys	0	0	0	0	X	0	0
			Erpetogomphus lampropeltis	Kennedy	0	0	X	X	X	0	0
			Gomphus s. lat.		0	0	0	X	0	0	0
			Genus sp.		0	0	0	0	0	0	X
		Libellulidae									
		Libellulinae	Perithemis seminale	Calvert	0	0	X	0	0	0	0
			Perithemis tenera	Say	0	X	0	0	0	0	0
			Ladona sp.	Needham	X	X	X	X	0	0	0
			Miathyria sp.	Kirby	X	0	0	0	0	0	0
			Miathyria marcella		0	0	X	0	0	0	0
			Plathemis lydia	Drury	X	0	0	0	0	0	0
			Paltothemis lineatipes	Karsch	0	0	0	X	0	0	0
			Libellula sp.	L.	0	0	X	0	0	0	0
			Sympetrum sp.	Newman	0	0	X	0	0	0	0
			Tramea carolina		0	0	X	0	0	0	0
			Dythemis velox	Hagen	0	X	0	0	0	0	0
			Genus sp. 1		0	X	X	0	0	0	0
			Genus sp. 2		0	X	0	0	0	0	0
		Corduliinae	Cordulia sp.	Leach	0	X	0	0	0	0	0
			Tetragoneuria spinosa	Hagen	0	X	0	0	0	0	0

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Hexapoda	Ondonata	Libellulidae									
Pterygota	Anisoptera	Corduliinae	Tetragoneuria sp.	Hagen	0	X	0	0	0	0	0
			Tetrogoneuria petechialis	Muttkowski	0	0	X	0	0	0	0
		Macrominae	Didymops transversa	Say	0	0	X	0	X	0	0
			Macromia illinoiensis	Walsh	0	0	0	0	X	0	0
			Macromia alleghaniensis	Williamson	0	0	X	X	0	0	0
			Macromia caderita		0	0	X	0	0	0	0
			Macromia sp.		0	0	X	0	0	0	0
		Aesnidae	Boyeria vinosa	Say	0	0	0	0	0	0	X
		Cordulegastridae	Cordulegaster erroneus	Hagen	0	0	0	0	0	0	X
	Zygoptera	Agrionidae	Argia sp.	Rumbar	0	X	X	0	X	0	0
			Telebasis sp.	Selys	0	X	0	0	0	0	0
			Enallagma sp. 1	Charpentier	0	X	X	0	0	0	0
			Enallagma sp. 2	Charpentier	0	0	X	0	0	0	0
			Enallagma sp. 3	Charpentier	0	0	X	0	0	0	0
			Chromagrion sp.	Needham	0	0	0	0	X	0	0
			Nehalennia sp.	Selys	0	X	X	0	0	0	0
			Neoneura sp.		0	0	X	0	0	0	0
			Genus sp. 1		0	X	X	0	0	0	0
			Genus sp. 2		0	0	X	0	0	0	0
			Genus sp. 3		0	X	X	0	0	0	0
		Calopterygidae	Calopteryx sp.	Leach	0	0	0	0	0	0	X
			Hetaerina sp.		0	0	0	0	0	X	0
		Family	Genus sp.		0	0	0	0	X	0	0
	Diptera	Simuliidae	Genus sp.		0	0	0	0	0	0	X
		Empididae	Genus sp.		0	0	0	0	0	0	X
		Chironomidae	Genus sp.		X	X	X	X	X	0	X
		Tipulidae	Tipula abdominalis	Say	0	0	0	0	0	0	X
			Tipula sp.	L.	0	0	0	0	0	0	X

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Hexapoda Pterygota	Diptera	Tipulidae	Erioptera sp.	Meigen	0	0	X	0	0	0	0
		Tabanidae	Tabanus sp.		0	0	0	0	0	X	0
		Culicidae	Aedes sp.		X	0	0	0	0	0	0
			Chaoborus punctipennis		0	0	0	X	0	0	0
			Culex sp.		0	0	0	X	0	0	0
		Anthomyiidae	Genus sp.		0	0	0	0	0	X	0
		Family	Genus sp.		0	0	0	0	0	0	X
		Family	Genus sp.		0	0	0	X	0	0	X
	Psocoptera	Psocidae	Genus sp.		X	0	0	0	0	0	X
	Coleoptera	Gyrinidae	Gyretes sp.		0	0	X	0	0	0	0
			Dineutus sp.	MacLeay	0	X	0	0	0	0	X
		Haliplidae	Peltodytes sp.	Regimbart	X	X	X	0	0	0	0
		Carabidae	Pseudomorphinae sp.		0	0	0	0	0	0	X
		Amphizoidae	Amphizoa sp.	LaConte	0	X	0	0	0	0	X
		Chelonariidae	Chelonarium sp.	Fab.	0	X	0	0	0	0	0
		Psephenidae	Psephenus sp.	Haldeman	0	0	0	0	0	0	X
		Dytiscidae	Oreodytes sp.	Seidlitz	0	0	X	0	0	0	0
		Elmidae	Genus sp.		0	0	X	0	0	0	0
		Hydrophilidae	Berosus sp.		0	0	0	X	0	0	0
			Genus sp.		0	0	0	0	0	0	X
	Orthoptera	Gryllidae									
		Nemobiiinae	Genus sp.		0	0	0	X	0	0	0
		Eneopterinae	Genus sp.		X	0	0	0	0	0	0
		Trigonidiinae	Genus sp.		0	0	0	X	0	0	0
		Gryllacrididae	Genus sp.		0	0	0	0	0	0	X
		Tettagoniidae									
		Decticinae	Genus sp.		X	0	0	0	0	0	0

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Hexapoda											
Apterygota	Collumbola	Entomobryidae	Isotomurus palustris	(Muller)	0	0	X	0	0	0	0
		Sminthuridae	Genus sp.		0	0	X	0	0	0	0
Crustacea											
Malacostraca	Decapoda	Palaemonidae	Palaemonetes paludosus	(Gibbes)	X	X	X	0	0	0	0
			Palaemonetes kadiakensis	Rathbun	0	0	X	0	0	0	0
		Astacidae									
		Cambarinae	Cambarus bartoni	(Fab.)	0	0	0	0	0	0	X
			Genus sp.		0	0	0	0	0	0	X
			Genus sp.		0	0	X	0	0	0	X
	Amphipoda	Talitridae	Hyallela azteca	Saussure	0	X	X	X	X	0	X
		Gammaridae	Synurella sp.		0	0	0	0	0	0	X
	Isopoda	Asellidae	Asellus militaris	Hay	0	0	X	0	0	0	0
			Asellus sp.	St.Hillaire	X	0	X	X	0	0	X
Arachnida	Araneida	Family	Genus sp. 1		X	0	0	0	0	0	X
			Genus sp. 2		0	0	0	0	0	0	X
			Genus sp. 3		0	0	0	0	0	0	X
		Family	Genus sp.		0	0	0	X	0	0	0
	Labidognatha										
		Anyphaenidae	Genus sp.		0	0	0	0	0	0	X
		Clubionidae	Genus sp.		0	0	0	0	0	0	X
	Acarina	Hydracarina	Genus sp.		0	0	X	0	0	0	0
Diplopoda											
Chilognatha	Spirobolida		Narceus americanus	Beauvois	0	0	0	0	0	0	X
	Polydesmida		Genus sp.		0	X	0	0	0	0	0

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Phylum Mollusca											
Gastropoda											
Prosobranchia	Mesogastropoda	Viviparidae	Campeloma sp.	Rafinesque	0	0	X	X	0	0	0
			Viviparus sp.	Montfort	0	0	X	0	0	0	0
		Pleuroceridae	Goniobasis sp.		0	0	0	0	0	X	0
	Basommatophora	Physidae	Physa sayi		X	X	X	X	0	0	0
		Lymnaeidae	Lymnaea Bulimnaea sp.	Haldeman	X	0	0	0	0	0	0
		Planorbidae	Menetus sp.	H.&A. Adams	0	0	X	0	0	0	0
			Gyraulus sp.	Charpentier	0	0	X	0	0	0	0
			Helisoma sp.	Swainson	0	0	X	0	0	0	0
			Planorbula sp.	Haldeman	0	0	0	0	X	0	0
		Family	Genus sp.		0	0	X	0	0	0	0
Pelecypoda	Heterodonata	Corbiculidae	Corbicula manilensis	Phillipi	0	0	X	X	X	0	0
		Sphaeriidae	Eupora sp.	Bourguignat	0	0	X	0	0	0	0
		Sphaeriinae	Musculium sp.	Link	X	X	X	X	X	0	0
	Eulamellibranchia	Unionidae									
		Lampsilinae	Ligumia sp.	Swainson	0	0	0	0	X	0	0
		Anodontinae	Anodonta sp.		0	0	X	X	0	0	0
Phylum Annelida											
Hirudinae		Glossiphoniidae	Glossiphonia heteroclita	(L.)	X	X	X	X	0	0	0
			Helobdella sp.		0	0	X	0	0	0	0
		Family	Genus sp.		0	X	X	0	0	0	0
		Planariidae	Placobdella sp.		0	0	X	0	0	0	0
Oligochaeta		Lumbriculidae	Lumbriculus sp.		X	0	0	0	0	0	0
		Tubificidae	Branchiura sowerbyi	Bedd	0	X	0	0	0	0	0
		Family	Genus sp.		X	X	X	X	X	X	X

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

Table 3.5.11 (Continued)

Phylum / Class / Subclass	Order / Suborder	Family / Subfamily	Genus and Species	Author	Transect A	B	C	D*	E	F	G
Amphibiata		Family	Genus sp.		0	0	0	0	0	0	X
Lepospondyli	Salientia	Bufonidae	Bufo woodhousei	Hinckley	0	0	0	0	0	0	X
	Caudata	Plethodontidae	Desmognathus sp.		0	0	0	0	0	0	X
			Eurycea bislineata	(Green)	0	0	0	0	0	0	X
Osteichthyes	Perciformes	Centrarchidae	Lepomis macrochirus	Rafinesque	0	0	X	0	0	0	0
			Lepomis sp. 1		0	0	X	0	0	0	0
			Lepomis sp. 2		0	0	X	0	0	0	0
	Cypriniformes	Cyprinidae	Notropis boops	(Gilbert)	0	0	0	0	X	0	0
			Notropis anagenus	(Forbes)	0	0	0	0	0	0	X
Number of Species per Sampling Area					25	35	64	27	43	6	57

* - Mid River Island Station, Not Sampled in March 1972; ** - Tentative Identification; X - Present.

The number of species collected by transect during the four collections is presented in Table 3.5.12. It should be remembered that these studies were not quantitative, however, these data can indicate species diversity at a particular transect.

Table 3.5.13 lists the coefficients of similarity for Transects A through G as related to habitat type. None of the areas appear to be very similar, the maximum value, 0.2933, is less than 30 percent of the value for identical habitats. In most cases, each group appears to have values that are quite closely related. Notable exceptions include Transect F when it is compared to E and A and Transect A compared to D.

3.5.6.4 Discussion

It was anticipated that in four samples most of the number of different benthic species in Parr Reservoir would have been collected. However, this has not proven to be the case. There are four factors which have contributed to the number of different species found to date. The first is seasonal change. Since each sample in this report was taken during a different season, and since every species has its own intrinsic periodicity relative to the calendar year, identification of different species was expected for each season. Seasonality effects will tend to disappear with subsequent samples.

The second factor contributing to the number of different species is the variety of habitats being sampled. Having collected the major littoral zone habitats around the reservoir, further contributions of different species from this source should not be significant.

The third source of different species is the species pool of the region, i.e., all the habitats which may occasionally contribute species to the habitats regularly being sampled (Golley, et al. 1965). New species accumulate from the regional species pool at a slow rate. Theoretically we could discover

Table 3.5.12 Number of species collected in qualitative sampling, Broad River Study Area, 1971-72.

	Transect						
	A*	B	C	D	E	F	G
Summer							
June 1971	NS**	6	26	5	1	NS	NS
Fall							
Sept. 1971	18	10	17	9	20	5	30
Winter							
Jan. 1972	4	7	25	21	19	NS	17
Spring							
March 1972	5	15	28	NS	17	2	25

* Transect A' during June and September, 1971.
** Not sampled.

Table 3.5.13 Functional habitat groupings and average annual coefficients of similarity* based on littoral zone fauna.

Habitats	Compared Transects	Coefficient of Similarity
Impounded Areas	C-D	0.2933
	B-C	0.2616
	B-D	0.2260
Unimpounded Areas	F-G	0.1799
	E-G	0.1723
	E-F	0.0526
Main River Channel vs Impounded Areas		
	A-D	0.2400
	A-B	0.1818
	A-C	0.1337
Impounded vs Unimpounded Areas	A-F	0.2857
	D-G	0.1302
	B-E	0.1240
	C-G	0.1028
	C-E	0.0968
	A-E	0.0887
	A-G	0.0809
	D-E	0.0730
	B-G	0.0500
	C-F	0.0333
	D-F	0.0000
	B-F	0.0000

* Transect A' not utilized.

new species present from this regional pool for many years.

The fourth factor contributing to different species is taxonomic revision of the specimens already collected.

The composite list of species shows several very prominent differences between the various transects. For example, most of the Plecoptera are found in Transect G or E. These transects are characterized by swiftly flowing waters whereas Transects A, B, C, and D are more lentic in nature. Many of the Ephemeroptera are also characterized by living in swift water, whereas Hexagenia limbata is found only in the more lentic stations with mud substrates. Among the odonates there seems to be, except for Boyeria vinosa, a general aversion to the upper part of Frees Creek. This could be partially due to the predatory nature of this species. Hunting success would appear to be greater in slower moving water than those with high velocities. It is significant that Boyeria vinosa was found exclusively in protected areas consisting of sticks and detritus caught in the branches of bushes growing beside the creek. These little backwaters provide the more lentic habitat necessary for the species.

The sandy substrate in Cannons Creek is different from the usual soft mud common in the study area. As could be expected, the sandy substrate produced a quite different littoral fauna than the soft mud. Almost all the snails were found in this sandy area.

Organisms found in the littoral zone differ from those found in deeper waters. These differences can be noted by comparing the species list for both studies. For example, the grass shrimp, Palaemonetes paludosus, has been found in considerable numbers in the littoral zone, but has not been recorded in the quantitative benthic samples. These shrimp are large enough to contribute significantly to the carnivorous fish, while smaller organisms are important food sources for small forage fish as well as juvenile game species.

The dissimilarity between habitats, as noted by the coefficients of similarity, was expected since these areas were selected by noting differences so as to include all possible ecosystems within the study area.

The impounded areas were the most consistently similar of any group. Their low was 0.2260 (B-D) and their high was 0.2933 (C-D).

The unimpounded areas, characterized by swift flowing water, are clearly of two groups, with E and F very dissimilar 0.0526, and E-G (0.1723) and F-G (0.1799) relatively similar.

The September quarterly report indicated that Transect F was peculiar in having such a poor faunal composition for such a well oxygenated riffle area. Since both Transect E and F are riffle areas in the same river, they would be expected to be quite similar faunistically. The March 1972 samplings of these two areas did show some improvement over the September 1971 sample, from 0.0000 to 0.1052. Transects E and F may have a strong seasonal differences which could account for their lack of similarity. Further sampling would be necessary to substantiate seasonal differences.

The river channel proper (Transect A in January and March, 1972) shows an intermediate position of similarity between the previous groups. This is expected since the river is quite swift at Transect A, however, it is beginning to show the effects of impoundment.

As expected, least similar habitats are the impounded areas when compared to the swift flowing streams.

The prediction which can be made is that upper Frees Creek and any other currently unimpounded areas will, after impoundment, become more similar in faunal composition to the currently impounded areas. There will still be ecological differences between the drowned watersheds even as there are differences today between Transects B and C after many years of being impounded.

3.5.6.5 Summary

In four seasons of qualitative sampling of littoral organisms, 2,190 specimens representing 186 species were collected. Many species were found which were not included in the quantitative benthic samples taken by use of the Ekman dredge. Since these species contribute significantly to the food web of the ecosystem, their identity and abundance are important. These littoral organisms are of special significance in the Broad River Study Area since this zone will undergo water-level fluctuations.

Species were related to stream flow velocity, depth, substrate, and vegetation. Each factor or combination of factors defines the habitat in which a particular species can survive.

Similar habitats account for similar species composition between transects. Unimpounded areas, after impoundment, can be expected to show changes in faunal composition, becoming more similar to impounded forms.

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3.6 FISH

3.6.1 INTRODUCTION

Fishes are often the most obvious components of the aquatic community. To understand the position of the fishes in the aquatic ecosystem it is necessary to know what species occur in the area and certain aspects of the biology of the fishes involved. The objectives of the fisheries investigations included ascertaining the following aspects of the biology of fishes of the Broad River Study Area: species composition; distribution; relative abundance; length-weight relationships; standing crop estimates; age and growth; sex ratios; gonad condition; condition factors; food habits; and parasitism.

The information contained in this report will be helpful in attempts to minimize possible adverse effects of the proposed project and in forming the basis of a fishery management program.

3.6.2 METHODS AND MATERIALS

3.6.2.1 Collection

Fishes were collected with electrofishing equipment and modified hoop nets. Electrofishing equipment used during initial surveys consisted of two boat-mounted electrodes connected to a 2000 watt, McCulloch single-phase AC alternator. After November 1972, a Smith-Root Type VI electrofisher was used. This unit allows adjustment of voltage and amperage for maximum efficiency under various water conditions.

The shoreline areas surrounding each transect were fished for two hours during each sampling period prior to November 1972. The Smith-Root electrofisher proved much more efficient and collecting time was reduced to one hour per transect. Stunned fishes were retrived by dipnet and held for processing in water-filled tubs. Prior to initiation of food-habit studies, fishes were returned alive to the reservoir. Investigation of food habits necessitated

sacrificing some specimens.

To reduce bias attributable to any single collecting technique, netting operations were conducted in the immediate vicinity of all transects except F. Swift currents prohibited use of nets and only electrofishing was utilized at this transect. Netting gear consisted of a three-ring hoop net constructed of 12.7 mm (0.5 in) square mesh netting and fitted with square throat hoops. A single lead 15 m (50 ft) in length of 12.7 mm (0.5 in) square mesh netting was attached to the throat hoops. A sample consisted of two nets set perpendicular to the shoreline on opposite shores for 24 hours each. At the end of the period, the nets were retrieved and all fish were held in water-filled containters for analysis.

Fishes which could not be identified in the field were preserved and identified in the laboratory or referred to a specialist.

Fishes were identified, counted, and locality and date of collection were recorded. Species composition, distribution, and relative abundance were determined from this data.

3.6.2.2 Age and Growth

Scales were removed from important species in the field and placed in envelopes which were labeled to identify the species, length, weight, place of collection, and other pertinent data. The scales were removed from the left side of the fish, between the lateral line and dorsal fin. The left pectoral spines of catfishes were removed.

In the laboratory scales were cleaned and impressions of five scales from each fish in the sample were made on cellulose acetate slides with the use of a roller press. The impressions were projected on a plane surface with a Bausch and Lomb microprojector. Annuli were counted and distances between them measured in millimeters and recorded.

Back calculation of length at successive annuli was performed using the method of Lee (1920) which assumes a linear body-scale relationship and a positive length at scale formation. The formula is expressed as:

$$l_n - C = S_n(l - C/S)$$

where l_n is the length of fish when annulus 'n' was formed; l is the length of fish at time scale sample was obtained; S_n = radius of scale annulus 'n' (at length = "l_n"); S is the total scale radius; and C is a constant, representing the Y-intercept of the regression equation or length at which scales were first formed.

Because this type of determination of accurate age-growth relationships requires establishment of the length of fishes at the time of scale formation, statistical methods were utilized as an estimation procedure. Linear regression using least squares was performed by regressing fish length on scale radius. From the equation describing the regression line, the Y intercept was estimated. In addition, the product-moment-correlation coefficient was calculated to test the linear nature of the data.

3.6.2.3 Length-Weight Relationships

All fishes collected in March and June, 1971, were measured to the nearest tenth of an inch and weighed to the nearest hundredth of a pound. These values were converted to centimeters and grams. Subsequent data were taken directly in metric measurements.

The relationship of length to weight for each species at each transect was analyzed. Empirical plots of individual specimens were made on double logarithmic graph paper. Regression lines were fitted to the scatter plots by least squares and the equation describing the line determined and presented in the general form:

$$W = aL^b$$

where W is the estimated weight in grams; a is the Y intercept of the regression line; L is the total-length in mm; and b is the regression coefficient (or slope of the regression line). In addition to the above, the product-moment correlation coefficient was calculated.

3.6.2.4 Condition Factor

Condition factors (K) were calculated for individual fish and the mean condition factor for each species in each centimeter group was determined. The formula $K_{(TL)} = 1000\ W/L^3$ was used for all condition factor determinations. (W = weight in grams, L = total length in centimeters.)

3.6.2.5 Sex Ratios and Gonad Condition

Specimens from which stomachs and gonads were removed were sexed in the field and recorded. Gonads were classified according to the method proposed by Nikolsky (1963), and presented in Table 3.6.1.

3.6.2.6 Standing Crop Estimate

Annual rotenone cove samples in Cannons Creek and Frees Creek were initiated 11-13 November 1972, to establish standing crop data and to refine the relative abundance information from other sampling methods. The Frees Creek and Cannons Creek areas of the reservoir were selected as sites for estimation of biomass of fishes because:

1. These two impounded creeks were ecologically representative of the majority of the lake-like habitat in Parr Reservoir;
2. This sampling method was applicable to both areas;
3. Data from the first year revealed that these embayments supported relatively large numbers of important species; and
4. These areas would likely be affected by the proposed facility.

Table 3.6.1 The classification of maturity stages (gonadal condition) in fishes (from Nikolsky 1963).

Stage		Gonadal Condition
1	Immature	- Young individuals which have not yet engaged in reproduction; gonads of very small size.
2	Resting stage	- Sexual products have not yet begun to develop; gonads of very small size; eggs not distinguishable to the naked eye.
3	Maturation	- Eggs distinguishable to the naked eye; a very rapid increase in weight of the gonad is in progress; testes change from transparent to a pale rose color.
4	Maturity	- Sexual products ripe; gonads have achieved their maximum weight; but the sexual products are still not extruded when light pressure is applied.
5	Reproduction	- Sexual products are extruded in response to very light pressure on the belly; weight of the gonads decreased rapidly from the start of spawning to its completion.
6	Spent condition	- The sexual products have been discharged; genital aperature inflamed; gonads have the appearance of deflated sacs, the ovaries usually containing a few left-over eggs, and the testes some residual sperm.

To achieve appreciable meaning from the sampling procedure, one must assume that the sampling areas for biomass estimation are representative of the majority of habitat in the embayments sampled. The rotenone cove sampling sites were selected by evaluating the available habitat types in the Frees and Cannons Creek areas; including depth, cover, bottom type, and other general observations. An effort was made to select an area representative of the entire sample area.

A 0.41 ha (1.0 acre) area was blocked off with 12.7 mm (0.5 in) square mesh nets, (200 ft X 20 ft), constructed according to Lambou (1959). A net was secured to the shoreline and vertically dropped by boat to its maximum length and secured with a pole forced into the lake bottom. A second net was set in a like manner perpendicular to the first net and parallel to the shoreline. This net was secured to a dead tree at this corner. A third net was secured to the tree and dropped in like manner and secured to the shoreline.

The nets were checked for firm contact with the bottom by two divers equipped with SCUBA gear.

A system of mark and recapture using the Petersen estimate formula (Ricker 1971) was employed to determine the percentage of fish collected within the net and to refine estimates of the numbers of individual species. Fishes were collected outside the net with electrofishing gear. The total-length was measured and individuals were marked for later recognition by clipping the lower lobe of the caudal fin. The marked fish were released within the enclosed area and allowed to remain overnight. The area was checked the following morning for dead fish, but none were found. It was assumed that all fish (marked and unmarked) were equally susceptible to the toxicant.

A solution containing 2.5 percent rotenone plus 2.5 percent sulfoxide (ProNox fish) was applied to the blocked area from a boat and thoroughly

mixed. Three boats with a minimum crew of two persons per boat were used to collect distressed fish. Random boat movements were maintained and all fish encountered were retrieved by dipnet. No special capture effort was given to any size, species, or marked fish. The fish were sorted to species and all marked specimens were removed. Unmarked fish were weighed, measured, and sexed in the field.

3.6.2.7 Food Habits and Parasites

Food habits of selected species of fish from the reservoir and river were examined. Attempts were made to collect as many specimens of each species as possible from each transect although abundance of species in the collections varied widely. Viscera were taken from a representative number of each general size group of fishes in the field for food habit analysis. The viscera were taken by cutting the esophagus as near the isthmus as possible and removing the entire viscera. All specimens were placed in individual plastic containers or cheesecloth, labeled, and preserved with 10 percent formalin.

The following quantities were calculated:

1. $\bar{Y}\%TV$, mean percentage of total volume comprised by a taxon;
2. % frequency, the frequency of occurrence of the item in the stomach of a grouping expressed as a percentage;
3. $\bar{Y}TN$, mean total number of an item.

In the laboratory, the liver and other organs adjacent to the stomach were examined for evidence of parasitism. Next, the stomach was cut away from the rest of the viscera and weighed to the nearest 0.1 g. A longitudinal cut was then made from the pylorus to the esophageal sphincter and the stomach contents were washed into a labeled jar and preserved in 5 percent formalin or 70 percent alcohol. The empty stomach was then weighed. This procedure was altered for the Catostomidae and Cyprinidae. In these families, the entire

digestive tract was emptied and examined since a stomach region per se was not identifiable. In addition, parasites of the Catostomidae and Cyprinidae most often occurred in the intestine.

Analysis of stomach and gut contents was made by examining the contents in a gridded petri dish using a dissecting microscope. Organisms were identified, counted, and assigned an estimated volume. Unidentifiable organic and inorganic material was also volumetrically estimated. The data were compiled by species, transect, and sampling period.

Analysis of food habits of gizzard shad were conducted somewhat differently than those for other species. A total of 27 gizzard shad stomachs were analyzed to determine food items ingested by this species. The shad were divided into size classes by 50 mm (1.97 in) total length increments from 0 to 300 mm (11.82 in) total length, and by 300 mm increments above 300 mm total length. When possible, three fish of each size class from each transect were examined. One previously examined gizzard shad from Transect B in November, 1972, was not included in this analysis.

The stomach contents of the shad were diluted to a specified volume (usually 50 ml) with distilled water. The sample was then thoroughly mixed, and a one ml subsample was placed in a Sedgwick-Rafter counting chamber. The entire chamber was scanned at 100X, organisms were identified to genus, and the number of each organism recorded. In addition, a cell count on the number of centric and pennate diatoms was made by examining several longitudinal strips the width of the Whipple square at 200X. All counts were then converted to total number present in the stomach. A proportional count of the diatom species present was made from prepared diatom slides.

3.6.3 FINDINGS AND DISCUSSION

3.6.3.1 Species Composition and Relative Abundance

Species composition and relative abundance provide basic information about species diversity of the fish fauna and their numerical status in the fish community.

Since the study area is primarily reservoir habitat, collecting efforts were concentrated in that habitat.

Bluegill (Lepomis macrochirus) were the most abundant fish when data from all stations were combined in Table 3.6.2. Bluegill (34.58%), gizzard shad, Dorosoma cepedianum (18.82%), white crappie, Pomoxis annularis, (12.70%), redear sunfish, Lepomis microlophus (8.42%), and largemouth bass, Micropterus salmoides, (3.85%) comprised 78.87 percent of the fishes collected. These figures reflect the intentional bias in sampling reservoir habitat more intensively than flowing river habitat. At Transect F, flat bullhead, Ictalurus platycephalus (45.24%) numerically dominated collections.

Species composition, distribution by transect, and relative abundance were determined for all fishes collected. They are arranged phylogenetically and discussed by species in an annotated list. Arrangement and use of common names are from Bailey (1970).

The following is an annotated list of species of fishes collected at the Broad River Study Area, March 1971 through May 1973:

Lepisosteidae - Gar family

Lepisosteus osseus - Longnose gar. The longnose gar was extremely abundant at Transect E, however, it was collected at all transects. Many gar, species unknown, were observed during routine activities on the study area. The longnose gar ranked ninth in overall abundance and is not considered a sport fish in the study area.

Table 3.6.2 Species composition and relative abundance of all fishes collected from the Broad River Study Area from March 1971 through May 1973.

Common Name	Scientific Name	No.	%
Bluegill	Lepomis macrochirus	1454	34.58
Gizzard shad	Dorosoma cepedianum	794	18.82
White crappie	Pomoxis annularis	534	12.70
Redear sunfish	Lepomis microlophus	354	8.42
Largemouth bass	Micropterus salmoides	162	3.85
River carpsucker	Carpiodes carpio	102	2.43
Carp	Cyprinus carpio	86	2.05
Flat bullhead	Ictalurus platycephalus	78	1.86
Longnose gar	Lepisosteus osseus	74	1.76
Black crappie	Pomoxis nigromaculatus	65	1.55
Redhorse*	Moxostoma spp.	55	1.31
Channel catfish	Ictalurus punctatus	53	1.26
White catfish	Ictalurus catus	52	1.24
Pumpkinseed	Lepomis gibbosus	50	1.19
Warmouth	L. gulosus	42	1.00
Golden shiner	Notemigonus crysoleucas	42	1.00
Shorthead redhorse	Moxostoma macrolepidotum	35	0.83
Silver redhorse	M. anisurum	21	0.50
Silvery minnow	Hybognathus nuchalis	18	0.43
Redbreast sunfish	Lepomis auritus	16	0.38
Quillback	Carpiodes cyprinus	14	0.33
White sucker	Catostomus commersoni	13	0.31
Yellow bullhead	Ictalurus natalis	10	0.24
American eel	Anguilla rostrata	10	0.24
Green sunfish	Lepomis cyanellus	10	0.24
Spotted sucker	Minytrema melanops	9	0.21
White bass	Morone chrysops	9	0.21
Satinfin shiner	Notropis analostanus	8	0.19
Unidentified shiner	Notropis spp.	6	0.14
Brown bullhead	Ictalurus nebulosus	5	0.12
Hybrid sunfish	Lepomis sp.	5	0.12
Longear sunfish	L. megalotis	5	0.12
Creek chubsucker	Erimyzon oblongus	2	0.05
Black bullhead	Ictalurus melas	2	0.05
Spotted gar	Lepisosteus oculatus	1	0.02
Tadpole madtom	Noturus gyrinus	1	0.02
Speckled madtom	N. leptocanthus	1	0.02
Chub**	Hybopsis sp.	1	0.02
Pallid shiner	Notropis amnis	1	0.02
Yellow perch	Perca flavescens	1	0.02
Swamp darter	Etheostoma fusiforme	1	0.02
Total No.		4204	
Total Species		40 minimum	

*There was difficulty positively identifying species of Moxostoma during initial surveys.
** Pending verification.

Lepisosteus oculatus - Spotted gar. A single specimen of spotted gar was collected. It is likely that this species is more common than collections would indicate since many gar of unknown species were observed. They are not considered a sport fish.

Anguillidae - Freshwater eel family

Anguilla rostrata - American eel. The American eel was collected only at Transect E, below Parr Dam. This species was much more abundant than indicated by numbers collected. Numerous specimens were sighted that were not collected. Eels are catadramous and the construction of Parr Dam undoubtedly hindered movements of eels upstream. This species ranked twenty-third in overall abundance.

Clupeidae - Herring family

Dorosoma cepedianum - Gizzard shad. Gizzard shad were the second most abundant fish overall. This species was collected at all transects. Gizzard shad are probably one of the most important forage species of the study area.

Cyprinidae - Minnow family

Cyprinus carpio - Carp. Carp were collected at all transects except F and carp ranked seventh in overall abundance in the study area. All carp collected were of a large size. There is a limited fishery for carp, especially during the spring.

Hybopsis sp. - Chub. A single specimen collected at Transect E was identified only to genus. The scarcity of specimens indicates this species is probably unimportant in the fishery of the study area. No further comments will be made concerning this specimen pending positive identification.

Hybognathus nuchalis - Silvery minnow. The silvery minnow was collected at Transects B, C, D, and E. This species ranked eighteenth in

overall abundance. The relatively low numbers and small size of specimens collected indicate that this species contributes little to the fishery of the study area, though it should be considered as part of the forage base.

Notemigonus crysoleucas - Golden shiner. This species ranked fifteenth in overall abundance in the study area. This species contributes to the forage base in the study area. Golden shiners were collected at all transects except F, though they were collected more commonly in the reservoir than the river.

Notropis amnis - Pallid shiner. A single specimen collected at Transect D was identified as the pallid shiner. This is outside the reported range of this species and the identification will be confirmed before further comments are made.

Notropis analostanus - Satinfin shiner. This species was collected only at Transect D in the study area. The satinfin shiner is a large river form and probably can be expected to thrive only in a river-type habitat.

Notropis sp. - Shiner. Four specimens of unidentified shiners have been collected in the study area. It is probable that several species of shiners occur in the study area that have not been collected. However, it is likely that these populations are small and contribute little to the forage base.

Carpiodes carpio - River carpsucker. The river carpsucker was collected at all stations in the study area. It was collected in large numbers at Transect E. This species ranked sixth in overall abundance in the study area. Spring spawning migrations of catostomids are very common and probably concentrate the fish at the base of the dam in the spring. The river carpsucker has no sport value in the study area.

Carpiodes cyprinum - Quillback. The quillback ranked twentieth in overall abundance in the study area. It was collected at all transects except

A. Though this species occurs in the reservoir, it was collected most commonly at Transect E. This species is not considered a sport fish in the study area.

Catostomus commersoni - White sucker. Thirteen white suckers were collected at Transect E in the study area. The white sucker is not considered a normal resident of the study area nor a part of the sport fishery.

Erimyzon oblongus - Creek chubsucker. The creek chubsucker ranked thirty-first in overall abundance in the study area. Two specimens were collected at Transect E. It is not considered an important part of the forage base or sport fishery of the study area.

Minytrema melanops - Spotted sucker. The spotted sucker ranked twenty-fifth in overall abundance. Nine specimens were collected at Transect E, and it was not collected at other stations. This species is considered an occasional resident of the study area and is not utilized as a sport fish.

Moxostoma anisurum - Silver redhorse. The silver redhorse ranked seventeenth in overall abundance. They were collected at Transects C, D, E, and F. There was difficulty in the positive identification of the redhorse species during initial surveys. The silver redhorse is common in the river and contributes significantly to the fauna of that ecosystem. The concentration at Transect E was probably due to the dam blocking upstream migrations. Although redhorse are not considered sport fish in the study area, they are in other areas.

Moxostoma macrolepidotum - Shorthead redhorse. The shorthead redhorse was collected at Transects D, E, and F. This species ranked sixteenth in overall abundance in the study area. The shorthead redhorse was collected primarily from the river though it was occasionally collected in the reservoir. The shorthead was the most commonly collected redhorse and some specimens identified only as redhorse during initial surveys were undoubtedly shortheads.

The redhorse are an important segment of the river fishery due to their abundance and large size.

Ictaluridae - Freshwater catfish family

Ictalurus catus - White catfish. The white catfish ranked eleventh in overall abundance. It was collected at Transects B, C, D, and E. This species occurs in sufficient numbers to be considered a significant segment of the sport fishery of the study area. Numerous fishermen seek "catfish" and it is doubtful that they discriminate between white and channel catfish.

Ictalurus melas - Black bullhead. Two specimens identified as black bullhead were collected from the study area. This species is rare in the study area and probably contributes minimally to the sport fishery.

Ictalurus natalis - Yellow bullhead. The yellow bullhead ranked twenty-second in overall abundance in the study area. It was collected at Transects A, B, and E. The yellow bullhead is a sport fish in the study area but due to the small number collected it appears to be of only minimal importance.

Ictalurus nebulosus - Brown bullhead. The brown bullhead ranked twenty-eighth in overall abundance and was collected at Transects A, B, and D. The brown bullhead is considered a sport fish in the study area, but due to its apparently low population density, it probably contributes little to the sport fishery.

Ictalurus platycephalus - Flat bullhead. The flat bullhead ranked eighth in overall abundance. This species was collected from all transects, but was more abundant in the river. Many specimens of a desirable sport size were collected and this species is considered a major segment of the sport fishery, especially in the river.

Ictalurus punctatus - Channel catfish. The channel catfish ranked twelfth in overall abundance. It was collected at all transects, but was most

commonly collected at Transect E. Although it is not highly abundant numerically, fishermen interviewed indicated it was one of the most desired sport fish in the study area. Several specimens of desirable sport size were collected.

Noturus gyrinus - Tadpole madtom. One tadpole madtom was collected at Transect E. Madtoms do not attain a sufficient size to be considered an important segment of the sport fishery. The low numbers collected indicate this species contributes minimally to the forage base.

Noturus leptacanthus - Speckled madtom. One speckled madtom was collected at Transect E. Speckled madtoms do not attain a suitable size to be an important sport fish and low abundance reduces the probability of its contributing significantly to the forage base.

Poeciliidae - Live bearer family

Gambusia affinis - Mosquito fish. The mosquito fish was not collected during the normal fish sampling program. It was observed and collected with an aquatic insect net in the reservoir at Transects B and C. This species typically occurs near the shoreline in shallow water. The mosquito fish probably contribute to the forage base of the reservoir.

Percichthyidae - Temperate bass family

Morone chrysops - White bass. This species ranked twenty-sixth in overall abundance in the study area. White bass were collected at Transects B, C, and E. Eight of the ten specimens collected were captured at Transect E. It is assumed that normal spring upstream movements concentrate these fishes at the base of Parr Dam. This species was rarely collected in the reservoir. The white bass may seasonally form a significant segment of the sport fishery, but it is probably not utilized by most fishermen in the study area.

Centrarchidae - Sunfish family

Lepomis auritus - Redbreast sunfish. The redbreast sunfish ranked

nineteenth in overall abundance. This species was collected at Transects C, E, and F. The redbreast sunfish made up a significant portion of the fish population at F. This species is considered a sport fish in the river but probably contributes relatively little to the sport fishery of the reservoir.

Lepomis cyanellus - Green sunfish. The green sunfish ranked twenty-fourth in overall abundance. It was collected at Transects C, D, E, and F. It was not abundant at any of the transects. Low numbers and low fishermen appeal appear to limit the importance of the sport fishery value of this species.

Lepomis gibbosus - Pumpkinseed. The pumpkinseed ranked thirteenth in overall abundance of the fishes collected in the study area. This species was collected at Transects B, C, and D. No specimens were collected from river transects. The pumpkinseed probably contributes to the forage base in the reservoir, but it is not considered an important sport fish.

Lepomis gulosus - Warmouth. The warmouth ranked fourteenth in overall abundance. This species was collected at all reservoir transects (A, B, C, D) but was not collected in the river. This species probably contributes to the forage base, but does not appear to be actively sought as a sport fish. It constituted only one percent of the total number of fishes collected.

Lepomis macrochirus - Bluegill. The bluegill was numerically the most abundant species collected. It was collected at all transects and was especially abundant in the reservoir. In the reservoir the bluegill is believed to be a major segment of the forage base and one of the primary sport fishes.

Lepomis megalotis - Longear sunfish. The longear sunfish ranked thirty-second in relative abundance. It was collected at Transects C and E. This species does not appear to be actively sought as a sport fish although some larger individuals could be taken.

Lepomis microlophus - Redear sunfish. The redear sunfish ranked fourth in overall abundance. It was collected at all transects though it was relatively rare in the river. This species is considered an important component of the sport fishery. Many individuals of catchable size were collected. The redear is actively sought and highly esteemed by local fishermen.

Micropterus salmoides - Largemouth bass. The largemouth bass ranked fifth in overall abundance. It was collected at all transects except F. The relatively high numbers and large size of bass collected indicate that the largemouth is one of the major predators in the reservoir. It is actively sought by fishermen and is considered a major component of the sport fishery.

Pomoxis annularis - White crappie. The white crappie ranked third in overall abundance in the study area. This species was collected at all transects, but was much more abundant in the reservoir. The white crappie is actively sought as a sport fish and undoubtedly also contributes to the forage base. The white crappie is considered an important segment of the sport fishery.

Pomoxis nigromaculatus - Black crappie. The black crappie ranked tenth in overall abundance. This species was collected at all transects except E. The black crappie is less abundant than the white, but generally follows the same pattern of distribution being much more prevalent in the reservoir than the river. The black crappie is considered an important segment of the sport fishery and undoubtedly contributes to the forage base.

Percidae - Perch family

Etheostoma fusiforme - Swamp darter. A single specimen of the swamp darter was collected at Transect C. This species usually inhabits slow-flowing, weedy areas. The small size and low density of swamp darters indicate that this species is not an important component of the fishery of the area.

Perca flavescens - Yellow perch. A single specimen was collected at Transect D. Since this species was encountered only one time during the survey, it is not considered an important segment of the sport fishery.

3.6.3.2 Age and Growth

The results from the age and growth study for important species indicate that, in general, fish in the Broad River Study Area are slower growing than fish from comparable areas (Table 3.6.3).

Mean lengths attained each year by bluegill in Broad River are slightly greater than values given for Lake Wappapello, Missouri (Patriarche 1953) for age classes I-IV, but fall below values given for Clearwater Reservoir, Missouri (Lane 1954).

The white crappie mean total lengths at age I exceeded values obtained for Lake Marion, South Carolina, but for every year after were less (Stevens 1959a). Growth rates for white crappies in Broad River were slower than those reported for Lake Moultrie, South Carolina (Stevens 1959a).

Mean back calculated total lengths for year classes of gizzard shad were less than those of comparable areas (Eschmeyer, et al. 1944; Turner 1953; Parsons and Lowry 1953).

Redear sunfish in the Broad River exhibited better values for mean total length at all ages than values given for Oklahoma (Jenkins et al. 1955). The lengths for each year class did, however, fall within the range given for Reelfoot Lake, Tennessee (Schoffman 1939).

Mean lengths for year classes of largemouth bass were less for comparable areas for all age classes (Stroud 1948; Patriarche 1953).

3.6.3.3 Length-Weight Relationship

Length-weight relationships of important species were calculated and equations describing the regression are presented in Table 3.6.4. The

Table 3.6.3 Mean back calculated total lengths and average growth increments of selected fishes from all Parr Reservoir transects (B, C, D), March 1971 - May 1973.

Year Class	n*	Total Length (mm) at Annulus 1	2	3	4	5	6	7
				Bluegill				
1971	69	54						
1970	103	55	91					
1969	83	52	86	115				
1968	53	56	87	115	141			
1967	12	65	97	130	155			
1966	8	29	69	106	134	154	172	
Mean Length		52	86	117	143	154	172	
Mean Increment		52	34	32	26	11	18	
				White Crappie				
1971	39	74						
1970	56	71	129					
1969	43	58	126	166				
1968	23	74	128	174	210			
1967	6	52	97	137	198	235		
1966	7	47	102	150	204	237	271	
Mean Length		63	116	157	204	236	271	
Mean Increment		63	56	44	50	35	34	
				Gizzard Shad				
1971	89	112						
1970	43	120	176					
1969	30	94	160	203				
1968	23	106	177	201	276			
1967	14	125	173	198	232	286		
1966	4	130	218	240	275	318	348	
1965	1	150	195	260	290	330	360	397
Mean Length		120	183	220	268	311	354	397
Mean Increment		120	62	36	44	46	30	37

*Number of fishes examined.

Table 3.6.3 (Continued)

Year Class	n*	Total Length (mm) at Annulus 1	2	3	4	5	6	7
				Redear				
1971	14	53						
1970	20	62	109					
1969	15	57	112	148				
1968	18	54	119	146	177			
1967	6	61	119	162	185	194		
1966	2	84	109	148	173	195	209	
1965	6	54	77	120	150	188	208	222
1964	4	54	80	124	167	196	221	241
Mean Length		60	106	141	170	193	214	332
Mean Increment		60	43	39	30	24	20	17
				Largemouth Bass				
1971	10	95						
1970	10	118	141					
1969	10	97	181	270				
1968	5	161	215	275				
1967	5	116	175	233	285	354		
1966	6	99	186	257	300	353	399	
1965	1	55	107	141	180	212	241	255
1964	1	40	80	148	235	323	375	405
Mean Length		98	155	221	250	289	338	330
Mean Increment		98	57	63	55	60	42	22

*Number of fishes examined.

Table 3.6.4 Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, November 1972.

Species	Transect	Equation
Bluegill	B	$W=3.136\times10^{-6}\ L^{3.336}$
	C	$W=1.705\times10^{-5}\ L^{2.950}$
	C	$W=9.899\times10^{-4}\ L^{2.168}$
	D	$W=4.719\times10^{-7}\ L^{3.719}$
	E	$W=1.135\times10^{-7}\ L^{3.960}$
Gizzard Shad	B	$W=2.984\times10^{-6}\ L^{3.211}$
	C	$W=7.674\times10^{-5}\ L^{2.584}$
	D	$W=1.315\times10^{-5}\ L^{2.946}$
	E	$W=8.128\times10^{-6}\ L^{3.063}$
	F	$W=1.774\times10^{-4}\ L^{2.462}$
White Crappie	B	$W=4.602\times10^{-6}\ L^{3.173}$
	C	$W=4.459\times10^{-6}\ L^{3.180}$
Redear	B	$W=6.232\times10^{-6}\ L^{3.203}$
	C	$W=2.088\times10^{-5}\ L^{2.936}$
	D	$W=1.053\times10^{-5}\ L^{3.558}$
Largemouth Bass	B	$W=4.352\times10^{-6}\ L^{3.188}$
	C	$W=1.286\times10^{-5}\ L^{2.958}$
	D	$W=2.508\times10^{-6}\ L^{3.305}$
	E	$W=2.138\times10^{-9}\ L^{4.474}$
Carp	E	$W=2.193\times10^{-4}\ L^{2.563}$
Longnose Gar	B	$W=4.331\times10^{-7}\ L^{3.240}$

Table 3.6.4 (Continued)

Species	Transect	Equation
Black Crappie	C	$W=1.320\times10^{-7}\ L^{3.907}$
	E	$W=3.042\times10^{-6}\ L^{3.279}$
Silver Redhorse	E	$W=7.127\times10^{-7}\ L^{3.472}$
Shorthead Redhorse	E	W=3.496x10-6 $L^{3.198}$
Channel Catfish	E	$W=7.294\times10^{-8}\ L^{3.822}$
White Catfish	B	$W=1.615\times10^{-6}\ L^{3.348}$
	C	$W=5.052\times10^{-6}\ L^{3.131}$
Pumpkinseed	B	$W=2.430\times10^{-6}\ L^{3.410}$
	C	$W=3.048\times10^{-4}\ L^{2.393}$
Warmouth	B	$W=8.060\times10^{-6}\ L^{3.165}$
	C	$W=1.977\times10^{-5}\ L^{2.974}$
Quillback Carpsucker	E	$W=7.779\times10^{-5}\ L^{2.685}$
Golden Shiner	B	$W=7.126\times10^{-6}\ L^{3.033}$

weight of a fish generally varies with the cube of its length. Values obtained fall generally within the reported range. There is a great deal of individual variation in length-weight relationships and the small sample size precludes drawing definite conclusions concerning observed differences.

3.6.3.4 Condition Factors

Condition factors may vary with the size of fish collected, sex, season, feeding activity, and numerous other factors. To reduce the bias, a large sample size collected over a long period of time is necessary. The sample size was so small for most species that condition factors must be viewed with caution with respect to the number of individuals collected with some variation expected. In general, the condition of Parr Reservoir fishes is average to slightly below average with respect to condition of fishes in other reservoirs of the nation.

Mean condition factors for all specimens collected from the Broad River Study Area are presented in Table 3.6.5.

Most bluegills collected were in the 7 to 15 cm (2.8 to 5.9 in) size group. Specimens from Transect D were generally larger than those from other transects. Condition factors did not appear to vary among transects.

Size groups of redear sunfish collected were distributed evenly throughout the range, however, an unusually high number of large, 23 to 26 cm (9.0 to 10.2 in), specimens were collected at Transect D. Larger fish tended to have higher condition factors.

Largemouth bass were collected primarily from reservoir transects. They were generally evenly distributed throughout the size ranges encountered. Specimens from Transect E were larger and had higher condition factors.

Carp were generally evenly distributed throughout the size ranges collected. Condition factors did not vary greatly among transects.

Table 3.6.5 Mean condition factors for all important species collected from the Broad River Study Area, March 1971 - May 1973.

Species	Total Number	Condition Factor
Bluegill	733	1.8
Gizzard shad	429	0.9
White crappie	95	1.3
Redear sunfish	211	1.8
Largemouth bass	87	1.3
River carpsucker	57	1.2
Carp	44	1.4
Flat bullhead	41	1.2
Longnose gar	29	0.2
Black crappie	52	1.2
Redhorse	4	1.1
Channel catfish	20	0.8
White catfish	25	1.1
Pumpkinseed	16	1.8
Warmouth	24	1.9
Golden shiner	13	1.0
Shorthead redhorse	36	1.2
Silver redhorse	21	1.2
Silvery minnow	17	1.1
Redbreast sunfish	16	1.9
Quillback	2	1.3
Yellow bullhead	3	0.7
American eel	5	0.2
White bass	2	1.5
Unidentified shiners	2	1.0
Brown bullhead	2	1.4
Hybrid sunfish	1	1.5
Longear sunfish	2	2.1
Creek chubsucker	2	1.1
Black bullhead	2	1.5
Spotted gar	1	0.2
Tadpole madtom	1	0.6
Yellow perch	1	1.1
Swamp darter	1	0.6

Longnose gar were generally evenly distributed by size groups collected. Condition factors did not vary between size groups or transects.

At Transect B most black crappie collected were in the 7 to 12 cm (2.8 to 4.7 in) size range. Condition factors did not vary greatly among transects, or by size group.

The sample size (5) of channel catfish was too small to draw conclusions.

Condition factors of white catfish did not vary greatly between transects. However, the small sample size makes conclusions difficult.

Larger pumpkinseed sunfish tended to have higher condition factors. Condition factors did not vary greatly between transects. Sample size prevents drawing conclusions concerning size group frequency distributions.

One specimen of warmouth from Transect D had an unusually high condition factor, however this is probably attributable to individual variation.

Due to the small sample size, it is impossible to draw conclusions concerning condition factor and frequency distribution by size groups for the silvery minnow, and yellow bullhead in the study area.

No significant variation was observed in the condition factors of the brown bullhead examined.

Two specimens of black bullhead were collected. Although the condition factors were considerably different at the two transects, the small sample size precludes drawing conclusions concerning the difference.

Larger specimens of white crappie were collected at Transects C and D and condition factors were slightly higher at those two transects. However, they were not significantly different.

There appeared to be no significant differences of condition factors among gizzard shad with transects or size groups.

3.6.3.5 Sex Ratios

The sex ratio data on the fish collected in November 1972 and February and May, 1973, were combined to obtain a better estimation of the sex ratios (Table 3.6.6). Even after the data were combined, several species of fish had insufficient numbers for an accurate evaluation of ratios. The various species of sunfish (bluegill, redear, warmouth, pumpkinseed, redbreast sunfish, and a hybrid) generally had more females present in the population than males. The average ratio for these sunfishes was 1:1.6 (males:females). In the other species of Centrarchidae (white crappie, black crappie, and largemouth bass), males and females were collected in nearly equal numbers. Although the number of rough fish (carp and redhorse) sexed was too small for a definitive statement on sex ratios, males were generally collected twice as frequently as females. The major forage fish (gizzard shad) in the study area exhibited nearly equal proportion of males and females in the population. The species of Ictaluridae (catfish and bullheads) were collected in very small numbers and no statement can be made on the sex ratios of these fish.

3.6.3.6 Gonad Condition

The average gonadal conditions of mature fishes collected in February 1973 are given in Table 3.6.7. The mean maturity stage for all sunfishes (Centrarchidae) was between the resting stage and maturation. According to Nikolski (1963), this indicates sexual products were either undeveloped or slightly developed. Therefore, spawning of these species had not occurred at the time of sampling.

Gizzard shad, golden shiner, river carpsucker, and carp were found to be between maturation and maturity. These species were approaching

Table 3.6.6 Sex ratios of fishes collected from the Broad River Study Area, November 1972 and February and May, 1973.

Species	Male	Female	Ratio
Bluegill	181	278	1:1.5
Redear sunfish	61	98	1:1.6
Warmouth	14	21	1:1.5
Pumpkinseed	6	12	1:2.0
Redbreast sunfish	4	5	1:1.3
Hybrid sunfish	1	1	1:1.0
White crappie	52	38	1:0.7
Black crappie	29	22	1:0.8
Largemouth bass	40	42	1:1.1
Gizzard shad	161	133	1:0.8
Carp	27	13	1:0.5
Shorthead redhorse	13	20	1:1.5
Silver redhorse	10	8	1:0.8
Redhorse	3	1	1:0.3
River carpsucker	42	12	1:0.3
Golden shiner	2	1	1:0.5
Creek chubsucker	1	0	1:0
Brown bullhead	0	1	0:1.0
Black bullhead	0	2	0:2.0
Flat bullhead	10	13	1:1.3
Channel catfish	2	11	1:5.5
White catfish	3	7	1:2.3

Table 3.6.7 Mean gonadal condition of mature female fishes collected in the Broad River Study Area, February and May, 1973.

Species	February		May	
	n*	Average Condition	n	Average Condition
Bluegill	123	2.0	89	4.3
Redear sunfish	42	2.2	27	4.2
Pumpkinseed	4	2.3	-	-
Warmouth	2	2.0	7	4.1
Redbreast sunfish	-	-	5	4.6
Hybrid	1	2.0	-	-
White crappie	11	2.6	3	4.6
Black crappie	-	-	2	2.0
Largemouth bass	15	2.5	8	3.1
Gizzard shad	46	3.1	23	4.0
Golden shiner	1	3.0	-	-
Carp	6	3.5	5	4.2
Silver redhorse	6	4.0	3	6.0
Shorthead redhorse	5	4.4	6	6.0
River carpsucker	4	3.5	7	4.1
Quillback	-	-	1	6.0
White catfish	2	3.0	1	6.0
Channel catfish	1	2.0	4	3.0
Brown bullhead	1	3.0	-	-
Black bullhead	-	-	2	5.0
Flat bullhead	5	3.4	8	5.4

*Number of fishes examined.

their spawning period at the time sampled.

The redhorse, which had the most advanced stage of maturity ranging from maturity through reproduction, were sampled just prior to their spawning period.

Channel catfish and white catfish had a gonadal condition indicating the resting stage. These species are known to spawn later than the period sampled (Stevens 1959b).

Brown and flat bullheads had a more advanced stage than other catfish. Their average stage ranged from maturation to maturity. Their spawning would probably occur earlier than the channel and white catfish.

The mean stage of gonadal maturity of fishes collected in May, 1973, is given in Table 3.6.7. The mean gonadal condition of most Centrarchidae was found to be the stage of maturity or approaching the stage of reproduction.

Gizzard shad, river carpsucker, and carp were between the stage of maturity and reproduction. These species were nearing their spawning period.

The redhorse sampled during this period were found to have a mean stage of spent condition. The redhorse, therefore, spawned between the February and May samples in 1973.

One mature female white catfish was collected and determined to have spawned prior to this sampling period. Four mature female channel catfish were found to have a stage of maturation. This indicates that this species would not spawn for some time.

The black and flat bullheads collected were determined to be in reproduction at the time of sampling.

This discussion of the mean gonadal condition of mature female fishes collected in February and May, 1973, suggests some preliminary insights of the spawning periods of selected fishes of the Broad River Study Area. All

trends evidenced correspond with expected spawning periods for the region being investigated.

3.6.3.7 Standing Crop

Rotenone samples, for biomass estimates, were conducted in the Cannons Creek and Frees Creek areas of Parr Reservoir. Transect C, Cannons Creek, was sampled November 9 to 11, 1972 (Table 3.6.8). At this station, a total of 5,841 fish, representing 14 species, were collected or observed. The weight of the fishes collected totaled 13.565 kg (29.8 lb). The recapture factors (marked/recaptured ratio) derived from the Petersen estimating procedure ranged from zero to 1.0. It is believed that reliable estimates of the percentage of fish were obtained from the rotenoned area.

The total biomass estimate from Cannons Creek area was 204.521 kg/ha (182.0 lb/acre). A total estimate of 50,076 fishes/ha (20,274/acre) was calculated for this area. The gizzard shad was the most abundant species with an estimated 32,700 fish/ha (13,239/acre) having a biomass of 51.562 kg/ha (45.9 lb/acre). The bluegill was second in abundance at 15,906 fish/ha (6,440/acre) but represented greatest biomass at 91.307 kg/ha (81.3 lb/acre). The contribution of individual species to the total biomass estimate are presented in Table 3.6.8.

Transect B (Frees Creek) was sampled November 11 to 13, 1972 (Table 3.6.9). A total of 728 fishes weighing 9,388 g (20.6 lb) and representing 19 species were collected. Estimated total standing crop was 60.843 kg/ha (54.1 lb/acre).

Standing crop in the Cannons Creek sample was over three times higher than found in the Frees Creek sample.

The Petersen estimate recapture factor (marked/recapture ratio) varied for the 19 species. It ranged from zero, which were species that had no marks placed in the rotenoned area, to 1.0, which indicated that all marked

Table 3.6.8 Standing crop estimates of the fishes from a shoreline rotenone sample of the Cannons Creek area of Parr Reservoir, South Carolina, November 9-10, 1972.

Species	Number Collected	Grams Collected	Recapture Factor	Number/Hectare	Kg/Hectare
Longnose gar	**	-	-	-	-
Gizzard shad	5563	8772	0.41	32700	51.562
Quillback	**	-	-	-	-
Golden shiner	1	66	1.0	2	0.159
White catfish	8	683	-	19††	1.646††
Tadpole madtoms	17	45	-	41††	0.108††
Largemouth bass	11	2496	0.17	156	35.384
Warmouth	27	354	0.17*	383†	5.018†
Bluegill	66	388	0.01*	15906†	93.508†
Pumpkinseed	3	74	0.50	14	0.357
Redear	6	169	0.03	482	13.576
Green sunfish	10	50	-	24††	0.121††
Black crappie	9	403	0.36	60	2.698
Young-of-the-year sunfish	110	50	-	265††	0.121††
Swamp darters	10	9	-	24	0.263
Totals	5841	13565	-	50076	204.521

* No recaptures were obtained, so factor based on assumption of one recapture.
**Species observed outside sampled area, assumed to occur 1/.5 hectare.
† Indicates minimum estimate assume one recapture.
††Minimum estimate because no recapture data available.

Table 3.6.9 Standing crop estimates of the fishes from a shoreline rotenone sample of the Frees Creek area of Parr Reservoir, South Carolina, November 11-13, 1972.

Species	Number Collected	Grams Collected	Recapture Factor	Number/Hectare	Kg/Hectare
Longnose gar	1	1910	-	2	4.720
Gizzard shad	283	1378	0.75	932	4.539
River carpsucker	**	-	-	-	-
Carp	**	-	-	-	-
Golden shiner	42	443	1.00	104	1.094
Silvery minnow	202	1265	1.00	499	3.126
Unidentified shiner	2	14	-	5††	0.035††
White catfish	9	756	1.00	22	1.868
Yellow bullhead	2	41	-	5††	0.101††
Tadpole madtom	16	32	-	40††	0.079††
Mosquitofish	4	1	-	10††	0.002††
Largemouth bass	1	6	0.47	5	0.032
Warmouth	13	276	0.40	82	1.705
Bluegill	59	753	0.08	1917	24.482
Pumpkinseed	1	27	0.33	7	0.202
Redear	35	1213	0.21	413	14.272
White crappie	22	688	1.00	54	1.700
Black crappie	30	581	0.50	148	2.871
Swamp darter	6	4	-	10††	0.015††
Totals	728	9388	-	4255	60.843

**Species observed outside sampled area, assumed to occur 1/0.5 hectare.

††Minimum estimate because no recapture data available.

fish of that species were recovered. It was felt that adequate estimates of the percentage of each species were obtained in the sample.

Table 3.6.9 illustrates the full breakdown of species composition and abundance. It is of interest to note that the gizzard shad at Transect B were present in much lower numbers than at Transect C. This phenomenon was noted not only in the rotenone samples but in other collecting procedures as well. The reason for this phenomenon is unclear at this time.

Of the species collected in this area, the bluegill comprised the greatest biomass with 24.482 kg/ha (21.8 lb/acre). They were also present in the largest numbers with 1917 individuals estimated per hectare.

Redear were second in biomass with 14.272 kg/ha (12.7 lb/acre). As noted previously, the standing crop of fishes in the Frees Creek area was significantly lower than in Cannons Creek (Transect C).

The standing crop as measured from Cannons Creek, closely approximates the mean standing crop of 207 kg/ha (183 lb/acre), reported by Jenkins (1967) for nine South Carolina reservoirs, although the mean of 132 kg/ha (117.5 lb/acre) from both Parr Reservoir samples is lower than both the South Carolina mean and the mean of 228 kg/ha (202.9 lb/acre) reported by Jenkins for South Carolina reservoir having moderately high sediment loads and low storage ratios. In addition, clupeid standing crop comprises more than half of the total standing crop of other South Carolina reservoirs. Gizzard shad make up less than one-fourth of the total standing crop of Parr Reservoir.

One of the greatest problems encountered in the sampling procedure was the low water temperature (15.0°C) at the time of sampling which caused the rotenone to affect the fish very slowly, thus precluding a rapid pickup. Further, the low water temperature likely allowed some fish to remain alive within the rotenoned area.

One of the limitations of the sampling procedure is, that fish are often not available for marking to perform the Petersen estimate. Related to this, investigators often recover none of the fish of a given species placed within the sampled area. To account for these sources of error, one assumes that the estimates for the species exhibiting these discrepancies are minimal. Therefore, the final estimates are recorded as n+ indicating an unknown error of positive nature. However, in the case of the two samples from Parr Reservoir, it is felt that these errors are small.

3.6.3.8 Food Habits

Food habits analyses were conducted on selected fishes collected from the Broad River Study Area from November 1972 through May 1973. These data were reported by collection period, transect, species, and size group.

Bluegill

A total of 147 bluegill stomachs were analyzed for food habits. There appeared to be differences in food habits between size classes, seasons, and transects.

A transition in food habits with increase in size was noted. Fish less than 50 mm (1.9 in) total length fed primarily on zooplankton with some chironomid larvae also being taken. Fish in the 51 to 100 mm (2 to 3.9 in) total length group fed approximately equally on zooplankton and chironomids. Aquatic insects were the major component in stomachs of specimens of the 101 to 150 mm (4 to 5.9 in) total length size group. Fish over 150 mm total length fed primarily on chironomid larvae. Zooplankton showed a definite decrease in importance as food items in fish over 100 mm total length. When fish eggs were detected as food items they usually comprise approximately 50 percent numerically and volumetrically of the food taken by fish over 100 mm total length.

Seasonal variation was also detected in bluegill feeding habits. In May 1973 all food items were ingested in higher numbers than at other seasons. May was the only month in which fish eggs were taken as food items, and during this sampling period fish eggs and chironomid larvae comprised 80 percent of the food items numerically and 90 percent of the total volume. Although pelecypods were never major constituents of the diet, they were more abundant in the stomachs of fish collected in November and February than in fish collected in May.

There appeared to be some variation in bluegill food habits between transects. Bluegill collected at Transect D had larger quantities of all food items except fish eggs in their stomachs. Bluegill from Transect D fed largely on chironomids. When present, fish eggs were the major food item found in fish stomachs collected at Transect B. Fish collected at Transects B, C, and D (reservoir) generally contained five to ten times as many food items as bluegill collected at Transects E and F (river).

According to Calhoun (1966) studies of bluegill diets in a wide variety of habitats in the eastern and central United States indicated that zooplankton and aquatic insects are usually dominant food.

Gizzard Shad

Twenty-eight stomachs of gizzard shad were analyzed for food habits. Twenty-seven of the specimens collected in May 1973 and a single stomach collected in November 1972 were analyzed.

Gizzard shad fed on a variety of organisms. Diatoms (Bacillariophyceae) were by far the most numerically abundant food item. Other prevalent items included species of Cyanophyta, Chrysophyta, Chlorophyta, and Rotifera. Rotifers and filamentous green algae (Cladophora spp. and Spirogyra spp.) generally comprised the majority of the biomass when present. There appeared

to be some variation of feeding habits with size. Smaller fish (50 to 110 mm [2 to 4.3 in] total length) fed primarily on the phytoplanktonic Dinobryon sp. Stomachs of specimens between 200 and 300 mm (7.8 to 11.8 in) total length contained greater numbers of zooplankton and types of phytoplankton other than Dinobryon sp. which decreased in relative abundance. Stomachs from fish greater than 300 mm total length showed a decrease in the relative abundance of phytoplankton and an increase in the abundance of filamentous green algae. The bulk of the biomass in larger fish was composed of filamentous green algae and zooplankton.

Several studies have shown that gizzard shad feed primarily on zooplankton during the first few weeks of development, after which phytoplankton becomes the major constituent of the diet (Kutkuhn 1957; Miller 1960; Cramer and Marzoff 1970). This shift in diet generally occurs when fish are between 25 and 30 mm (0.9 to 1.2 in) total length (Bodola 1966). Cramer and Marzolf (1970) showed that shad less than 20 mm (0.8 in) total length were able to feed selectively on certain species of zooplankton. After the fish had developed beyond the larval and post-larval stages greater than 60 mm (2.3 in) total length, they apparently fed randomly, utilizing the gill rakers as a filtering mechanism (Tiffany 1921; Bodola 1966). Jester and Jensen (1972) stated that the diet of gizzard shad was controlled primarily by the availability of food items. Jester and Jensen found that phytoplankton were numerically more abundant in the gut contents of shad, but zooplankton comprised the major portion of the biomass.

White Crappie

A total of 54 stomachs from white crappie were examined. There appeared to be a transition in food habits with size. Smaller fish fed primarily on zooplankton, intermediate size fish tended to feed on insects and larger fish were more piscivorous.

Seasonal changes in food habits were also evident. During November 1972, the larger, 201 mm (7.9 in), white crappie fed almost entirely on fishes, primarily gizzard shad. In February 1973, insects were evident in the diet, and by May 1973, the mean percent total volume of insects surpassed that of the fishes as food items. In November 1972, the intermediate sized, 101 to 200 mm (3.9 to 7.8 in), white crappie fed on zooplankton, insects, and gizzard shad in approximately equal volumes. In February, insects and fishes comprised the major protion of the diet; and by May, insects were the primary food.

Of the white crappie less than 100 mm (3.9 in) total length, those collected in November contained only zooplankton. In February, zooplankton and insects contributed approximately equal volumes of the observed food components. No specimens of the smaller size class were collected in May 1973.

These observations agree well with food habits reported by other workers (Harlan and Speaker 1956; Huish 1957; Sigler 1959). No differences in food habits were detected at different transects.

Redear Sunfish

A total of 88 redear stomachs were examined. There was no apparent difference in food habits between transects or between size groups, however, there appears to be a seasonal difference in redear food habits. Pelecypods, primarily the exotic asiatic clam, Corbicula manilensis, comprised from 70 to 99 percent of the total volume of the stomach contents of redear collected in May and November. C. manilensis was also found to be abundant in benthic samples. Unidentified organic matter was the next most prevalent item during May and November. In February, ephemeropterans and other insects, especially odonates, replaced pelecypods as the major food item. Ephemeropterans were particularly evident in the diet of specimens collected at Transect D in

February.

According to Calhoun (1966), newly hatched redear feed on green algae and microcrustacea, and older fish feed primarily on plankton, insects, snails, and occasional small fish. In Lake George, Florida, the November and December diet of redear was mainly small snails (Huish 1958).

Largemouth Bass

A total of 63 largemouth bass stomachs were examined from the study area. There appears to be no seasonal differences in food habits of largemouth bass. A difference in major food items was detected between fish collected in the reservoir (Transects B, C, and D) and those collected from the river (Transect E). A transition of feeding habits with size of fish also was detected. Bass in the 101 to 150 mm (3.9 to 5.9 in) total length size class from the reservoir appeared to be feeding on aquatic insects (Ephemeroptera, Trichoptera, Hemiptera). Fish of 151 to 300 mm (5.9 to 11.8 in) fed primarily on fishes, but the species of fish utilized could not be identified. Largemouth bass longer than 300 mm total length fed primarily on fishes (black crappie, gizzard shad, and bluegill), but decapods and frogs were occasionally utilized as food items. All largemouth bass collected at Transect E were longer than 300 mm (11.8 in) total length and contained decapods as the primary food item.

Largemouth bass feed on a wide variety of food items (Calhoun 1966); however, adults eat mainly fishes (Harlan and Speaker 1956; Sigler 1959).

River Carpsucker

Of the river carpsucker stomachs examined, a total of 23 contained food items. The majority of the food material was unidentified organic matter. Dipterous larvae, primarily larval chironomids, comprised the majority of the remainder of the food material. The volume of chironomids in the stomachs varied

from trace amounts to 30 percent. There appeared to be no difference among size groups, transects, or seasons.

Carp

Carp were collected only at Transects B and E. Eight carp stomachs were analyzed for food items. All fish examined were between 450 and 800 mm (17.7 to 31.5 in) total length. Unidentified organic matter was the most frequently detected food item, accounting for 85 to 100 percent of the total volume of the stomach contents for all fish examined. Cyclopoid copepods and chironomid larvae were numerically the most important food items encountered. Numerous references indicate carp feed primarily on bottom fauna such as chironomids, zooplankton, phytoplankton, and plant remains (Ewers and Boesel 1935; Rose and Moen 1951; Moen 1954; Sigler 1959; Rehder 1959; Scidmore and Woods 1960; Nelson 1962).

Flat Bullhead

Thirty-four stomachs were examined to determine the feeding habits of flat bullhead. Flat bullheads fed on a variety of organisms. There apparently was some difference in the feeding habits associated with size. Fifty percent of the larger specimens contained Notropis sp.

Plant material was abundant in 71 percent of the specimens collected at Transect F. Insects were present in the stomachs of 32 percent from the same location. Those specimens from Transects D and E contained primarily insects.

Twenty-one percent of the specimens examined contained other invertebrates (leeches, arachnids, and nematodes).

Black Crappie

A total of 22 stomachs from black crappie were analysed for food habits. There appeared to be some seasonal variation in black crappie feeding habits. Fish remains were the major food items detected in stomachs collected

in November 1972. During the February and May, 1973 samples, the black crappie appeared to be primarily insectivorous. During this period they fed on a wide variety of benthic forms with Ephemeroptera, Trichoptera, Chaoborus sp., and larval chironomids being the most frequently encountered food items.

There appeared to be some variation in feeding habits by transects during the May 1973 survey. Chaoborus sp. accounted for over 95 percent of the total volume at Transect B while at Transect C it formed approximately 20 percent. At Transect D, no stomachs contained Chaoborus sp. and Hexagenia sp. was the major food item.

Moxostoma spp.

There was difficulty during initial surveys identifying redhorse suckers. Consequenty at least two species are grouped under this heading. A total of 25 digestive tracts were examined. Insects dominated the food items observed. Chironomids, ephemopterans, and hydropsychids comprised the bulk of the ingested matter, and 75 percent of those specimens examined contained chironomids. There were no obvious differences between size groups or transects.

Channel Catfish

A total of 15 channel catfish stomachs were analyzed, 12 of which were collected in November 1972. Unidentified organic matter was the major food item detected in stomachs. Insects were low in mean total number and mean percent total volume in November 1972. However, in February 1973, insects comprised 80 percent of the stomach contents by volume (one stomach analyzed). One large specimen (801 to 850 mm [17.7 to 19.7 in] total length size group) contained 30 percent unidentified fish remains by volume. Fish were not detected as food items in stomachs of smaller individuals.

Published reports indicate channel catfish fed on aquatic insects (Ewers and Boessel 1935; Bailey and Harrison 1948) and bottom arthropods

(Darnell 1958) when small, but beyond 100 mm (3.9 in) total length were usually omnivorous (Bailey and Harrison 1948; Cross 1951; Darnell 1958; McDonald and Dotson 1960; Hoopes 1960; Davis 1960) or piscivorous (Dendy 1946; Russel 1964).

White Catfish

Food habits of white catfish are based on the analysis of nine stomachs which contained food items. Due to the small sample size and the variety of food items, no trends or differences could be detected. The mayfly, Hexagenia limbata, dominated the food items by volume in the stomachs of two white catfish collected in November 1972; however, both stomachs contained only single specimens of H. limbata. One stomach collected at the same time from a specimen captured at Transect D contained Ephmeroptera and other insects in trace amounts. Insects were also detected in the stomach of the single specimen collected at Transect B in February 1973. Several specimens collected in February 1973 contained only unidentified organic matter.

Published reports indicate white catfish feed on a variety of food items, including pondweeds, aquatic insects and fishes (Stevens 1959b; Miller 1966).

Pumpkinseed

A total of 13 stomachs were analyzed to determine the food habits of the pumpkinseed. Pumpkinseed fed primarily on aquatic insects (Chironomidae and Ephemeroptera), especially during February. Pelecypods and unidentified organic matter were also consumed. No differences in food habits were detected between size classes, transects, or seasons.

Trautman (1957) stated that pumpkinseed fed chiefly on aquatic insects, small mollusks, and crustacea, and that large individuals may also feed on small fishes.

Warmouth

Fourteen warmouth stomachs were analyzed to determine food habits. Thirteen of the specimens examined were less than 150 mm (5.9 in) total length. Specimens examined fed on aquatic insects, decapods, and amphipods. Stomach contents of the single specimen greater than 150 mm total length contained 90 percent by volume unidentified fish remains. There were no obvious differences in feeding habits between transects or seasons.

Other studies indicated that post-larval individuals fed on Protozoa and bacteria, with insects, zooplankton, snails, and small crustaceans becoming increasingly important as the fish grew; with fishes comprising a large part of the diet of those over 130 mm (5.1 in) total length (Lenis and English 1949; Harlan and Speaker 1956; Larimore 1957).

Golden shiner

A single specimen of golden shiner in the 101 to 150 mm (4 to 5.9 in) size group was collected at Transect C in May 1973. The stomach contained three chydorid cladocerans, and 80 percent algae and 20 percent unidentified organic matter by volume. According to Radcliff (1931) and Flemer and Woolcott (1966) young shiners feed principally on Entomostraca and phytoplankton, while adults feed largely on algae.

Shorthead Redhorse

A total of 16 digestive tracts of specimens positively identified as Moxostoma macrolepidotum were analyzed to determine food habits. No significant variation between size groups, transects, or seasons was detected. Insects, particulary chironomid larvae, appeared to be the primary food item encountered. Chironomids were present in all but two of the specimens in which ingested material was identifiable.

Small redhorse reportedly feed on Cladocera and chironomids

(Nurnberger 1930) and larger individuals feed on benthic insects (Meyer 1962; Reed 1962).

Silver Redhorse

Food habits of silver redhorse were based on examination of contents of the digestive tract of 15 specimens. Most specimens contained unidentifiable organic matter. Twenty percent of examined specimens contained molluscs, primarily Corbicula manilensis; and approximately 20 percent had ingested benthic insects, primarily chironomid larvae.

No obvious differences between size groups or seasons was detected. The greatest variety of food items was observed in specimens collected from Transect E.

Meyer (1962) found that chironomids, mayflies, and caddisflies were the principal foods of silver redhorse in the Des Moines River, Iowa.

Redbreast Sunfish

A total of nine redbreast were examined for food habits. Eight of the specimens were less than 200 mm (7.8 in) total length. Redbreast fed primarily on insects (Chironomidae and Odonata). Unidentified organic matter was also an important food item. The stomach of the single specimen larger than 200 mm total length contained a flat bullhead. No redbreast were collected during the November sampling, or from Transects A, B, C, or D on other sampling dates.

Yellow Bullhead

Food habits of a single specimen of yellow bullhead collected at Transect E in May 1973 were analyzed. The stomach contained unidentified organic matter.

According to Harlan and Speaker (1956) principal foods of the yellow bullhead included insects, crustaceans, mollusks, and small fishes.

Eddy and Surber (1947) stated that plant materials often form a large part of the diet.

Green Sunfish

Stomach contents of a single specimen of green sunfish captured at Transect E in November 1972 were analyzed. The stomach contained 90 percent unidentified organic matter by volume, one trichopteran, and one dipteran.

Sigler and Miller (1963) stated that adult green sunfish prefer larger animal foods such as fish, dragonfly larvae, freshwater shrimp, and aquatic snails.

White Bass

Two specimens of white bass were collected at Transect E in May 1973. Unidentified fish remains comprised 90 to 100 percent by volume of the food items detected. White bass feed on insects and fishes (Lamb 1951; Toole 1952; Bonn 1953).

Brown Bullhead

Stomach contents of two brown bullheads were analyzed for food habits. Stomachs from Transects B and D contained primarily unidentified organic matter. Both stomachs contained Chironomidae, trichopterans, Hexagenia sp., and unidentified insect remains.

Longear Sunfish

Stomach contents of a single specimen of longear sunfish in the 51 to 100 mm (2 to 3.9 in) length size group were analyzed. The stomach contained 100 bryozoan statoblasts comprising 50 percent of the contents by volume. Unidentified organic matter comprised 40 percent of the contents by volume. Seven dipteran larvae were also present in the stomach.

Black Bullhead

Two black bullhead stomachs were analyzed for food habits. Both specimens were collected in May 1973. One specimen was collected at Transect B and the other at E. Both stomachs contained unidentified organic matter.

According to Harlan and Speaker (1956) black bullhead are omnivorous; their diet includes insects, crustaceans, worms, mollusks, fish eggs, fish, and plant matter.

3.6.3.9 Parasites

No external parasites were noted at the time of collection. Internal parasites, mainly of the digestive tract, were noted and recorded during the course of stomach analysis. A table summarizing host-parasite relationships was compiled for each sampling period (Tables 3.6.10 to 3.6.12). The data are presented on a quarterly basis in order to show more clearly the differences which occurred during the sampling periods.

The two most important parasites in terms of number of species were Posthodiplostomum minimum and Nematode "a". P. minimum centrarchi, a metacercarial trematode, was noted in the liver and mesentaries of Centrarchidae in sampling periods November 1972 to May 1973; young centrarchids were often found to have large numbers of these metacercariae in the liver. The infecting agents of this parasite are the cercariae escaping from the first intermediate host (Physa sp.), entering the second intermediate host (Centrarchidae) through the skin, and migrating to the hepatic region where encystment occurs. The definitive host of Posthodiplostomum minimum centrarchi in the study area is probably the great blue heron.

The greatest variety of parasites is found in the Nematoda; up to eight possible species were noted in the November 1972 sample. The nematodes were, in general, morphologically similar with the exception of Nematode "a"

Table 3.6.10 Parasites of fishes collected from five transects in the Broad River Study Area, November 1972.

	Posthodiplostomum minimum	Posthodiplostomum centrarchi	P. minimum	Nematoda Species a	b	c	d	e	f	g	h	Camallanus	Camallanus type
Centrarchidae													
Bluegill		X (44)		X									X
Redear		X		X									
Pumpkinseed		X											
Warmouth				X									
Black crappie		X		X									
Largemouth bass				X									
Ictalauridae													
White catfish			X	X									
Channel catfish			X							X			
Flat bullhead			X		X								
Catostomidae													
Shorthead redhorse						X	X	X	X		X		
River carpsucker												X	

Table 3.6.11 Parasites of fishes collected from five transects in the Broad River Study Area, February - March, 1973.

	Posthodiplostomum minimum centrarchi	Trematoda Species a	b	c	Nematoda Species a	b	c	d	Camallanus	Cestoda
Centrarchidae										
Bluegill	X		X	X	X					
Redear	X	X	X		X					
Pumpkinseed	X				X					
Warmouth	X				X					
White crappie	X				X					
Black crappie					X					
Largemouth bass	X		X		X					
Redbreast	X									
Ictalauridae										
White catfish		X			X					
Channel catfish		X								
Flat bullhead							X			
Castostomidae										
Silver redhorse									X	X
Shorthead redhorse								X		
River carpsucker									X	

Table 3.6.12 Parasites of fishes collected from five transects in the Broad River Study Area, May 1973.

	Posthodiplostomum			Nematoda Species								Camallanus	Cestoda	Proteocephalus
	minimum	centrarchi	Trematoda	a	b	c	d	e	f	g	h		a	b
Centrarchidae														
Bluegill		X	X	X			X	X					X	
Redear		X	X	X	X									
Warmouth		X		X								X		
White crappie		X		X										
Black crappie				X	X	X								
Largemouth bass		X												X
Ictauridae														
Flat bullhead									X	X				
Catostomidae														
River carpsucker											X			
Cyprinidae														
Carp													X	

and Camallanus sp. Consequently, the letter designation given these parasites do not necessarily correspond to each other among the different samples. The majority of these roundworms, and the other parasites as well, are undescribed species (Dr. Wilmer Rogers, pers. comm.)[1].

Nematode "a" was originally reported as Spinitectus sp. to which it bears a strong resemblance. It is undescribed however, and occurs mainly in the Centrarchidae although white catfish were found to harbor this parasite also. A possible intermediate stage of the nematode has been found in the thorax of the mayfly nymph Hexagenia limbata. Percent infections of Nematode "a" and Posthodiplostomum minimum centrarchi in relation to the Centrarchidae and fish population as a whole are shown in Figure 3.6.1.

The most abundant parasite occurring in a single species was a nematode found in flat bullheads in November 1972 and May 1973 designated Nematode "b" and Nematode "f", respectively. This worm occurred in the pylorus of flat bullheads from Transect F and was found in very large numbers. Estimates of the number of worms per host vary from several hundred to several thousand.

Camallanus sp., a large (25 mm [1.0 in]) distinctive nematode, occurred in the Catostomidae, usually in river carpsuckers from swift water (Transects E and F). A larval form of this worm was found in one warmouth from Transect D in May 1973 and an incomplete specimen in one bluegill from Transect B in November 1972. Only a few were found in any one fish. Infection by Camallanus sp. occurs when the intermediate copepod host is ingested and development to the adult stage takes place in the final host's intestine.

Adult trematodes were found in February, March, and May, 1973 (Tables 3.6.11 and 3.6.12). In the former sampling period, three species of

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[1]Dr. Wilmer Rogers, Alabama Cooperative Fishery Unit, Auburn, Ala.

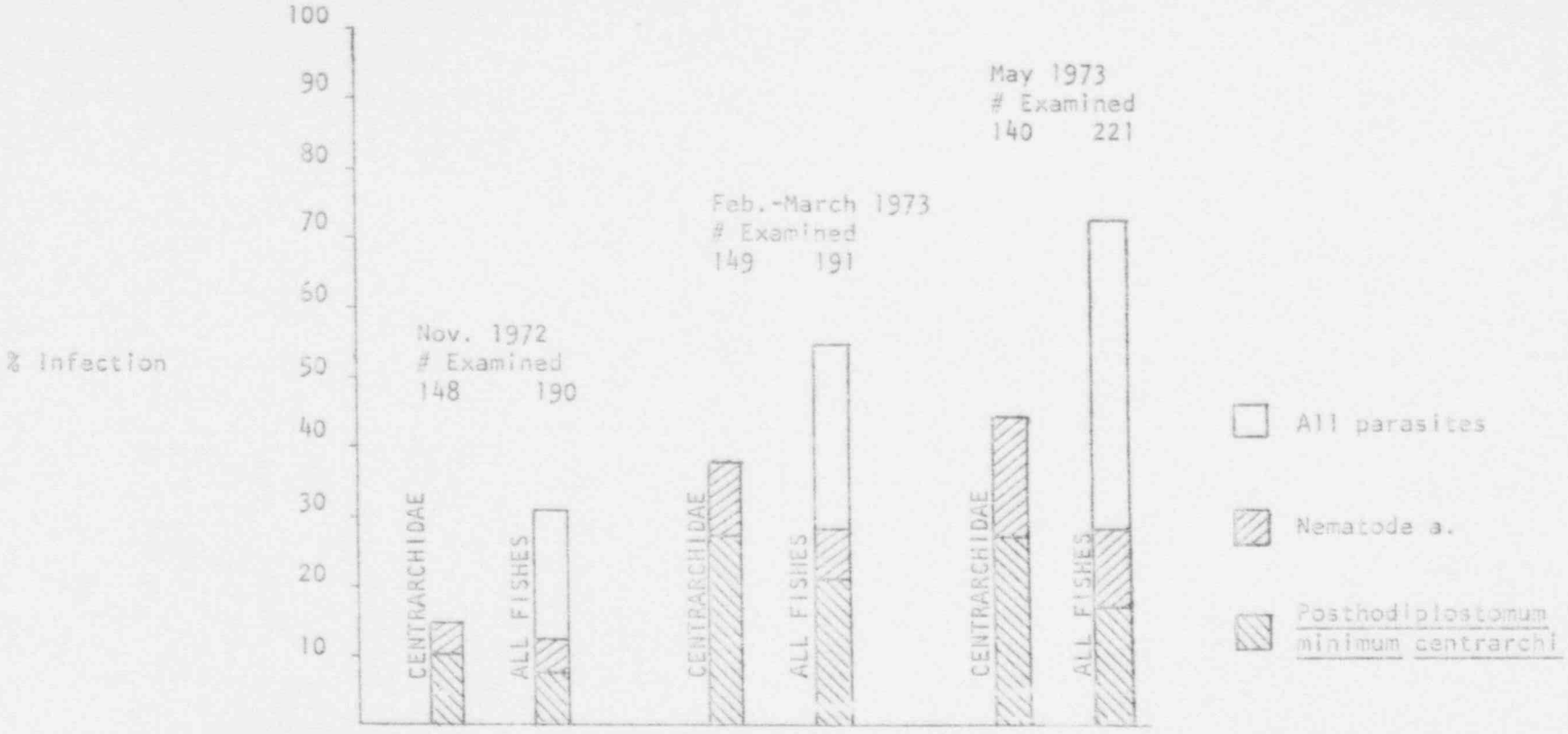

Figure 3.6.1 Percent infection of Centrarchidae and all fishes by selected parasites and all parasites in the Broad River Study Area, 1972-1973.

flukes were recorded from three Centrarchidae and two Ictaluridae. These trematodes are undescribed, but appear to belong in the Cryptogonimidae. In the May 1973 sample, one unidentified species belonging in Allocreadiidae occurred in bluegill and redear only. The fluke appears to be similar to Crepidostomum sp. but may be undescribed. Life cycles of the Cryptogonimidae and Allocreadiidae are not well known and varied modes of infection are possible. No heavy infections by trematodes were noted.

Cestodes were also first recorded in 1973. An undescribed cestode (Caryophyllaeidae) was recovered from three silver redhorse from Transects E and F. Another species of the same family, bearing a resemblance to Spartoides sp., occurred in two carp from Transect E; 43 were found in one intestine. These are small unsegmented tapeworms less than one cm in length, and varied modes of infection are possible. The unidentified Cestode "a" (May 1973) was found in one bluegill. It was not possible to identify this incomplete segmented worm. Four Proteocephalus sp. were recovered from one largemouth bass from Transect C. The adult develops in the final host after ingestion of a smaller fish containing the plerocercoid. Procercoid development takes place in the hemocoel of crustaceans.

It is likely that parasites recorded from the Broad River Study Area have little deleterious effect on their hosts. However, a few exceptions may be discussed further:

(1) Pyloric nematode of flat bullheads (Nematode "b", November 1972; Nematode "f", May 1973).

Generally speaking, the effects of parasitism are related to the abundance of the parasite in the host; this is especially true of nematodes. The fact that this nematode was found in extremely high concentrations may be significant. In most cases, the pylorus was completely blocked by masses of

this worm and other masses were found in adjacent regions of the stomach. Conceivably, digestion could be severely impaired by such masses of worms. Wasting or death of the host could be the result of this reduced assimilation efficiency. However, the particular hosts examined appeared healthy.

(2) Posthodiplostomum minimum centrarchi

This parasite can be detrimental during two of its life history stages. The infective miracidia can cause small hemorrag.. as they penetrate beneath the host's scales and migrate to the hepatic region. In addition, the miracidial entrance wounds may serve as sites for secondary bacterial or fungal infections. The metacercariae encysted in the liver could cause reduced hepatic function and death of the host (Hunter 1942). Mesenteric adhesions resulting from metacercariae of Posthodiplostomum minimum centrarchi have been reported from sunfishes by Bangham (1938) and Fischtal (1953). Hugghins (1972) has attributed the emaciated appearance of black crappie in Lake Frasier, South Dakota to the effects of this parasite.

Fishes of the Broad River Study Area showed no obvious effects from infection by this parasite; mitigating factors in the environment may be acting to reduce the effects of this trematode.

(3) Proteocephalus sp.

The adult form of this tapeworm is less harmful than the larval plerocercoid. The plerocercoid migrates in the visceral cavity and has been shown to cause gonadal fibrosis resulting in sterility (Hoffman 1967). Adhesions have also been reported (Hugghins 1972).

Plerocercoids were not found in any fish examined at the time of gut removal, and the adult was found in only one largemouth bass. It is probable that the incidence of Proteocephalus sp. is low in the bass population. However, should an epizootic of this parasite occur, the potential for a massive decrease

in largemouth bass reproduction would be very great.

Other parasites recorded were, with the exception of Nematode "a" and Posthodiplostomum minimum centrarchi, either sporadic in occurrence or occurred in low numbers in the hosts. Parasitism in the population as a whole has more than doubled from November 1972 to May 1973 (Figure 3.6.1), but the fishes examined appeared healthy. No detrimental effects of parasitic infections can be found in the total population or selected groups, including the relatively heavily parasitized Centrarchidae.

3.6.4 SUMMARY

Quarterly surveys of fishes were conducted at the Broad River Study Area from March 1971 through May 1973. Forty species of fishes representing ten families have been identified from the study area.

A total of 4,204 specimens were collected. Bluegill, gizzard shad, white crappie, redear sunfish, and largemouth bass comprised 78.9 percent of the fishes collected. The area sampled is dominated by sport fishes though river carpsucker, carp, flat bullhead, and longnose gar are abundant, especially in the river.

Age and growth of selected species were examined. Growth of bluegill in the study area was comparable to that reported from other areas. Growth rates of re crappie, gizzard shad, and redear sunfish were less than those reported for other areas of South Carolina.

Length-weight relationship regressions and condition factors were calculated and results agree reasonably well with published data. As more specimens are collected, this baseline data will be used for comparison.

Sex ratios were determined for important species. In the family Centrarchidae, males were collected more often than females. Males were much more abundant among the carp and suckers collected. The observed results may

be due to sampling during phases of upstream migrations. One sex often precedes the other during such migrations.

Gonad condition of mature fishes of important species was determined in May 1973. Most species had spawned by May 1973. Specimens of the following species; gizzard shad, carp, redhorse, river carpsucker, and flat bullhead had developing gonads or were ripe at this time.

Standing crop was estimated at two areas in the Broad River Study Area. The total biomass estimate from Cannons Creek area was 204 kg/ha (182.0 lb/acre) and the Frees Creek area estimate was 60 kg/ha (54.1 lb/acre). Low water temperature may have prevented a total kill in the sampled area.

Food habits of all fishes examined generally agreed with published studies. The variety of food items observed indicates that most organisms occurring in the aquatic habitat are being utilized.

Fishes were examined for external parasites as they were collected and internal parasites were noted as food habit studies were conducted. A variety of parasites were recorded but apparently had little observable effect on the hosts.

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3.7 PRODUCTIVITY

3.7.1 INTRODUCTION

The metabolism of aquatic plant and animal communities results in measurable changes in the chemical composition of water such as oxygen concentrations, carbon dioxide content, pH, alkalinity, etc. In habitats including polluted water, small ponds, and some streams the diurnal changes may be quite large. In these systems, such changes in the chemical environment are used to estimate primary productivity. However, in unproductive streams and in many productive large rivers, the magnitude of the diurnal changes is so small that reliable estimates are difficult to obtain. When applicable, the diurnal change method involving oxygen and carbon dioxide is advantageous because the communities are in a natural state and not in enclosures (e.g., light - dark bottle and carbon - 14 methods). Observations utilizing diurnal changes can be continued for lengthy periods whereas the enclosure type studies are limited in duration because of the accumulation of metabolites and bottle effects. On the other hand, diurnal change methods are grossly affected by input and output of substances being measured. The more commonly used diurnal curve method at a single station assumes that stream homogeneity exists above the zone of measurement and the incoming water has the same diurnal history as the water proceding it (Odum 1956). Diffusion should be taken into account since it is the main process which fluctuates diurnally, and diffusion rates very considerably, especially in large rivers.

Many attempts have been made to determine primary productivity rates of communities in running waters with very limited success. A variety of methods have been proposed but unfortunately all are subjected to questionable assumptions and numerous limitations. Algal biomass, pigment assays, carbon - 14 uptake, light and dark bottle method, and diurnal changes in oxygen and

carbon dioxide have been used to estimate stream productivity. Analysis of diurnal curves of dissolved oxygen has been frequently used (Odum 1956, 1957; Hoskin 1959; McConnell and Sigler 1959; Edwards and Owens 1962; Duffer and Dorris 1966). This method has been used successfully in environments such as productive springs, polluted waters, and in some streams and rivers. In large productive rivers or relatively low productive streams the magnitude of the diurnal change is quite low and experimental error alone may produce erratic results. Diffusion rates vary considerably and in rivers may vary from 0.6-5.0 g $O_2/m^2/hr$ (Udum 1956) and since diffusion is the main process which fluctuates diurnally, it should be taken into account. However, if the area under the rate of change curve is measured, approximate gross production is obtained without diffusion, and accrual corrections are small if deviations from saturation are small relative to the total production.

3.7.2 METHODS AND MATERIALS

Primary productivity estimates were determined by the diurnal single curve method of Odum (1956) at Transect D in the Broad River and in Frees Creek, a tributary to the Broad River. Samples were collected at 2 to 3 hour intervals throughout the 24 hour period and analyzed immediately after collection at a field laboratory. Dissolved oxygen was determined by the azide modification of the Winkler method and analyses were performed in duplicate. Oxygen values were corrected to the average daily temperature. Carbon dioxide was calculated from pH, methyl purple alkalinity, and temperature by means of an alkalinity nomogram (American Public Health Association, et al. 1971).

A hypothetical diurnal curve is both oversaturated and undersaturated with oxygen relative to the atmosphere and there is usually a balance between productivity and respiration. The method proposed by Odum (1956) is based on the following processes that affect the oxygen and carbon dioxide concentrations

in flowing waters:

(1) There is a release of oxygen into the water from photosynthetic processes during the day;

(2) There is an uptake of oxygen from the water by respiration of aquatic organisms;

(3) There is an exchange of oxygen with the air based on a saturation gradient;

(4) There may be an influx of oxygen with accrual of ground water and surface drainage.

These processes are expressed quantitatively in terms of g $O_2/m^2/$ hr as:

$$Q = P - R + D_{in} + A \qquad (1)$$

Where:

Q = rate of change of dissolved oxygen

P = rate of gross primary productivity per area

R = rate of respiration per area

D_{in} = rate of oxygen uptake by diffusion per area

A = rate of drainage accrual

Drainage accrual is usually negligible relative to the other influences and is often disregarded. The rate of diffusion into the water is dependent on the saturation deficit and should be taken into account. The gas transfer coefficient (K) is determined from the measurements of dissolved oxygen recorded shortly after sunset and just before sunrise.

At sunset:

$$qe = \frac{KSe}{Z} - r \quad (2)$$

where qe = evening rate of change in oxygen
Se = saturation deficit
Z = depth in meters
r = respiration

At sunrise:

$$qm = \frac{KSm}{Z} - r \quad (3)$$

where qm = morning rate of change in oxygen
Sm = saturation deficit
Z = depth in meters
r = respiration

Subtraction of the equations results in the following relationship:

$$K = \frac{Z\ (qm - qe)}{Sm - Se} \quad (4)$$

Subsequent values of oxygen concentrations throughout the study period are corrected for diffusion effects by subtracting diffusion rates.

The area under the diurnal rate of change curve is determined by the summation of the change in oxygen concentration per hr (ΔO_2 in $g/m^3/hr$) for the 24-hour period. The gross production in g $O_2/m^2/day$ is determined by the following equation:

Gross Primary Production PG = (Z) (Area under diurnal curve expressed as g $O_2/m^3/hr$)

Where PG = gross primary production
Z = depth in meters
Area = area under diurnal curve q

The rate of change of oxygen per unit time is calculated according to the relationships in equation (1). Carbon dioxide productivity estimates based on the diurnal carbon dioxide curve are calculated in the same manner.

It should be emphasized that the diurnal single curve method is no substitute for a two station method but may be useful in obtaining order of magnitude (Odum 1956).

3.7.3 FINDINGS AND DISCUSSION

Primary productivity estimates were determined seasonally by the single station diurnal curve method at Transect D in the Broad River and in Frees Creek, a tributary to the Broad River. Physicochemical data for the study periods are found in Tables 3.7.1 to 3.7.3. The diurnal oxygen curves are shown in Figures 3.7.1 to 3.7.4.

Primary productivity curves (Figures 3.7.5 - 3.7.8) resembled curves from other studies on 24 February 1973 at Transect D and in Frees Creek on 15 November 1973. However, the data at Transect D was extremely variable and no discernable pattern was evident on 15 November 1973 and

Table 3.7.1 Physicochemical data (average values in water column) at Transect D in Broad River and Frees Creek, 15 November 1972.

Time	Temp.	pH	Alkalinity	Free CO_2 mg/l	ΔCO_2/hr	* O_2 mg/l	ΔO_2 g/m^3/hr	O_2 % Saturation
TRANSECT D								
0830	14.5	6.95	28.00	4.84	-	8.92	+0.24	86.4
1245	14.5	6.97	28.00	4.84	0.00	8.72	-0.05	84.5
1720	14.5	6.85	26.00	6.60	+0.38	8.62	-0.02	83.5
2145	14.9	6.74	22.50	6.62	+0.01	8.69	+0.02	84.2
0200	14.1	6.63	20.75	7.04	+0.10	8.56	-0.03	82.9
0600	13.9	6.60	19.50	5.72	-0.33	8.32	-0.06	80.6
FREES CREEK								
1130	14.0	7.00	29.00	4.40	-	8.93	+0.05	86.5
1600	15.5	7.00	29.00	4.84	+0.07	9.45	+0.12	91.6
2030	15.0	6.62	32.00	12.32	+1.66	8.70	-0.17	84.3
2330	14.0	6.71	30.50	9.24	-1.03	9.09	+0.13	88.1
0330	13.9	6.72	30.00	9.24	0.00	8.65	-0.11	83.8
0745	13.8	6.62	30.50	12.32	+0.73	8.76	+0/03	84.9

* Corrected to average daily temperature of 14.4 C.

Table 3.7.2 Physicochemical data (average values in water column) at Transect D in Broad River, 24 February 1973.

Time	Temp.	Conductivity umho/cm	pH	Alkalinity	Free CO_2 mg/l	ΔCO_2/hr	* O_2 mg/l	ΔO_2/g/m^3/hr	O_2 % Saturation
0	10.0	100	7.20	20.00	3.4	-	11.13	-	99.4
0310	10.0	-	7.10	10.25	3.8	+0.06	11.10	-0.01	99.1
0600	8.9	100	7.05	19.00	4.5	+0.25	10.86	-0.09	97.0
0800	10.0	105	7.15	18.50	3.4	-0.55	11.05	+0.10	98.7
1030	12.0	-	7.20	18.00	2.9	-0.20	11.77	+0.29	105.1
1215	12.0	-	7.28	19.25	2.5	-0.23	11.87	+0.06	106.0
1400	13.0	-	7.35	19.25	2.1	-0.23	12.05	+0.10	107.6
1600	12.8	-	7.20	19.00	2.8	+0.35	11.95	-0.05	106.7
1800	11.0	-	7.28	18.50	2.4	-0.20	11.50	-0.23	102.7
2100	8.8	-	7.35	18.50	2.1	-0.10	10.95	-0.18	97.8
2400	8.3	-	7.28	18.50	2.6	-0.17	10.88	-0.02	97.2

* Corrected to average daily temperature of 10.5 C.

Table 3.7.3 Physicochemical data (averaged values in water column) at Transect D in Broad River, 16 May 1973.

Time	Temp.	*mg/l O_2	ΔO_2	$\Delta O_2 g/m^3/hr$	% Saturation	Free CO_2	ΔCO_2	CO_2/hr
0	20.0	9.38	-	-	102.0	2.4	-	-
0200	20.0	9.43	+0.05	+0.03	102.5	1.9	-0.55	-0.28
0400	20.0	9.40	-0.03	-0.01	102.2	1.5	-0.40	-0.20
0630	20.0	9.25	-0.15	-0.06	100.5	1.6	+0.15	+0.06
0930	20.0	9.40	+0.15	+0.05	102.2	1.0	-0.60	-0.20
1130	20.0	9.33	-0.08	-0.04	101.4	1.0	0.00	0.00
1500	20.0	9.60	+0.28	+0.08	104.3	0.9	-0.10	-0.03
1600	20.0	9.35	-0.25	-0.25	101.6	1.0	+0.10	-0.10
1845	20.3	9.60	+0.25	-0.09	104.9	1.8	+0.80	+0.29
2210	19.3	9.90	+0.30	+0.09	107.1	2.4	+0.60	+0.18

*Corrected to average daily temperature of 20.0 C.

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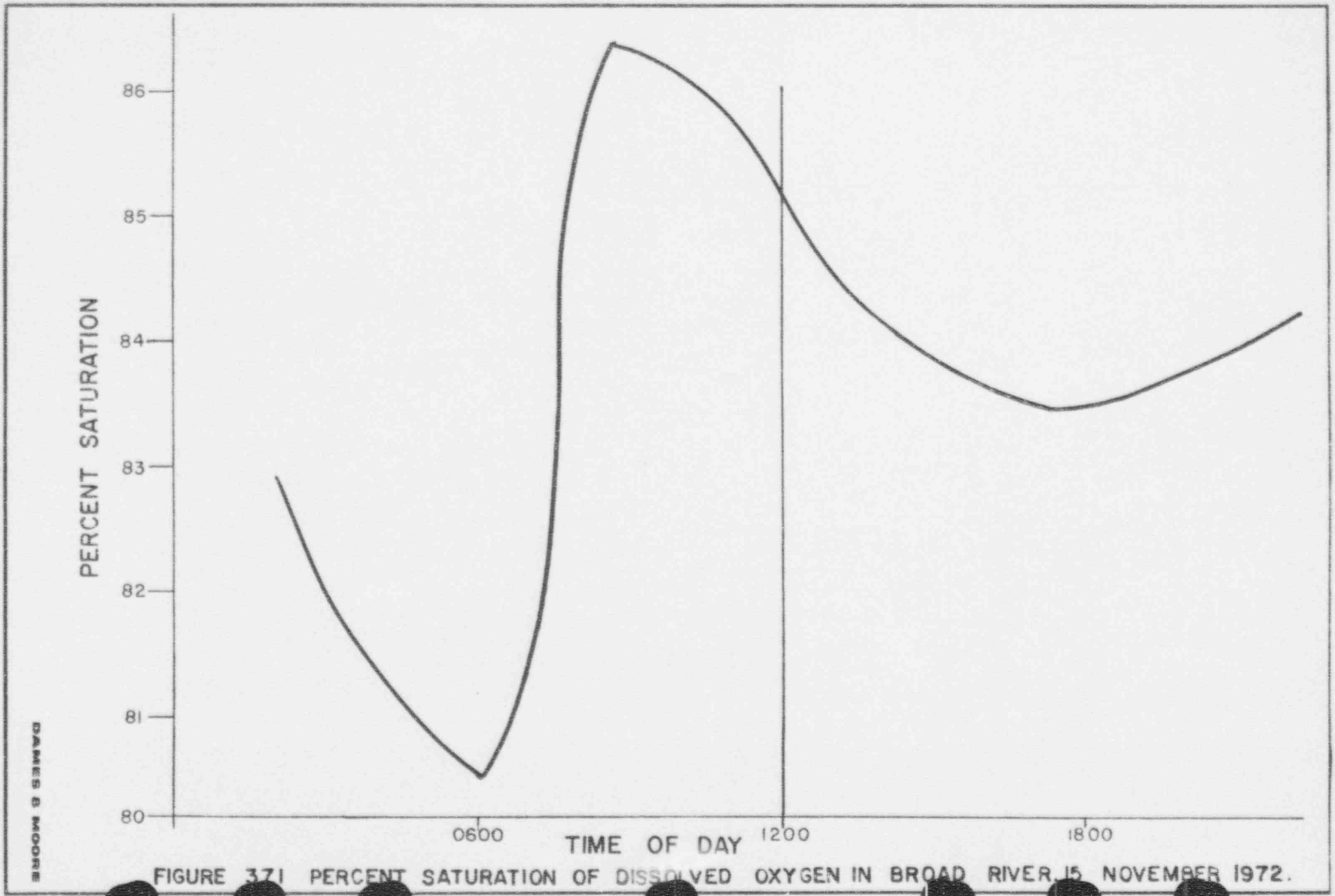

FIGURE 3.7-1 PERCENT SATURATION OF DISSOLVED OXYGEN IN BROAD RIVER 15 NOVEMBER 1972.

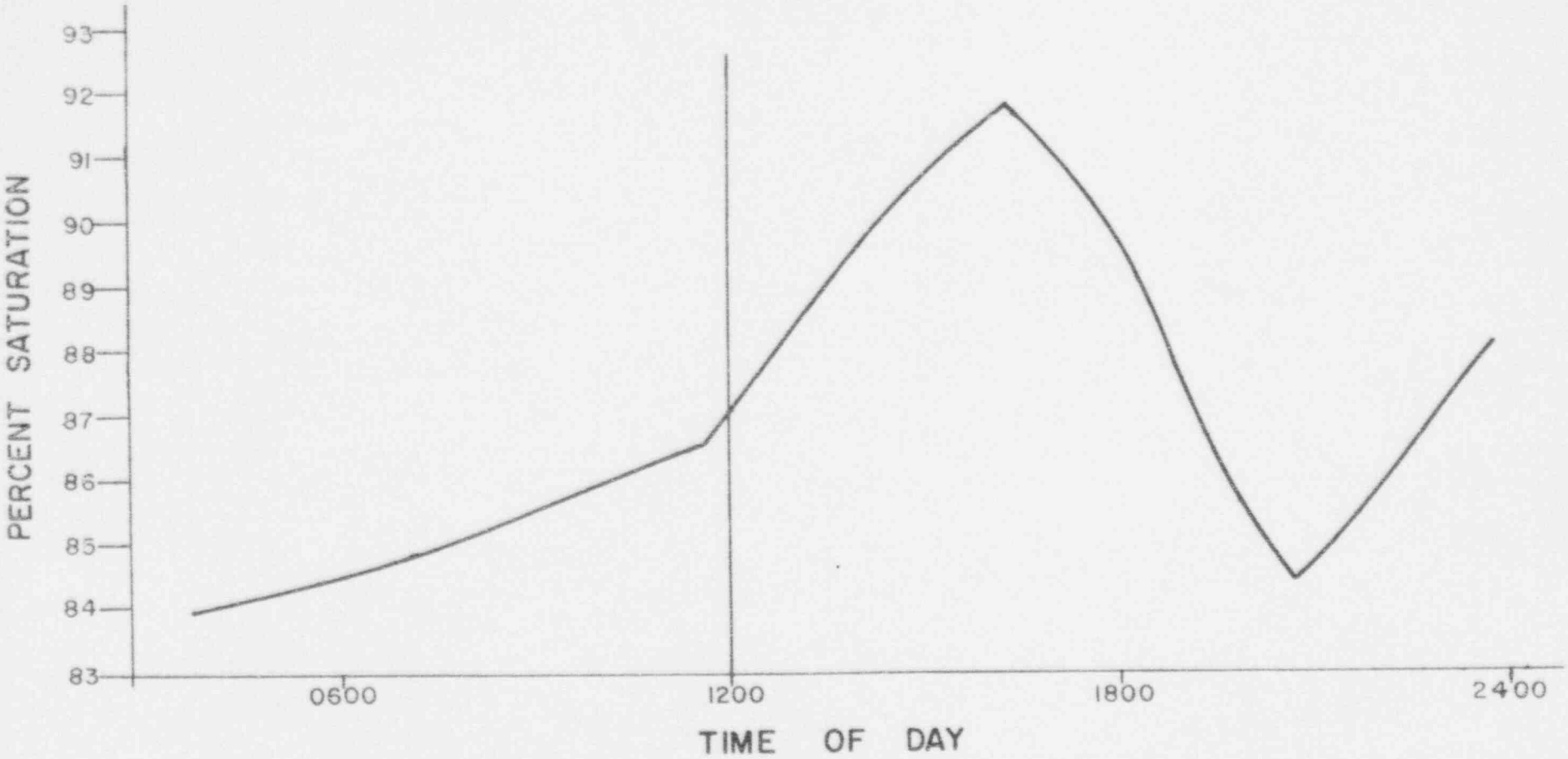

FIGURE 3.7.2 PERCENT SATURATION OF DISSOLVED OXYGEN IN FREES CREEK, 15 NOVEMBER 1972.

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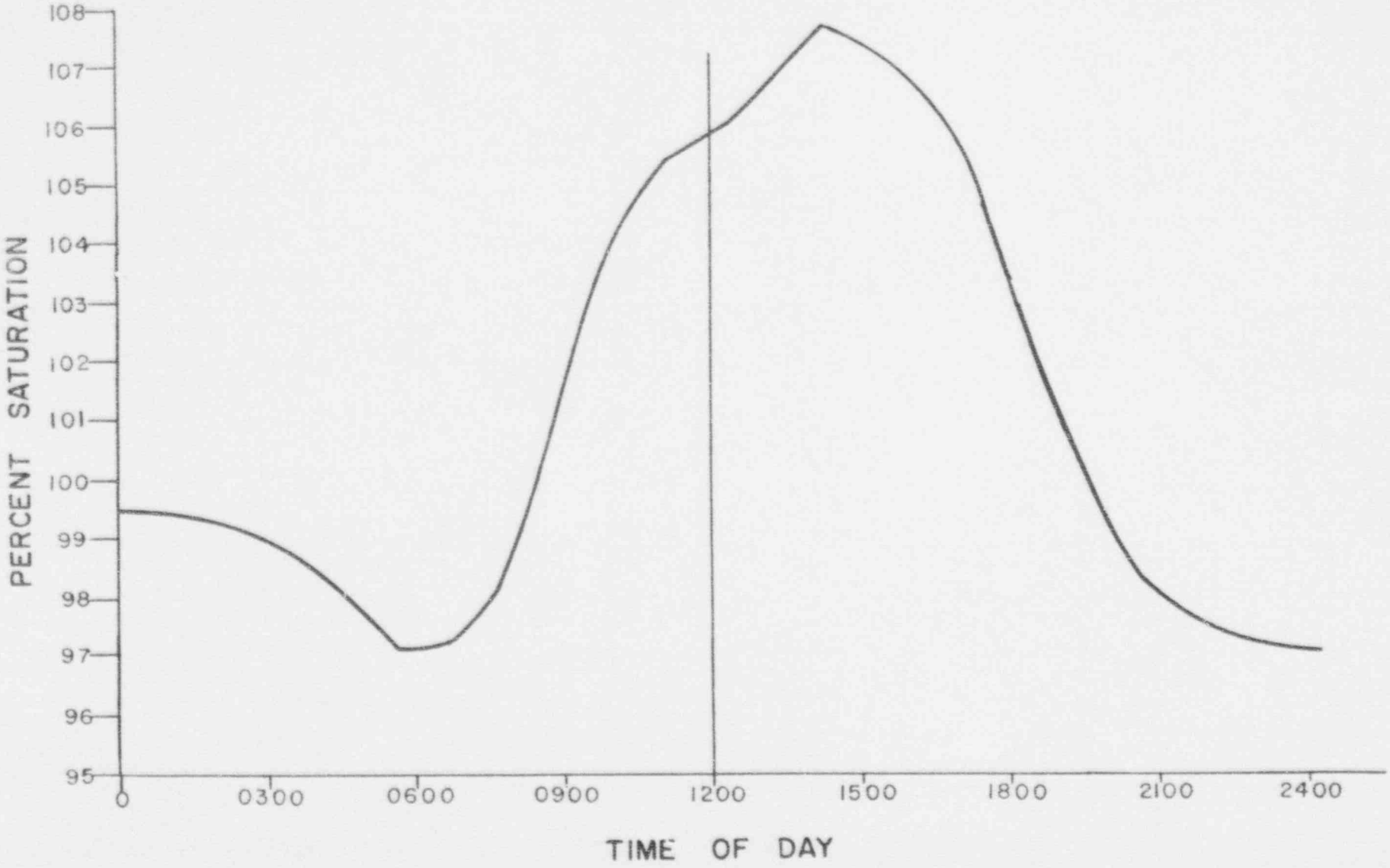

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FIGURE 3.7.3 PERCENT SATURATION OF DISSOLVED OXYGEN AT TRANSECT D IN BROAD RIVER, 24 FEBRUARY 1973.

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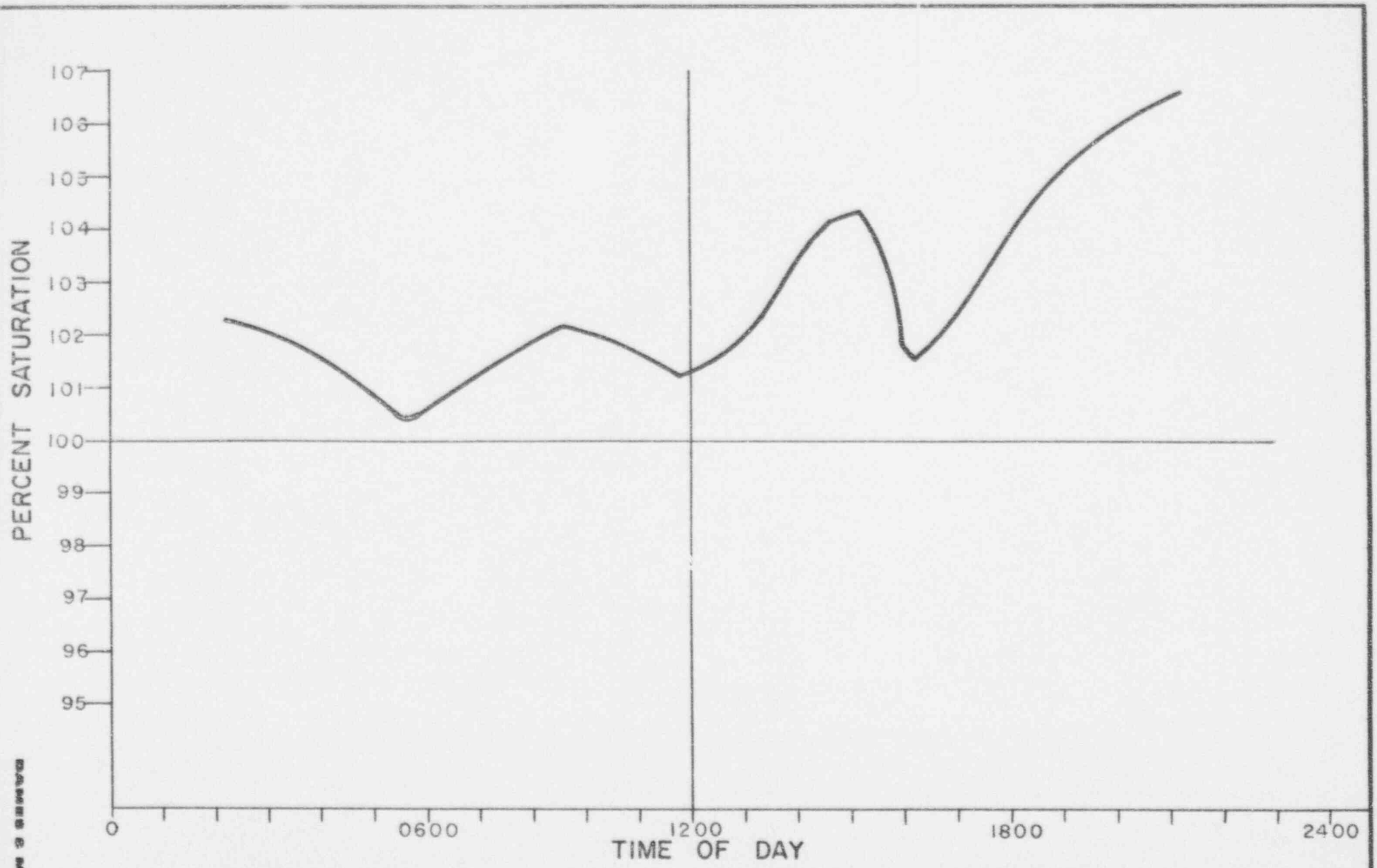

FIGURE 3.7.4 PERCENT SATURATION OF DISSOLVED OXYGEN AT TRANSECT D IN BROAD RIVER, 16 MAY 1973.

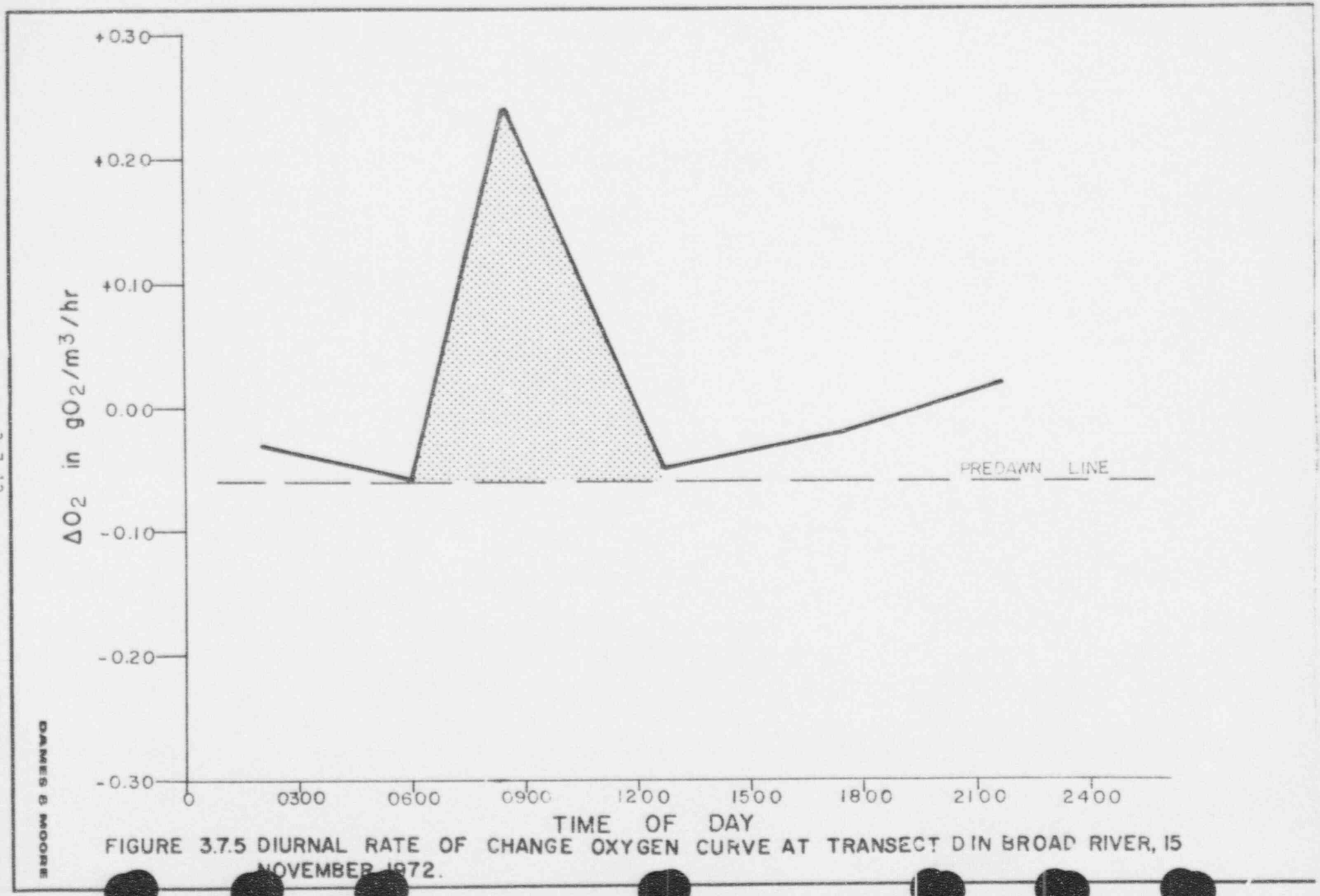

FIGURE 3.7.5 DIURNAL RATE OF CHANGE OXYGEN CURVE AT TRANSECT D IN BROAD RIVER, 15 NOVEMBER 1972.

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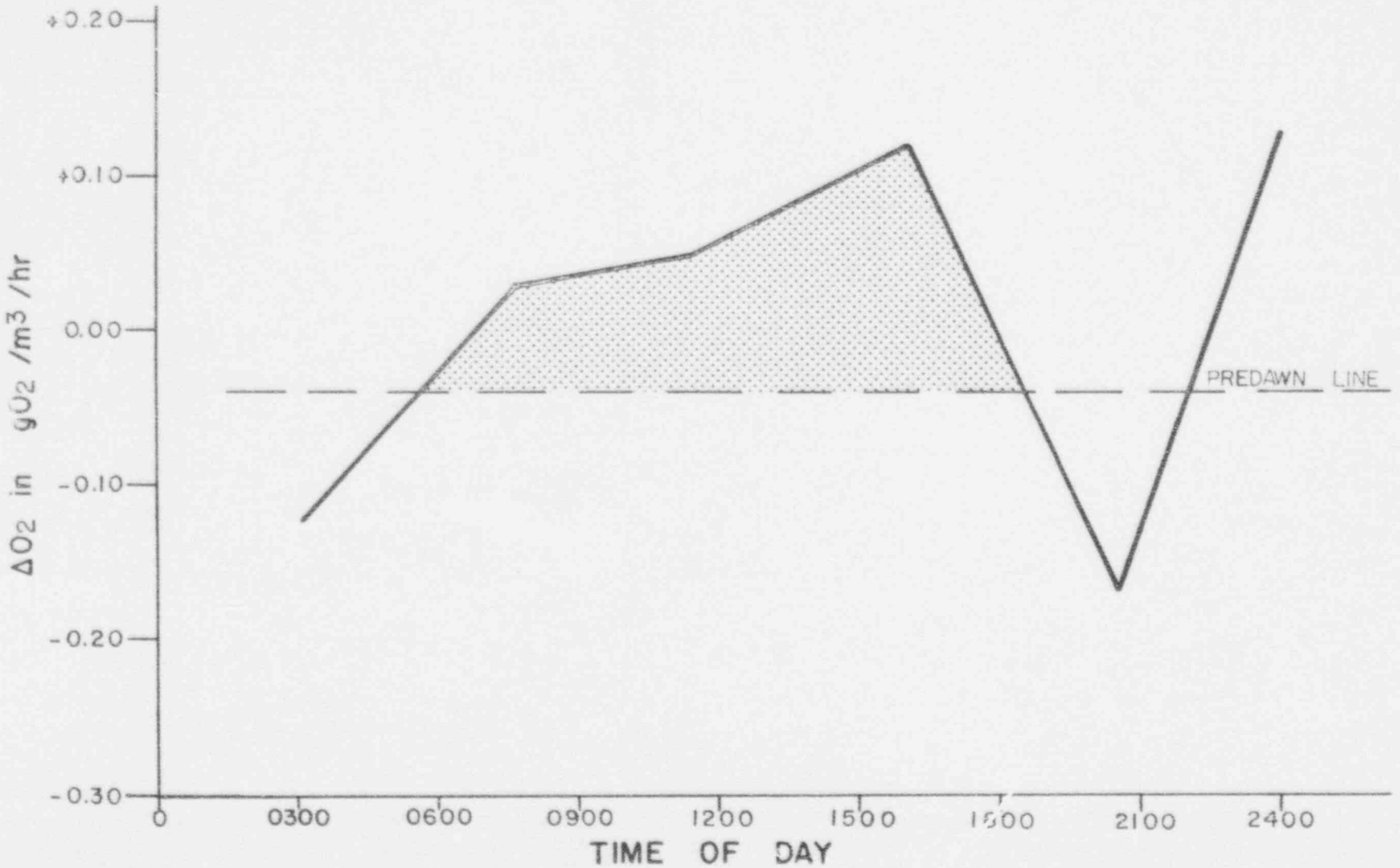

FIGURE 3.7.6 DIURNAL RATE OF CHANGE OXYGEN CURVE IN FREES CREEK, 15 NOVEMBER 1972.

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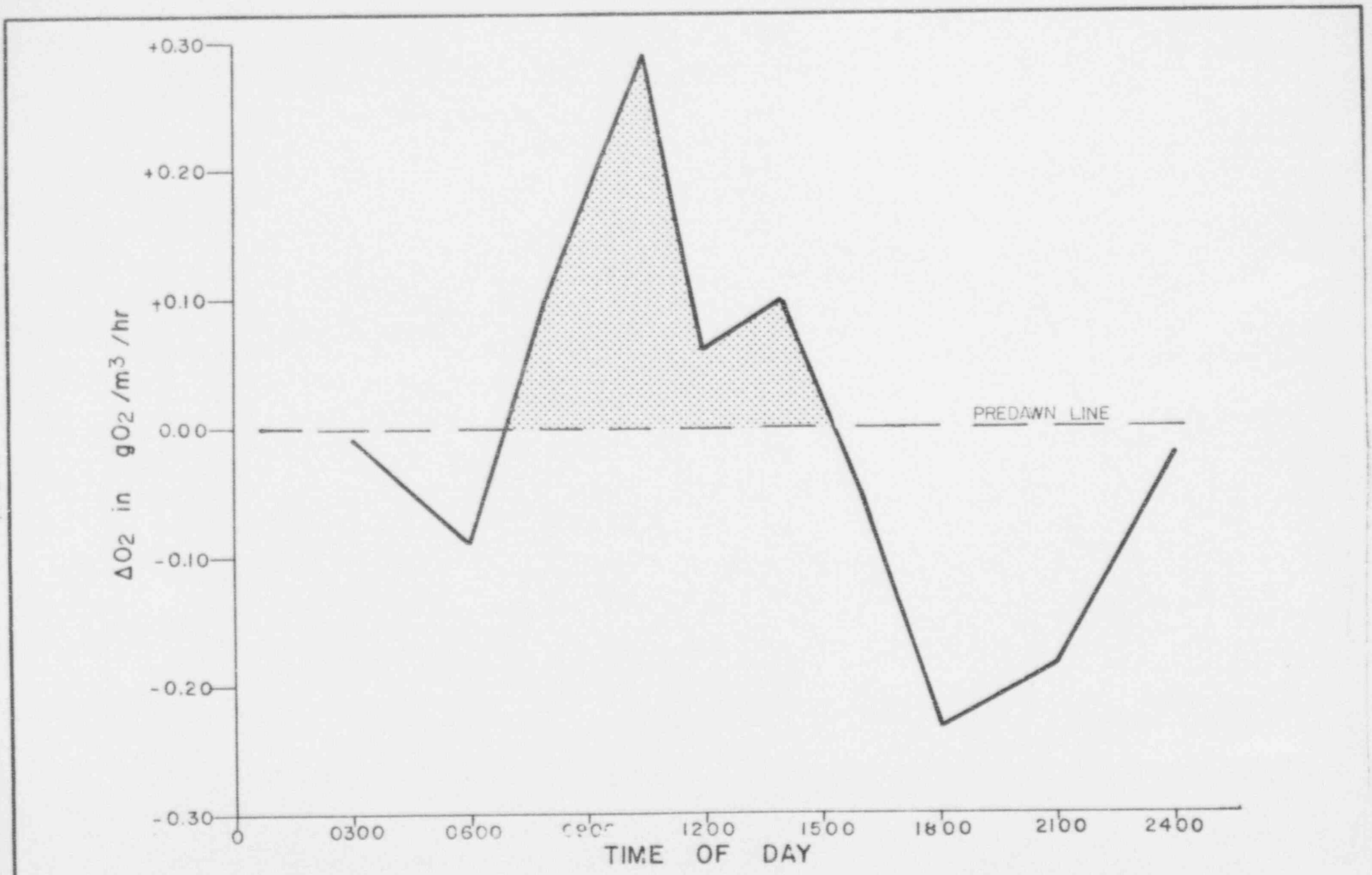

FIGURE [illegible] DIURNAL RATE OF CHANGE OXYGEN CURVE AT TRANSECT D IN BROAD RIVER, 24 FEBRUARY 1973

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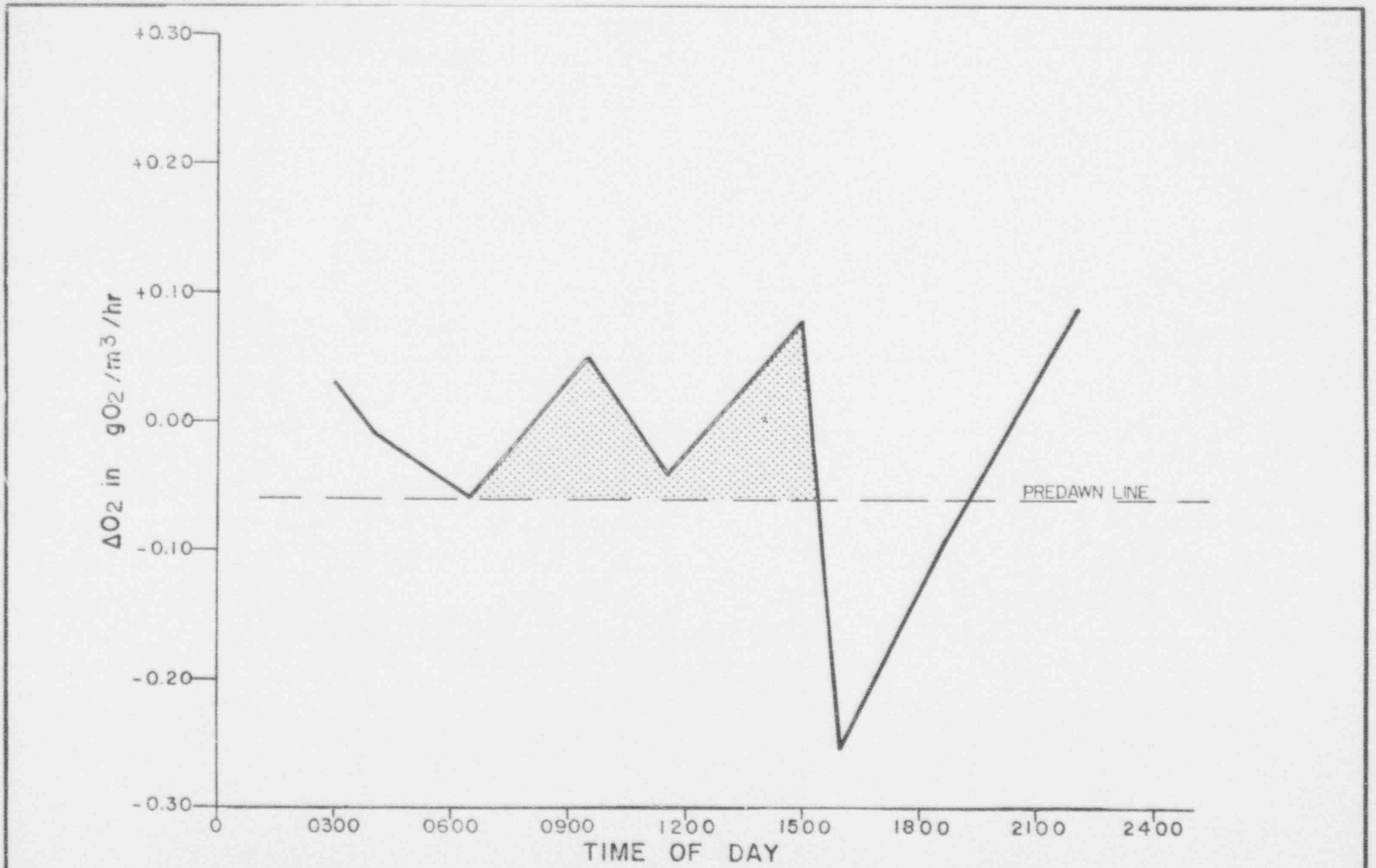

FIGURE 3.7.3 DIURNAL RATE OF CHANGE OXYGEN CURVE AT TRANSECT D IN BROAD RIVER, 16 MAY 1973.

May 1973. It must be emphasized that the single station curve assumes that the water passing a given point has had the same diurnal history in respect to oxygen changes as that preceding it. It is highly probable that this assumption is not valid at Transect D in the Broad River because of its variable levels of discharge and stream velocity.

The diurnal curve at Frees Creek on 15 November 1972 shows a more typical pattern and it is reasonable that the diurnal oxygen method is applicable to this station. Estimates at this site exceeded values from Transect D, although gross production was low for both sites. Highly productive systems may approach 60 g O_2/m^2/day (Odum 1956). Productivity rates in g O_2/m^2/day are shown in Table 3.7.4 and all were less than 5 g O_2/m^2/day. The metabolic rates reported in this study are similar to values reported in North Carolina (Hoskin 1959).

3.7.4 SUMMARY

Single station diurnal curve gross production estimates were determined for Transect D on the Broad River and Frees Creek. Both systems exhibited low primary productivity results.

The activities of the hydroelectric plant will probably influence estimates of production rates at Transect D because of variable discharge rates. Alkalinities of 15 to 20 mg/liter were too low to obtain significant carbon dioxide changes throughout a diurnal period for reliable productivity estimates.

Table 3.7.4 Gross production at Transect D and Frees Creek in the Broad River Study Area, 15 November 1972 - 6 May 1973.

Date	Gross Production ($g\ O_2/m^2/day$)
TRANSECT D	
15 November 1972	3.94
24 February 1973	3.92
16 May 1973	2.56
FREES CREEK	
15 November 1973	4.57

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TABLE OF CONTENTS

Section	Title	Page
4.0	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION	4.0-1
4.1	SITE PREPARATION AND PLANT CONSTRUCTION	4.1-1
4.1.1	Effects on Terrestrial Ecology	4.1-1
4.1.2	Effects on Aquatic Ecology	4.1-5
4.1.2.1	Plankton	4.1-6
4.1.2.2	Vascular Hydrophytes	4.1-7
4.1.2.3	Benthic Macroinvertebrates	4.1-7
4.1.2.4	Fish	4.1-8
4.1.3	Impacts on Regional Historic, Scenic, Cultural, and Natural Features	4.1-9
4.1.4	Impacts on Human Populations	4.1-10
4.1.5	References	4.1-11
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
4.2.1	South Carolina Electric & Gas Company Lines	4.2-1
4.2.2	South Carolina Public Service Authority Lines	4.2-2
4.2.3	References	4.2-4
4.3	RESOURCES COMMITTED	4.3-1
4.3.1	Material Resources	4.3-1
4.3.2	Land and Land-Related Resources	4.3-1
4.3.2.1	Plant Site	4.3-1
4.3.2.2	Monticello Reservoir	4.3-2
4.3.2.3	Transmission Lines and Related Facilities	4.3-3

3

LIST OF TABLES

Table	Title	Page
4.1-1	Compilation of Lands Affected by Site Preparation and Plant Construction by Dominant Vegetation Type	4.1-13
4.1-2	Estimated Land Use After Plant Start-Up	4.1-13
4.2-1	Transmission Line Land Use	4.2-5
4.3-1	Numerical Estimates of Material Resource Commitments for the Virgil C. Summer Nuclear Station	4.3-4

3

LIST OF FIGURES

Figure	Title
4.1-1	Historic, Scenic and Cultural Features in Site Vicinity

4.0 AQUATIC ECOLOGY OF THE BROAD RIVER STUDY AREA

The Broad River in the Study Area is characterized by having a high silt load, moderately high dissolved oxygen levels, low dissolved solids, and low buffering capacity. Parr Reservoir, being narrow and shallow, has a relatively high flow rate and a low storage ratio resulting in the main portion of the reservoir having more lotic characteristics than lentic. In the Cannons and Frees Creek arms, more lentic conditions prevail. The abundance of aquatic organisms appears to vary between reservoir areas. Phytoplankton production appeared to be greatest in the more lentic areas while benthic macroinvertebrate biomass was greatest in the lotic areas near the dam.

In the Broad River Study Area, as with many similar river systems, euplanktonic diatom species are numerically the dominant phytoplankton. Densities of net phytoplankton were always low and population levels were observed to fluctuate greatly throughout the study period.

Nannoplanktonic[1] algae are often important in turbid riverine reservoirs and can comprise the greatest portion of the total volume of planktonic algae (Bensen and Cowell 1967). The contribution of these small plankters to the primary productivity of the Broad River System is undoubtedly significant, as the total number of species was approximately 50 percent greater than the number of net phytoplankton species.

Nutrients are probably not limiting to primary productivity, even though phosphorus was measured in trace amounts. Turbidity, suggested as being the major limiting factor in primary productivity for most river systems

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[1] Very minute plankton not retained in a No. 25 silk bolting cloth plankton net (mesh, 0.03 to 0.04 mm).

(Williams 1965; 1966), is the primary factor limiting autotrophic production in the Broad River. As a consequence, phytoplankton contributes only small amounts to the productivity of the Broad River. Most rivers are in fact, net consumers of organic matter, most of which is provided from allochthonous materials washed in from the surrounding watershed (Hynes 1969). It is this allochthonous organic material that is believed to provide a large portion of the energy requirements for the Broad River biota. The presence of large amounts of partially degraded organic plant materials is believed to account for the frequently observed increases in the chemical oxygen demand (COD) of the water while biological oxygen demand (BOD) remains moderately low. Some nutrients may also be introduced into the system via upstream pollution. This is suggested by periodically high levels of BOD and the presence of some industrial contaminants in the bottom sediments.

The composition of net zooplankton of the study area is similar to many major river systems, in that it is numerically dominated by rotifers in characteristically low numbers for turbid rivers. Four of the six most frequently collected rotifer species are considered omnivores and ingest organic particles of appropriate size (Pennak 1953). Detritus is an important food source for these forms. In a similar southern Piedmont stream, primary consumer organisms were found to derive as much as 66 percent of their energy from allochthonous organic matter, consisting largely of leaf material (Nelson and Scott 1962). Other common genera in the study area, Asplanchna and Trichocera are considered predators on small metazoa. Copepods and cladocerns were present in small numbers.

The community of benthic macroinvertebrates is characterized by having relatively low diversity but high biomass in some portions of the reservoir and, in general, indicates moderate organic enrichment. The

Asiatic clam, Corbicula malinensis, has only recently invaded the study area and is now found in high densities in the reservoir. These pelecypods appear to serve as an important food source to the redear sunfish and possibly other sunfish. The burrowing mayfly, Hexagenia limbata, occurs throughout the system and contributes significantly to the benthic invertebrate biomass. These mayflies are known to be detritophages in their aquatic stages. Other ephemeropterans as well as dipterans and tubificids are common in the study area and serve as important food sources to several fishes.

Submergent vascular hydrophytes were found mainly in protected areas near the dam. The predominant emergents were found throughout the reservoir although their abundance was usually low. The paucity of submergent forms in the protected arms of the reservoir is undoubtedly due to the high turbidity and fluctuating water levels.

At first observation, the lack of submergent hydrophytes in the protected areas would appear to limit habitat diversity. However, qualitative littoral zone sampling indicated that the diversity of littoral zone invertebrate life was over four times greater than that of the profundal benthic invertebrates. A greater diversity of habitats formed by aquatic vegetation, fallen and submerged trees, and quiet back waters accounts for the great difference in species composition between littoral and profundal areas.

The fishes of the study area are represented by an diverse assemblage of at least 41 species, dominated numerically by the bluegill sunfish, an important sport and forage species. In fact, four of the five most numerically abundant fishes are considered sport fishes. Gizzard shad, a non-sport species, is an important primary consumer and forage species which ranks second in numerical abundance. In terms of biomass, standing crop data suggest that bluegill sunfish, gizzard shad, redear

sunfish, and largemouth bass predominate. The composition of fishes in the study area contrasts with other turbid reservoir systems where carp, river carpsucker, and white crappie predominate (Walburg 1964; Gasaway 1970).

The low numbers of carp and carpsucker in the study area may be due in part to high levels of inter-specific competition, especially with the bluegill sunfish, which are notorious predators upon the eggs and fry of other species. The predominance of nest building centrarchids is especially important when considering any future modification of the reservoir environment.

The occurrence of gizzard shad as the second most abundant species attests to its importance in the trophic structure of the aquatic community. Gizzard shad are known to be the most important fish forage organism in warm water reservoirs (Miller 1960). As a forage base, gizzard shad in the study area are utilized mainly by largemouth bass, white and black crappies, catfish, and gar. Gizzard shad are important additionally, as they are believed to directly utilize allochthonous organic detrital material as well as plankton as a food source.

In summary, the Broad River system in the study area supports a moderately diverse assemblage of aquatic organisms whose primary consumers derive their major energy from allochthonous organic material.

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5.0 TERRESTRIAL SURVEY

5.1 DESCRIPTION OF SAMPLING STATIONS

The objectives of the terrestrial survey in the project area were: (1) to inventory birds, mammals, insects, and vegetation of the environs; (2) to provide indices of abundance of these species; and (3) to determine the role of the animals in the ecosystem of the Broad River Study Area.

5.1.1 STUDY SITES

Study Site 1 is approximately 2.4 km (1.5 miles) south of the town of Monticello (map, back cover). This study site was subdivided into three subunits: 1A represents second growth loblolly pine which best typify vegetation of the Broad River Study Area. Site 1B is predominately deciduous with some loblolly pine. Study Sites 1A and 1B will be flooded by the proposed Monticello Impoundment. Site 1C is predominately loblolly pine with deciduous trees occurring on areas of low elevation and will not be flooded by the impoundment. Mammal studies were conducted on Sites 1A and 1B, avian studies are being conducted on Sites 1B and 1C, and vegetation analyses were conducted on Study Sites 1A and 1B.

Specific location instructions are as follows: beginning at Keller's Grocery on Route 125 between Monticello and Jenkinsville, go north 0.5 km (0.3 miles) and turn left (west) on the first road. Study Site 1C is represented by a strip between 40 m (131 ft) and 180 m (591 ft) along this road. Study Site 1A is a total of 1.1 km (0.7 miles) and is located on the left side of the road. Study Site 1B is 1.1 km (0.7 miles) west and 120 m (394 ft) south to the center of the trap grid. The trapline on Site 1A is oriented north-south at right angles to the road with trapping stations marked by wooden stakes numbered 1 through 20.

The census of birds was conducted on Site 1C along a compass

heading of 200°. The census at Site 1B occurred along a compass heading of 140° to the second creek; a westward direction was taken along the creek for approximately 0.96 km (0.60 mile).

Study Site 2 is approximately 3.2 km (2 miles) west and 0.8 km (0.5 mile) south of Monticello. This area has been clear-cut and replanted to loblolly pine and represents an early seral stage of succession. This area will not be flooded by the proposed impoundment. Vegetation, mammals, and birds were all studied at this site. Specific location instructions are as follows: from the junction of Route 257 and Route 99, go south 3.5 km (2.2 miles) on Route 257, turn left (south) on a dirt road toward the proposed dam site, go 0.3 km (0.2 mile) from Route 257 staying left at the fork. A stake marked 2S on the right side of the road marks the location of the small mammal trapline which begins approximately 6.1 m (20 ft) to the right of the road and follows a compass heading of 120°. Avian censuses began on the left (north) side of the road 100 m (328 ft) east of Route 257. The census occurred along a compass heading of 110° for 550 m (1805 ft) and returned paralleling the south side of the road for 490 m (1608 ft).

Study Site 3 is on the east side of the present Parr Reservoir near the Frees Creek embayment. Study Site 3 was subdivided into two subunits: 3A represented a mixed deciduous-pine forest in an area that will be flooded by the proposed impoundment. Deciduous trees, though not present in pure stands, are most abundant in low areas near the water course; 3B represented a mixed deciduous-pine forest on the north side of Frees Creek that will not be flooded, however, it may be affected by construction activities. Vegetation and small mammal studies were conducted at Study Site 3A. On Site 3B avian censuses have been conducted since May 1973. The small mammal trapline at Study Site 3A began approximately 40 m (131 ft) from the railroad trestle that crosses

Frees Creek and ran parallel to the creek. The avian survey route of Site 3A is located on the northeast side of the Frees Creek embayment, beginning approximately 200 m (656 ft) north of the embayment and paralleling the transmission line corridor.

Study Site 4 is located 2.7 km (1.7 miles) north of the existing power plant at Parr, on the east side of the road leading to the proposed nuclear station site. This site represents a stand of pine that will not be flooded by the proposed project. The vegetation has been relatively undisturbed by man and represents a later succession stage than Study Site 1. Pines were selectively cut for pulpwood on this site during March 1972. The resulting open canopy has allowed an increase in shrubs and herbaceous vegetation.

Specific location instructions are as follows: beginning at Monticello, travel approximately 6.4 km (4 miles) south on Route 215 to Route 311, a paved road running east-west. Turn west (right) for 2.5 km (1.6 miles) and turn right on an unimproved road and go 1.6 km (1.0 mile) to a stake on the left marked 4S. The trapline runs at right angles to the road.

Study Site 5 is located approximately 7.6 km (4.8 miles) south of Monticello on the south side of the road leading to the proposed Virgil C. Summer Nuclear Station. The site is a loblolly pine plantation of relatively even aged trees. This site was chosen because it represented an intermediate age stand of pine, a middle and lower story vegetation was absent, it was close to the construction zone, and the site will not be flooded. Bird censuses on this study site were intiated during March 1973.

Study Site 6 is located 2.5 km (1.6 miles) no thwest of Monticello on Route 99. Bird censuses have been conducted in the grassland on the south side of the road since March 1973. The vegetation is typical of abandoned pasture land consisting of dense growth of annual and perennial vegetation. The site will be

flooded by the proposed Monticello Impoundment.

Study Site 7 is located 5.4 km (3.4 miles) north of Monticello, 0.4 km (0.3 mile) west of Route 215 on Route 347. Bird censuses, parallel to Route 347, have been conducted on this site of predominately loblolly pine since March 1973. A small area of mixed deciduous-conifer forest was included as part of the study site. This site will not be flooded by the proposed Monticello Impoundment. Pine was selectively removed from this site between the May and August 1973 avian survey periods.

Study site adjacent to Aquatic Station G is located on upper Frees Creek north of the Route 99 bridge. The upper limits of the site was 160 m (512 ft) north of the bridge. The vegetation is predominately deciduous trees and a lower story of dense shrubs and herbaceous vegetation. A live-trap grid for medium sized mammals was located at this site during the November 1972 sampling period. This site would be flooded by the proposed Monticello Impoundment.

5.1.2 WILDLIFE SURVEY ROUTES

Three wildlife auto survey routes were established to obtain an index of bird species and abundance (see map, back cover). Identification was made by sightings and recognizing characteristic bird songs.

Wildlife Survey Route A, during the 1971, 1972, and 1973 sampling periods, began at the junction of Highways 215 and 347 and followed Highway 347 to Highway 99, proceeded east on Highway 99 and then followed Highway 215 south to the conclusion of the route. Wildlife Survey Route A was chosen because it could be followed without back-tracking (no dead-end roads) and it sampled the periphery as well as crossed the proposed Monticello Impoundment.

Survey Route B proceeded in a southerly direction for 3.2 km (2 miles) along Highway 257 from a point 0.3 km (0.2 mile) from the junction of

Highway 99 and 257. This survey route, initiated in January 1972, was established to provide a continuous survey during the construction of the Monticello Impoundment.

In March 1973, Route C was initiated which covered a distance of 4.8 km (3 miles). It then began 161 m (0.1 mile) north of the junction of Highways 215 and 99 and proceeded along Highway 215 to Highway 347. It is anticipated that travel along Highway 99 will be restricted in the area of Frees Creek during construction. When this occurs the Wildlife Survey Route will begin at Route C, continue along Route A following Highway 347 to Highway 257, and finish along Route B.

Survey Route D (control) began on Highway 99, 0.3 km (0.2 mile) north of its junction with Highway 347, proceeded north on Highway 99, west on Highway 34, and finally southeast on Highway 28. Highway 28 was followed to Cannons Creek where the survey was concluded. This survey route, initiated in March 1973, will provide a comparative index of the avian abundance and diversity in an area anticipated to be unaffected by the impoundment or construction activities which may influence portions of Wildlife Survey Routes A and B.

5.1.3 WATERFOWL SURVEY

Waterfowl and shorebird counts were made from a boat on the Broad River and its tributaries. This survey was initiated in March 1972 to: (1) obtain an index of seasonal abundance of waterfowl in the area to be affected by Parr Reservoir; (2) obtain an index of waterfowl in each major tributary; and (3) evaluate the effect of construction and operation of the facilities on this resource.

The survey route starts at the public boat launch in Blair, South Carolina, extends 3.5 km (2.2 miles) north to the southern end of Henderson's Island. The route proceeds southward to the mouth of the Enoree River and

continues up river for approximately 5 km (3 miles). The survey then returns to the Broad River and continues south in the direction of Parr. Frees Creek, Hellers Creek, and Cannons Creek were examined by boat as far up each tributary as possible. Ponds, floodings, and river inlets along either side of the Broad River and its tributaries were checked for water birds. The route concluded after a survey of Parr Reservoir.

5.2 SOILS

5.2.1 INTRODUCTION

Previous surveys in the Broad River area of Fairfield County, South Carolina, for the South Carolina Electric and Gas Company, included detailed information relative to vegetation and fauna but included only a general description of soils on the site. The 1972 fall survey was expanded to obtain a more detailed examination of the soils, including an analysis to establish soil nutrient content, the presence of heavy metals and the presence of residual chlorinated pesticides. This survey was to develop information for a threefold purpose: (1) to establish base information on soils that will be flooded upon completion of Monticello Impoundment, (2) to examine the relationship of soils to plant communities, and (3) to determine recommendations to produce a wildlife habitat and establish upland recreational areas.

A majority of the wooded areas is a mixture of pine and hardwoods. Piedmont soils are naturally acidic with a pH of 5.0 to 5.5 which favors growth of pine as hardwoods grow best on soils with a pH of 6.5. However, cropping management of these areas has established a pine-hardwood mixture over the entire project area. Where areas have been denuded of trees, native grasses, forbs and legumes have become established indicating these soils will support a wide diversity of vegetation.

5.2.2 METHODS AND MATERIALS

Only generalized soil information was available for the site under study (Craddock and Ellerbe 1966) and this was used to determine soil associations for each sampling area. Detailed profile descriptions to determine soil class were taken from those reported for adjacent Newberry

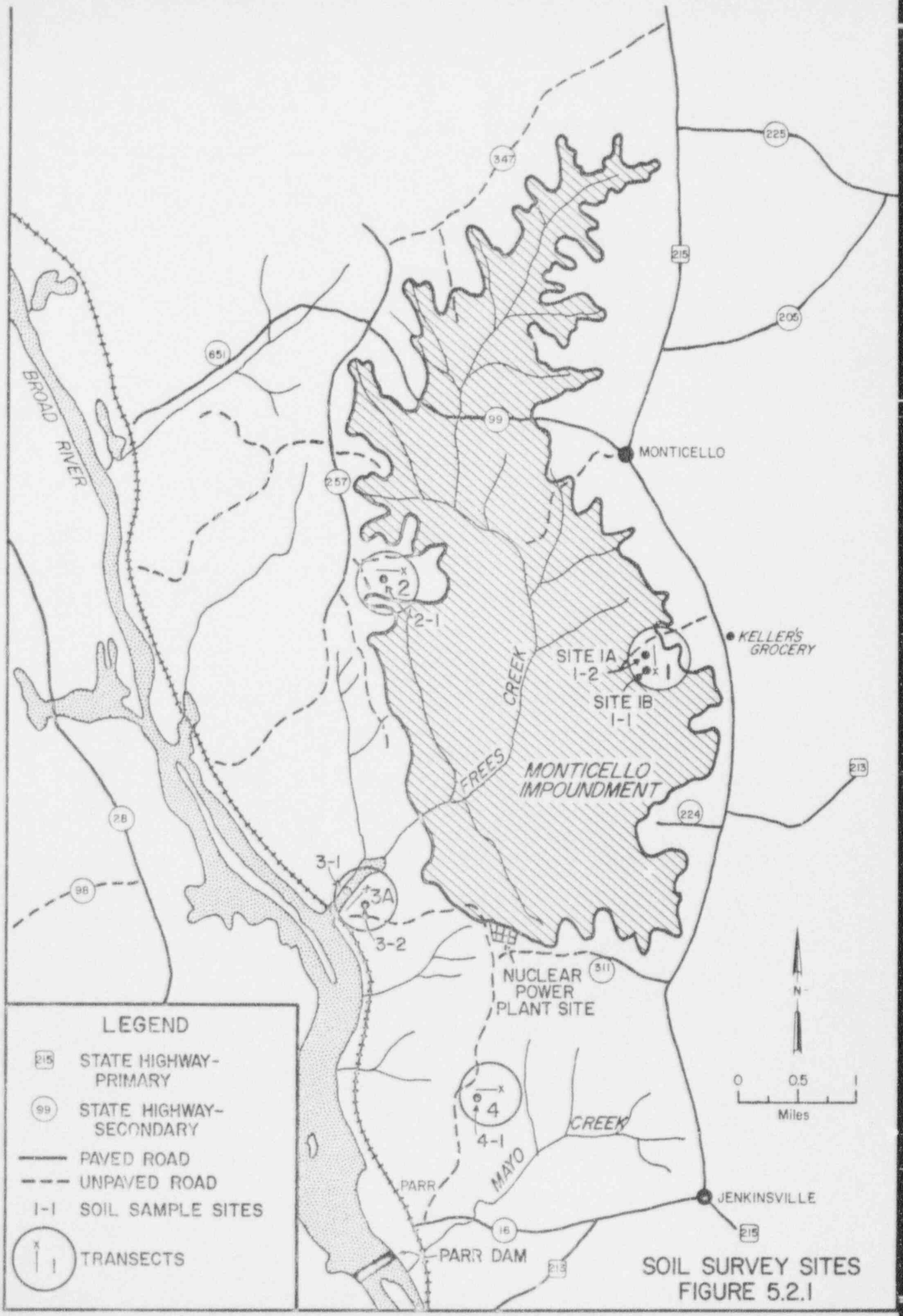
County (Camp et al. 1960).

Soil samples were collected from an area within previously established survey sites representing the dominant combination of vegetation and soil type for that site (Figure 5.2.1). In Study Site 1 there were two rather distinct types of woody vegetation and, therefore, two sub-areas were established; pine were the major trees in Site 1A while Site 1B had a dominance of hardwoods with a few pine. Site 2 was steep and had been cleared of trees but the area had been replanted to pine and growth of the young trees was quite good. Subsequent to removal of trees from Site 2, natural revegetation consisted of grasses, forbs and vines. Site 3A was primarily hardwoods with some pine. Soil sample 3-1 was located near the mouth of Frees Creek and will be flooded in the future. Sample 3-2 was taken from an area that is to remain as upland after completion of Monticello Impoundment. Site 4 was mixed pine-hardwoods and timber removal was in progress so that the final proportion of pine to hardwoods cannot be estimated at this time, however, it appeared pine was being removed in preference to hardwoods.

To observe and sample an undisturbed soil profile, a fresh pit was dug at each site. A field description of the vertical section, or soil profile, included variation in soil color, structure and texture with a notation of the depth where changes occurred. This field description was used to determine a soil class (Camp et al. 1960). Also, variations in the soil profile were determined where individual soil profile samples would be taken.

Litter cover, especially in the wooded areas, was removed to expose a firm soil surface before digging a pit and only the decomposed litter that had become incorporated into the firm uppermost portion of soil was considered part of the profile.

Samples were obtained by cutting a vertical section from the



SOIL SURVEY SITES
FIGURE 5.2.1

profile within limits of an observed soil variation. Two samples were collected from each profile. One sample was collected in plastic bags and transported to a field house where it was mixed and an aliquot was air dried, put into a soil sample box and taken to the Fairfield County Extension Agent at Winnsboro who forwarded them to Clemson University Soil Testing Laboratory at Clemson, South Carolina. Soil test results were returned to the Fairfield County Agent who made fertilizer recommendations for three conditions that may occur within the land site of South Carolina Electric & Gas Company:

1. For stands of pine and mixed hardwoods.
2. To establish and maintain native weed, grass and legume (lespedeza) species for improved wildlife habitat in areas that have been cleared or have had selective thinning of trees.
3. To establish and maintain common bermuda grass in recreational areas.

A second soil sample was placed in a glass jar that had previously been washed with petroleum ether, rinsed with acetone and air dried. The jar opening was covered with aluminum foil before closing with a screw lid. This sample was air dried and sent to the Environmental Science and Engineering Corporation at Mt. Juliet, Tennessee for analysis of heavy metals and residual chlorinated hydrocarbon pesticides. A hot 6 N hydrochloric acid extraction was used to remove heavy metals from the soil.

5.2.3 FINDINGS

5.2.3.1 Soil Nutrient Status

The general fertility level of all soils throughout the project site was about the same although two had some variation in pH; one was 4.8 and another was 6.1 (Table 5.2.1). All soils were low in

Table 5.2.1 Soil sample identification and soil test results.

Sample Number	Survey Site	Soil Sample	Profile Depth (cm)	Future Disposition	pH	Soil Test Results* P	K	Ca	Mg
1	1A	1-2	0-12	Flooded	5.4	L+	M-	L+	M+
2	1A	1-2	12-35	Flooded	5.6	L+	L+	M	H
3	1B	1-1	0-3	Flooded	6.1	L+	H+	VH	H
4	1B	1-1	3-45	Flooded	5.6	L+	M	M	H
5	2	2-1	0-8	Upland	5.4	L+	H-	H-	H
6	2	2-1	8-40	Upland	5.6	L+	M	M	H
7	3A	3-2	0-30	Upland	5.1	L	M	L	H
8	3A	3-2	30-50	Upland	5.2	L+	H-	L-	H
9	3A	3-1	0-7	Flooded	5.5	L	H	VH	H
10	3A	3-1	7-21	Flooded	5.2	L-	M-	M+	H
11	3A	3-1	21-42	Flooded	5.3	L-	L+	M-	H
12	4	4-1	0-20	Upland	4.8	L	L+	L-	M-
13	4	4-1	20-42	Upland	5.1	L	L-	L-	M

*L-low, M-medium, H-high and VH-very high. (See Appendix A for relative level of plant nutrients).

phosphorus but had a relatively high level of magnesium (Table 5.2.2). Their calcium content varied from low to very high and there was some variation in potassium levels. The amount of lime recommended (Table 5.2.3) is the amount necessary to bring the soil pH to 6.5. None of the soil nutrients were a limiting factor for plant survival although an application of fertilizer will produce increased plant growth. An estimated productivity of soils under average and good management with the adaptability of bermuda grass and bicolor lespedeza to soil types is presented in Table 5.2.4. It is obvious that good management practices can increase production, and in most cases by about 100 percent. Except for bicolor lespedeza on Appling soil, the adaptability of both bermuda grass and bicolor lespedeza to various soil types is good.

5.2.3.2 Residual Pesticides in the Soil

The concentration of BHC, DDE and Aldrin was very low and generally below the minimum detection limits of 0.005 ppm (Table 5.2.5). Dieldrin, DDD, Hexachloro Benzene, Lindane, Heptachlor, Heptachlor Epoxide, Toxaphene, Technical Chlordane and Mirex were below detectable limits, if present at all.

Concentration of DDT in the topsoil of Study Site 1B, soil sample 1-1, Site 2, soil sample 2-1 and Site 3A, soil sample 3-1 was 0.016, 0.017 and 0.010 ppm respectively (Table 5.2.5).

5.2.3.3 Heavy Metal Concentration in the Soil

Boron had the highest concentration of all the heavy metals determined (Table 5.2.6). The concentration of copper, zinc, lead and chromium was approximately equal and in low concentration. Both arsenic and mercury have a very low concentration in the soil. The lithium concentration had considerable variability (Table 5.2.6). Of the six soil sample sites, four had the greatest lithium concentration in the topsoil. The topsoil of

Table 5.2.2 Relative level of plant nutrients from soil test results.

Nutrient Level	Nutrient Concentration			
	Phosphorus (ppm)	Potassium (ppm)	Calcium (ppm)	Magnesium (ppm)
Low	0-13	0-35	0-200	<25
Medium	14-30	36-78	201-400	26-50
High	31-50	79-117	401-1000	>50
Very High	>50	>117	>1000	

Table 5.2.3 Fertilizer recommendations for pine and hardwoods, wildlife habitats and bermuda grass for recreational areas.

Soil Sample Number	Fertilizer Recommendations-Pounds per acre* Pine and Hardwoods				Wildlife and Recreational Areas			
	Lime	N	P	K	Lime	N	P	K
1	2500	0	0	0	2500	60-180	100-200	20-40
2	2400	0	0	0	2400	60-180	100-200	80-110
3	1900	0	0	0	1900	60-180	100-200	0-20
4	3300	0	0	0	3300	60-180	100-200	20-40
5	4200	0	0	0	4200	60-180	100-200	0-20
6	3100	0	0	0	3100	60-180	100-200	20-40
7	4000	0	0	0	4000	60-180	100-200	20-40
8	3600	0	0	0	3600	60-180	100-200	0-20
9	4000	0	0	0	4000	60-180	100-200	0-20
10	3200	0	0	0	3200	60-180	100-200	20-40
11	3100	0	0	0	3100	60-180	100-200	80-110
12	5300	0	0	0	5300	60-180	100-200	80-110
13	4700	0	0	0	4700	60-180	100-200	80-110

*Expressed as elemental P and K, ($P \times 2.27 = P_2O_5$; $K \times 1.20 = K_2O$).

Table 5.2.4 Estimated productivity of soils under two levels of management and the adaptability of bermuda grass and bicolor lespedeza to soil types.

Survey Site	Soil Sample	Soil Type	Annual Lespedeza* Tons per acre A	Annual Lespedeza* Tons per acre B	Annual Lespedeza* % Increase	Pasture* Cow-Acre-Days** A	Pasture* Cow-Acre-Days** B	Pasture* % Increase	Adaptability Bermuda Grass	Adaptability Bicolor Lespedeza
1A	1-2	Cecil sandy loam gently sloping phase	0.5	1.2	140	125	250	100	Very Good	Very Good
1B	1-1	Appling sandy loan, eroded strongly sloping phase	-	-	-	60	125	108	Good	Fair
2	2-1	Cecil clay loan, severely eroded sloping phase	0.3	0.6	100	75	125	66	Good	Good
3A	3-2	Cecil sandy loam, eroded moderately steep phase	-	-	-	80	140	75	Very Good	Very Good
3A	3-1	Mecklenburg sandy loan, eroded sloping phase	0.5	1.0	100	100	200	100	Good	Good
4	4-1	Cecil sandy loam, eroded sloping phase	0.4	1.0	150	110	225	105	Very Good	Very Good

*A-Average Management; B-Good Management

**Cow-Acre-Days = Number of days one acre will support one cow, steer or horse; or five hogs; or seven sheep or goats without injury to the pasture (Camp et al. 1960).

Table 5.2.5 Concentration of residual pesticides in soil samples from South Carolina Electric & Gas Company project area at Parr, South Carolina.

Survey Site	Soil Sample	Profile Depth (cm)	BHC (ppm)	DDE (ppm)	DDT (ppm)	Estimated PCB (ppm)	Aldrin (ppm)
1A	1-2	0-12	0.075	<0.005	<0.005	0.019	<0.005
1A	1-2	12-35	<0.005	<0.005	<0.005	0.008	0.006
1B	1-1	0-3	<0.005	0.006	0.016	0.018	<0.005
1B	1-1	3-45	<0.005	<0.005	<0.005	0.010	<0.005
2	2-1	0-8	<0.005	0.005	0.017	0.019	<0.005
2	2-1	8-40	<0.005	<0.005	<0.005	0.015	<0.005
3A	3-2	0-30	<0.005	<0.005	<0.005	0.008	0.006
3A	3-2	30-50	<0.005	<0.005	<0.005	0.024	<0.005
3A	3-1	0-7	<0.005	0.007	0.010	0.015	<0.005
3A	3-1	7-21	<0.005	<0.005	<0.005	0.011	<0.005
3A	3-1	21-42	<0.005	<0.005	<0.005	0.011	0.005
4	4-1	0-20	<0.005	<0.005	0.006	0.027	<0.005
4	4-1	0-42	<0.005	<0.005	<0.005	0.022	<0.005

Table 5.2.6 Concentration of heavy metals in soil samples from South Carolina Electric & Gas Company project area at Parr, South Carolina.

Survey Site	Soil Sample	Profile Depth (cm)	Arsenic (ppm)	Copper (ppm)	Zinc (ppm)	Lead (ppm)	Mercury (ppm)	Boron (ppm)	Chromium (ppm)	Lithium (ppm)
1A	1-2	0-12	<0.020	13.70	13.00	7.61	0.008	156	26.1	0.90
1A	1-2	12-35	<0.020	10.70	10.20	7.42	0.038	174	14.4	0.86
1B	1-1	0-3	0.028	5.76	34.00	20.80	0.017	160	25.0	1.26
1B	1-1	3-45	<0.020	7.38	27.10	16.20	0.004	268	15.3	1.54
2	2-1	0-8	0.060	8.16	10.40	20.80	0.004	196	18.6	1.06
2	2-1	8-40	<0.020	8.28	9.21	19.00	0.038	142	16.5	1.00
3A	3-2	0.30	0.040	13.70	14.10	9.21	0.031	102	46.8	0.82
3A	3-2	30-50	0.010	20.60	10.00	6.64	0.013	118	27.8	0.88
3A	3-1	0-7	0.029	20.00	24.20	14.60	0.033	184	31.8	2.12
3A	3-1	7-21	<0.020	18.40	22.10	10.20	0.013	180	43.2	1.48
3A	3-1	21-42	<0.020	16.50	10.30	7.23	0.008	122	54.5	0.86
4	4-1	0-20	<0.020	4.98	7.02	11.80	0.054	200	27.6	1.02
4	4-1	20-42	<0.020	5.22	4.03	12.40	0.125	130	21.9	0.56

sample 3-1 from Site 3A had the highest lithium concentration of all soils and there was a decrease in concentration with an increase in soil profile depth.

5.2.4 DISCUSSION

Soils in Fairfield County have severe erosion characteristics and most, if not all, topsoil has been washed away exposing the subsoil. Soil profile observations during the 1972 fall survey revealed that where forests have been established and undisturbed for several years, decaying litter has become incorporated into the uppermost soil layer. There are varying degrees of staining which extends into lower levels of the soil as streaks or there may be a general fading of the dark color. Where weathering has occurred for several years with little surface erosion, clay has moved down from the soil surface resulting in a sandy soil overlaying a much more dense lower layer that is very friable. However, there appears to have been sufficient outside influence from logging and general removal of trees that neither the soil nor plant communities have become stabilized under natural conditions.

5.2.4.1 Areas to be Flooded

Seven of the thirteen soil samples were collected from areas to be flooded upon completion of Monticello Impoundment (Table 5.2.1). These seven samples relate the nutrient status of the soils prior to submergence and also help to provide a broad overview of the soil types within the project area.

Upon submergence, the soil fertility is expected to increase through deposition of organic matter, however, because of the general steep slope and consistent fluctuation of the water level, no change in the nutrient status is expected in those soils subject to alternate flooding.

Parts of Monticello Impoundment will be sufficiently large to have waves during periods of strong wind. This may cause some erosion where

wave action is against steep slopes.

5.2.4.2 Upland Areas

Soils in areas that will not be flooded have virtually the same nutrient status as those that will be submerged. This emphasizes the uniform soil conditions that exist over the entire project area.

Soils on the project area are subject to severe erosion and maintenance of a good plant cover is definitely recommended to minimize soil movement. Unless stabilized, excessive soil erosion will fill the water impoundments and shorten their expected time of efficient use.

5.2.4.3 Soil Nutrient Status

The low pH and phosphorus in these soils do not represent favorable conditions for satisfactory growth of legumes. If wildlife habitats are to be developed, application of lime and phosphorus will aid in establishing grasses, pigweed (Amaranthus retroflexus) and lamb's quarter (Chenopodium album) for cover and food sources.

Generally, neither fertilizer nor lime is recommended for wooded areas (Boggs 1972). Hardwoods grow best in a soil with pH 6.0 to 6.5 while pines tend to do better at a pH of 5.5 to 5.9 (Boggs 1972). The uppermost layer of all soils, except in Site 1B, soil sample 1-1, has a soil pH near optimum for growth of pine (Table 5.2.1). To adjust the soil pH for best growth of hardwoods, 2400 to 5300 pounds of lime per acre would be needed (Table 5.2.3). Since the soil in Site 1 will eventually be flooded, no further consideration of soils in this site need be given at this time. However, for growth of hardwoods, any soil with a very high calcium content and a pH of 6.1 need not have 1900 pounds of additional lime applied per acre, although this was suggested by the County Agent (Table 5.2.3). All soils that were sampled have a capacity to respond to good management (Camp et al.

1960) when known deficiences are corrected within practical limits.

5.2.4.4 Native Wildlife

The Piedmont Region of South Carolina consists of habitat types that can support deer, quail, squirrel, fox, rabbit, raccoon and opossum. However, these animals are generally in low abundance in the Broad River area of the South Carolina Electric & Gas project area, especially in pine communities. Most of the pine-hardwood areas are also quite sterile of desirable habitat for cover and source of food. A greater number and diversity of birds was observed in an area previously cleared for a power transmission line where re-vegetation included brambles, honeysuckle, bicolor lespedeza, wild lespedeza and shrubs. This indicates that if the total area of diverse habitat can be increased through soil and plant management, both diversity of wildlife and number of animals would also increase.

5.2.4.5 Residual Pesticides in the Soil

Presence of a detectable level of DDT in the topsoil of samples from Sites 1B, 2 and 3A, soil sample 3-1 (Table 5.2.5), indicates a low level of contamination. The time or reason for applying DDT is not known, however, the concentration is very low and is not expected to be of concern unless additional DDT is applied in this area. The concentration of all other pesticides in the soil is very low and is not expected to present a problem of contamination for existing or proposed impoundments unless materials are applied in the future.

5.2.4.6 Heavy Metal Concentration in the Soil

The boron concentration was the highest of all heavy metals determined and varied from 102 to 268 ppm. The boron concentration in soil as reported by Murtvedt (1972) may range from about 2 to 100 ppm and

generally has a range between 7 and 80 ppm, however, the concentration is reported to vary between 0.1 and 1500 ppm (Bear 1964). The boron concentration found in the South Carolina soils is well within the range of total soil boron reported in the literature, however, boron is not strongly retained by South Carolina soils (Page 1973). The high boron content found in these soils is due to tourmaline, a complex silicate containing boron.

The concentration of boron in plants is very uneven. In the same leaf, necrotic (dead) areas usually contain more than 1500 ppm boron, chlorotic (chlorophyll deficient) areas about 1000 ppm and green (normal) areas vary from 100 to 1000 ppm (Mortvedt 1972). There is considerable variation in plant tolerance to boron. Soy beans accumulate up to 200 ppm boron in the tissue with only slight toxicity symptoms. The yield of sugar beets and sugar content reductions were not noted even when beets were grown in concentrations up to 40 ppm boron and the tissue concentration did not rise above 30 ppm. Boron is not expected to be of concern to the growth of native plants. Toxicity symptoms were not evident at the time of the 1972 fall survey and boron toxicity to plants is most often associated with alkaline soils.

The arsenic content of soils varies from less than 1 to 20 ppm, but may be as high as 80 ppm (Bear 1964). Arsenic concentrations in the Piedmont soil samples (Table 5.2.6) varied from less than 0.02 to 0.06 ppm, hence, the arsenic concentration is very low.

Copper normally varies from less than 10 to 100 ppm (Bear 1964), but generally varies from 10 to 80 ppm in the soil (Mortvedt 1972). The copper concentration of the South Carolina soils varied from 4.98 to 20.60 ppm (Table 5.2.6) which is about normal concentration for mineral soil.

Zinc is reported to vary from 9 to 500 ppm (Bear 1964) and

generally confirmed to vary between 10 and 300 ppm (Mortvedt 1972). The South Carolina soil varied from 4.03 to 34.00 ppm (Table 5.2.6) which is well within the normal soil concentration for zinc.

The lead content of the Piedmont soil (Table 5.2.6) was about average as a normal soil may contain from 2 to 200 ppm, but generally varies from about 20 to 80 ppm (Bear 1964).

Mercury may vary from 10 to 500 ppm with an average of about 100 ppm for U.S. soils (Mortvedt 1972). The soils from South Carolina varied from 4 to 125 ppm (Table 5.2.6).

Chromium varies from 6 to 1000 ppm in soil but in Scotland it reached 3000 ppm in some surface soils derived from Serpentine (Bear 1964). The chromium content of Parr, South Carolina soils varied from 14.4 to 54.5 ppm (Table 5.2.6). The chromium content of the South Carolina soils is relatively low and not expected to be a problem. During the past 15 years, chromium has been added as an element required by animals (Mortvedt 1972).

Lithium in the South Carolina soil (Table 5.2.6) varied from 0.56 to 2.12 ppm which is below the normal expected concentration of 6 to 200 ppm (Bear 1964).

5.2.4.7 Impounding of Water

No adverse effects are expected on soils from impounded water. There may be some change in tree species near the impoundments to species associated with a high water table or periodic flooding, i.e., cottonwood, willow, alder and beech. However, this would only be spotted around the impoundments and constitute only a small percentage of the total wooded area.

There is no indication that a rise in water table associated with the impoundments will cause formation of saline or alkaline conditions to the soil.

5.2.5 SUMMARY

A baseline level for residual pesticides and certain heavy metals has been established for soils that will remain as upland areas and also for some soils that will be flooded.

The nutrient status was virtually the same for all soils that were sampled and the pH was about 5.5 which favors growth of pine more than hardwood.

All the soils that were tested have a capacity to respond to good management when known deficiencies are corrected.

Most of the pine-hardwood areas are quite sterile of desirable wildlife habitat for food and cover. Proper soil and plant management will increase the diversity of vegetation and provide for a greater number and diversity of birds and other wildlife.

The concentration of residual pesticides in the soil is very low. There was an indication of some DDT contamination in surface soils at Sites 1B, 2 and 3A, soil sample 3-1, but the concentration is sufficiently low that it is not expected to be of concern unless additional DDT is applied in the area.

The boron concentration of the soil is somewhat higher than the general range of 7 to 80 ppm, but boron is not expected to be a problem as boron toxicity to plants is most obvious in alkaline soils and boron toxicity was not evident on plants during the fall survey.

The soil concentration of arsenic, copper, zinc, lead, mercury, chromium and lithium are at a normal level or below and will not present a problem.

No adverse soil salinity or alkalinity is expected from an increased water table due to impounding of water.

Erosion must be controlled or movement of soil will fill the impoundments and shorten their effective use.

There has been a constant disturbance from logging so that all soil and plant communities are in a state of flux and plant succession has not stabilized under natural conditions.

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5.3 VEGETATION

5.3.1 INTRODUCTION

The Broad River Study Area is located in the Piedmont Region and bordered on the south by the Coastal Plains (Johnson 1964). Vegetation of the area is typical pine-hardwood of the southern Piedmont of South Carolina. Prior to white settlement in 1752 (Camp et al. 1960), oak-hickory-pine forests prevailed (Küchler 1964). These forests were apparently free of brushy undergrowth.

Loblolly pine, slash pine, and long leaf pine dominated upland, well-drained sites characterized by sandy soil, low in nutrients and water retention properties.

Lowlands were at least 75 percent dominated by hardwoods. Species composition varied, depending upon drainage. On well-drained first bottom flood plain, yellow poplar, cottonwood, ash, oak, and sycamore were the dominant tree species. Trees growing on poorly drained flood plains included willow, birch, black gum and tupelo species, water oak, and red maple (Camp et al. 1960).

Continuous rotation type farming resulted in a change from the original mixed pine-hardwoods forests to pine. While oak-hickory forest would normally be climax for the area, routine removal of trees, eroded top soils, and recurrent fires have maintained stands of pine. Loblolly pine is currently cultivated in the area for pulp production. Most hardwoods which exist are scrubby and inferior in quality compared to the virgin forest.

A map (back cover) was prepared from 1970 U.S.G.S. aerial photographs showing the distribution of pine, deciduous, mixed pine-hardwoods, and grassland communities. The concurrent timber harvest prevented accurate portrayal of existing plant communities at the present time.

A comprehensive study was conducted of the Broad River Study Area

in 1971 to inventory and quantitatively describe woody vegetation which currently exists in the areas based on stands considered representative of the Broad River plant communities. The study was expanded in 1972 to complement vegetative description of the overstory vegetation with a quantitative analysis of existing herbaceous and shrubby understory vegetation. Soil data were utilized in the description of vegetative communities.

5.3.2 METHODS AND MATERIALS

Plant collections were made from sites within the Broad River Study Area. The sites included an immediate vicinity around four small mammal trap lines and have corresponding site numbers. Particular care was taken to determine species composition nearest the trap line at each site.

Quantitative analysis of perennial woody vegetation on Study Sites 1A, 3A, and 4 was accomplished using the point-centered quarter method (Cottam and Curtis 1956). This technique provides quantitative information on relative, absolute, and total density, as well as relative frequency, relative dominance, and age class composition of the forest habitat (Phillips 1959). Study Site 2 was not included because it had been recently cleared of all commercial timber and woody underbrush (clear-cut).

On Study Sites 1A and 4, using the quarter method, the two point centers were 10 m (32.8 ft) to the right and 10 m (32.8 ft) to the left of each trapping station. Each point was considered the center of four quarters and the nearest tree (2.5 cm or greater in diameter) to this point in each of four quarters was sampled. Forty point centers for 160 trees were obtained in this manner. Each tree was measured for distance to the point and dbh (diameter at breast height) at 1.3 m (4.5 ft). The dbh provides an estimate of the tree's basal area.

Because Frees Creek was northwest of Study Site 3A, all point

centers were located three meters to the southeast side of the established trapping stations and the mid points between stations (including one point center beyond Station 20 to obtai forty point centers for 160 trees).

Point-centered quarter data were processed using the following equations from Cottam and Curtis (1956):

Distance = distance from point center to species.

$$\text{Mean distance} = \frac{\text{sum of distances}}{\text{number of measurements}}$$

$$\text{Mean area} = (\text{mean distance})^2$$

$$\text{Total density (plants/hectare)} = \frac{\text{10,000 square meters 1 hectare}}{\text{mean area } (m^2) \text{ of plants}}$$

$$\text{Relative density} = \frac{\text{number of individuals/species} \times 100}{\text{number of individuals of all species}}$$

$$\text{Frequency of species} = \frac{\text{number of points at which species occurs} \times 100}{\text{total points (40)}}$$

$$\text{Relative frequency} = \frac{\text{frequency of individual species} \times 100}{\text{sum of frequency values of all species}}$$

$$\text{Basal area per tree} = \frac{\text{total basal area}}{\text{number of trees}}$$

$$\text{Relative dominance} = \frac{\text{total basal area of the species} \times 100}{\text{total basal area of all species}}$$

Forty one-meter square quadrats were employed to determine species distribution of understory vegetation within the sites (Phillips 1959). Study Site 2 had recently been clear-cut and planted to loblolly pine. A dense grass cover indicated a need for more detailed study of the area, therefore, quantitative analysis of the grass community was obtained by using the point-center quarter method (Cottam and Curtis 1956).

Litter accumulation was estimated by collecting all surface organic material within four, 1/4 m^2 quadrats per site. The material was air-dried at the South Carolina Electric & Gas Company field office at Parr, South Carolina to keep weight loss due to microbial activity to a minimum.

The samples were then shipped to the Dames & Moore Environmental Services Laboratory at Cincinnati, Ohio, oven-dried at 80°C for forty-eight hours and weights reported.

5.3.3 FINDINGS

5.3.3.1 Floristic Composition

Flora of the Broad River Study Area consisted of 51 families represented by 99 genera and 108 identified species (Table 5.3.1). Phenological conditions of 15 specimens prohibited identification to the species level. Thirty-six tree species were best represented by pines, oaks, and hickories. The flora also was well represented by a variety of herbaceous species which included grasses, legumes, and composites. The diversity of species within these three groups is significant considering the area is predominatly closed canopy forest.

Eighteen species of vascular hydrophytes were collected from the study area. This group is discussed in Section 3.4.

5.3.3.2 Vegetative Communities

Total area scheduled for inundation by Monticello Impoundment included 47 percent pine, 15 percent hardwood (deciduous), 26 percent mixed pine-hardwood, and 12 percent grassland. Hardwood forests are predominately in the bottomlands of Frees Creek.

The coniferous communities to be inundated consisted mainly of loblolly pine which produces a closed canopy forest with a sparce understory of herbaceous vegetation. Only limited numbers of pine seedlings and saplings are capable of growing under the dense canopy which reduces light penetration to the substrate.

Of the area described as mixed community, 73 percent consisted of areas where pine was selectively removed. The hardwood understory was predominant

Table 5.3.1 Summary of flora identified in the environs of the Broad River Study Area.

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Pteridaceae					
Pteridium aquilinum Bracken Fern	0*	0	X*	0	0
Polypodiaceae					
Asplenium platynuron Fern	X	0	X	0	0
Polystichum acrostichoides Fern	0	0	X	0	0
Pinaceae					
Pinus echinata Short Leaf Pine	0	0	0	0	X
Pinus palustris Long Leaf Pine	0	0	X	0	X
Pinus taeda Loblolly Pine	X	X	X	X	X
Pinus virginiana Scrub Pine	0	0	0	X	0
Cupressaceae					
Juniperus virginiana Eastern Red Cedar	X	0	X	X	0
Alismataceae					
Sagittaria latifolia Arrowhead	0	0	X	0	X
Gramineae					
Alopecurus carolinianus Foxtail	0	X	0	0	0
Andropogon virginicus Broomsedge	0	X	0	0	0
Aristida purpurascens Three-awned Grass	0	X	0	0	0
Arundinaria gigantea Cane	0	0	X	0	0
Bothriochloa sp. Beardgrass	0	X	0	0	0
Cynodon dactylon Bermuda Grass	X	0	0	0	X
Panicum scribnerianum Scribner's Panicum	X	X	X	X	X

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Gramineae					
Panicum sp. Panic Grass	O	X	O	O	O
Paspalum plicatulum Brownseed	O	X	O	O	X
Schizachyrium scoparium Little Bluestem	O	X	O	X	O
Setaria sp. Foxtail Grass	O	X	O	X	O
Sorghastrum nutans Indiangrass	O	O	X	X	X
Sorghum halepense Johnson Grass	O	X	O	X	O
Uniola latifolia Sea Oats	O	O	X	O	O
Cyperaceae					
Rhynchospora corniculata Beak Rush	O	O	X	O	O
Carex sp. Sedge	X	O	X	X	O
Cyperus erythrorhizos Sedge	O	O	X	O	O
Bromeliaceae					
Tillandsia usneoides Spanish Moss	O	O	O	O	X
Pontederiaceae					
Pontederia cordata Pickerel Weed	O	O	X	O	O
Liliaceae					
Allium canadense Wild Onion	O	X	O	O	O
Polygonatum pubescens Solomon's Seal	O	O	O	O	X
Smilax glauca Greenbrier	O	X	O	O	O
Smilax walteri Walter's Smilax	X	O	X	X	X

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Juglandaceae					
Carya glabra Pignut Hickory	0	0	X	0	0
Carya laciniosa Shellback Hickory	0	0	X	0	0
Carya ovata Shagbark Hickory	0	0	X	0	0
Carya tomentosa Mockernut Hickory	0	0	X	0	0
Betulaceae					
Carpinus caroliniana American Hornbeam	X	0	X	0	0
Ostrya virginiana Eastern Hophornbeam	X	0	X	X	0
Fagaceae					
Quercus alba White Oak	0	0	X	0	0
Quercus borealis var. *rubra* Red Oak	0	0	X	0	0
Quercus laevis Turkey Oak	0	0	0	X	X
Quercus laurifolia Laurel Oak	X	0	X	X	X
Quercus nigra Water Oak	X	0	X	X	0
Quercus phellos Willow Oak	0	0	X	0	0
Quercus schumardii Schumards Oak	0	0	X	0	0
Quercus stellata Post Oak	0	0	X	0	0
Quercus velutina Black Oak	X	0	0	0	0
Ulmaceae					
Celtis laevigata Sugarberry	X	0	0	0	X
Ulmus alata Winged Elm	X	0	X	0	X
Loranthaceae					
Asarum sp. Wild Ginger	0	0	X	0	0

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Aristolchiaceae					
Hexastylis arifolia Heartleaf	0	0	X	0	X
Phytolaccaceae					
Phytolacca americana Pokeberry	0	X	0	0	0
Portulacaceae					
Claytonia virginica Spring Beauty	0	0	X	0	0
Caryophyllaceae					
Silene antirrhina Sleepy Catchfly	0	X	0	0	0
Menispermaceae					
Cocculus carolinus Coralbeads	0	0	0	0	X
Magnoliaceae					
Liriodendron tulipifera Tulip Poplar	X	0	0	0	0
Hamamelidaceae					
Hamamelis virginiana Witch Hazel	0	0	X	0	0
Liquidamber styraciflua Sweet Gum	X	0	X	X	0
Rosaceae					
Amelanchier sp. Juneberry	0	0	0	0	X
Crataegus sp. Hawthorn	X	0	0	0	0
Potentilla sp. Cinquefoil	X	0	X	0	0
Prunus americana Wild Plum	0	X	0	0	0
Prunus serotina Black Cherry	X	X	0	X	0
Rosa bracteata Rose	X	X	0	0	0
Rubus allegheniensis Blackberry	X	X	0	0	0

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Leguminosae					
Albizzia julibrissin Mimosa	0	X	0	0	0
Astragalus sp. Milk Vetch	0	0	X	0	0
Cassia nictitans Sensitive Plant	0	0	X	0	0
Cercis canadensis Redbud	0	X	X	0	0
Desmanthus sp. Bundle Flower	0	0	0	X	0
Gleditsia tricanthes Honey Locust	0	0	0	0	X
Lespedeza procumbens Lespedeza	0	X	0	X	0
Lespedeza repens Lespedeza	0	X	X	X	0
Lespedeza stuevei Lespedeza	0	X	0	X	0
Lespedeza virginica Lespedeza	X	0	X	X	X
Pueraria lobata Kudzu Vine	0	0	0	0	X
Vicia caroliniana Carolina Vetch	0	0	X	0	0
Oxalidaceae					
Oxalis sp. Wood Sorrel	X	0	0	0	0
Guttiferae					
Hypericum denticulatum St. John's Wort	X	0	0	0	0
Meliaceae					
Melia azedarach China Berry	0	0	0	0	X
Euphorbiaceae					
Euphorbia corollata Spurge	0	X	0	0	0
Anacardiaceae					
Rhus copallina Winged Sumac	0	0	0	X	X
Rhus glabra Smooth Sumac	0	0	0	0	X

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Aquifoliaceae					
Ilex opaca American Holly	X	0	X	X	X
Celastraceae					
Euonymus americanus Strawberry Bush	X	0	0	0	0
Aceraceae					
Acer rubrum Red Maple	X	X	X	X	0
Acer saccharum Sugar Maple	0	0	X	0	0
Balsaminaceae					
Impatiens capensis Jewel Weed	0	0	0	0	X
Vitaceae					
Parthenocissus quinquefolia Virginia Creeper	0	X	0	0	0
Vitis rotundifolia Muscadine Grape	0	X	0	0	0
Tiliaceae					
Tilia americana Basswood	0	0	X	0	0
Passifloraceae					
Passiflora incarnata Passion Flower	0	X	0	0	0
Elaeagnaceae					
Elaeagnus umbellata Silver Berry	0	0	X	0	X
Cornaceae					
Cornus florida Dogwood	X	0	X	X	0
Ericaceae					
Chimaphila maculata Spotted Wintergreen	X	0	0	0	0
Nyssaceae					
Nyssa sylvatica Black Gum	0	X	X	0	0

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Oleaceae					
Fraxinus americana White Ash	0	0	X	0	0
Ligustrum sp. Privet	0	0	0	X	0
Asclepiadaceae					
Asclepias tuberosa Milkweed	X	0	X	0	0
Convolvulaceae					
Convolvulus arvensis Bindweed	X	0	0	0	0
Verbenaceae					
Callicarpa americana Beauty Berry	0	0	X	X	0
Verbena riparia Verbena	0	X	0	0	0
Labiatae					
Prunella vulgaris Selfheal	0	X	0	0	0
Solanaceae					
Physalis sp. Ground-cherry	0	X	0	0	0
Solanum carolinense Nightshade	0	X	0	0	0
Bignoniaceae					
Campsis radicans Trumpet-creeper	X	0	0	0	0
Acanthaceae					
Ruellia caroliniensis Ruellia	0	0	X	0	0
Plantaginaceae					
Plantago aristata Plantain	0	X	0	0	0
Plantago lancealata Buckhorn	0	X	0	0	0
Rubiaceae					
Cephalanthus occidentalis Button-bush	0	0	X	0	0

Table 5.3.1 (Continued)

Family Scientific Name Common Name	COLLECTION SITES 1A	2	3A	4	General
Caprifoliaceae					
Lonicera japonica Honeysuckle	X	X	X	0	X
Compositae					
Ambrosia artemisiifolia var. *elator* Common Ragweed	0	X	0	0	0
Antennaria sp. Pussy's-toes	0	0	0	X	0
Aster pilosus Aster	0	X	0	X	0
Elephantopus tomentosus Elephant's-foot	X	0	0	0	0
Erigeron strigosus Daisy-fleabane	0	0	0	0	X
Eupatorium capillifolium Dog-fennel	0	0	0	0	X
Eupatorium lineaifolium Eupatorium	0	X	0	0	0
Helenium amarum Bitter-weed	0	X	0	0	0
Lactuca scariola Prickly Lettuce	0	X	0	0	0
Pyrrohopappus carolinianus Leafy Stemmed Dandelion	0	X	0	X	0
Senecio vulgaris Groundsel	0	X	0	0	0
Solidago sp. Goldenrod	X	0	0	0	0
Taraxacum sp. Dandelion	X	0	0	0	0

* 0 = not present in area sampled; X = present.

as viewed from aerial photographs, resulting in those areas being classified as mixed pine-hardwood community.

The grassland community type included seven percent cultivated or pasture and five percent abandoned farmland. Abandoned farmland included communities representing several seral stages of succession.

The area to be inundated by enlargement of Parr Reservoir contained 2 percent pine, 86 percent hardwood, 8 percent mixed pine-hardwood, and 4 percent grassland communities. Grasslands were abandoned farmlands or clear-cut timber lands, predominately in early stages of succession.

5.3.3.3 Study Sites

5.3.3.3.1 Study Site 1

Study Site 1 was subdivided into Site 1A consisting of second growth pine and Site 1B which was predominately hardwood. Tree data were collected only on Site 1A. Density of trees greater than 2.5 cm dbh was 2,422 trees per ha (980 trees per acre), with a mean basal area of 4.2 m^2 per tree. Average height per tree was 15.8 m (51.8 ft) with a height range from 12.2 m (40 ft) to 21.9 m (71.4 ft).

Species diversity was low with loblolly pine being the most important canopy species (Table 5.3.2) on the site. Loblolly pine was represented in each of six diameter classes ranging from 5 to 30 cm (2 to 12 in), however, 69 percent of these were in the 5 and 10 cm class sizes. All other tree species present had a dbh of 10 cm or less.

Honeysuckle was the most frequently occurring understory species in the pine stand (Table 5.3.3). Other species which occurred in more than 25 percent of the quadrats included Schribner's panicum, blackberry, and dandelion. Litter accumulation weighed 13.8 x 10^3 kg/ha (Table 5.3.4), and was composed primarily of pine needles.

Table 5.3.2 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 1A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance* Value
Loblolly Pine	52.9	69.4	80.8	203.1
Sweet Gum	21.4	18.0	13.9	53.3
Flowering Dogwood	11.4	6.3	2.7	20.4
Eastern Red Cedar	7.1	3.1	1.5	11.7
Tulip Tree	2.9	1.3	.6	4.8
Hop-hornbeam	2.9	1.3	.4	4.6
Red Maple	1.4	0.6	.2	2.2
Totals	100.0	100.0	100.1	300.1

*Importance Value is the sum of relative frequency, relative density, and relative dominance.

Table 5.3.3 Frequency of occurrence (%) of understory, herbaceous,and woody plant species growing within pine, hardwood, mixed pine-hardwood, and grassland environs in the Broad River Study Area.

Growth Form / Common Name	COLLECTION SITES 1A	1B	2	3A	4
Vascular Cryptogams					
Fern	4	-	-	10	-
Herbaceous Forbs					
Arrowhead	-	-	10	10	-
Aster	-	-	10	-	10
Bundle Flower	-	-	-	-	15
Cinquefoil	-	8	-	5	-
Common Ragweed	-	-	5	-	-
Dandelion	28	-	-	-	-
Goldenrod	12	-	20	-	5
Heartleaf	-	-	-	20	-
Lespedeza	-	-	5	-	10
Pussy's Toes	-	-	-	-	5
St.John's Wort	4	-	-	-	-
Wild Ginger	-	-	-	20	-
Wood Sorrel	20	-	-	-	-
Grasses					
Bamboo	-	-	-	35	-
Bermuda Grass	24	-	-	-	-
Broom Sedge	-	-	65	-	40
Brownseed	-	-	10	-	-
Cane Bluestem	-	-	4	-	-
Indiangrass	-	-	-	10	30
Little Bluestem	-	-	45	-	30
Scribner's Panicum	28	-	30	15	25
Three-awned Grass	-	-	40	-	-
Sedges					
Sedge	-	20	-	45	-

Table 5.3.3 (Continued)

Growth Form / Common Name	COLLECTION SITES 1A	1B	2	3A	4
Woody					
Shrubs					
American Holly	8	16	-	15	15
Blackberry	28	-	5	-	-
Rose	4	8	15	-	-
Trees (<5 cm d.b.h.)					
American Hornbeam	-	4	-	-	-
Black Cherry	4	-	-	-	-
Black Oak	-	8	-	-	-
Dogwood	-	4	-	-	15
Eastern Red Cedar	4	-	-	10	-
Hawthorn	4	4	-	-	-
Laurel Oak	4	28	-	15	10
Loblolly Pine	40	20	5	35	25
Pignut Hickory	-	-	-	5	-
Red Maple	-	-	-	5	-
Sugarberry	-	8	-	-	-
Sweet Gum	8	4	-	5	-
Water Oak	4	8	-	5	5
White Ash	-	-	-	5	-
Winged Elm	12	20	-	15	-
Vines					
Honeysuckle	72	16	25	-	-
Walter's Smilax	4	52	-	50	15

Table 5.3.4 Mean litter production from the various sites within the Broad River Study Area.

Collection Sites	Litter Production (thousands) kg/ha*
1A	13.8
1B	15.5
2**	2.7
3A	12.1
4	13.5

* kg/ha x 0.891 = lb/acre
**Standing and accumulated litter from within a pine plantation.

Walter's smilax was the most frequently occurring understory species in the hardwood stand on Study Site 1B (Table 5.3.3). Seedlings of laurel oak and loblolly pine also were present. A sedge was the most frequently encountered herbaceous plant. Litter production under hardwood was 1.7×10^3 kg/ha greater than under the pine stands (Table 5.3.4). Litter composition was predominately leaves and twigs, since sampling was accomplished shortly after leaf fall.

5.3.3.3.2 Study Site 2

Site 2 consisted of plantation pine approximately three years after planting. Vegetation on the site typifies an early successional stage of a disturbed site. The site had been clear-cut and replanted to loblolly pine. No tree on the site had a dbh greater than 2.5 cm.

Density of grass species (bunch grasses, with each bunch considered a plant) was 6,756 plants/ha (2,735 plants/acre). Protection of the soil surface was provided by basal cover of nearly 0.15 m^2 per plant, for a total basal cover of 978 m^2/ha (4,260 sq ft/acre). This represents a total ground cover of 9.8 percent.

Broomsedge was the most important grass species on the site (Table 5.3.5) with triple-awned grass being the next most important. Although the importance value of little bluestem was not as high as triple-awned grass, relative dominance of little bluestem was somewhat greater. This would indicate that, while the density and frequency of little bluestem were low, the plants which did occur were well established.

Honeysuckle, rose, goldenrod, and aster were frequently occurring forbs within the site (Table 5.3.3). No substantial amount of litter had accumulated (Table 5.3.4) since the area had been clear-cut.

Table 5.3.5 Relative frequency, density, and dominance of the various grass species within a pine plantation (Site 2) in the Broad River Study Area .

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value*
Broomsedge	34.1	38.7	61.3	134.1
Triple-awned Grass	31.7	27.5	14.7	73.9
Little Bluestem	22.0	23.7	16.6	62.3
Witchgrass	7.3	6.3	3.5	17.1
Brownseed	4.9	3.7	3.9	12.5
Total	100.0	99.9	100.0	299.9

*Importance Value is the sum of relative frequency, relative density, and relative dominance.

5.3.3.3.3 Study Site 3A

This site was located along Frees Creek and supported a diverse community of woody species. A total of 2,219 trees/ha (898 trees/acre), representing 16 species, occupied a mean area of 4.5 m^2 per tree. Loblolly pine, eastern red cedar, and red maple were the most important species (Table 5.3.6). Loblolly pine was the dominant species within the area, but eastern red cedar was the most dense.

Clinometer height samples revealed a range from 15.2 m (49.8 ft) to 21.3 m (70 ft) with an average tree height of 19.2 m (63 ft). Forty-two percent of all trees sampled had a dbh of 5 cm or greater, while eight percent had a dbh greater than 25 cm. The largest tree on the site, a loblolly pine, measured 45 cm (17.7 in) dbh. Only loblolly pine, ash, and oak species had dbh's greater than 25 cm (9.8 in). Walter's smilax was the most frequent understory plant species within the site (Table 5.3.3) and sedge was the most frequent herbaceous species. Bamboo was common along the water margin. Loblolly pine seedlings were found throughout the site. Litter accumulation, chiefly pine needles, was lowest of the forested areas, 12.1 X 10^3 kg/ha (Table 5.3.4).

5.3.3.3.4 Study Site 4

Study Site 4 consisted of a mature stand of plantation pine as indicated by the range of size classes. Loblolly pine trees were represented in each of the 5 cm diameter class intervals from 5 to 35 cm. Diversity of other woody species also indicated a mature stand. The area supported a population of 1,930 trees/ha (780 trees/acre) with a mean area of 5.2 m^2 per tree. The heights averaged 20.4 m (67 ft) and ranged from 19.2 m (63 ft) to 22.8 m (74.8 ft).

Loblolly pine was the most important woody species in the area

Table 5.3.6 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 3A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value*
Loblolly Pine	16.0	18.6	21.7	56.3
Eastern Red Cedar	16.0	19.2	13.0	48.2
Red Maple	13.4	14.8	13.5	41.7
Ash	8.4	6.2	9.2	23.8
Hop-hornbeam	7.6	5.6	6.8	20.0
Oak sp. 1	7.6	6.2	5.4	19.2
Shagbark hickory	5.9	4.7	6.0	16.6
Hickory sp.	5.0	4.7	4.3	14.0
Oak sp. 2	3.4	3.8	4.6	11.8
Oak sp. 3	4.2	3.1	4.1	11.4
Ironwood	2.5	4.7	3.3	10.5
Basswood	3.4	3.8	3.3	10.5
Live Oak	2.5	1.8	3.0	7.3
Flowering Dogwood	1.7	1.2	0.5	3.4
Redbud	1.7	1.2	0.5	3.4
Willow Oak	0.7	0.6	0.8	2.1
Total	100.0	100.2	100.0	300.2

*Importance Value is the sum of relative frequency, relative density, and relative dominance.

(Table 5.3.7). Eastern red cedar was the most important sub-dominant species. Other woody species over 2.5 cm dbh were only of minor importance, with over 50 percent occurring in the 5 and 10 cm diameter size classes.

Understory vegetation of Study Site 4 was well represented by graminoids (Table 5.3.3). Broomsedge, the most frequent species, occurred in small herbaceous communities in areas created by the removal of scattered mature pines. Little bluestem and Indiangrass also were quite common. Loblolly pine seedlings occurred throughout the open areas.

Accumulated litter on the forest floor was comparable to litter accumulated in Study Site 1A (Table 5.3.4). Pine needles contributed most to the total weight.

5.3.4 DISCUSSION

5.3.4.1 Habitat Description

Southern pine forests of the South Atlantic and Gulf States are considered part of the temperate-deciduous forest since they represent a seral stage rather than climax. The physiognomy is medium-tall to tall forest of needle leaf evergreen and broad leaf deciduous trees. Unless maintained by fire and cutting, these forests are succeeded by such hardwoods as oak and hickory (Smith 1966). Physiognomy of flood plain forest is dense, medium-tall to tall forest of broad leaf deciduous and evergreen trees, inter-mixed with shrubs and needle leaf deciduous trees.

Forests are often stratified because of an existing variety of life forms. Four strata are usually recognized in a highly developed, uneven-aged, deciduous forest: the upper canopy consists of dominant or co-dominant trees; the lower tree canopy of subdominant tree species; the shrub layer; and the ground or field layer consisting of herbs, ferns, and mosses. Species composition of the ground layer varies with the season.

Table 5.3.7 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 4 of the Broad River Study Area, June 1971

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value*
Loblolly Pine	60.7	81.3	85.9	227.9
Eastern Red Cedar	12.2	6.3	5.1	23.6
Holly	6.1	3.1	1.5	10.7
Black Cherry	4.5	2.5	2.4	9.4
Oak sp. 1	4.5	1.9	1.8	8.2
Red Maple	4.5	1.9	0.9	7.3
White Oak	1.5	0.6	0.9	3.0
Hop-hornbeam	1.5	0.6	0.6	2.7
Oak sp. 2	1.5	0.6	0.3	2.4
Willow Oak	1.5	0.6	0.3	2.4
Sweet Gum	1.5	0.6	0.3	2.4
Total	100.0	100.0	100.0	300.0

*Importance Value is sum of relative frequency, relative density, and relative dominance.

Even-aged stands resulting from disturbances such as fire and clear-cutting have a poorly developed understory. The low tree, shrub, and ground layers are thin and poorly developed except in small, open areas.

Forest communities of the Broad River Study Area are basically poorly developed. Planting loblolly pine for pulp production results in even-aged stands with closed canopies, thereby eliminating any consistent stratification within the community. Seeding to harvest of marketable loblolly pine in the area requires 35 to 50 years.

The forest floor plays a dominant role in the life and distribution of many plants and animals and in mairtenance of soil fertility. A constant interchange of materials takes place from the surface to the soil through vegetation and back again. Plants utilize nutrients from the soil and deposit them on the surface as litter. Decomposition of plant and animal material reverses the process. The nature and quality of the organic layer is dependent in part on the kind and quality of litter, and the litter in turn influences the abundance and composition of soil fauna.

Plant littler, composed of pine needles, is high in lignins and resins which resist decomposition and which inhibit the decomposition of cellulose. Coniferous forest soils are characterized by a well defined unincorporated, compact organic deposit resting on mineral soil. The layer is a result of slow mineralization and no mixing with the mineral soil. The soil characteristics support only limited population of small soil organisms, of which most live at the interface of the decaying organic layer and the mineral surface.

Acid characteristics of these soils make them more suitable to pines than hardwoods. Pines generally thrive on soils with a pH of 5.0 to 5.5 which supply too little potassium, phosphorous, and nitrogen for most hardwood trees. Soils of the Broad River Study Area generally were slightly

acidic in nature and very low in phosphorus. Potassium content varied from low to high. While supplemental nitrogen was not required for growing hardwood trees, lime appeared to be necessary to ameliorate the environment for optimum growth of hardwood species.

Litter accumulation for the coniferous forest was approximately 15 metric tons which agreed with accumulations reported by Switzer and Nelson (1972) for a 20-year old loblolly pine plantation. Age data are not available for the older loblolly pine stands of the Broad River Study Area, therefore comparisons cannot be made with accumulations reported in the literature. Low accumulation for Site 2 has to be attributed to the age of the stand and the influence of recent clear-cutting.

Soils of mixed or hardwood forests have a better developed humus layer. Chemical composition of deciduous leaves allows faster decomposition and mineralization of the leaf litter. Thus, the litter is incorporated with the mineral soil much faster.

More litter was accumulated on Site 1B than on the pine stands. Usually the opposite would be true due to differential decomposition rates of the type litter within each system. However, the fall sampling occurred immediately after leaf fall, resulting in an accumulated litter mass.

5.3.4.2 Ecologically Important Species

Thirty-six woody species were identified growing in the Broad River environs. Although several species can be considered important, loblolly pine was the most important species in the area. Most of the area was composed of second growth loblolly. Consequently, this species was the dominant canopy species and contributed much of the accumulated litter to the forest floor. Accumulation of litter, which is a demise of pine seedlings, provides a protective medium for hardwood fruits and drought resistant seedlings. Loblolly is an

intolerant species and new seedlings will not establish in the heavy litter.

Because of its wide range occurrence in pure stands, its abundance and its versatility in use, loblolly is a principal commercial pine in the southeastern United States. This also is true for the Broad River Study Area. Site indices, an estimate of total height attained by the average dominant and co-dominant trees in a 50-year stand, generally increase from rich upper slopes to bottomlands, but variations are related to soil differences rather than to slope position or steepness. Loblolly pine grows best on sandy soils with poor surface drainage, a deep surface layer, and a firm subsoil (Forest Service 1965).

Loblolly pine had a potential site index of 80 (Ellerbe and Smith 1964) on the Cecil sandy loam soil of Site 1A. The same site index would have applied to the Appling sandy loam of Site 1B. However, loblolly pine was not a major species at that site.

The Appling and Cecil sandy loams are well drained soils with a moderate moisture supplying capacity. These soils are moderately high in natural fertility and in well-stocked unmanaged stands at fifty years of age could produce an average annual growth of 466 board feet of loblolly pine per acre (Ellerbe and Smith 1964).

Site 2 and 4 occur on severely eroded Cecil clay loam and have a site index of 60. While moisture supplying capacity is medium to high, these soils are moderately low in natural fertility. Annual production of 390 board feet can be expected on a well-stocked unmanaged stand at fifty years of age (Ellerbe and Smith 1964). Wind fall can be severe, especially on Site 4, where shallow phases of the soil restrict root development.

Site 3A was characterized by two soil types; a Cecil sandy loam on the upper slopes and a Mecklenburg sandy loam on the lower slopes. The Cecil sandy loam soils were more severely eroded than those identified on Site 1A.

Thus, production could not be expected to be as high on Site 3A. The site index for Site 3A was 70 to 80.

An average site index of 60 can be expected for loblolly pine on Mecklenburg sandy loam soils. The surface layer overlays a very firm, slightly plastic clay subsoil with medium moisture supplying capacity. Wind throw does not pose any particular problem on this soil type.

Other woody species in the Broad River Study Area did not occur in sufficient numbers to be of any apparent economic importance, however, their importance as food sources and habitat for wildlife cannot be ignored. These discussions, however, must be limited to potential habitat since the wildlife populations were very limited within the study area.

Fruits from oaks, eastern red cedar, and holly provide a valuable food source for turkeys and song birds. Small scattered patches of grasses and forbs occur in openings in the trees which offer potential habitat for turkey and quail. Lespedeza and seeds from other forbs and grasses growing within these open areas serve as a food source.

Japanese honeysuckle was the most common understory species in the area. According to Segelquist, Rogers, and Ward (1972) honeysuckle plantings provide emergency winter rations for deer. Nutrient quality of the leaves is apparently very consistent throughout the year, being especially high in protein. Honeysuckle leaves are retained during the winter and more digestible than any native forage, including eastern red cedar leaves.

No plant species were collected or observed in the Broad River Study Area which could be classified as rare or endangered.

5.3.4.3 Environmental Stresses and Ecological Succession

Original forest of the Broad River Study Area consisted of pines, oaks, and hickories, which was practically free of brush undergrowth. Early

settlers destroyed most of the timber they cut to clear for farm. They cultivated their cleared fields until yields began to decline, then cleared new land or abandoned the entire settlement. The significant effect of the clearing and abandonment was a conversion of most of the original forest to pine stands.

There is a fairly definite succession of vegetation on land abandoned after cultivation. When a cultivated field is abandoned it produces a crop of annual weeds the first year, numerous perennials the second year and a community of perennials thereafter. In the interim of change, the open, low herbaceous cover alludes to a closed and elevated forest canopy, usually near the end of the second decade. Oosting (1942) outlined the successional sequence of an abandoned field in the Piedmont Region:

Approximate Age Years	Vegetative Character
0	Abandoned field.
1	Herbaceous weedy forbs and grasses.
2	Herbaceous weedy forbs dominated by annuals and perennials.
3-10	Transitional to perennial grasses with pine seedlings becoming established.
10-20	Canopy of loblolly pine stand closes.
Approximately 200	Stable stand of white and red oaks.

These vegetational changes effect a shift to moderation of microclimatic extremes, influence the disposition of precipitation and the character and composition of the microflora and fauna; all of which, directly and indirectly influence the disposition of nutrients within the system.

The successional stage of Site 2 is currently in the third year. The area is dominated by broomsedge among the small planted loblolly pines.

Grasses are important soil stabilizers. Soils of the Broad River Study Area are very subject to erosion, especially after clear-cutting. Triple-awned grass is an early invader since it is capable of colonizing on low fertility soils. Broomsedge is another grass characteristic of low fertility areas. Little bluestem is characteristic of more fertile areas. The combination of these three species within Site 2 would indicate a moderate level of fertility and that the succession described is progressing as expected.

Young pine seedlings were becoming established among the planted pines. Since pine seedlings can only become readily established on exposed mineral soil, this must occur in the early succession process. After the loblolly pines are well established and the ground cover has improved, an understory of hardwood begins to develop.

Loblolly pine is normally followed by hardwood in natural succession. On the fine-textured soils characteristic of the Piedmont, the single-stem selection method of harvesting favors the succession of hardwoods, but clear-cutting in patches or strips of limited size, or cutting everything except selected seed trees, favors reproduction of pine.

Other stresses may be imposed upon the vegetative communities of the Broad River Study Area, but were not identified during this survey. These include rust diseases caused by the genus Fusiformis which is the most prevalent of diseases that effect loblolly pine. The cankers cause deformation and losses in stem volume. Canker diseases also attack hardwoods and cause the stems to decay.

Little leaf disease, a disease of short leaf pine, also can affect loblolly. The disease is most prevalent in loblolly where the disease is particularly severe in short leaf pine. This usually occurs on sites where aeration and internal drainage are poor. However, short leaf pine is

not very abundant within the Broad River Study Area.

Pine-tipped moths also can affect loblolly pine in the area by deforming the trees which prevent growth to a normal height.

5.3.5 SUMMARY

The Broad River Study Area has undergone various disturbances since early white settlement in 1752. While hardwood forest is the climax for the area, disturbances have kept the plant communities in a seral stage with loblolly pine being the dominant species. Disturbance also has inhibited the development of a vertical structure within the community resulting in poorly developed shrub and ground layer.

Successional patterns appear to follow seral stages described for other areas of the Piedmont Region. Grasses and forbs, desirable for wildlife habitat, develop within openings in the forest.

Loblolly pine is the most important economic plant species within the study area. Most of the wood fiber produced by this species is utilized in pulp production. Potential wood production is related to soil type. The turnover rate for marketable timber is 35 to 50 years.

Hardwoods occur as small scattered stands on the uplands and predominate on the river bottoms. No hardwood species occur in numbers great enough to be of economic importance.

No rare or endangered plant species were found in the project area.

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5.4 INSECTS AND OTHER ARTHROPODS

5.4.1 INTRODUCTION

The objectives of arthropod and insect collections on the Parr Reservoir Study Area were to assess the species of insects present at selected areas, their density, diversity, and distribution patterns. Insects are important to the ecological system because of their great numbers. Several hundred-thousand species of insects exist in the world along with numerous species of other arthropods (Borror and DeLong 1971). Therefore, the insects can provide e basic data on species diversity of an area simply by their numbers and accessibility. Trapping insects is not extremely difficult and since there are many species, a great deal of information can be extracted from a careful collection taken at the proper time. This information along with similar information for plants and vertebrates will allow comparisons to be made among the various terrestrial parts of the area. The plants are the primary producers of any ecosystem. That is, the plants are the only part of any biological system which is able to fix carbon compounds in a biologically usable form using the energy from the sun. Many insects are primary consumers, that is, they feed directly upon the tissues and juices of plants. Other insects are of different trophic or feeding le , preying upon the primary or secondary consumers or feeding upon the detritus, the non-living remains of plants. These insects would be considered secondary or tertiary consumers. Thus, the arthropod studies fill the gap between primary production studies and studies of small mammals and birds which are tertiary or quarternary consumers.

The scope of work with respect to insects and other arthropods was limited. Concentrated terrestrial arthropod collecting was done only in March 1972. Information on species having an economic importance are continually being obtained and recent infestations recorded.

Previous biological studies in Fairfield County, South Carolina, have been limited, especially the western portion of the county which is bordered by the Broad River. The primary reason for lack of investigations appears to be the area's inaccessability. Only one reference, Kirk (1970), was located which listed terrestrial insects collected from Fairfield County.

5.4.2 METHODS AND MATERIALS

Insects were collected on the study area by three methods. The first method involved staking out two 50 by 100 m (164 by 328 ft) quadrats.

Quadrat 1 was located at Study Site 1C on the eastern shore of the proposed Monticello Impoundment, about 300 m (984 ft) east of the small mammal transect and just about 20 m (66 ft) west of State Highway 215 (see map, back cover). This location was chosen because it is on the top of a hill supporting a dense and virtually pure stand of pines. This hilltop will not be flooded when the reservoir is filled.

Quadrat 2 was located at Study Site 2 on the northwest shore of the proposed Monticello Impoundment. The small mammal trapline runs through the quadrat. Both quadrats are oriented with their long axis on a due east-west line. Quadrat 2 was established in order to sample the cut-over habitat. The vegetation consists of grasses, forbes, and small pine; thus approximating the classical old field successional communities.

The inside of Quadrat 2 was lined along both axes at five meter intervals. A stake was driven where the lines intersected and pitfall traps were buried in the ground so the top of the trap was at or just below ground level. The pitfall traps were steel cylinders, 11.8 cm (4.6 in) high and 10.7 cm (4.2 in) in diameter. They were placed on the east side of each stake with the quadrat on the inside of all stakes around the periphery. A total of 231 pitfall traps were set out on Quadrat 2. Quadrat 1 was not completed in time for sampling.

The second method of collecting insects was by sweep netting in various parts of the study area. Unfortunately, no systematic sweep netting was done during the March sample due to unusually cold temperatures. The temperature was too cold for a sufficient number of flying insects and, therefore, comparative sweep netting was not possible.

The third method of sampling was by blacklight trapping at selected areas. A blacklight trap consists of a long-wave ultra-violet bulb, with directing vanes and a catch basin into which alcohol is poured. The insects are attracted to the ultraviolet light, to which their eyes are sensitive, directed into the basin by the vanes, become trapped in the alcohol, and die. All specimens captured in a blacklight trap were kept and preserved in the alcohol. Blacklight trapping was carried out at Cannons Creek in the same area that the littoral zone collection was made.

All arthropods captured by terrestrial means were pinned with standard insect pins. Millipedes collected in pitfall traps were preserved in alcohol. The pinned specimens were separated by taxon, their location within the quadrat described, and stored in cabinets in the laboratory. Specimens trapped by blacklight were separated by taxon, preserved in 85 percent ethanol, and stored in vials. These vials were labeled and stored in a storage cabinet at the laboratory.

There was not enough successful light trapping done to allow for numerical analysis. Since only one quadrat was completed for sampling, there were no paired data available for comparative statistical or numerical testing.

5.4.3 FINDINGS

Table 5.4.1 lists the identified insects collected on Quadrat 2 by pitfall traps. Several specimens have yet to be positively identified, i.e., millipedes, spiders, etc. Two orders of insects were identified: Coleoptera

Table 5.4.1 Identified insects collected on Site 2, northwest shore of proposed Monticello Impoundment, 22 and 24 March 1972

Coleoptera
- Carabidae
  - *Triplectrus rusticus* (Say) - (11) adults
  - *Chlaenius tomentosus* (Say) - (1) adult
  - *Stenolophus* sp. - (5) adults
  - *Notiophilus* sp. - (1) adult
  - Misc. Carabidae representing 3 spp. - (4) adults (unidentified)
- Scarabaeidae
  - *Phyllophaga* sp. - (1) adult
- Cantharidae
  - *Silis latilabus* Blatchley - (1) adult
  - *Cantharis bilineatus* Say - (2) adults
- Dermestidae
  - *Attagenus* sp. - (1) adult
- Curculionidae
  - *Hypera postica* (Gyllenhal) - (2) adults
- Chrysomelidae
  - *Systena elongata* (Fab.) - (13) adults
  - *Oedionychis indigoptera* LeC. - (21) adults
  - *Monomacra tibialis* (Oliv.) - (6) adults
  - *Chaetocnema cribrifrons* LeC. - (1) adult

Hemiptera
- Cydnidae
  - *Pangaeus* sp. - (2) adults
  - *Aninestus* sp. - (1) adult

(beetles) and Hemiptera (bugs), with Coleoptera having the majority of species.

Quadrat 2 was divided into two parts on the basis of vegetative cover. The relative abundance of vegetative cover was determined by field observation. Determinations made of spatial patterns relative to these separated communities revealed several very interesting relationships. As expected, different species were distributed differently within the quadrat. Those animals more adapted to terrestrial life, the millipedes, were most uniformly distributed. They were collected from barren, eroded areas as well as the grassy parts of the quadrat. The soft, easily dessicated animals such as slugs and the earthworms were largely confined to the intermediately vegetated areas. The chrysomelid beetle, Oedionychis indigoptera was clearly confined to the more vegetated parts of the quadrat.

The adults of the predatory carabid beetle, Triplectrus rusticus, were found in the more heavily vegetated areas. The spiders which were collected also are predators. It is of interest, however, to note that they were distributed in a manner quite different from the carabids. Spiders were more uniformly distributed, the majority being found where vegetation was less dense.

The trap success with the blacklight was rather poor. This was probably due to the cold, wet weather which characterized the sampling dates. One trapnight, 29 March 1972, at Cannons Creek along the shoreline where qualitative samples were taken, was quite successful. Table 5.4.2 lists the insects trapped.

5.4.3.1 Insect Infestations

Insect infestation of pine trees was noted during the summer of 1973. There are three bark beetles of major importance in this area; 1) Southern pine beetle, 2) Ips beetle, and 3) Black turpentine beetle. Of these, the Southern pine beetle is the most damaging and was the one of importance during

Table 5.4.2 Insects collected by blacklight trapping on the shore of Cannons Creek, Newberry County, South Carolina, 23 March 1972.

Trichoptera	
Psychomyiidae	
Phylocentropus placidas (?)	Banks - (7) adults
Lype diversa	Banks - (8) adults
Hydroptilidae	
Hydroptyla sp.	Dalman - (5) adults
Diptera	
Chironomidae	
Genus sp. - (534) adults	
Tipulidae	
Genus sp. - (1) adult	
Psychodidae	
Genus sp. - (1) adult	
Cyclorrapha	
Family unidentified	
Genus sp. - (2) adults	
Hymenoptera	
Ichneumonidae	
Genus sp. - (1) adult	
Lepidoptera	
Psychidae	
Genus sp. - (2) adults	
Family unidentified	
Genus sp. - (1) adult	

this recent infestation. They study area was generally considered out of the epidemic area although there was some "spillover" near Frees Creek (Stan Clark, pers. comm.).

5.4.4 DISCUSSION

The majority of insects collected by the pitfall traps were beetles. This was probably due to greater pitfall trap susceptibility of beetles and, also, early seasonal trapping during which many of the other insects had not emerged.

Of the beetles collected only Hypera postica had previously been described from Fairfield County. This is not surprising since the collecting done for the records was done primarily in the northern-most four counties of South Carolina.

Distribution of organisms in relation to vegetative and non-vegetative areas indicates several interesting patterns. The slugs, which were generally confied to vegetated areas, would be expected to be found in this habitat since they depend on the vegetation for food. Also, along with the earthworms, they would be much more susceptible to dessication in the non-vegetated areas.

Oedionychis indigoptera is a leaf-eating beetle constrained in distribution by food availability rather than the harshness of the environment. These beetles can and do fly about and are thus able to escape from unsuitable conditions, such as high temperatures near the ground, dryness, or runoff water, much more quickly than can the slug. This quick mobility is important in an environment such as at Quadrat 2.

The carabids are hunting beetles which run along the ground and search for food to kill and eat. The majority were found in the more vegetated areas, probably due to the availability of prey species in these areas.

Spiders are among the heartiest terrestrial arthropods physiologically. This accounts for some of their more widespread distribution within the quadrat. However, Triplectrus rusticus is a heavily armored beetle and quite well equipped to deal with harshness in the physical environment. Yet, even though both T. rusticus and the spiders are predators, the spiders are much more widely distributed spatially. This indicated that the spiders are feeding upon a different prey than are the carabids. This conclusion is supported by the observations of spiders building webs. Webs are designed optimally to catch small, lightweight flying insects such as flies, mosquitoes, and small moths. These small insects have a much thinner cuticle than the heavier ground insects. Thus they would be more suited to the spiders' piercing-sucking type of feeding than would the heavily armored types. The carabids, on the other hand, possess heavy mandibles to crush and masticate their prey. They would not be capturing small fast-flying insects, as a general rule. The conclusion is that the spider is more widely distributed because their prey, the small flying insects, are more widely and uniformly distributed. Also, optimum sites for spider webs would be in more open areas where vegetation is less dense. The carabid beetles' prey is found in more densely vegetated areas where the short range chemical and tactile sensors of the beetles would be of greater use. Thus the anatomy, ecology, and nature of prey serve to delimit the distribution of these species.

The species-dependent spatial distribution patterns outlined above underscore the utility of a fairly large quadrat size and intensive sampling. Small quadrats can give a very misleading picture of faunal spatial distribution. For example, if the quadrat was one-fourth hectare instead of one-half hectare, the spatial distribution of slugs would be different depending on which area had been sampled.

Blacklight trapping success was low because of the cold weather.

It is instructive to note that not only the adults of the Chironomidae were obtained by blacklighting, of which literally thousands of larvae were collected in the benthos samples, but several adults of a genus of caddis flies, Lype diversa, were collected which had not been collected in any life stage by other methods. Unfortunately blacklight trapping is a method which yields only qualitative data. That is, it reveals only the presence of certain species and nothing about their absolute abundance. Moreover, because multiple habitats can be sampled simultaneously (an open field and surrounding woods, for example), it does not yield data suitable for comparative analysis. Blacklight trapping is, therefore, a tool for qualitative determination of the presence or absence of a species, nothing more.

Meteorological conditions play an important role in defining arthropod activity. Temperature is known to be an extremely critical parameter in regulating activity. The millipedes captured in pitfall traps indicate a fairly direct relationship to the minumum temperature.

Date	No. of Millipedes Captured	Minimum Temperature
3-22	9	52°F
3-23	13	38°F
3-24	2	22°F
3-25	10	36°F
3-27	1	20°F

5.4.4.1 Insect Infestations

Although recent observations did record an epidemic outbreak of the Southern pine beetle, it occurred only in isolated areas within the study area. Mild winters allow overwintering survival and several consecutive mild winters have allowed a build-up of these insects to an epidemic proportion (Stan Clark, pers. comm).

Mr. Clark indicated that an insecticidal program was not recommended. The procedure involves spotting infested areas and notifying owners to salvage

trees by cutting. Although no definite charting has been done, weather conditions do allow a cyclic build-up of the Southern pine beetles about every 7 to 10 years on the average. The normal activity of this insect is to attack trees that are not healthy, but when epidemics occur, the beetles will attack any tree. Basically, the beetles tunnel just under the bark eating through the phloem and cambium layers which produces the same effect as girdling the tree. Needles die very rapidly, often within two weeks following infestation. After build-up of beetles, the natural predators tend to provide control, however, due to a lag in predator build-up, the beetles can do severe damage when in epidemic proportions.

5.4.5 SUMMARY

Since Quadrat 2 has already been planted to slash pine, rapid plant succession to slash pine subclimax forest will occur (Golley and Gentry 1966; Golley 1965; Oosting 1942; Odum 1960; Odum, Connell, and Davenport 1962). Concomitant with this plant succession, the arthropods will undergo a rapid change in both species present and in numbers of individuals. Since the microclimate in Quadrat 2 will probably change when the Monticello Impoundment shoreline is established, there will be a contemporaneous change in the arthropod fauna.

Southern pine beetle infestations observed within the study area were of minor importance. Serious epidemic outbreaks did occur outside the study area and were related to several consecutive mild winters. Since local microclimatic warming in the vicinity of Monticello Impoundment will occur, background information on these beetles could be very important.

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5.5 AMPHIBIANS AND REPTILES

5.5.1 INTRODUCTION

Amphibians and reptiles are often important links in terrestrial and aquatic food webs. A search of the literature revealed that very little has been published on the distribution of hereptofauna in the Piedmont of South Carolina and apparently nothing has been published on this group from Fairfield County.

5.5.2 METHODS AND MATERIALS

Amphibians and reptiles on the Broad River Study Area were collected as they were encountered in the field or along roads. Several specimens were collected in the Broad River and its tributaries incident to invertebrate and fish sampling operations. All specimens were preserved in 10 percent formalin and either identified in the field or in the laboratory. Common and scientific names are from Conant (1958).

5.5.3 FINDINGS AND DISCUSSION

Amphibians and reptiles were observed and collected during the June and September 1971 sampling periods (Table 5.5.1) and were observed in March and November 1972 and March and May 1973, although few were collected. None were observed during the March 1971 and January 1972 sampling periods. Activity of hereptofauna appears to extend from March through November with hibernation occurring during the cooler months from about November to March.

The number of hereptofaunal species expected to range in this area include: 5 toads; 17 frogs; 19 salamanders; 9 turtles; 9 lizards; and 34 snakes (Conant 1958). A much lower count was actually observed or collected on the study site (Table 5.5.1). Because hereptofauna were recorded only as they were encountered, the list represents only a portion of the amphibians and reptiles likely to occur on the Broad River Study Area.

Table 5.5.1 Species list of amphibians and reptiles observed or collected by location and date from the Broad River Study Area.

Species	Study Site or Location	Sampling Period*
Class Amphibia		
Bufo americanus American Toad	2	1
Bufo woodhousei fowleri Fowler's Toad	2; road	1; 2
Rana palustris Pickerel Frog	3A; Frees Cr.	2; 6,7
Desmognathus sp. Dusky Salamander	C	3
Eurycea bislineata Two-lined Salamander	C	2,3
Class Reptilia		
Sternothaerus odoratus Stinkpot Turtle	A; C	1; 7
Kinosternon s. subrubrum Eastern Mud Turtle	C	1,7
Terrapene c. carolina Eastern Box Turtle	Road; forest road	1; 7
Chrysemys p. picta Eastern Painted Turtle	A; C	1; 7
Pseudemys s. scripta Yellow-bellied Turtle	A; B,E; C	1; 7
Pseudemys c. concinna River Cooter	C; E	1,7; 1
Pseudemys rubriventris Red-bellied Turtle	C	7
Trionyx spinifer asper Gulf Coast Softshell Turtle	E; C	1,7
Sceloporus undulatus Fence Lizard	1B,3B; 3A,4	6,7; 1,7
Cnemidophorus sexlineatus Six-lined Racerunner	4	1
Eumeces laticeps Broad-headed Skink	3A	1
Anolis carolinensis Green Anole	Fenceline forest edge Fenceline forest edge	4,6 4,6
Natrix sipedon Water Snake	Broad R.; Frees Cr.	5; 7
Natrix taxispilota Brown Water Snake	C	1
Opheodrys aestivus Rough Green Snake	C	1
Agkistrodon c. contortrix Southern Copperhead Snake	Roadkill 2 mi. N.	1

Table 5.5.1 (Continued)

Species	Study Site or Location	Sampling Period*
Class Reptilia		
Lampropeltis calligaster rhombomaculata Mole Snake	Roadkill 1 mi. S.	5
Thamnophis sauritus Eastern Ribbon Snake	Near G	6

*Sampling Period — Date

Sampling Period	Date
1	6-71
2	9-71
3	3-72
4	11-72
5	3-73
6	5-73
7	8-73

Five of the 23 species of hereptofauna recorded were amphibians, represented by two toads, one frog and two salamander species. The American toad and Fowler's toad were collected at Study Site 2, a grassland-pine plantation. The American toad is found in a wide variety of habitats from grassland to backyards in suburban developments. The Fowler's toad is more restricted in its distribution. Inland from the Coastal Plain, it is found chiefly in sandy areas near lake shores or in river valleys.

A pickerel frog was collected near Study Site 3A along the shore of Frees Creek. Pickerel frogs are usually found near water, ponds, streams, or springs, but wander into grassy fields in the summer. Collection of the pickerel frog is of interest because this species was not previously known from the Piedmont, although Conant (1958) records it in the northwestern part of South Carolina. It has been collected in the Coastal Plain of South Carolina since Conant's work appeared (Albert Sanders, Curator of Natural History, Charlestown Museum, pers. comm.).

Five two-lined salamander larvae were collected during littoral zone sampling in upper Frees Creek during the September 1971 sampling period. During March 1972, five larvae and one adult female two-lined salamanders were collected along with five larvae and one adult male of a species of the dusky salamander at Transect G. The dusky salamander and two-lined salamander are typically found near small brooks and streams in the water or under debris along the shores. They are usually absent from larger streams where predatory fish occur.

Desmognathus sp., a dusky salamander, may represent a previously undescribed species (Dr. Barry Valentine, Ohio State University, pers. comm.). The color pattern resembles D. fuscus although their gill structure is closer

to D. auriculatus. The possibility that it represents a new species is being investigated by Dr. Valentine.

The amphibians are largely primary consumers during early life stages and become secondary or tertiary consumers as adults. The American toad, Fowler's toad, and pickerel frog are carnivores and require an abundance of invertebrates for survival. The pickerel frog may often be at the top of the food web since few snakes will eat this supposedly distasteful frog (Conant 1958).

Eighteen reptile species were observed in the study area. Eight were turtles, five were snakes and five were lizards. All the turtles collected from the Broad River are typically aquatic or semi-aquatic in their habitat preferences. The stinkpot, Eastern mud turtle, and Eastern painted turtle generally prefer shallow freshwater ponds, streams, rivers or lakes. The Eastern painted turtle is most abundant where dense aquatic vegetation grows on soft mud bottoms.

The river cooter is largely a vegetarian (Conant 1958). Yellow-bellied turtles are primarily carnivorous as juveniles but are mainly herbivorous as adults (Clark and Gibbons 1969). The painted turtle has been reported to consume large numbers of mosquito larvae during the summer (Oliver 1955). According to studies made by Karl F. Lagler, the stinkpot turtle is an important scavenger with more than 40 percent of its food being made up of carrion (Oliver 1955).

Many aquatic turtles often bask in the summer sun on logs, stumps, and tree roots along the shore of swamps and water courses of the Broad River Study Area. The sand bars and similar areas of sandy soil found along the bays and creeks of the Broad River serve as sites where some aquatic turtles deposit their eggs. The sun heats the sand which acts as a natural incubator until the young turtles hatch from the eggs and seek water.

The Eastern box turtle, the only land turtle observed on the Broad River Study Area, was observed in deciduous forests and on highways near pine forests and grasslands during the August 1973 sampling period. The Eastern box turtle is found in a variety of terrestrial habitats from woodlands to backyards. It is sometimes found soaking in puddles. It is omnivorous and will feed on leaves, fruits, berries and carrion.

The most frequently observed reptile during the terrestrial program was the fence lizard. This lizard was observed in almost every habitat category (grassland, pine, mixed pine-deciduous, and deciduous forest).

Only one six-lined racerunner and one broad-headed skink were encountered throughout the terrestrial program.

The fence lizzard, broad-headed skink, and green anole favor brush and woodlands where cover is readily available. The fence lizard frequents open pine woods. The green anole is an abundant southern lizard often seen on fences and near buildings. All the fence lizards, broad-headed skinks, and green anoles are active climbers in contrast to the six-lined racerunner which seeks food and shelter on the ground. The racerunner prefers well-drained areas of sandy or loose soils. Its habitats include cavities under dead trees or under other debris in fields, open woods and thicket margins, river flood-plains, etc.

The fence lizard, six-lined racerunner, broad-headed skink, and green anole are carnivorous whose diets consist mainly of insects and spiders.

Snakes are common on the Broad River Study Area but they were infrequently observed. Both the copperhead snake and mole snake were found dead along highways near the study area.

The two species of water snakes occur in or near water where they obtain food. The Eastern ribbon snake and rough green snake are seldom

found far from water but prefer stream-side vegetation in which to search for food. The southern copperhead also frequents swamp and river borders of lowland forests.

The mole snake is a burrower found near thickets, woodlots, cultivated fields, or near residential areas, and is seldom found above ground except when turned up by the plow or following heavy spring or summer rains (Conant 1958).

The rough green snake feeds on insects and spiders while the copperhead snake consumes small rodents, insects, and birds. Both water snakes feed on aquatic or semi-aquatic animals such as frogs, salamanders, small fish and crustaceans.

5.5.4 SUMMARY

Twenty-three species of hereptofauna, including five amphibian, eight turtle, four lizard and six snake species were recorded during the sampling periods. Two species were of particular interest; Desmognathus sp., a dusky salamander which could represent a new species, and Rana palustris, the pickerel frog which has not been previously reported from the Piedmont of South Carolina.

Amphibians and reptiles are important consumers and scavengers in both the aquatic and terrestrial environments and are important prey for other hereptofauna, fish, birds, and mammals.

5.5.5 REFERENCES

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5.6 BIRDS

5.6.1 INTRODUCTION

The relative abundance of various avian species may serve as indicators of environmental changes. As the habitat is altered by man or as natural succession proceeds, the species and numbers of birds using the area will change. The baseline study provides the basis for detecting and evaluating these changes in the avian fauna which correspond to environmental changes.

5.6.2 METHODS AND MATERIALS

5.6.2.1 Survey Periods

Bird observations were made by systematic auto surveys during June and September 1971, January and March 1972, and March and May 1973. Waterfowl and shorebird counts were conducted on the Broad River during March and November 1972, and March and July 1973. Quantitative estimates of birds were obtained by strip census in various vegetation communities during March and May 1973. Common names and scientific names are taken from Robbins, Bruun, and Zim (1966) and Peterson (1947). The residency status is taken from Sprunt and Chamberlain (1970) and the Columbia Bird Club (1967).

5.6.2.2 Wildlife Auto Survey Routes

Four Wildlife Auto Survey Routes (map, back cover) were established to obtain an index of game bird, song bird, and game mammal abundance.

Morning surveys were conducted beginning at the time of official sunrise (U.S. Government Printing Office 1962) during June and September 1971 and January and March 1972. The final two survey periods included in this report, March and May 1973, began one hour following official sunrise when the visibility had increased. Evening surveys were conducted on Wildlife Survey Route A beginning one hour before official sunset during January and March 1972.

Three minutes were spent listening and observing at Stop 1, the

specified distance was driven at the rate of 32 to 48 kilometers per hour (20 to 30 miles per hour), and another three minutes were spent listening and observing at Stop 2. This procedure was followed until completion of each survey route during which all birds and game mammals seen at and between stops were recorded.

The four survey routes were initiated during different survey periods. Before 1973, the distance interval between stops was 1.6 kilometers (1.0 miles) whereas, in March and May 1973, the distance between stops was reduced to 0.8 kilometers (0.5 mile). These changes are summarized as follows:

Survey Route	Total Miles	Number of Stops	Initiating Period
A	9.0	10	June 1971
B	2.0	3	January 1972
A	9.0	19	March 1973
B	2.0	5	March 1973
C	2.5	6	March 1973
D	14.5	31	March 1973

The driver noted time and mileage as well as counted wildlife while the second observer recorded the observations and also counted wildlife. The survey routes were continuous from (C to A to B to D) and ended when all stops had been made (approximately six hours).

Route D was established as a control out of the Broad River Study Area to compare seasonal and annual fluctuations in avian abundance in and out of the study area. The diversity of avian species can also be compared between routes.

At each stop the numbers of calling bobwhite males and calling mourning doves were recorded (the number of calling individuals, not the number of calls).

A mourning dove and bobwhite quail call count survey conducted in May 1973 followed modified procedures described by the United States Bureau of Sport Fisheries and Wildlife. The standardized procedure is described as

follows: The survey is conducted on one day only between May 20 and 31 along an established 20 mile route. The survey begins one half hour before official sunrise. Three minutes are spent listening at Stop 1, 1.6 kilometers (one mile) is driven at an average speed of 40 kph (25 mph), three minutes are spent listening at Stop 2, etc. The number of calling mourning doves are recorded at each stop. The number of mourning doves seen at each stop or during travel are also recorded. Only the driver makes and records all observations and the survey is terminated one mile following the 20th stop.

Modifications were made in the standardized procedure while conducting the survey on the Broad River Study Area. The number of calling bobwhite quail were also counted at each stop. The survey was conducted by two observers for two mornings and contained 25 stops so as to terminate at the end of Wildlife Survey Route D.

5.6.2.3 Strip Census

The Forbes-Gross strip census method described in Graber and Graber (1963) was used to estimate bird populations in various habitats. The method requires two observers to walk in parallel lines a specified distance apart. All birds between and 100 yards in front of the individuals and a specified distance on the outside of the strip were recorded. The area censused was calculated from strip width and distance traveled.

The strip census method was employed in March and May 1973 in a number of areas representing three habitat types on the Broad River Study Area, pine forest, mixed deciduous-conifer forest, and grassland. Birds were censused in forest communities during the mornings and the grassland communities during the afternoons. The width of each strip in all habitats censused was approximately 60 meters (200 feet); 30 meters (100 feet) between the observers and approximately 15 meters (50 feet) on each side of the strip.

5.6.2.4 Bird Census Transects

Birds were also recorded by one observer while walking in relatively homogeneous habitat types. This method was employed in March and May 1973 to obtain additional information about the avian diversity in pine, mixed deciduous conifer, deciduous, and grassland communities.

5.6.2.5 Waterfowl Survey

Waterfowl and shorebird counts were made from a boat on the Broad River and its tributaries. The survey usually began within one hour after official sunrise. Observations were recorded by area: 1) north of Blair, 2) Blair to Hellers Creek, 3) Hellers Creek, 4) Hellers Creek to Frees Creek, 5) Frees Creek, 6) Cannons Creek, and 7) Parr Reservoir. Observations were made by two individuals during the overall survey time of approximately eight hours. Waterfowl surveys were conducted in March and November 1972 and March and July 1973.

5.6.2.6 Additional Sources of Information

During the November 1973 sampling period, four areas on the Broad River flood plain were examined qualitatively for habitat characteristics that would support wood ducks and other game birds. The four sites were: 2.5 miles of lower Frees Creek; a pond at Dawkins; a pond near the mouth of Terrible Creek; and approximately 1.9 kilometers (1.2 miles) of the Broad River between Dawkins and Terrible Creek.

A few ground feeding birds were inadvertently caught and collected in snap traps set for small mammals.

5.6.3 FINDINGS

A list of 117 species of birds was compiled from all field activities on the Broad River Study Area during the six survey periods, excluding the waterfowl survey conducted in November 1972 (Table 5.6.1). Most of the

Table 5.6.1 Birds observed on the Broad River Study Area during six survey periods during 1971-1973.

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Podicipedidae	Podilymbus podiceps	Pied-billed Grebe	0	0	0	X	0	0	P
Phalacrocoracidae	Phalacrocorax auritus	Double-crested Cormorant	0	0	0	X	0	0	W
Anatidae	Anas platyrhynchos	Mallard	X	X	X	X	X	X	W
	Anas rubripes	Black Duck	0	0	0	X	X	0	W
	Anas acuta	Pintail	0	0	0	0	X	0	W
	Anas discors	Blue-winged Teal	0	0	0	X	X	0	W
	Aix sponsa	Wood Duck	X	0	0	X	X	X	P
	Aythya collaris	Ring-necked Duck	0	0	0	0	X	0	W
	Aythya affinis	Lesser Scaup Duck	0	X	X	X	X	0	W
	Bucephala albeola	Buffle-head	0	0	X	X	X	0	W
	Lophodytes cucullatus	Hooded Merganser	0	0	0	X	0	0	W
	Mergus merganser	Common Merganser	0	0	0	X	0	0	W
Cathartidae	Cathartes aura	Turkey Vulture	X	X	X	X	X	X	P
	Coragyps atratus	Black Vulture	X	X	X	X	X	X	P
Accipitridae	Accipiter cooperii	Copper's Hawk	0	0	0	0	X	0	P
	Circus cyaneus	Marsh Hawk	0	0	X	X	X	X	P
	Buteo jamaicensis	Red-tailed Hawk	0	0	X	X	X	X	P
	Buteo lineatus	Red-shouldered Hawk	0	0	0	0	X	0	P
	Buteo platypterus	Broad-winged Hawk	X	0	0	0	0	X	S
Pandionidae	Pandion haliaetus	Osprey	0	X	0	X	C	0	P
Falconidae	Falco sparverius	Sparrow Hawk	0	X	X	X	X	0	P
Phasianidae	Colinus virginianus	Bobwhite	X	X	0	X	X	X	P

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

Table 5.6.1 (Continued)

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Ardeidae	Casmerodius albus	Common Egret	X	0	0	X	0	X	P
	Bubulcus ibis	Cattle Egret	0	0	0	0	0	X	T
	Ardea herodias	Great Blue Heron	X	X	X	X	X	X	P
	Florida caerulea	Little Blue Heron	X	0	0	0	0	0	P
	Butorides virescens	Green Heron	0	0	0	0	0	X	P
	Nycticorax nycticorax loactli	Black-crowned Night Heron	0	0	0	X	0	0	P
Rallidae	Fulica americana	American Coot	0	0	0	X	0	0	P
Charadriidae	Charadrius vociferus	Killdeer	0	0	0	0	X	X	T
Scolopacidae	Actitis macularia	Spotted Sandpiper	0	0	0	0	0	X	S
Laridae	Larus argentatus	Herring Gull	0	0	0	X	0	0	T
	Larus delawarensis	Ring-billed Gull	0	0	0	0	X	0	T
Columbidae	Columba livia	Rock Dove	X	X	X	X	0	X	P
	Zenaidura macroura	Mourning Dove	X	X	X	X	X	X	P
Cuculidae	Coccyzus americanus	Yellow-billed Cuckoo	X	X	0	0	0	X	S
	Coccyzus erythropthalmus	Black-billed Cuckoo	X	0	0	0	0	0	T
Strigidae	Otus asio	Screech Owl	0	X	X	0	0	0	P
Caprimulgidae	Caprimulgus carolinensis	Chuck-will's-widow	X	0	0	0	0	0	S
	Caprimulgus vociferus	Whip-poor-will	0	0	0	X	0	0	S
	Chordeiles minor	Nighthawk	0	0	0	X	0	0	S

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

Table 5.6.1 (Continued)

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Apodidae	Chaetura pelagica	Chimney Swift	X	X	X	0	0	X	S
Trochilidae	Archilochus colubris	Ruby-throated Hummingbird	X	0	0	0	0	X	P
Alcedinidae	Megaceryle alcyon	Belted Kingfisher	0	0	X	0	X	X	P
Picidae	Colaptes auratus	Yellow-shafted Flicker	0	X	X	X	X	X	P
	Dryocopus pileatus	Pileated Woodpecker	0	X	X	X	X	0	P
	Centurus carolinus	Red-bellied Woodpecker	0	0	0	X	X	X	P
	Sphyrapicus varius	Yellow-bellied Sapsucker	0	0	X	X	0	0	W
	Dendrocopos villosus	Hairy Woodpecker	0	0	0	0	X	0	P
	Dendrocopos pubescens	Downy Woodpecker	X	X	X	X	X	X	P
Tyrannidae	Tyrannus tyrannus	Eastern Kingbird	X	0	0	0	0	X	S
	Myiarchus crinitus	Great Crested Flycatcher	0	0	0	0	0	X	S
	Sayornis phoebe	Eastern Phoebe	0	0	X	X	X	X	W
	Contopus virens	Eastern Wood Pewee	X	0	0	0	0	X	S
Hirundinidae	Hirundo rustica	Barn Swallow	X	0	0	X	0	X	S
	Iridoprocne bicolor	Tree Swallow	0	0	0	0	0	X	T
	Riparia riparia	Bank Swallow	0	X	0	0	0	0	T
	Stelgidopteryx ruficollis	Rough-winged Swallow	0	0	0	0	X	0	S
	Progne subis	Purple Martin	X	0	0	X	0	X	S

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

Table 5.6.1 (Continued)

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Corvidae	Cyanocitta cristata	Blue Jay	X	X	X	X	X	X	P
	Corvus brachyrhynchos	Common Crow	X	X	X	X	X	X	P
	Corvus ossifragus	Fish Crow	0	0	0	X	X	X	P
Paridae	Parus carolinensis	Carolina Chickadee	0	X	X	X	X	X	P
	Parus bicolor	Tufted Titmouse	X	X	X	X	X	X	P
Sittidae	Sitta pusilla	Brown-headed Nuthatch	X	0	X	X	X	X	P
Certhiidae	Certhia familiaris	Brown Creeper	0	0	0	0	X	0	W
Troglodytidae	Thryomanes bewickii	Bewick's Wren	0	0	0	X	0	0	W
	Thrythorus ludovicianus	Carolina Wren	X	X	0	X	X	X	P
Mimidae	Mimus polyglottos	Mockingbird	X	X	X	X	X	X	P
	Dumetella carolinensis	Catbird	0	X	0	0	0	X	P
	Toxostoma rufum	Brown Thrasher	X	X	0	X	X	X	P
Turdidae	Turdus migratorius	Robin	X	0	X	X	X	X	P
	Hylocichla mustelina	Wood Thrush	X	0	0	0	0	X	S
	Hylocichla guttata	Hermit Thrush	0	0	X	X	X	0	W
	Sialis sialis	Eastern Bluebird	X	X	X	X	X	X	P
Sylviidae	Polioptila caerulea	Blue-gray Gnatcatcher	0	0	0	X	0	X	S
	Regulus satrapa	Golden-crowned Kinglet	0	0	X	X	X	0	W
	Regulus calendula	Ruby-crowned Kinglet	0	0	X	X	X	0	W

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

Table 5.6.1 (Continued)

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Bombycillidae	Bombycilla cedrorum	Cedar Waxwing	O	O	X	O	O	O	W
Laniidae	Lanius ludovicianus	Loggerhead Shrike	X	X	X	X	X	X	P
Sturnidae	Sturnus vulgaris	Starling	X	X	X	X	X	X	P
Vireonidae	Vireo olivaceus	Red-eyed Vireo	O	O	O	O	O	X	S
Parulidae	Mniotilta varia	Black and White Warbler	O	O	O	X	O	O	S
	Vermivora pinus	Blue-winged Warbler	O	O	O	O	X	X	T
	Dendroica petechia	Yellow Warbler	X	O	O	O	O	O	S
	Dendroica coronata	Myrtle Warbler	O	O	X	X	X	O	W
	Dendroica dominica	Yellow-throated Warbler	O	O	O	X	O	O	P
	Dendroica striata	Blackpoll Warbler	O	O	O	O	O	X	T
	Dendroica pinus	Pine Warbler	O	O	X	X	X	X	P
	Dendroica discolor	Prairie Warbler	O	O	O	O	O	X	S
	Seiurus aurocapillus	Oven-bird	O	X	O	X	O	O	T
	Geothlypis trichas	Yellowthroat	O	O	O	O	O	X	P
	Icteria virens	Yellow-breasted Chat	X	O	O	O	O	X	S
	Wilsonia citrina	Hooded Warbler	O	O	O	O	O	X	S
Ploceidae	Passer domesticus	English Sparrow	X	X	O	X	X	X	P
Icteridae	Sturnella magna	Eastern Meadowlark	X	X	X	X	X	X	P
	Agelaius phoeniceus	Red-winged Blackbird	X	O	O	X	X	X	P
	Quiscalus quiscula	Common Grackle	X	O	O	X	X	X	P
	Molothrus ater	Brown-headed Cowbird	X	O	O	X	O	X	P
	Icterus spurius	Orchard Oriole	O	O	O	O	O	X	S

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

Table 5.6.1 (Continued)

Family	Scientific Name	Common Name	6-71	9-71	1-72	3-72	3-73	5-73 7-73	Status*
Thraupidae	Piranga rubra	Summer Tanager	X	0	0	0	0	X	S
Fringillidae	Richmondena cardinalis	Cardinal	X	X	X	X	X	X	P
	Guiraca caerulea	Blue Grosbeak	X	X	0	0	0	X	S
	Passerina cyanea	Indigo Bunting	X	0	0	0	0	X	S
	Hesperiphona vespertina	Evening Grosbeak	0	0	0	X	0	0	W
	Carpodacus purpureus	Purple Finch	0	0	X	0	X	0	W
	Spinus tristis	American Goldfinch	0	0	X	X	0	X	P
	Loxia curvirostra	Red Crossbill	0	0	0	0	X	0	W
	Pipilo erythrophthalmus	Rufous-sided Towhee	X	X	X	X	X	X	P
	Passerculus sandwichensis	Savannah Sparrow	0	0	0	X	0	0	W
	Pooecetus gramineus	Vesper Sparrow	0	0	X	0	X	X	W
	Junco hyemalis	Slate-colored Junco	0	0	X	X	X	0	W
	Spizella passerina	Chipping Sparrow	0	X	X	X	X	X	P
	Spizella pusilla	Field Sparrow	0	0	X	X	X	X	P
	Zonotrichia leucophrys	White-crowned Sparrow	0	0	0	X	X	0	W
	Zonotrichia albicollis	White-throated Sparrow	0	0	X	X	X	0	W
	Melospiza melodia	Song Sparrow	0	0	X	X	X	X	W
Total Species per Survey Period			45	36	46	74	63	63	

Totals: 40 Families; 117 Species

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

117 species of birds recorded were permanent residents (55 species) while 28 species were winter residents, 24 species were summer residents, and 10 species were transients.

5.6.3.1 Wildlife Survey Routes

5.6.3.1.1 Abundance of Birds

The number of birds recorded per route per stop is presented by season in Figure 5.6.1. The highest numbers of birds were recorded during the summer season. Wildlife Survey Routes A and B during the spring and Route A during the summer represent two year averages. The high number recorded on Route C during the spring is because migratory robins and grackles contributed to 72 percent of the total birds in 1973.

The variability of habitats at each stop influences the variety and number of birds recorded. The least number of birds were recorded at stops where loblolly pine was the dominant habitat type while the greatest number were recorded at stops where grassland was the most prevalent habitat. An increase in the diversity of species was usually associated with wildlife-survey-route stop locations surrounded by a variety of habitat types. The high abundance of birds associated with grassland communities was the result, in part, of an increase in the area visible to the observer. In comparison, forested areas effectively reduce visibility, especially when foliage was present.

The evening wildlife surveys conducted in January and March 1972 reflect similar results, with greater abundance of birds at stops from grassland communities as compared to pine communities. The downy woodpecker, Eastern phoebe, and Eastern purple finch were the only species recorded during an evening survey that were not observed during one of the four seasonal morning wildlife surveys conducted in 1971 and 1972. In addition, fewer total birds were observed during the two evening surveys and, consequently, the evening surveys were dis-

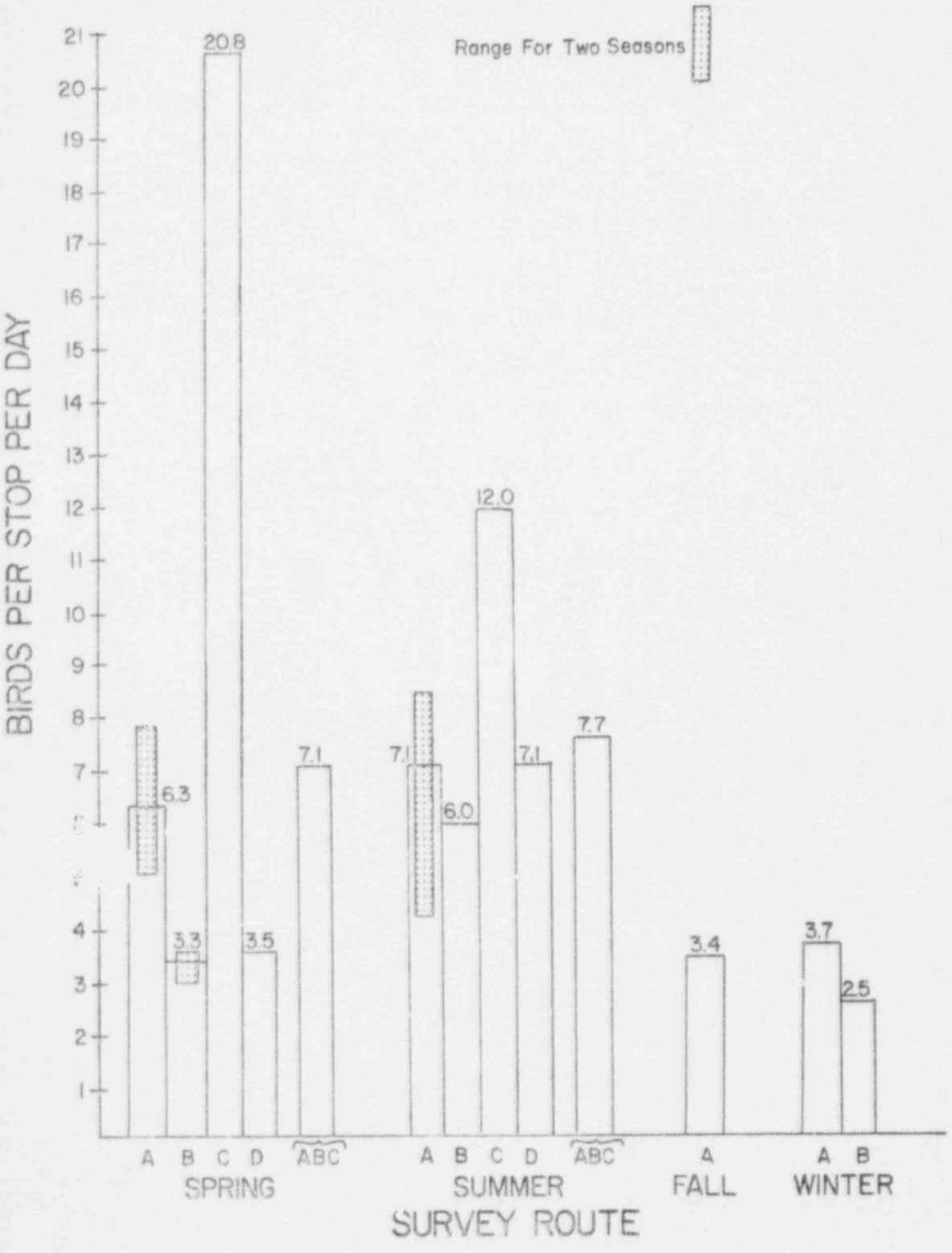


Figure 5.6.1 Average number of birds recorded on each wildlife survey route.

continued.

5.6.3.1.2 Diversity of Birds

It was indicated that the diversity of avian species recorded by the auto wildlife surveys on the Broad River Study Area was usually highest at stops where a variety of habitats occurred.

Survey Route D, initiated in March 1973, was chosen as a control to show whether changes in the abundance and diversity of birds were occurring off as well as on the site. A Chi-square test was used to indicate whether the similarity of avian species was different between the two areas; Route D off the study area, and combined Routes A, B & C on the study area during March and May, 1973. In May the species diversity was not significantly different (26 percent dissimilar). In March, 37.5 percent of the 40 species observed were dissimilar and a significant difference was recorded. The species listed as dissimilar were normally low in abundance with sparce distribution and they were infrequently sighted.

5.6.3.1.3 Fluctuations in Indicator Species

The Wildlife Survey Routes provide information on seasonal abundance and diversity of birds on the Broad River Study Area. An analysis of the seasonal abundance and annual trend in avian populations on the Broad River Study Area will be restricted to a few species chosen as indicators of change in the environment. Before identifying the select species it is important to first describe the criteria used to select indicator species.

Environmental changes, either slight or wide ranging, should cause change in the abundance indices of many avian species. Such avian species would be indicators of these changes in the environment. In order to select indicator species, the following four criteria were used; 1) particular habitat preference, 2) relative abundance, 3) random distribution within the limits

of its habitat, and 4) small home range of movement. In addition to these criteria, birds that are permanent residents provide a continuous, more desirable annual index and it is also desirable that each trophic level be represented among the indicator species.

Avian species that have a narrow tolerance limit toward change in the environment, including being limited by preference or selective forces toward a single community type are ideal species as indicators of change. Birds that accept a variety of habitats are least likely candidates as indicators of change.

The second criteria, relative abundance, requires that each species chosen be numerous on the study area such that they are readily observable and a mathematical mean and variance can be calculated during the baseline investigations. It is recognized that the accumulation of observations of several indicator species may prove a better measure of environmental change than an individual species.

A random distribution negates recording several specimens with aggregate distribution on one day and then not recording any on the following day of survey when the group was not observed. The effect of this behavior would result in indices having wide natural fluctuations.

The final criteria requires that the species have a narrow range of movement. If the daily movement of a species covers too large an area, it would result in wide fluctuations in the index.

It is recognized that every likely indicator species will not fit all of these criteria. The following species recorded on the Broad River Study Area have been designated as potential indicators of environmental change based on the above four criteria, however, additions and deletions may occur during the course of the study:

Wood Duck	Mockingbird
Great Blue Heron	Loggerhead Shrike
Mourning Dove	Red-winged Blackbird
Eastern Bluebird	Eastern Meadowlark
	Belted Kingfisher

5.6.3.1.4 Game Bird Call Counts

Calling mourning doves were counted during all wildlife auto surveys with the exception of June 1971. The number of doves recorded per stop per survey period was as follows:

Period	Survey Route	Stops	Doves/Stop/Day
Sept. 1971	A	10	0.04
Jan. 1972	A & B	13	0.00
March 1972	A & B	13	0.03
March 1973	A, B, C, & D	61	0.02
May 1973	A, B, & C	30	0.08
May 1973	D	31	0.04

The greatest number of doves heard or seen per stop per day occurred during May 1973. Also, in May 1973, a special two day dove survey was conducted during the two week period that the national dove-call-counts were conducted. The average number of calling doves per stop for the first twenty stops can be used for comparison with the nationally conducted surveys. A total of 15 doves were heard on the two mornings. This represents an average of 0.38 calling doves per stop per day.

The number of calling bobwhite quail heard during each stop along the Wildlife Auto Survey Routes is presented below:

Period	Route	Days	Stops	Quail/Stop/Day
June 1971	A	3	10	1.53
Sept. 1971	A	5	10	0.00
Jan. 1972	A & B	5	13	0.00
March 1972	A & B	5	13	0.04
March 1973	A, B, C, & D	2	61	0.00
May 1973	A, B, & C	3	30	0.35
May 1973	D	3	31	0.22

The data for June 1971 represents an average of 1.53 quail heard

per stop per day. The data for May 1973 represents an average of 0.35 quail heard per stop per day on Routes A, B, and C combined. This suggests a decline in quail abundance from 1971 to 1972. Only 0.22 quail were heard per stop per day on Route D. Twenty-five bobwhite quail were heard on twenty stops during the two day special dove survey. This represents an average of 0.63 bobwhite per stop per day.

5.6.3.2 Bird Census

The variety and number of birds per 40 hectares (100 acres) recorded by the strip census method in three general habitat types are shown in Tables 5.6.2 and 5.6.3. Each location chosen for the census of birds is variable in the age structure and species composition of vegetation. Data collected from similar sites, such as pine, were combined to provide a more accurate assessment of bird abundance and species diversity found in each major habitat category. Sampling Site 4, however, where loblolly pine had been selectively removed in March 1972, is presented separately in Table 5.6.2. Another exception, is the separate tabulation of bird abundance on the two grassland communities (Sites 2 and 6). The species diversity between the two grassland communities was significantly different as tested by Chi-square in March ($0.05>P>0.025$) and in May ($0.05>P>0.025$).

Nineteen species of birds were recorded by strip census in grassland habitat, 17 in pine forest, and 16 in mixed deciduous-pine forest in March 1973. In May 1973, 20 species of birds were recorded in the grassland habitat and 15 in the pine communities. A strip census was not conducted in the mixed deciduous-pine forest. The greatest number of birds per 40 hectares (100 acres) occurred in the grassland habitat during both sampling periods.

The combined strip census and census transect data (Tables 5.6.2 and 5.6.3) show that 25, 16, and 17 species were recorded in the pine, grass-

Table 5.6.2 Birds recorded by strip census and census transects in various habitats on the Broad River Study Area, March 1973.

	Strip Census					Census Transects	
Common Name	Pine Forest	Cut Pine Site 4	Grassland Site 2	Grassland Site 6	Mixed	Grassland	Mixed
Turkey Vulture	1	-	-	-	1	-	-
Cooper's Hawk	1	-	-	-	-	-	-
Marsh Hawk	-	-	-	-	-	1	-
Red-shouldered Hawk	-	-	-	-	1	-	-
Unidentified Hawk	-	-	-	-	1	-	-
Bobwhite	-	-	-	2	6	11	9
Belted Kingfisher	-	-	-	1	-	-	-
Yellow-shafted Flicker	2	-	-	-	-	1	-
Red-bellied Woodpecker	-	-	-	-	1	-	-
Hairy Woodpecker	-	1	-	-	1	-	-
Unidentified Woodpecker	1	-	-	-	-	-	-
Blue Jay	1	-	-	-	-	-	-
Carolina Chickadee	6	2	1	-	2	1	-
Tufted Titmouse	1	-	1	-	-	-	-
Brown-headed Nuthatch	2	-	-	-	-	-	-
Unidentified Nuthatch	1	-	-	-	-	-	-
Brown Creeper	-	-	-	-	2	-	-
Carolina Wren	1	-	-	-	6	4	-
Unidentified Wren	-	-	-	-	1		-
Mockingbird	-	-	-	-	-	1	-
Brown Thrasher	-	-	-	-	-	1	-
Robin	1	-	-	-	-	2	-
Hermit Thrush	2	-	-	-	-	-	-
Unidentified Thrush	-	1	-	-	3	-	-
Golden-crowned Kinglet	7	-	-	-	-	-	-
Ruby-crowned Kinglet	1	-	-	-	1	-	-
Unidentified Kinglet	1	-	-	-	2	-	-
Blue-winged Warbler	6	-	-	-	-	-	-
Myrtle Warbler	-	-	-	-	3	-	-
Unidentified Warbler	-	-	-	-	9	-	-
Eastern Meadowlark	-	-	20	2	-	2	-
Common Grackle	1	-	-	-	-	-	-

Table 5.6.2 (Continued)

Common Name	Strip Census					Census Transects	
	Pine Forest	Cut Pine Site 4	Grassland Site 2	Grassland Site 6	Mixed	Grassland	Mixed
Cardinal	-	-	-	-	3	4	-
Rufous-sided Towhee	1	1	-	-	1	5	-
Slate-colored Junco	-	-	-	-	-	8	-
Chipping Sparrow	-	1	-	1	-	4	-
Field Sparrow	-	-	-	3	-	-	2
White-throated Sparrow	-	-	-	-	3	3	3
Song Sparrow	5	-	-	-	5	2	-
Unidentified Sparrow	1	-	7	7	-	3	2
Unidentified Birds	3	-	-	-	5	-	-
Total Birds	46	6	29	16	57	53	16
Number of Species	17	5	4	5	17	15	3
Area censused (ha)	20.2	5.6	5.8	7.3	11.0	-	-
Birds per 40 hectares	92	44	201	89	63	-	-

Table 5.6.3 Birds recorded by strip census and census transects in various habitats on the Broad River Study Area, May 1973.

	Strip Census			Transect		
	Pine	Grassland Site 2	Grassland Site 6	Pine Site 3B	Selectively Cut Pine Site 4	Mixed
Black Vulture	-	-	2	-	-	-
Broad-winged Hawk	-	-	-	-	1	-
Bobwhite	-	3	4	-	-	-
Mourning Dove	-	1	-	-	-	-
Yellow-billed Cuckoo	4	-	-	-	-	-
Chimney Swift	2	-	3	-	-	-
Unidentified Woodpeckers	-	-	-	-	-	2
Eastern Kingbird	-	-	4	-	-	-
Great Crested Flycatcher	1	-	-	-	-	-
Eastern Wood Pewee	1	-	-	-	-	8
Barn Swallow	-	3	1	-	-	-
Tree Swallow	2	-	-	-	-	-
Blue Jay	5	-	1	-	-	1
Fish Crow	-	-	-	-	-	3
Carolina Chickadee	-	-	-	2	-	1
Tufted Titmouse	2	-	-	-	-	3
Brown-headed Nuthatch	-	-	-	4	-	-
Carolina Wren	-	-	-	-	3	-
Mockingbird	2	2	-	-	-	-
Robin	1	-	-	-	-	2
Wood Thrush	1	-	-	-	-	-
Blue-gray Gnatcatcher	-	-	-	-	2	-
Red-eyed Vireo	-	-	-	-	-	1
Blackpoll Warbler	4	-	-	-	-	-
Pine Warbler	2	-	-	-	-	-
Prairie Warbler	5	8	1	-	1	-
Yellowthroat	-	-	3	-	-	-
Yellow-breasted Chat	-	-	3	-	-	-
Unidentified Warbler	7	-	-	-	-	2
Eastern Meadowlark	-	5	4	-	-	-

Table 5.6.3 (Continued)

	Strip Census			Transect		
	Pine	Grassland Site 2	Grassland Site 6	Pine Site 3B	Selectivity Cut Pine Site 4	Mixed
Red-winged Blackbird	-	-	9	-	-	-
Common Grackle	-	2	10	-	-	3
Brown-headed Cowbird	-	1	-	-	-	-
Summer Tanager	-	-	-	-	-	3
Cardinal	2	-	-	1	-	1
Blue Grosbeak	-	-	5	-	-	-
Indigo Bunting	-	2	7	-	-	-
American Goldfinch	-	-	1	-	-	-
Rufous-sided Towhee	1	-	-	2	2	-
Vesper Sparrow	-	1	-	-	-	-
Field Sparrow	-	3	6	-	-	-
Unidentified Sparrow	-	4	1	-	-	-
Unidentified Birds	17	4	3	2	1	17
Total Birds	59	39	68	11	10	47
Number of Species	15	11	16	4	5	10
Area censused (ha)	11.1	6.4	7.3	-	-	-
Birds per 40 hectares	216	252	378	-	-	-

land, and mixed deciduous-conifer communities respectively, in March, and 18, 20, and 11 species, respectively, were observed in May 1973. As expected, the species diversity between habitats for each season was not similar.

5.6.3.3 Waterfowl Survey

Twenty-two species of waterfowl and shorebirds were observed along the Broad River between the Enoree River and Parr Reservoir during four sample periods; March and November, 1972, and March and July, 1973 (Table 5.6.4). It was assumed that the occurrence of waterfowl in specific areas indicates seasonal preference and use. Table 5.6.4 shows that migratory and wintering waterfowl were found in all of the assigned divisions of the survey route, however, most of them were flushed near Frees Creek, Cannons Creek, and the broad expanse of water retained by Parr Dam. Wood ducks, the major breeding waterfowl in South Carolina, were most abundant in the Enoree River during the spring and fall as well as in Hellers Creek and near Frees Creek during the fall season.

Two wood duck broods were observed during the July 1973 waterfowl survey. A single brood (7 ducklings) was seen in a pond adjacent to the mouth of the Enoree River. The second brood (one duckling) was seen at the west end of the impounded portion of Hellers Creek.

5.6.3.4 Additional Findings

5.6.3.4.1 Suitable Wood Duck and Other Game Bird Habitat

An assessment was made of the vegetation composition in upper, middle, and lower story; crown density; and the presence of visible cavities in each of the four areas examined during the November 1972 sample period.

The hike along lower Frees Creek commenced at the Southern Railroad Railway bridge that spans Frees Creek near its confluence with the Broad River and ended some 4.1 km (2.5 miles) upstream. The lowland deciduous forest was composed primarily of oak, sycamore, ash, and hickory. Pine formed the

Table 5.6.4 Maximum waterfowl and shorebirds seen any one day along the boat survey route during four study periods.

Common Name	Broad & Enoree River north of Blair, S.C.				Broad River from Blair south to Hellers Creek				Hellers Creek				Broad River from Hellers Creek to Frees Creek			
	1972		1973		1972		1973		1972		1973		1972		1973	
	Mar	Nov	Mar*	Jul*	Mar	Nov	Mar*	Jul*	Mar	Nov*	Mar*	Jul*	Mar	Nov	Mar*	Jul*
Eared Grebe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pied-billed Grebe	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Unidentified Grebe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mallard	7	1	2	1	4	-	2	-	2	13	-	-	5	-	-	-
Black Duck	-	-	-	-	-	-	-	-	-	5	-	-	4	-	-	-
Pintail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoveler	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue-winged Teal	2	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
Wood Duck	23	24	15	10	2	9	2	1	1	32	10	2	-	1	2	-
Ring-necked Duck	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Unidentified Scaup	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-
Bufflehead	-	1	-	-	-	3	-	-	-	-	-	-	4	-	-	-
Ruddy Duck	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
Common Merganser	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Hooded Merganser	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Unidentified Merganser	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Common Egret	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Great Blue Heron	4	3	-	1	5	11	1	1	2	5	1	3	-	5	3	1
Green Heron	-	-	-	2	-	-	-	4	-	-	-	3	-	-	-	3
Black-crowned Night Heron	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
American Coot	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Spotted Sandpiper	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Ring-billed Gull	-	-	-	-	-	-	3	-	-	-	4	-	-	-	-	-
Belted Kingfisher	-	1	2	2	-	2	-	8	-	3	1	4	-	1	2	2
Unidentified Ducks	6	7	3	-	2	30	-	-	1	-	-	-	2	-	31	-
Minimum No. of Species	5	7	3	5	6	6	5	5	4	5	6	5	4	4	3	3

* Two day observation
** One day observation

Table 5.6.4 (Continued)

Common Name	Frees Creek 1972 Mar	Frees Creek 1972 Nov*	Frees Creek 1973 Mar*	Frees Creek 1973 Jul*	Cannons Creek 1972 Mar	Cannons Creek 1972 Nov**	Cannons Creek 1973 Mar*	Cannons Creek 1973 Jul*	Parr Reservoir 1972 Mar	Parr Reservoir 1972 Nov	Parr Reservoir 1973 Mar*	Parr Reservoir 1973 Jul*
Eared Grebe	-	-	-	-	-	-	-	-	-	1	-	-
Pied-billed Grebe	-	1	-	-	-	-	-	-		-	-	-
Unidentified Grebe	-	-	-	-	1	-	-	-	-	-	-	-
Mallard	2	-	14	2	2	5	-	-	18	1	17	-
Black Duck	7	12	-	-	-	-	-	-	12	-	4	-
Pintail	-	-	1	-	-	-	-	-	-	-	-	-
Shoveler	-	-	-	-	-	-	-	-	-	-	-	-
Blue-winged Teal	-	-	-	-	-	-	1	-	3	-	-	-
Wood Duck	-	28	13	4	-	3	-	-	-	-	4	2
Ring-necked Duck	-	-	-	-	-	-	-	-	-	2	6	-
Unidentified Scaup	-	-	-	-	-	-	-	-	71	15	54	-
Bufflehead	-	-	-	-	-	-	-	-	5	3	24	-
Ruddy Duck	-	6	-	-	-	-	-	-	-	22	-	-
Common Merganser	-	-	-	-	-	-	-	-	1	-	-	-
Hooded Merganser	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Merganser	-	-	-	-	-	-	-	-	-	-	-	-
Common Egret	-	-	-	1	-	-	-	-	-	-	-	-
Great Blue Heron	4	12	5	1	4	5	3	1	2	2	2	1
Green Heron	-	-	-	6	-	-	-	3	-	-	-	-
Black-crowned Night Heron	-	-	-	-	-	-	-	-	-	-	-	-
American Coot	-	-	-	-	-	1	-	-	4	34	-	-
Spotted Sandpiper	-	-	-	-	-	-	-	-	-	-	-	-
Ring-billed Gull	-	-	-	-	-	-	-	-	-	-	-	-
Belted Kingfisher	-	3	2	4	-	-	2	-	-	-	1	-
Unidentified Ducks	2	-	2	-	2	-	2	-	4	-	-	-
Minimum No. of Species	3	6	5	6	3	4	3	2	8	8	8	2

* Two day observation
** One day observation

forest on the upland sides of the flood plain valley.

Both pine and deciduous trees with a dbh between 23 and 38 cm (9 and 15 in) at cut surface, had been removed in several localities along Frees Creek. Sedge, spikerush, cane, raspberry, and honeysuckle were beginning to develop under the open canopy. A transmission line right-of-way contained the highest density of middle and lower story vegetation encountered during the hike.

Tree cavities were most frequently observed in the first quarter-mile of the hike, near the railroad bridge. Oak, shagbark hickory, and sycamore trees contained visible cavities. Few cavities were observed in trees in more northern areas of the 4.1 km traveled.

The pond at Dawkins was entirely surrounded by a lowland deciduous forest with a closed canopy. A middle story was absent and a mixture of grass-sedge was found on the flooded south end. Only a few cavities in sycamore and cottonwood trees were noticed.

The pond on Terrible Creek was bordered on the east, north, and west by a forest of cottonwood, ash, and oak. The more upland, southern side, consisted of loblolly pine with a middle story absent. Willow and other shrubs bordered the eastern side of the pond. Lower story vegetation bordering the pond was predominantly smartweed and sedge. Tree cavities were not noticed around Terrible Creek.

A lowland forest of oak, cottonwood, ash, and pine bordered the Broad River between Dawkins and Terrible Creek. The middle story consisted primarily of cottonwood, especially where the ground had been cleared for cultivation and abandoned. Infrequent patches of cane and smartweed were observed under the partially open forest canopy. A few cavities were seen in sycamore and cottonwood trees.

5.6.3.4.2 Birds Inadvertently Snap Trapped

During the March 1972 sample period, three savannah sparrows (Passerculus sandwichensis) were collected in snap traps on the grassland, Site 2 (map, back cover). On Study Site 4, a pine forest, a broad-winged hawk (Buteo platypterus) was caught during the June 1971 sample period and a hermit thrush (Hylocichla guttata) was caught during the March 1972 sample period. An oven-bird (Seiurus aurocapillus) was caught in a snap trap on Study Site 1 in March 1972.

5.6.4 DISCUSSION

A total of 234 bird species may utilize the Broad River Study Area during their seasonal migrations (Peterson 1947; Robbins, Bruun and Zim 1966; Columbia Bird Club 1967; Sprint and Chamberlain 1970). This includes 65 permanent residents, 50 winter residents, 43 summer residents, and 76 transient residents. Of these, 81 percent, 56 percent, and 13 percent, respectively, were observed and included in the 117 species recorded on the Broad River Study Area (Table 5.6.1).

An annual Christmas bird countin the Columbia, South Carolina area was initiated in 1959 under the direction of the National Audubon Society. Eighty-six species of birds have been recorded during the last five annual Christmas bird counts (Table 5.6.5). These counts are taken in Richland and Lexington Counties within a 24.1 km (15 mile) diameter circle with its center at the intersection of Gills Creek and Bluff Road approximately 48.2 km (30 miles) southeast of the project site. The sampled area is 25 percent deciduous forest along river and creek swamps, 20 percent pine woods, 30 percent fields, 20 percent lake shores, and 5 percent urban. This area is quite different from the Broad River Study Area in which pine woods are more abundant, the proportion of deciduous forest, fields, and lake shores is less, and urban areas are nearly absent.

Table 5.6.5 Annual Christmas Bird Counts taken by National Audubon Society near Columbia, South Carolina in 1968, 1969, 1970, 1971, and 1972 (Cruikshank 1969; 1970; 1971; Gilbert Bristow, pers. comm.).

Common Name of Species Observed	Number of Individuals Counted				
	1968	1969	1970	1971	1972
Pied-billed Grebe	9	4	7	7	10
Great Blue Heron	6	0	1	3	2
Common Egret	0	0	0	0	4
Mallard	6	6	8	0	4
Black Duck	0	8	0	0	0
Wood Duck	1	11	0	2	10
Ring-necked Duck	116	22	2	2	34
Lesser Scaup	0	14	0	1	0
Ruddy Duck	0	0	1	0	0
Turkey Vulture	0	1	0	3	0
Black Vulture	3	7	0	7	3
Cooper's Hawk	0	1	0	1	1
Red-tailed Hawk	3	7	1	10	27
Red-shouldered Hawk	7	3	2	6	2
Marsh Hawk	2	3	2	1	15
Sparrow Hawk	12	4	5	8	16
Bobwhite	23	1	22	4	22
American Coot	20	20	21	22	36
Killdeer	12	19	12	22	44
American Woodcock	0	1	0	0	0
Common Snipe	0	1	0	0	0
Herring Gull	1	0	0	8	0
Ring-billed Gull	123	33	115	71	210
Mourning Dove	175	252	19	154	16
Barn Owl	0	1	1	0	0
Great Horned Owl	1	0	0	0	0
Belted Kingfisher	2	5	1	7	2
Yellow-shafted Flicker	7	14	16	60	39
Pileated Woodpecker	1	2	2	2	5
Red-bellied Woodpecker	4	4	5	24	10
Red-headed Woodpecker	0	5	0	7	11
Yellow-bellied Sapsucker	7	4	5	17	18
Hairy Woodpecker	2	1	1	3	1
Downy Woodpecker	17	6	3	8	2
Red-cockaded Woodpecker	0	0	0	1	0
Eastern Phoebe	5	3	1	7	0

Table 5.6.5 (Continued)

Common Name of Species Observed	Number of Individuals Counted				
	1968	1969	1970	1971	1972
Blue Jay	37	61	43	52	94
Common Crow	26	20	18	50	24
Carolina Chickadee	18	32	12	39	23
Tufted Titmouse	4	7	11	6	9
White-breasted Nuthatch	0	0	0	0	4
Brown-headed Nuthatch	15	2	2	3	3
Brown Creeper	2	0	1	0	0
Winter Wren	0	0	0	0	1
House Wren	0	0	1	0	0
Carolina Wren	5	12	8	27	31
Mockingbird	25	42	31	28	69
Catbird	0	0	1	0	0
Brown Thrasher	9	10	11	3	22
Robin	152	31	108	23	68
Hermit Thrush	2	2	4	5	0
Eastern Bluebird	31	4	8	12	11
Golden-crowned Kinglet	5	3	1	4	2
Ruby-crowned Kinglet	8	18	12	24	37
Water Pipit	19	0	150	25	0
Cedar Waxwing	17	0	27	17	4
Loggerhead Shrike	9	1	8	8	9
Starling	1,100	680	311	182	290
Solitary Vireo	1	0	0	0	0
Myrtle Warbler	0	13	1	4	7
Pine Warbler	3	14	1	7	0
Palm Warbler	0	0	0	0	8
English Sparrow	91	248	0	0	141
Eastern Meadowlark	118	297	180	205	147
Red-winged Blackbird	11,350	10,350	1,521	2,442	3,477
Baltimore Oriole	0	0	0	2	0
Rusty Blackbird	1	1	0	0	0
Brewer's Blackbird	0	0	40	3	40
Common Grackle	31	611	38	610	422
Brown-headed Cowbird	35	451	200	220	160
Cardinal	88	314	53	90	95
Evening Grosbeak	37	0	0	22	150
Purple Finch	2	88	0	3	17
Pine Siskin	10	24	0	0	0

Table 5.6.5 (Continued)

Common Name of Species Observed	Number of Individuals Counted				
	1968	1969	1970	1971	1972
American Goldfinch	46	211	103	53	87
Rufous-sided Towhee	43	130	31	47	97
Savannah Sparrow	15	17	51	506	185
Vesper Sparrow	19	1	0	0	13
Slate-colored Junco	133	57	232	5	64
Chipping Sparrow	11	6	3	2	7
Field Sparrow	59	41	71	25	145
White-crowned Sparrow	3	0	0	0	0
White-throated Sparrow	264	202	221	219	420
Fox Sparrow	1	0	5	2	2
Swamp Sparrow	3	2	0	2	6
Song Sparrow	45	64	31	37	81
Species per Year	67	66	60	66	64
Total Individuals	14,456	14,530	3,803	5,475	7,009

The evening grosbeak observed during the March 1972 sampling period was the only bird recorded that was not listed as a bird occurring in South Carolina (Sprunt and Chamberlain 1970). However, it also was observed during the 1968, 1971, and 1972 Christmas bird counts.

The three red crossbills observed on Survey Route D in March 1973 are considered a rare and irregular winter resident in South Carolina according to Sprunt and Chamberlain (1970).

5.6.4.1 Endangered or Threatened Species

The American osprey recorded on the Broad River Study Area during the June 1971 and March 1972 sampling periods (Table 5.6.1) is listed as "Status Undetermined" (e.g., additional information needed to determine status) by the U.S. Bureau of Sport Fisheries and Wildlife (1973). National Audubon Society biologists now feel that the number of osprey appears to be declining and have included it on their "Blue List" (Anon. 1971). Other populations observed on the study area that may be declining and thus appear on the "Blue List" include the double-crested cormorant, black-crowned night heron, turkey vulture, black vulture, marsh hawk, Bewick's wren, and loggerhead shrike.

The eastern pigeon hawk, also included as "status - undetermined" by the U.S. Bureau of Sport Fisheries and Wildlife (1973), has not been recorded on the Broad River Study Area. This bird of prey winters from southern Texas, east to South Carolina and south to the West Indies and northern South America. According to Sprunt and Chamberlain (1970), the eastern pigeon hawk is a fairly common winter resident over much of the state but most frequent along the coast. The pigeon hawk frequents open country, fields, beaches, and marshes.

The southern bald eagle, red-cockaded woodpecker, and Bachman's warbler, known from South Carolina, are listed as threatened species by the U.S. Bureau of Sport Fisheries and Wildlife (1973).

The southern bald eagle is a fairly common permanent resident of the coastal region of South Carolina (Sprunt and Chamberlain 1970). Nesting primarily in estuarine areas of the Atlantic and Gulf Coasts, the bald eagle is locally common from New Jersey to Texas, and lower Mississippi Valley southward from eastern Arkansas and western Tennessee, and through southern states west to California and Baja California.

Eagles nest in mid-winter and actively migrate during the spring and summer, remaining in the southeast, or traveling as far north as southeastern Canada. They return in the fall and early winter. One adult bald eagle was observed at Parr Reservoir by personnel of the South Carolina Electric and Gas Company in early August, 1973, during this migratory period. No nests have been seen during any of the field work conducted by Dames & Moore personnel.

The red-cockaded woodpecker is not known to be on the Broad River Study Area, although it was observed near Columbia during the 1971 Christmas bird count (Table 5.6.5). Recent investigations have not discovered this species in Fairfield or Newberry Counties, South Carolina (Jackson 1971). The red-cockaded woodpecker has a strong habitat preference for open, mature pine forests and a nest site preference for pines that are infected with red heart disease.

Bachman's warbler is listed as a threatened species by the Office of Endangered Species and International Activities of the Department of the Interior (U.S. Bureau of Sport Fisheries and Wildlife 1973). The warbler's present distribution is known only from recent observations of non-breeding individuals in Virginia, Alabama, and near Charleston and the Francis Marion National Forest, South Carolina. So few individuals are seen that little is known of its present breeding or wintering distribution. The former breeding distribution included the river swamp forests of southeastern Missouri, northeastern Arkansas, western Kentucky, central Alabama, and South Carolina.

Migrations to and from the wintering range in Cuba, is during early spring and fall (Chapman 1968). Spring migration, through Florida, occurs in March and fall migration occurs in July and August.

The nesting habitat described from near Charleston, South Carolina, in 1906 included heavily timbered, swampy land with more or less stagnant water. The few nests found in Missouri, South Carolina, and Kentucky were in low brushes, briers, or canes less than one meter (two to three feet) above the ground. Habitat comparable to this description only occurs in small, local areas on the Broad River Study Area.

5.6.4.2 Song Birds

5.6.4.2.1 Diversity

The three different terrestrial bird census methods employed on the Broad River Study Area contributed to the accumulative list of birds. The morning wildlife survey routes conducted during six seasons contributed 62.6 percent of the total 117 species identified on the study area. The avian strip census and census transects contributed 50.4 percent of the total species observed in March and 64.4 percent of the 90 species identified in May. The majority of waterfowl and shorebirds were recorded during the censuses on the Broad River.

The comparison of bird diversity between the control Route D and Routes A, B, and C showed that the on-site and off-site routes were comparable during May 1973. A significant difference was found in March 1973 but the species that were dissimilar were low in abundance, therefore, it was concluded that the species diversity was similar between routes during the spring as well as the summer.

5.6.4.2.2 Abundance

Only a general consideration of the abundance of birds will be made

at this time. Each of the nine avian species that were selected as indicators of environmental change will be looked at more intensely once the construction phase has begun.

The degree to which the chosen indicator species meets each of the four previously mentioned selection criteria varies. All of the indicator species meet the first criteria except the mockingbird. The mockingbird utilizes a variety of habitat types throughout the year. The relative abundance of all nine species is considered sufficient for analysis. However, the relative abundance of the loggerhead shrike is low, but it is included in the list because shrikes are seen with some regularity. The criteria of random distribution is met by the great blue heron, mockingbird, loggerhead shrike, and belted kingfisher. Breeding behavior or gregarious behavior in the spring and fall are the primary reasons that the remaining species do not comply with this criteria. The fourth criteria, that of having a restricted range of movement, is met by the Eastern meadowlark, and belted kingfisher. The wood duck and great blue heron are generally restricted to the aquatic environs of the Broad River and adjoining tributaries. The mourning dove and mockingbird are usually wide-ranging in their movements.

The aquatic species, wood duck, great blue heron, red-winged blackbird, and belted kingfisher, should show changes in abundance and distribution with the proposed increase in aquatic environs and a change in shorelines. The direction and amount of change should be detected during future operational investigations.

The abundance of birds, based on the auto survey routes, was highest in the spring and summer seasons. The most abundant species in the pine forest in March 1973 were the Carolina chickadee, golden-crowned kinglet, blue-winged warbler, and song sparrow. In May, the blue jay and prairie warbler

were most abundant.

In the grassland habitats censused, an increase in avian abundance corresponded to an increase in diversity, as well as changes in behavior. The number of bobwhite quail and field sparrows increased whereas the number of meadowlarks declined as a result of the population establishing territories.

5.6.4.2.3 Distribution

The ecology of an area, such as the Broad River Study Area, is the result of the interrelationships that exist among the numerous species of invertebrates, vertebrates, flora and the physical environment. Natural selection among birds has developed a diverse avifauna which utilize the broad spectrum of vegetation communities, food sources, and physical environment. Habitat and food preferences are two attributes of an ecosystem that influence the diversity, abundance, and distribution of birds.

Monticello Impoundment will inundate approximately 47 percent pine forest, 12 percent grassland, 15 percent deciduous forest and 26 percent mixed pine-deciduous forest. The percentage of habitat types represented on the wildlife survey routes is shown below:

	ROUTE		
Habitat	A and B (1 mile interval) 14 Stops	A, B, and C (1/2 mile interval) 30 Stops	D (1/2 mile interval) 31 Stops
Pine	50	47	46
Grassland	35	38	29
Deciduous	1	1	8
Mixed pine-deciduous	15	14	15
Adjacent to water	0	0	2

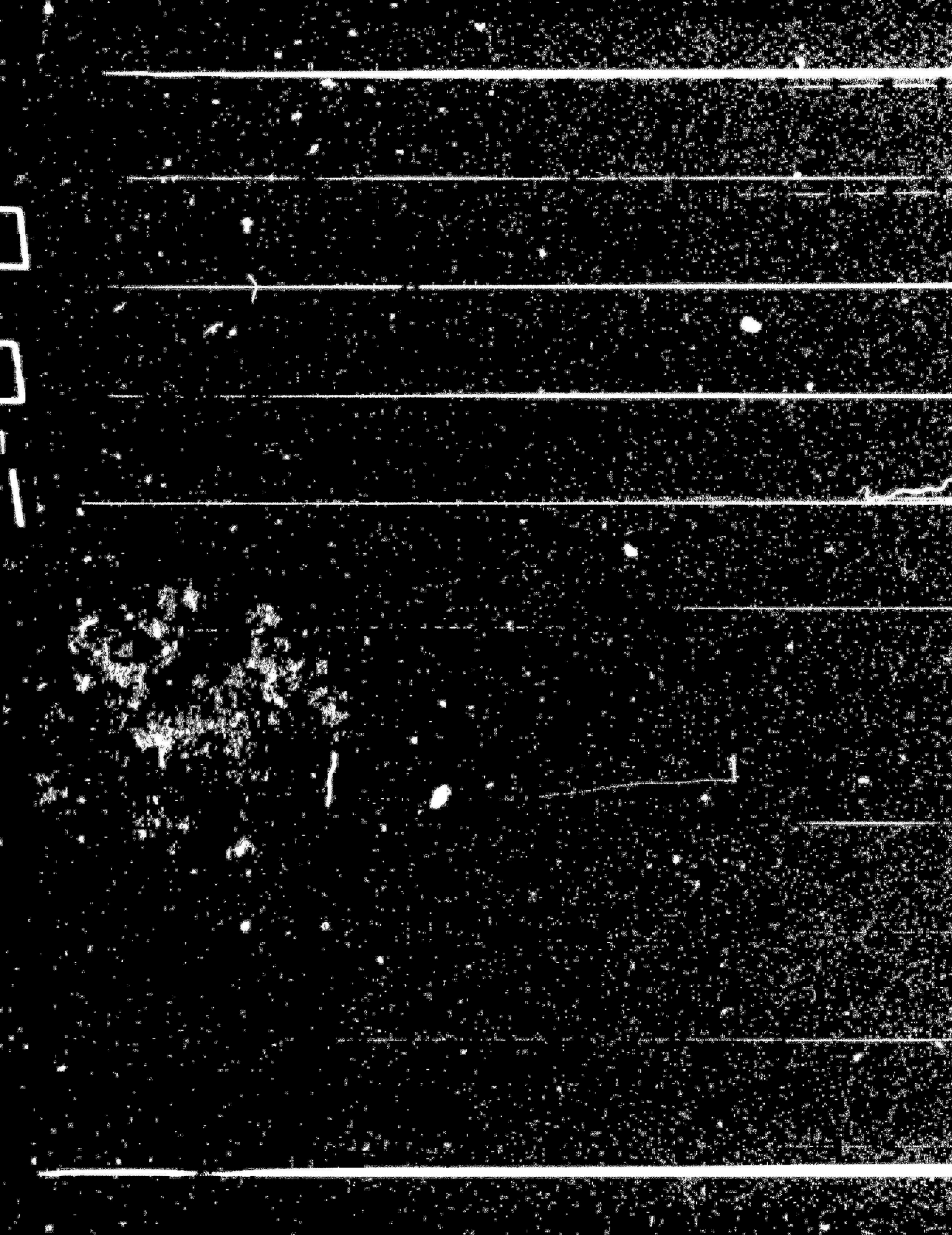
The diversity and abundance of species were varied along the wildlife survey route as a result of the configuration of habitats at each stop. A change in the habitat configuration of the Broad River Study Area will lead to a change in species diversity, abundance, and distribution.

Habitat preference is a major factor in determining the distribution of birds on the Broad River Study Area. Chickadees, kinglets, warblers, and nuthatches typically associated with pine communities are widely distributed because of the predominance of pine. The kingbirds, meadowlarks, grackles, indigo buntings, hawks, and other species associated with grassland habitats will be less widely distributed because of the limited amount of grasslands available on the study area. Most species like the bobwhite quail, towhees, and sparrows are not habitat specific and are found in various habitats, thus having a broad distribution.

Figure 5.6.1 shows the seasonal abundance of birds as recorded by the morning wildlife survey routes. The strip census and census transect methods (Table 5.6.2 and 5.6.3) show composition and abundance in specific habitats. The strip census method is best suited for more or less open country (cropland or old field habitat). The reduced visibility of birds in woodland or dense shrub habitat probably affect the accuracy of this census technique (Graber and Graber 1963).

The food habits of birds also describes some of the interrelationships and adaptations of birds toward the flora and fauna. The principle foods of each bird provides a clue to its role in the food web and flow of energy in the Broad River Study Area.

Plants, macroinvertebrates, and vertebrate animals known to occur in the diet of birds in the southeast are discussed by Martin, Zim, and Nelson (1951). Only food items that occur in at least two percent of the diet are



considered for the following discussion. The degree that a particular plant or animal is used would depend on the abundance of the plant or animal and the abundance of other palatable plant or animal species.

Grebes, cormorants, herons, egrets, and mergansers are secondary and tertiary consumers that feed on aquatic macroinvertebrates and fish. Waterfowl and coots are primary, secondary, and occasionally tertiary consumers feeding on macroinvertebrates as well as seeds, leaves, and roots of plants. Raptors (hawks and owls) are secondary or tertiary consumers that feed on macroinvertebrates, reptiles, amphibians, small birds, and small mammals. However, the osprey feeds primarily on fish and hence is principally a tertiary consumer. Carrion feeders include the turkey and black vultures, raptors, and herring gull. The herring gull is also a predator (secondary or tertiary consumer).

Birds that feed almost exclusively on invertebrates include the members of the following families: Cuculidae, Caprimulgidae, Tyrannidae, Hirundinidae, Sylviidae, and a few members of the Parulidae family. All other families are primary and secondary or tertiary consumers with plant and animal foods in their diets.

5.6.4.3 Game Birds

5.6.4.3.1 Diversity

Game birds present on the Broad River Study Area include the wild turkey, American woodcock, mourning dove, bobwhite quail, wood duck, and mallard duck. Additional migratory waterfowl are also common during the late fall and winter seasons.

5.6.4.3.2 Abundance and Distribution

The wild turkey was reintroduced into the Enoree District of the Sumter National Forest in 1951. The first legal hunt was in the spring of 1960 and a spring "gobbler" hunt has continued to the present year. The wild turkey

population has increased in response to management; consequently the range of the wild turkey population has also expanded and small flocks have been sporadically sighted in the Frees Creek and adjacent Broad River watersheds. The approximate boundary of wild turkey distribution includes a portion of the Piedmont along the Broad River flood plain (Spinks 1966), including the Broad River Study Area.

According to Spinks (1966), the most favorable habitat for turkeys is composed mainly of mature open hardwoods, with some brushland, grassland, and cultivation.

The Frees Creek watershed is reported to be fair to good wild turkey habitat (Walter Schrader, pers. comm.). The mixture of bottomland oak, pine, and upland abandoned fields is potentially good habitat that may provide seasonally abundant food and shelter for males, nesting females, and poults. The diet of the turkey, a primary and secondary consumer, includes invertebrates, fruits, leaves, and buds of numerous plants.

One American woodcock was observed on the Broad River Study Area during November 1972 and one was observed during the Christmas bird count near Columbia (Table 5.6.5). Sprunt and Chamberlain (1970) indicate that woodcock breed regularly in South Carolina. However, the breeding population is too low to warrant the establishment of woodcock singing-ground surveys (Eldon R. Clark, pers. comm.).

The mourning dove is a permanent resident and hunted as a game bird in South Carolina. In North Carolina, migration activity reaches its peak in March and the number of doves is variable until the end of April (Quay 1954). Nesting begins in late March and increases steadily during April and numbers become stabilized in May (Quay 1954). Flocks are common until nesting begins and the sighting of pairs becomes a regular occurrence. A similar sequence of

events would occur in South Carolina. Duever and Fatora (1968) found the peak of annual morning and evening dove activity (frequency of sightings) occurs principally in May at the AEC Savannah River Plant. The number of calling doves also reaches its peak in the morning during May in North Carolina (Quay 1954) and in Florida (Winston 1954).

Call-count surveys have been established and run in May since the early 1950's (Ruos 1971a; Southeast Association of Game and Fish Commissioners 1957). This survey technique for obtaining abundance indices by calling male counts is well established (Bennitt 1951; Hanson and Kossack 1963; Preno and Labisky 1971; Robel, Dick, and Krause 1969; Ruos 1971a and b). State-wide trends in mourning dove breeding density indices in South Carolina were significantly greater in 1970 than in 1960 (Ruos 1971a). Breeding population density indices continued to increase from 1970 to 1971 (Ruos 1971b).

An increase in hunter success is an index to an increase in population density. Ruos (1970) records a state-wide increase of the average number of successful hunts per hunter from 2.1 hunts in 1967 to 2.7 hunts in 1969. During the same years the average daily bag per hunter increased from 6.6 birds to 8.5 birds. The average seasonal kill per hunter increased from 14.0 birds in 1957 to 22.9 birds in 1969.

Amend (1969) counted the numbers of mourning doves heard on "....25 call-count routes in a 10-county intensive study area and 45 call-count routes in a 33-county extensive study area" in South and North Carolina. The 43 counties are located in the Coastal Plain and Piedmont physiographic regions. Mourning dove densities are reported to be the highest in the nation around the Carolina Sandhills National Wildlife Refuge, near McBee, South Carolina. During the May-June period, 49.0 doves were heard per route in 1968 and 49.7 doves were heard per route in 1969 on the intensive study area. On the extensive area,

38.8 and 37.5 doves were heard per route in 1968 and 1969, respectively.

Twenty of the 33 extensive survey routes represent the 20 national mourning dove call-count survey routes in South Carolina. One of these routes (#0100, Union-Chester), is approximately 16 km (10 miles) north of the Broad River Study Area and extends east. On this route, seven doves were heard in May 1971, eight were heard in May 1972, and six doves were heard in May 1973 (Ruos, pers. comm.). A similar number of mourning doves (seven) were heard on the call-county survey on the Broad River Study Area in May 1973. The number of cooing doves was fewer than the average number of doves recorded on all 20 call-count survey routes in South Carolina. Duever and Fatora (1968) observed between 72 and 76 mourning doves during two two-week periods in May near the AEC Savannah River Plant. This represents an average of 4.9 doves per 20 miles per day and 5.2 doves per 20 miles per day, respectively.

The mourning dove is not an abundant game bird in the Broad River Study Area. If the environs of the study area included an adequate habitat, mourning doves would probably be seen and heard at a much greater frequency during the spring. There appears to be sufficient nesting habitat for the doves but the abundance of small grain crops for food is limited. The mourning dove's diet is almost 100 percent plant material during each of the four seasons.

A breeding population of bobwhite was present on the Broad River Study Area. According to the results of the wildlife surveys, calls of non-breeding males had ceased by early September 1971 but resumed by the March 1972 sampling period. According to Fatora and Duever (1968) the activity (frequency of sightings) of bobwhite in South Carolina was highest in May. Morning was considered the peak period of male calling activity. The evening surveys during the March 1972 sampling period did not record calling males even though morning surveys indicated their presence. Earlier studies in South Carolina have found

an evening period of bobwhite activity (Factora and Duever 1968). Rosene (1969) found that the highest number of bobwhite in the southern United States occurs in the June 15 to July 10 interval.

The June 1971 and May 1973 sampling periods provide two years of indices to bobwhite quail abundance on the Broad River Study Area. Bobwhite call-count surveys, to our knowledge, are not being conducted elsewhere in South Carolina to provide comparative data.

Seasonal sampling programs in the Broad River Study Area, and in particular, the vicinity of Monticello Impoundment, have not flushed many quail in the pine stands. The majority were near field borders or forested areas where lower story vegetation provided suitable cover.

The adult bobwhite quail feeds primarily on plant foods throughout the year (primary consumer). The young chicks feed primarily on animal foods (secondary consumer). A low abundance and sparse distribution of preferred seed producing and leafy plants may also be a factor limiting their abundance in the pine communities.

South Carolina State Game Biologists conducted a midwinter waterfowl survey on the Broad River from Lockhart through Parr Dam. On the 5 January 1972 Survey, biologists counted 40 mallards, 6 black ducks, 51 wood ducks, and 53 Canada geese (Walter Schrader pers. comm.). Migratory waterfowl utilize the Broad River and its tributaries in the fall and spring as verified by November and March surveys.

The number of wood ducks fluctuated seasonally. The variability in the number of wood ducks observed in the seven areas (Table 5.6.4) provides a clue to the suitability of habitat.

Habitat requirements of the wood duck are briefly summarized (McGilvrey 1968) so they may be compared with the habitat conditions of the

area.

Breeding Habitat

Hardwood bottomlands along streams or temporarily flooded lowlands attract breeding pairs of wood ducks. A fairly closed crown cover and a middle story of young trees and shrubs which provide lateral cover are important for broods and breeding pairs. Nest cavities need not be near water. Sycamore, water oak, willow oak, and red maple readily form and retain usable cavities and are common to the Broad River Study Area. Adult wood ducks, in general, are vegetarians except during the breeding period when invertebrates form a part of their diet.

Brood Rearing Habitat

Food, cover, and water are all necessary for brood survival. Invertebrates found in association with the shrub vegetation are the primary food supply of the young. Dense shrub cover, permitting broods to move beneath the foliage, is considered optimum. Herbaceous emergents are also important. Waterways of at least 30.5 m (100 ft) in width are desirable for broods to insure safety from predators.

Fall and Winter Habitat

Wood ducks will utilize almost any flooded timber or shrub area that affords visibility of their surroundings. They may travel several miles from feeding areas to evening roost. Acorns, domestic grains, smartweed, buttonbush, ash, bulrush, and burreed supply seeds and fruits in the fall and winter.

Frees and Terrible Creeks may provide acceptable brood habitat but not optimum because of insufficient cover and food. The ponds at Dawkins and Terrible Creek have the necessary components to be considered as fair to good breeding habitat. Ideal brood rearing habitat, however, is limited in these areas as well as along the Broad River. According to Hopkins et al. (1969),

the forest north-east of the pond at Terrible Creek floods several times each year. The seeds of ash, gum, and oak trees in this area become readily available to many waterfowl.

The Enoree River bank appears to have many of the qualities of good wood duck breeding habitat, especially tree cavities. Overhanging trees and shrubs for brood cover are present but limited. This area appears to have cover for staging wood ducks gathering in the spring and fall, the time when the ducks were most frequently observed. Ponds located near the mouth of the Enoree River probably have good breeding and brood rearing habitat during spring high water periods. One brood of seven wood ducks was observed here in July 1973. However, low fall water levels may restrict wood duck utilization and increase the likelihood of predation.

Wood ducks were most numerous in Hellers Creek during the November 1972 and March 1973 surveys. The broods seen during the July 1973 survey indicate that wood ducks were nesting in the vicinity. The perimeter of the flooded mouth of Hellers Creek was bordered by overhanging trees and shrubs, which provide a limited amount of brood cover. The better wood duck areas were away from regular public use and located in the upper reaches of Hellers Creek.

The flooded portions of Frees Creek, east of the Southern Railway and paralleling the Broad River, were assessed as fair to good breeding habitat but poor brood rearing habitat. Flooded timber provides an excellent source of cavities for nesting as well as protective cover for adults in the fall. Shrubs that border the flooded areas form a narrow strip along the shoreline, hence, brood cover is limited. However, portions of this area does provide adequate brood cover as well as food in the form of aquatic invertebrates and plants.

The flooded portion of Cannons Creek was quite similar to the

habitat at Hellers and Frees Creeks. The amount of flooded lowland is a function of water levels maintained at Parr Reservoir. Nesting habitat appears to be available along the shoreline but brood rearing habitat is limited and restricted to the flooded western end of the creek.

5.6.5 SUMMARY

Changes in the environment are reflected in the abundance, diversity, and local distribution of the avian populations. The baseline investigations, through the utilization of several techniques, are designed to provide a basis to assess future changes in these populations.

A total of 117 species of birds were identified on the Broad River Study Area. The diversity, abundance, and distribution of birds were seasonal and habitat related. More birds were recorded along the auto survey routes during the spring and summer than the fall and winter. The abundance of birds was higher at auto survey stops in grassland communities than selectively cut forests of mixed deciduous-conifer forests and lowest at stops where pine was the major vegetative type.

The density of birds as measured by strip census was also highest in grassland communities. This method is especially suitable in open country. Reduced visibility caused by trees and shrubs may affect the accuracy in woodland habitats. The bird census transects recorded additional species associated with forest habitats and grasslands which were not observed by the strip census method.

Each avian species fulfills a role in cycling energy through the environment. The majority of bird species are omnivores but some are specialized as insectivores or granivores.

Game birds that occur on the study area include the wild turkey, American woodcock, mourning dove, bobwhite quail, and various species of water-

fowl. Only a few wild turkey have been reported or seen on the Broad River Study Area. The few sightings are believed to be from a population in the Sumter National Forest, north of the study area. Only one American woodcock was observed on the area and does not represent a significant game resource.

The mourning dove is not an abundant game bird on the study area. This is verified by comparing the number of doves heard on a special calling-dove-survey route on the study area to results obtained by other investigators in South Carolina. These results are not absolute numbers but only an index of a breeding population.

Bobwhite represent another game bird resource on the study area. Our indices and the limited habitat suggest that their abundance is low, however, published literature was not available to support these contentions.

Migratory waterfowl utilize the Broad River and its tributaries during the fall, winter, and spring. Particular emphasis has been placed on the wood duck because it is the major nesting duck in South Carolina. Wood ducks are abundant during the fall and spring on the tributaries and embayments created by Parr Reservoir.

Breeding habitat for the wood duck appears to be abundant on the Broad River and the tributaries where the census was conducted. The absence of brood nesting habitat appears to be a major limiting factor controlling wood duck production on the study area.

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5.7 MAMMALS

5.7.1 INTRODUCTION

The presence and relative abundance of the various mammalian species is dependent on the environmental conditions, or factors, of an area. Some of these environmental factors are: the amount and diversity of food; the amount and kind of vegetative cover; the quality of the soil; the microclimate of the soil and vegetation; frequency of severe storms, floods, fire, etc. The mammals of the Broad River Study Area reflect a series of ecological communities that are succeeding one another in biotic development. Little work has been done on the mammals of the general area although Golley (1966) gives known distributions of mammals collected in the state. Only a few species, such as the oldfield mouse, Peromyscus polionotus, have been studied intensively (Biggers and Dawson 1971).

Information on large mammals was obtained through field observation and conversations with state and local game officials. Detailed field surveys were not conducted on large mammals because their wide ranging habits makes them very difficult to study. Smaller mammals have a much more limited range and are relatively easy to capture. These smaller animals serve as good indicators of the areas productivity and habitat condition.

5.7.2 METHODS AND MATERIALS

5.7.2.1 Sampling Locations

Six sampling sites were established to census mammal populations in the study area (see map, back cover). Study Site 1A, located approximately 2.4 km (1.5 miles) south of Monticello, was chosen because its primary vegetation was second growth pine. Study Site 1B located 0.32 km (0.2 miles) southeast of Site 1A represented a mixed deciduous-conifer upland forest with a 20 to 80 percent crown cover and a moderately dense understory. Study Site 2,

located approximately 4.0 km (2.5 miles) southwest of Monticello, was clear cut in 1967 and replanted in pine. Primarily a grassland in an early seral stage of community succession, it eventually will become dominated by the pine. Study Site 3A, on the east side of Parr Reservoir along the Frees Creek embayment, consisted of a mixed hardwood-conifer forest. Study Site 4, located 2.7 km (1.7 miles) north of the Parr power plant, was chosen as a representative stand of conifers. The last study site was located along Frees Creek adjacent to aquatic Transect G. It was composed of mixed deciduous-conifers with an open crown canopy cover and a dense shrub and herb understory.

5.7.2.2 Snap Trapping

A trapline for small mammals was utilized at four study sites (1A, 2, 3A, and 4) during the June, September, and January, 1971 and March 1972 sampling periods. Each trapline included 20 trapping stations linearly arranged at 15 meter intervals and marked with a wooden stake. Within two meters of each station marker, three snaptraps (two mouse traps and one rat trap) were set and baited with peanut butter and/or dry rolled oats. In addition, in March 1972, a single snaptrap was placed near each of the 231 pit traps (see Section 5.4) on Study Site 2. Each trap was visited on three to five successive days during each sampling period. Trapped mammals were identified as to species, sexed, weighed, measured, examined for evidence of lactation and pregnancy, catalogued, and preserved in 10 percent formalin.

5.7.2.3 Pit Trapping

In March 1972 pit traps used for collecting insects on Study Site 2 proved effective in the capture of shrews. Two hundred thirty-one pitfall traps were placed at 5 meter intervals in a 50 x 100 meter quadrat. The traps consisted of steel cans 11.8 cm high and 10.7 cm in diameter buried in the ground so that the top of the traps were at ground level. Mammals collected in the

pit traps were examined and processed in the same manner as snaptrapped mammals.

5.7.2.4 Live Trapping

To capture larger mammals, such as rabbits, opossum, and raccoons, a grid of twelve live traps (Tomahawk Live Trap Company, 10x12x32 inches) was laid in each of the four major vegetational communities; loblolly pine (Site 1A), mixed deciduous-conifer upland (Site 1B), mixed deciduous-conifer lowland (adjacent to aquatic Transect G), and grassland with cultivated loblolly pine (Site 2). The traps were placed in a rectangular grid measuring 121.9 x 182.9 m (400 x 600 ft). Each trap was placed 60.9 m (200 ft) apart and baited with sardines, apple and carrot slices, and raw peanuts.

The traps were checked once each day for seven days and rebaited as necessary. Captured animals were measured, weighed, and both ears tagged with a numbered metal tag (National Band and Tag Company).

A trapping grid of 50 small mammal live traps was nested among the larger live traps at Site 1B during 17-20 November 1972. This square grid measured 61 m (200 ft) on a side, with one station every 15.24 m (50 ft). Two traps were placed at each station, one baited with rolled oats and the other with peanut butter and rolled oats.

5.7.2.5 Supplemental Collections and Observations

During the June 1971 sampling period, bats were collected at dusk with a .22 caliber rifle and a .410 gauge shotgun. The .22 shells contained #12 shot and the .410 shells contained #9 shot.

Mammals killed by vehicles, observed along the Wildlife Survey Route or seen during the course of other field work, were identified and recorded. Mammal signs such as tracks and scats were noted. Taxonomy and published distributional records are from Golley (1966).

A foot-survey was conducted along Frees Creek by a single observer

in November 1972. The survey began at the Southern Railway Bridge, followed the south bank, and ended approximately 2.5 km (1.6 miles) upstream. A portion of the Broad River flood plain from Dawkins north to Terrible Creek also was examined for evidence of mammals.

A foot-survey was made during the May 1973 sampling period by two observers following Frees Creek 4.2 km (2.6 miles) from Route 99 southward to the proposed Virgil C. Summer Nuclear Station site.

5.7.2.6 Density Estimates

An estimate of the area that the grid of live traps effectively trapped is essential for estimating the density of a mammal population. To compute this area, one-half the diameter of the home range was considered the effective trapping distance from the grid perimeter and the following formula was utilized (Golley, et al. 1965):

$$2r\ (L_1+L_2) + L_1L_2 + \pi r^2 = \text{area trapped}$$

In this formula r is the radius of the home range and L_1 and L_2 represent the lengths of the two sides (in a rectangular grid).

5.7.2.7 Stomach Content Analysis

The stomach contents of the preserved mammals were removed and washed into a 1.0 mm sieve. The sieved material was washed into small petri dishes and dried at 90°C for two to three hours. All item identifications and volume percentages were determined from these dried samples using methods described by Korschagen (1962). Items were grouped according to plant, animal or miscellaneous components. Within each of these general categories, identification to the generic level was attempted by comparing samples with reference seeds, insect parts, as well as various literature sources (Delorit 1970; U.S. Forest Service 1948; Smith 1970). Percent frequency of occurrence of all items was determined for each mammal species collected during the first four sampling

periods.

5.7.3 FINDINGS

A total of 17 species of wild mammals were observed or collected in the Broad River Study Area. Included in this total was one introduced species, the house mouse (Mus musculus). Game mammals observed or signs seen in the area included the white-tailed deer (Odocoileus virginianus); the gray fox (Urocyon cinereoargenteus); the gray squirrel (Sciurus carolinensis); the Eastern cottontail rabbit (Sylvilagus floridanus); and the raccoon (Procyon lotor). Ninety-six mammals of 14 species were collected by trapping in the six study sites during the five sampling periods from June 1971 to November 1972. The number of each species and percent of males collected are presented in Table 5.7.1.

Free-ranging dogs were abundant in the study area. Likewise, the domestic cat is common but it is doubtful that a "feral" population is present. Free-ranging swine have not been observed in the project vicinity, although feral swine have been reported from an adjacent county (Hanson and Karstad 1959).

5.7.3.1 Study Site 1A

The cotton mouse was the only small mammal species collected at this study site. Two were captured during both the June 1971 and March 1973 sampling periods. Live traps for medium size mammals were set during the November 1972 sampling period; however, no mammals were captured.

5.7.3.2 Study Site 1B

One white-footed mouse was caught in a grid of 50 small live traps over a three-day period. This represents only one mammal per 150 trap-nights.

5.7.3.3 Study Site 2

The relative abundance of small mammals collected by the snaptrap method along the established trapline in Study Site 2 is shown in Table 5.7.2.

Table 5.7.1 Number of each species and percent of males trapped during four survey periods.

Species	Common Name	Number Trapped	Percent Males
Didelphis marsupialis	Opossum	4	75
Sorex longirostris	Southeastern shrew	7	71
Cryptotis parva	Least shrew	3	67
Blarina brevicauda	Shorttail shrew	7	71
Procyon lotor solutus	Raccoon	1	0
Spilogale putorius	Spotted Skunk	1	?
Reithrodontomys humulis	Eastern harvest mouse	8	63
Peromyscus leucopus	White-footed mouse	1	?
Peromyscus gossypinus	Cotton mouse	35	54
Ochrotomys nuttalli	Golden mouse	3	67
Sigmodon hispidus	Cotton rat	12	33
Microtus pinetorum	Pine vole	1	?
Mus musculus	House mouse	11	36
Sylvilagus floridanus	Eastern cottontail rabbit	2	100
		96	

Table 5.7.2 Relative abundance of small mammals collected along traplines in Study Sites 1A, 2, 3A, and 4.

Study Site / Animal	6/71 Survey Total No. Caught	6/71 Survey Trap-nights/ Animal*	9/71 Survey Total No. Caught	9/71 Survey Trap-nights/ Animal*	1/72 Survey Total No. Caught	1/72 Survey Trap-nights/ Animal*	3/72 Survey Total No. Caught	3/72 Survey Trap-nights/ Animal*
Site 1A								
Total Trapnights	300		360		240		240	
Cotton mouse	2	150	0	--	0	--	2	120
Site 2								
Total Trapnights	240		360		240		240	
Cotton rat	2	120	6	60	2	120	0	--
House mouse	4	60	7	51	0	--	0	--
Cotton mouse	0	--	1	360	3	80	3	80
Cottontail rabbit	0	--	2	180	0	--	0	--
Harvest mouse	0	--	0	--	1	240	3	80
Site 3A								
Total Trapnights	240		360		240		240	
Shorttail shrew	1	240	4	90	3	80	1	240
Cotton mouse	4	60	5	72	0	--	3	80
Cotton rat	0	--	0	--	0	--	1	240
Site 4								
Total Trapnights	180		360		240		240	
Cotton mouse	3	60	4	90	1	240	1	240
Golden mouse	2	90	1	360	0	--	0	--
Shorttail shrew	0	--	1	360	0	--	0	--
Pine vole	0	--	0	--	1	240	0	--

*Trapnights per animal caught

It should be noted that the best yields occurred during the September 1971 survey.

In addition to the established trapline, single snaptraps were placed near each of the pit traps. Ten shrew, four harvest mice, and one cotton rat were collected in pit traps or snaptraps placed near pit traps. The trapping yield on the grid was as follows: one Southeastern shrew per 231 pit trap nights; one least shrew per 539 pit trap nights; one harvest mouse per 231 snaptrap nights; one cotton rat per 924 snaptrap nights.

One spotted skunk was captured and released on Study Site 2 during the November 1972 sampling period.

5.7.3.4 Study Site 3A

The shorttail shrew, cotton mouse, and cotton rat were the small mammal species collected along the trapline on Study Site 3A (Table 5.7.2). The greatest number of mammals (nine) was collected during the September 1971 survey.

5.7.3.5 Study Site 4

The relative abundance of small mammals collected along the trapline on Study Site 4 is shown on Table 5.7.2. The greatest number of mammals (six) was collected during the September 1971 survey.

5.7.3.6 Study Site Adjacent to Aquatic Transect G

Medium size mammals were live trapped adjacent to aquatic Transect G during the November 1972 sampling period. Four opossum (2 adults) and one raccoon (adult) were captured, tagged, and released. Three of the four opossum were recaptured and were the only mammals collected in sufficient number to obtain an estimate of density.

In a trapping study in Illinois, Holmes and Sanderson (165) found that the average mean distance traveled from a central area of activity by all opossums, juvenile and adults, was 212.4 m (697 ft), i.e., radius of home range.

This mean distance was utilized to calculate the area trapped by the 121.9 x 182.9 m (400 x 600 ft) grid. The effective trapping area, therefore, would be 29.35 ha (72.6 acres) and the density of the four trapped opossum would be one per 7.3 ha (18 acres) or 36 per square mile.

5.7.3.7 Supplemental Collections and Observations

Small game mammals observed on the Wildlife Survey Route included one gray squirrel in June 1971, no game in September 1971, three gray squirrels in January 1972, and one gray squirrel in March 1972 and no game in March or May 1973. One road-killed cottontail rabbit was found in January 1972 and May 1973 and several cottontails were observed in the study area in both January and March 1972, and March and May 1973.

Three female red bats (Lasiurus borealis) were shot and collected at dusk over small ponds approximately one mile east of Study Site 3A during the June 1971 survey.

Few white-tailed deer have been seen on the Broad River Study Area. One was observed in September 1971, and two in March 1972. In November 1972, fresh tracks were observed near Site 1A and a buck was sighted along Route 16 near the Route 213 junction. One doe was seen swimming across the Broad River approxmately 13.6 km (8.5 miles) north of Parr Dam and another was observed below the Parr Dam along the Broad River. A fresh trail and single track of white-tailed deer were observed during the hike along Frees Creek in November 1972. Old bed sites were observed in an abandoned farm field along the Broad River between Dawkins and Terrible Creek. Tracks of three white-tailed deer were observed in March 1973 in an area where all merchantable timber had been removed.

One set of opossum tracks were observed near an intermittent creek located between Dawkins and Terrible Creek.

A foot survey was made during the May 1973 sampling period along Frees Creek southward from Route 99. A hard rainfall the previous day permitted easy identification of fresh mammal tracks. Within 0.52 km (one-third mile) of highway 99, fresh tracks and three white-tailed deer were observed near dense cover of shrubs and herbaceous vegetation. Along the entire 4.2 km (2.6 miles) of Frees Creek examined by the two observers, 26 sets of deer tracks (set equals one deer) were observed either crossing or paralleling the creek. Some of the 26 sets of tracks may have been made by the same deer and, therefore do not represent 26 deer but the movement of an undetermined smaller number in the vicinity of Frees Creek.

5.7.3.8 Stomach Content Items

The stomach contents of small mammals were examined to describe their food habits. The percent frequency of occurrence of stomach content items from four cotton mice collected at Site A during the June 1971 and March 1972 sampling periods, indicated that all had unidentified insect parts in their stomachs.

The percent frequency of occurrence of stomach content items of the mammal species collected from Study Sites 2, 3A, and 4 are shown in Tables 5.7.3, 5.7.4, 5.7.5, respectively.

5.7.3.9 Rare and Endangered Species

No rare or endangered mammal species were found in the Broad River Study Area, however, a mountain lion (Felis concolor) was reported to have been seen in the vicinity (W. Schrader, pers. comm.).

5.7.4 DISCUSSION

5.7.4.1 General Habitat Conditions

A variety of factors can control animal populations, i.e., food, space, weather, disease, chemical applications, etc. The major factor affecting

Table 5.7.3 Percent frequency of occurrence of stomach content items of small mammals from Study Site 2.

Species	Cotton Rat*				Cotton Mouse*		
Survey Period	6/71	9/71	1/72	3/72	9/71	1/72	3/72
No. of Animals	2	6	2	1	1	3	3
	Percent Frequency						
Vegetation							
Fungus	50	34	50	0	0	33	0
Blackberries	50	0	0	0	0	0	0
Groundcherry	50	17	0	0	0	0	0
Sorghum	0	34	0	0	0	0	0
Lespedeza	0	100	100	0	0	33	33
Dicot leaf	0	17	0	0	0	66	0
Monocot leaf	0	0	50	0	0	33	0
Unidentified	50	0	50	0	0	0	0
Animal							
Insect parts	50	50	50	100	100	100	33
Insect eggs	0	0	0	0	0	33	0
Hair	50	34	50	100	0	0	33
Nematode	50	34	50	0	0	0	0
Miscellaneous							
Sand	50	67	50	0	0	0	33
Paper	50	0	0	0	0	0	0

*Cotton rat = Sigmodon hispidus;
Cotton mouse = Peromyscus gossypinus

Table 5.7.3 (Continued)

Species	House Mouse*		Eastern Harvest Mouse*		SE Shrew*	Least Shrew*
Survey Period	6/71	9/71	1/72	3/72	3/72	3/72
No. of Animals	4	6	1	7	7	3
Vegetation						
Foxtail	50	0	0	0	0	0
Fungus	50	34	100	0	0	0
Blackberries	0	0	0	0	0	0
Groundcherry	0	0	0	0	0	0
Sorghum	0	34	0	0	0	0
Lespedeza	0	17	0	0	14	0
Dicot leaf	0	0	0	0	0	0
Monocot leaf	0	0	0	0	0	0
Unidentified	25	17	100	0	14	11
Animal						
Insect parts	50	83	100	86	57	33
Insect eggs	0	0	0	0	0	0
Hair	50	34	0	28	14	33
Nematode	50	17	0	0	0	0
Miscellaneous						
Sand	0	0	100	0	29	0
Paper	0	0	0	0	0	0

*House mouse = Mus musculus;
Eastern harvest mouse = Reithrodontomys humulus;
Southeastern shrew = Sorex longirostris;
Least shrew = Cryptotis parva

Table 5.7.4 Percent frequency of occurrence of stomach content items of small mammals from Study Site 3A.

Species	Cotton Mouse*				Shorttail Shrew*			Cotton Rat*
Survey Period	6/71	9/71	1/72	3/72	6/71	9/71	3/72	3/72
No. of Animals	4	5	3	3	1	4	1	1
	Percent Frequency							
Vegetation								
Lespedeza	0	0	33	0	0	0	0	0
Dicot leaf	0	20	33	0	0	0	0	0
Endosperm	0	0	100	0	0	0	0	0
Unidentified	50	20	66	0	0	0	0	0
Animal								
Insect parts	100	100	0	66	100	100	100	100
Hair	50	0	66	0	100	0	0	0
Nematode	0	0	0	0	0	25	0	0
Miscellaneous								
Glass	0	0	0	33	0	0	?	0

*Cotton mouse = Peromyscus gossypinus

Shorttail shrew = Blarina brevicauda

Cotton rat = Sigmodon hispidus

Table 5.7.5 Percent frequency of stomach content items of small mammals from Study Site 4.

Species	Cotton Mouse*				Golden Mouse*		Shorttail Shrew*	Pine Vole*
Survey Period	6/71	9/71	1/72	3/72	6/71	9/71	9/71	1/72
No. of Animals	3	4	1	1	2	1	1	1
Vegetation								
Sorghum	0	25	0	0	0	0	0	0
Lespedeza	0	0	0	100	0	0	0	0
Unidentified	33	0	100	100	50	0	0	0
Animal								
Insect	100	75	100	100	50	100	100	0
Hair	66	25	0	0	0	100	0	0

*Cotton mouse = Peromyscus gossypinus

Golden Mouse = Ochrotomys nuttalli

Shorttail shrew = Blarina brevicauda

Pine vole = Microtus pinetorum

mammalian populations in the Broad River Study Area appear to be changes in the vegetative community structure. These changes are brought about primarily by natural succession and the influence of man. Utilization of pine for pulpwood and lumber has had a strong influence on the development of soil and vegetation on the Broad River Study Area.

A closed canopy of loblolly pine at Site 1A has limited the development of adequate cover and, subsequently, the food supply of small mammals. Site 4, in contrast, has a more open canopy of primarily pine that has permitted the penetration of sunlight to the forest floor and encouraged the development of a more diverse lower and middle strata that supplies cover and food for small mammals. Despite suitable habitat the mammals are not abundant at this site.

The foregoing discussion illustrates that the selective removal of merchantable pine in the Broad River Study Area will cause changes in sunlight availability, soil moisture, and nutrient exchange resulting in an increase in lower stata vegetation and, consequently, a change in animal populations. It is recognized that such changes will be beneficial to some animal species and yet detrimental to others.

Sites where deciduous trees comprised an important part of the vegetation (1B, 3A, and near G), differences in the vegetational community structure were considerable. Moisture was one major cause of such differences.

The lack of cover for dens appeared to be the most critical limiting factor of medium-sized mammals at Site 1B. The trees at the site were not large, dbh ranging from 7.6 to 20.3 cm (3 to 8 in). Large trees with tree cavities that could be used by squirrels or raccoons were absent from this site. As the stand matures, its value to the gray squirrel and raccoon should increase.

Grasses and forbes formed a complete ground cover under an open canopy near aquatic Transect G. Food was plentiful at Sites 1B, 3A, and near Transect G. Oaks, present at all three sites are considered to be one of the most important food plants for wildlife. Opossum, raccoon, rabbits, squirrels, and deer are known to utilize parts of this tree (Martin, et al. 1951).

Site 2 was cultivated in 1967 and loblolly pine seedlings were planted. Grasses and forbes dominate the ground cover and provide protective cover and food for small mammals. Shrubs are increasing in importance and provide cover for medium-size mammals such as cottontail rabbits and browse for rabbits and white-tailed deer.

5.7.4.2 Small Mammal Populations

The diversity of mammals within each of the study sites is, in part, a function of the habitat requirements of each mammal. The diversity of vegetation between Study Sites 1A and 4, both predominately upland pine communities, is sufficient to result in an apparent change in diversity of small mammals. The lack of diversity in the flora of Site 1A is reflected by the low diversity of small mammal species and by the few individuals collected.

Study Site 4 has a more diverse mammal population as a result of a more open canopy and a greater diversity of herbaceous species. A few grasses, lespedeza, and asteraceous plants, provide a more diverse vegetative food supply, shelter, and a higher diversity of associated invertebrates.

Invertebrates represent a significant portion of the food items observed in mammal stomachs. The frequency that a particular plant part or animal is used as a diet item depends on the abundance of that plant part or animal as well as the abundance of other palatable plant or animal species. The availability of plant or animal species is seasonal and, therefore, their utilization by the mammals is seasonal.

The food and shelter requirements of numerous mammal species are satisfied by the diverse qualities of the abandoned field habitat. Study Site 2 has a high diversity of herbaceous vegetation and associated invertebrates, both of which are important food sources for the mammals collected.

Among the three forested study areas, the diversity of overstory vegetation is greatest on Study Site 3A. This is due in part to a greater slope and more moist condition; the site is often inundated by water.

Very little is known of the habitat or food requirements of the southeastern shrew. This species inhabits a variety of conditions; moist areas near swamps, woods, and open fields (Golley 1962; Gentry, Golley, and Smith 1968; Gentry, Smith, and Chelton 1971). In a study by Gentry, Golley, and Smith (1971), 92 percent of southeastern shrews were trapped in a lowland hardwood swamp habitat on the U.S. Atomic Energy Commission's Savannah River Project. Southeastern shrews from the Broad River Study Area were collected in pit traps near Study Site 2, the old field habitat.

The least shrew was similarly collected in the old field (grassland) habitat. This shrew, commonly called the old field shrew, is most often found in abandoned fields in an early stage of succession (Golley 1962; Golley, et al. 1965).

The shorttail shrew occurs most frequently in moist, deciduous woodlands (Golley 1962) such as Study Site 3A. It also has been collected in old fields and upland hardwood habitats (Gentry, Golley, and Smith 1968).

The shrews are secondary or tertiary consumers feeding primarily on a variety of insects.

The eastern harvest mouse is found in abandoned fields that are in a late herbaceous stage of succession (Golley 1962). The harvest mouse was only collected on Study Site 2, an old field (grassland).

The cotton mouse inhabits the moist river bottom woodlands that are "...often subject to periodic inundation by water" (Golley 1962). The cotton mouse has also been collected in old fields, upland pine, and lowland hardwood habitat (Golley, et al. 1965). Forty-four percent of all cotton mice collected on the Broad River Study Area were from Site 3A, moist river bottom woodlands. They were not restricted to this habitat, however, and were collected on the four study areas where trapping occurred.

The cotton rat prefers abandoned fields or roadside areas with a dense growth of vines, shrubs, or herbaceous vegetation that provides security from predators (Golley 1962). It also occurs in upland and lowland hardwood habitat (Golley, et al. 1965). Study Site 3A provided the optimum conditions based on the collection of 11 out of 12 rats were from this site.

The pine vole is common in either pine or hardwood forests in upland or lowland sites (Golley 1962). Only one specimen was collected from Study Site 4 which is predominately an upland pine forest. Distribution and abundance of the pine vole within the study area has yet to be determined. The pine vole, cotton mouse, and cotton rat are omnivorous mammals feeding on both animal and plant species.

The house mouse commonly occurs in old field communities (Gentry 1966; Golley, et al. 1965; Ramsey and Briese 1971). This mouse was collected from Study Site 2, the grassland.

The white-footed mouse occurs in or on the border of deciduous woodlands. However, they are frequently trapped in grasslands and in areas dominated by shrubby vegetation. A single individual was collected at Site 1B in November 1972.

The red bat is a migratory species which roosts in trees (Golley 1962). They frequent small ponds where their principle food, insects,

congregate and drinking water is available.

Although the number of small mammals captured in each habitat is not sufficient for statistical treatment to express differences and/or similarities in abundance or diversity, comparisons can be made to the success of other investigators in South Carolina (Table 5.7.6). The relative abundance of small mammals in old field habitat is quite variable between the Broad River environs and the Savannah River Project. The relative abundance for the cotton mouse, shorttail shrew, and the harvest mouse in old field habitat is very low in the Broad River Study Area. The relative abundance of the cotton mouse and shorttail shrew is similar between the two localities in the lowland hardwood habitat. The relative abundance for cotton mice in upland pine habitat is higher in the Broad River Study Area. The cotton rat was not collected in upland pine habitat on either site.

According to Gentry, Smith, and Chelton (1971), all species trapped in the Savannah River Project (USAEC) environs were not as abundant in the winter (December to March) as in the summer (July to October). Gentry (1966) found similar trends in the small mammal populations with peaks of abundance during the fall. This trend was also observed among all the Broad River study sites. Table 5.7.7 shows seasonal abundance of small mammals by habitat including the number of specimens trapped per season and the percent of the total number of small mammals collected on the study sites. An analysis of individual species abundance by season was not possible in the Broad River Study Area because of the low trapping yield including an absence of mammals in some areas during some seasons.

Ecological changes, either man-made or through natural community succession, may also be reflected by changes in small mammal body sizes. Body measurement means and ranges are determined by the gene pool of the population,

Table 5.7.6 Trapping success of small mammals by habitat on the Broad River Study Area and Savannah River Project (SRP), all seasons combined; trapping success is one individual for number of trap-nights.

Habitat	Cotton Mouse			Cotton Rat			Shorttail Shrew			Harvest Mouse		
	A	B	C	A	B	C	A	B	C	A	B	C
Old field	344	13,783	120	132	84	NS*	0	5,040	0	222	1,532	0
Lowland hardwoods	77	130	358	1,080	234	NS*	180	0	137	0	0	0
Upland hardwoods	NS	180	686	NS	660	NS	NS	0	474	NS	0	0
Upland pine	166	630	NS	0	0	NS	1,020	0	NS	0	0	0

A = Broad River Environs, B = SRP Golley et al. (1965), C = SRP Gentry, Golley and Smith (1968).

*Habitat not sampled

Table 5.7.7 Seasonal abundance of small mammals by habitat during the first four sampling periods.

Season	Pine Area		Grassland		Lowland deciduous		Total	
	Area No. 1A & 4	Percent	Area No. 2	Percent	Area No. 3A	Percent	All Sites	Percent
Summer	7	10	6	8	5	7	18	25
Fall	6	8	14	19	9	13	29	40
Winter	2	3	6	8	3	4	11	15
Spring	3	4	6	8	5	7	14	19
Total	18	25	32	43	22	31	72	99

the level of nutrition attained by the population, plus other factors. No body measurements of small mammals from the Broad River Study Area or from Fairfield County have been recorded in the literature. However, the present study is beginning to yield baseline data concerning body measurements of local populations of small mammals.

The separation of sub-adult (sexually immature) from adult (sexually mature) is necessary if the body measurement ranges and their mean values are to be of value for comparative purposes. However, the separation of sub-adults from adults may be difficult. Table 5.7.8 lists the criteria used to separate these two groups. South Carolina and Georgia mammals apparently tend to be smaller at the time of sexual maturity than individuals of the same species in more northern parts of their ranges (Golley 1962).

Any collected mammal which was larger in either body weight and/or total length than the corresponding values in Table 5.7.8 was considered to be an adult. Means, ranges, and standard deviations of body measurements of adult mammals are in Table 5.7.9. Sample sizes were not large enough to yield data on sexual dimorphism, seasonal differences, or study site differences.

5.7.4.3 Medium-Sized Mammals

Although the major emphasis in the quarterly surveys was on small mammal populations, evidence of medium-sized mammals was recorded. Gray squirrel, gray fox, cottontail rabbit, raccoon, opossum, and skunk are present but they do not represent a significant sport resource in the Broad River Study Area. The low abundance of these mammals in the study area was verified by state personnel (Walter Schrader, pers. comm).

One spotted skunk (Spilogale putorius) was caught during the 72 trapnights. The known range of this animal in South Carolina was restricted to the western edge of the state (Golley 1966). Its capture on Study Site 2

Table 5.7.8 Minimum body weight and/or total length of mammals considered to be adults.

Species	Common Name	Body Weight,g	Total Length,mm	Source
Sorex longirostris	Southeastern shrew	3.5	76	Burt and Grossenheider, 1964
Blarina brevicauda	Shorttail shrew	12.0	92	Golley, 1962
Cryptotis parva	Least Shrew	4.0	69	Burt and Grossenheider, 1964
		3.4	64	Golley, 1962
Reithrodontomys humulis	Eastern harvest mouse	---	107	Hall and Kelson, 1959
		9.4	--	Burt and Grossenheider, 1964
		6.3	107	Golley, 1962
Peromyscus gossypinus	Cotton mouse	20.2	117	Golley, 1962
Ochrotomys nuttalli	Golden mouse	---	150	Hall and Kelson, 1959
		18.8	--	Burt and Grossenheider, 1964
		11.4	132	Golley, 1962
Sigmodon hispidus	Cotton rat	47.0	150	Sealander and Walker, 1955
		56.2	119	Golley, 1962
Microtus pinetorum	Pine vole	---	105	Hall and Kelson, 1959
		21.0	105	Burt and Grossenheider, 1964
		14.5	81	Golley, 1962
Mus musculus	House mouse	11.3	--	Burt and Grossenheider, 1964
		10.0	120	Golley, 1962
Sylvilagus floridanus	Eastern cottontail rabbit	907.0	355	Burt and Grossenheider, 1964

Table 5.7.9 Body measurements of adult mammals collected from study areas.

Measurement Statistic	Common Name of Adults							
	Southeastern Shrew	Shorttail Shrew	Least Shrew	Harvest Mouse	Cotton Mouse	Golden Mouse	Cotton Rat	House Mouse
No. of Individuals	7	6	3	8	26	3	12	9
Total length (mm)								
Mean	82	93	70	118	160	166	227	164
Range	78-87	77-99	65-75	108-134	140-203	162-170	171-268	150-177
Std. Deviation	3.2	8.5	5.0	9.0	13.5	4.0	53.0	9.0
Tail length (mm)								
Mean	32	18	13	53	67	76	90	79
Range	28-34	16-20	11-15	50-59	50-79	69-80	67-125	75-83
Std. Deviation	2.3	1.4	2.0	3.5	6.6	6.4	17.0	2.5
Length of Hind Foot (mm)								
Mean	10	11	9.5	15	20(25)**	18	28	18
Range	9-11	11	9-10	14-16	17-23	17-20	22-31	16-19
Std. Deviation	0.4	0	0.6	1.0	1.8	1.5	2.7	0.9
Ear Length (mm)								
Mean	6	NM*	4	10	16(24)**	17	18(10)**	12.3(8)**
Range	5-7	NM	3-5	11-14	12-20	17	14-22	10-13
Std. Deviation	0.7	--	1.5	4.0	2.2	0	2.6	1.1
Body weight (g)								
Mean	3.5	10	4	8	24	18	77	21
Range	3-4	8-11	3.5-4.5	7-8.5	17-37	15-21	35-136	17-23
Std. Deviation	0.2	1.0	0.4	0.3	6.3	3.1	32.0	2.1
Sex Ratio (M:F)	2.5	2.5(7)***	2.0	1.6	1.2(35)***	2.0	0.5	0.6(11)***

*NM = Not measured
**(10) = No. of animals used for mean
***(7) = No. of animals used for ratio

will extend its recorded range approximately 64 km (40 miles) eastward. The spotted skunk has a home range of 65 ha (160 acres) or less and is omnivorous (Burt and Grossenheider 1964). The spotted skunk is a secondary or tertiary consumer eating any available small animal life. During winter and spring it depends largely on smaller mammals. The rest of the year, insects are its most important food.

The lone raccoon trapped was an adult female weighing 7,747 g (14.9 pounds) which was captured adjacent to aquatic Transect G. Raccoons are omnivorous and mainly nocturnal. Golley (1966) stated that this animal occurs abundantly throughout South Carolina. They den in hollow trees, rock crevices, or ground burrows (Burt and Grossenheider 1964). Since there is an absence of den-size trees near Transect G, it was presumed that raccoons were either ground dwellers or lived elsewhere. Raccoons may range 3.2 km (2 miles) and have a density of one per six hectares (15 acres) (considered high: Burt and Grossenheider 1964). The absence of raccoon tracks and other signs along Frees Creek, however, seem to indicate a low density.

The gray fox is a predator upon other small animals and, hence, is a secondary and often a tertiary consumer.

The cottontail rabbit may be found throughout the Broad River Study Area. The gray squirrel is found in the vicinity of hardwood forests, principally oak and hickory (Golley 1962). The rabbit and squirrel are primary consumers feeding on vegetation.

Opossum, omnivores found throughout South Carolina, are said by Golley (1966) to be most abundant in the low tangled woodlands, characteristic of stream bottoms. This preference was also noted by Llewellyn and Dale (1964).

Holmes and Sanderson (1965) estimated the opossum density in a favorable habitat in Illinois as about 300 per square mile. Sanderson (1961)

found the population along a large stream in Illinois to be 230-240 opossum per square mile, as opposed to ten animals per square mile in cultivated land. The computed opossum density along Frees Creek is undoubtedly underestimated. A better estimate would involve several more weeks of trapping data.

None of the recaptured opossum were caught in the same trap. One opossum (tag no.'s 503-504) was recaptured twice. This juvenile male caught first on 17 November was caught on 20 November in a trap 136 m (447 ft) from the original capture site. The two others were recaptured in the nearest trap, approximately 60.9 m (200 feet) from where they were captured previously.

It is likely that mammals such as the cottontail rabbit, raccoon, and opossum have a low density because of unfavorable habitat. The unaccounted loss of these mammals to free roaming domestic dogs (Canis familaris) could also be significant. Many of the people living near the Broad River Study Area have a pack of hounds.

5.7.4.4 Large Mammal Populations

The white-tailed deer is presently not an abundant game mammal on the Broad River Study Area. The frequency of white-tailed deer being seen is increasing and may reflect an increase in deer in the study area. Suitable habitat is increasing in the area. The white-tailed deer is associated with edge where both shelter and browse are present. In the compact mature stands of loblolly pine and deciduous hardwood communities, little middle and lower strata vegetation occurs. Where the forests are partially open or selective cutting has increased the size and number of openings among the trees, a mixture of deciduous shrubs and saplings grow and provide both shelter and food. Important deer foods of the southeast include oak, green briar, ferns, sumac, dogwood, holly, and other woody shrubs, vines, and herbaceous vegetation.

5.7.4.5 Rare and Endangered Species

The subspecific identify, and hence the official status, of the mountain lion is uncertain. The Eastern Cougar, F. c. cougar, formerly thought extinct, may have re-established itself in this part of its former range, presumably from Canadian relict populations. Alternatively, the Florida panther, F.c. coryi, which appears to have extended its range northward into Georgia recently, may have come to range still farther north. The present distinction of the Eastern cougar as extinct and of the Florida panther as endangered (Bureau of Sport Fisheries and Wildlife 1973) will presumably be clarified in the next edition.

5.7.5 SUMMARY

Mammals form an important part of the energetics of the Broad River Study Area. Changes in their abundance and distribution are indicators of environmental changes. Small mammals are the easiest to sample, therefore, the most intensive program was conducted on them to describe their distribution, diversity, and abundance.

Intensive qualitative small mammal investigations were conducted on four primary sites during June 1971, September 1971, January 1972, and March 1972. The diversity, abundance, and distribution of larger mammals were qualitatively assessed on wildlife survey routes and during other field activities during the same four sampling periods. A quantitative live trapping program was conducted in November 1972 for medium sized mammals on four study sites and small mammals on one study site.

Ninety-six mammals of 14 species were collected by trapping on six study sites during the five sampling periods. An additional two species, the gray squirrel and white-tailed deer, were observed on the study area.

Habitat and food are two important factors that influence the

abundance and diversity of mammals on each study site. Combining all four sampling periods, the highest diversity of small mammals was found in the grassland (Study Site 2). Ground cover, and herbaceous vegetation, were more abundant at this site than at the other three sites. The least diversity and abundance of small mammals occurred in a relatively even aged, closed canopy stand of loblolly pine (Site 1A) with clustered pockets of herbaceous vegetation in a few places where the canopy was open. The other two sites produced intermediate results in the diversity and abundance of small mammals. The cotton mouse was the most widely distributed as it was collected at all four small mammal study sites. This mouse adapts to a variety of habitat conditions and feeds on both vegetation and insects. In contrast, the Eastern harvest mouse is primarily restricted to a grassland habitat in a late herbaceous stage of succession and feeds on vegetation and insects.

Game mammals observed on the study area include; opossum, cotton tail rabbit, gray squirrel, raccoon, spotted skunk, and the white-tailed deer. The cottontail rabbit was observed in all habitat types, whereas the gray squirrel was observed primarily near deciduous trees. The opossum and raccoon were live-trapped among dense herbaceous vegetation adjacent to Frees Creek. A spotted skunk was captured on the grassland site. Only the opossum was captured in sufficient number to estimate a population density (one per 7.3 ha). This is considered to be an underestimation of the population. The opossum and raccoon are omnivores which is characteristic of environs undergoing continuous change as a result of human activity.

More white-tailed deer were recorded on the study area during later survey periods. This may be a result of an increase in lower and middle strata vegetation following selective pine cutting.

The small and medium sized mammal trapping programs were dis-

continued because of the limited numbers of individuals of each representative species. Statistical analysis would be most difficult to describe significant changes subsequent to environmental changes from project construction and operation. The investigations provide a baseline description of the mammals inhabiting the Broad River Study Area.

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6.0 TERRESTRIAL ECOLOGY OF THE BROAD RIVER STUDY AREA

The Broad River Study Area is located in the Piedmont Region and bordered on the south by the Coastal Plain. Vegetation of the area is typical pine-hardwood of South Carolina. Prior to white settlement in 1752, oak-hickory-pine forest prevailed which was apparently free of brushy undergrowth.

Continuous rotation-type farming since white settlement has resulted in a change from the original mixed hardwood-pine forest to pine. While oak-hickory forest would normally be climax for the area, routine removals of trees, eroded topsoils, and recurrent fires have maintained stands of pine.

Erosion has removed most of the topsoil from the Broad River Study Area. The soils which currently exist have a very low nutrient status and a pH of about 5.5. This pH level favors the growth of pine over other plant species. Erosion also has removed many of the traces of agriculture since only low concentrations of DDT were found in the soils. Cotton was the major cash crop during the period of extensive agriculture in the area and DDT was the major insecticide used for cotton boll weevil control.

Succession of plant communities in the Broad River Study Area is in a continuous state of flux with clear-cutting and agriculture disrupting the successional pattern. Plant succession of the area would normally proceed from an abandoned field through a community of herbaceous annual weedy forbs and grasses after one year. The community then becomes dominated by annuals and perennials in the second year. A transition to perennial grasses with pine seedlings occurs between 3 and 10 years after abandonment. The next 10 years result in a closed canopy of loblolly pine at the expense of a well-developed herbaceous community. The pine community will eventually give way to a stable stand of hardwood trees dominated by white and red oak which will

last approximately 200 years.

Three basic habitat types currently exist in the Broad River Study Area. The first is a transitional stage from perennial grasses to loblolly pine which is a result of clear-cutting and mechanical planting of pine. The second type is a loblolly pine community. The third type is basically mixed hardwood-pine with oaks and loblolly pine being the important species.

The grassland type community was dominated by broomsedge and triple-awned grass while little bluestem occurred on more fertile soil. The vegetative cover provided habitat for millipedes, slugs, earthworms, and numerous predatory spiders and carabid beetles. The low stature of the vegetation created a microhabitat which reduced the dessicating power of the atmosphere. Thus, an environment existed in which soft-bodied invertebrates such as the slugs and earthworms could survive.

The American toad and Fowler's toad were the only two herpetofaunal species observed in the grassland area. These toad species were probably feeding upon insects which inhabit the grassland area.

Birds were more abundant in the grassland community than in any other community studied. Meadowlark, bobwhite quail, and field sparrows occupied this area during all seasons. Insects and seeds as well as good cover probably attracted these birds to the area. Bobwhite feed mostly on seeds, however, during the first few weeks of life, the young feed on insects.

Summer inhabitants of the grassland area include the barn swallow, prairie warbler, blue grosbeaks, indigo bunting and red-winged blackbird. The red-winged blackbird apparently moved into the area during nesting.

Birds of prey were not common over the grassland area. This was probably due to a low population of prey species such as rodents and herpeto-

fauna. Vultures were common throughout the Broad River Study Area but their presence was probably due more to the number of roadkill dogs which occurred in the area than any abundance of natural prey or carrion.

The grassland area supported the greatest population of rodents with cotton rats and house mice being the most common species collected. Insects and vegetation were important food items for these rodents. Lespedeza was the most common food item found on examination of rodent stomachs.

The pine communities were dominated by loblolly pine which was an important economic plant species within the Broad River Study Area and consequently, the age of these pine communities varied considerably. Clear-cutting and fire have resulted in the development of even-aged stands with a poorly developed understory except in small open areas. Seedling to marketable pine timber in this area require 35-50 years.

Plant litter resulting from pine needles was high in lignins and resins which resist and inhibit decomposition of cellulose. The coniferous forest soils were characterized by a well-defined unincorporated, compact organic deposit resting on mineral soil. The layer was a result of slow mineralization and no mixing with the mineral soil. The soil characteristics support only limited populations of small soil organisms, most of which live at the interface of the decaying organic layer and mineral surface.

The insect fauna were not well represented in the pine community. Southern pine beetle infestations were observed in the study area, but were of minor importance.

The Pickerel frog and fence lizard were the only herpetofaunal species observed in the pine forest. While these species are principally aquatic, they do travel away from the aquatic habitat during moist seasons.

Chickadees, kinglets, bluewinged warblers, and brown-headed

nuthatches were common bird species associated with pine communities. The chickadee is a multi-habitat bird species which utilizes the shrubs in the pine understory. This species feeds upon insects and seeds. Most of the other bird inhabitants of the pine community were insect eaters. Prairie and pine warblers were summer breeders in this area.

The understory of the pine community was poor habitat for rodents and other small mammals which require cover for protection. The most common mammal species found was the cotton mouse. Golden mouse, shorttail shrew and pine vole were captured in limited numbers. Sorghum and lespedeza were the most common identified plant parts in rodent stomachs. The presence of sorghum in the diet would indicate the rodents were going outside the area to feed. Insect parts also were found in stomach analyses.

While hardwood forest would be climax vegetation for the area, disturbances have kept the pine communities in a seral stage. Most of the upland hardwoods occurred as mixed hardwood-pine communities. Hardwoods occurred in small scattered stands on the uplands and predominated on the riverbottom. Important species in these communities included loblolly pine, eastern red cedar, red maple, and several oak species.

Soils of the mixed hardwood-pine community have a better developed humus layer than pine forest. Chemical composition of deciduous leaves allows for faster decomposition and mineralization of the leaf litter. Thus, the litter is incorporated with the mineral soil much faster.

While the litter layer and the plant species of the mixed hardwood-pine community were capable of supporting a more diverse population of invertebrates, these populations were not well documented for the Broad River Study Area. Spiders were the most uniformly distributed insect species in the area. The majority were found where vegetation was less dense.

The Pickerel frog and fence lizard and several turtle species were found in the mixed hardwood-pine community. The fence lizard prefers logs and trees for habitat. The Eastern box turtle, a terrestrial species, was an omnivore in the area which feeds upon seeds, fruits, berries and carrion.

The bird population within the mixed hardwood-pine community was dependent upon understory vegetation. The bobwhite quail occurred in openings in the timber which had a well-developed herbaceous understory. Other year-round residents included the Carolina wren which feeds on insects, cardinals, and white-throated sparrows which are seed eaters. Summer residents included the eastern wood pewee which is an insect eater.

The shorttail shrew, cotton mouse, and the cotton rat were the most common mammal species in the mixed hardwood-pine community. Opossum and raccoon were captured adjacent to aquatic habitats within these communities. These two mammal species probably used the woods for cover during the day and moved to the water's edge at night to feed.

While small amounts of plant material were found, insects appeared to be the most common food of small rodents captured in the mixed hardwood-pine communities.

Red bats were collected around ponds adjacent to the mixed hardwood-pine community. This bat is a migratory species which roosts in trees and frequents small ponds where insects congregate and water is available.

Migratory waterfowl utilize the Broad River and its tributaries during the fall, winter and spring. The wood duck is of particular interest because it is a major nesting duck in South Carolina. Wood ducks are abundant during the fall and spring on the tributaries and embayments created by Parr Reservoir. Breeding habitat for the wood duck appeared to be abundant on the Broad River and its tributaries while good habitat for turkey exists

in the Broad River Study Area, this bird is not present in any abundance. This species requires a mixture of grasslands, mature hardwood, and mixed hardwood-pine. If clearing of trees occurs at the present rate, the carrying capacity for turkey will decrease in this area.

Adequate habitat exists to support deer in the Broad River Study Area. With proper management, the deer population can increase. The clearing practices can play a major part in increasing the deer population.

Respectively submitted,

DAMES & MOORE

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RCKA/JDK:gh

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APPENDIX 2B

ADDENDUM TO THE BASELINE BIOTIC SURVEY
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA
SEPTEMBER 1974
FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY

Dames & Moore
Project No. 5182-059-17

TABLE OF CONTENTS

		Page
1.0a	INTRODUCTION	1.0-1
3.0a	AQUATIC SURVEY	3.2-1
3.1a	DESCRIPTION OF SAMPLING LOCATIONS	3.2-1
3.2a	PHYSICAL AND CHEMICAL CHARACTERISTICS	3.2-1
3.2.1a	INTRODUCTION	3.2-1
3.2.2a	METHODS AND MATERIALS	3.2-4
3.2.3a	FINDINGS	3.2-4
3.2.3.1a	Temperature	3.2-4
3.2.3.2a	Transparency	3.2-7
3.2.3.3a	Sediment	3.2-7
3.2.3.4a	Sediment Chemistry	3.2-7
3.2.3.5a	Dissolved Oxygen	3.2-7
3.2.3.6a	pH	3.2-9
3.2.3.7a	Other Water Quality Parameters	3.2-9
3.2.4a	DISCUSSION	3.2-9
3.2.5a	SUMMARY	3.2-12
3.3a	PLANKTON	3.3-1
3.3.1a	INTRODUCTION	3.3-1
3.3.2a	METHODS AND MATERIALS	3.3-1
3.3.3a	FINDINGS	3.3-2
3.3.3.1a	Phytoplankton	3.3-2
3.3.3.1.1a	Qualitative Analysis	3.3-2
3.3.3.1.1a	Quantitative Analysis	3.3-8
3.3.3.2a	Zooplankton	3.3-10
3.3.3.2.1a	Qualitative Analysis	3.3-10
3.3.3.2.2a	Quantitative Analysis	3.3-10
3.3.4a	DISCUSSION	3.3-14
3.3.4.1a	Phytoplankton	3.3-14
3.3.4.2a	Zooplankton	3.3-16
3.3.5a	SUMMARY	3.3-17
3.3.5.1a	Phytoplankton	3.3-17
3.3.5.2a	Zooplankton	3.3-17
3.4a	VASCULAR HYDROPHYTES	3.4-1
3.5a	BENTHOS	3.5-1
3.5.1a	INTRODUCTION	3.5-1
3.5.2a	METHODS AND MATERIALS	3.5-1
3.5.3a	FINDINGS	3.5-1
3.5.3.1a	Insects	3.5-1
3.5.3.1.1a	Qualitative Analysis	3.5-1
3.5.3.1.2a	Quantitative Analysis	3.5-5

TABLE OF CONTENTS (Continued)

		Page
3.5.3.2a	Other Benthic Macroinvertebrates	3.5-8
3.5.3.2.1a	Qualitative Analysis	3.5-8
3.5.3.2.2a	Quantitative Analysis	3.5-8
3.5.3.3a	Biomass	3.5-11
3.5.4a	DISCUSSION	3.5-11
3.5.5a	SUMMARY	3.5-13
3.5.5.1a	Insects	3.5-13
3.5.5.2a	Other Benthic Macroinvertebrates	3.5-14
3.5.5.3a	Biomass	3.5-14
3.6a	FISH	3.6-1
3.6.1a	INTRODUCTION	3.6-1
3.6.2a	METHODS AND MATERIALS	3.6-1
3.6.2.1a	Collection	3.6-1
3.6.2.2a	Age and Growth	3.6-1
3.6.2.3a	Length-Weight Relationships	3.6-1
3.6.2.4a	Condition Factor	3.6-1
3.6.2.5a	Sex Ratio and Gonadal Condition	3.6-2
3.6.2.6a	Standing Crop Estimate	3.6-2
3.6.2.7a	Food Habits	3.6-2
3.6.3a	FINDINGS AND DISCUSSION	3.6-2
3.6.3.1a	Species Composition and Relative Abundance	3.6-2
3.6.3.2a	Age and Growth	3.6-7
3.6.3.3a	Length-Weight Relationship	3.6-7
3.6.3.4a	Condition Factor	3.6-15
3.6.3.5a	Sex Ratio	3.6-15
3.6.3.6a	Gonadal Condition	3.6-15
3.6.3.7a	Standing Crop Estimate	3.6-19
3.6.3.8a	Food Habits	3.6-19
3.6.3.9a	Parasites	3.6-23
3.6.4a	SUMMARY	3.6-23
5.0a	TERRESTRIAL SURVEY	5.3-1
5.1a	DESCRIPTION OF SAMPLING LOCATIONS	5.3-1
5.3a	VEGETATION	5.3-1
5.3.2a	METHODS AND MATERIALS	5.3-1
5.3.3a	FINDINGS	5.3-2
5.3.3.1a	Floristic Composition	5.3-2
5.3.3.2a	Dendrochronology	5.3-2
5.3.3.3a	Present Stresses	5.3-7
5.3.4a	SUMMARY	5.3-8
5.6a	BIRDS	5.6-1
5.6.1a	INTRODUCTION	5.6-1
5.6.2a	METHOD AND MATERIALS	5.6-1
5.6.2.1a	Survey Periods	5.6-1
5.6.2.2a	Strip Census	5.6-1

TABLE OF CONTENTS (Continued)

		Page
5.6.2.3a	Auto Survey	5.6-1
5.6.2.4a	Waterfowl Survey	5.6-3
5.6.2.5a	Additional Sources of Information	5.6-3
5.6.3a	FINDINGS	5.6-3
5.6.3.1a	Auto Survey	5.6-3
5.6.3.2a	Indicator Species	5.6-9
5.6.3.3a	Strip Census	5.6-9
5.6.3.4a	Waterfowl Survey	5.6-13
5.6.3.5a	Additional Findings	5.6-13
5.6.3.5.1a	Qualitative Assessment of Habitats	5.6-13
5.6.4a	DISCUSSION	5.6-13
5.6.5a	SUMMARY	5.6-19
		5.6-21
6.0a	REFERENCES	6.0-1

LIST OF TABLES

Table		Page
3.2.9a	Summary of chemical analyses of the Broad River Study Area (Broad River) from selected transects (September 1972-April 1974).	3.2-5
3.2.10a	Summary of chemical analyses of the Broad River Study Area (Frees Creek) from selected transects (September 1972-April 1974).	3.2-6
3.2.11a	Physical and chemical parameters from the Broad River Study Area during baseline surveys (August 1973 and April/May 1974).	3.2-8
3.2.12a	Trace metal analyses of surface waters of the Broad River Study Area (24 April 1974).	3.2-10
3.3.1a	Species list of phytoplankton present (P) in surface (S) and vertical tow (VT) plankton samples in August 1973 and April/May 1974.	3.3-3
3.3.2a	Total phytoplankton species by phyla collected at transects in the Broad River Study Area in August 1973 and April/May 1974.	3.3-7
3.3.3a	Mean density (number/liter) of major phytoplankton taxa in the Broad River Study Area from Transects A through E in August 1973 and Transects B through D in April/May 1974.	3.3-9
3.3.4a	Species list of zooplankton present (P) in surface (S) and vertical tow (VT) plankton samples in August 1973 and April/May 1974.	3.3-11
3.4.1a	Vascular hydrophytes found during a shoreline survey of the Broad River Study Area in the fall of 1973.	3.4-2
3.5.1a	Species list of benthic macroinvertebrates present (P) at sample periods in August 1973 and April/May 1974 on the Broad River Study Area.	3.5-2
3.5.2a	Total insect species by order and mean number per square meter on transects in the Broad River Study Area in August 1973.	3.5-6
3.5.3a	Total insect species by order and mean number per square meter on transects in the Broad River Study Area in April/May 1974.	3.5-7
3.5.8a	Quantitative comparison (number per square meter) of pelecypod families Sphaeriidae and Corbiculidae at ten collecting points along the transects in the Broad River Study Area between August 1973 and April/May 1974.	3.5-10

LIST OF TABLES (continued)

Table		Page
3.5.9a	Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transects B and D in the Broad River Study Area in August 1973.	3.5-12
3.6.2a	Species composition and relative abundance of all fishes collected from the Broad River Study Area between March 1971 and April/May 1974.	3.6-3
3.6.3a	Mean back-calculated total lengths and average growth increments of selected fishes from all Parr Reservoir transects (B, C, D), March 1971 - August 1973.	3.6-8
3.6.4a	Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, November 1972 and August 1973.	3.6-10
3.6.5a	Mean condition factors for all important species collected from the Broad River Study Area between March 1971 and April/May 1973.	3.6-16
3.6.6a	Sex ratios of fishes collected from the Broad River Study Area, November 1972; February, May and August 1973, and April/May 1974.	3.6-17
3.6.7a	Mean gonadal condition of mature female fishes collected in the Broad River Study Area, February, May and August 1973 and April/May 1974.	3.6-18
5.3.1a	Relative frequencies, densities, dominances and importance values of tree species (2.5 cm or greater dbh) growing on Site 1B of the Broad River Study Area, August 1973.	5.3-3
5.3.2a	Distribution and mean age, by midpoint of diameter size classes, of tree species growing on the Broad River Study Area, 1973.	5.3-5
5.6.1a	Census techniques employed during sampling periods, August 1973 - September 1974.	5.6-2
5.6.2a	Birds observed on the Broad River Study Area during five survey periods during 1973 - 1974.	5.6-4
5.6.3a	Results of avian strip censuses in different habitats, Fall 1973 to Fall 1974.	5.6-11
5.6.4a	Maximum waterfowl and shorebirds seen any one day along the boat survey route during three study periods.	5.6-15

LIST OF FIGURES

Figure		Page
3.1.1a	Location of new and old Transect D	3.2-2
3.1.2a	Depth profiles of sampling transects	3.2-3
3.5.1a	Mean number of oligochaetes (Branchiura sowerbyi and other species) per square meter on Transects B through D in the Broad River Study Area in August 1973 and April/May 1974	3.5-9
5.6.1a	Average number of birds recorded on each auto survey route	5.6-8
5.6.2a	Mean and range recorded of total indicator species during auto surveys	5.6-10
5.6.3a	Results of waterfowl surveys on seven sections of the Broad River	5.6-14

INTRODUCTION

1.0a

This addendum presents recent results of additional baseline biotic surveys of the Broad River Study Area, Parr, South Carolina, for South Carolina Electric and Gas Company (SCE&G). The purpose of these studies conducted in August 1973 and April/May 1974 was to complete the baseline surveys and supplement the Report on the Baseline Biotic Survey (Dames & Moore, 1973) (henceforth, referred to as baseline survey). As was stated in Section 1.0 of that report, this baseline information will provide the basis for vaildating predictions regarding anticipated environmental impacts resulting from construction and operation of the proposed Parr Hydroelectric Project (FPC Project No. 1894) and the proposed Virgil C. Summer Nuclear Station project (AEC Docket No. 50-395).

The format of this addendum is so designed that each section is numbered the same as its corresponding section in the baseline survey, with the exception that all addendum numbers are followed by a lower case "a". The same system is used on the tables and figures, wherever possible.

3.0a AQUATIC SURVEY

3.1a DESCRIPTION OF SAMPLING LOCATIONS

Descriptions of transect locations were given in the Baseline Biotic Survey. With the exception of Transect D, all transects remained in the same location. In April 1974, Transect D was relocated a short distance upstream from its original location and is interrupted by a sand bar (Figure 3.1.1a). The east end of the transect is approximately 945 m (3100 ft) upstream from Parr Dam and extends due west across the Broad River. The transect is 750 m (2460 ft) long and has five collecting points.

All stations that have more than one collecting point have been profiled and collecting points have been identified (Figure 3.1.2a).

3.2a PHYSICAL AND CHEMICAL CHARACTERISTICS

3.2.1a INTRODUCTION

Selected physical and chemical parameters were measured at various locations in the Broad River Study Area between September 1972 and April/May 1974. The end of April and the first few days of May 1974 were arbitrarily chosen as the termination of the baseline survey and the beginning of the construction monitoring phase for the aquatic environment. Slight increases in suspended solids at several stations were considered when choosing this date. These data are useful in expanding the data base of the Baseline Biotic Survey. Some new parameters were added to this phase of the sampling program (see accompanying tables) and some sampling stations were added, relocated, or dropped from the baseline survey.

During the Baseline Biotic Survey six transects (A, B, C, D, E, and F) were selected for study of the water quality of the Broad River

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FIGURE 3.1.1a
Location of Old and New Transect D

SOURCE: MAP [illegible] PROJECT AR[illegible] Baseline Biot[illegible]rvey)

DAM[illegible] MOORE

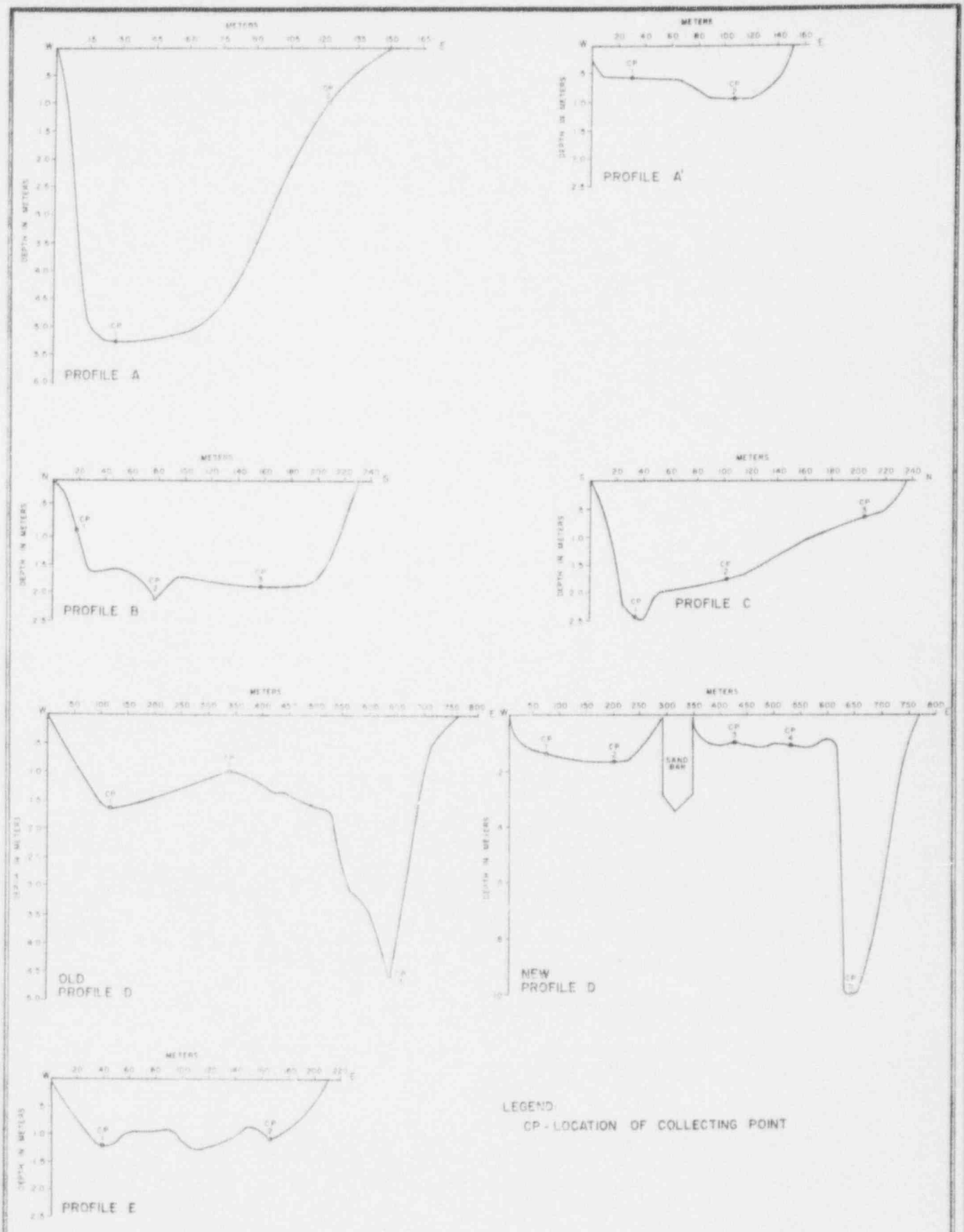

FIGURE 3.1.2a
DEPTH PROFILES OF
SAMPLING TRANSECTS

DAMES & MOORE

Study Area. Sampling at Transect E was discontinued after May 1973 with the exception of fish collections. After August 1973, sampling was discontinued at Transects A and F and Transect D was moved a short distance upstream. These changes were made to streamline the sampling program and provide data for areas of greater concern.

Presently the sampling program includes samples from the deepest collecting point on Transects B, C, and D. Since Transect D is interrupted by a sand bar, collecting points have been located on both sides.

Water quality data collected by SCE&G are also considered. These analyses were conducted routinely at least once a month (but usually more often) between September 1972 and April 1974 at six collecting points. Four of these collecting points were located upstream or downstream from established transects in which case their actual location is noted in the relevant tables.

3.2.2a METHODS AND MATERIALS

Bottom sediment samples were discontinued after the May 1973 sample period. Sediments (SED) were added after September 1972 by SCE&G. This determination is made by weighing a 0.45μ filter through which a 100 ml water sample was passed. Methods for the other parameters are described in Section 3.2.2 of the baseline survey.

3.2.3a FINDINGS

3.2.3.1a Temperature

Mean seasonal water temperature from September 1972 to April 1974 ranged from 12.7 to 16.5°C (Tables 3.2.9a, 3.2.10a), at six collecting points monitored by SCE&G. The number of observations per transect varied from 29 to 318. Transect D+ had the highest and lowest temperatures of 29.7°C and 3.3°C, respectively. The average temperature for this

Table 3.2.9a Summary of chemical analysis of the Broad River Study Area (Broad River) from selected transects (September 1972 - April 1974).[1] Test results reported in mg/l unless otherwise noted.

Transect [2]	E+				D+				A-			
Determination	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points
Total Dissolved Solids	12	25	18.5	2	7	580	107.5	20	8	865	142.2	20
Total Suspended Solids	53	55	54	2	12	1110	275.9	20	16	1170	275.4	20
Total Solids	67	78	72.5	2	43	1310	385	20	48	1750	417.6	20
Specific Conductance (umhos/cm)	31	100	61	196	27	100	58.5	318	33	116	63	218
Total Alkalinity	19	21	20	2	13	29	21	20	13	26	20	20
Calcium Hardness	14	14	14	2	4	18	12.4	20	10	16	13	20
Magnesium Hardness	2	4	3	2	2	6	2.7	20	2	6	2.6	20
Total Hardness	16	18	17	2	12	20	15.5	20	14	20	15.6	20
Chlorides (Cl)	3.39	4.39	3.89	2	1.89	6.89	4.56	20	1.39	5.89	4.34	20
Sulfates (SO_4)	3.7	4.0	3.8	2	2.0	5.5	3.6	20	2.0	5.3	3.5	20
Nitrates (NO_3)	0.44	0.51	0.47	2	0.33	0.89	0.70	20	0.33	0.89	0.67	20
pH	6.6	7.7	7.1	135	6.4	7.6	7.0	315	6.3	8.0	7.2	207
Air Temperature (C)	9.6	33	18.7	196		33	17.6	318	0.0	29.7	16	218
Water Temperature (C)	5.0	28.6	16.5	196	~~3.3~~ 1.1	29.7	16.0	318	3.3	28.1	14.9	218
Dissolved Oxygen	4.5	13.5	7.7	196	3.8	13.2	7.7	318	5.0	14.8	8.3	218
Secchi Disc (meters)	0.25	0.25	0.25	2	0.03	0.51	0.28	20	0.03	0.46	0.23	20
Color	60	75	67	2	40	750	122	20	40	750	143	20
Chemical Oxygen Demand	0	0	0	2	0	47	15.12	15	0	65.60	19.61	16
Soluble SiO_2	17.0	18.6	17.8	2	12	23	18.6	20	12	22.5	18.0	20
SED [3]	40	6540	485	196	40	4780	450	318	60	6340	623	218

[1] Data from SCE&G River Sampling Program.

[2] Transect locations - E+, three-forths mile downstream from Transect E; D+, one-quarter mile downstream from Transect D; and A-, 6.1 miles upstream from Transect A.

[3] SED = mg/l of solids retained on a 0.45μ filter.

Table 3.2.10a Summary of chemical analyses of the Broad River Study Area (Frees Creek) from selected transects (September 1972 - April 1974).[1] Test results reported in mg/l unless otherwise noted.

Transect[2]	B				B-				G			
	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points
Determination												
Total Dissolved Solids	6	1070	138	20	32	33	32.5	2	16	17	16.5	2
Total Suspended Solids	24	1220	402.8	20	74	79	76.5	2	65	75	70	2
Total Solids	52	1730	540.8	20	106	112	109	2	81	92	86.5	2
Specific Conductance µmhos/cm	29	108	72	175	53	103	81	20	25	126	82	206
Total Alkalinity	19	35	26	20	31	44	37	2	31	42	36	2
Calcium Hardness	12	20	16.3	20	18	20	19	2	18	22	20	2
Magnesium Hardness	2	8	4.7	20	2	10	6	2	2	8	5	2
Total Hardness	16	24	21	20	20	30	25	2	20	30	25	2
Chlorides (Cl)	2.89	5.89	4.76	20	4.89	5.89	5.39	2	4.39	5.39	4.89	2
Sulfates (SO_4)	2.0	5.0	2.9	20	1.3	2.0	1.6	2	1.7	2.3	2.0	2
Nitrates (NO_3)	0.22	0.89	0.64	20	0.51	0.51	0.51	2	0.51	0.69	0.60	2
pH	6.3	8.2	7.2	179	6.7	7.4	7.2	20	6.2	7.7	7.0	199
Air Temperature (C)	-5.5	29.7	15.4	175	0.6	23.1	13.8	20	-7.7	29.7	14.3	206
Water Temperature (C)	2.8	29.2	16.5	175	6.6	21.5	12.7	20	3.3	23.1	12.7	206
Dissolved Oxygen	4.5	11.2	7.4	175	5.8	10.4	8.2	20	4.6	16.6	9.0	188
Secchi Disc (meters)	0.03	0.46	0.20	20	0.25	0.41	0.33	2	0.46	0.46	0.46	2
Color	60	750	203	20	75	125	100	2	40	45	42	2
Chemical Oxygen Demand	0	30.8	19.0	15	9.7	11.0	10.4	2	0	114.8	57.4	2
Soluble SiO_2	18.5	26.5	22.4	20	30.0	30.5	30.2	2	32.0	34.0	33.0	2
SED[3]	72	3750	405	175	20	140	75	20	0	5440	220	206

[1] Date from SCE&G River Sampling Program

[2] Transect location - B-, 1 mile upstream from Transect B.

[3] SED = mg/l of solids retained on a 0.45µ filter.

transect was 16°C.

Surface and bottom temperatures were measured during August 1973 and April/May 1974 (Table 3.2.11a). A maximum vertical temperature difference of 4.2°C was noted at Transect C in April/May 1974. In August 1973, this difference was only 3.0°C at Transect C. At all other transects, 1.5°C was the maximum difference in top and bottom temperatures.

3.2.3.2a Transparency

Mean seasonal Secchi disc values measured between September 1972 and April 1974 ranged from 0.20 to 0.46 m (Tables 3.2.9a, 3.2.10a) at the six collecting points monitored by SCE&G. Minimum readings of 0.03 m were recorded at both Transects B and D+. The maximum transparency of 0.51 m also occurred at D+.

Data collected during the biological surveys indicated a maximum of 0.7 m at both Transect C and the new Transect D (east end) in April/May 1974.

3.2.3.3a Sediment

No additional data.

3.2.3.4a Sediment Chemistry

No additional data.

3.2.3.5a Dissolved Oxygen

SCE&G's monitoring of DO indicated a low of 3.8 mg/l and a high of 14.8 mg/l at Transects D+ and A-, respectively.

During August 1973 and April/May 1974, DO was measured at both the top and bottom. At the more lentic Transects C and B, vertical DO differences averaged 2.0 mg/l. Percent saturation also decreased from top to bottom. Percent saturation at Transects C and B decreased from 101 to 72 percent and 95 to 60 percent, respectively.

Table 3.2.11a Physical and chemical parameters from the Broad River Study Area during baseline surveys (August, 1973 and April/May, 1974).

Transect	A	B	B	B	B	C	C	C	D	D	D	D	D	F
Collecting point	1	2	2	2	3	1	1	1	2	2	2	3	5	-
Date	Aug.	Aug.	Apr.	Mean	Aug.	Aug.	Apr.	Mean	Aug.	Apr.	Mean	Aug.	Apr.	Aug.
Parameter														
Temperature, Air (C)	NS[1]	NS	23.0	23.0	NS	NS	22.0	22.0	NS	27.0	27.0	NS	25.0	NS
Temperature, Water (C)														
Surface	26.5	25.5	23.5	24.5	27.0	27.0	22.2	24.6	28.0	23.0	25.5	27.5	23.0	26.5
Bottom	25.0	24.5	22.0	23.3	26.5	24.0	18.0	21.0	27.5	22.5	25.0	26.5	22.2	26.5
Dissolved oxygen (mg/l)														
Surface	9.0	8.0	7.8	7.9	10.0	9.0	9.2	9.1	11.0	8.7	9.9	9.0	8.8	11.0
Bottom	NS	NS	5.2	5.2	NS	NS	6.8	6.8	NS	8.6	8.6	NS	8.6	NS
Specific conductance (μmhos/cm)														
Surface	NS	NS	81	81	NS	NS	85	85	NS	45	45	NS	70	NS
Bottom	NS	NS	80	80	NS	NS	81	81	NS	65	65	NS	100	NS
pH (surface)	7.0	7.0	7.1	7.1	7.0	7.5	7.7	7.6	7.0	7.4	7.2	7.0	7.1	7.5
Secchi disc (m)	0.55	0.3	0.3	0.3	0.15	0.7	0.5	0.6	0.3	0.7	0.5	0.5	0.5	0.6

[1] NS = Not Sampled

3.2.3.6a pH

Mean seasonal pH values for surface water between September 1972 and April 1974 ranged from 7.0 to 7.2 (Tables 3.2.9a, 3.2.10a), at the six collecting points monitored by SCE&G. The minimum (6.3) and maximum (8.0) pH values were recorded on the Broad River at Transect A- (Table 3.2.9a). The minimum pH on Frees Creek was 6.2 at Transect G and the maximum was 8.2 at Transect B (Table 3.2.10a).

During August 1973 and April/May 1974, pH values measured in the field ranged from 7.0-7.7 (Table 3.2.11a). These values were similar to other baseline data (Table 3.2.7).

3.2.3.7a Other Water Quality Parameters

The Broad River Study Area is characterized by soft water (below 61 mg/l total hardness) with limited buffering capacity (Tables 3.2.9a, and 3.2.10a). Phosphate determinations are only run occasionally and values are usually in trace amounts. Silica and nitrate concentrations were moderately high. Biological oxygen demand (BOD) were generally quite low. A maximum chemical oxygen demand (COD) of 114 mg/l was noted at Transect G. However, most values were below 20 mg/l.

Trace metal analyses were initiated in April 1974 (Table 3.2.12a). Copper occurred in concentrations above safe levels at all transects in Frees Creek. Becker and Thatcher (1973) have stated that concentrations above 0.02 mg/l may be chronically toxic to many aquatic organisms in soft waters. The majority of other metals were below detection limits.

3.2.4a DISCUSSION

A water temperature of 3.3°C recorded during this period is the lowest temperature reported during the baseline survey. Unusually

Table 3.2.12a Trace metal analyses of surface waters of the Broad River Study Area (24 April 1974)[1]. Test results reported in mg/l unless otherwise noted.

Transect[2]	E+	D+	A-	B	B-	G
Determination						
Sodium (Na)	5.8	6.2	3.6	6.5	8.3	7.6
Magnesium (Mg)	1.2	1.5	1.7	3.4	2.7	3.4
Aluminum (Al)	0.6	2.9	1.8	4.6	1.9	0.5
Arsenic (As)	<0.01	<0.01	0.01	0.01	0.01	0.01
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium, Total (Cr)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Fluoride (F)	0.14	0.18	0.10	0.18	0.19	0.17
Iron, Total (Fe)	0.90	1.2	0.95	2.5	2.7	1.4
Lead (Pb)	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese (Mn)	0.06	0.06	0.05	0.28	0.82	0.02
Mercury (Hg), µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel (Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Zinc (Zn)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium (Be)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Boron (B)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt (Co)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum (Mo)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Silver (Ag)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.03
Strontium (Sr)	0.2	0.3	<0.2	0.4	0.6	0.6
Copper (Cu)[3]	0.012	0.008	0.008	0.024	0.036	0.030

[1] Data from SCE&G River Sampling Program; Analysis by Analytical Services Laboratory, NUS Corporation, Houston, Texas.

[2] Transect locations - E+, three-fourths mile downstream from Transect E; D+, one-quarter mile downstream from Transect D: A-, 6-1/10 miles upstream from Transect A; and B-, 1 mile upstream from Transect B.

[3] Analysis by SCE&G.

low air temperatures probably account for the newly recorded minimum. The previously reported high of 31.5°C was not approached. The abnormally high value is probably an exception that occurs only during extreme low flow and high ambient air temperatures.

In the baseline survey, vertical temperature data indicated a difference of 7°C from top to bottom at the more lentic stations. Addendum data showed a maximum difference of 4°C. High water in August 1973, probably reduced (temperature differences) stratification. The shallow nature of this reservoir lends to occasional interruption of normal seasonal stratification.

Secchi disc values were generally quite low (below 0.7 m). They compared closely to previous measurements, being lowest at the new Transect D (Collecting Point 1) and Transect B, and highest at Transect C and the new Transect D (Collecting Point 5). However, the previous low of 0.15 m was surpassed by a 0.03 reading at Transects B and D.

The DO minimum (3.8 mg/l) and maximum (14.8 mg/l) exceeded those reported in the baseline survey. However, these values are still within tolerance limits of organisms present in the study area. Vertical DO differences were also noted at Transects B and C. As noted in the baseline survey, this is characteristic of the more lentic areas. Bottom DO values were not below 50 percent saturation during either survey. Thus, benthic organisms generally had more than an adequate DO supply.

The nutrient content of waters in the study area were high enough to support algal blooms. The occasional supersaturation DO levels indicate that blooms do occur. However, as concluded in the baseline survey, turbidity may be a factor limiting the extent of these blooms.

The pH values, which were essentially quite similar at all

transects on the Broad River Study Area were generally indicative of an unstressed ecosystem. The low alkalinity, however, affords little buffering capacity, therefore, the aquatic ecosystem of the Broad River Study Area is susceptible to rapid pH changes.

As stated in the Baseline Biotic Survey, occasional high COD values have been reported. Agricultural runoff in the Frees Creek area may account for the frequent high values at Transect G. BOD values are quite low, therefore, the agents contributing to high COD are not readily biodegradeable. DO values also support this conclusion as they are generally very high.

Copper is the only metal that occurred at toxic levels in the Broad River Study Area in 1974. The toxic level occurred at all three Frees Creek Transects; B, B-, and G. Previous copper analysis of sediment samples in February 1972 (Section 3.2.4) had indicated possible industrial contamination.

3.2.5a SUMMARY

The larger number of data points available for many of the water quality parameters has expanded the range of reported values in many cases. There have been no significant changes in the water quality during this portion of the baseline survey. Initial data concerning heavy metals analysis indicates that most metals analyzed are below detectable limits. Copper is one metal, however, which occurs at concentrations which could be slightly toxic to aquatic biota, particularly in Frees Creek.

3.3.a PLANKTON

3.3.1a INTRODUCTION

Phytoplankton and zooplankton populations were sampled qualitatively and quantitatively in the Broad River Study Area at specific sampling locations during August 1973 and April/May 1974. These studies were conducted to supplement existing baseline data.

3.3.2a METHODS AND MATERIALS

Field and laboratory procedures were similar to those described in Section 3.3.2 of the baseline survey. During August 1973, surface samples were collected from Transects A through F, but vertical tow plankton net samples were collected only from Transects C and D. No vertical tows were made during April/May 1974. The only samples collected were surface samples from collecting points on Transects B through D and samples for qualitative analyses from the littoral zones of Transects B and C.

Plankton biomass determinations were not included in laboratory analyses.

In April/May 1974, phytoplankton primary productivity was estimated by the ^{14}C method (Strickland and Parsons 1972). A solution of radioactive carbonate was added to duplicate light and dark bottles filled with water samples from Transects B and D. Bottles were placed at their respective stations and incubated at the depth from which the samples were collected. After approximately 4 hours of in situ incubation, water samples were fixed with 10 ml of formalin. Samples were later filtered in the laboratory and treated with hydrochloric acid to remove inorganic carbon. Liquid scintillation counting was conducted at Virginia Commonwealth University.

3.3.3a FINDINGS

3.3.3.1a Phytoplankton

3.3.3.1.1a Qualitative Analysis

A total of 127 phytoplankton taxa were collected in the Broad River Study Area in August 1973 and April/May 1974 by surface samples and vertical plankton net tows (Table 3.3.1a). The number of taxa in each major taxonomic group was: Chlorophyta, 30; Chrysophyta, 83; Cyanophyta, 8; Euglenophyta, 4 and Pyrrophyta, 2. The numbers of Chlorophyta, Euglenophyta and Pyrrophyta taxa are similar to those reported previously in the baseline survey. However, about half as many Cyanophyta taxa and almost twice as many Chrysophyta taxa occurred in the August 1973 and April/May 1974 samples as compared to previous samples from June 1971 through May 1973. Table 3.3.1a indicates 77 taxa not previously reported in the collections. These include 15 Chlorophyta, 57 Chrysophyta, two Cyanophyta, two Euglenophyta and one Pyrrophyta taxa.

A total of 102 phytoplankton taxa had been observed in the previous baseline survey. The higher number of taxa reported for August 1973 and April/May 1974 appears to reflect more detailed species analyses for genera previously collected. For example, Table 3.3.1 in the baseline report includes only two Navicula taxa while an additional 14 are recorded in Table 3.3.1a Similarly Table 3.3.1a includes eight Nitzschia taxa, six Synedra taxa and three Fragilaria in addition to those included in Table 3.3.1.

Numbers of phytoplankton taxa per transect are summarized in Table 3.3.2a. Taxa per transect ranged from 11 to 19 in August 1973 and from 40 to 48 in April/May 1974. The general increase in taxa in April/May reflects a sharp increase in diatom taxa.

Table 3.3.1a Species list of phytoplankton present (P) in surface (S) and vertical tow (VT) plankton samples in August 1973 and April/May 1974

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Chlorophyta			
Actinastrum sp.	P	0	P
Actinastrum hantzschii*	P	0	P
Ankistrodesmus sp.	P	P	0
Ankistrodesmus falcatus	P	0	P
Chaetophora sp.*	P	0	0
Chlorococcus sp.*	0	0	P
Closterium sp.	0	0	P
Coelastrum sp.*	0	0	P
Coleochaete irregularis*	0	0	P
Cosmarium sp.	0	0	P
Crucigenia sp.*	0	0	P
Desmidium sp.*	P	0	0
Dictyosphaerium sp.*	P	0	0
Eudorina elegans	0	0	P
Gloeocystis sp.	0	0	P
Kirchneriella sp.*	0	P	0
Mougeotia sp.	P	0	P
Pediastrum duplex	P	P	0
Pediastrum duplex va. reticulatum*	P	0	0
Pediastrum tetras*	P	0	P
Scenedesmus sp.	P	P	P
Scenedesmus acuminatus*	0	0	P
Scenedesmus bijuga*	0	0	P
Scenedesmus quadricauda	0	0	P
Sphaerocystis sp.	P	P	0
Sphaerocystis schroeteri	0	0	P
Spirogyra sp.*	0	0	P
Staurastrum sp.	P	0	P
Tetraedron sp.	P	P	P
Treubaria sp.	0	0	P
Total Chlorophyta	14	6	22
Chrysophyta			
Achnanthes sp.	0	0	P
Achnanthes denticula*	0	0	P
Achnanthes lanceolata va. dubia*	0	0	P
Amphora sp.*	0	0	P
Amphora ovalis*	0	0	P

Table 3.3.1a (Continued)

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Chrysophyta (Continued)			
*Amphora veneta**	0	0	P
Asterionella formosa	P	P	P
Caloneis sp.*	0	0	P
*Caloneis ventricosa**	0	0	P
*Cocconeis placentula**	0	0	P
Cocconeis placentula var. *euglypta**	0	0	P
Cyclotella sp.	0	0	P
*Cyclotella kutzingiana**	0	0	P
Cyclotella meneghiniana	0	0	P
Cyclotella stelligera	0	0	P
Cymbella sp.	0	0	P
*Cymbella affinis**	0	0	P
Denticula sp.*	0	0	P
*Denticula elegans**	0	0	P
Diatoma sp.*	0	0	P
Dinobryon sp.	P	P	P
Eunotia sp.	0	0	P
*Fragilaria construens**	0	0	P
*Fragilaria pinnata**	0	0	P
*Fragilaria virescens**	P	0	0
Frustulia sp.	0	0	P
Gomphonema sp.	0	0	P
*Gomphonema augur**	0	0	P
*Gomphonema olivaceum**	0	0	P
Gyrosigma sp.	P	0	P
*Gyrosigma acuminatum**	0	0	P
*Gyrosigma kutzingiana**	0	0	P
Melosira sp.	0	P	0
*Melosira ambigua**	0	0	P
Melosira distans	0	0	P
Melosira granulata	P	P	0
Melosira granulata va. *angustissima**	P	P	P
*Melosira italica**	P	0	0
Melosira varians	P	0	P
Navicula sp.	P	P	P
*Navicula aikenensis**	0	0	P
Navicula auriculata	0	0	P
*Navicula cryptocephala**	0	0	P
*Navicula exigua**	0	0	P
Navicula exigua var. *capitata**	P	0	0
*Navicula gastrum**	0	0	P

Table 3.3.1a (Continued)

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Chrysophyta (Continued)			
Navicula gysingensis*	0	0	P
Navicula hungarica var. capitata*	0	0	P
Navicula muralis*	0	0	P
Navicula mutica var. undulata*	0	0	P
Navicula pupula var. rectangularis*	0	0	P
Navicula pusilla*	0	0	P
Navicula tripunctata*	0	0	P
Navicula viridula var. linearis*	0	0	P
Nitzschia sp.	0	0	P
Nitzschia acicularis	0	0	P
Nitzschia amphibia*	0	0	P
Nitzschia filiformis*	0	0	P
Nitzschia holsatica*	0	0	P
Nitzschia lorenziana*	0	0	P
Nitzschia microcephala*	0	0	P
Nitzschia palea	0	0	P
Nitzschia paradoxa*	0	0	P
Nitzschia sigmoidea*	0	0	P
Nitzschia tryblionella*	0	0	P
Pinnularia biceps*	0	0	P
Stauroneis sp.	P	0	P
Stephanodiscus sp.	0	0	P
Stephanodiscus astrea*	0	0	P
Stephanodiscus invisitatus*	0	0	P
Stephanodiscus niagarae*	P	0	0
Surirella sp.	0	0	P
Synedra sp.	P	P	P
Synedra actinastroides*	P	0	0
Synedra delicatissima*	0	0	P
Synedra fasciculata var. truncata*	P	0	0
Synedra rumpens*	P	P	0
Synedra rumpens var. familiaris*	0	0	P
Synedra ulna	P	P	P
Synedra vaucheriae*	0	0	P
Tabellaria sp.	0	0	P
Tabellaria fenestrata	P	P	0
Terpsinoe sp.*	P	P	0
Total Chrysophyta	19	11	72

Table 3.3.1a (Continued)

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Cyanophyta			
Anabaena sp.	P	P	P
Calothrix sp.*	0	0	P
Lyngbya sp.*	P	0	0
Merismopedia sp.	P	P	P
Microcystis sp.	0	0	P
Oscillatoria sp.	P	0	0
Phormidium	0	0	P
Spirulina sp.	P	0	0
Total Cyanophyta	5	2	5
Euglenophyta			
Euglena sp.	P	P	0
*Euglena acus**	0	0	P
*Phacus torta**	P	P	0
Trachelomonas sp.	0	0	P
Total Euglenophyta	2	2	2
Pyrrophyta			
Ceratium hirundinella	0	0	P
Glenodinium sp.*	0	0	P
Total Pyrrophyta	0	0	2
TOTAL TAXA	40	21	103

*Not reported in previous baseline collections

Table 3.3.2a Total phytoplankton species by phyla collected at transects in the Broad River Study Area in August 1973* and April/May 1974**

	A	B	C		D		E	F
			S	VT	S	VT		
August 1973								
Chlorophyta	4	3	5	5	3	2	6	10
Chrysophyta	11	5	8	7	6	8	7	6
Cyanophyta	0	2	1	1	1	2	5	0
Euglenophyta	1	1	1	2	1	0	1	0
Total/Depth			15	15	11	12		
Total/Transect	16	11	18		19		19	16

April/May 1974	B			BL			C			CL			D				
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4	5
Chlorophyta	8	5	5	4	8	3	3	2	2	2	1	4	5	2	6	2	1
Chrysophyta	21	18	20	21	23	17	18	26	20	15	21	20	17	15	13	16	22
Cyanophyta	1	0	0	2	1	0	1	0	0	0	1	0	0	0	1	0	1
Euglenophyta	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
Pyrrophyta	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0
Total/Station	30	24	25	28	34	21	22	29	22	17	24	24	23	17	20	18	24
Total/Transect		47			48			45			40				45		

*Only one surface sample was collected per transect, except at Transects C and D where surface (S) and vertical tows (VT) were made.

**Three collecting points were sampled at Transects B, BL, C, and CL and five at Transect D. Transects A, E, and F were not sampled. BL and CL represen the littoral zones of Transects B and C, respectively.

Of those taxa listed in Section 3.3.3.1.1 of the baseline report as common in the Broad River Study Area, Pleurosigma and Chroococcus were not present in the August 1973 or April/May 1974 samples and Oscillatoria and Microcystis were relatively scarce.

3.3.3.1.2a Quantitative Analysis

Laboratory analyses revealed that very low phytoplankton populations characterized the Broad River Study Area during August 1973. Densities averaged 47 phytoplankters per liter and ranged from 32 per liter at Transect B to approximately 51 per liter at Transects A and F. These are the lowest densities which have been recorded in the study area.

None of the diatoms listed in Table 3.3.3 of the Baseline Biotic Survey were predominant in the August 1973 samples. Although Table 3.3.3a lists the most numerous taxa, it can be seen readily that none were found in abundance. The greatest density of any taxon was 25 Ankistrodesmus per liter occurring at Transect F.

Much higher phytoplankton populations characterized the study area during April/May 1974. Densities averaged 1480 phytoplankters per liter and ranged from 240 per liter at Collecting Point 5 of Transect C to 5977 at Collecting Point 3 of Transect B. These densities are within the range of those previously reported in the study area during spring. Highest densities consistently occurred at Transect B while lowest densities generally occurred at Transect D.

With the exception of Melosira granulata var. angustissima, which was the most abundant species, the predominant taxa in the April/May 1974 samples (Table 3.3.3a) differed from those in the previous baseline survey (Table 3.3.3). However, as in previous collections, all were chrysophytes.

Table 3.3.3a. Mean density (number/liter) of major phytoplankton taxa in the Broad River Study Area from Transects A through F in August 1973 and Transects B through D in April/May 1974.

	A	B	C		D		E	F
			S	VT	S	VT		
August 1973								
Ankistrodesmus sp.	0	6	13	10	12	0	0	0
Ankistrodesmus falcatus	0	0	0	0	0	0	0	25
Pediastrum duplex	3	1	0	1	4	13	4	0
Anabaena sp.	0	3	2	9	2	2	2	0
Phacus torta	0	2	7	1	2	0	7	0
Desmidium sp.	0	0	0	0	13	0	3	3

	B			C			D				
	1	2	3	1	2	3	1	2	3	4	5
April/May 1974											
Melosira granulata var. *angustissima*	2278	804	2917	37	106	60	0	31	0	0	8
Dinobryon sp.	405	0	870	65	54	43	0	0	0	0	0
Nitzschia acicularis	172	138	510	57	109	48	16	24	43	12	0
Melosira ambigua	555	432	51	0	37	5	0	12	0	2	12
Cyclotella sp.	234	60	434	2	6	3	14	0	8	2	8

As with phytoplankton densities, primary productivity was higher at Transect B than at Transect D. ^{14}C assimilation values were 51.6 and 27.8 $mgC/m^3/hr$ at Transects B and D, respectively.

3.3.3.2a Zooplankton

3.3.3.2.1a Qualitative Analysis

A total of 28 zooplankton taxa were collected in the Broad River Study Area in August 1973 and April/May 1974 by surface samples and vertical plankton net tows (Table 3.3.4a). The number of taxa in each major taxonomic group was: Protozoa, 1; Rotifera, 20; Copepoda, 1; and Cladocera, 6. These numbers are similar to those reported previously in the baseline survey. Table 3.3.4a includes seven rotifer taxa and one cladoceran taxa not previously reported in the baseline survey. These include four additional species of genera previously observed as well as four additional genera.

Of those taxa listed in Section 3.3.3.2.1 of the baseline report as common in the Broad River Study Area, all occurred in the August 1973 and April/May 1974 samples, except Cyclops sp. which only occurred at Transect C in August.

Taxa per transect ranged from 1 to 9 in August 1973 and from 6 to 15 in April/May 1974. During both sampling periods, Transects B and C had the highest number of taxa. As in the previous baseline survey, few taxa were collected from Transects E and F in August 1973.

3.3.3.2.2a Quantitative Analysis

Laboratory analyses revealed that low zooplankton populations characterized the Broad River Study Area during August 1973. Densities averaged 31 zooplankters per liter and ranged from 2 per liter at Transect E to 94 per liter at Transect C. These low densities are within the range

Table 3.3.4a Species list of zooplankton present (P) in surface (S) and vertical tow (VT) plankton samples in August 1973 and April/May 1974.

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Rotifera			
Asplanchna sp.	P	0	0
*Asplanchna priodonta**	0	0	P
Brachionus spp.	P	0	P
Brachionus bidentata	0	0	P
Conochilus sp.	P	P	P
Chromogaster sp.*	0	0	P
Filinia sp.	P	0	0
Filinia longiseta	0	0	P
Gastropus sp.	P	0	P
Keratella cochlearis	P	P	P
*Keratella quadrata**	0	0	P
Lecane sp.	P	0	0
Lepadella sp.	0	0	P
Notholca sp.	0	0	P
Platyias sp.*	P	P	P
*Platyias polyacanthus**	0	0	P
Ploesoma sp.	0	0	P
Polyarthra sp.	P	P	P
Synchaeta sp.	0	0	P
Trichocerca sp.	P	P	P
Total Rotifera	10	5	17
Copepoda			
Cyclops sp.	0	P	0
Calanoid copepod	0	0	P
Cyclopoid copepod	0	0	P
Nauplii	P	P	P
Total Copepoda	1	2	3
Cladocera			
Alona sp.	0	0	P
Bosmina longirostris	0	0	P
Chydorus sphaericus	0	0	P
Daphnia sp.	0	P	0
Diaphanosoma sp.*	0	0	P
Scapholeberis kingi	0	0	P
Total Cladocera	0	1	5

*Not reported in previous baseline collections.

Table 3.3.4a (Continued)

Taxa	August 1973 S	August 1973 VT	April/May 1974 S
Protozoa			
Astrameba radiosa	P	0	0
Total Protozoa	1	0	0
Total Taxa	12	8	25

of densities reported previously in the baseline survey. Although rotifers were the dominant taxonomic group in most samples, their numbers were rather low compared to most aquatic systems. Rotifers ranged from 1 per liter at Transects D and E to 72 per liter at Transect C. According to Pennak (1953), most plankton communities average 40 to 500 rotifers per liter.

Much higher zooplankton populations occurred in the study area during April/May 1974. Densities averaged 338 zooplankters per liter, but sample densities had a wide range. Zero zooplankters were reported for Collecting Point 5 of Transect D while 1505 per liter were reported for Collecting Point 3 of Transect B. In general, densities at all Transect B stations were much higher than those at Transects C and D.

As in previous baseline studies, rotifers were the predominant taxonomic group. Copepods were more numerous than cladocerans, but neither group was abundant. In contrast to previously reported findings, a single rotifer genus, Conochilus, was dominant in both the August 1973 and April/May 1974 samples. It comprised as much as 79 percent of the Transect F sample in August and 91 percent of the Collecting Point 1 sample at Transect B in April/May.

It was previously stated in Section 3.3.3.2.2 of the baseline survey, that mean zooplankton densities generally did not exceed 50 per liter, but several exceptions to this occurred in August 1973 and April/May 1974. The sample period, transects having a density greater than 50 per liter and the dominant rotifer taxa follow: August at B (51/liter), Conochilus; August at C - vertical tow (94/liter), Conochilus and Platyias; August at F (56/liter), Conochilus; April/May at Collecting Points 1-3 at Transect B (1231, 776, and 1505/liter, respectively),

Conochilus and Keratella cochlearis; and April/May at Collecting Points 1 and 3 at Transect C (72 and 62/liter, respectively), Conochilus and Keratella cochlearis.

3.3.4a DISCUSSION

3.3.4.1a Phytoplankton

In contrast to the previous baseline survey, the August 1973 phytoplankton collections were numerically dominated by chlorophytes. As in previous studies, the April/May 1974 collections were qualitatively and quantitatively dominated by chrysophytes. The composition of the phytoplankton in the Broad River Study Area reflects seasonal variation in light and temperature. According to Williams (1966), in temperate climates during the cooler ths, phytoplankton communities largely consist of diatoms, but increasing temperatures encourage the development of green and blue-green algae, which attain their maximum development during the warmer months. Although blue-green algae were generally sparse in both August 1973 and April/May 1974, like the green algae, they were more diversified and numerous in August 1973.

As mentioned in Section 3.3.3.1.2a, the August 1973 phytoplankton densities are the lowest of any which have been reported for the study area. Although the principal phytoplankton taxa are listed in Table 3.3.3a, because their numbers for August are relatively low, a discussion of their ecological significance would not be meaningful. On the other hand, principal taxa were sufficiently abundant in the April/May 1974 collections to warrant consideration of their ecological significance (Table 3.3.3a). Melosira granulata, the most abundant species in the April/May 1974 samples has been a dominant plankter in the previous baseline survey. According to Hutchinson (1967), this species is indicative

of nutrient enrichment. In Palmer's (1953) list of the 60 most pollution tolerant algal species in order of decreasing emphasis, Melosira granulata is ranked 59th and Nitzschia acicularis is 18th. Melosira ambigua is not listed. In a similar list of the 52 most pollution tolerant genera, Nitzschia is ranked sixth; Cyclotella, 15th; and Melosira, 19th (Palmer, 1963). The genus Dinobryon is not included in the list.

It was mentioned in Section 3.3.3.1.1a that several different species of Navicula and Nitzschia occurred in the April/May 1974 samples. Because these are typically benthic genera (Hynes, 1972), their abundance reflects the high spring water levels characterizing the study area during April/May. Hynes (1972) states that when water levels are high, numbers of benthic algae increase disproportionately to true plankters.

Transect B, near the mouth of Frees Creek, appears to provide a more suitable habitat for phytoplankton than other sampling transects, although its Secchi disc readings of light penetration were consistently low. Damann (1951) found substantially higher phytoplankton populations in 19 Missouri River tributaries than in the main channel of the river and suggested the difference might be attributed to the more stable substrates and lower current velicities as well as lower turbidity levels characterizing the tributaries.

Examination of water quality data from August 1973 and April/May 1974 gives no indication that plankton are nutrient-limited. According to Chu (1942), algae are likely to suffer a nutrient deficiency when nitrogen concentrations are less than 0.2 mg/l. This level was exceeded in all water samples collected in the study area in August 1973 and April/May 1974.

Values for ^{14}C assimilation were moderately high. Samsel (1974) reported similar values for a eutrophic pond. Highest primary productivity coincided with highest algae density, reflecting the fact that standing crop affects ^{14}C assimilation, though apparently no direct correlation exists (Tunzi and Porcella, 1974). Section 3.3.4.1 of the baseline survey discusses factors which may limit primary productivity in the Broad River Study Area.

3.3.4.2a Zooplankton

Zooplankton composition and densities in the Broad River Study Area during August 1973 were similar to those discussed in the baseline survey. Exceptionally high zooplankton densities reported for the April/May 1974 samples are probably related to the increased spring phytoplankton densities. Hynes (1972) observes that when diatom numbers increase, rotifers, the principal river zooplankters, become more common. This may indicate either a trophic effect or that similar conditions favor both types of organisms.

As with phytoplankton, highest and lowest zooplankton densities occurred at Transects B and D, respectively. Williams (1966), comparing phytoplankton and rotifer data from the national water quality network samples, found that stations with high phytoplankton populations generally had high rotifer populations. The opposite relationship also occurred.

According to Edmondson (1959), the colonial sessile rotifer Conochilus may accumulate in great numbers under suitable light and trophic conditions. However, specific ecological factors stimulating its great abundance, particularly at Transect B in April/May 1974, have not been determined.

3.3.5a SUMMARY

3.3.5.1a Phytoplankton

A total of 127 phytoplankton taxa were collected in the Broad River Study Area in August 1973 and April/May 1974. Seventy-seven of these taxa were not previously reported in the baseline survey. These include 15 Chlorophyta, 57 Chrysophyta, two Cyanophyta, two Euglenophyta and one Pyrrophyta taxa. This higher number of taxa compared to previous studies not only reflects more detailed species analyses for genera previously collected, but also an increase in benthic algae corresponding to high water levels in April/May 1974.

Phytoplankton populations in August 1973 were the lowest reported in the study area. The April/May 1974 populations, however, were within the range of those previously reported. In contrast to previous samples, the August 1973 collections were dominated by chlorophytes while the April/May 1974 collections were qualitatively and quantitatively dominated by diatoms.

With the exception of Melosira granulata var. angustissima, the predominant taxa in the August 1973 and April/May 1974 collections differed from those in the previous baseline survey.

Primary productivity in the study area in April/May 1974 was moderately high.

3.3.5.2a Zooplankton

A total of 28 zooplankton taxa were collected in the Broad River Study Area in August 1973 and April/May 1974. Although this number of taxa is similar to that previously reported for the baseline survey, it includes seven rotifer taxa and one cladoceran taxa not previously reported.

Low densities, averaging 31 zooplankters per liter, characterized the August 1973 samples. Much higher densities, averaging 338 zooplankters per liter, occurred during April/May 1974. As in the previous baseline survey, zooplankton abundance appeared to be directly related to phytoplankton abundance.

In contrast to previous findings, the colonial rotifer Conochilus was dominant in the August 1973 and April/May 1974 collections. Ecological factors stimulating its dominance were not determined.

3.4a VASCULAR HYDROPHYTES

A shoreline survey of the Broad River Study Area during the fall of 1973 resulted in the collection and identification of four previously unidentified species (Table 3.4.1a). Collection techniques and identification were the same as those used in previous surveys. Identification was facilitated because the plants bore the proper reproductive structures necessary for positive identification.

Bentgrass (Agrostis stolonifera) was found growing along the banks of the Broad River. Deer will graze the young shoots of this species during the spring. The other three species belong to the sedge family. All three species; sedge (Cyperus acuminatus), beak rush (Rhynchospora sp.) and wool grass (Scirpus cyperinus) are emergent hydrophytes and were found growing along the banks of Frees Creek. The nutlets of all three species are desirable food sources for waterfowl.

Table 3.4.1a Vascular hydrophytes found during a shoreline survey of the Broad River Study Area in the fall of 1973.

Family Scientific Name Common Name	Growth Form	Location
Gramineae		
Agrostis stolonifera Bent Grass	Emergent	Broad River
Cyperaceae		
Cyperus acuminatus Sedge	Emergent	Frees Creek
Rhynchospora sp. Beak Rush	Emergent	Frees Creek
Scirpus cyperinus Wool Grass	Emergent	Frees Creek

3.5a BENTHOS

3.5.1a INTRODUCTION

Benthic macroinvertebrate populations were examined qualitatively and quantitatively at specific collecting points in the Broad River Study Area in August 1973 and April/May 1974. The purpose of these studies was to amplify the baseline survey.

3.5.2a METHODS AND MATERIALS

Sampling methods and materials remained the same as those described in Section 3.5.2 of the baseline survey with the following exceptions. After the August 1973 sampling period, the number of Eckman dredge samples was reduced from five to three at each collecting point, since the larger number of samples did not significantly reduce the variability of organisms collected. Biomass analyses were discontinued after August 1973.

3.5.3a FINDINGS

3.5.3.1a Insects

3.5.3.1.1a Qualitative Analysis

Five new insect species were identified, three to genus, and two to subfamily. This increased the total insect taxa collected for the baseline survey from 66 to 71 (Table 3.5.1a). Of the new taxa collected, four were dipterans and one was an ephemeropteran. A change in nomenclature reclassified Sialis sp. as a Megaloptera rather than a Neuroptera.

Nine and 20 insect taxa were identified, respectively, in the August and April/May sampling periods (Table 3.5.1a). These values are within the range determined during the baseline survey.

The seasonal range of total insect species from individual

Table 3.5.1a Species list of benthic macroinvertebrates present (P) at sample periods in August 1973 and April/May 1974 on the Broad River Study Area.

Taxa	August 1973	April/May 1974
Insecta		
Diptera		
Ceratopogonidae		
Palpomyia sp.	0	P
Unidentified*	P	P
Chironomidae		
Cladotanytarsus sp.	0	P
Clinotanypus sp.	0	P
Chironomus sp.	0	P
Coelotanypus sp.	0	P
Cricotopus sp.	0	P
Cryptochironomus sp.	0	P
Dicrotendipes sp.	0	P
Metriocnemus sp.	0	P
Paracladopelma sp.	0	P
Polypedilum sp.	0	P
Procladius sp.	0	P
Tanypus sp.	0	P
Chironominae	P	0
Tanypodinae	P	0
Culicidae		
Chaoborus punctipennis	P	P
Diptera Total	4	15
Ephemeroptera		
Caenidae		
Caenis sp.	P	0
Ephemeridae		
Hexagenia limbata	P	P
Ephemeroptera Total	2	1
Hemiptera		
Corixidae		
Unidentified*	0	P
Hemiptera Total	0	1
Megaloptera		
Sialidae		
Sialis sp.	P	P
Megaloptera Total	1	1

Table 3.5.1a (Continued)

Taxa	August 1973	April/May 1974
Odonata		
Gomphidae		
Gomphus sp.	0	P
Unidentified*	P	0
Odonata Total	1	1
Trichoptera		
Psychomiidae		
Phylocentropus sp.	P	0
Trichoptera Total	1	0
Insecta Total	9	19
Archnoidea		
Hydracarina		
Pionidae		
Piona sp.	0	P
Uniocolidae		
Huitfeldtia rectipes?	0	P
Unicola sp.	0	P
Unidentified*	0	P
Archnoidea Total	0	4
Nematoda		
Dorylaimidae		
Laimydurus sp.?	0	P
Unidentified*	P	P
Nematoda Total	1	2
Nemertea		
Prostoma rubrum	P	P
Nemertea Total	1	1
Hirudinea		
Glossophoniidae		
Batrachobdella sp.	0	P
Unidentified*	0	P
Hirudinea Total	0	2

Table 3.5.1a (Continued)

Taxa	August 1973	April/May 1974
Oligochaeta		
Lumbriculidae		
Unidentified*	0	P
Naididae		
Arcteonais lomondi	0	P
Dero obtusa	0	P
Dero digitata	0	P
Dero nivea	0	P
Dero sp.	P	0
Nais elinguis	0	P
Slavina appendiculata	0	P
Specaria josinae	0	P
Stylaria lacustris	0	P
Tubificidae		
Aulodrilus limnobius	0	P
Aulodrilus pigueti	0	P
Branchiura sowerbyi	P	P
Ilyodrilus templetoni	0	P
Limnodrilus hoffmeisteri	0	P
Peloscolex multisetosus	0	P
Immature sp.1	0	P
Immature sp.2	0	P
Unidentified*	P	0
Oligochaeta Total	3	17
Mollusca		
Pelecypoda		
Corbiculidae		
Corbicula manilensis	P	P
Sphaeriidae		
Pisidium sp.	0	P
Sphaerium striatinum	0	P
Sphaerium sp.	0	P
Unidentified*	P	P
Mollusca Total	2	5
Taxa Total	16	50

*Species unknown, may be more than one species but considered here as one.

transects was as follows: B, 6-7; C, 13; and D, 6-8 (Tables 3.5.2a, 3.5.3a). This extends the range at Transect B from 10-17 taxa to 6-17 taxa and Transect D from 8-17 taxa to 6-17 taxa.

Nine insect species were considered ubiquitous to the Broad River Study Area during the baseline survey; however, in the August 1973 and the April/May 1974 surveys two chironomids, Ablabesmia sp. and Tanytarsus sp., were not collected. Only three (Chaoborus punctipennis, Hexagenia limbata and Sialis sp.) of the nine ubiquitous species were present during both surveys. Although it is likely that on any sampling date most of the nine "ubiquitous species" will be collected, it should be understood that under certain circumstances (e.g. just after emergence) even the most common species might be omitted from a collection.

3.5.3.1.2a Quantitative Analysis

The orders Diptera and Ephemeroptera (mayflies) continued to be numerically predominant in the Broad River Study Area during all seasons (Tables 3.5.2a, 3.5.3a). The chironomid larvae and phantom midges continued to be the most abundant dipteran and Hexagenia limbata continued to be the most abundant mayfly. The density of insects were comparable with previous data for the Broad River Study Area. Both the August 1973 and the April/May 1974 data had mean insect densities of about 1100/m^2, characteristic of baseline data for spring and late summer.

Seasonal density changes in the numerically predominant taxa (Diptera and mayflies) were more clearly identified; data shows that densities for both groups were relatively low in April/May, but that by August they were much higher. This coincides with past trends since density peaks for Diptera and mayflies occurred in November and September, respectively (Tables 3.5.2 to 3.5.7).

Table 3.5.2a Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in August 1973

	B	D
Insecta		
Diptera	3 (1813)	3 (173)
Ephemeroptera	1 (5)	2 (43)
Megaloptera	1 (62)	0 (0)
Odonata	0 (0)	1 (9)
Trichoptera	1 (9)	0 (0)
Total Taxa	6 (1889)	6 (325)

Table 3.5.3a Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in April/May 1974.

	B	C	D
Insecta			
Diptera	6 (859)	11 (1363)	6 (445)
Ephemeroptera	0 (0)	1 (128)	1 (437)
Hemiptera	0 (0)	1 (5)	0 (0)
Odonata	0 (0)	0 (0)	1 (5)
Megaloptera	1 (10)	0 (0)	0 (0)
Total Taxa	7 (869)	13 (1496)	8 (887)

3.5.3.2a Other Benthic Macroinvertebrates

3.5.3.2.1a Qualitative Analysis

In addition to the insects, the oligochaetes and molluscs comprised the other important benthic fauna of the Broad River Study Area (Table 3.5.1a). The species composition of the oligochaetes was examined in more detail in August 1973 and April/May 1974. During these surveys, a total of 20 different taxa were recognized of which Branchiura sowerbyi was the only species definitely common to the prior surveys. The predominant species of molluscs included the pelecypods, Corbicula manilensis and Sphaerium spp. No gastropods were collected during either survey period. Other major taxa represented in the August 1973 and April/May 1974 collections (Table 3.5.1a) included: Arachnoidea, Hirudinea (leeches), Nematoda (roundworms) and Nemertea (Proboscis worms); however, the densities of these taxa were relatively low.

3.5.3.2.2a Quantitative Analysis

The density of oligochaetes continued to vary by sample period and transect (Figure 3.5.1a). These data reflect trends similar to other baseline data since mean oligochaete densities at Transects B, C, and D were usually greater than 400/m^2 and exceeded 1000/m^2 on several occasions. Branchiura sowerbyi usually comprised a major proportion of the total oligochaete numbers.

The density and species composition of pelecypod molluscs was similar to other baseline data. Corbicula manilensis and Sphaerium spp. continued to have low densities except at Transect D where densities usually ranged from about 400 to 2600/m^2. During April/May 1974, the density of clams of the family Sphaeriidae (at Transect D) exceeded 3000/m^2, more than 1200/m^2 greater than previously reported for the Broad River Study Area (Tables 3.5.8, 3.5.8a).

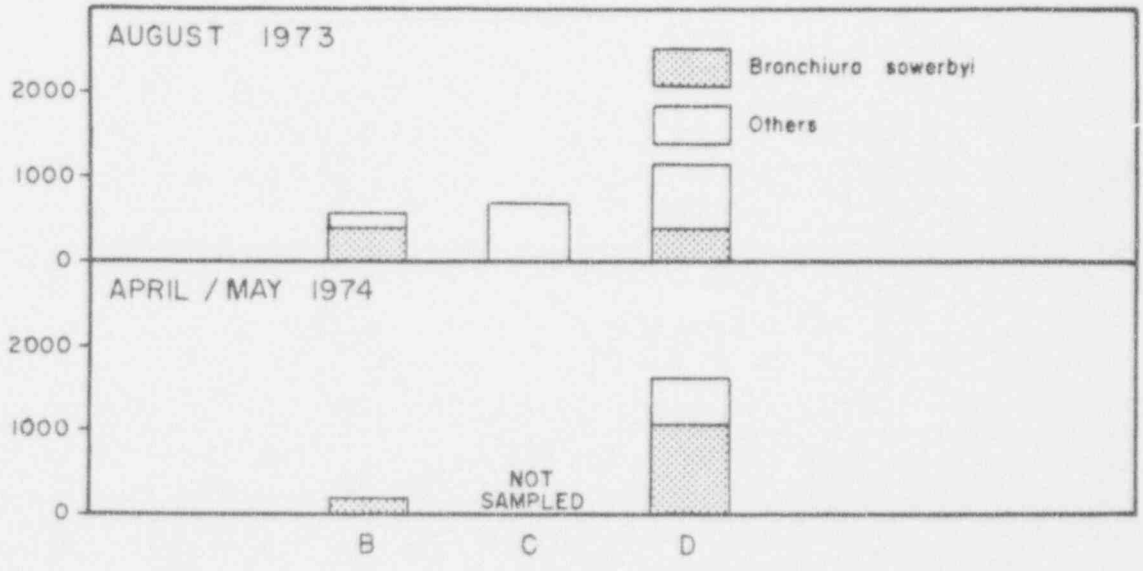

Figure 3.5.1a Mean number of oligochaetes (Branchiura sowerbyi and other species) per square meter on Transects B through D in the Broad River Study Area in August 1973 and April/May 1974

Table 3.5.8a Quantitative comparison (number per square meter) of pelecypod families Sphaeriidae and Corbiculidae at ten collecting points along three transects in the Broad River Study Area between August 1973 and April/May 1974.

	B			C			D*				
	1	2	3	1	2	3	1	2	3	4	5
August 1973											
Sphaeriidae											
Sphaerium spp.	0	NS**	0	NS	NS	NS	0	NS	36	NS	NS
Corbiculidae											
Corbicula manilensis	9	NS	0	NS	NS	NS	711	NS	2018	NS	NS
April/May 1974											
Sphaeriidae											
Sphaerium spp.	0	15	0	15	30	400	NS	NS	430	578	NS
Pisidium sp.	0	0	0	0	0	0	NS	NS	2633	0	NS
Corbiculidae											
Corbicula manilensis	0	0	0	0	0	0	NS	NS	356	1393	NS

*This transect was relocated in April 1974 (Figure 3.1-2a)

**NS = not sampled

3.5.3.3a Biomass

Benthos standing crop was determined (reported as ash-free dry weight biomass) from shallow and deep collecting points of Transects B and D in August 1973 (Table 3.5.9a). The total biomass at Transect B was much lower than at Transect D. There was not much difference between shallow and deep collections at Transect B as reported earlier; however, values of 0.158 and 0.600 grams per square meter were lower than any earlier reports. At Transect D, the biomass of the deep collection was more than three times greater than the shallow collection. This falls within the earlier reported range for which the biomass was 2 to 5 times greater from the deep collections than the shallow ones.

Insects and oligochaetes accounted for about 86 percent of the biomass at Transect B. The oligochaetes accounted for most of the biomass in the shallow area and the insects accounted for most of the biomass in the deep area. At Transect D, the mollusc, Corbicula manilensis was the major component of the biomass in both the shallow (97 percent) and deep (99 percent) areas. The total biomass reported for this period (August 1973) was more than twice as great as earlier reported values (Table 3.5.10) for both shallow (91.385 g/m^2) and deep (337.348 g/m^2) collections.

3.5.4a DISCUSSION

Most of the species of benthic organisms previously identified (Section 3.5.4) as faculative or pollution tolerant were present in August 1973 and/or April/May 1974. Two species of aquatic oligochaetes, Branchiura sowerbyi, and Limnodrilus hoffmeisteri (present during the baseline survey, Tables 3.5.1, 3.5.1a) are also considered as pollution tolerant organisms (Mason, et al., 1971). Two species of Diptera,

Table 3.5.9a Ash-free dry weight biomass in grams per square meter of benthic organisms in quantitative samples at two stations on Transects B and D in the Broad River Study Area in August 1973.

	B-1 (Shallow)	B-3 (Deep)	D-1 (Shallow)	D-3 (Deep)
Insecta				
Diptera				
Chironomidae	0.047	0.048	0.013	0.013
Others	0.001	0.098	0.001	-
Ephemeroptera				
Ephemeridae	0.030	-	0.074	0.004
Others	-	-	-	0.002
Megaloptera	0.101	-	-	-
Odonata	-	-	0.171	0.163
Trichoptera	0.027	-	-	-
Oligochaeta				
Tubificidae	0.288	0.012	2.059	0.762
Others	-	-	-	0.001
Nematoda	0.001	-	-	-
Mollusca				
Corbiculidae	0.105	-	89.067	336.400
Sphaeriidae	-	-	-	0.002
Others	-	-	-	0.001
TOTAL	0.600	0.158	91.385	337.348

Ablabesmia sp. and Tanytarsus sp., which were considered ubiquitous to the study area (Section 3.5.4) and which are also considered pollution sensitive were not collected in August 1973 or April/May 1974. The absence of these organisms could indicate recent environmental stress; however, the continued presence of Hexagenia limbata (a pollution sensitive species) refutes this premise. This new information on indicator species does not change conclusions drawn during previous baseline work.

Seasonal differences in the number of taxa and density continued to be observed (Tables 3.5.2a, 3.5.3a, 3.5.8a). These differences are generally similar to previously collected data for a given station during the same season. The high density of clams of the family Sphaeriidae at Transect D in April/May 1974 was one exception to the above generality. This high density (more than 3000/m^2) may be due in part to the relocation of Transect D and related changes in habitat types.

The relatively consistent characteristics of the biomass values at Transect B (mean biomass was 2.247 g/m^2 at the shallow and 2.244 g/m^2 at the deep collecting points) provides data which may be used in the future to determine changes in benthic productivity (Tables 3.5.9, 3.5.9a). Although the mean biomass values at the shallow and deep collecting points on Transect D were not similar (45.981 g/m^2 at the shallow and 165.461 g/m^2 at the deep collecting points), they were relatively constant throughout the survey (Tables 3.5.10, 3.5.9a). Thus, they too provide data which may be used to determine future changes in benthic productivity.

3.5.5a SUMMARY

3.5.5.1a Insects

A total of 71 insect taxa were collected during the baseline

survey (June 1971 - April/May 1974). The seasonal range of total insect taxa from individual transects was as follows: A', 7-11; A, 1-15; B, 6-17; C, 10-16; D, 6-17; E, 0-21; and F, 0-16. Chaoborus punctipennis, Hexagenia limbata and Sialis sp. were the only insect species which may be considered ubiquitous to the Broad River Study Area for the entire baseline survey.

The mean density of insects from individual transects varied by sample period and ranged from a minimum of $0/m^2$ to a maximum of $3845/m^2$. The greatest overall mean density of insects occurred in June 1971 (489 to $3763/m^2$) and November 1972 (1630 to $3845/m^2$).

3.5.5.2a Other Benthic Macroinvertebrates

The oligochaetes and molluscs were the numerically predominant taxa in this category. The species composition of the oligochaetes was examined in more detail in August 1973 and April/May 1974, revealing at least 20 different taxa. Branchiura sowerbyi continued to be the most numerically abundant oligochaete. The predominant molluscs continued to be Corbicula manilensis and Sphaerium spp. During April/May 1974 the density of clams of the family Sphaeriidae (at Transect D) exceeded $3000/m^2$, more than $1200/m^2$ greater than previously reported for the Broad River Study Area.

3.5.5.3a Biomass

Biomass standing crop determinations were relatively consistent at given collecting points. The minimum biomass values for Transect B were observed in August 1973 as were the maximum values for Transect D. These data should be useful for determining future changes in benthic productivity.

3.6a FISH

3.6.1a INTRODUCTION

The addendum contains two additional fisheries investigations not contained in the baseline survey, August 1973 and April/May 1974. The purpose and objectives of these investigations are described in Section 3.6.1 of the baseline report.

3.6.2a METHODS AND MATERIALS

3.6.2.1a Collection

Collection methods are the same as those reported in Section 3.6.2.1 of the baseline survey. However, in 1974 the sampling effort was increased in the littoral area by the addition of seining and back-pack shocking for larval and juvenile fish at three collection points on Transects B, C, and D. The areas of fish collection were in conjunction with areas where littoral plankton was collected and also within areas covered with the boat electroshocker, but inaccessible due to vegetative overgrowth and shallow depth. Back-pack shocking was done for 15 minutes at each collecting point in order to adequately sample the entire area. In addition, three seine hauls were randomly taken in corresponding collecting points outside the vegetative cover.

3.6.2.2a Age and Growth

Described in Section 3.6.2.2 of the baseline report.

3.6.2.3a Length-Weight Relationships

Described in Section 3.6.2.3 of the baseline report.

3.6.2.4a Condition Factor

Described in Section 3.6.2.4 of the baseline report.

3.6.2.5a Sex Ratio and Gonadal Condition

Described in Section 3.6.2.5 of the baseline report.

3.6.2.6a Standing Crop Estimate

The rationale and objectives of annual rotenone sampling appears in Section 3.6.2.6 of the baseline report. Baseline samples in Cannon and Frees Creeks were taken on 11-13 November 1972, and 27-29 August 1973.

The location of the cove sample at Transect B was 128 m upstream from the trestle on the north side of Frees Creek and the location of the Transect C cove sample was 1026 m downstream from the bridge on the north side.

3.6.2.7a Food Habits

Described in Section 3.6.2.7 of the baseline report.

3.6.3a FINDINGS AND DISCUSSION

3.6.3.1a Species Composition and Relative Abundance

Table 3.6.2a is modeled after Table 3.6.2 in the baseline report, with additional data from the August 1973 and April/May 1974 samplings. Dominance of the five most abundant species was relatively unchanged (76.4 versus 76.9 percent) by the additional data. Gizzard shad (Dorosoma cepedianum) was the only species which had increased dominance; however, the decline in white crappie (Pomoxis annularis) almost equaled the gizzard shad increase. The other three dominant species changed little. The increased shocking efficiency below the dam (Transect E) may account for changes in dominance as reflected by gizzard shad and white crappie since more gizzard shad were collected below the dam than previously reported.

Two additional samples contributed five new species: mosquitofish

Table 3.6.2a Species composition and relative abundance of all fishes collected from the Broad River Study Area between March 1971 and April/May 1974.

Common Name	Scientific Name	No.	Percent
Bluegill	Lepomis macrochirus	1830	34.12
Gizzard shad	Dorosoma cepedianum	1041	19.41
White crappie	Pomoxis annularis	565	10.54
Redear sunfish	Lepomis microlophus	458	8.54
Largemouth bass	Micropterus salmoides	206	3.84
Longnose gar	Lepisosteus osseus	137	2.55
Carp	Cyprinus carpio	122	2.27
River carpsucker	Carpiodes carpio	117	2.18
Shorthead redhorse	Moxostoma macrolepidotum	105	1.96
Black crappie	Pomoxis nigromaculatus	82	1.52
Flat bullhead	Ictalurus platycephalus	78	1.45
Channel catfish	I. punctatus	70	1.31
Warmouth	Lepomis gulosus	64	1.19
Quillback	Carpiodes cyprinus	64	1.19
White catfish	Ictalurus catus	61	1.14
Pumpkinseed	Lepomis gibbosus	56	1.04
Golden shiner	Notemigonus crysoleucas	53	0.99
Silver redhorse	Moxostoma anisurum	40	0.75
Mosquitofish	Gambusia affinis	34	0.63
Redbreast sunfish	Lepomis auritus	27	0.50
Silvery minnow	Hybognathus nuchalis	19	0.35
Snail bullhead	Ictalurus brunneus	17	0.32
White sucker	Catostomus commersoni	13	0.24
Brown bullhead	Ictalurus nebulosus	12	0.22
White bass	Morone chrysops	12	0.22
American eel	Anguilla rostrata	11	0.21
Yellow bullhead	Ictalurus natalis	10	0.19
Green sunfish	Lepomis cyanellus	10	0.19
Spotted sucker	Minytrema melanops	9	0.17
Satinfin shiner	Notropis analostanus	8	0.15
Unidentified shiner	Notropis spp.	6	0.11
Hybrid sunfish	Lepomis sp.	6	0.11
Longear sunfish	L. megalotis	5	0.09
Smallfin redhorse	Moxostoma robustum	2	0.04
Striped jumprock	M. rupiscartes	2	0.04

Table 3.6.2 (continued)

Common Name	Scientific Name	No.	Percent
Creek chubsucker	Erimyzon oblongus	2	0.04
Black bullhead	Ictalurus melas	2	0.04
Tadpole madtom	Noturus gyrinus	2	0.04
Spotted gar	Lepisosteus oculatus	1	0.02
Speckled madtom	Noturus leptocanthus	1	0.02
Chub	Hybopsis spp.	1	0.02
Pallid shiner	Notropis amnis	1	0.02
Yellow perch	Perca flavescens	1	0.02
Swamp darter	Etheostoma fusiforme	1	0.02
Johnny darter	E. nigrun	1	0.02
Total No.		5363	
Total Species		45 minimum	

(Gambusia affinis), snail bullhead (Ictalurus brunneus), smallfin redhorse (Moxostoma robustum), striped jumprock (M. rupiscartes), and johnny darter (Etheostoma nigrum). All of these species, with the exception of the mosquitofish, were collected only at non-reservoir Transects E or F.

The following annotated list of species contains the new species reported and data which differs from that reported in Section 3.6.3.1 of the baseline survey. Additional data including the percentage each species comprises of the total are included in Table 3.6.2a.

Lepisosteidae - Gar family

Lepisosteus osseus - Abundance of longnose gar increased from ninth to sixth during the two additional surveys. Their large numbers at Transects B and E in April/May 1974 accounted for their increase.

Cyprinidae - Minnow family

Carpiodes carpio - River carpsucker decreased in rank from sixth to seventh. Few river carpsucker were taken probably because spawning activity had ceased as the gonadal condition average was 5.5.

Carpiodes cyprinus - The quillback rank increased from 20th to 14th. In April/May 1974, 47 quillback were collected at Transect E, near the dam. As stated in the baseline survey in Section 3.6.3.1, spawning migrations probably concentrate fish at the base of the dam in the spring. Gonadal condition of quillbacks collected in April/May 1974 averaged 5.0, which indicates active spawning condition (Nikolsky, 1963).

Moxostoma robustum - Prior to the August 1973 sampling period, all redhorse specimens collected were identified only to genus. With subsequent sampling, identification to species was possible. The

smallfin redhorse (Moxostoma robustum) and striped jumprock (Moxostoma rupiscartes) collected at Transect E in April/May 1974 represent two species not recorded previously in the baseline collections.

Ictaluridae - Freshwater catfish family

Ictalurus brunneus - Another addition to the species list is the snail bullhead collected at Transects E and F. Prior to 1970, this species was synonymous with I. platycephalus, the flat bullhead (Bailey et al., 1970).

Ictalurus catus - The ranking of white catfish decreased to 15th from 11th.

Ictalurus nebulosus - The rank of brown bullhead increased from 28th to 24th. To date, specimens have been collected from all transects except F.

Ictalurus platycephalus - A decline from 8th to 11th was observed for the flat bullhead. This species was not collected in the two additional surveys, which accounts for its overall decline in the abundance ranking.

Centrarchidae - Sunfish family

Lepomis gibbosus - The pumpkinseed's ranking decreased from 13th to 16th. In April/May 1974, a single specimen was collected at Transect E, representing the first pumpkinseed collected at a non-reservoir transect.

Lepomis gulosus - Warmouth increased in rank from 14th to 13th.

Percidae - Perch Family

Etheostoma nigrum - In April/May 1974, a single specimen of johnny darter was collected, representing an additional darter species.

3.6.3.2a Age and Growth

A gradual increase in back-calculated growth rate for the age I bluegill occurred from 1966 through 1972 (Table 3.5.3a). However, subsequent age groups did not have the same gradual increase. The maximum growth rate for age group II occurred in 1967, while for age groups III through V, it was in 1968.

This growth increase for age I bluegills indicates an increase in stability of the littoral area, which promoted higher zooplankton densities. Since bluegills depend on zooplankton longer than the other four species for which growth was calculated, this might explain the growth increase for bluegills compared to the other species. Even with an increase in growth rate, the bluegill, as well as gizzard shad, and largemouth bass, had slower growth rates than other area lakes (Stevens, 1959). The opposite was true for age I white crappie and all age classes of redear sunfish.

3.6.3.3a Length-Weight Relationship

Data for both the November 1972 and April/May 1974 surveys appear in Table 3.6.4a. Most variation is due to small samples used in the regression analysis. However, Ricker (1970) stated that coefficient a varies seasonally with the time of day and between one habitat and another, but coefficient b is more stable and only changes at maturity or as a result of major environmental changes.

Coefficient b generally increased in August 1973 over values in November 1972 at Transect C for the five most abundant species: bluegill, gizzard shad, white crappie, redear, and largemouth bass. The remaining Transects, B, D, and E, had decreased b values. This indicates that habitat was more favorable in November 1972 than August 1973. The

Table 3.6.3a Mean back calculated total lengths and average growth increments of selected fishes from all Parr Reservoir transects (B, C, D), March 1971 - August 1973.

Year Class	n*	Total Length (mm) at Annulus 1	2	3	4	5	6	7
				Bluegill				
1972	44	64						
1971	115	56	88					
1970	117	57	92	126				
1969	85	53	86	115	146			
1968	54	56	87	115	141	143		
1967	12	65	97	130	155	-		
1966	8	29	69	106	134	154	172	
Mean Length		54	87	118	144	149	172	
Mean Increment		54	34	32	27	11	18	
				White Crappie				
1972	5	60						
1971	41	73	139					
1970	59	71	129	181				
1969	44	58	125	165				
1968	23	74	128	174	210			
1967	6	52	97	137	198	235		
1966	7	47	102	150	204	237	271	
Mean Length		62	120	161	204	236	271	
Mean Increment		62	57	45	47	35	34	
				Gizzard Shad				
1972	3	181						
1971	95	116	193					
1970	44	121	177	196				
1969	30	94	160	203				
1968	23	106	177	201	276			
1967	14	125	173	198	232	286		
1966	4	130	218	240	275	318	348	
1965	1	150	195	260	290	330	360	397
Mean Length		128	185	216	268	311	354	397
Mean Increment		128	57	33	44	46	30	37

Table 3.6.3a (Continued)

Year Class	n*	Total Length (mm) at Annulus 1	2	3	4	5	6	7
				Redear				
1972	9	81						
1971	21	62	118					
1970	23	65	111	148				
1969	17	60	111	147	197			
1968	18	54	119	146	177			
1967	6	61	119	162	185	194		
1966	2	84	109	148	173	195	209	
1965	6	54	77	120	150	188	208	222
1964	4	54	80	124	167	196	221	241
Mean Length		64	106	142	175	193	214	232
Mean Increment		64	41	38	34	24	20	17
				Largemouth Bass				
1972	1	103						
1971	13	98	143					
1970	11	120	145	237				
1969	10	97	181	270	250			
1968	5	161	215	275	-			
1967	5	116	175	233	285	354		
1966	6	99	186	257	300	353	399	
1965	1	55	107	141	180	212	241	255
1964	1	40	80	148	235	323	375	405
Mean Length		99	154	223	250	289	338	330
Mean Increment		99	56	68	29	39	42	22

*Number of fishes examined.

Table 3.6.4a Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, November 1972 and August 1973.

Species	November, 1972 Transect	Equation	August, 1973 Transect	Equation
Bluegill	B	$W=3.136\times10^{-6}L^{3.336}$	B	$W=9.970\times10^{-6}L^{3.099}$
	B (cove)	-	B (cove)	$W=6.626\times10^{-6}L^{3.175}$
	C	$W=1.705\times10^{-5}L^{2.950}$	C	$W=5.624\times10^{-6}L^{3.223}$
	C	$W=9.899\times10^{-4}L^{2.168}$	C (cove)	$W=7.888\times10^{-6}L^{3.148}$
	D	$W=4.719\times10^{-7}L^{3.719}$	D	$W=4.025\times10^{-6}L^{3.286}$
	E	$W=1.135\times10^{-7}L^{3.960}$	E	$W=5.803\times10^{-7}L^{3.694}$
Gizzard Shad	B	$W=2.984\times10^{-6}L^{3.211}$	B	$W=7.991\times10^{-6}L^{3.021}$
	B (cove)	-	B (cove)	$W=1.166\times10^{-4}L^{2.529}$
	C	$W=7.674\times10^{-5}L^{2.584}$	C	$W=1.277\times10^{-6}L^{3.401}$
	C (cove)	-	C (cove)	$W=3.082\times10^{-6}L^{3.207}$
	D	$W=1.315\times10^{-5}L^{2.946}$	D	$W=1.564\times10^{-5}L^{2.889}$
	E	$W=8.128\times10^{-6}L^{3.063}$	E	-
	F	$W=1.774\times10^{-4}L^{2.462}$	F	-

Table 3.6.4a (Continued)

Species	November, 1972 Transect	Equation	August, 1973 Transect	Equation
White Crappie	B	$W=4.602\times10^{-6}L^{3.173}$	B	$W=1.650.10^{-5}L^{2.958}$
	B (cove)	-	B (cove)	$W=1.349\times10^{-6}L^{3.450}$
	C	$W=4.459\times10^{-6}L^{3.180}$	C	$W=7.549\times10^{-6}L^{3.036}$
	D	-	D	$W=4.351\times10^{-7}L^{3.603}$
Redear	B	$W=6.232\times10^{-6}L^{3.203}$	B	$W=2.48\times10^{-5}L^{2.899}$
	B (cove)	-	B (cove)	$W=1.865\times10^{-5}L^{2.943}$
	C	$W=2.088\times10^{-5}L^{2.936}$	C	$W=2.772\times10^{-5}L^{3.401}$
	C (cove)	-	C (cove)	$W=1.448\times10^{-6}L^{3.507}$
	D	$W=1.053\times10^{-5}L^{3.558}$	D	$W=8.198\times10^{-6}L^{3.107}$
	E	-	E	$W=6.178\times10^{-7}L^{3.626}$
Largemouth Bass	B	$W=4.352\times10^{-6}L^{3.188}$	B	$W=4.454\times10^{-5}L^{2.752}$
	B (cove)	-	B (cove)	$W=3.089\times10^{-5}L^{2.820}$
	C	$W=1.286\times10^{-5}L^{2.958}$	C	$W=7.405\times10^{-7}L^{3.477}$
	C (cove)	-	C (cove)	$W=6.314\times10^{-6}L^{3.117}$

Table 3.6.4a (Continued)

Species	November, 1972 Transect	Equation	August, 1973 Transect	Equation
Largemouth Bass (con't.)	D	$W=2.503\times10^{-6}L^{3.305}$	D	-
	E	$W=2.138\times10^{-9}L^{4.474}$	E	$W=1.225\times10^{-3}L^{2.273}$
Carp	E	$W=2.193\times10^{-4}L^{2.563}$	E	$W=1.093\times10^{-6}L^{3.385}$
Longnose Gar	B	$W=4.331\times10^{-7}L^{3.240}$	B	$W=1.344\times10^{-10}L^{5.455}$
	E	-	E	$W=3.163\times10^{-5}L^{3.066}$
Black Crappie	C	$W=1.320\times10^{-7}L^{3.907}$	C	-
			D	$W=6.63\times10^{-6}L^{3.122}$
	E	$W=3.042\times10^{-6}L^{3.279}$	E	-
Silver Redhorse	E	$W=7.127\times10^{-7}L^{3.472}$	E	-
Shorthead Redhorse	E	$W=3.496\times10^{-6}L^{3.198}$	E	$W=2.444\times10^{-4}L^{2.478}$
	F	-	F	$W=1.015\times10^{-5}L^{3.016}$
Channel Catfish	E	$W=7.294\times10^{-8}L^{3.822}$	E	$W=3.113\times10^{-5}L^{2.734}$

Table 3.6.4a (Continued)

Species	November, 1972 Transect	Equation	August, 1973 Transect	Equation
White Catfish	B	$W=1.615\times10^{-6}L^{3.348}$	B	-
	B (cove)	-	B (cove)	$W=6.475\times10^{-5}L^{2.533}$
	C	$W=5.052\times10^{-6}L^{3.131}$	C	-
			C (cove)	$W=3.194\times10^{-5}L^{2.769}$
	D	-	D	$W=1.101\times10^{-5}L^{2.986}$
Pumpkinseed	B	$W=2.430\times10^{-6}L^{3.410}$	B	-
	C	$W=3.048\times10^{-4}L^{2.393}$	C	-
Warmouth	B	$W=8.060\times10^{-6}L^{3.165}$	B	$W=1.085\times10^{-6}L^{3.572}$
	B (cove)	-	B (cove)	$W=2.763\times10^{-8}L^{4.288}$
	C	$W=1.977\times10^{-5}L^{2.974}$	C	$W=3.713\times10^{-6}L^{3.327}$
	C (cove)	-	C (cove)	$W=5.899\times10^{-6}L^{3.240}$
Quillback Carpsucker	E	$W=7.779\times10^{-5}L^{2.685}$	E	-
Golden Shiner	B	$W=7.126\times10^{-6}L^{3.033}$	B	-
	B (cove)	-	B (cove)	$W=7.914\times10^{-6}L^{3.054}$
	C (cove)	-	C (cove)	$W=7.494\times10^{-7}L^{3.486}$

Table 3.6.4a (Continued)

Species	November, 1972 Transect	Equation	August, 1973 Transect	Equation
River Carpsucker	E	-	E	$W=5.99\times10^{-6}L^{3.136}$
Yellow Bullhead	C (Cove)	-	C (cove)	$W=2.409\times10^{-5}L^{2.836}$
Snail Bullhead	E	-	E	$W=9.526\times10^{-6}L^{3.014}$
	F	-	F	$W=1.015\times10^{-5}L^{3.016}$
Noturus Spp.	C (Cove)	-	C (cove)	$W=3.884\times10^{-4}L^{2.145}$
Swamp Darter	C (Cove)	-	C (cove)	$W=8.844\times10^{-2}L^{0.606}$

reason for the change is unclear, but it may be attributed to smaller specimens collected in August, which have lower b values.

3.6.3.4a Condition Factor

The additional data from August 1973 and April/May 1974 resulted in a change in condition factor for three species, longnose gar, pumpkinseed, and white bass (Table 3.6.5a). The longnose gar k factor increased from 0.2 to 0.3. The previous small sample and a large specimen collected at Transect E accounted for the increase. Pumpkinseed condition factor also increased, from 1.8 to 1.9. Several large adults at Transect C in April/May 1974 accounted for the increase. White bass was the only species whose k declined. The decline from 1.5 to 1.4 is attributed to several rather small individuals being collected at Transect E in April/May 1974.

3.6.3.5a Sex Ratio

Table 3.6.6a contains combined sex ratios from November 1972 through April/May 1974. Several species still had insufficient numbers for an accurate estimate; however, sufficient data were collected to accurately predict the male:female ratio of bluegills, showing an increase from 1:1.6 to 1:1.7 for that species.

3.6.3.6a Gonadal Conditions

All gonadal condition data through April/May 1974 are presented, with mean surface water temperature, in Table 3.6.7a. In August 1973, all species except river carpsucker which were in a maturing state (3.0), were in the nesting stage (2.0).

Fishes collected in April/May 1974 had a mean gonadal condition of 4.7. The average for the previous spring survey was 4.5. This increase in spawning condition can be explained by the warmer water in April/May 1974.

Table 3.6.5a Mean condition factors for all important species collected from the Broad River Study Area between March 1971 and April/May 1974.

Species	Total Number	Condition Factor
Bluegill	1105	1.8
Gizzard shad	667	0.9
White crappie	126	1.3
Redear sunfish	315	1.8
Largemouth bass	131	1.3
River carpsucker	72	1.2
Carp	80	1.4
Flat bullhead	41	1.2
Longnose gar	92	0.3
Black crappie	69	1.2
Redhorse	4	1.1
Channel catfish	37	0.8
White catfish	34	1.1
Pumpkinseed	22	1.9
Warmouth	46	1.9
Golden shiner	24	1.0
Shorthead redhorse	67	1.2
Silver redhorse	24	1.2
Silvery minnow	18	.1
Redbreast sunfish	27	..9
Quillback	52	1.3
Yellow bullhead	3	0.7
American eel	6	0.2
White bass	5	1.4
Unidentified shiners	2	1.0
Brown bullhead	7	1.4
Hybrid sunfish	2	1.9
Longear sunfish	2	2.1
Creek chubsucker	2	1.1
Black bullhead	2	1.5
Spotted gar	1	0.2
Tadpole madtom	1	0.6
Yellow perch	1	1.1
Swamp darter	1	0.6
Snail bullhead	17	1.1
Noturus spp.	1	1.0
Robust redhorse	1	1.1
Striped jumprock	1	1.1
Johnny darter	1	0.9

Table 3.6.6a Sex ratios of fishes collected from the Broad River Study Area, November 1972; February, May and August 1973; and April/May 1974.

Species	Male	Female	Ratio
Bluegill	231	452	1:2
Redear sunfish	115	142	1:1.2
Warmouth	21	28	1:1.3
Pumpkinseed	7	16	1:2.3
Redbreast sunfish	4	8	1:2.0
Hybrid sunfish	1	1	1:1.0
White crappie	58	58	1:1
Black crappie	35	28	1:0.8
Largemouth bass	61	60	1:1
Gizzard shad	182	154	1:0.8
Carp	46	21	1:0.5
Shorthead redhorse	26	32	1:1.2
Silver redhorse	10	8	1:0.8
Redhorse	3	1	1:0.3
River carpsucker	50	18	1:0.4
Golden shiner	2	1	1:0.5
Creek chubsucker	1	0	1:0
Brown bullhead	0	1	0:1.0
Black bullhead	0	2	0:2.0
Flat bullhead	10	13	1:1.3
Channel catfish	4	14	1:3.5
White catfish	3	10	1:3.3
Snail bullhead	1	0	1:0
Quillback	25	21	1:0.8
Mosquitofish	14	10	1:0.7

Table 3.6.7a Mean gonadal condition of mature female fishes collected in the Broad River Study Area, February, May and August 1973 and April/May 1974.

Species	February		May		August		April/May	
	n*	Average Condition	n	Average Condition	n	Average Condition	n	Average Condition
Bluegill	123	2.0	89	4.3	66	2.1	73	3.8
Redear sunfish	42	2.2	27	4.2	13	2.1	29	4.4
Pumpkinseed	4	2.3	-	-	1	3.0	3	4.7
Warmouth	2	2.0	7	4.1	3	2.0	4	4.0
Redbreast sunfish	-	-	5	4.6	1	2.0	2	5.0
Hybrid sunfish	1	2.0	-	-	-	-	-	-
White crappie	11	2.6	3	4.6	6	2.0	4	4.0
Black crappie	-	-	2	2.0	3	2.0	2	4.5
Largemouth bass	15	2.5	8	3.1	6	2.0	9	3.7
Gizzard shad	46	3.1	23	4.0	2	2.0	17	4.2
Golden shiner	1	3.0	-	-	-	-	-	-
Carp	6	3.5	5	4.2	4	2.0	4	5.3
Silver redhorse	6	4.0	3	6.0	-	-	-	-
Shorthead redhorse	5	4.4	6	6.0	6	2.0	6	5.8
River carpsucker	4	3.5	7	4.1	2	3.0	4	5.5
Quillback	-	-	1	6.0	-	-	21	5.0
White catfish	2	3.0	1	6.0	3	2.7	-	-
Channel catfish	1	2.0	4	3.0	1	2.0	2	6.0
Brown bullhead	1	3.0	-	-	-	-	-	-
Black bullhead	-	-	2	5.0	-	-	-	-
Flat bullhead	5	3.4	8	5.4	-	-	-	-
Silvery minnow	-	-	-	-	1	2.0	-	-
Mosquitofish	-	-	-	-	-	-	10	**
Temperature (C)***	9.8		20.0		26.7		22.6	

*Number of fishes examined

**All females had mature embryos

***Mean surface water temperature from all lake transects

Sunfish, crappie, largemouth bass, and gizzard shad were approaching spawning condition, but had not spawned when the April/May 1974 sample was collected. Members of the sucker family either were spawning or had spawned because their condition ranged from 5.0 to 5.8. The only species of catfish checked, the channel catfish, had already spawned. Because only two specimens were collected, these data could be misleading, since this species normally does not spawn until early summer.

3.6.3.7a Standing Crop Estimate

An estimate of standing crop was not possible in August 1973. No fish were recaptured from the cove sample at Transect C and the number of recaptures from Transect B, six (representing five species), was no greater than the number assumed recaptured when no actual recapture occurs. A reliable standing crop estimate cannot be based solely on assumed recaptures.

3.6.3.8a Food Habits

Additional food habit data collected in August 1973 and April/May 1974 are presented below only if enough specimens were collected to add validity or differ from observations made in the baseline survey, Section 3.6.3.8.

Bluegill

Trends stated in the baseline report were confirmed by 191 stomach analyses from the August 1973 and April/May 1974 surveys.

Gizzard Shad

Thirty-three specimens confirmed use of plankton and unidentified organic matter (UOM). However, during the August 1973 survey, chironomids were quite prominent as a food source.

White Crappie

Fish were the main contents of three additional stomachs which were analyzed in August 1973 and April/May 1974.

Redear Sunfish

Stomach analyses of 53 specimens revealed differences between transects and seasons which deviated from the baseline survey. Corbicula manilensis, the asiatic clam, was more prevalent in the diet at Transect C during the summer period, while the spring diet for all size groups was dominated by chironomids. Differences in benthic availability probably account for dietary changes in use of Corbicula versus Sphaerium at Transect C.

Largemouth Bass

Many of the 36 stomachs analyzed contained more benthic fauna than reported in the baseline survey, particularly in the small size groups. Also, several specimens collected at Transect E contained fish in addition to Decapoda.

River Carpsucker

The 10 stomachs analyzed contained UOM almost exclusively. This substantiates the data in the baseline survey.

Black Crappie

Analyses of nine additional stomachs were correlated closely with those reported in the baseline survey.

Channel Catfish

The six additional specimens collected at Transect E in April/May 1974 contained 65 percent algae by volume, differing significantly from the UOM and benthic diet reported in the baseline survey. These fish were all in the 301 to 600 mm size range. Because the algae were

not identified, their source is uncertain.

White Catfish

Eight additional stomachs were analyzed, confirming previous reported food habits.

Pumpkinseed

Three stomachs, analyzed from Transect C in April/May 1974, confirmed use of benthos as a food source and indicated that during the spring, Sphaerium sp. dominated as a food component.

Warmouth

Variation between Transects B and C was noted in 14 specimens collected in August 1973 although two size groups, 51-100 and 101-150 mm, depended on benthos at both transects. However, at Transect B, Hexagenia sp. (burrowing mayfly) dominated, while at Transect C, Pelecypoda dominated. The larger size groups, 151-200 and 201-251 mm, collected in April/May 1974, depended more on crayfish and fish, as reported for this size group in the baseline survey.

Golden Shiner

One specimen, collected in August 1973 at Transect C, contained only UOM.

Shorthead Redhorse

Twenty-four additional stomachs analyzed confirmed food habits reported in the baseline survey.

Redbreast Sunfish

In April/May 1974, nine additional stomachs were analyzed. At Transect C, Isopoda dominated food for the specimens below 100 mm and Pelecypoda for specimens larger than 100 mm. This differs from food habits of specimens at Transect E where insects (Chironomidae and Odonata) dominated.

White Bass

In April/May 1974, three specimens were collected at Transect E. One specimen's (101-150 mm) stomach was empty; one (151-200 mm) contained UOM; and one (301-600 mm) contained unidentified fish remains. These data correspond to food habits of the two specimens reported in the baseline survey.

Snail Bullhead

In the 17 specimens analyzed, aquatic plants dominated food components of almost all size groups above 100 mm. At Transect F, in August 1973, plant material was identified as Podostemum sp., an aquatic species.

Brown Bullhead

Of the seven brown bullheads collected in April/May 1974, two at Transect B had empty stomachs. A trend noted in the other specimens was that the small size group depended on benthos, particularly Hexagenia sp., while with increasing size, fish became a more important food source.

Quillback

Six stomachs analyzed from Transect E in April/May 1974 contained over 95 percent UOM. Three specimens were in the 251-300 mm category and three in the 301-500 mm category.

Silvery Minnow

One silvery minnow in the 51-100 mm category collected at Transect E in August 1973, contained largely UOM.

Mosquitofish

Stomach analyses of 19 specimens collected in the littoral area at Transect B and D, indicated that zooplankton (Daphnia) and UOM comprised most of the diet.

Johnny Darter

One specimen collected at Transect C in the littoral area during the April/May 1974 survey, contained primarily chironomids and zooplankton.

3.6.3.9a Parasites

Studies of fish parasites were not included in August 1973 or April/May 1974.

3.6.4a SUMMARY

Fish collections in August 1973 and April/May 1974 yielded five additional species: mosquitofish, snail bullhead, smallfin redhorse, striped jumprock, and johnny darter. This increases the total number of species collected throughout the baseline survey to 45 species, representing ten families.

The additional data obtained in August 1973 and April/May 1974 supported previous findings on age and growth, length-weight relationships, sex ratios, and gonadal condition. However, slight deviations in food habits were noted for redear, largemouth bass, and channel catfish. Because of limited recaptures, no data on fish standing crop were obtained. Studies of fish parasites were not included in the August 1973 or April/May 1974 surveys.

5.0a TERRESTRIAL SURVEY

5.1a DESCRIPTION OF SAMPLING LOCATIONS

Described in Section 5.1 in the baseline survey.

5.3a VEGETATION

5.3.2a METHODS AND MATERIALS

Earlier studies were conducted in 1971 to inventory and quantitatively describe woody vegetation which currently exists in the area based on stands considered representative of the Broad River plant community. Site 1 was divided after the initial survey to include two representative habitat types; 1A, representative of planted pine forests and 1B, representative of hardwood forests. Another survey in the fall of 1973 was conducted to quantify Site 1B.

Increment cores were collected from trees at all sites in an attempt to age the stands and to determine what stresses, such as fire and drought, have been imposed upon these communities.

5.3.2a

Quantitative analyses of perennial woody vegetation on Site 1B were the same as those employed during the previous study (Section 5.3.2).

Stand age was estimated by counting annual rings on cores extracted from trees in each community. Cores were extracted at approximately 30 cm (12 in) from the base of the tree with an increment borer and were packaged in plastic straws, and shipped to the Dames & Moore Environmental Services Laboratory, Cincinnati, Ohio. Each core was prepared for dating in the laboratory by mounting the core on a wood holder, carefully observing that the core was mounted in a position to vertically expose the vascular structures. Once mounted, the core was sanded and stained with acidic phloroglucinal (Jensen 1962). The stain was used to accentuate the annual growth

ring which facilitates counting the rings for age and characterizing any signatures of cyclic or unique occurrences which could provide insight into the vegetational history of these sites.

5.3.3a FINDINGS AND DISCUSSION

5.3.3.1a Floristic Composition

Study Site 1B was represented by 16 tree species and a density of 533 trees/ha (1317/acre). Each tree had a mean area of 18.8 m^2. Sweetgum was the most important species on the site while white oak and loblolly pine were considered subdominant (Table 5.3.1a). The high importance value for red maple indicated that the stand was tending toward maturity and loblolly was declining.

Climax vegetation of the area is potentially oak-hickory. The number of oak and hickory species present in the area indicated that succession had progressed to the deciduous phase. It also should be pointed out that selective cutting was taking place in the area during the sampling period. The more mature loblolly pine and hardwoods had been removed thus making the data somewhat biased. The harvest also accounts for the lower tree density when compared with the other study sites.

5.3.3.2a Dendrochronology

Annual growth rings formed by trees provide a chronological record of the developmental history on a particular site. During a growing season, individual trees form wood by cellular growth thereby increasing the diameter. The yearly growth generally occurs in two phases, a spring wood phase and a summer phase. The spring wood phase is initiated at the beginning of the growing season and the wood is characteristically very porous, of low density, and exhibits a light color. The summer wood phase commences as the growing season progresses and the wood is less porous, more dense, and much

Table 5.3.1a Relative frequencies, densities, dominances and importance values of tree species (2.5 cm or greater dbh) growing on Site 1B of the Broad River Study Area, August 1973.

Species	Relative Frequency	Relative Frequency	Relative Frequency	Importance Value*
Sweet Gum	17.48	25.63	26.71	69.82
White Oak	13.99	12.50	25.04	51.53
Loblolly Pine	13.29	15.63	11.11	40.03
Red Maple	10.49	9.38	9.30	29.17
Dogwood	12.24	11.88	4.85	28.97
Black Cherry	3.50	2.50	10.65	16.65
Shagbark Hickory	4.55	3.75	1.74	10.04
Black Jack Oak	4.55	3.13	1.87	9.55
Sugarberry	2.80	2.50	1.89	7.19
Red Oak	2.80	2.50	1.41	6.71
Laurel Oak	1.75	1.88	0.93	4.56
Water Oak	1.75	1.25	1.21	4.21
Pignut Hickory	1.75	1.25	0.93	3.93
Eastern Red Cedar	1.75	1.25	0.41	3.41
Virginia Pine	1.75	1.25	0.31	3.31
Winged Elm	1.05	0.63	0.16	1.84
	100.04	100.04	100.01	300.09

*Importance value is the sum of values for relative frequency, density and dominance.

darker than the spring wood. The seasonal variation in wood density and color provide the foundation for age determination (Douglas 1946; Fritts 1958).

Annual rings also provide evidence of stresses to which a tree has responded. Stresses include fire, water and temperature variation (Schulman 1953). These stresses are reflected in varying widths of the annual rings. The annual rings will be very narrow in years of stress reflecting the lack of growth induced by reduced water availability. Correspondingly, in years of optimum moisture and temperature, the rings will be wide, reflecting a good growth rate. By analyzing these wide and narrow annual ring signatures, a index to the type condition may be obtained.

Study Site 1A was predominantly loblolly pine. Estimated ages ranged from 14 to 35 years (Table 5.3.2a). Variability of age to diameter class would indicate highly variable growing conditions. For example, the tree in the 7.5 cm diameter class had an age of 22 years which would indicate very slow growth when compared to the 14 year old tree sampled in the 22.5 cm diameter class. A white oak was estimated at the same age as the oldest pine which would indicate this species became established at the same time the pines were planted. Sweetgum became established approximately 20 years B.P. (before present). This species is one of the early deciduous species to become established during successional processes. Two periods of subdued growth were indicated by narrow annual growth rings. These were for the periods 1959-1961 and 1965 to present. The subdued growth was probably due to moisture stress.

Study Site 1B was currently being selectively cut for the higher grade timber; both coniferous and deciduous. Where possible, the annual rings were read on some of the cut stumps. Two periods of white oak establishment were noted. The first period was approximately 95 years B.P. and the second period was approximately 50 years B.P. These observations are in agreement

Table 5.3.2a Distribution and mean age*, by midpoint of diameter size classes, of tree species growing on the Broad River Study Area, 1973.

Study Site / Species	Midpoint of Diameter Classes 7.5	12.5	17.5	22.5	27.5	32.5	>32.5
1-A							
Loblolly Pine	22	17	20	14	27	35	
Sweet Gum			20	**			
Flowering Dogwood	22						
White Oak		35					
1-B							
Sweet Gum	9.5		25	54			62+
White Oak			47	35	100+		100+
Loblolly Pine	32		30			18	
Red Maple			92				
Flowering Dogwood			40	57			
Black Cherry		25					
Shagbark Hickory		32.5					
Water Oak				41			
Eastern Red Cedar			54	50			
Yellow Poplar		37					
3-A							
Loblolly Pine			36		34	42	48
Eastern Red Cedar	27						
Red Maple	**						
Hop Hornbeam		62					
White Oak					71		
Red Oak			54	52		27+	73+
Shagbark Hickory			69	59			
Basswood	30						
Flowering Dogwood		69+		76			
Elm sp.					61+		
Pignut Hickory	29	35					
4							
Loblolly	30	28	27	39	41	43	37
Eastern Red Cedar			60				
White Oak			**	59			
Red Maple				52			
Shagbark Hickory		62					
Virginia Pine		60	36		51		

*Ages estimated from cores collected at 15 to 45 cm above ground line.

**Core collected but age undetermined.

with actual core counts as indicated in Table 5.3.2a. One loblolly pine stump was estimated to be 75 years old before cut in 1923.

The age distribution of the first four species is in agreement with the importance values obtained. Sweetgum has obtained its maximum importance in the stand and its reproductive capacity is quite depressed. White oaks are the oldest trees in the stand, some exceeding 100 years. Most trees in the higher diameter classes have been selectively removed.

Selected areas are clear-cut on approximately a 35 year rotation basis. This area probably was selectively cut 50 to 60 years B.P. since age of some of the white oaks and the red maple would indicate that the area was not entirely clear-cut. Eastern red cedar, a species which invades disturbed areas, became established within the same time frame. The absence of younger trees of this species indicates it has not been cleared since that time.

Observations of cut stumps revealed the possibility of a major fire through the area, approximately 90 years B.P. However, this could not be substantiated.

Increment cores collected from this site also indicated a stress from 1965 to the present. Optimal conditions were apparently present from 1953 to 1961 B.P. as evidenced by broad annual rings. From 1930 to 1935, the annual rings reflected a high stress level, possibly an effect of the drought of the 1930's. The ring configuration for the period 1912 to 1930 was somewhat narrow. This may be indicative of a closed stand prior to clear-cutting.

Study Site 3A was dominated by loblolly pine as indicated in Table 5.3.6 in the Baseline Biotic Survey. This species was apparently reaching its maturity for cutting. A review of the various species and

their ages would indicate timbering harvest on this area has been on a selective basis. This is evident by the number of deciduous species older than loblolly pine (Table 5.3.2a). White and red oak and shagbark hickory are the oldest trees in the stand.

Study Site 4 also was dominated by loblolly pine. The age distribution of this species ranged from approximately 25 to 45 years. The even age of this species would indicate that the pine has become established within the last 50 years. The age of white oak, red maple, and shagbark hickory would indicate that pine was the only species selectively removed within the past 50 years (Table 5.3.2a). The absence of older trees would indicate that the area had been selectively cut between 75 and 100 years B.P. This site also supported a number of mature Virginia pines. Virginia pine was one of the original dominant coniferous species in the area.

The drought of the 1930's was evident in the narrow rings that occurred between 1931 through 1934. Another group of narrow bands occurred between 1941 through 1945. This was followed by a period of wide bands from 1946 to 1948.

Man has played an important role in the development of the vegetation patterns of the Broad River Study Area. It is apparent that his activities have created a development of vegetation which is inconsistent with the natural successional pattern for the area. Continued activity by man in the area also makes it difficult to attribute ring signatures to natural phenomena or man-induced stresses.

5.3.3.3a Present Stresses

A recent stress imposed upon the vegetative community of the Broad River Study Area was invasion by the pine bark beetle. This insect

attacks and kills pine trees. This invasion which became apparent in 1971 was attributed to the lack of any sustained freezing temperatures in the area during the winters of 1971 and 1972 (Lynn, M.H. Pers. Comm.).

5.3.4a SUMMARY

Human activities in the Broad River Study Area have resulted in the development of vegetation inconsistent with natural successional patterns. Continued human activity in the area has made the interpretation of ring signatures difficult.

Study Sites 1A, 3A and 4 were predominantly loblolly pine. Variability of age to diameter class indicated highly variable growing conditions at Site 1A. Moisture stress probably caused periods of subdued growth from 1959-1961 and 1965 to the present. Analyses of various species and their ages on Site 3A indicated that timbering harvest in the area has been selective. At Site 4, the age of white oak, red maple and shagbark hickory indicated that pine was the only species selectively removed within the past 50 years. Narrow growth rings occurring between 1931 and 1934 reflected the drought of the 1930's. Sweet gum was the most important tree species on Study Site 1B while white oak and loblolly pine were considered subdominant. During the present study, higher grade coniferous and deciduous timber was being selectively cut at Site 1B. Most trees in the higher diameter classes have been selectively removed.

An invasion by the pine back beetle has recently stressed the vegetative community of the Broad River Study Area.

5.6a BIRDS

5.6.1a INTRODUCTION

The following data on avian populations in the Broad River Study Area include information from five survey periods between August 1973 and September 1974. This material supplements the Baseline Biotic Survey, Broad River Study Area, Parr, South Carolina, March 1971 to May 1973, and completes two years of quarterly baseline collections.

5.6.2a METHODS AND MATERIALS

5.6.2.1a Survey Periods

Avian surveys were conducted during the months of August of 1973 and January, April, June, and September of 1974. The different census techniques utilized during each of these periods are listed in Table 5.6.1a. Methods were generally the same as those described in Section 5.6.2 of the Baseline Biotic Survey, except as noted below.

5.6.2.2a Strip Census

Census methods were altered somewhat for the different survey periods in order to gather additional information. One such change was the addition of two sites near the proposed nuclear power plant for avian strip censuses. These sites were established to provide information on environmental changes occurring in this area due to construction activities. The methods utilized in these areas are described in the Baseline Biotic Survey.

5.6.2.3a Auto Survey

Auto surveys were conducted during the August 1973 and January 1974 survey periods. The routes and methods used in the auto surveys are the same as previously reported in Section 5.6.2.2 of the Baseline Biotic Survey.

Table 5.6.1a Census techniques employed during sampling periods August 1973 - September 1974.

August 1973	January 1974	March 1974	June 1974	September 1974
Auto Survey	Auto Survey			
Strip Census	Strip Census	Strip Census	Strip Census	Strip Census
Waterfowl Survey	Waterfowl Survey		Waterfowl Survey	

The auto surveys were discontinued after the survey of January 1974 because it was felt that sufficient baseline data had been assembled. The auto surveys will be reinstituted after Monticello Impoundment has been filled to determine any construction effects and attempt to establish new baseline conditions prior to operation.

5.6.2.4a Waterfowl Survey

See Section 5.6.2.5 of the Baseline Biotic Survey for methods. The survey was run in August of 1973 and in January and June of 1974.

5.6.2.5a Additional Sources of Information

During the April, June, and September 1974 surveys, three areas were examined qualitatively for suitability as wildlife habitat. These areas were the ponds and surrounding deciduous forest at Dawkins and Terrible Creek and approximately 731 m (800 yds) along Frees Creek south from County Road 99.

5.6.3a FINDINGS

A total of 90 species of birds were observed during the five survey periods (Table 5.6.2a). Of the 90 species recorded, 44 were permanent residents, 21 were winter residents, 23 were summer residents, and two species were considered transients.

5.6.3.1a Auto Surveys

The number of birds recorded per stop per day on each of the four auto survey routes are presented in Figure 5.6.1a. When combined with previous reported baseline data, a complete picture of the abundance of birds on all four survey routes is provided for each season of the year. The fall and winter surveys were conducted during the morning since it was found during the baseline study that this was the most productive period of the day for a survey of this nature.

Table 5.6.2a Birds observed on the Broad River Study Area during five survey periods during 1973-1974.

Family	Scientific Name	Common Name	8-73	1-74	4-74	6-74	9-74	Status*
Ardeidae	Casmerodius albus	Common Egret	X	0	0	0	0	P
	Bubulcus ibis	Cattle Egret	X	0	X	0	0	T
	Ardea herodias	Great Blue Heron	X	X	X	0	0	P
	Butorides virescens	Green Heron	X	0	X	0	0	P
Anatidae	Anas platyrhynchos	Mallard	0	X	X	0	0	W
	Anas acuta	Pintail	0	X	0	0	0	W
	Anas discors	Blue-winged Teal	X	0	0	0	0	W
	Aix sponsa	Wood Duck	X	X	X	0	0	P
	Aythya collaris	Ring-necked Duck	0	X	0	0	0	W
	Bucephala albeola	Buffle-head	0	X	0	0	0	W
	Mareca americana	Baldpate	0	X	0	0	0	W
	Anas strepera	Gadwell	0	X	0	0	0	W
Cathartidae	Cathartes aura	Turkey Vulture	X	X	0	0	X	P
	Coragyps atratus	Black Vulture	X	X	0	0	X	P
Accipitridae	Circus cyaneus	Marsh Hawk	X	X	0	0	X	P
	Buteo jamaicensis	Red-tailed Hawk	X	X	0	0	X	P
Falconidae	Falco sparverius	Sparrow Hawk	0	X	0	0	X	P
Phasianidae	Colinus virginianus	Bobwhite	X	X	0	X	0	P
Charadriidae	Charadrius vociferus	Killdeer	0	X	0	0	X	T
Scolopacidae	Actitis macularia	Spotted Sandpiper	X	0	0	0	0	S
Columbidae	Zenaidura macroura	Mourning Dove	X	X	0	0	0	P
Cuculidae	Coccyzus americanus	Yellow-billed Cuckoo	X	0	0	X	X	S
Caorimulgidae	Caprimulgus carolinensis	Chuck-will's-widow	0	0	X	0	0	S
	Caprimulgus vociferus	Whip-poor-will	0	0	X	0	0	S
Apodidae	Chaetura pelagica	Chimney Swift	X	0	0	0	0	S
Trochilidae	Archilochus colubris	Ruby-throated Hummingbird	X	0	0	0	0	P

Table 5.6.2a (Continued)

Family	Scientific Name	Common Name	8-73	1-74	4-74	6-74	9-74	Status*
Alcedinidae	Megaceryle alcyon	Belted Kingfisher	X	X	X	0	X	P
Picidae	Colaptes auratus	Yellow-Shafted Flicker	X	X	0	X	X	P
	Dryocopus pileatus	Pileated Woodpecker	0	0	0	0	0	P
	Centurus carolinus	Red-bellied Woodpecker	X	X	X	X	X	P
	Sphrapicus varius	Yellow-bellied Sapsucker	0	X	0	0	0	W
	Dendrocopos villosus	Hairy Woodpecker	0	X	X	X	0	P
	Dendrocopos pubescens	Downy Woodpecker	X	X	X	X	X	P
	Melanerpes erythrocephalus	Red-headed Woodpecker	0	0	0	0	X	P
Tyrannidae	Tyrannus tyrannus	Eastern Kingbird	X	0	0	0	0	S
	Myiarchus crinitus	Great Crested Flycatcher	X	0	0	X	0	S
	Sayornis phoebe	Eastern Phoebe	0	X	0	0	X	W
	Contopus virens	Eastern Wood Pewee	X	0	0	X	0	S
	Empidonax virescens	Acadian Flycatcher	0	0	0	X	X	S
Hirundinidae	Hirundo rustica	Barn Swallow	X	0	0	0	0	S
Corvidae	Cyanocitta cristata	Blue Jay	X	X	X	X	X	P
	Corvus brachyrhynchos	Common Crow	X	X	0	X	X	P
	Corvus ossifragus	Fish Crow	X	0	0	0	0	P
Paridae	Parus carolinensis	Carolina Chickadee	X	X	X	X	X	P
	Parus bicolor	Tufted Titmouse	X	X	X	X	X	P
Sittidae	Sitta pusilla	Brown-headed Nuthatch	X	X	X	X	X	P
Certhiidae	Certhia familiaris	Brown Creeper	0	0	0	0	X	W
Troglodytidae	Thrythorus ludovicianus	Carolina Wren	X	X	X	X	X	P
Mimidae	Mimus polyglottos	Mockingbird	X	X	0	X	X	P
	Dumetella carolinensis	Catbird	X	0	X	0	0	P
	Toxostoma rufum	Brown Thrasher	0	X	0	X	X	P

Table 5.6.2a (Continued)

Family	Scientific Name	Common Name	8-73	1-74	4-74	6-74	9-74	Status*
Turdidae	Turdus migratorius	Robin	X	X	0	0	X	P
	Hylocichla mustelina	Wood Thrush	0	0	X	X	0	S
	Hylocichla guttata	Hermit Thrush	0	X	0	0	0	W
	Sialis sialis	Eastern Bluebird	X	X	0	0	X	P
Sylviidae	Polioptila caerulea	Blue-gray Gnatcatcher	X	0	X	X	0	S
	Regulus satrapa	Golden-crowned Kinglet	0	X	0	0	0	W
	Regulus calendula	Ruby-crowned Kinglet	0	X	X	0	X	W
Laniidae	Lanius ludovicianus	Loggerhead Shrike	X	X	0	0	X	P
Sturnidae	Sturnus vulgaris	Starling	X	X		0	X	P
Vireonidae	Vireo flavifrons	Yellow-throated Vireo	0	0		0	0	S
	Vireo olivaceus	Red-eyed Vireo	X	0		X	X	S
	Vireo griseus	White-eyed Vireo	X	0	X	0	0	S
Parulidae	Parula americana	Paula · rbler	0	0	X	X	0	S
	Dendroica coronata	Myrt rbler		X	X	0	X	W
	Dendroica dominica	Yellow throated Warbler		0	0	0	0	P
	Dendroica pinus	Pine Warbler		X	X	X	X	P
	Dendroica discolor	Prairie Warbler	0	0	X	X	X	S
	Geothlypis trichas	Yellowthroat	X	0	X	X	0	P
	Wilsonia citrina	Hooded Warbler	X	0	X	0	0	S
Ploceidae	Passer domesticus	English Sparrow	X	X	0	0	X	P
Icteridae	Sturnella magna	Eastern Meadowlark	X	X	0	0	X	P
	Agelaius phoeniceus	Red-winged Blackbird	0	X	0	0	X	P
	Molothrus ater	Brown-headed Cowbird	0	0	X	0	0	P
	Icterus spurius	Orchard Oriole	0	0	0	X	0	S
Thraupidae	Piranga rubra	Summer Tanager	X	0	X	X	X	S
Fringillidae	Richmondena cardinalis	Cardinal	X	X	X	X	X	P
	Guiraca caerulea	Blue Grosbeak	X	0	0	0	0	S
	Passerina cyanea	Indigo Bunting	X	0	0	X	0	S
	Carpodacus purpureus	Purple Finch	X	X	0	0	0	W
	Spinus tristis	American Goldfinch	X	X	0	0	X	P

Table 5.6.2a (Continued)

Family	Scientific Name	Common Name	8-73	1-74	4-74	6-74	9-74	Status*
Fringillidae (continued)	Spinus pinus	Pine Siskin	0	X	0	0	X	W
	Pipilo erythrophthalmus	Rufous-sided Towhee	X	X	X	X	X	P
	Junco hyemalis	Slate-colored Junco	0	X	0	0	X	W
	Spizella pusilla	Field Sparrow	X	X	0	0	X	P
	Zonotrichia leucophrys	White-crowned Sparrow	0	X	0	0	0	W
	Zonotrichia albicollis	White-throated Sparrow	0	X	0	0	X	W
	Melospiza melodia	Song Sparrow	X	X	0	0	X	W
	Aimophila aestivalis	Bachman's Sparrow	0	0	X	0	0	S
	Passerella iliaca	Fox Sparrow	0	X	0	0	0	W
Total Species Per Survey Period			55	54	33	29	44	

Totals: 33 Families; 90 Species

*P-Permanent Resident; S-Summer Resident; W-Winter Resident; T-Transient

X-Present

0-Not Present

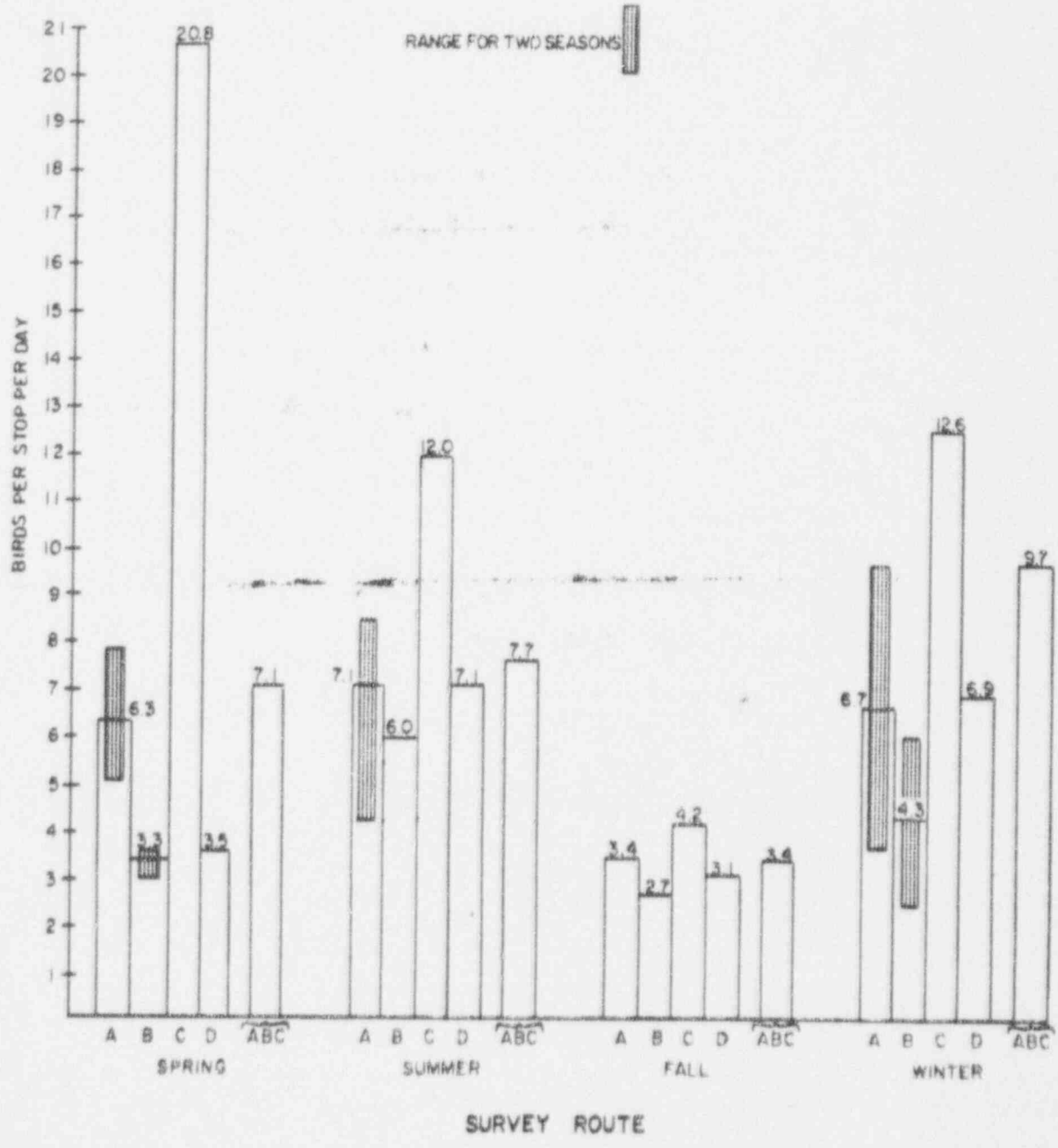

Figure 5.6.1a Average number of birds recorded on each auto survey route

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DAMES & MOORE

The variability of the abundance of birds observed along each survey route is a result of the variety of habitats found at each stop. Not only do the different habitats contain different numbers and species of birds, but certain habitats, such as grasslands, provide better visibility over large areas which aids in observation of birds.

5.6.3.2a Indicator Species

Section 5.6.3.1.3 in the Baseline Biotic Survey presented the criteria for selecting indicator species and listed nine species as potential indicators of environmental change. During the auto census, it was found that four of these species occurred in sufficient abundance to qualify them as indicator species. Four additional species which occurred along the auto survey routes were found to be acceptable as indicators. These eight species are the following:

Mockingbird	Cardinal
Loggerhead Shrike	Pine Warbler
Eastern Meadowlark	Rufous-sided Towhee
Mourning Dove	Carolina Chickadee

The mean and range of the combined totals of indicator species observed along the test and the control auto routes during each season are presented in Figure 5.6.2a. These data will be compared later with data obtained from surveys of cleared and cut areas associated with the pumped storage facility.

5.6.3.3a Strip Census

The variety and number of birds per 100 acres (40 hectares) recorded by the strip census method in pine, cut pine, deciduous, and mixed habitat types are shown on Table 5.6.3a. As in the Baseline Biotic Survey, data collected from similar sites, such as pine, were combined to provide a better idea of avian abundance in these habitat types. Data from Areas 1C and 5B were combined as pine habitats; Areas 1B and 5C were

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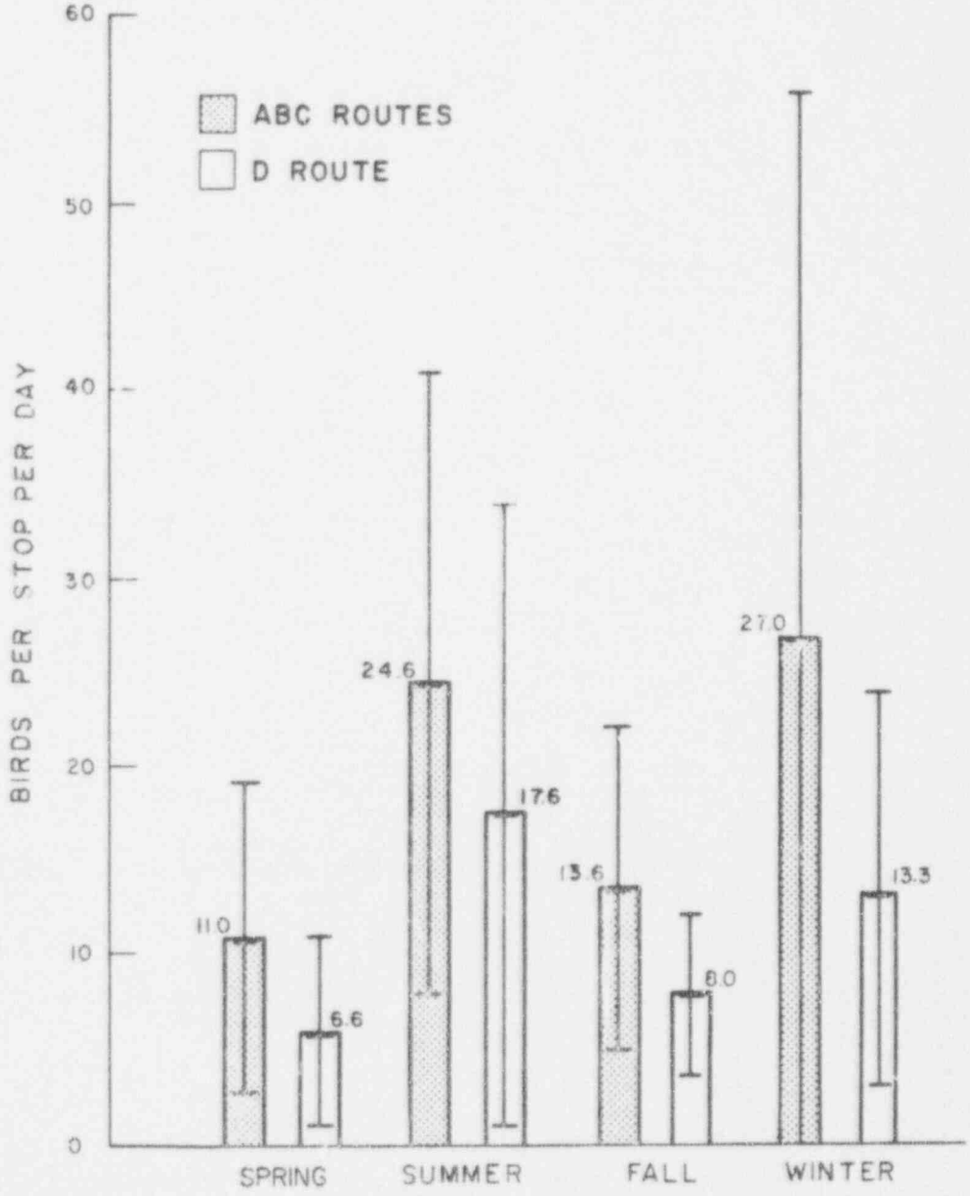

Figure 5.6.2a Mean and range recorded of total indicator species during auto surveys

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Table 5.6.3a Results of avian strip censuses in different habitats, Fall 1973 to Fall 1974.

	PINE					SELECTIVELY CUT PINE					DECIDUOUS					PINE AND DECIDUOUS				
	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall
Bobwhite		12		1			13					8								
Mourning Dove																	2			
Yellow-billed Cuckoo	1			1							2			3	2	1				
Chuck will's-widow																		2		
Whip-poor-will								1												
Ruby-throated Hummingbird											1									
Common Flicker							3			1				1						
Red-bellied Woodpecker			2	4				1		1		2			1					
Yellow-bellied Sapsucker		1															1			
Hairy Woodpecker							1	1	1			1								
Downy Woodpecker				2	1					1	1		10	1						
Great Crested Flycatcher				5																
Acadian Flycatcher										1				7	2					
Eastern Wood Peewee				1										3						
Blue Jay	7		1	6	12		1	1	3	5			2		1					5
Crow		2		1																
Carolina Chickadee	13	3	5	7	3		2	7	7	5	11	16	5	4	4		1		3	1
Tufted Titmouse	1		1						2	6	1			1			2			
Brown-headed Nuthatch	5		4	16	6		1	4	11	16	1	11		2		1				
Carolina Wren		2	2	9		1		1	1	2	4	3	14		8					
Mockingbird				1																
Catbird								1												
Brown Thrasher				3										1						
Robin							40													
Wood Thrush			1	1																3
Hermit Thrush		2					3					1								
Blue-gray Gnatcatcher			5					2	11				14	3						
Golden-crowned kinglet												19								
Ruby-crowned Kinglet			2				1					2	14							
Kinglet sp.							3					6								
White-eyed Vireo			1										3		1					
Yellow-throated Vireo													3							
Red-eyed Vireo				2					1				1	4						
Parula Warbler													11	1						
Myrtle Warbler			17					2					6		3					
Pine Warbler	6	2	12	4	4		1	1	6		10									
Prairie Warbler			4	2				12	6	1			2							
Yellowthroat			1					1	2				11	2						
Hooded Warbler											6		1							
Warbler sp.			3																	
Orchard Oriole				1															1	
Cowbird								1												
Summer Tanager			3	2	1	1		1	6	3			1	3					2	
Cardinal	3			5	4		7	7	7		4	4	5	4	4	1		2		4

Table 5.6.3a (Continued)

	PINE					SELECTIVELY CUT PINE					DECIDUOUS					PINE AND DECIDUOUS				
	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall	Fall	Winter	Spr.	Summer	Fall
Indigo Bunting				1										2						
Purple Finch							2													
American Goldfinch												5								
Rufous-sided Towhee			2	7		5	2	1	6	1		5	3		1					
Bachman's Sparrow													4							
White-throated Sparrow												15								
Fox Sparrow							6													
Song Sparrow												4								
Unidentified	12		5	6	3	1	2		2	1	18	6	20		1					
Total Species	8	7	18	23	8	4	16	17	15	13	11	16	13	16	11	3	4	2	4	4
Total Birds	48	24	71	83	34	8	33	45	72	44	53	108	130	42	53	3	6	4	6	13

both deciduous habitats; Areas 4 and 7 were selectively cut pine habitats and Area 3B was a mixed stand. Loblolly pine were selectively removed from Area 4 in March of 1972, and Area 7 was selectively cut during the summer of 1973. Area 1B was referred to as "mixed" habitat in the Baseline Biotic Survey since one portion was covered with pine and the other with hardwoods. In May 1973, the pine portion was clear-cut so this area is now considered deciduous habitat. Twenty-nine species of birds were observed by strip census in the pine habitat, 29 in selectively cut pine habitat, 36 in deciduous habitat, and 21 in the mixed (pine and deciduous) stand.

5.6.3.4a Waterfowl Survey

Waterfowl and shorebirds were surveyed along the Broad River between the Enoree River and Parr Reservoir during August 1973 and January and June 1974. Fourteen waterfowl species, eight duck and six shorebird species, were observed in the area (Table 5.6.4a). Waterfowl occurrences in each of the survey sections along the Broad River are compared in Figure 5.6.3a.

The Wood Duck was the most commonly observed duck having been observed in 82.4 percent of the surveys. The Great Blue Heron and the Belted Kingfisher were the most common shorebirds occurring 82.4 and 100 percent of the time, respectively. These three species are listed as indicator species in the Baseline Biotic Survey and will be important during interpretation of impacts.

5.6.3.5a Additional Findings

5.6.3.5.1a Qualitative Assessment of Habitats

Dawkins and Terrible Creek

A brief description of the habitat surrounding these two areas is presented in Section 5.6.3.4 of the Baseline Biotic Survey. Ponds at

Table 5.6.4a Maximum waterfowl and shorebirds seen any one day along the boat survey route during three study periods.

	Broad & Enoree River north of Blair, S.C.			Broad River from Blair South to Hellers Creek			Hellers Creek			Broad River from Hellers to Frees Creek			Frees Creek			Cannons Creek			Parr Reservoir		
	1973	1974		1973	1974		1973	1974		1973	1974		1973	1974		1973	1974		1973	1974	
Common Name	Aug*	Jan*	June	Aug*	Jan*	June	Aug*	Jan*	June	Aug*	Jan*	June	Aug*	Jan*	June*	Aug	Jan*	June	Aug	Jan*	June
Great Blue Heron		1		3	1			2	1	2	1		2	3	4	2	5		2	2	
Common Egret										1											
Cattle Egret										1					1						
Green Heron	2								1	2			3		3	2		2	3		
Mallard		5													10					3	
Gadwall					2																
American Widgeon		2																			
Pintail																				2	
Blue-winged Teal							1														
Wood Duck	5	16		1	6		5	1		7			6		16	6	2	3	5	5	
Ringneck								2						2			1			2	
Bufflehead																				12	
Unidentified Duck		8							3				1							16	
Spotted Sandpiper	5			5			1			4								3			
Belted Kingfisher	1	1		2	3		2	1	3	1	2		3	4	4	3	4	1	3	2	
Minimum # species	4	5		4	4		4	4	4	6	2		5	3	6	4	4	3	5	7	
# ducks	5	34		1	8		6	3	3	7			7	2	26	6	3	3	5	40	
# shorebirds	8	2		10	4		3	3	5	7	3		12	7	12	7	11	3	11	4	

*Two Day Observation

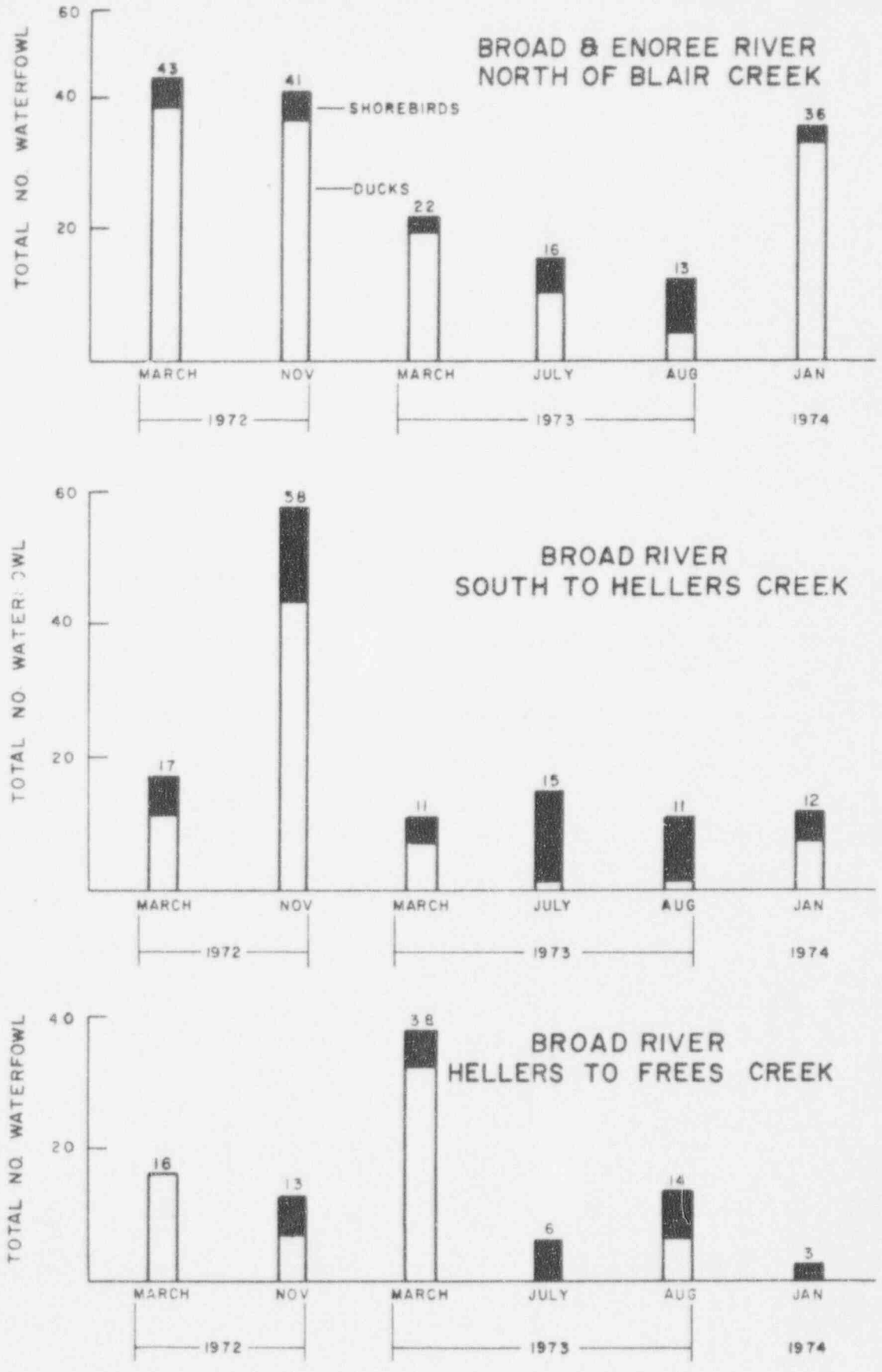

Figure 5.6.3a Results of waterfowl surveys on seven sections of the Broad River

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REVISIONS BY _____ DATE _____

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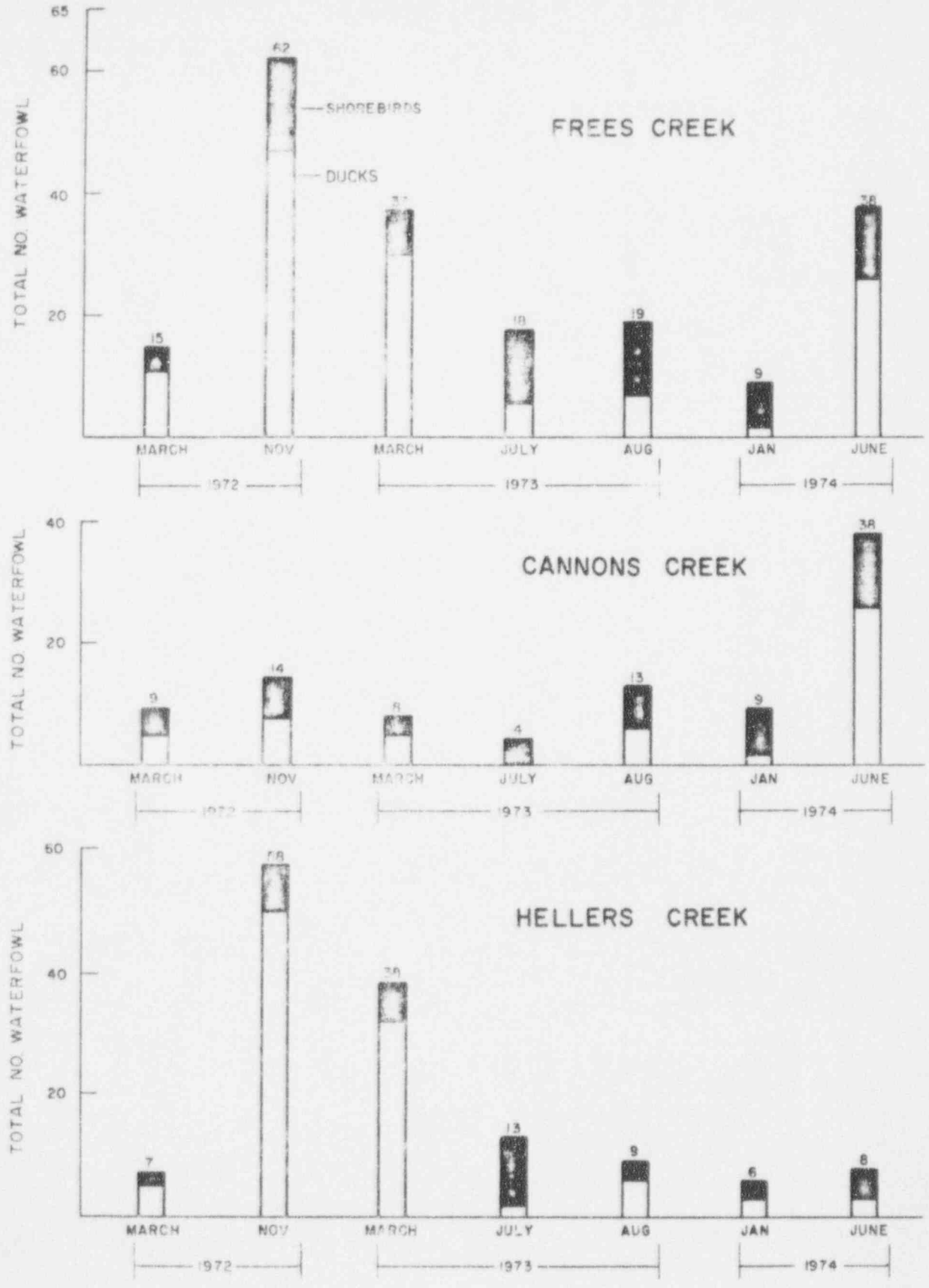

Figure 5.6.3a (continued)

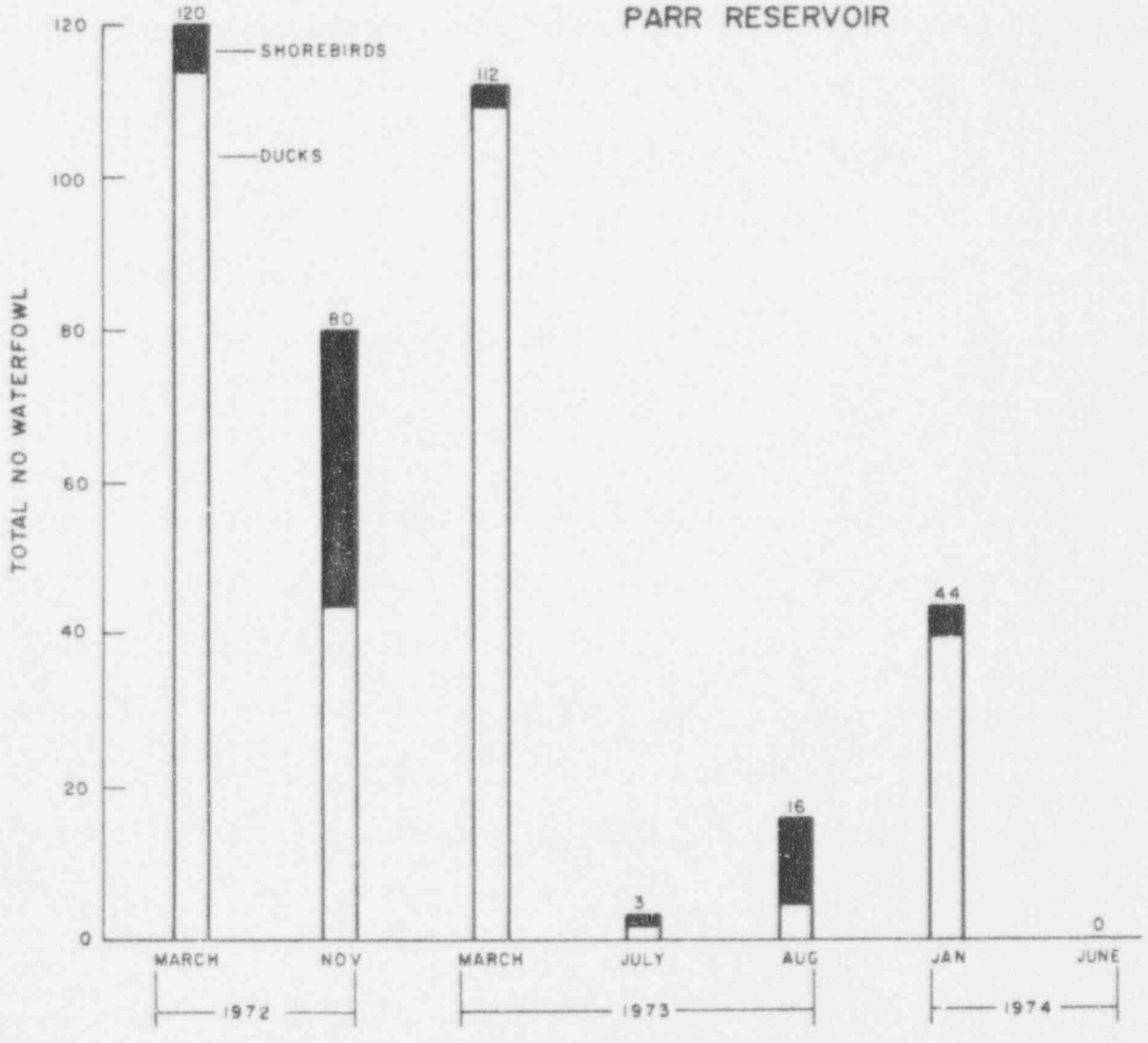

Figure 5.6.3a (continued)

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Dawkins Creek, located approximately 6.5 miles north-northwest of Parr, South Carolina, ar surrounded by a border of emergent macrophytes and/or overhanging shrubs. The deciduous forest is mature and the soils are often saturated from frequent flooding. The ponds at Terrible Creek are approximately 8.25 miles north-northwest of Parr. Bordered by mature timber and shrubs, the Terrible Creek ponds contain little emergent vegetation. The growth of smartweeds noted in the Baseline Biotic Survey were not as extensive in September 1974 as in November 1972.

Both Dawkins and Terrible Creek provide abundant tree cover, however, although deer tracks were noted in these areas, this habitat provides little in the way of food sources. Where the elevation rises to upland sites, forbs, shrubs, and other plants increase in abundance and serve as a food supply.

Wild turkey prefer habitat of deciduous forests on the river flood plain. Their tracks were noted during each visit to the ponds at Terrible Creek. Six turkey had traveled through the bottomlands near Terrible Creek in January 1974, and between two and four sets of tracks were observed in April, June, and September 1974. A brief description of habitat requirements for turkey is presented in Section 5.6.4.3.2 of the Baseline Biotic Survey.

Central Frees Creek

A portion of the Frees Creek Watershed was examined to assess its value to wildlife species. The area covered during each survey period included approximately 274 m (300 yds) south of County Road 99. Disturbances by clearing for wood harvest or farming have occurred in the area during the last two decades, and during the summer months these clearings supported dense herbaceous vegetation and shrubs. A portion of the area

examined, however, still remains in mature timber of deciduous trees and loblolly pine.

Evidence of whitetail deer, raccoon, cottontail rabbit, and opossum were noted in the area during one or more survey periods. Food for these species was abundant and the distribution of abandoned sites and mature timber provides habitat suitable for the above game mammals as well as game birds and non-game wildlife. The overall value of the watershed prior to 1973 is considered to be moderate to high.

Since 1973, considerable timber harvest has occurred. Some harvest had begun prior to 1973. One to two years following harvest of timber resources, increases in the growth of honeysuckle, greenbriar, and a variety of herbaceous plants were noted. Deciduous tree seedlings were also sprouting in the disturbed soils. Whitetail deer, cottontail rabbit, and bobwhite should respond favorably to these changes, while the turkey and squirrel will find them unfavorable. The value of the environs for wildlife, although low to moderate following a timber harvest, will increase as vegetation grows to fill the void.

5.6.4a DISCUSSION

It is possible to make some comparisons of bird densities in certain areas of the study area between years. Auto route A was run in January 1972 and again in January 1974. During January 1972, 3.7 birds per stop per day were observed while in January 1974, 9.7 birds per stop per day were seen. This same route was run in September 1971, and again in August 1973, and at both times 3.4 birds per stop per day were counted. One explanation for the difference at one season and similarity in another may be the weather. The average temperature for the three survey days in January 1972 was 43.8°F. While the temperature in January 1974 was 57.3°F.

The milder temperature in 1974 may have been responsible for more birds being active and therefore available for observation. The average temperatures for the two fall surveys were 75.4°F for September 1971 and 78.7°F in August 1973. These similar temperatures may have been at least partially responsible for the similar density of birds observed at these two seasons.

The aggregate baseline data can now be used for comparisons with data from continuing monitoring programs to determine what changes may be taking place on the study area due to natural or man-made disturbances. This method will also be used to determine the changes in bird populations after the reservoir is filled with water. Thus the present information reported in the auto survey will be valuable as a baseline to determine the changes in bird populations brought about by the clearing of a large section of land and its subsequent inundation. Control and impact areas have been established in each of the major habitat types around the study area to further monitor the environmental changes in the area. Data gathered from the impact areas which are placed in or near areas of expected major disturbance will be compared to data from the control sites and data already reported in the Baseline Biotic Survey. Indicator species designated in the baseline report and addendum will be important in future assessments of environmental quality.

The establishment of the upper impoundment and the expansion of Parr Reservoir for use as a lower reservoir for the pumped storage facility is expected to have a great impact on waterfowl usage in the area. A great quantity of waterfowl habitat will be added and substantial changes will be made to the terrestrial habitat presently in existence. Therefore, the waterfowl data presented in this and the baseline report

is important for determining the effects of these changes on this area's bird life.

5.6.5a SUMMARY

The purpose of this addendum has been to add pertinent, supplementary information to the Baseline Biotic Survey. The data reported herein cover the establishment of two strip census sites in the vicinity of the nuclear power plant for monitoring environmental changes in this area. Auto surveys conducted in the fall and winter seasons have been combined with previously reported baseline data to give a complete four season picture of bird abundance over the study area. Once extensive clearing has been accomplished in the Monticello Impoundment area, the auto survey data will be useful as a comparison to post-clearing bird surveys. Additional information was gathered on waterfowl occurrence in the Broad River and Parr Reservoir areas. This will be useful for monitoring changes due to clearing and construction activities in these areas at a latter date.

TABLE OF CONTENTS

Section	Title	Page	
6.0	EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAM	6.0-1	
6.1	APPLICANT'S PREOPERATIONAL MONITORING PROGRAMS	6.1-1	
6.1.1	Surface Waters	6.1-1	
6.1.1.1	Physical and Chemical Parameters	6.1-1	
6.1.1.2	Ecological Parameters	6.1-3	
6.1.2	Ground Water	6.1-11	
6.1.2.1	Physical and Chemical Parameters	6.1-11	
6.1.2.2	Models	6.1-12	
6.1.3	Air	6.1-12	
6.1.3.1	Meteorology	6.1-12	
6.1.3.2	Models	6.1-20	
6.1.4	Land	6.1-26	
6.1.4.1	Geology and Soils	6.1-26	1
6.1.4.2	Land Use and Demographic Surveys	6.1-26	
6.1.4.3	Ecological Parameters	6.1-26	
6.1.5	Radiological Monitoring	6.1-29	
6.1.6	References	6.1-32	
6.2	APPLICANT'S PROPOSED GPERATIONAL MONITORING PROGRAMS	6.2-1	
6.2.1	Surface Waters	6.2-1	
6.2.1.1	Physical and Chemical Parameters	6.2-1	
6.2.1.2	Ecological Parameters	6.2-1	
6.2.2	Ground Water	6.2-3	
6.2.3	Air	6.2-3	
6.2.4	Land	6.2-4	
6.2.4.1	Geology and Soils	6.2-4	
6.2.4.2	Land Use and Demographic Surveys	6.2-5	
6.2.4.3	Ecological Parameters	6.2-5	
6.2.5	Radiological Monitoring	6.2-5	

TABLE OF CONTENTS (Continued)

Section	Title	Page
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAM	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITOR.NG DATA	6.4-1

LIST OF TABLES

Table	Title	Page
6.1-1	Water Quality Monitoring Program for the Pre-operational Phase of the Virgil C. Summer Nuclear Station	6.1-37
6.1-2	Summary of Scope of Work for the Preoperational Biological Sampling Program	6.1-39
6.1-3	Important Species of the Parr/Monticello Reservoir System	6.1-40
6.1-4	Classification of Maturity Stages (Gonadal Condition) in Fish	6.1-41
6.1-5	Meteorological Instrumentation Virgil C. Summer Nuclear Station	6.1-42
6.1-6	Meteorological Tower Calibration Virgil C. Summer Nuclear Station (6 January - 9 January 1975)	6.1-43
6.1-7	Meteorological Tower Calibration Virgil C. Summer Nuclear Station (14 April - 17 April 1975)	6.1-44
6.1-8	Meteorological Tower Calibration Virgil C. Summer Nuclear Station (8 September - 11 September 1975)	6.1-45
6.1-9	Meteorological Tower Calibration Virgil C. Summer Nuclear Station (26 April - 30 April 1976)	6.1-46
6.1-10	Annual Average Relative Concentration (Ground Level Release; Open Terrain Factors)	6.1-47

1

LIST OF TABLES (Continued)

Table	Title	Page
6.1-11	Annual Average Deposition Rate (Ground Level Release; Open Terrain Factors)	6.1-48
6.1-12	Annual Average Relative Concentration (Ground Level Release; Open Terrain Factors) Reduction Due to Decay (2.26 Days)	6.1-49
6.1-13	Annual Average Relative Concentration (Ground Level Release; Open Terrain Factors) Reduction Due to Decay (8.0 Days)	6.1-50
6.1-14	Annual Average Relative Concentration (Ground Level Release; Open Terrain Factors) Reduction Due to Decay (8.0 Days) and Depleted	6.1-51
6.1-15	Radiological Environmental Monitoring Program Virgil C. Summer Nuclear Station	6.1-52
6.1-16	Detection Capabilities for Environmental Sample Analysis Media/Detection Capabilities	6.1-61
6.1-17	Duration of Preoperational Radiological Environmental Monitoring Program	6.1-62
6.1-18	Environmental Radiological Monitoring Program Summary Virgil C. Summer Nuclear Station Docket No. 50-395 Fairfield County, South Carolina	6.1-63

1

LIST OF FIGURES

Figure	Title
6.0-1	Conceptual Overview of the Virgil C. Summer Nuclear Station and the Fairfield Pumped Storage Facility
6.1-1	Aquatic Preoperational Monitoring Stations
6.1-2	Onsite Ground Water Monitoring Wells
6.1-3	Terrestrial Sampling Locations and Survey Routes
6.1-4	Radiological Monitoring Program Local Indicator Sample Sites
6.1-5	Radiological Monitoring Program Remote Sample Sites

1

6.0 EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAM

Although the Virgil C. Summer Nuclear Station and the Fairfield Pumped Storage Facility (FPSF) are separate and distinct components of the South Carolina Electric & Gas (SCE&G) generating network, they are related in that they are located in the same general area and they both utilize Monticello Reservoir. A perspective view of the two facilities is shown in Figure 6.0-1.

The Fairfield Pumped Storage Facility is comprised of the Fairfield Powerhouse and Parr and Monticello Reservoirs. Parr Reservoir, which is the facility's lower reservoir, has been enlarged to the required capacity by adding gates to the existing Parr Dam. The upper reservoir, Monticello Reservoir, was created by damming the Frees Creek drainage basin and has a surface area of 6800 acres at the maximum pool elevation of 425 feet. Eight reversible pump-turbine units of 60 MW capacity each are mounted in the powerhouse, giving the facility a total capability of 480 MW. During periods of off peak power demand, a portion of the excess system generating capacity will be used to operate the FPSF in the pumping mode and transfer water from Parr Reservoir to Monticello Reservoir, an elevation difference of about 150 feet. The pump-turbine units can then be operated in the generating mode, as required to meet peak system loads, by releasing water from the upper reservoir to flow in the reverse direction through the penstocks to its original elevation. A maximum of 29,000 acre-feet of water can be transferred during this process; maximum water level changes will be about 10 feet in Parr Reservoir and 4 1/2 feet in Monticello Reservoir. Pumping/generating cycles will probably occur daily during seasons of highest power demand (winter and summer), but considerably less use of the facility may be made during spring and fall when electric requirements are lower. On December 3, 1977, pumping operations began, and on February 8, 1978, Monticello Reservoir was filled to elevation 425.5'. Units 1 through 4

1

of the FPSF are planned to begin commercial operation in the summer of 1978, and the remaining four units by late 1978.

The Virgil C. Summer Nuclear Station is a three loop, 900 MWe Westinghouse pressurized water reactor. Condenser cooling is provided by using Monticello Reservoir as the cooling lake. Intake and discharge structures are separated by a jetty, which ensures maximum circulation within the reservoir. Fuel loading is scheduled for late 1979, with initial operation planned for mid-1980. Details of the plant design and operating characteristics are presented in Chapter 3.

As a part of activity related to the nuclear plant, programs of water quality monitoring and aquatic and terrestrial ecological monitoring have been conducted in the site area since 1971 (Appendix 6A), terminating with the initial operation of the FPSF. However, the inundation of more than 6800 acres of former woodland by Monticello Reservoir and the concurrent operation of the pumped storage facility will significantly modify the previously existing environmental conditions. Since the FPSF will be in operation at least one year prior to initial operation of the Virgil C. Summer Nuclear Station, there will be an opportunity to characterize the modified environmental setting in both Monticello and Parr Reservoirs which may later be subject to impact by operation of the nuclear plant. Thus, in order to provide an adequate framework for assessing effects of the Virgil C. Summer Nuclear Station, a new biological and water quality baseline must be established which takes into account these modifications. The preoperational water quality and biological monitoring programs described in Section 6.1 will be implemented beginning one year prior to commercial operation of the nuclear plant to provide this characterization and to supply data from which operational impacts can be determined. 1

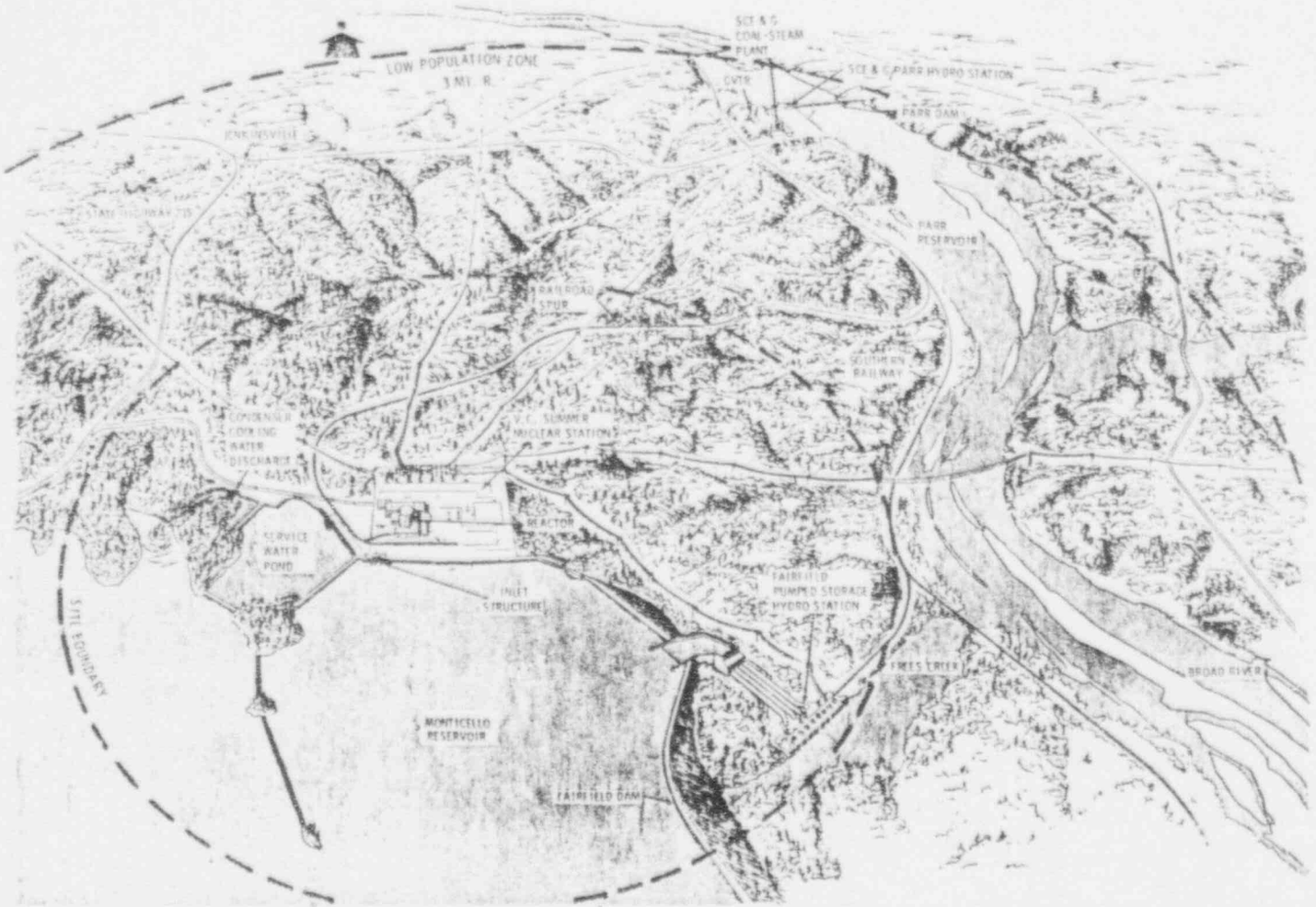

Figure 6.0-1 Conceptual Overview of the Virgil C. Summer Nuclear Station and the Fairfield Pumped Storage Facility

6.1 APPLICANT'S PREOPERATIONAL MONITORING PROGRAMS

6.1.1 SURFACE WATERS

6.1.1.1 Physical and Chemical Parameters

The surface water quality monitoring program is designed to 1) determine the levels of various water quality parameters in the waterways around the Virgil C. Summer Nuclear Station; 2) provide a basis of comparison, where possible, with operational water quality data so that an assessment of the impact of nuclear plant activities can be made; 3) furnish information which may be used in determining possible causes for any changes in aquatic populations; and 4) provide a means of determining that water quality in the Broad River, Parr Reservoir, and Monticello Reservoir meets South Carolina state water quality standards.

The program will be instituted one year prior to the initial commercial operation of the Virgil C. Summer Nuclear Station which is scheduled for May 1980. After analysis of the year's data, the monitoring program will be evaluated, and the need for modification of the operational program determined. 1

Nine water quality sampling stations will be initially established in the study area during the preoperational phase of the Virgil C. Summer Nuclear Station (all stations, except No. 11 shown on Figure 6.1-1). Stations 1, 2, and 5A, located at various points along the Broad River and in Parr Reservoir, were selected because they are similar or identical in location to sites sampled during the construction monitoring program. In addition, a newly established control station, designated as Station 11, will be located on the Broad River at the S. C. 121 bridge, 29 river miles upstream of Parr Dam. Each of the above stations will provide general information about the origin of various substances contained in the water at different points in the river. Data from both physical and chemical and ecological sampling programs may be correlated to determine the influence of water quality parameters upon any changes observed in the biotic resources.

Stations 12 through 18 will be located in the newly created Monticello Reservoir. Station 12 will be situated near intakes of both the Fairfield Pumped Storage Facility (FPSF) and the Virgil C. Summer Nuclear Station. This station will provide information on water quality prior to passage through both the pumped storage facility and the nuclear plant. Station 14 will be near the outlet of the holding basin for waters discharged from the Virgil C. Summer Nuclear Station. Location of the sampling station at this point may allow correlation of discharge water quality with that of surface waters in other parts of the study area. Stations 16 and 17, located in the main portion of Monticello Reservoir, will provide information on dispersion of plant effluents. These stations will be monitored in order to provide a more complete overview of reservoir water quality. Data collected at Stations 12 through 17 may then be correlated with biological data from nearby sampling sites to provide insight into the biotic-abiotic relationships within the site area. Data collected at Station 18 will be used to determine compliance of the small recreational area waters with state water quality criteria. 1

Stations sampled during the latter part of the construction water quality monitoring program which will not be included during the preoperation sampling include Station 3, Frees Creek above the diversion dam; Station 4, Frees Creek at S. C. 99; Station 5, Broad River at Parr Dam; Station 6, Broad River at S. C. 213 bridge; Station 7, Broad River at Richtex; and Station 8, Broad River at Interstate 20. Station 3 will be dropped from the monitoring program because it was inundated when Monticello Reservoir was filled; Station 4 will be eliminated since the location of S. C. 99 will be changed. Station 5A is located midway between Stations 5 and 6 and was relocated to insure comparability with the USGS continuous monitoring station. The stations at Richtex and at Interstate 20 on the Broad River will not be sampled because impacts on water quality in this waterway as a result of plant operation will be measured upstream from them at Station 5A.

AMENDMENT 1
APRIL 1978

Water quality parameters and their frequency of measurement for each station are shown in Table 6.1-1. In addition to these measurements, temperature, conductivity, transparency, dissolved oxygen, and pH will be monitored at biological sampling stations during the field surveys.

Water quality parameters to be measured as part of the abiotic monitoring program were selected primarily for some or all of the following reasons:

1. The parameters will provide a measure of existing environmental levels of materials which may be released in various quantities from the Virgil C. Summer Nuclear Station.
2. Baseline or construction data are available for comparison with preoperational data.
3. The parameters are particularly important for assessment of the well being of biological communities. 1
4. The State of South Carolina has prescribed concentration limitations for those parameters in state surface waters.

Measurement of the selected parameters will provide the basis for a comprehensive assessment of the impact of plant operation on the water quality in the study area.

Water samples will be collected with a Van Dorn sampler. If appropriate, preservatives will be added to the samples before they are sent to the laboratory for analysis. Instrumentation and laboratory techniques used in measuring each parameter are indicated in Table 6.1-1.

6.1.1.2 Ecological Parameters

6.1.1.2.1 General Monitoring Program

A monitoring program similar to the baseline study will be implemented in Parr and Monticello Reservoirs and in the Broad River near the Parr 1

Hydroelectric Project facilities. This program will be instituted one year prior to the initial commercial operation of the Virgil C. Summer Nuclear Station.

The general field monitoring program will involve in-depth, seasonal field studies of the following biological parameters: vascular hydrophytes, phytoplankton, zooplankton, ichthyoplankton, benthic macroinvertebrates, and fish. The planned scope of the biological sampling program and the primary list of references for species identification are summarized in Table 6.1-2. The locations of all sampling stations, with the exception of the control station (Station P), are shown in Figure 6.1-1. This control station will be on the Broad River in Chester County, above the Neals Shoals Dam 29 river miles upstream of Parr Dam.

Sampling stations in the Broad River and Parr Reservoir will be the same as those surveyed during all or portions of the baseline monitoring program. Six sampling stations will be located in the main portion of Monticello Reservoir. These stations will be positioned at various distances from the intake and discharge structures of the Virgil C. Summer Nuclear Station. Placement of the stations in this manner will help assure that spatial variations of levels of plant impacts can be detected. In addition to these six sites, Station H will be located in the northern portion of Monticello Reservoir. This station will provide data on biological communities in the portion of the reservoir that will be unaffected by water level fluctuations caused by operation of the FPSF and heat input from the Virgil C. Summer Nuclear Station. Sampling stations and scope will be modified should results indicate that such a change is justified. 1

6.1.1.2.1.1 Vascular Hydrophytes

The presence of significant rooted and floating vascular plant populations will be determined by a survey of the shorelines of Parr and Monticello Reservoirs and the Broad River. Identification of observed

species will be made in the field when possible; representative specimens of unknown macrophytes will be collected, marked as to their point of observation, and sent to the laboratory for identification to the lowest practicable taxon. Stand densities will be estimated.

Results of field observations will be compiled as a species list for the study area. A map of the area will also be prepared to show those locations which were observed to support significant macrophyte populations, if any exist.

6.1.1.2.1.2 Phytoplankton

Phytoplankton will be sampled quarterly to determine the species composition, diversity, and biomass. Duplicate one liter whole water samples will be collected from a depth of about 0.2 meter at each station. A minimum of 20 liters of water will be pumped into a composite, volumetric container, and stirred to insure even distribution of plankton. From this container, two subsamples (one liter each) will be removed and preserved. 1

In the laboratory, each phytoplankton sample will be concentrated by settling in one liter columns for 120 hours. Forty milliliters of commercial formalin will be added to the column contents to promote sedimentation. After settling, the supernatant will be siphoned from the top of the column, and the phytoplankton concentrate placed into a Sedgwick-Rafter (S-R) cell and analyzed by identifying and counting phytoplankton in one to three standardized whipple disc strips at 300X. Proportional count diatom sildes will be prepared with Hyrax mounting medium to determine S-R cell diatom densities and identification. Glycerine jelly slide mounts may be used for some phytoplankton identifications.

Plytoplankton densities represent the number of cells per liter of water the equation is expressed as :

$$\text{Phytoplankton/liter} = \frac{C \times SR\text{-}V}{WD\text{-}V} \times \frac{CV}{OS\text{-}V} \times \frac{TV}{TV\text{-}FV} \times 1000$$

where:

C = Average number of organisms counted from 3 strips.
SR-V = Sedgwick-Rafter cell volume (mm^3).
WD-V = Standardized Whipple disc strip-volume (mm^3).
CV = Concentrate volume (ml).
OS-V = Original sample volume (liters).
TV = Total column height (ml).
FV = Formalin volume (ml).

Plankton biomass will be determined in the laboratory after enumeration of the organisms. The water samples will be filtered through a Millipore HA filter, or equivalent, of known weight, using standard apparatus. The samples will then be dried to constant weight, ashed, and reweighed so that the ash free dry weight can be calculated. 1

Data collected on phytoplankton populations in both Parr Reservoir and the Broad River will be compared to baseline and construction monitoring data. Analysis of data from Monticello Reservoir will focus on the trophic conditions and succession of species assemblages in the newly created impoundment.

6.1.1.2.1.3 Zooplankton

Zooplankton will be sampled quarterly to determine the species composition, diversity, and biomass. Duplicate zooplankton samples will be pumped from a depth of about 0.2 meter at each station. Each sample will be concentrated from 100 liters of water by filtration through a No. 25 mesh plankton net and bucket. The bucket will be removed and the contents washed into a container, utilizing a preservative as needed. Laboratory procedures for identification and enumeration will be identical to those described for phytoplankton.

Data collected on zooplankton populations in Parr Reservoir and the Broad River will be compared to baseline and construction monitoring data. Analysis of data from Monticello Reservoir will focus on the trophic conditions and evolution of species in the newly created impoundment.

6.1.1.2.1.4 Ichthyoplankton

Fish eggs and larvae will be sampled biweekly during the primary spawning period (late February-September). The sampling transects specified for Monticello Reservoir are located near the intake and discharge structures for the FPSF and the Virgil C. Summer Nuclear Station. In addition, there will be general sampling locations along the shoreline in the upper end of Monticello Reservoir. Sampling will be accomplished by pumping a known volume of water through a net or by towing a net through the water. The specific method employed will be determined according to observed conditions. However, in each case, a known volume of water will be filtered. 1

In the laboratory, fish larvae and eggs will be separated from plankton and debris. When the samples contain less than 100 larvae, each specimen will be measured and weighed. If larger numbers of organisms are obtained, subsampling will be accomplished. Data analysis will be conducted to document taxonomic composition and relative abundance. Densities of eggs and larvae will be compared by statistical tests to determine significant spatial and temporal variations in distribution. The data will be used to evaluate spawning time of taxa encountered and the utilization of the various portions of the reservoir as spawning habitat.

6.1.1.2.1.5 Benthic Macroinvertebrates

The benthic macroinvertebrates will be sampled on a quarterly basis to determine species composition, diversity, abundance, and biomass.

Triplicate benthos samples will be collected with an Ekman dredge from sampling stations. All samples will be sieved with a U. S. Standard No. 30 wire mesh sieve and preserved.

Macroinvertebrates will be sorted in the laboratory, and then placed under a dissecting microscope for identification and enumeration. The mean number of organisms collected in the samples will be computed and reported as numbers per square meter. Species diversity and equatability will be calculated from the data.

The data from Parr Reservoir and the Broad River will be compared to baseline and construction monitoring information to determine the impact of fluctuating water levels. Data collected from surveys at stations in Monticello Reservoir will be used to document the process of colonization by benthic organisms in the newly created impoundment.

6.1.1.2.1.6 Fish 1

The fish populations of Parr and Monticello Reservoirs and the Broad River will be sampled on a quarterly basis to determine the following: species composition, distribution, relative abundance, age and growth, length-weight relationships, condition factors, sex ratios and gonad conditions, standing crop and parasitism. Items 2-6 described below will be accomplished for collected specimens of the species which are listed in Table 6.1-3.

1. Fish Collection

Fish will be collected with electrofishing equipment, gill nets, fyke nets, and hoop nets. Rotenoning will be conducted annually. Shoreline areas around transects will be sampled by electrofishing for one hour at each location. Stunned fish will be retrieved and held for processing. Stations will also be sampled by gill, fyke, and hoop nets, as appropriate for conditions at that site. Nets will be set perpendicular to

the shoreline for approximately 24 hours. At the end of this period, the nets will be retrieved, and captured fish will be held for processing. Fish collected by these techniques will be identified, counted, and the locality and date of collection recorded. Species composition, distribution, and relative abundance will be determined from these data.

Fish samples will be collected by rotenoning at Stations C and P and at selected locations in Monticello Reservoir to establish standing crop estimates and to refine relative abundance information derived from other sampling methods. Rotenoning may also be conducted at Station B if conditions permit. An area will be completely blocked off with square mesh nets. Fish will be collected outside the nets with electrofishing gear. The total length will be measured, and individual fish will be marked for later recognition by clipping the lower lobe of the caudal fin. The marked fish will be released within the enclosed area and allowed to remain for a period of 24 hours. The enclosed area will be checked the following morning for dead fish.

A rotenone solution will be applied to the blocked area and thoroughly mixed. It will be assumed that all fish (marked and unmarked) are equally susceptible to the toxicant. Distressed fish will be collected, sorted to species, counted, weighed, measured, sexed, and a scale sample taken. All marked specimens will be counted. 1

2. Age and Growth

Scales will be removed from the left side between the lateral line and dorsal fin of most important fish species. In the laboratory, impressions of scales from each fish in the sample will be made on cellulose acetate slides. The impressions will be projected on a plane surface so that the annuli can be counted and distances between them measured. Calculation of fish length at successive annulus formation will be in accordance with the method of Lee (1). Other age and growth determination techniques will be implemented for those species for which scale studies are not possible.

The data obtained as a result of fish scale analysis will provide insight into the growth rate of each fish sampled for successive periods during its lifetime. Such information will allow a general assessment of changes in habitat quality from the standpoint of fish growth rates.

3. Length-Weight Relationship

Fish collected will be measured and weighed.

4. Condition Factor

Condition factors (K) will be calculated for individual fish, and the mean condition factor for each species in each centimeter group will be determined. The formula $K_{(TL)} = W/L^3$ will be used for all condition factor determinations (where the weight, W, is in grams; and the total length, L, is in centimeters). 1

5. Sex Ratios and Gonad Condition

Specimens will be sexed in the field. Gonads will be classified according to the method presented in Table 6.1-4.

6. Standing Crop Estimate

A system of mark and recapture using the Petersen estimate formula (2) will be employed to determine the standing crop.

7. Parasites

A visual examination for ectoparasites from all captured fish will be conducted.

6.1.1.2.2 FPSF Intake Studies

An intensive sampling effort near the FPSF intake structure (Transect L) will be conducted every two months to determine what impacts, if any, are affecting the aquatic biota being pumped up to Monticello Reservoir. Sampling will be conducted during the FPSF pumping cycle; techniques will include visual observation of fish to determine their condition. Note will be made as to whether they are dead or stunned and the distance from the intake structure. Other biotic components will be sampled to determine the number being pumped to Monticello Reservoir; their condition will also be noted to ascertain if they are being harmed as a result of pumping activities. 1

The information collected may be compared with operational impingement/entrainment studies for the Virgil C. Summer Nuclear Station.

6.1.2 GROUND WATER

The various tasks described in the following discussion of the ground water monitoring program have been designed to satisfy regulations and requirements that pertain to site operation of the Virgil C. Summer Nuclear Station. Although the physical area encompassed by the program includes the FPSF and others, the monitoring program is concerned only with satisfying requirements for nuclear plant operation.

6.1.2.1 Physical and Chemical Parameters 1

The preoperational ground water monitoring program is based upon onsite observation wells. Seven onsite observation wells have been installed in the nuclear plant area. The locations of these onsite wells are shown on Figure 6.1-2. The respective total depth of each well was determined through evaluation of existing logs of borings drilled in the general area. Each well was terminated at an elevation less than that of the ground water level prior to filling of Monticello Reservoir. Sand-gravel filters and well screens were installed near the bottom of

each well at elevations selected to encounter the most suitable permeable subsurface zone. Usually, this zone was the layer of highly weathered rock which generally overlies fresh rock in the site area.

The onsite observation wells will document on a quarterly basis the water level changes which may occur as a result of filling of Monticello Reservoir, and for a period of one year after the reservoir is filled or until equilibrium is reached. 1

6.1.2.2 Models

Ground water modeling is not being employed for the preoperational ground water monitoring program.

6.1.3 AIR

6.1.3.1 Meteorology

6.1.3.1.1 Proximal Weather Stations

Long-term data records used in the evaluation of site meteorology discussed in Section 2.3 are from National Weather Service (NWS) first-order stations and NWS cooperative stations. Procedures for collecting these data are standardized (3). 1

6.1.3.1.2 Onsite Meteorological Program

The onsite meteorological program is designed to measure the parameters needed to evaluate the dispersive characteristics of the site, in accordance with Safety Guide 23, as applicable at the construction permit stage, for both routine operational and hypothetical accidental releases of radionuclides to the atmosphere and to determine the potential environmental impact of Monticello Reservoir.

The onsite preoperational meteorological monitoring program at Virgil C. Summer Station began with the initial deliver, and set up of the system in June 1973. System refinement for optimum availability, data recovery and minimization of susceptability to lightening damage continued through October 1974. During this period corrective measures were undertaken (including rewiring and regrounding of the system) along with the development of detailed maintenance procedures in order to obtain the one year of site meterological data required pursuant to Regulatory Guide 1.23 (Sept. 72) and license requirements (CPPR 550-3, 4-2-73) applicable to the Virgil C. Summer Nuclear Station. The date of initiation of the current measurements program was November 1974. The required year of record for the onsite Meteorological Monitoring Program ended in January 1976 though the equipment has continued to be maintained and calibrated as explained in Section 6.1.3.1.2.2. In 1976, the instrumentation housing for the large tower site was relocated due to construction activities and a more accurate dew point measurement system installed. 1

6.1.3.1.2.1 Instrumentation

Wind, temperature, and dewpoint sensors are installed on a 61 meter self-supporting tower, and a precipitation sensor is installed on an individual 5 foot pedestal near this tower. An air conditioned 8 x 12 foot aluminum enclosure, which houses the signal conditioning and recording equipment, is located approximately 100 feet from the tower. The tower is located about 1500 feet west of the reactor building at elevation 438'. The reactor building is at elevation 435', and Monticello Reservoir is filled to elevation 425'. Elevations in the site vicinity range from below 230' on the Broad River to over 600' near Little Mountain. The tower-mounted sensors are as follows: 1

1. At 61.5 meters above ground level, the upper wind speed and wind direction sensors are mounted on a retractable 12 foot long instrument boom. The upper temperature sensor for the 10-61 meter

delta temperature measurement is housed in an aspirated temperature shield which is attached at 61 meters to the railing of the upper level access walkway;

2. At 40 meters above ground level, the upper temperature sensor for the 10-40 meter delta temperature measurement is housed in an aspirated temperature shield which is secured to the railing of the intermediate level access walkway;

3. At 10.5 meters above ground level, the lower wind speed and wind direction sensors are mounted on a 12 foot long, retractable instrument boom. Lower delta temperature sensors and ambient temperature and dewpoint sensors are housed in aspirated temperature shields which are attached at 10 meters to the railing of the lower level access walkway.

Descriptions of the instruments employed on the tower are given in Table 6.1-5. | 1

Additionally, a 10 meter climbable power pole has been erected on the shore of Monticello Reservoir across from the meteorology tower and reactor building at approximately elevation 430'. Wind speed, wind direction, dewpoint, and ambient temperature sensors are mounted at the 10 meter level. These sensors have the same specifications as the tower mounted sensors. An 8 x 12 foot aluminum enclosure housing signal conditioning and recording equipment is located approximately 100 feet from the pole. Data from this system will be available for defining reservoir effects, as required.

Lithium chloride dewcells formerly used for dewpoint measurements on both the tower and 10 meter pole were replaced in mid-August 1976 by the more accurate Pelpier cooled mirror sensor. This instrument has a stated accuracy of ±0.28°C over an operating range of -50°C to +50°C.

Telephone jacks are provided on the tower to facilitate maintenance. In the equipment enclosure for the tower location the following equipment is installed:

1. Central floor mounted equipment racks
   a. Wind sensor translator
   b. Wind speed and wind direction upper strip chart recorder
   c. Wind speed and wind direction lower strip chart recorder
   d. Strip chart recorders for delta temperature
   e. Aspirator motor ammeters for differential temperature systems
   f. Isolation transformer
   g. Dewpoint and ambient temperature control module
   h. Dewpoint and ambient temperature strip chart
2. Three wall mounted enclosures
   a. Pulse transmitters (signal conditioning devices) for all parameters measured
   b. Magnetic tape recording packages
   c. Delta temperature measuring amplifiers

The stated accuracies of the present tower mounted instruments are given in Table 6.1-5. Those of various other components are summarized below: | 1

Translator for wind sensors	
Wind speed and wind direction circuit cards	
Linearity	±0.01%
Long term gain	±0.002% of full scale per day
Long term zero	±0.001% of full scale per day per degree C
Sigma circuit card	±3%
Amplifier for solar radiation	±0.1% of full scale
Pulse transmitters	±0.5% of full scale

Magnetic tape recorders	±1 pulse per interval; ±4 pulses per tape
Strip chart recorders	±1% of full scale

The meteorological instrumentation accuracies for primary measurements are intended to meet the recommendations stated in Regulatory Guide 1.23 (September 1972). 1

6.1.3.1.2.2 Calibration and Maintenance

To assure data quality and accuracy, the weather instruments and recorders are calibrated at approximately six month intervals. The procedure includes inspection of instrument sensors for wear, electronic component calibration, ambient temperature and dewpoint comparison using mercury-type thermometers, and calibration of recorders.

During the 1975 year, three calibrations of the meteorological tower system at Virgil C. Summer Nuclear Station occurred. Summaries of these calibrations, plus the first calibration of 1976, are presented in Tables 6.1-6 through 6.1-9. These tables present the results of the pre-calibration and post-calibration check of the system. The tolerance criteria for calibration are those given in Regulatory Guide 1.23.

The calibrations of the meteorological systems have been performed according to accepted and standard meteorological practices. The instrumentation used to calibrate the meterological system has been maintained such that recordings can be traced to the National Bureau of Standards. These procedures and the test instrument qualities ensure the quality of the meteorological measurements obtained from the Virgil C. Summer Nuclear Station. 1

In addition to the above calibration of the meteorological system, the following operational procedures are enforced:

Daily Checks	To identify any abnormal functions (at least two per week)
Biweekly Calibration checks	To identify need for maintenance or calibration

During the daily checks the verification is made that each data channel is being recorded and that they are being recorded at a reasonable rate. Also the strip chart recorders are checked to ensure their operation. Support systems are also checked to ensure their continued operation (i.e., air conditioning, lighting, etc.).

The calibration checks are made approximately every two weeks or any time a channel is suspected to be malfunctioning. This includes the verification of the measurement of the pulse system with that of the analog system plus, when possible, the comparison of recorded values with those determined from portable instruments. 1

These quality control precedures, semi-annual calibrations, biweekly calibration checks, and daily checks, ensure that the measurements of the meteorological variables at Virgil C. Summer Nuclear Station are valid. Further verification that the procedures for maintenence, calibration, data collection and data reduction are in accordance with the recommendations of Regulatory Guide 1.23 (September 1972) is demonstrated by greater than 90 percent data recovery for primary variables for the year of record 1975.

6.1.3.1.2.3 Data Output and Recording System

Recording packages are installed on the inside of the enclosures. In each package, signals produced by the associated meteorological sensors are first converted to pulse rates (via pulse or differential temperature transmitters) which are proportional to the sensor output levels, then the pulses are recorded.

The pulse transmitter performs the function of converting the analog input signal to a proportional pulse rate. The pulse rate varies from 0 to 1500 pulses per 15 minute interval in direct proportion to the input signal variation. The data pulse produced by the pulse transmitters is recorded on magnetic tape. Three channels are assigned for recording data pulses, and a fourth channel is used for recording timing pulses on each recorder. At the end of each 15 minute interval, a timing pulse is generated in each recorder and recorded on tape channel T. These pulses are used during magnetic tape translation to separate data pulses recorded in one 15 minute interval from the data pulses recorded in the next interval. 1

In the event of an a-c power outage, correct recorder time to real time relationship is maintained by a battery carryover feature which provides power from batteries for tape drive and timing pulse recording. The batteries, which are mounted directly above the recorders, are capable of operating the recorders for 3-1/2 hours. Once a-c power is restored, the batteries are recharged. During an a-c power outage, no data pulses are recorded.

Additionally, backup strip chart records are used for measured wind, vertical temperature difference, and temperature parameters. The analog (strip chart) recording system is used to provide a level of verification for the accuracy of the primary (tape) recording system and to provide a secondary means of data recording so that at least 90 percent data recovery is accomplished.

For the 1975 annual record, almost 100 percent recovery of the primary variables (10.5 meter winds and 10-61 meter delta temperature) has been accomplished. Furthermore, only about 2 percent of the 61.5 meter measurements were lost.

The analog lower level wind speed, wind direction, and differential temperature (10-61 meter) signals from the tower will be made available in the control room to aid in the estimation of offsite short-term doses. For long-term calculations, a permanent file of onsite meteorological data will be maintained.

6.1.3.1.2.4 Data Processing

The processing of the magnetic tape recorded data is a two step process. The magnetic tape cartridges are translated using a Westinghouse translator. The pulses recorded on magnetic tape cartridges are totaled for each 15 minute interval for each data channel, and the totals are then recorded on magnetic tape for further processing. This output magnetic tape from the translator is processed by electronic data processing equipment to convert the pulse totals per interval into parameter measurements expressed in engineering units. Hourly averages are calculated by averaging each valid 15 minute value recorded on tape for the hour. An hourly average value is considered to be missing or invalid only if all four 15 minute average values are missing or invalid. Thus, the hourly averages are based upon a minimum of one 15 minute recording interval. 1

Whereas most of the averages are scalar in form, the average hourly wind directions are determined from the unit-vector components of the wind for each 15 minute value recorded during that hour.

Quality control procedures have been established to ensure the validity of the meteorological data used to satisfy reporting requirements. Average hourly values of wind direction, wind speed, and delta temperature are checked for extreme or missing values; that is, values not normally expected to occur. Flagged values are then checked by comparing the 15 minute values for that hour with strip chart average values. If there is an error, the hourly average is corrected from the strip chart record and inserted into the master data record. 1

Data analysis for both wind distribution and diffusion characteristics of the site requires three basic atmospheric variables. These three variables together with the primary and secondary (back-up) measurements for each are as follows:

Horizontal wind speed:	primary - 10.5 meter wind speed
	secondary - 61.5 meter wind speed
Horizontal wind direction:	primary - 10.5 meter wind direction
	secondary - 61.5 meter wind direction
Delta temperature:	primary - 10 to 61 meters
	secondary - 10 to 40 meters

The secondary measurements are needed only during periods of outage of the primary system. It should be noted that the entire wind measurement (wind speed and direction both) is replaced with secondary sensor data when either the primary wind speed or wind direction is invalid. Since the 1975 data period had almost 100 percent recovery of the primary variables, no substitution of the secondary variables was used in the data analyses.

The final step in the data reduction program is the listing, in sequential order, of the concurrent, hourly averaged values of the meteorological variables observed at the site. A sequential listing of the hourly data for a full year constitutes the annual meteorological record of the site. The annual record provides the input data for all types of meteorological analyses needed to define the site atmospheric dispersive qualities.

6.1.3.2 Models

Estimates of the atmospheric dilution qualities of the site are used in the calculation of the atmospheric dispersion of radionuclides released during routine plant operation and during postulated accident conditions. These estimates are based on the site period of meteorological record - calendar year 1975.

The dilution factors calculated using the 1975 data will be conservative for two reasons:

1. The calendar year was a representative year in terms of meteoro logical conditions except that the frequency of winds at very low speeds was over 20 percent as compared to less than 10 percent for the longer period of record of 1970 through 1974, at Columbia, S. C. This high frequency of low wind speeds has unquestionably increased the magnitude of the χ/Q values calculated from these data when compared to that expected over the longer climatic period.
2. The ameliorative influence of the heated Monticello Reservoir, as indicated in Section 5.1.4, will reduce the frequency of the very stable Pasquill classes at the site.

6.1.3.2.1 Short-Term (Accident) Dispersion of Effluents

The calculation of the short-term or accidental diffusion conditions at the site were performed in accordance with the criteria presented in Regulatory Guide 1.4. These calculations were based on the assumption that the release emanates from a point source near the ground, with the effluent plume spreading according to a Gaussian dispersion model.

The short-term diffusion climatology of a site is defined by the frequency distribution of dilution factors. This distribution is dependent on the climatological expectance of concurrent values of wind speed; σ_y and σ_z; on the downwind distances of interest; and on the plant wake terms. The wind speeds, wind directions, and delta temperatures (from which Pasquill stability class is determined) have been recorded at the site (see Section 6.1.3.1.2.1). For calm wind observations, the calculations for short-term diffusion are performed using the threshold value of the wind vane, with the resultant χ/Q values distributed throughout the 16 wind direction sectors in proportion to the directional frequency of the lowest wind speed class interval.

6.1.3.2.1.1 Diffusion Model for 8 Hours or Less

Estimates of the dilution factors (relative concentrations) for periods of 8 hours or less are made using a continuous release, centerline, point source model. Ground reflection is assumed at all points, thereby doubling the concentrations to be expected in the free atmosphere. The average relative concentrations are calculated as follows:

$$\chi/Q\ (i, n) = \frac{1}{n} \left[\sum_{j=1}^{n} \frac{K}{\bar{u}(j)\ (\pi \sigma_y(j)\ \sigma_z(j) + cA)} \right] \qquad \text{(Eq. 6.1-1)}$$

where:

$\chi/Q(i,n)$ = average dilution factor (seconds/meter^3) at a specific distance, D, in affected direction sector, i, over n hours

i = wind direction sector index

n = number of hours to average

$\sigma_y(j)$ = horizontal dispersion coefficient of the plume (meters) for hour j (dependent on Pasquill Class) at distance D

$\sigma_z(j)$ = vertical dispersion coefficient of the plume (meters) for hour j (dependent on Pasquill Class) at distance D

c = building wake shape factor (taken as 0.5)

A = estimated cross-sectional area of the reactor containment structure (1740 meters^2) [Dimensions used to compute this minimum cross-sectional area are: width = 134'; elevation of spring line = 557'; elevation of grade = 455'; radius of dome circle = 84.5'; and height of dome = 45'.] 1

$\bar{u}(j)$ = hourly-average wind speed (meters/second) for hour j

D = distance from reactor containment structure to point of concern or receptor

K = wind direction dependent variable with two criteria:

- when n=1, K=1; calculation of hourly average relative concentrations which are direction independent
- when n>1

  K = 1 if wind blowing in sector i

  K = 0 if wind not blowing in sector i

  For calculations of relative concentrations for each of the 16 wind direction sectors the effect of the wake factor (cA) on the relative concentration is limited to a factor of 3 or less; i.e., χ/Q wake $\geq (1/3)$ χ/Q no wake.

6.1.3.2.1.2 Diffusion Model for Periods Longer than 8 Hours

For releases beyond the first 8 hours, the dilution factors are estimated from an equation which recognizes the tendency for winds to meander throughout a direction sector during longer time periods, i.e.:

$$\chi/Q\ (i,n) = \frac{2.032}{nD} \sum_{j=1}^{n} \frac{K}{\bar{u}(j)\ \sigma_z(j)} \quad \text{(Equation 6.1-2.)}$$

where:

$\chi/Q\ (i,n)$ = average dilution factor (seconds/meter^3) over n hours in sector i at distance D.

$\sigma_z(j)$ = vertical dispersion coefficient for hour j (dependent on Pasquill class) at distance D.

$\bar{u}(j)$ = average wind speed (meter/second) for hour j

D = distance from the reactor containment building to receptor or point of concern.

K = wind direction dependent variable:

1 if wind blowing to sector i

0 if wind not blowing to sector i

6.1.3.2.2 Long-Term (Routine) Diffusion

The average annual dilution factors which are applicable to routine venting or other routine gaseous-effluent releases, have been evaluated from the meteorological data record using the technique presented in Regulatory Guide 1.111.

The equation used is for ground level release and is:

$$\chi/Q\ (i,n) = \frac{2.032T}{nD} \sum_{j=i}^{n} \frac{K}{\bar{u}(j)\ (\sigma_z^2(j) + \frac{cV^2}{\pi})^{1/2}} \quad \text{(Eq. 6.1-3)}$$

where:

$\chi/Q\ (i,n)$ = average dilution factor (seconds/meter^3) over n hours in sector i at distance D

$\sigma_z(j)$ - vertical dispersion coefficient for hour j (dependent on Pasquill class) at Distance D

$\bar{u}(j)$ = average wind speed (meter/second) for hour j

D = distance from reactor containment building to point of concern

V = height of highest adjacent building (50.9 meters)

c = building wake shape factor (0.5)

K = wind direction dependent variable:

1 if wind blowing to sector i

0 if wind not blowing to sector i

T = terrain correction factor; open terrain, valley flow, or other factor for χ/Q adjustment (distance dependent)

n = number of hourly observations in data period

The wake factor (cV^2/π) influence is limited such that the resultant χ/Q may not be reduced greater than a factor of $\sqrt{3}$; i.e., $[\chi/Q]$ wake $\geq [(1/\sqrt{3})(\chi/Q)$ no wake]. Calm conditions are included in the calculations

by setting the wind speed to one half the threshold value of the speed or direction sensor and distributing them among the 16 direction sectors in proportion to the directional frequencies of the 1 and 2 mph speed class intervals in the appropriate stability class.

Equation 6.1-3 is the straightline trajectory model defined in NRC Regulatory Guide 1.111 assuming a ground level release mode; that is, the release occurs at an elevation less than or equal to the adjacent building height. Since the site is basically in open terrain with gently rolling hills, the T factor in Equation 6.1-3 is the open terrain correction factors given in Regulatory Guide 1.111.

The estimates of the deposition, χ/Q with decay, and χ/Q with decay and depletion were also calculated according to Regulatory Guide 1.111. The curves presented in that guide (Figure 3 for ground release plume depletion and Figure 7 for ground released plume deposition) were used.

The decay was calculated using:

$$\chi/Q \text{ decay} = \chi/Q \exp(-\lambda t)$$

where:

$$t = \text{time (hours)} = \frac{\text{Distance (m)}}{\text{wind speed (m/hour)}}$$

λ = disintegration constant in hours, or decay factor = $0.693/T_r$

T_r = halflife (hours) of particular isotope.

The resultant calculations, used in Section 5.2 of this Environmental Report, are presented in Tables 6.1-10 through 6.1-14. These tables present the annual average relative concentrations, deposition, χ/Q with decay for isotopes of 2.26 days halflife, χ/Q with decay for isotopes of 8 days halflife, and χ/Q with decay and depletion for 8 days halflife at the various distances of interest required in the evaluation of the radiological impact from routine operation. 1

AMENDMENT 1
APRIL 1978

6.1.4 LAND

6.1.4.1 Geology and Soils

The baseline geology and soils monitoring programs described in Section 6A.4.1 of Appendix 6A are complete. No additional sampling is planned for the preoperational phase. 1

6.1.4.2 Land Use and Demographic Surveys

Those programs described in Section 6A.4.2 of Appendix 6A are complete and are not to be continued in the preoperational or operational phases of the Virgil C. Summer Nuclear Station. The single exception will be the continuation of an annual milk-producing animal and garden survey (used for human consumption) within several miles of the site. This information is generated by a canvassing technique defined by procedure. Information on dairying activity more than 5 miles from the site may be obtained through enumeration using appropriate referenced information such as that available from county agricultural agents. Data from this effort will be utilized in the Environmental Radiological Monitoring Program. 1

6.1.4.3 Ecological Parameters

6.1.4.3.1 Flora

The preoperational monitoring program for flora will be based on analysis of false color infrared aerial photographs. These photographs will be taken in the spring following initial operation of the FPSF. The photographs will be used to document the health of the vegetation on the site and surrounding areas after filling of Monticello Reservoir. These photographs, combined with those taken each spring since 1974 (Section 6A.4.3, Appendix 6A), will form the basis for assessing operational impacts of the Virgil C. Summer Nuclear Station. 1

Although qualitative information on vegetative communities will be obtained by general site reconnaissance during bird surveys, quantitative field sampling will not normally be a part of the preoperational monitoring program. Field sampling of vegetative communities was discontinued after sufficient data were collected for establishing baseline conditions on the site. Field sampling will be instituted as appropriate after any apparent change (other than a change due to natural succession) is noticed in vegetative communities as a result of analyzing aerial photographs, as discussed above.

A map showing major vegetative associations in the site area will be prepared on the basis of data derived from these photographs. Visual changes which have occurred in vegetative communities since the previous analysis of aerial photographs will be noted and documented. The cause of such changes will be investigated through contact with appropriate regulatory agencies and other knowledgeable sources. Appropriate field observations and sampling efforts will be conducted to further define the cause of changes in floral health. 1

6.1.4.3.2 Fauna

Because of the high sensitivity of bird populations to alterations in their environment, these animals were selected as the only faunal component in the preoperational terrestrial monitoring program for the Virgil C. Summer Nuclear Station. Most birds have definite habitat preferences and confine themselves to certain community types (4). When these habitats or community types are disturbed, the density and diversity of the bird populations usually reflect these changes. Other reasons for the decision to limit terrestrial sampling to the avian species are that birds are very conspicuous, and they are generally present in large enough numbers to conduct meaningful statistical population analyses.

Bird populations will be surveyed for one year prior to initial commercial operation of the Virgil C. Summer Nuclear Station. During that period, song birds will be surveyed once each winter and once each summer. Upland game birds will be surveyed only during the summer

(between May 20 and June 10) in order to coincide with the United States Department of the Interior Nationwide Game Bird Call Count (5). Waterfowl populations will be studied during the same sampling periods as song birds, with one additional survey conducted during the fall. Survey routes and strip locations are indicated in Figure 6.1-3.

Common and scientific names will be in accordance with Robbins and others (6). Residency status will be based on information compiled by Sprunt and Chamberlain (7) and the Columbia Bird Club (8).

Three main census techniques will be employed in the monitoring program for bird species. An auto survey technique modified from methods described by Foote and others (5) will be used to monitor qualitative abundance and diversity of song and game bird species. Auto surveys will be conducted around the site and in a control area outside of the anticipated region of plant influence (Route D, Figure 6.1-3). During the auto survey, incremental, specified distances will be driven along each route. A three-minute stop will be made at the end of each increment, and species type and numbers will be recorded for those birds actually observed or heard calling at the stop. Data will be tabulated and both species abundance and diversity will be determined. Diversity will be expressed as the number of species observed in each habitat.

The Forbes-Gross strip census technique described by Graber and Graber (9) will be used to quantify changes in bird populations within the various habitats on the site. For purposes of implementing the strip census technique, control and test sites have been established in each of three habitat types representative of those found around the plant site. These habitat types include pine forest (Strips 1 and 5B), selectively cut pine forest (Strips 4 and 7), and hardwood forest (Strips 5C and 8). The control sites (Strips 1, 7, and 8) are located well away from any influence of the Virgil C. Summer Nuclear Station, while the test sites (Strips 4 5B, and 5C) are located in close proximity to the plant.

During strip censusing of each habitat, two observers walking in parallel will note birds sighted or heard within a strip 200 feet wide. The area actually censused will be calculated from the strip width and distance travelled.

A waterfowl survey will be conducted to monitor seasonal abundance and importance of waterfowl and shorebird species in the site area. Two survey routes will be used. The first route covers Cannons Creek, Frees Creek, Parr Reservoir, and the backwater area north of Frees Creek. The second route will be established around the perimeter of Monticello Reservoir.

Data collected by each sampling technique during the preoperational monitoring phase will be compared to that compiled during the baseline and construction phase surveys and will form the basis for assessing the impacts of operation of the Virgil C. Summer Nuclear Station. Changes in bird populations will be determined primarily through comparison of indicator species populations. Indicator species used to assess results collected by auto survey and strip census techniques will include the mockingbird, loggerhead shrike, eastern meadowlark, cardinal, pine warbler, rufous-sided towhee, Carolina chickadee, and mourning dove. The great blue heron, belted kingfisher, and wood duck will serve as indicator species in evaluating results of the waterfowl survey data. 1

A standard Chi-square test will be applied to each set of data. The results of this statistical analysis may show whether any significant differences in bird populations exist between control and test populations and whether any significant changes may have occurred during the period just prior to operation of the nuclear plant.

6.1.5 RADIOLOGICAL MONITORING

The environmental radiological monitoring program for the Virgil C. Summer Nuclear Station is designed to: 1) analyze selected samples in

important anticipated pathways for the qualification and quantification of radionuclides released to the surrounding environment and 2) to establish correlations between levels of environmental radioactivity and radioactive effluent from plant operation. This program utilizes the concepts of control-indicator and preoperational-operational intercomparisons in order to establish the adequacy of source control and to realistically verify the assessment of environmental levels and resultant human radiation dose as demonstrated by both the in-plant effluent monitoring program and the environmental monitoring program. Significant upgrading of program scope and sensitivity has occurred as a result of the review of more comprehensive site-specific baseline environmental and land use data which had been unavailable at the construction permit stage.

The sample types, criteria for selection, collection frequencies, locations, and analyses which are performed are presented in Table 6.1-15. and Figures 6.1-4 and 6.1-5. Site related dispersion characteristics, demography, hydrology, land use, anticipated source terms, and critical pathways have been considered in the selection of sample media, sampling and analysis frequencies, sample locations, and types of analyses (see Chapters 2 and 5). The corresponding individual program elements set forth in Table 6.1-15 are indicated on Figures 5.2-3 and 5.2-4, as are normalized anticipated percentages of dose commitment by the particular pathways. Detailed examination of possible critical pathways and site related specific dose estimates are presented in Section 5.2. The results of this analysis assure that reasonably conceivable pathways to man and the environment are monitored with frequencies justified on the basis of potential dose. Locations are selected on the basis of site-specific characteristics. Anticipated maximum lower limits of detection for the analyses are presented in Table 6.1-16. 1

The radiological monitoring program implemented in the preoperational phase assures that the minimum amount of baseline data acquired describes

the samples of interest for those time periods reflected in Table 6.1-17. Preoperational sampling and sample measurements indicate the existent fluctuating background levels of radioactivity due to naturally occurring and manmade radionuclides. The methodology and frequency of sampling and analyses has been reviewed and optimized (as necessary) during the preoperational phase to obtain a realistic qualitative and quantitative estimate of the radiological environment. Experience gained through the use of analytical procedures and quality control reviews provides the basis for appropriate analytical modifications. Annual reviews of site specific existent exposure pathways provide a basis for the evaluation of possible changes in sampling and sample site selections (see Section 6.2.4). | 1

The operational phase of the radiological monitoring program will be an extension of the preoperational phase. Raw data is analyzed and presented in a format similar to Table 6.1-18. These summaries include certain median values (with corresponding error estimate) and ranges for observed environmental concentration estimates. The preoperational median (with error estimate) and range values establish general preoperational baseline concentrations which provide one basis for evaluation of possible long-term changes in the radiological environment. The similarly developed data for "paired" control and indicator samples are utilized, as appropriate, during operation to assess the probability that any observed high concentration estimate is due to random or regional fluctuations in measurements rather than to a true increase in local environmental concentrations. | 1

These intercomparable estimates thus form a level of verification for population and environmental dose calculations based on effluent release data, while the absolute sensitivities of measurement provide assurance that environmental concentrations are well within 10 CFR 20 Appendix B requirements.

6.1.6 REFERENCES

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TABLE 6.1-1

WATER QUALITY MONITORING PROGRAM FOR THE
PRE-OPERATIONAL PHASE OF THE VIRGIL C. SUMMER NUCLEAR STATION(1)

Station Number(2)	Parameter	Analysis Technique(4)
	CONTINUOUS MONITORING	
12	Water Temperature	Continuous Recording Meters
	Dissolved Oxygen	
	Conductivity	
	pH	
17	Water Temperature	Continuous Recording Meter
	MONTHLY MONITORING	
1, 5A, 11, 12	Water Temperature	EPA
	Dissolved Oxygen	EPA (electrode)
	Conductivity	ASTM D1125-64, A
	pH	ASTM D1293-65
	Transparency	Secchi Disc
	Odor(3)	Detectable
	Color	EPA (Platinum-Cobalt)
	Turbidity	ASTM D1889-71
	BOD	SM 507(4)
	TSS	ASTM D1888-67, A
	TDS	ASTM D1888-67, A
	p-Alkalinity	ASTM D1067-70, C
	M.O. Alkalinity	ASTM D1067-70, C
	Calcium Hardness	ASTM D1126-67, B
	Magnesium Hardness	ASTM D1126-67, B
	Total Hardness	ASTM D1126-67, B
	Ammonia	ASTM D1426-74, B
	Nitrate	SM 419D
	Orthophosphate	ASTM D515-72, B
	Sulfate	ASTM D516-68, B
	Phenols	ASTM D1783-70
	Oil and Grease	EPA (Separatory Funnel Extraction)
	Aluminum	EPA
	Boron	SM 107B (1971)
	Cadmium	EPA
	Chromium	EPA
	Cooper	EPA
	Iron	EPA
	Lead	EPA
	Manganese	EPA
	Mercury	EPA
	Zinc	EPA

1

AMENDMENT 1
APRIL 1978

Station Number[2]	Parameter	Analysis Technique[4]
	QUARTERLY MONITORING	
2, 14, 16, 18	Same parameters as monthly, above, at Stations 1, 5A, 11, 12	1
	plus	
1, 2, 5A, 11 12, 14, 16, 18	Total Kjeldahl nitrogen (TKN)	EPA
	Organic nitrogen (calculated from TKN & ammonia levels)	
	Total phosphorus	ASTM D515-72, C

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(1) Analysis techniques are taken from:

SM - Standard Methods for the Examination of Water and Wastewater, 1976, 14th Edition. Publ. by Amer. Publ. Health Assoc., Amer. Water Works Assoc., Water Poll. Control Fed.

ASTM - American Society for Testing and Materials, 1975. Annual Book of ASTM Standards, Part 31.

EPA - U. S. Environmental Protection Agency, 1974, Methods for Chemical Analysis of Water and Wastes. EPA-625-6-74-003.

(2) Station numbers refer to locations on Figure 6.1-1.

(3) Measured at Station 5A only. 1

(4) May be replaced by equivalent or better methods, as they become available.

TABLE 6.1-2

SUMMARY OF SCOPE OF WORK FOR THE PREOPERATIONAL BIOLOGICAL SAMPLING PROGRAM

Program Component	Sampling Station	Sampling Frequency	References for Species Identification
Vascular Hydrophytes	Shorelines of Parr and Monticello Reservoirs	Quarterly	Reference 10
Phytoplankton	B, C, D, and H through P	Quarterly	References 11-19
Zooplankton	B, C, D, and H through P	Quarterly	References 20-22
Ichthyoplankton	B, C, and H through P	Biweekly(2)	References 23, 24
Benthic Macroinvertebrates	B, C, D, and H through P	Quarterly	References 25-34
Fish	B, C, D, and H through P(1)	Quarterly	References 35-39

(1) Electrofishing will be conducted at these stations; locations for rotenoning are discussed in Section 6.1.1.2.1.6

(2) Late February through September only.

1

TABLE 6.1-3

IMPORTANT SPECIES OF THE PARR/MONTICELLO RESERVOIR SYSTEM

Gizzard shad	*Dorosoma cepedianum*
White catfish	*Ictalurus catus*
Flat bullhead	*I. platycephalus*
Channel catfish	*I. punctatus*
White bass	*Morone chrysops*
Redbreast sunfish	*Lepomis auritus*
Bluegill	*L. macrochirus*
Redear sunfish	*L. microlophus*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*P. nigromaculatus*

1

TABLE 6.1-4

CLASSIFICATION OF MATURITY STAGES (GONADAL CONDITION) IN FISH

Stage	Gonadal Condition
Immature	- Young individuals which have not yet engaged in reproduction; gonads of very small size.
Resting Stage	- Sexual products have not yet begun to develop; gonads of very small size; eggs not distinguishable to the naked eye.
Maturation	- Eggs distinguishable to the naked eye; a very rapid increase in weight of the gonad is in progress; testes change from transparent to a pale rose color.
Maturity	- Sexual products ripe; gonads have achieved their maximum weight; but the sexual products are still not extruded when light pressure is applied.
Reproduction	- Sexual products are extruded in response to very light pressure on the belly; weight of the gonads decreased rapidly from the start of spawning to its completion.
Spent Condition	- The sexual products have been discharged; genital aperture inflamed; gonads have the the appearance of deflated sacs, the ovaries usually containing a few leftover eggs, and the testes some residual sperm.

Source: Reference 40.

TABLE 6.1-5

METEOROLOGICAL INSTRUMENTATION
VIRGIL C. SUMMER NUCLEAR STATION

Measurement	Level (meters)	Instrument	Minimum Accuracy	Minimum Threshold	Minimum Operating Conditions	Minimum Calibrated Range
Wind Speed	10.5, 61.5	3-cup Anemometer	±1% or .15mph	0.6 mph	-50 to +155°F	0 - 90 mph
Wind Direction	10.5, 61.5	Wind Vane	±1%	0.75 mph	-50 to +155°F	0 - 540°
Temperature	10	Platinum RTD Probe	±0.28°C	NA[1]	-50 to +130°F	-50 to +50°C
		Aspirated Shield (temp., dewpoint, ΔT)	NA	NA	-60 to +150°F	NA
Dewpoint[2]	10	Lithium Chloride Dewcell	±1.1°C	NA	-50 to +130°F	-50 to +50°C
	10	Pelpier Mirror	±0.28°C	NA	-50 to +50°C	-50 to +50°C
Delta Temperature	10-61, 10-40	Platinum RTD Probe	±.1°C	NA	-50 to +130°F	-10 to +15°F
Precipitation	1.5	Tipping Bucket Rain Gage	±0.5%	.01 inch	no limitation	NA
Solar Radiation	1.5	Pyranometer	±0.04 ly/min	NA	no limitation	0 to 2 ly/min

(1) NA = not applicable

(2) Lithium chloride dewcell replaced by Pelpier mirror 8/76.

AMENDMENT 1
APRIL 1978

TABLE 6.1-6

Meteorological Tower Calibration
Virgil C. Summer Nuclear Station
6 January - 9 January 1975

Parameter	Pre-Calibration Condition	Post-Calibration Condition
Wind Speed/10 meters	Analog recorder reading 1 mph low	In Calibration
Wind Direction/10 meters	Analog and pulse recorder >5° off	In calibration
Wind Speed/60 meters	Analog recorder ≥1 mph off for WS >25 mph	In calibration 1
Wind Direction/60 meters	Analog recorder >5 off	In calibration
Delta Temperature/10-60 meters	In calibration	In calibration
Delta Temperature/10-35 meters	In calibration	In calibration
Temperature/10 meters	In calibration	In calibration
Dew Point Temperature/ 10 meters	Analog and pulse recorders >2°F off	In calibration
Solar Radiation	In calibration	In calibration

AMENDMENT 1
APRIL 1978

TABLE 6.1-7

Meteorological Tower Calibration
Virgil C. Summer Nuclear Station
14 April - 17 April 1975

Parameter	Pre-Calibration Condition	Post-Calibration Condition
Wind Speed/10 meter	In calibration	In calibration
Wind Direction/10 meters	In calibration	In calibration
Wind Speed/60 meters	Analog Recorder ≥0.5 mph off	In calibration
Wind Direction/60 meters	In calibration	In calibration
Delta Temperature/10-60 meters	Analog Recorder off >0.1°F	In calibration
Delta Temperature/10-35 meters	Analog Recorder off >0.1°F	In calibration
Temperature/10 meters	In calibration	In calibration
Dew Point Temperature/ 10 meters	In calibration	In calibration
Solar Radiation	In calibration	In calibration

1

TABLE 6.1-8

Meteorological Tower Calibration
Virgil C. Summer Nuclear Station
8 September - 11 September 1975

Parameter	Pre-Calibration Condition	Post-Calibration Condition
Wind Speed/10 meters	Analog Reading >1 mph low	In calibration
Wind Direction/10 meters	Analog Reading >5° low	In calibration
Wind Speed/60 meters	Analog Reading >1 mph low	In calibration
Wind Direction/60 meters	In calibration	In calibration
Delta Temperature/10-60 meters	In calibration	In calibration
Delta Temperature/10-35 meters	Analog Reading >0.2° high	In calibration
Temperature/10 meters	In calibration	In calibration
Dew Point Temperature/ 10 meters	In calibration	In calibration
Solar Radiation	In calibration	In calibration

1

TABLE 6.1-9

Meteorological Tower Calibration
Virgil C. Summer Nuclear Station
26 April - 30 April 1976

Parameter	Pre-Calibration Condition	Post-Calibration Condition
Wind Speed/10 meters	Rough Bearings	In calibration
Wind Direction/10 meters	In calibration	In calibration
Wind Speed/60 meters	In calibration	In calibration
Wind Direction/60 meters	In calibration	In calibration
Delta Temperature/10-60 meters	In calibration	In calibration
Delta Temperature/10-35 meters	In calibration	In calibration
Temperature/10 meters	In calibration	In calibration
Dew Point Temperature/ 10 meters	Sensor Removed For Replacement By Cooled Mirror Dew Point System	
Solar Radiation	In calibration	In calibration

1

TABLE 6.1-10

ANNUAL AVERAGE RELATIVE CONCENTRATION
(GROUND LEVEL RELEASE; OPEN TERRAIN FACTORS)

AVERAGE ANNUAL RELATIVE CONCENTRATION DEPLETED (SEC/CUBIC METER)
WITH REDUCTION DUE TO RADIOACTIVE DECAY
PERIOD OF RECORD : 01/01/75 TO 12/31/75

RADIOACTIVE HALF LIFE = 8.00 DAYS

BASE DISTANCE IN MILES / KILOMETERS

AFTO SECT	.50 .80	1.50 2.41	2.50 4.02	3.50 5.63	4.50 7.24	7.50 12.07	15.00 24.13	25.00 40.22	35.00 56.31	45.00 72.46
NNE	1.5E-05	1.3E-06	4.3E-07	2.2E-07	1.3E-07	5.5E-08	1.7E-08	7.4E-09	4.2E-09	2.7E-09
NE	1.6E-05	1.4E-06	4.6E-07	2.3E-07	1.4E-07	5.8E-08	1.8E-08	7.7E-09	4.4E-09	2.9E-09
ENE	1.4E-05	1.2E-06	3.9E-07	2.0E-07	1.2E-07	4.9E-08	1.5E-08	6.5E-09	3.7E-09	2.4E-09
E	1.3E-05	1.1E-06	3.7E-07	1.9E-07	1.2E-07	4.8E-08	1.5E-08	6.3E-09	3.5E-09	2.3E-09
ESE	1.3E-05	1.1E-06	3.6E-07	1.8E-07	1.1E-07	4.7E-08	1.5E-08	6.2E-09	3.5E-09	2.2E-09
SE	1.8E-05	1.6E-06	5.2E-07	2.6E-07	1.7E-07	6.8E-08	2.1E-08	9.1E-09	5.1E-09	3.3E-09
SSE	1.2E-05	1.0E-06	3.5E-07	1.8E-07	1.1E-07	4.5E-08	1.4E-08	6.0E-09	3.4E-09	2.1E-09
S	1.4E-05	1.2E-06	3.9E-07	2.0E-07	1.3E-07	5.2E-08	1.6E-08	6.9E-09	3.9E-09	2.5E-09
SSW	1.3E-05	1.1E-06	3.7E-07	1.9E-07	1.2E-07	4.7E-08	1.5E-08	6.3E-09	3.5E-09	2.3E-09
SW	1.6E-05	1.4E-06	4.6E-07	2.3E-07	1.4E-07	5.9E-08	1.8E-08	7.8E-09	4.4E-09	2.8E-09
WSW	1.3E-05	1.1E-06	3.5E-07	1.8E-07	1.1E-07	4.5E-08	1.4E-08	5.9E-09	3.3E-09	2.1E-09
W	8.6E-06	7.6E-07	2.5E-07	1.3E-07	7.8E-08	3.2E-08	9.8E-09	4.2E-09	2.4E-09	1.5E-09
WNW	7.1E-06	6.4E-07	2.1E-07	1.1E-07	6.6E-08	2.7E-08	8.3E-09	3.6E-09	2.0E-09	1.3E-09
NW	8.9E-06	7.9E-07	2.6E-07	1.3E-07	8.2E-08	3.4E-08	1.1E-08	4.6E-09	2.6E-09	1.7E-09
NNW	8.8E-06	8.0E-07	2.6E-07	1.3E-07	8.2E-08	3.3E-08	1.0E-08	4.5E-09	2.6E-09	1.7E-09
N	1.2E-05	1.1E-06	3.6E-07	1.8E-07	1.1E-07	4.5E-08	1.4E-08	6.0E-09	3.4E-09	2.2E-09

TABLE 6.1-11

ANNUAL AVERAGE DEPOSITION RATE
(GROUND LEVEL RELEASE; OPEN TERRAIN FACTORS)

AVERAGE ANNUAL RELATIVE CONCENTRATION (SEC./CUBIC METER)
WITH REDUCTION DUE TO RADIOACTIVE DECAY
PERIOD OF RECORD : 01/01/75 TO 12/31/75

RADIOACTIVE HALF LIFE = 8.00 DAYS

BASE DISTANCE IN MILES / KILOMETERS

SECT	.50 .80	1.50 2.41	2.50 4.02	3.50 5.63	4.50 7.24	7.50 12.07	15.00 24.13	25.00 40.22	35.00 56.31	45.00 72.40
[illegible]	1.8E-05	1.7E-06	6.1E-07	3.2E-07	2.1E-07	9.5E-08	3.5E-08	1.8E-08	1.1E-08	8.2E-09
[illegible]	1.9E-05	1.9E-06	6.5E-07	3.5E-07	2.2E-07	1.0E-07	3.7E-08	1.9E-08	1.2E-08	8.4E-09
[illegible]	1.8E-05	1.8E-06	5.9E-07	2.9E-07	1.9E-07	8.5E-08	3.1E-08	1.6E-08	1.0E-08	7.2E-09
[illegible]	1.8E-05	1.5E-06	5.3E-07	2.8E-07	1.8E-07	8.2E-08	3.0E-08	1.5E-08	9.6E-09	6.9E-09
[illegible]	1.5E-05	1.4E-06	5.1E-07	2.8E-07	1.8E-07	8.1E-08	3.0E-08	1.5E-08	9.6E-09	6.8E-09
[illegible]	2.2E-05	2.1E-06	7.4E-07	4.0E-07	2.6E-07	1.2E-07	4.3E-08	2.2E-08	1.4E-08	1.0E-08
[illegible]	1.5E-05	1.4E-06	4.9E-07	2.6E-07	1.7E-07	7.8E-08	2.9E-08	1.4E-08	9.2E-09	6.6E-09
[illegible]	1.8E-05	1.8E-06	5.6E-07	3.0E-07	2.0E-07	8.9E-08	3.3E-08	1.7E-08	1.1E-08	7.8E-09
[illegible]	1.5E-05	1.5E-06	5.2E-07	2.8E-07	1.8E-07	8.2E-08	3.0E-08	1.5E-08	9.7E-09	7.0E-09
[illegible]	1.9E-05	1.9E-06	6.5E-07	3.5E-07	2.2E-07	1.0E-07	3.7E-08	1.9E-08	1.2E-08	8.4E-09
[illegible]	1.5E-05	1.4E-06	5.0E-07	2.7E-07	1.7E-07	7.8E-08	2.8E-08	1.4E-08	9.1E-09	6.6E-09
[illegible]	1.0E-05	1.0E-06	3.5E-07	1.9E-07	1.2E-07	5.5E-08	2.0E-08	1.0E-08	6.5E-09	4.7E-09
[illegible]	8.3E-06	8.4E-07	3.0E-07	1.6E-07	1.0E-07	4.6E-08	1.7E-08	8.6E-09	5.6E-09	4.0E-09
[illegible]	1.0E-05	1.0E-06	3.7E-07	2.0E-07	1.3E-07	5.8E-08	2.2E-08	1.1E-08	7.1E-09	5.1E-09
[illegible]	1.0E-05	1.1E-06	3.7E-07	2.0E-07	1.3E-07	5.8E-08	2.1E-08	1.1E-08	7.0E-09	5.1E-09
[illegible]	1.4E-05	1.5E-06	5.1E-07	2.7E-07	1.7E-07	7.8E-08	2.9E-08	1.4E-08	9.3E-09	6.7E-09

TABLE 6.1-12

ANNUAL AVERAGE RELATIVE CONCENTRATION
(GROUND LEVEL RELEASE; OPEN TERRAIN FACTORS)
REDUCTION DUE TO DECAY (2.26 DAYS)

AVERAGE ANNUAL RELATIVE CONCENTRATION (SEC./CUBIC METER)
WITH REDUCTION DUE TO RADIOACTIVE DECAY
PERIOD OF RECORD : 01/01/75 TO 12/31/7-

RADIOACTIVE HALF LIFE = 2.26 DAYS

BASE DISTANCE IN MILES / KILOMETERS

AFTD SECT	.50 .80	1.50 2.41	2.50 4.02	3.50 5.63	4.50 7.24	7.50 12.07	15.00 24.13	25.00 40.22	35.00 56.31	45.00 72.40
NNE	1.8E-05	1.7E-06	6.0E-07	3.2E-07	2.0E-07	9.1E-08	3.2E-08	1.5E-08	9.7E-09	6.8E-09
NE	1.9E-05	1.9E-06	6.4E-07	3.4E-07	2.2E-07	9.7E-08	3.4E-08	1.6E-08	1.0E-08	7.0E-09
ENE	1.6E-05	1.6E-06	5.4E-07	2.9E-07	1.8E-07	8.2E-08	2.9E-08	1.4E-08	8.4E-09	5.8E-09
E	1.6E-05	1.5E-06	5.2E-07	2.8E-07	1.8E-07	7.8E-08	2.7E-08	1.3E-08	7.8E-09	5.7E-09
ESE	1.5E-05	1.4E-06	5.0E-07	2.7E-07	1.7E-07	7.6E-08	2.7E-08	1.3E-08	7.6E-09	5.1E-09
SE	2.2E-05	2.0E-06	7.2E-07	3.9E-07	2.5E-07	1.1E-07	3.9E-08	1.8E-08	1.1E-08	7.4E-09
SSE	1.5E-05	1.4E-06	4.8E-07	2.6E-07	1.7E-07	7.4E-08	2.6E-08	1.2E-08	7.2E-09	4.9E-09
S	1.6E-05	1.5E-06	5.5E-07	2.9E-07	1.9E-07	8.4E-08	2.9E-08	1.4E-08	8.2E-09	5.5E-09
SSW	1.5E-05	1.5E-06	5.1E-07	2.7E-07	1.8E-07	7.8E-08	2.7E-08	1.3E-08	7.9E-09	5.4E-09
SW	1.9E-05	1.8E-06	6.4E-07	3.4E-07	2.2E-07	9.7E-08	3.4E-08	1.6E-08	9.9E-09	6.8E-09
WSW	1.5E-05	1.4E-06	5.0E-07	2.6E-07	1.7E-07	7.4E-08	2.6E-08	1.2E-08	7.2E-09	5.3E-09
W	1.0E-05	1.0E-06	3.5E-07	1.8E-07	1.2E-07	5.3E-08	1.9E-08	8.9E-09	5.5E-09	3.9E-09
WNW	8.3E-06	8.4E-07	2.9E-07	1.6E-07	1.0E-07	4.4E-08	1.6E-08	7.6E-09	4.7E-09	3.3E-09
NW	1.0E-05	1.0E-06	3.6E-07	1.9E-07	1.3E-07	5.6E-08	2.0E-08	9.5E-09	5.8E-09	4.1E-09
NNW	1.0E-05	1.1E-06	3.7E-07	1.9E-07	1.3E-07	5.6E-08	2.0E-08	9.9E-09	6.2E-09	4.4E-09
N	1.4E-05	1.4E-06	5.0E-07	2.6E-07	1.7E-07	7.5E-08	2.7E-08	1.3E-08	8.0E-09	5.6E-09

TABLE 6.1-13

ANNUAL AVERAGE RELATIVE CONCENTRATION
(GROUND LEVEL RELEASE; OPEN TERRAIN FACTORS)
REDUCTION DUE TO DECAY (8.0 DAYS)

AVERAGE ANNUAL RELATIVE DEPOSITION RATE (SQUARE METER -1)
PERIOD OF RECORD : 01/01/75 TO 12/31/75

BASE DISTANCE IN MILES / KILOMETERS

SECT	.50 .80	1.50 2.41	2.50 4.02	3.50 5.63	4.50 7.24	7.50 12.07	15.00 24.13	25.00 40.22	35.00 56.31	45.00 72.40
NNE	1.0E-07	7.5E-09	2.1E-09	9.6E-10	5.6E-10	2.1E-10	5.6E-11	2.2E-11	1.1E-11	6.6E-12
NE	1.1E-07	8.1E-09	2.3E-09	1.1E-09	6.1E-10	2.3E-10	6.1E-11	2.3E-11	1.2E-11	7.2E-12
ENE	9.4E-08	6.8E-09	1.9E-09	8.8E-10	5.1E-10	1.9E-10	5.1E-11	2.0E-11	1.0E-11	6.0E-12
E	7.7E-08	5.6E-09	1.6E-09	7.2E-10	4.2E-10	1.5E-10	4.2E-11	1.6E-11	8.2E-12	4.9E-12
ESE	5.6E-08	4.0E-09	1.1E-09	5.2E-10	3.0E-10	1.1E-10	3.0E-11	1.2E-11	5.9E-12	3.5E-12
SE	8.0E-08	5.8E-09	1.6E-09	7.5E-10	4.4E-10	1.6E-10	4.4E-11	1.7E-11	8.6E-12	5.1E-12
SSE	5.8E-08	4.2E-09	1.2E-09	5.4E-10	3.2E-10	1.2E-10	3.2E-11	1.2E-11	6.2E-12	3.7E-12
S	4.9E-08	3.5E-09	9.9E-10	4.6E-10	2.7E-10	9.8E-11	2.7E-11	1.0E-11	5.3E-12	3.1E-12
SSW	6.4E-08	4.6E-09	1.3E-09	6.0E-10	3.5E-10	1.3E-10	3.5E-11	1.3E-11	6.8E-12	4.1E-12
SW	9.6E-08	6.9E-09	1.9E-09	8.9E-10	5.2E-10	1.9E-10	5.2E-11	2.0E-11	1.0E-11	6.1E-12
WSW	8.1E-08	5.9E-09	1.6E-09	7.6E-10	4.4E-10	1.6E-10	4.4E-11	1.7E-11	8.7E-12	5.2E-12
W	5.5E-08	4.0E-09	1.1E-09	5.1E-10	3.0E-10	1.1E-10	3.0E-11	1.1E-11	5.9E-12	3.5E-12
WNW	4.5E-08	3.3E-09	9.1E-10	4.2E-10	2.5E-10	9.0E-11	2.4E-11	9.4E-12	4.8E-12	2.9E-12
NW	6.3E-08	4.5E-09	1.3E-09	5.8E-10	3.4E-10	1.2E-10	3.4E-11	1.3E-11	6.7E-12	4.0E-12
NNW	7.2E-08	5.2E-09	1.5E-09	6.7E-10	3.9E-10	1.4E-10	3.9E-11	1.5E-11	7.7E-12	4.6E-12
N	8.9E-08	6.4E-09	1.8E-09	8.3E-10	4.8E-10	1.8E-10	4.9E-11	1.9E-11	9.5E-12	5.7E-12

TABLE 6.1-14

ANNUAL AVERAGE RELATIVE CONCENTRATION
(GROUND LEVEL RELEASE; OPEN TERRAIN FACTORS)
REDUCTION DUE TO DECAY (8.0 DAYS) AND DEPLETED

AVERAGE ANNUAL RELATIVE CONCENTRATION (SEC./CUBIC METER)
PERIOD OF RECORD : 01/01/75 TO 12/31/75

BASE DISTANCE IN MILES / KILOMETERS

AFTD EFCT	.50 .80	1.50 2.41	2.50 4.02	3.50 5.63	4.50 7.24	7.50 12.07	15.00 24.13	25.00 40.22	35.00 56.31	45.00 72.40
NNE	1.8E-05	1.7E-06	6.1E-07	3.3E-07	2.1E-07	9.6E-08	3.4E-08	1.9E-08	1.2E-08	9.0E-09
NE	1.9E-05	1.6E-06	6.8E-07	3.5E-07	2.3E-07	1.0E-07	3.8E-08	2.0E-08	1.3E-08	9.5E-09
ENE	1.6E-05	1.4E-06	5.8E-07	3.0E-07	1.9E-07	8.7E-08	3.2E-08	1.7E-08	1.1E-08	8.0E-09
E	1.6E-05	1.5E-06	5.3E-07	2.9E-07	1.9E-07	8.4E-08	3.1E-08	1.6E-08	1.1E-08	7.8E-09
ESE	1.5E-05	1.5E-06	5.2E-07	2.8E-07	1.8E-07	8.3E-08	3.1E-08	1.6E-08	1.1E-08	7.9E-09
SE	2.2E-05	2.1E-06	7.4E-07	4.0E-07	2.6E-07	1.2E-07	4.4E-08	2.4E-08	1.5E-08	1.2E-08
SSE	1.5E-05	1.4E-06	5.0E-07	2.7E-07	1.7E-07	8.0E-08	3.0E-08	1.6E-08	1.0E-08	7.6E-09
S	1.6E-05	1.6E-06	5.6E-07	3.0E-07	2.0E-07	9.2E-08	3.5E-08	1.8E-08	1.2E-08	8.8E-09
SSW	1.5E-05	1.5E-06	5.2E-07	2.8E-07	1.8E-07	8.3E-08	3.1E-08	1.6E-08	1.1E-08	7.8E-09
SW	1.9E-05	1.9E-06	6.8E-07	3.5E-07	2.3E-07	1.0E-07	3.9E-08	2.0E-08	1.3E-08	9.6E-09
WSW	1.5E-05	1.4E-06	5.1E-07	2.7E-07	1.7E-07	7.9E-08	2.9E-08	1.5E-08	9.9E-09	7.3E-09
W	1.0E-05	1.0E-06	3.6E-07	1.9E-07	1.2E-07	5.6E-08	2.1E-08	1.1E-08	7.0E-09	5.2E-09
WNW	8.3E-06	8.5E-07	3.0E-07	1.6E-07	1.0E-07	4.7E-08	1.8E-08	9.1E-09	6.0E-09	4.4E-09
NW	1.0E-05	1.0E-06	3.7E-07	2.0E-07	1.3E-07	5.9E-08	2.2E-08	1.2E-08	7.6E-09	5.6E-09
NNW	1.0E-05	1.1E-06	3.7E-07	2.0E-07	1.3E-07	5.8E-08	2.2E-08	1.1E-08	7.4E-09	5.4E-09
N	1.4E-05	1.5E-06	5.1E-07	2.7E-07	1.8E-07	7.9E-08	2.9E-08	1.5E-08	1.0E-08	7.3E-09

TABLE 6.1-15

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
VIRGIL C. SUMMER NUCLEAR STATION

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis
AIRBORNE					
I. Particulates	A 3 Indicator samples to be taken at locations (in different sectors) beyond but as close to the exclusion boundary as practicable where the highest offsite sectoral ground level concentrations are anticipated.(2)	Continuous sampler operation with weekly collection.	2 5 10	1.1 SW 1.3 SE 2.4 NNE	Gross beta following filter change; Monthly composite (by location) for gamma isotopic.
	B 1 Indicator sample to be taken in the sector beyond but as close to the exclusion boundary as practicable corresponding to the residence having the highest anticipated offsite ground level concentration or dose.(2)		6	1.1 ESE	
	C 1 Indicator sample to be taken at the location of one of the dairies most likely to be affected.(2) (4)		14(4)	5.7 W	

1

1

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Mi/Dir	Type and Frequency of Analysis	
AIRBORNE, (continued)	D 2 Control samples to be taken at locations at least 10 air miles from the site and not in the most prevalent wind directions.(2)		17 16	24.7 SE 28.0 W		1
II. Radioiodine	A 3 Indicator samples to be taken at two locations as given in I.A above.	Continuous sampler operation with weekly cannister collection.	2 5 10	1.1 SW 1.3 SE 2.4 NNE	Gamma isotopic screening of all five indicators with conjunctive screening of the two controls. If screening is positive, each sample will be subjected to isotopic analysis for iodine.	
	B 1 Indicator sample to be taken at the location as given in I.B above.		6	1.1 ESE		
	C 1 Indicator sample to be taken at the location as given in I.C above.		14(5)	5.7 W		1
	D 2 Control samples to be taken at locations similar in nature to A-C above.		17 16	24.7 SE 28.0 W		1

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Mi/Dir	Type and Frequency of Analysis
AIRBORNE, (continued)					
III. Direct	A 5 Indicator samples to be taken at the locations as given in I.A through D above.	Monthly exchange.(5) Two or more dosimeters at each location.	#'s 2, 5, 6, 10, and 14.		Gamma dose monthly
	B 3 Additional indicator samples to be taken in sectors different from III.A above, beyond but as close to the exclusion boundary as practicable.		1 4 8	1.3 S 1.2 NW 1.3 ENE	
	C Control samples to be taken at the locations as given in I.D above.		16 17	28.0 W 24.7 SE	
	D 1 Additional control sample to be taken at a location as set forth in I.D above.		18	16.5 S	
WATERBORNE					
IV. Surface Water	A 1 Indicator sample to be taken at a location which allows for mixing and dilution in the ultimate receiving river.	Time composite samples with collection every month (corresponds to USGS continuous sampling site).	21(3)	2.7 SSE	Gamma isotopic with quarterly composite (by location) to be analyzed for tritium.

1

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
WATERBORNE, (continued)	B 1 Control sample to be taken at a location on the receiving river, sufficiently far upstream such that no effects of pumped storage operation are anticipated.		22(3)	12-15 NNW		1
	C 1 Indicator sample to be taken in the upper reservoir of the pumped storage facility.	Grab sampling every 2 weeks.	23(3)	<1 E	As in V above.	1
	D 1 Indicator smaple to be taken in the upper reservoir's non-fluctuating recreational area.		24(3)	4.7 N		1
	E 1 Control sample to be taken at a location on a separated unaffected watershed reservoir.		18(3)	16.5 S		1
V. Ground Water	A 2 Indicator samples to be taken within the exclusion boundary and in the direction of potentially affected ground water supplies.	Quarterly grab sampling.	26 27	Onsite Onsite	Gamma isotopic and tritium analyses quarterly.	1
	B 1 Control sample from an unaffected location.		16	28.0 W		1

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample		Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
WATERBORNE, (continued)							
VI. Drinking Water	A	1 Indicator sample from nearby public ground water supply source.	Monthly grab sampling	28	1.3 ESE	Gamma isotopic and tritium analyses monthly	1
	B	1 Indicator sample from a location immediately upstream of the nearest downstream municipal water supply.	Time composite sample with monthly collection.	17	24.7 S	Monthly gamma isotopic analysis and quarterly tritium analysis.	1
INGESTION							
VII. Milk(5)	A	1 Indicator sample to be taken at the location of one of the dairies most likely to be affected. (2) (5)	Monthly	14(4)	5.7 W	Radioiodine analyses monthly when animals pasture. Monthly gamma isotopic.	1
	B	1 Control sample to be taken at the location of a dairy 10-20 miles distant and not in the most prevalent wind direction. (2)		16	28.0 W		1
	C	1 Indicator grass (forage) sample to be taken at one of the locations beyond but as close to the exclusion boundary as practicable where the highest offsite sectoral ground level concentrations are anticipated.(2)	Monthly when available	6	1.1 ESE	Gamma Isotopic	1

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
INGESTION, (continued)	D 1 Indicator grass (forage) sample to be taken at the location of VIII.A above when animals are on pasture.		14(4)	5.7 W		
	E 1 Control grass (forage) sample to be taken at the location of VIII.B above.		16	28.0 W		
VIII. Food Products	A 1 Indicator sample to be taken at a nearby garden likely to be affected.	Annually at the approximate median harvest time for the area. Samples, if available, will include: green leafy, tuberous or root, fruit, and grain.	6	1.1 ESE	Gamma isotopic on edible portion. Radioiodine on green leafy vegetables.	1
	B 1 Control sample for the same foods taken at a location at least 10 miles distant and not in the most prevalent wind direction.		18(3)	16.5 S		
IX. Fish	A 1 Indicator sample to be taken at a location in the upper reservoir.	Semi-annual collection of the following species: bass, bream/crappie, catfish, and shad.	23(3)	0.3-4	Gamma isotopic on edible portions semi-annually	1

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location[1]	Sample Locations Mi/Dir	Type and Frequency of Analysis	
INGESTION, (continued)	B 1 Indicator sample to be taken at a location in the lower reservoir		21[3]	1-3		1
	C 1 Indicator sample to be taken at a location in the upper reservoir's non-fluctuating recreational area.		24[3]	4-5 N		1
	D 1 Control sample to be taken at a location on a separated unaffected watershed reservoir.		18[3]	15-17 S		1
	E 1 Control sample to be taken at a location on the receiving river, sufficiently far up-stream such that no effects of pumped storage operation are anticipated.		22[3]	12-15 NNW		1
AQUATIC						
X. Sediment	A 1 Indicator sample to be taken at a location in the upper reservoir.	Semi-annual grab sample	23[3]	0.3-4	Gamma isotopic semi-annually (3)	1

TABLE 6.1-15 (Continued)

Exposure Pathway and/or Sample	Criteria for Selection of Sample Number and Location	Sampling and Collection Frequency	Sample Locations Location(1)	Sample Locations Mi/Dir	Type and Frequency of Analysis	
AQUATIC (continued)	B 1 Indicator sample to be taken in the upper reservoir's non-fluctuating recreational area.		24(3)	4-5 N		1
	C 1 Indicator sample to be taken on the shoreline of the lower reservoir.		21(3)	1-3		1
	D 1 Control sample to be taken in receiving river, sufficiently far upstream such that no effects of pumped storage operation are anticipated.		22(3)	12-15		1
	E 1 Control sample to be taken at a location on a separated unaffected watershed reservoir.		18(3)	15-17		1

(1) Location numbers refer to Figures 6.1-3 and 6.1-4.

(2) Sample site locations are based on the meteorological analysis for the period of record as presented in Chapters 5 and 6.

(3) Though generalized areas are noted for simplicity of sample site enumeration, airborne, water and sediment sampling is done at the same location whereas biological sampling sites are generalized areas in order to reasonably assure availability of samples. 1

(4) Only one of these dairies will therefore be sampled. Milking animal and garden survey results will be analyzed annually. Should the survey indicate new dairying activity in a quadrant(s) other than W or NW and closer than 5-7 miles, sites(s) will be added for additional milk sampling. | 1

(5) Not to exceed six weeks. | 1

NOTE: Deviations from this sampling schedule may occasionally be necessary if sample media are unobtainable due to hazardous conditions, unavailability, insufficient sample size, or malfunctions of automatic sampling or analysis equipment. Should these conditions occur, immediate corrective actions are undertaken and samples are obtained as soon as practicable. Deviations from sampling-analyses schedule will be described in the annual report. | 1

TABLE 6.1-16

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS
MEDIA/DETECTION CAPABILITIES

	Lower Limit of Detection (LLD)[1]					
Analysis	Water (pCi/l)	Airborne Particulate of Gas (pCi/m^3)	Fish, Meat or Poultry (pCi/kg,wet)	Milk (pCi/l)	Vegetation (pCi/kg,wet)	Sediment (pCi/kg,dry)
gross beta		(1×10^{-2})				
^{3}H	330					
^{54}Mn	15		130			
^{59}Fe	30		260			
$^{58,60}Co$	15		130			
^{65}Zn	30		260			
$^{95}Zr-Nb$	10					
^{131}I	.5	(7×10^{-2})		.8	25	
$^{134,137}Cs$	15	(1×10^{-2})	130	15	80	150
$^{140}Ba-La$	10			15		

Direct TLD measurements should have detection sensitivities approaching 10 mrem/yr.

(1) The nominal lower limit of detection is defined in HASL 300 (Rev. 8/74), pp. D-08-01, 02, 03 at the 95% confidence level. The LLD levels are decay corrected to the end of the total sampling period. The LLD for radionuclides analyzed by gamma spectrometry will vary according to the number of radionuclides encountered in environmental samples. These LLD levels will be used as minimum criteria for objectives for instrumentation and analytical procedure selection.

TABLE 6.1-17

1

DURATION OF PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample		Preoperational Period of Record
AIRBORNE		
I.	Particulates	1 year
II.	Radioiodine	6 months
III.	Direct	2 years
WATERBORNE		
IV.	Surface Water	1 year
V.	Ground Water	1 year
VI.	Drinking Water	1 year
INGESTION		
VII.	Milk	6 months I, 1 year other
VIII.	Fruits and Vegetables	2 years(1)
IX.	Meat and Poultry	2 years(1)
X.	Fish	2 years(1)
AQUATIC		
XI.	Sediment	2 years

(1) 2 years on an "as reasonably available basis."

TABLE 6.1-18

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY
VIRGIL C. SUMMER NUCLEAR STATION Docket No. 50-395
FAIRFIELD COUNTY, SOUTH CAROLINA

Reporting Period _____

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (1)	All Indicator Locations (2) Mean (f) Range	Location with Highest Annual Mean (2)		Control Locations (2) Mean (f) Range	Number of Nonroutine Reported Measurements
				Name Distance and Direction	Mean (f) Range		

(1) Nominal Lower Unit of Detection (LLD) as defined in HASL-300 (Rev. 8/73), pp. D-08-01, 02, 03.

(2) Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses. (f)

RECREATION
AREA DAM

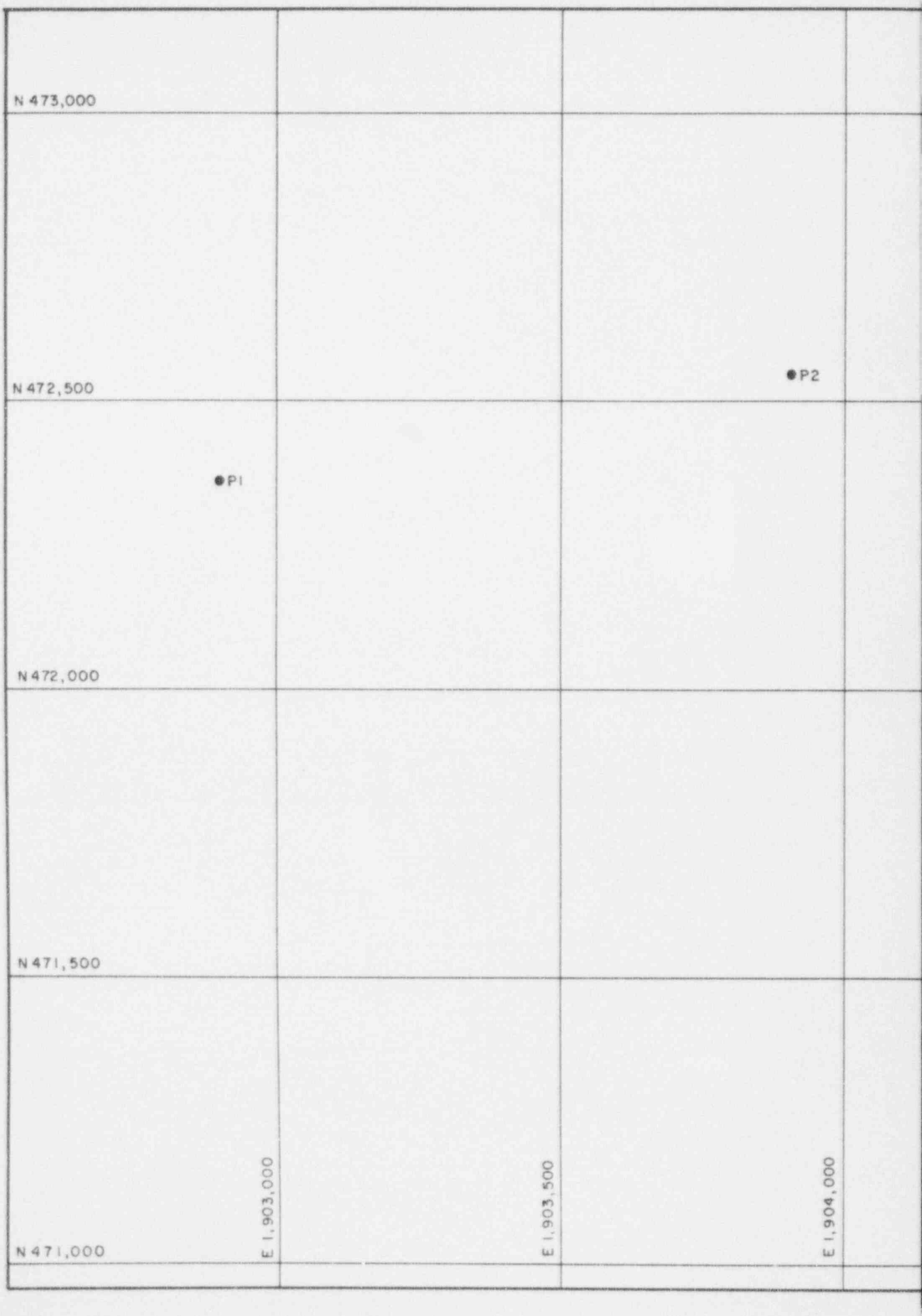
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

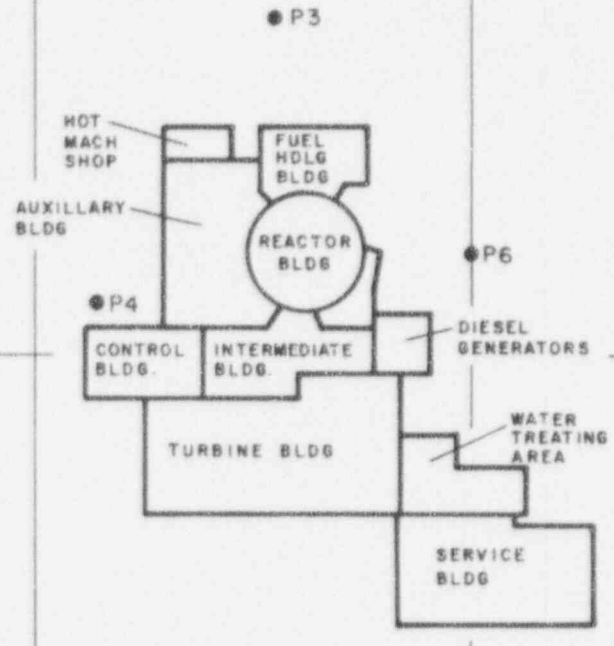
Aquatic Preoperational Monitoring Stations

Figure 6.1-1

ANSTEC APERTURE CARD
Also Available on Aperture Card

9406090201-24


N 473,000
N 472,500
P2
P1
N 472,000
N 471,500
N 471,000
E 1,903,000
E 1,903,500
E 1,904,000



ANSTEC APERTURE CARD

Also Available on Aperture Card

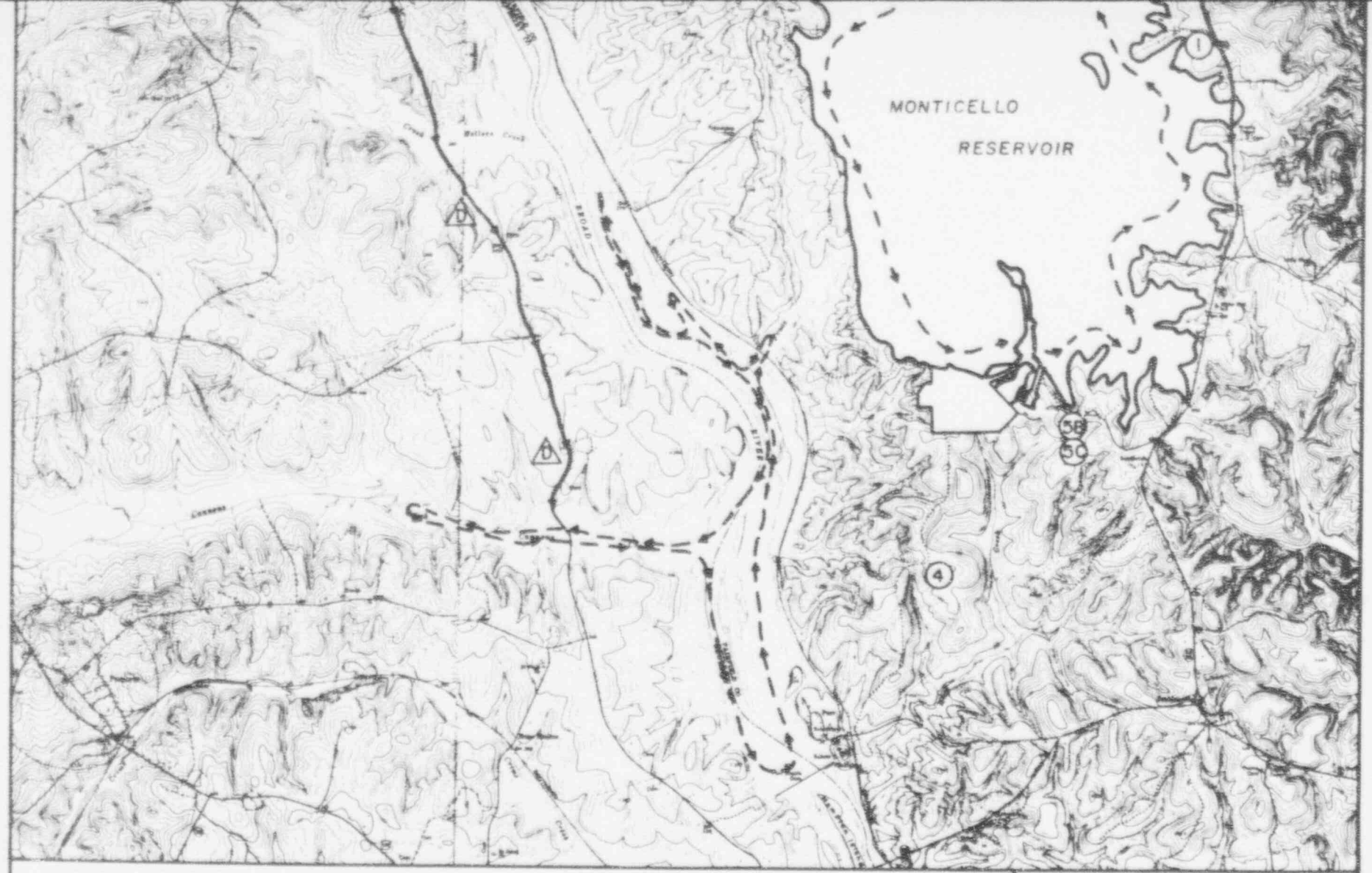
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Onsite Ground Water Monitoring Wells

Figure 6.1-2

9406090201-25

RECREATION
AREA
7
8



South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station

Terrestrial Sampling Locations and Survey Routes

Figure 6.1-3

ANSTEC APERTURE CARD
Also Available on Aperture Card

9406090201-26

DAWKINS
St Marks Ch
New Hope Ch
FREE
CREE
DAM
FAIRFI
POWER
N475,000
N450,000
E1,875,000
14
(A,D,I,O)
30 (O)
St James Ch
Victory Ch
Bethlehem Ch
Garmany Sch
Cannons
POMARIA
POP 230
Hope Ch
HOPE STATION
St Johns Ch
St Pauls Ch
SOUTHERN
Crims
RAILWAY
KIBLER
Creek
FAS

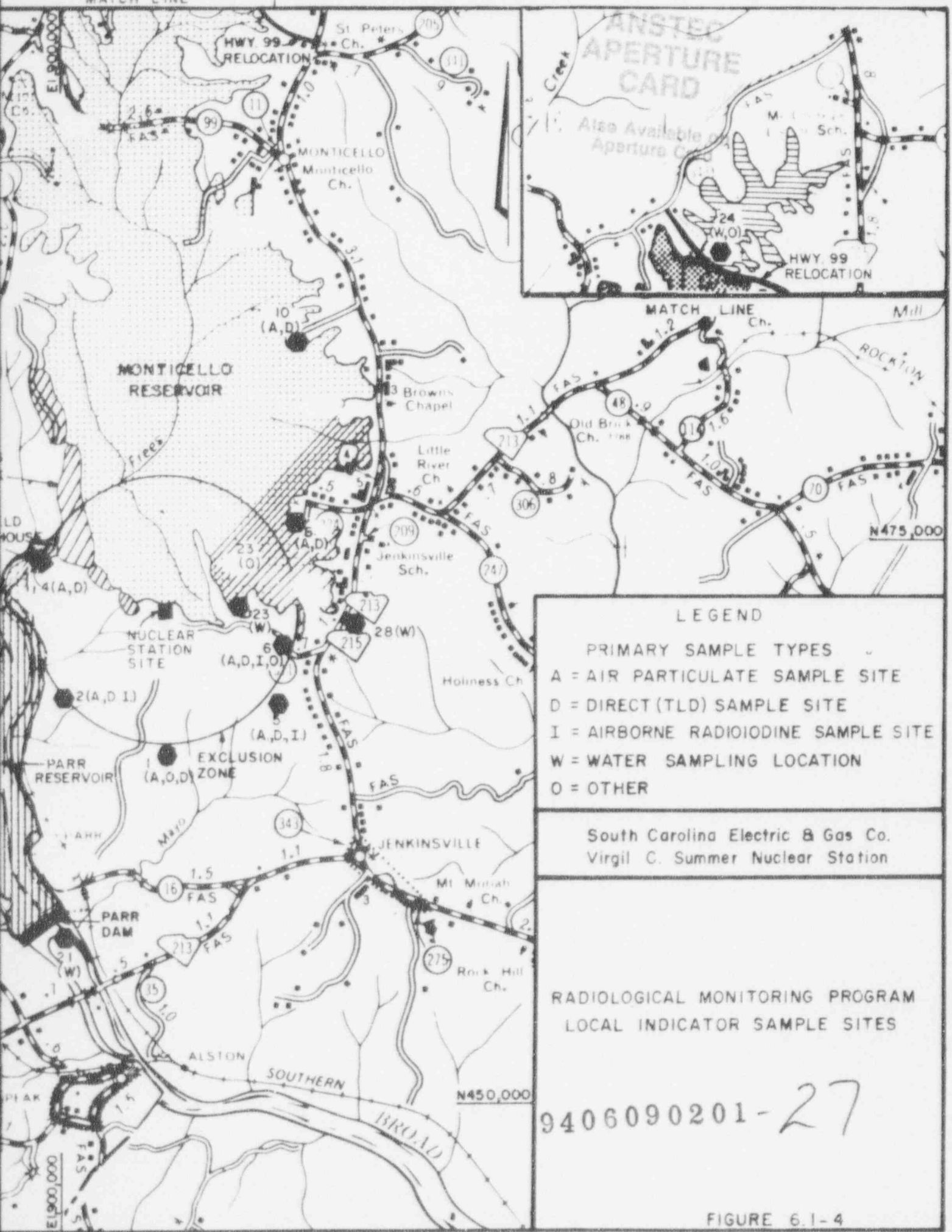
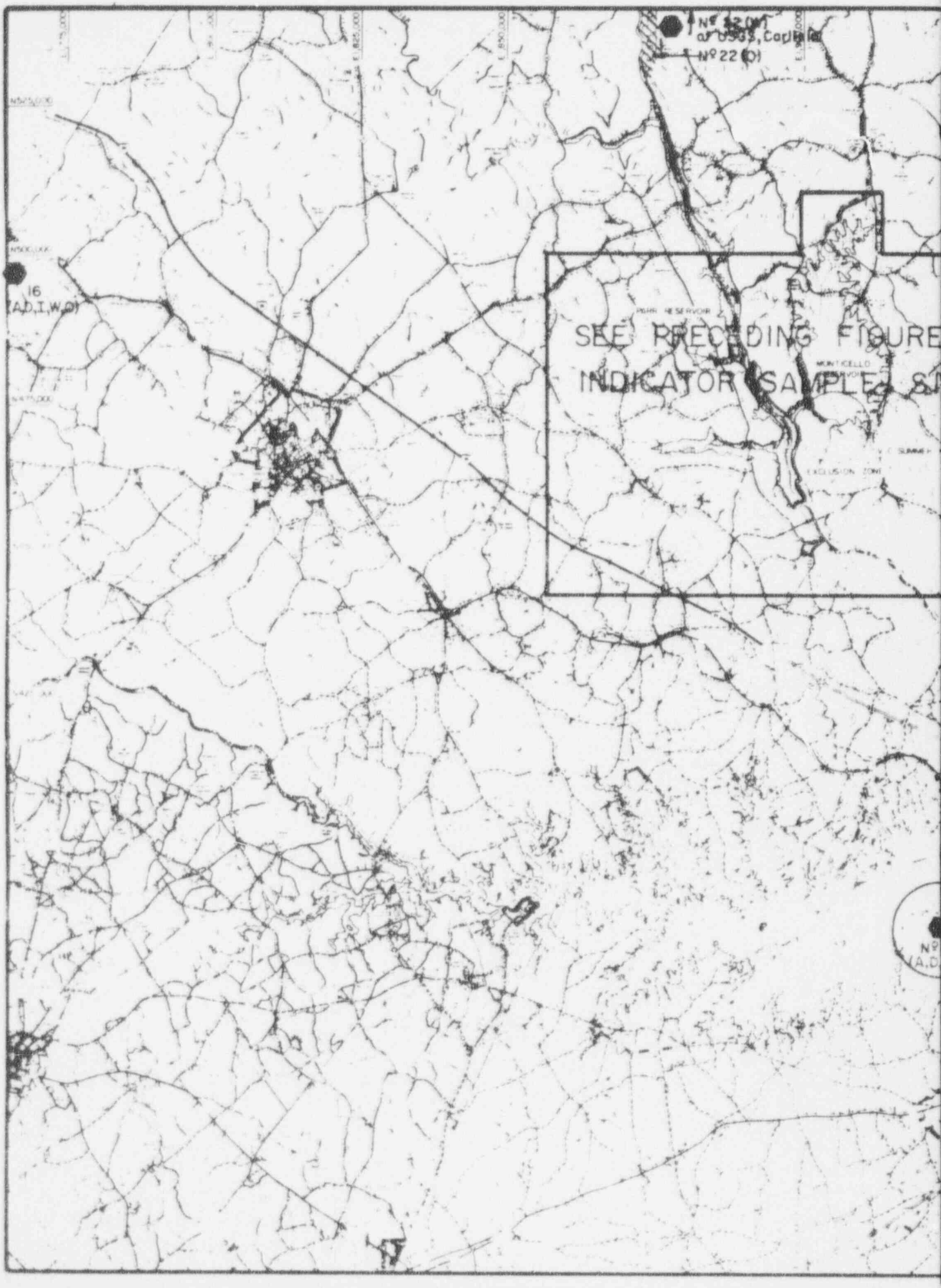
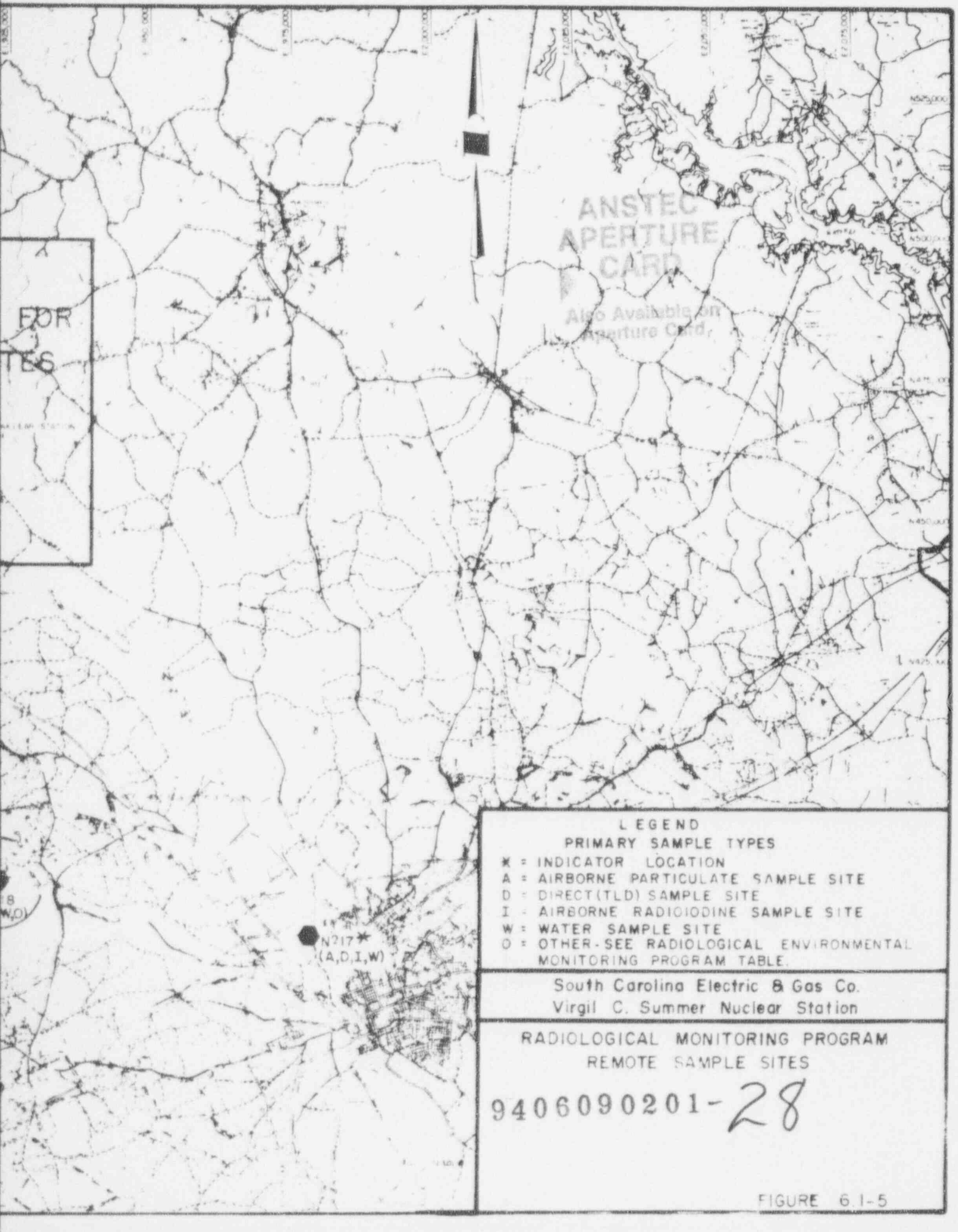

MATCH LINE
HWY. 99 RELOCATION
St. Peters Ch.
MONTICELLO
Monticello Ch.
MONTICELLO RESERVOIR
Browns Chapel
Little River Ch.
Jenkinsville Sch.
Old Brick Ch.
Holiness Ch.
NUCLEAR STATION SITE
EXCLUSION ZONE
PARR RESERVOIR
PARR DAM
JENKINSVILLE
Mt. Moriah Ch.
Rock Hill Ch.
ALSTON
SOUTHERN
BROAD
ROCKTON
Mill
N475,000
N450,000
LEGEND
PRIMARY SAMPLE TYPES
A = AIR PARTICULATE SAMPLE SITE
D = DIRECT (TLD) SAMPLE SITE
I = AIRBORNE RADIOIODINE SAMPLE SITE
W = WATER SAMPLING LOCATION
O = OTHER
South Carolina Electric & Gas Co.
Virgil C. Summer Nuclear Station
RADIOLOGICAL MONITORING PROGRAM
LOCAL INDICATOR SAMPLE SITES
9406090201-27

FIGURE 6.1-4


SEE PRECEDING FIGURE
INDICATOR SAMPLE
16
(A,D,I,W,D)



ANSTEC
APERTURE
CARD
Also Available on
Aperture Card

9406090201-28

FIGURE 6.1-5

6.2 APPLICANT'S PROPOSED OPERATIONAL MONITORING PROGRAMS

6.2.1 SURFACE WATERS

6.2.1.1 Physical and Chemical Parameters

Operational monitoring of physical and chemical parameters in waters near the Virgil C. Summer Nuclear Station will be conducted for one year following initial commercial operation as a continuation of the pre-operational program described in Section 6.1.1.1. Data collected in this fashion will allow a determination of nuclear plant impacts by direct comparison with preoperational data. 1

6.2.1.2 Ecological Parameters

6.2.1.2.1 General Monitoring Program

The general monitoring program described in Section 6.1.1.2.1 will be continued for one year following initial commercial operation of the Virgil C. Summer Nuclear Station. Monitoring of biota pumped into Monticello Reservoir by the Fairfield Pumped Storage Facility (FPSF) (Section 6.1.1.2.2) will be continued only if significant adverse effects are noted during the preoperational phase. 1

Thermal plume mapping studies in Monticello Reservoir will be undertaken sixty days after commercial operation of the Virgil C. Summer Nuclear Station as prescribed in the state NPDES permit.

6.2.1.2.2 Fish Impingement

A monitoring program for fish impingement will be instituted in order to identify fish species impinged on the travelling screens and to provide an adequate means of assessing the impact of impingement losses on

fish populations in Parr and Monticello Reservoirs. Fish impinged on the travelling screens will be sampled for one 24-hour period on a monthly basis. Impingement studies will begin 60 days after the start of initial commercial operation of the Virgil C. Summer Nuclear Station and continue for a period of one year. When feasible, all fish will be collected from the screens, weighed, measured, and identified to species; the fish collected will also be examined for incidence of parasites. If large numbers of fish are impinged, subsampling will be performed to estimate the population of each species. 1 1

The impact of fish impingement will be estimated by assuming mortality of all impinged organisms. The number of important game species lost through impingement will be compared to the total number of that species estimated (from data collected during field studies) to be in Parr and Monticello Reservoirs. A determination of long-term impacts of impingement on important fish populations in the area will be made from this information. 1

6.2.1.2.3 Plankton Entrainment

Entrainment studies will be conducted in order to determine the types and quantities of organisms passing through the Virgil C. Summer Nuclear Station with the cooling water. This information will be used to assess the impact of entrainment on planktonic and plankton-dependent populations in Parr and Monticello Reservoirs.

6.2.1.2.3.1 Phytoplankton and Zooplankton

Phytoplankton and zooplankton will be sampled quarterly at selected locations in Monticello Reservoir and in the intake bays of the Virgil C. Summer Nuclear Station. A series of samples will be taken simultaneously at selected depths in the water column; the samples will be collected by pumping a known volume of water through a plankton net. Laboratory analyses to determine species composition, abundance, and biomass will be conducted according to methods previously described. 1

6.2.1.2.3.2 Ichthyoplankton

The ichthyoplankton will be sampled in the water at the circulating water intake structure during the first year of commercial operation of the nuclear plant. A series of samples will be collected on a biweekly basis only from late February through September. 1

At the circulating water intake structure, samples will be collected by pumping a known volume of water through a net. All samples will be preserved and sent to the laboratory for enumeration and identification to the lowest practicable taxon.

6.2.2 GROUND WATER

The operational ground water monitoring program for the Virgil C. Summer Nuclear Station will be a continuation of the preoperational program described in Section 6.1.2.1 beginning during the quarter preceeding commercial operation of the nuclear plant, and continuing for one year thereafter. 1

6.2.3 AIR

The operational meteorological monitoring program for the Virgil C. Summer Nuclear station will basically be a continuation of selected parameters of the preoperational program. The purposes of the operational program are to provide: 1

1. Meteorological data useful in the estimation of short-term diffusion characteristics to plant personnel on a timely basis.
2. A data base of certain meteorological information for the assessment of plant operational impacts.

The equipment currently utilized in the preoperational program will be used in the operational program. However, the specific method of digital data recording (pulse tapes) presently used may be replaced. 1

AMENDMENT 1
APRIL 1978

Possible alternatives to the present digital system include analogue to digital conversion, microprocessor averaging and/or direct output of time averaged values to an in-plant data reduction system for ease of correlation of information which may be required on a continuing operational basis. Regardless of the digital recording system utilized, the goals of accuracy and data recovery per Regulatory Guide 1.23 (February 17, 1972) will be maintained. Meteorological Site 2 (pole) equipment will be maintained and operated for a one year period after commercial station operation commences to provide comparative (vs. Site 1 tower) data from which environmental heat dissipation system effects may be estimated. 1

Parameters to be measured in the meteorological heat dissipation study are to indlude: 1) Site 1 - wind speed, wind direction, differential and ambient temperature, and dewpoint; 2) Site 2 - wind speed, wind direction, ambient temperature, and dewpoint. 1

After the data base for assessing these effects has been acquired, the pole site (Site 2) will be deactivated along with those measurement systems at the tower site (Site 1) which are not utilized in the estimation of diffusion characteristics.

Parameters to be measured on a continuing basis for the operational estimation of diffusion characteristics on site include differential temperature, wind speed and wind direction. Lower wind speed and direction and differential (10-61M) temperature output devices will be deleted from the tower enclosure as they are made available in the control room to aid in the estimation of off site short-term doses. 1

6.2.4 LAND

6.2.4.1 Geology and Soils

Not applicable.

6.2.4.2 Land Use and Demographic Surveys

The annual milk-producing animal and garden survey described in Section 6.1.4.2 will be continued in the operational phase of the Virgil C. Summer Nuclear Station. Data from this effort will be utilized in the Environmental Radiological Monitoring Program. 1

6.2.4.3 Ecological Parameters

The program of terrestrial monitoring described in Section 6.1.4.3 will be continued for a period of one year after initial commercial operation of the Virgil C. Summer Nuclear Station. 1

6.2.5 RADIOLOGICAL MONITORING

The radiological monitoring program, operational stage will be a continuation of the preoperational program previously described in Section 6.1.5. The operational phase will be continued for the first three full years of commercial operation to verify the adequacy of source control. If data from the program and effluent calculations indicate that doses and concentrations associated with a particular pathway are sufficiently small, the number of media sampled in the pathway and the frequency of sampling may be appropriately reduced.

TABLE OF CONTENTS

APPENDIX 6A

Section	Title	Page
6A	BASELINE AND CONSTRUCTION MONITORING PROGRAMS	6A-1
6A.1	SURFACE WATERS	6A-1
6A.1.1	Physical and Chemical Parameters	6A-1
6A.1.2	Ecological Parameters	6A-2
6A.2	GROUND WATER	6A-5
6A.3	AIR	6A-6
6A.4	LAND	6A-7
6A.4.1	Geology and Soils	6A-7
6A.4.2	Land Use and Demographic Surveys	6A-7
6A.4.3	Ecological Parameters	6A-9

1

LIST OF TABLES

APPENDIX 6A

Table	Title	Page	
6A.1-1	Hydrological Construction Monitoring Program (March 1975 - FPSF Operation)	6A-4	1
6A-4-1	Biotic Baseline Survey Periods	6A-12	

APPENDIX 6A

BASELINE AND CONSTRUCTION MONITORING PROGRAMS

6A.1 SURFACE WATERS

A program for monitoring the physical, chemical and ecological parameters of the surface waters in the study area was established in 1971. The monitoring program has been undertaken in two general phases. The first phase, the baseline monitoring program, consisted of sampling efforts from March 1971 to May 1974, and documented conditions existing prior to construction of the Virgil C. Summer Nuclear Station and the Fairfield Pumped Storage Facility (FPSF). The second phase, the construction monitoring program, covers the period from May 1974 to initial filling of Monticello Reservoir (February 1978). 1

A summary description of the surface water monitoring program is presented in the following sections.

6A.1.1 Physical and Chemical Parameters

During the period March 1971 to May 1974, baseline conditions of surface water were established by taking hourly measurements of selected parameters at four stations and collecting monthly samples for more complete analyses at eight additional stations; this program is described briefly in the following paragraphs.

Hourly measurements of water temperature, dissolved oxygen, pH, flow, and specific conductance were recorded at four United States Geological Survey Stations. Three of the stations are upstream of Parr Dam: one on the Broad River at Carlisle, and two on its tributaries - on the Enoree River at Whitmire, and the Tyger River near Delta. These stations provide data on water quality upstream of areas affected by the project. The fourth station is located on the Broad River below Parr Dam. Funding and support for establishment of three of the stations was provided by SCE&G.

Monthly samples were collected at eight stations for complete chemical analyses. Six of the eight stations are located in the study area: Station 1 - Broad River at bridge over S. C. 34; Station 2 - Broad River at Frees Creek Trestle; Station 3 - Frees Creek Embayment; Station 4 - Frees Creek at S. C. 99; Station 5 - Broad River at Parr Dam; and Station 6 - Broad River at S. C. 213. The other two are located outside of the immediate project area: on the Broad River at Richtex and the Broad River at Interstate 20 bridge.

In April 1974, analysis of heavy metals in water samples collected at the eight sampling stations was initiated.

Construction monitoring was conducted from May 1974 up to initial filling of Monticello Reservoir. 1

Hydrological monitoring as described above was continued until March 1975 at which time the program was modified. The modified program is summarized in Table 6A.1-1. The changes were 1) relocation of Station 3 on Frees Creek to a point above the diversion dam constructed in connection with the Fairfield Pumped Storage Facility, 2) implementation of daily monitoring at Station 5 for pH, conductivity, transparency, oil and grease, and odor, 3) implementation of monitoring twice weekly at Stations 1 through 6 for air and water temperature, pH, conductivity, dissolved oxygen, sediment, oil and grease, and odor, and 4) reducing the frequency from monthly to quarterly sampling at all stations for some of the heavy metals.

6A.1.2 Ecological Parameters

Baseline conditions for aquatic biota were established by a quarterly sampling along nine transects (Transects A through G, "Map of Project Area," Appendix 2A) in the study area between March 1971 and the spring of 1974. The biotic parameters sampled included vascular hydrophytes, phytoplankton, zooplankton, benthic macroinvertebrates, and fish.

Vascular hydrophytes were sampled three times (March 1972, May 1973, and September 1973). Phytoplankton, zooplankton, and benthic macroinvertebrates were examined qualitatively and quantitatively in the area to determine trophic relationships, species composition, density, diversity, and biomass.

Investigations of fish included ascertaining the following aspects of the populations: species composition, distribution, relative abundance, length-weight relationships, standing crop estimates, age and growth, sex ratio, gonad condition, condition factors, food habits, and parasitism.

In the summer of 1974, monitoring was continued to evaluate construction impacts. During this period, adjustments in the monitoring program were made to focus on potential construction effects (most of which were associated with the FPSF). Transects A, F, and G were eliminated since they were not directly affected by construction activities. The frequency of sampling was reduced from quarterly to three times per year since very few seasonal differences were noted. During this period four transects were sampled. Transects B, C, and D were sampled for phytoplankton, zooplankton, benthic macroinvertebrates and fish; Transect E was sampled for fish only through 1976. Transect E was dropped from the program at the end of 1976 since it is the farthest station downstream (no significant construction effects were noted during 1974-1976). 1

AMENDMENT 1
APRIL 1978

TABLE 6A.1-1

HYDROLOGICAL CONSTRUCTION MONITORING PROGRAM
(March 1975 - FPSF Operation)

Period	Location[1]	Parameters
Daily[2] (Mon.-Fri.)	Station 5	Odor, obvious oil and/or grease, transparency, pH, conductivity
Twice Weekly	Stations 1, 2, 3, 4, 5, 6	pH, dissolved oxygen, conductivity, sediment, water temperature, air temperature, odor, obvious oil and grease
Monthly	Stations 1, 2, 3, 4, 5, 6	pH, water temperature, air temperature, p-alkalinity, m.o. alkalinity, chloride, conductivity, Ca-hardness, Mg-hardness, total hardness, color, turbidity, total solids, suspended solids, NH_3, PO_4, SiO_2, NO_3, SO_4, CO_2, COD, BOD, dissolved oxygen, transparency, oil and grease, aluminum, beryllium, boron, cobalt, magnesium, manganese, molybdenum, selenium, silver, strontium, tin, vanadium
Quarterly	Stations 1, 2, 3, 4, 5, 6, 7, 8	Same as monthly and arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc

1

(1) Sampling Locations:
1. Broad River at Bridge over S. C. 34
2. Broad River at Frees Creek Trestle
3. Frees Creek above Diversion Dam
4. Frees Creek at S. C. 99
5. Broad River at Parr Dam
6. Broad River at Bridge over S. C. 213
7. Broad River at Richtex
8. Broad River at Interstate 20

(2) Under certain conditions, monitoring may be limited to three times per week.

AMENDMENT 1
APRIL 1978

6A.2 GROUND WATER

Water table measurements presented in Section 2.4 were made by converting borings drilled as part of the engineering and geologic investigations into temporary observation wells. Repeated observations of water levels were made to determine stabilized water levels. Permeability values for the underlying strata were computed from both laboratory and field permeability tests.

Ground water quality tests were made on water samples collected from three of the observation wells. The test data are presented in Table 2.4-6. 1

Yields, uses, locations, and depths of water supply wells within the region were determined primarily from government publications, and supplemented by a well survey program.

6A.3 AIR

Although monitoring has been conducted, in part, prior to operation of the Fairfield Pumped Storage Facility, the program represents the preoperational meteorological monitoring program for the nuclear plant. Accordingly, it is discussed in Section 6.1.3. 1

6A.4 LAND

6A.4.1 Geology and Soils

A program of soil analysis was conducted during the fall 1972 sampling period of the terrestrial ecology monitoring program to provide detailed information on the relationships of soils to plant communities. Included in the study were analyses to establish nutrient content and the level of presence of heavy metals and residual chlorinated pesticides.

An extensive geologic and foundation investigation was conducted which included a review of published and unpublished data, soil sampling, rock coring, and mapping of surface geologic features in the site vicinity. The subsurface conditions were explored by drilling over 200 borings within the general site area to depths ranging from 6 feet to 235 feet below the ground surface.

6A.4.2 Land Use and Demographic Surveys

1

The land use survey was conducted in conjunction with interviews with the following agencies:

1. Central Midlands Regional Planning Council
2. Clemson University Cooperative Extension Service, Fairfield and Newberry County offices
3. South Carolina Aeronautic Commission
4. South Carolina Department of Parks, Recreation, and Tourism
5. South Carolina Land Resources Conservation Commission
6. South Carolina Wildlife and Marine Resources Department
7. South Carolina State Highway Department
8. U. S. Department of Agriculture; Agricultural Stabilization and Conservation Service, Fairfield and Newberry County offices
9. U. S. Department of Agriculture, Soil Conservation Service
10. U. S. Department of Agriculture, U. S. Forest Service

Historical land use in the site area was developed from publications and data available from the South Carolina Land Resources Conservation Commission and the U. S. Department of Agriculture Soil Conservation Service. In addition, aerial photographs available for the immediate site vicinity flown in 1970 by the U. S. Department of Agriculture were analyzed.

Updated land use information was obtained from recent aerial photography which was taken in conjunction with biological field surveys.

Mapping of the land use within 5 miles of the reactor was accomplished using false color infrared aerial photography flown in April 1976. Original mapping was performed at a scale of 1:24,000 on USGS 7 and 1/2 minute quadrangles. Field surveys and aerial reconnaissance were undertaken in July 1976 to confirm and supplement photo interpretations.

Six categories of land use were chosen for classification purposes. These categories include: 1) residential, 2) industrial, 3) cropland and pasture, 4) forested, 5) water, and 6) cleared land (no indication of use). The residential classification includes urban and rural concentrations of dwellings but does not include isolated farm houses. The industrial classification includes large gravel pits and quarries but does not include small isolated manufacturers. Cropland and pasture categories include cultivated land used for row cropping and areas cleared of brush and trees for grazing purposes. Wooded rangeland is not included under this category. Forest land was considered to be any area with over 10 percent canopy cover. Wooded rangeland is within this category also. Streams, rivers, lakes, and ponds are included in the water classification. Cleared land in many instances had been clear cut of trees for either timber or pasture purposes, with little indication of intended future use. 1

The percentages of land in each land use classification were determined by the use of dot grids.

Future land use trends in the area were determined from data available from the Central Midlands Regional Planning Council and interviews with the Council's staff members.

Data concerning the location of farm animals, residences, and vegetable gardens were collected during the field survey of July 1976. Information on households was obtained through personal interviews, using a standardized questionnaire format. Persons in approximately 50 households were interviewed.

Water use information was taken primarily from South Carolina Department of Health and Environmental Control compilations supplemented by field surveys in the plant vicinity and discussions with Fairfield and Newberry County Extension agents. Information collected for ground and surface water use included rates of consumption, sources of supply, locations and associated populations. Irrigation practices in the vicinity were also investigated.

6A.4.3 Ecological Parameters

1

A program for monitoring the terrestrial ecological parameters in the site vicinity has been conducted since 1971. A baseline survey of the study area was conducted during nine sampling periods between June 1971 and July 1973 (Table 6A.4-1). Supplemental data were gathered during five survey periods between August 1973 and September 1974. Additional construction monitoring has been conducted up to initial operation of the FPSF. The original locations of the study sites are shown on the "Map of the Project Area" in Appendix 2A. Sampling sites, procedures, analytical techniques, and the scope of the program have evolved over the period as more information on ecological characteristics at the site and on operating experience at other facilities became available. Information on soils, vegetation, insects, amphibians and reptiles, mammals, and birds was gathered during the baseline survey. Waterfowl surveys, auto surveys and strip census techniques were used in monitoring bird populations.

It was determined during the baseline surveys that birds provided the best indicators of the environment in the area, and that they would also be the most useful forms in defining any impacts of construction. Construction monitoring efforts have, therefore, been concerned primarily with birds.

During the baseline program, the auto survey was used to select species of birds which could be used as indicators of environmental changes. Nine species were originally chosen as indicator species. During the six surveys conducted between June 1971 and May 1973, it was found that only four of these species occurred in sufficient numbers to qualify them as indicator species. Four other species were added to these four in August 1973, and the resulting group were considered indicator species during the five sampling periods between August 1973 and September 1974. These eight species are:

Mockingbird	Cardinal
Loggerhead Shrike	Pine Warbler
Eastern Meadowlark	Rufous-sided Towhee
Mourning Dove	Carolina Chickadee

1

During the construction monitoring period, the game bird call count was run in June 1975 and June 1976, with the intent of comparing results to those found in June 1971 and May 1973 to determine if clearing operations which began in 1975 have influenced area usage by game bird species.

The strip census was employed during February and June 1975, February and June 1976, and February 1977, with one difference. A new hardwood habitat was established in February 1975 to replace one sampling site which was located in the Monticello Reservoir area. The new sampling site is located on the north side of S. C. 347, 1.66 miles west of S. C. 215.

The areas surveyed for waterfowl were decreased in June 1975 to concentrate effort around the site vicinity. The revised route covered Cannons Creek, Frees Creek, Parr Reservoir, and the backwater area north of Frees Creek to the east of the Broad River.

The auto survey was reestablished during the summer of 1977, as sufficient clearing had been completed in the Monticello Reservoir area so that any changes which had occurred in this area could be identified. The game bird call count was taken at the same time and along the same route as the auto survey and was used to assess changes in game bird populations during the impoundment of the reservoir.

The waterfowl survey of the Broad River and its tributaries was conducted in the winter, summer, and fall seasons of 1977. These surveys identified the impact of these clearing activities and of the filling of the reservoir on the availability of nesting sites for resident waterfowl and general attractiveness of the area to migratory waterfowl.

Aerial color infrared photographs of the project area were first obtained in the spring of 1974; this program has continued on an annual basis until the pumped storage facility is in operation. Analysis of the infrared photographs is an effective way of determining the site acreage which has been affected by land clearing and construction activities. It is also a means by which environmental stress to site vegetation may be monitored. Infrared photographs taken during the spring will reveal changes in plant vigor by changes in color shades on the photos from year to year. The cause of any significant changes were investigated by field study.

1

TABLE 6A.4-1

BIOTIC BASELINE SURVEY PERIODS

	June 71	Sept 71	Jan 72	Mar 72	Sept 72	Nov 72	Mar 73	May 73	July 73	Aug 73	Jan 74	Mar 74	June 74	Sept 74
Vegetation	X													
Insects				X										
Amphibians & Reptiles	X	X		X		X	X	X						
Birds	X	X	X	X	X		X	X	X	X	X	X	X	X
Mammals	X	X	X	X		X	X	X						

APPENDIX 2C

INTERIM REPORT ON CONSTRUCTION MONITORING
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA
SEPTEMBER 1974
FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY

Dames & Moore
Project No. 5182-059-17

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1.0-1
2.0	AQUATIC SURVEY	2.2-1
2.1	DESCRIPTIONS OF SAMPLING LOCATIONS	2.2-1
2.2	PHYSICAL AND CHEMICAL CHARACTERISTICS	2.2-1
2.2.1	INTRODUCTION	2.2-1
2.2.2	METHODS AND MATERIALS	2.2-1
2.2.3	FINDINGS	2.2-1
2.2.3.1	Temperature	2.2-1
2.2.3.2	Transparency	2.2-4
2.2.3.3	Dissolved Oxygen	2.2-4
2.2.3.4	pH	2.2-4
2.2.3.5	Other Water Quality Parameters	2.2-4
2.2.4	DISCUSSION	2.2-6
2.2.5	SUMMARY	2.2-10
2.3	PLANKTON	2.3-1
2.3.1	INTRODUCTION	2.3-1
2.3.2	METHODS AND MATERIALS	2.3-1
2.3.3	FINDINGS	2.3-1
2.3.3.1	Phytoplankton	2.3-1
2.3.3.1.1	Qualitative Analysis	2.3-1
2.3.3.1.2	Quantitative Analysis	2.3-8
2.3.3.2	Zooplankton	2.3-10
2.3.3.2.1	Qualitative Analysis	2.3-10
2.3.3.2.2	Quantitative Analysis	2.3-12
2.3.4	DISCUSSION	2.3-12
2.3.4.1	Phytoplankton	2.3-12
2.3.4.2.	Zooplankton	2.3-14
2.3.5	SUMMARY	2.3-15
2.3.5.1	Phytoplankton	2.3-15
2.3.5.2	Zooplankton	2.3-15
2.4	BENTHOS	2.4-1
2.4.1	INTRODUCTION	2.4-1
2.4.2	METHODS AND MATERIALS	2.4-1
2.4.3	FINDINGS	2.4-1
2.4.3.1	Insects	2.4-1
2.4.3.2	Other Benthic Macroinvertebrates	2.4-6
2.4.4	DISCUSSION	2.4-6
2.4.5	SUMMARY	2.4-10
2.5	FISH	2.5-1
2.5.1	INTRODUCTION	2.5-1

TABLE OF CONTENTS (continued)

		Page
2.5.2	METHODS AND MATERIALS	2.5-1
2.5.2.1	Collection	2.5-1
2.5.2.2	Age and Growth	2.5-1
2.5.2.3	Length-Weight Relationship	2.5-1
2.5.2.4	Condition Factor	2.5-1
2.5.2.5	Sex Ratios and Gonad Condition	2.5-1
2.5.2.6	Standing Crop Estimate	2.5-1
2.5.2.7	Food Habits	2.5-1
2.5.3	FINDINGS AND DISCUSSION	2.5-2
2.5.3.1	Species Composition and Relative Abundance	2.5-2
2.5.3.2	Age and Growth	2.5-6
2.5.3.3	Length-Weight Relationship	2.5-6
2.5.3.4	Condition Factor	2.5-11
2.5.3.5	Sex Ratio	2.5-11
2.5.3.6	Gonad Condition	2.5-11
2.5.3.7	Standing Crop	2.5-11
2.5.3.8	Food Habits	2.5-16
2.5.4	SUMMARY	2.5-17
3.0	TERRESTRIAL SURVEY	3.1-1
3.1	PHOTOGRAMMETRIC ANALYSIS OF THE BROAD RIVER STUDY AREA	3.1-1
3.2	BIRDS	3.2-1
3.2.1	INTRODUCTION	3.2-1
3.2.2	METHODS AND MATERIALS	3.2-1
3.2.2.1	Strip Census	3.2-1
3.2.2.2	Auto Survey	3.2-2
3.2.2.3	Waterfowl Survey	3.2-2
3.2.3	FINDINGS	3.2-2
3.2.3.1	Effect of Timber Harvest	3.2-2
3.2.3.2	Effect of Construction Activities	3.2-3
3.2.3.3	Results of Strip Censuses	3.2-3
3.2.3.4	Results of the Waterfowl Survey	3.2-8
3.2.4	DISCUSSION	3.2-8
3.2.4.1	Effect of Timber Harvest	3.2-8
3.2.4.2	Effect of Construction Activities	3.2-15
3.2.4.3	Effects of Other Environmental Factors	3.2-17
3.2.5	SUMMARY	3.2-18
4.0	REFERENCES	4.0-1

LIST OF TABLES

Table		Page
2.2.1	Summary of chemical analyses of the Broad River Study Area (Frees Creek) from selected transects (May 1974-September 1974)	2.2-2
2.2.2	Summary of chemical analyses of the Broad River Study Area (Broad River) from selected transects (May 1974-September 1974)	2.2-3
2.2.3	Physical and chemical parameters from the Broad River Study Area during biological field surveys (September 1974)	2.2-5
2.2.4	Trace metal analyses of surface waters of the Broad River (22 May 1974 through 11 September 1974)	2.2-7
2.2.5	Trace metal analyses of surface waters of Frees Creek (22 May 1974 through 11 September 1974)	2.2-8
2.3.1	Species list of phytoplankton in surface plankton samples in September 1974	2.3-2
2.3.2	Density, percentages of Chlorophyta and diatoms and density percentages of principal taxa in phytoplankton collections from September 1974 in the Broad River Study Area	2.3-9
2.3.3	Zooplankton in surface plankton samples in the Broad River Study Area in September 1974	2.3-11
2.4.1	Species list of benthic macroinvertebrates present in September 1974 in the Broad River Study Area	2.4-2
2.4.2	Total insect species by order and mean number per square meter on transects in the Broad River Study Area in September 1974	2.4-5
2.4.3	Quantitative comparison (number per square meter) of pelecypod families Sphaeriidae and Corbiculidae at eleven collecting points along three transects in the Broad River Study Area in September 1974	2.4-8
2.5.1	Species composition and relative abundance of all fishes collected from the Broad River Study Area, September 1974	2.5-3
2.5.2	Species composition and relative abundance of fishes collected from four transects in the Broad River Study Area, September 1974	2.5-4

LIST OF TABLES (continued)

Table		Page
2.5.3	Species composition and relative abundance of fishes collected from nine littoral collecting points in the Broad River Study Area, September 1974	2.5-5
2.5.4	Mean back calculated total lengths and average growth increments of selected fishes from all Parr Reservoir Transects (B, C, D), September 1974	2.5-7
2.5.5	Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, September 1974	2.5-9
2.5.6	Mean condition factors of fishes collected from the Broad River Study Area, September 1974	2.5-12
2.5.7	Sex ratios of fishes collected from the Broad River Study Area, September 1974	2.5-13
2.5.8	Mean gonadal condition of mature female fishes from the Broad River Study Area, September 1974	2.5-13
2.5.9	Standing crop estimates of the fishes from a shoreline rotenone sample of the Cannons Creek area of Parr Reservoir, South Carolina, September 9-11, 1974	2.5-14
2.5.10	Standing crop estimates of the fishes from a shoreline rotenone sample of the Frees Creek area of Parr Reservoir, South Carolina, September 11-13, 1974	2.5-15
3.1.1	Infestations of major South Carolina coniferous species occurring in the Broad River Study Area	3.1-3
3.2.1	Results of avian strip censuses conducted on "control" site from fall 1973 to fall 1974	3.2-4
3.2.2	Indicator species recorded by strip census in different habitats from fall 1973 to fall 1974	3.2-9
3.2.3	Results of avian strip censuses conducted on "test" sites from fall 1973 to fall 1974	3.2-10
3.2.4	Maximum waterfowl and shorebirds seen any one day along the boat survey route during three study periods	3.2-12

LIST OF FIGURES

Figure		Page
2.4.1	Mean number of oligochaetes (*Branchiura sowerbyi* and other species) per square meter on Transects B through D in the Broad River Study Area in September 1974.	2.4-7
3.2.1	Avian density in selected habitats during strip censuses.	3.2-6
3.2.2	Avian diversity in selected habitats during strip censuses.	3.2-7

1.0 INTRODUCTION

This report presents the results of a biological survey which occurred after construction had commenced on the Virgil C. Summer Nuclear Power Station and Fairfield Pumped Storage Project. The purpose of this report is to identify environmental impacts resulting from that construction. Contained within are the results and discussion of one aquatic field survey, four terrestrial field surveys, and several water quality samples taken by South Carolina Electric & Gas (SCE&G). Terrestrial impacts of construction have included the displacement of birds and mammals from the site. However, little change in water quality, and no change in aquatic life has been detected.

2.0 AQUATIC SURVEY

2.1 DESCRIPTION OF SAMPLING LOCATIONS

Refer to Sections 3.1 and 3.1a of the Baseline Biotic Survey.

2.2 PHYSICAL AND CHEMICAL CHARACTERISTICS

2.2.1 INTRODUCTION

The objectives of this portion of the survey were to determine if there were any construction effects on the aquatic ecosystem as reflected by changes in physical and chemical water quality characteristics. In order to evaluate possible changes in the data from the baseline survey (June 1971 to April/May 1974), they were compared with data collected during the initial phase of the construction period (May-September 1974). During this phase of the program, data from the September 1974 biological field survey were used in conjunction with data from SCE&G's Broad River Study Ares sampling program.

2.2.2 METHODS AND MATERIALS

Refer to Sections 3.2.2 and 3.2.2a of the Baseline Biotic Survey.

2.2.3 FINDINGS

2.2.3.1 Temperature

Mean surface water temperatures from May-September 1974 ranged from 18.7 to 24.8°C (Tables 2.2.1 and 2.2.2), at six collection points monitored by SCE&G. Maximum temperatures observed equaled or exceeded values reported during the baseline survey at most stations. Transects E+, B, and B- had temperature which exceeded earlier reported maximums by 0.6, 1.6, and 1.6°C, respectively.

Surface and bottom water temperatures measured during the biological field survey (September 1974) had greater differences than reported during the baseline survey at Transects C and D.

Table 2.2.1 Summary of chemical analysis of the Broad River Study Area (Frees Creek) from selected stations (May 1974-September 1974)[1]. Test results reported in mg/l unless otherwise noted.

Transect[2]	B				B-				G			
	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points
Determination												
Total Dissolved Solids	37	82	55	5	20	55	34	4	4	30	11	5
Total Suspended Solids	37	130	72	5	20	175	106	4	10	41	23	5
Total Solids	165	430	200.7	5	40	230	137	4	20	45	43.8	5
Specific Conductance (umhos/cm)	58	90	77	52	92	110	101	4	60	108	95	59
Total Alkalinity	28	40	32.8	5	43	47	44.8	4	38	48	43.6	5
Calcium Hardness	16	18	17.2	5	22	24	23.5	4	22	24	23.6	5
Magnesium Hardness	2	8	4.4	5	8	12	10	4	8	10	9.2	5
Total Hardness	20	24	21.6	5	32	36	33.5	4	30	45	35	5
Chlorides (Cl)	6.19	8.30	7.73	5	7.60	8.30	8.12	4	7.60	8.30	8.16	5
Sulfates (SO_4)	1.87	3.12	2.62	5	2.08	2.91	2.44	4	2.08	3.54	3.25	5
Nitrates (NO_3)	.35	.35	.35	5	.35	.35	.35	4	.35	.35	.35	5
Carbonates (HCO_3)	28	40	32	5	43	47	44	4	38	48	43	5
pH	6.6	7.4	6.9	52	6.7	7.2	7.0	4	6.7	7.1	6.9	59
Air Temperature (C)	10.5	28.6	23.1	52	25.8	29.7	27.0	4	11.0	34.1	23.1	59
Water Temperature (C)	18.2	30.8	24.8	52	19.8	23.1	21.5	4	12.7	23.1	18.7	59
Dissolved Oxygen	5.3	7.9	6.5	52	7.4	8.9	8.0	4	6.0	8.8	7.1	59
Secchi Disc (meters)	0.05	0.15	0.1	5	0.08	0.25	0.15	4	0.46	0.46	0.46	5
Color	100	350	235	5	50	275	143	4	25	50	39	5
Chemical Oxygen Demand	0	34.8	15.8	3	0	6.0	3.0	2	0	46	30	3
Soluble SiO_2	19.0	26.0	23.1	5	29	35.6	31.8	4	30.0	43	37.2	5
SED[3]	200	1790	442	52	40	650	260	4	10	90	21	59

[1] Data from SCE&G River Sampling Program.

[2] Transect B- is 1 mi upstream from Transect B.

[3] SED = mg/l of solids retained on a 0.45u filter.

Table 2.2.2 Summary of chemical analysis of the Broad River Study Area (Broad River) from selected stations (May 1974-September 1974)[1]. Test results reported in mg/l unless otherwise noted.

Transect[2]	E+				D+				A-			
Determination	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points	Minimum	Maximum	Mean	No. of Data Points
Total Dissolved Solids	1	54	18.3	7	12	34	21	4	22	74	53	4
Total Suspended Solids	58	156	106	5	76	178	116	5	61	226	143.6	5
Total Solids	80	210	132	5	92	230	143.8	5	83	300	186	5
Specific Conductance	52	78	63	59	47	77	62	59	50	78	65	59
Total Alkalinity	20	24	21.2	5	19	23	20.4	5	19	24	21.4	5
Calcium Hardness	10	10	10	5	10	10	10	5	10	10	10	5
Magnesium Hardness	4	4	4	5	4	4	4	5	4	4	4	5
Total Hardness	14	14	14	5	14	14	14	5	14	14	14	5
Chlorides (Cl)	7.60	8.30	8.16	5	7.60	8.30	8.16	5	6.19	8.30	7.73	5
Sulfates (SO_4)	2.89	3.64	3.01	5	2.29	3.33	2.95	5	2.91	3.74	3.34	5
Nitrates (NO_3)	.35	.35	.35	5	.35	.35	.35	5	.35	.35	.35	5
Carbonates (HCO_3)	20	24	21	5	19	23	20	5	19	24	21	5
pH	6.8	6.9	6.9	59	6.8	7.0	6.9	59	6.9	7.2	7.0	59
Air Temperature (C)	9.9	31.9	25.3	59	16.5	32.5	23.1	59	13.8	29.7	24.2	59
Water Temperature (C)	18.2	29.2	24.2	59	18.2	27.0	20.0	59	17.1	26.4	23.1	59
Dissolved Oxygen	5.9	8.8	6.7	59	5.9	8.0	6.5	59	6.2	8.5	6.9	59
Secchi Disc (meters)	0.1	0.25	0.18	5	0.1	0.2	0.15	5	0.08	0.25	0.18	5
Color	45	100	71	5	45	100	71	5	50	75	67	5
Chemical Oxygen Demand	0	20.0	8.6	3	2	17.3	10.4	3	18.4	72.4	42.2	5
Soluble SiO_2	18.0	22.0	20.7	5	18.0	22.0	20.5	5	17.0	21.5	20.3	5
SED[3]	80	480	196	59	60	810	206	59	70	650	209	59

[1] Data from SCE&G River Sampling Program.

[2] Transect locations - E+, 0.75 mi downstream from Transect E; D+, 0.25 mi downstream from Transect D, and A-, 6.1 mi upstream from Transect A.

[3] SED = mg/l of solids retained on a 0.45μ filter.

2.2.3.2 Transparency

Mean monthly Secchi disc readings from May-September 1974 ranged from 0.1 to 0.46 m (Tables 2.2.1, 2.2.2). The lowest readings reported from the biological survey and SCE&G were at Transect B. However, the low of 0.05 m at Transect B was slightly higher than the low of 0.03 m reported in the baseline survey for both Transects B and D. A new low of 0.2 m was reported during the September biological surveys which surpassed the previous low of 0.3 m (baseline survey).

2.2.3.3 Dissolved Oxygen

Dissolved oxygen extremes reported by SCE&G for monthly samples from May-September 1974 were 5.3 mg/l to 8.9 mg/l. The low values of 5.3 mg/l at Transect B were higher than the 3.8 mg/l reported for Transect D during the 1973 summer sampling.

Deviations in vertical DO readings ranged from 0 at Transect D to 9.2 mg/l at Transect C. This maximum deviation was greater than the 5 mg/l difference reported in the baseline report at Transect B.

2.2.3.4 pH

Mean surface water pH from May-September 1974 ranged from 6.8 to 7.0 (Tables 2.2.1, 2.2.2), at six collecting points monitored by SCE&G. Minimum and maximum pH values recorded at each transect were within minimum (6.6) and maximum (7.4) values reported for the baseline survey.

The pH of surface water during the biological field survey (September 1974) ranged from 7.0 to 8.0 (Table 2.2.3). A pH of 8.0 reported at Transect C exceeds a maximum value of 7.7 reported for this transect during the baseline survey.

2.2.3.5 Other Water Quality Parameters

The maximum total hardness on the Broad River was 14 mg/l and

Table 2.2.3 Physical and chemical parameters from the Broad River Study Area during biological field surveys (September 1974).

Transect	B	C	D	D
Collecting Point	2	1	2	5
Date	Sept.	Sept.	Sept.	Sept.
Parameter				
Temperature, Air (C)	25.0	30.0	35.0	34.0
Temperature, Water (C)				
Surface	24.0	30.0	25.0	25.0
Bottom	21.0	21.5	22.0	23.0
Dissolved oxygen (mg/l)				
Surface	9.3	12.2	8.2	7.6
Bottom	6.8	3.0	8.2	7.6
Specific Conductance (µmhos/cm)				
Surface	73	70	70	70
Bottom	82	55	70	70
pH (Surface)	7.0	8.0	7.0	7.0
Secchi disc (M)	0.1	0.2	0.5	0.5
Turbidity (JTU)	83	43	16	17

45 mg/l on Frees Creek (Tables 2.2.1, 2.2.2). This low total hardness is indicative of a low buffering capacity. COD was generally low; mean values ranged from 42.2 mg/l at Transect A- to 3.0 mg/l at Transect B-. Specific conductance was also relatively low, with maximums of 78 and 110 µmhos/cm on the Broad River and Frees Creek, respectively. Specific conductance during the biological field survey ranged from 55 to 82 µmhos/cm (Table 2.2.3). Nutrients were generally high, particularly nitrates (NO_3) which averaged 0.35 mg/l at all transects (Tables 2.2.1, 2.2.2).

Heavy metal analyses were conducted monthly at each transect (Tables 2.2.4, 2.2.5) from May-September 1974. Copper was the only metal occurring in concentrations which might be toxic. Copper in concentrations above 0.02 mg/l is known to be chronically toxic to many aquatic organisms (Becker and Thatcher, 1973) and was found to be above this level at all transects on Frees Creek. The maximum reported concentration of 0.55 mg/l was at Transect B- during the May sampling period. The maximum concentration of copper on the Broad River never exceeded 0.016 mg/l and was usually much lower.

2.2.4 DISCUSSION

Several transects (E+, B and B-) had surface water temperatures which exceeded those reported during the baseline survey. These higher temperatures are attributed to warmer air temperatures rather than any effect due to construction. The warmer weather and resulting higher surface temperatures probably account for the large differences between surface and bottom temperatures particularly at Transects C and D.

Secchi disc data indicated that the transparency of Frees Creek has been reduced. However, occasional high flows during the baseline survey have caused some lower Secchi disc readings. The mean Secchi disc values

Table 2.2.4 Trace metal analysis of surface waters of the Broad River (22 May 1974 through 11 September 1974)[1]. Test results reported in mg/l unless otherwise noted.

Transect[2] / Sample Date[3]	E+						D+						A-					
	a	b	c	d	e	Mean[4]	a	b	c	d	e	Mean	a	b	c	d	e	Mean
Determination																		
Sodium (Na)	10.3	6.0	8.8	8.9	8.7	8.5	10.3	8.0	8.4	18.0	8.8	10.7	8.7	12.0	8.3	7.5	6.0	8.5
Magnesium (Mg)	1.4	1.4	1.6	2.5	1.2	1.6	2.4	1.7	1.4	2.9	1.0	1.9	1.4	1.6	1.0	0.2	1.2	1.1
Aluminum (Al)	2.6	3.7	3.0	1.2	3.3	2.8	3.4	6.6	5.5	1.2	2.7	3.9	2.6	4.5	3.5	1.4	2.0	2.8
Arsenic (As)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01
Chromium, Total (Cr)	<0.02	<0.03	<0.02	<0.03	<0.03	<0.03	<0.02	<0.03	<0.02	<0.03	<0.03	<0.03	<0.02	<0.03	<0.02	<0.03	<0.03	<0.03
Fluoride (F)	0.17	0.13	0.2	0.1	0.1	0.14	0.16	0.13	0.2	0.1	0.2	0.16	0.11	0.07	0.2	0.1	<0.1	0.1
Iron, Total (Fe)	0.97	1.5	2.0	3.2	3.2	2.2	0.99	2.5	2.6	3.1	2.8	2.4	1.1	1.9	2.0	1.5	2.2	1.7
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese (Mn)	0.05	<0.02	0.06	0.09	0.16	0.09	0.04	0.03	0.07	0.07	0.16	0.37	0.05	<0.02	0.06	0.04	0.08	0.06
Mercury (Hg), µg/l	8.5	<0.2	<0.2	<0.2	1.4	5.0	10.0	0.6	<0.2	<0.2	<0.2	5.3	0.4	0.2	0.2	<0.2	0.4	0.3
Nickel (Ni)	<0.02	<0.05	<0.02	<0.02	<0.02	<0.03	<0.02	<0.05	<0.02	<0.02	<0.02	<0.03	<0.02	<0.05	<0.02	<0.02	<0.02	<0.03
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Zinc (Zn)	<0.02	<0.02	0.04	0.10	0.06	0.07	0.03	<0.02	<0.02	0.05	0.06	0.05	0.03	0.11	0.13	0.05	0.06	0.08
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Beryllium (Be)	<0.02	<0.02	<0.02	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02
Boron (B)	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1
Cobalt (Co)	<0.02	<0.02	<0.02	<0.05	<0.05	<0.03	<0.02	<0.02	<0.02	<0.05	<0.05	<0.03	<0.02	<0.02	<0.02	<0.05	<0.05	<0.03
Molybdenum (Mo)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Silver (Ag)	<0.05	<0.02	<0.02	<0.02	<0.21	<0.09	<0.05	<0.02	<0.03	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1	<0.2	<0.2	<0.2	<0.2	0.1	0.1	<0.2	<0.02	<0.2	<0.2	0.1	0.1	<0.2	<0.2	<0.2	<0.2	0.1
Copper (Cu)[5]	0.007	0.012	0.010	0.014	0.008	0.010	0.009	0.010	0.010	0.014	0.010	0.011	0.010	0.010	0.012	0.016	0.012	0.012

[1] Data from SCE&G River Sampling Program; analysis by Analytical Services Laboratory, NUS Corporation, Houston, Texas.

[2] Transect locations - E+, three-fourths mile downstream from Transect E; D+, one-quarter mile downstream from Transect D; and A-, 6.1 miles upstream from Transect A.

[3] Sample dates; a - May 22, 1974; b - June 19, 1974; c - July 17, 1974; d - August 21, 1974; e - September 18, 1974

[4] Means do not include values that are below detectable limits (e.g. <0.1) unless all values for a given determination are below detectible limits.

[5] Analysis by SCE&G.

Table 2.2.5 Trace metal analysis of surface waters of Frees Creek (22 May 1974 through 11 September 1974).[1] Test results reported in mg/l unless otherwise noted.

Transect[2] / Sample Date[3]	B						B-						G					
	a	b	c	d	e	Mean[4]	a	b	c	d	e	Mean	a	b	c	d	e	Mean
Determination																		
Sodium (Na)	11.3	8.0	7.6	8.2	7.6	8.5	12.5	10.0	9.8	10.9	ND[5]	10.6	13.0	10.0	10.3	10.0	9.4	10.5
Magnesium (Mg)	3.4	2.4	1.8	2.2	1.7	2.3	4.1	4.1	3.1	3.4	ND	3.7	3.8	3.6	2.9	3.1	1.6	3.0
Aluminum (Al)	9.5	7.9	4.9	1.6	6.1	6.0	6.8	3.5	1.8	1.0	ND	3.3	0.9	6.5	0.8	0.1	<0.1	2.1
Arsenic (As)	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	ND	0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	ND	<0.01	<0.01	0 01	0.01	<0.01	<0.01	0.01
Chromium, Total (Cr)	<0.02	<0.03	<0.02	<0.03	<0.03	<0.03	<0.01	<0.03	<0.02	<0.03	ND	<0.02	<0.02	<0.03	<0.02	<0.03	<0.03	0.03
Fluoride (F)	0.17	0.15	0.2	0.1	0.1	0.14	0.22	0.16	0.20	0.20	ND	0.19	0.21	0.12	0.2	0.1	0.1	0.15
Iron, Total (Fe)	3.1	4.3	3.3	2.4	0.7	2.8	4.1	4.0	3.2	3.6	ND	3.7	1.5	1.4	1.8	1.4	1.5	1.5
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	ND	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese (Mn)	0.16	0.12	0.30	0.12	0.19	0.18	0.46	0.39	0.70	0.57	ND	0.53	0.17	0.05	0.16	0.12	0.22	0.14
Mercury (Hg), ug/l	10.3	<0.2	<0.2	<0.2	<0.2	10.3	4.2	1.0	<0.2	<0.2	ND	2.6	0.2	0.5	<0.2	<0.2	0.5	0.5
Nickel (Ni)	<0.02	<0.05	<0.02	<0.02	<0.02	<0.03	<0.02	<0.05	<0.02	<0.02	ND	<0.02	<0.02	<0.05	<0.02	<0.02	<0.02	<0.03
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Zinc (Zn)	<0.02	<0.02	<0.02	0.05	0.04	0.05	<0.02	0.09	0.04	0.01	ND	0.05	<0.02	<0.02	0.04	0.06	0.02	0.04
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)	<0.01	<0.01	<0.0ol	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium (Be)	<0.02	<0.02	<0.02	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.01	ND	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.02
Boron (B)	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	ND	0.1	<0.1	<0.02	<0.1	<0.1	<0.1	<0.02
Cobalt (Co)	<0.02	<0.02	<0.02	<0.05	<0.05	<0.03	<0.02	<0.02	<0.02	<0.05	ND	<0.03	<0.02	<0.3	<0.02	<0.05	<0.05	<0.09
Molybdenum (Mo)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	ND	<0.3	<0.3	<0.02	<0.3	<0.3	<0.3	<0.24
Silver (Ag)	0.05	<0.02	<0.09	<0.02	<0.02	0.05	0.03	<0.02	<0.02	<0.02	ND	0.03	0.01	<0.2	<0.02	<0.02	<0.02	0.01
Strontium (Sr)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	ND	0.3	0.3	<0.1	<0.2	<0.2	<0.2	0.3
Copper (Cu)[6]	0.036	0.030	0.018	0.025	0.032	0.028	0.055	0.044	0.036	0.028	ND	0.041	0.032	0.026	0.032	0.024	0.028	0.028

[1] Data from SCE&G River Sampling Program; analysis by Analytical Services Laboratory, NUS Corporation, Houston, Texas

[2] Transect location - B-, 1 mile upstream from Transect B.

[3] Sample dates; a - May 22, 1974; b - June 19, 1974; c - July 17, 1974; d - August 21, 1974; e - September 18, 1974.

[4] Means do not include values that are below detectable limits (e.g. <0.1) unless all values for a given determination are below detectable limits.

[5] ND = No data.

[6] Analysis by SCE&G.

for Frees Creek were much higher during the baseline survey. If Transect B- is considered as a control station with regards to construction effects, then a mean reduction of 0.05 m has occurred. Additional support for this conclusion is afforded by comparing the difference in values for the maximum reading at Transect B and the reading at Transect C, which is 0.05 m also. A 0.05 m reduction in the mean Secchi disc reading results in a decreased photic zone. Thus, a slight decrease in total photosynthesis (primary productivity) can be expected.

Surface DO values are normally above 4.0 mg/l and approach 100 percent saturation. During the late summer, plankton blooms may cause supersaturation. The lowest surface DO reported in the baseline was 3.8 mg/l reported from Transect D+.

During construction monitoring (May-September 1974) surface DO was not reported below 5.3 mg/l. The low was observed at Transect B. An increase in allochthonous material (including silt from construction) probably accounted for the reduction in DO. However, because this reduction is not below 4.0 mg/l or 50 percent saturation, it probably had little effect on aquatic life.

Vertical differences in DO greater than reported in the baseline were noted at Transect C. This increase is not related to construction effects but does indicate that subminimal bottom DO can result when thermal stratification occurs.

The pH values were all within acceptable limits for the existence of typical aquatic communities of the region. The high pH reported at Transect C may be due to a plankton bloom; however, it is unlikely that it is related to any effects of construction.

Chemical parameters (analyzed by SCE&G) confirmed the Sawyer and

McCarty (1967) classification of South Carolina's surface water as usually being soft (total hardness <75 ppm). Broad River transects had lower total hardness than Frees Creek.

Specific conductance is also quite low. During construction, monitoring values were below maximums reported in the baseline survey. As with total hardness, specific conductance was highest in Frees Creek. In Frees Creek, specific conductance was higher at the more upstream stations which confirms observations for total hardness. Generally, soft waters support less plankton biomass than corresponding hard waters. However, in the case of Parr Reservoir, turbidity is probably the major factor which suppresses plankton blooms. Minimum variations between transects indicate construction has not significantly affected nutrient loading of Parr Reservoir.

Copper seems to be the only metal reported in concentrations that approach 50 percent of levels known to be acutely toxic to most aquatic organisms. These high levels of copper occurred at all Frees Creek transects during the baseline as they did during the initial construction monitoring. Therefore, construction is not the cause of these high values. The reported copper levels, although not directly toxic, may have a chronic effect on the more intolerant aquatic species.

2.2.5 SUMMARY

Stable water conditions prior to the September 1974 biological sampling survey resulted in greater thermal stratification than previously reported. This stratification is directly related to increased differences in top and bottom DO values. A subminimal DO value of 3.0 mg/l was noted at Transect C.

Secchi disc readings, primarily affected by suspended solids, and DO were the only parameters that reflected the effects of construction.

A comparison of mean Secchi disc values (between baseline and construction data) indicate a 0.05 m reduction in transparency. Surface DO was also lower at Transect B than the others. This probably reflects increased allochthonous material. Heavy metal data indicate there is a possibility that chronic toxicity levels of copper occur in Frees Creek; however, this potential problem is not related to construction effects since levels were high prior to construction and also occur at the upstream Transect G.

2.3 PLANKTON

2.3.1 INTRODUCTION

Plankton collected in the study area in September 1974 was analyzed to determine if construction activities beginning the previous May had any detectable effects on the structure of the phytoplankton and zooplankton communities. Possible effects were evaluated by comparing the September 1974 data with data collected during the baseline survey.

2.3.2 METHODS AND MATERIALS

Field and laboratory procedures are similar to those previously described in Section 3.3.2 of the baseline survey and 3.3.2a of the addendum. As in the April/May 1974 collection, the only samples collected were surface samples from collecting points on Transects B through D and samples for qualitative analyses from the littoral zones of Transects B and C. Samples for estimates of primary productivity were incubated approximately 0.5 m below the surface at Transects B and D and also about 0.5 mi upstream from Transect D.

2.3.3 FINDINGS

2.3.3.1 Phytoplankton

2.3.3.1.1 Qualitative Analysis

A total of 260 phytoplankton taxa were collected in the Broad River Study Area in September 1974 (Table 2.3.1). The number of taxa in each major group was Chlorophyta, 48; Chrysophyta, 199; Cyanophyta, 6; Euglenophyta, 5; and Pyrrophyta, 2. These numbers are similar to those reported during the baseline survey except that a much higher number of diatom taxa occurred in the September 1974 samples. Table 2.3.1 indicates 173 taxa not collected during the baseline surveys. These include 24 Chlorophyta, 148 Chrysophyta, and one Euglenophyta taxa.

Table 2.3.1 Species list of phytoplankton in surface plankton samples in September 1974.

Chlorophyta

- Actinastrum hantzschii
- Ankistrodesmus convolutus*
- Ankistrodesmus falcatus
- Arthrodesmus sp.
- Carteria sp.*
- Chlamydomonas sp.
- Closterium spp.
- Coelastrum sp.
- Cosmarium sp.
- Crucigenia spp.
- Dictyosphaerium ehrenbergianum*
- Dictyosphaerium pulchellum*
- Eudorina elegans
- Gloeocystis sp.
- Golenkinia spp.
- Gonium pectorale*
- Kirchneriella lunaris*
- Kirchneriella sp.
- Lagerheimia sp.*
- Mougeotia sp.
- Oocystis pusilla*
- Oocystis sp.*
- Pediastrum biradiatum*
- Pediastrum duplex
- Pediastrum tetras
- Polyedriopsis spinulosa*
- Pteromonas sp.*
- Scenedesmus arcuatus*
- Scenedesmus bijuga
- Scenedesmus denticulatus*
- Scenedesmus dimorphus
- Scenedesmus incrassatulus*
- Scenedesmus opoliensis*
- Scenedesmus quadricauda
- Scenedesmus sp.
- Schroedaria sp.*
- Selenastrum minutum*
- Selenastrum westii*
- Sphaerocystis schroeteri
- Spondylosium sp.*
- Staurastrum chaetoceras*
- Staurastrum sp.
- Tetraedron spp.
- Tetraspora lacustris*
- Tetrastrum heteracanthum*
- Treubaria sp.

Table 2.3.1 (Continued)

Chlorophyta (continued)
- Ulothrix sp.
- Wislouchiella planctonica*

Total Chlorophyta Taxa 48

Chrysophyta
- Achnanthes detha*
- Achnanthes exigua*
- Achnanthes hungarica*
- Achnanthes lanceolata
- Achnanthes lewisiana*
- Achnanthes linearis*
- Achnanthes microcephala*
- Achnanthes minutissima*
- Achnanthes peragalli*
- Achnanthes stewartii*
- Amphipleura pellucida*
- Amphora ovalis
- Anomoeoneis serians*
- Anomoeoneis vitrea*
- Asterionella formosa
- Bacillaria paradoxa*
- Biddulphia laevis*
- Caloneis bacillaris*
- Caloneis bacillum*
- Caloneis hyalina*
- Caloneis limosa*
- Caloneis ventricosa
- Cocconeis fluviatilis*
- Cocconeis placentula
- Cyclotella atomus*
- Cyclotella meneghiniana
- Cyclotella pseudostelligera*
- Cyclotella stelligera
- Cymbella affinis
- Cymbella gibba*
- Cymbella gracilis*
- Cymbella lanceolata*
- Cymbella naviculiformis*
- Cymbella perpusilla*
- Cymbella prostrata*
- Cymbella tumida*
- Cymbella turgida*
- Cymbella ventricosa*
- Diploneis elliptica*
- Diploneis marginestriata*
- Diploneis puella*

Table 2.3.1 (Continued)

Chrysophyta (continued)
*Epithemia zebra**
Eunotia curvata
*Eunotia incisa**
*Eunotia maior**
*Euontia pectinalis**
*Euontia praerupta**
*Euontia rabenhorstii**
*Euontia tenella**
Euontia sp.
*Fragilaria brevistriata**
Fragilaria construens
Fragilaria crotonensis
*Fragilaria leptostauron**
Fragilaria pinnata
*Fragilaria vaucheriae**
*Frustulia rhomboides**
Frustulia vulgaris
*Frustulia weinholdii**
*Gomphonema acuminatum**
*Gomphonema angustatum**
*Gomphonema gibba**
*Gomphonema gracile**
*Gomphonema intricatum**
*Gomphonema lanceolatum**
*Gomphonema longiceps**
*Gomphonema parvulum**
Gomphonema sp.
*Gyrosigma exilis**
*Gyrosigma nodiferum**
*Gyrosigma scalproides**
*Gyrosigma spencerii**
Gyrosigma sp.
*Hantzschia amphioxys**
Hydrosera sp.*
Melosira ambigua
Melosira distans
Melosira granulata
*Melosira islandica**
Melosira varians
Meridion circulare
*Navicula accomoda**
Navicula aikenensis
*Navicula anglica**
*Navicula arenaria**
*Navicula arvensis**
*Navicula atomus**
Navicula auriculata
*Navicula bicephala**
*Navicula biconica**
*Navicula capitata**
*Navicula clementis**

Table 2.3.1 (Continued)

Chrysophyta (continued)
Navicula cocconeiformis*
Navicula confervacea*
Navicula contenta*
Navicula convergens*
Navicula cryptocephala
Navicula cuspidata*
Navicula decussis*
Navicula dystrophica*
Navicula elginensis*
Navicula festiva*
Navicula gottlandica*
Navicula gregaria*
Navicula gysingensis
Navicula halophila*
Navicula hambergii*
Navicula heufleri*
Navicula hustedtii*
Navicula lanceolata*
Navicula latelongitudinalis*
Navicula lateropunctata*
Navicula luzonensis*
Navicula menisculus*
Navicula minima*
Navicula minuscula*
Navicula muralis
Navicula mutica
Navicula notha*
Navicula placenta*
Navicula pseudoreinhardtii*
Navicula pupula
Navicula phgmaea*
Navicula radiosa*
Navicula rhynchocephala*
Navicula salinarum*
Navicula schroeteri*
Navicula secreta*
Navicula secura*
Navicula seminulum*
Navicula symmetrica*
Navicula tenera*
Navicula tripunctata
Navicula viridula
Navicula zanoni*
Navicula sp.*
Neidium affine*
Neidium bisulcatum*
Nitzschia acicularis
Nitzschia amphibia

Table 2.3.1 (Continued)

Chrysophyta (continued)
- Nitzschia biacrula*
- Nitzschia clausii*
- Nitzschia dissipata*
- Nitzschia filiformis
- Nitzschia fonticola*
- Nitzschia gracilis*
- Nitzschia hungarica*
- Nitzschia ignorata*
- Nitzschia linearis*
- Nitzschia lorenziana
- Nitzschia obtusa*
- Nitzschia palea
- Nitzschia parvula*
- Nitzschia sigma*
- Nitzschia sublinearis*
- Nitzschia tryblionella
- Nitzschia sp.
- Pinnularia abaujensis*
- Pinnularia biceps
- Pinnularia bogotensis*
- Pinnularia borealis*
- Pinnularia braunii*
- Pinnularia brebissonii*
- Pinnularia divergens*
- Pinnularia gibba*
- Pinnularia intermedia*
- Pinnularia obscura*
- Pinnularia termitina*
- Pinnularia sp.
- Pleurosigma sp.
- Rhoicosphenia curvata*
- Rhopalodia gibba*
- Rhopalodia gibberula*
- Stauroneis anceps*
- Stauroneis crucicula*
- Stauroneis obtusa*
- Stauroneis smithii*
- Stenopterobia intermedia*
- Stephanodiscus astrea
- Stephanodiscus hantzschii*
- Stephanodiscus invisitatus
- Surirella angustata*
- Surirella ovata*
- Surirella robusta*
- Surirella stalagma*
- Surirella suecica*
- Surirella sp.
- Synedra acus*

Table 2.3.1 (Continued)

Chrysophyta (continued)
Synedra delicatissima
*Synedra filiformis**
Synedra pulchella
Synedra rumpens
Synedra ulna
Tabellaria fenestrata
*Tabellaria flocculosa**
*Terpsinoe musica**
*Thalassiosira fluviatilis**
Mallomonas sp.
Ophiocytium sp.
Total Chrysophyta Taxa 199
Cyanophyta
Anabaena sp.
Aphanocapsa sp.
Chroococcus sp.
Microcystis sp.
Oscillatoria spp.
Spirulina sp.
Total Cyanophyta Taxa 6
Euglenophyta
Euglena acus
Euglena spp.
Lepocinclis sp.*
Phacus spp.
Trachelomonas spp.
Total Euglenophyta Taxa 5
Pyrrophyta
Glenodinium spp.
Peridinium sp.
Total Pyrrophyta Taxa 2
TOTAL TAXA 260

*Not reported in baseline collections.

In baseline collections, a total of 173 taxa had been observed. The higher number of taxa in September 1974 possibly reflects more detailed species analyses for diatom genera previously collected. For example, Table 2.3.1 includes 45 Navicula species not reported in the baseline survey. Similarly, the table also includes 12 Nitzschia species, 10 Pinnularia species, 9 Cymbella species and 8 Gomphonema species not collected previously. Eleven additional diatom genera were identified in September samples. These were Amphipleura, Anomoeoneis, Bacillaria, Biddulphia, Diploneis, Hantzschia, Hydrosera, Rhoicosphenia, Rhopalodia, Stenopterobia, and Thalassiosira.

Table 2.3.2 includes the percentage composition in the samples of diatoms and Chlorophyta, the two major groups. The table also includes principal taxa, those which constituted at least five percent of cells counted in a sample. Diatoms comprised from 32 percent of the total phytoplankters at Collecting Point 2 of Transect B to almost 80 percent of the total at Collecting Point 3 of Transect C. Chlorophyta were less abundant, comprising approximately 11 percent of the total phytoplankters at Collecting Point 4 of Transect D to approximately 51 percent of the total at Collecting Point 2 of Transect C. Of principal phytoplankters for September, Melosira distans, Nitzschia palea, Achnanthes lanceolata, Trachelomonas and those listed as unidentified Chlamydomonadaceae were not predominant in baseline collections.

2.3.3.1.2 Quantitative Analysis

Phytoplankton densities during September 1974 averaged 497 per liter and ranged from 134 per liter at Collecting Point 1 of Transect D to 1163 per liter at Collecting Point 1 of Transect B. These densities are within the range of those previously reported in the study area. As in the baseline survey, highest densities generally occurred at Transect B while

Table 2.3.2 Density, percentages of Chlorophyta and diatoms and density percentages of principal taxa in phytoplankton collections from September 1974 in the Broad River Study Area.

Collecting Point	Depth (meters)	Total Number/l (all species)	Percentage of Chlorophyta	Percentage of Diatoms	Principal Taxa*	Percentage of Total
B1	1.0	1163	43.4	48.2	Unidentified Chlamydomonadaceae	35.6
					Melosira distans	16.3
B2	2.1	1081	49.0	32.0	Unidentified Chlamydomonadaceae	39.6
					Phacus spp.	5.8
					Nitzschia palea	5.0
B3	1.8	308	22.7	65.6	Melosira distans	24.4
					Trachelomonas spp.	8.1
					Phacus spp.	7.8
					Oscillatoria spp.	7.8
C1	2.5	203	27.1	59.6	Unidentified Chlamydomonadaceae	13.8
					Melosira distans	8.4
					Nitzschia palea	7.4
					Achnanthes lanceolata	5.9
C2	1.8	477	51.4	35.2	Unidentified Chlamydomonadaceae	35.2
					Oscillatoria spp.	7.1
C3	0.7	902	12.7	79.5	Achnanthes lanceolata	9.0
					Nitzschia palea	5.2
D1	1.4	134	18.7	54.5	Oscillatoria spp.	11.2
					Trachelomonas spp.	8.2
					Melosira distans	8.2
					Achnanthes lanceolata	5.2
					Nitzschia palea	5.2
					Unidentified Chlamydomonadaceae	5.2
D2	1.7	156	14.1	65.4	Melosira distans	11.5
					Unidentified Chlamydomonadaceae	5.8
					Oscillatoria spp.	5.1
					Achnanthes lanceolata	5.1
D3	1.0	185	15.7	68.6	Nitzchia palea	8.1
					Melosira distans	7.6
					Phacus spp.	5.0
					Unidentified Chlamydomonadaceae	5.0
D4	1.1	481	10.6	73.6	Melosira distans	18.1
					Melosira granulata	5.8
					Phacus spp.	5.4
					Trachelomonas spp.	5.2
					Nitzschia palea	5.0
D5	10.0	372	14.5	70.2	Melosira distans	23.4
					Unidentified Chlamydomonadaceae	6.2
					Nitzschia palea	5.6

*Taxa which composed at least 5 percent of the phytoplankters in a sample

lowest densities generally occurred at Transect D.

The most abundant algae in the samples were those described as unidentifed Chlamydomonadaceae. Table 2.3.2 shows that they were the most abundant algae in four of eleven samples and were included among principal taxa in eight of eleven samples. They comprised as much as 40 percent of the phytoplankters at Collecting Point 2 of Transect B. Melosira distans, the second most abundant alga, was also among principal taxa in eight of eleven samples. At Collecting Point 3 of Transect B, it comprised approximately 24 percent of the total phytoplankters. Nitzschia palea was among the principal taxa in seven of eleven samples, but its maximum percentage of the total was about 8 percent at Collecting Point 3 of Transect D.

As with phytoplankton densities ^{14}C values decreased from Transect B to D. Primary productivity at Transect B was 47.0 mg $C/m^3/hr$ while values 0.5 mi upstream from Transect D and at Transect D were 5.2 and 2.6 mg $C/m^3/hr$, respectively.

2.3.3.2 Zooplankton

2.3.3.2.1 Qualitative Analysis

A total of 34 zooplankton taxa were collected in the Broad River Study Area in September 1974 (Table 2.3.3). The number of taxa in each major group was Protozoa, 6; Rotatoria, 20; Copepoda, 2; and Cladocera, 3. These numbers are similar to those reported for the baseline survey. Table 2.3.3 includes three rotifers, two cladocerans, one protozoan and one endoproctan not reported in the baseline collections.

Number of taxa per transect ranged from 4 at Collecting Point 1 of Transect C to 15 in the littoral zone of Transect B. Generally, fewer taxa were collected from Transect D than from Transects B and C.

As in baseline samples, rotifers were the predominant taxonomic group. They comprised up to 73 percent of the total at Collecting

Table 2.3.3 Zooplankton in surface plankton samples in the Broad River Study Area in September 1974.

Rotatoria
Asplancha sp.
*Brachionus angularis**
Brachionus spp.
Conachiloides sp.
*Conochilus unicornis**
Filinia longiseta
Keratella cochlearis
Lecane sp.
Monostyla sp.
*Platyias patulus**
Polyarthra spp.
Synchaeta spp.
Trichocerca spp.
Unidentified Bdelloidea
Unidentified Flosculariacea
Unidentified Flosculariidae
Unidentified Monogononta
Unidentified Ploima
Copepoda
Cyclopoid copepodite
Copepod nauplii
Cladocera
*Diaphanosoma leuchtenbergianum**
Pleuroxus sp.*
Unidentified Moinidae
Protozoa
Arcella sp.*
Centropyxis spp.
Difflugia spp.
Unidentified Difflugiidae
Unidentified Ciliata
Unidentified Testacea
Diptera
Chaoborus sp.
Unidentified Chironomidae
Entoprocta
*Urnatella gracilis**
Unidentified Nematoda
Unidentified Ostracoda

*Not reported in baseline collections

Point 2 of Transect B, which were characterized by the highest zooplankton densities.

2.3.3.2.2 Quantitative Analysis

Low zooplankton populations characterized the study area in September 1974. Densities averaged approximately 13 per liter and ranged from 1 per liter at Collecting Point 3 of Transect D to 60 per liter at Collecting Point 2 of Transect B. In general, densities at Transect B were much higher than those at Transects C and D. Although densities were low, they are within the range of those previously reported for the area. As mentioned above, rotifers were the dominant taxonomic group, yet their numbers were generally low compared to most aquatic ecosystems. Their densities ranged from less than 1 at Collecting Point 3 of Transect D to 44 at Collecting Point 2 of Transect B. Most plankton communities average 40 to 500 rotifers per liter (Pennak, 1953).

The rotifer Brachionus was the most abundant taxon, though no single genus was extremely abundant. It comprised approximately 27 percent of the zooplankters at Collecting Point 2 of Transect B. Conochilus unicornis and Trichocerca spp. were second and third in abundance, respectively.

2.3.4 DISCUSSION

2.3.4.1 Phytoplankton

The abundance of green, blue-green and euglenoid algae in the September 1974 samples reflected the existing light and temperature conditions. Diatoms, which typically dominate the phytoplankton of temperate rivers (Hynes, 1972), were numerically dominant at most sampling stations. However, the warmer water temperatures of late summer are optimal for the development of these other forms (Hynes, 1972; Williams, 1966).

Principal taxa were sufficiently abundant in September to

warrant evaluation of their ecological significance. The factors stimulating the extremely high abundance of unidentified Chlamydomonadaceae cannot be determined from existing data. However, the best-known genus of the family, Chlamydomonas, has been ranked third on Palmer's (1963) list of the 52 most pollution tolerant genera. All of the genera included among the principal taxa (Table 2.3.2) were on Palmer's list. These genera and their ranks follow: Oscillatoria, 2nd; Nitzschia, 6th; Navicula, 7th; Phacus, 11th; Melosira, 19th; Trachelomonas, 26th; and Achnanthes, 43rd. In a similar list of the 60 most pollution tolerant species, Nitzschia palea, the third most abundant species in the September collections, is ranked second.

As in baseline studies, highest densities occurred at Transect B, near the mouth of Frees Creek, even though Secchi disc readings indicate lower light penetration there than at Transects C or D. The highest light penetration occurred at D, the transect with the lowest densities. The composition of the benthos at Transect D indicate that it may be an area of environmental stress.

The primary productivity value at Transect B (47.0 mg $C/m^3/hr$) was similar to that for April/May 1974 of the baseline survey. According to Samsel's (1974) study, values of this magnitude are characteristic of eutrophic systems. The much lower values upstream from Transect D and at Transect D are more typical of a nutrient-poor environment, though water quality data are not indicative of differences. In the study area, highest primary productivity has been associated with highest algal density and vice versa, thus, reflecting the fact that algal standing crop affects ^{14}C assimilation, though assimilation apparently is more directly related to algal growth rate (Tunzi and Porcella, 1974).

In conclusion, phytoplankton diversity and density apparently

have not been adversely affected by construction activities from May-September 1974, although water quality data indicated a reduction in transparency. Present data are insufficient to explain the abundance of eutrophic taxa in the September collections.

2.3.4.2 Zooplankton

Because zooplankton composition and densities during September 1974 were similar to those reported in the baseline survey to date, construction activities appear to have had no significant effects on the zooplankton community.

As with phytoplankton, highest and lowest zooplankton densities occurred at Transects B and D, respectively. This relationship was also reported during the baseline survey. Williams (1966) in analyzing plankton data from national water quality network samples, found that stations with high phytoplankton populations usually had high rotifer populations.

Williams (1966) also observed that the five most widely distributed and dominant rotifer genera in water samples from the U.S. are Keratella, Polyarthra, Brachionus, Synchaeta, and Trichocera. All occurred in the September 1974 samples (Table 2.3.3). Brachionus and Trichocera were the most abundant and third most abundant taxa, respectively. The second most abundant genus, Conochilus, was extremely abundant in the April/May 1974 samples.

Specific zooplankters in these collections have not been discussed as trophic indicators because present knowledge of their ecology is inadequate to classify them by this criterion (Gannon, 1972). The indicator organism concept is not supported among dominant rotifers in a sample because dominant species apparently are determined by edaphic factors within a watershed (Williams, 1966).

2.3.5 SUMMARY

2.3.5.1 Phytoplankton

A total of 260 phytoplankton taxa were collected in the study area in September 1974, during the construction phase of the project. This includes 173 taxa not reported in the baseline survey. The higher number of taxa in September appears to reflect more detailed diatom species analyses. Qualitatively and quantitatively, chlorophytes and diatoms were the prominent groups.

Phytoplankton densities averaged 497 per liter and were within the range of those reported previously for the area. The most abundant algae were unidentified Chlamydomonadaceae, Melosira distans and Nitzschia palea. All of the principal algal taxa are on Palmer's (1963) list of the most pollution tolerant genera.

Primary productivity values at Transect B were similar to those which have been reported for eutrophic systems, while much lower values characterized the area near Transect D.

At present, there is no evidence that phytoplankton diversity and density have been adversely affected by construction activities. The factors stimulating the abundance of eutrophic taxa in the September collections have not been determined.

2.3.5.2 Zooplankton

A total of 34 zooplankton taxa were collected in the study area in September 1974, including three rotifers, two cladocerans, one protozoan and one endoproctan not reported in the baseline collections. As in baseline samples, rotifers were the dominant taxonomic group, comprising as much as 73 percent of the total zooplankters at one collecting point.

Population densities were very low, averaging 13 per liter. As in past studies, zooplankton densities appeared to be directly related to

phytoplankton abundance. Zooplankters in greatest abundance were Brachionus, Conochilus unicornis and Trichocerca.

Zooplankton composition and densities during September 1974 were similar to those reported in the baseline survey, indicating that construction activities have had no detectable effect on the zooplankton community.

2.4 BENTHOS

2.4.1 INTRODUCTION

The objectives of this portion of the survey were to determine if there were any construction effects to the aquatic ecosystem as reflected by changes in the benthic macroinvertebrate community structure. In order to evaluate possible changes, the data from the baseline survey (June 1971 to April/May 1974) were compared with data collected during the initial phase of the construction period (May - September 1974). During this initial phase of the construction program, one field survey was made in September 1974. The evaluation of the environmental effects of construction were based on comparisons of species present, indicator species, and density.

2.4.2 METHODS AND MATERIALS

Refer to Section 3.5.1 and 3.5.1.2 of the Baseline Biotic Survey.

2.4.3 FINDINGS

2.4.3.1 Insects

A total of 16 insect species were identified at least to genus, with an additional 2 identified to family for a total of 18 taxa collected in the Broad River Study Area in September 1974 (Table 2.4.1). The species composition by major taxonomic groups was as follows: Diptera (flies, mosquitoes, midges), 15; Ephemeroptera (mayflies), 1; and Odonata (dragonflies), 2.

The total insect taxa reported for September 1974 (18 was slightly higher than reported in September 1972 (16) in the baseline survey. The total insect species by taxa was 5, 8, and 12, respectively at Transects B, C, and D (Table 2.4.2). The values reported at Transects B and C were slightly lower than any reported during the baseline survey where a minimum of 6 and 10 taxa, respectively were reported.

Sialis sp. (alderfly) was not reported in September 1974; this

Table 2.4.1 Species list of benthic macroinvertebrates present in September 1974 in the Broad River Study Area

Taxa
Ectoprocta
Lophopodidae
Pectinatella magnifica
Ectoprocta Total - 1
Insecta
Diptera
Ceratopogonidae
Unidentified*
Chironomidae
Cladotanytarsus sp.
Chironomus sp.
Coelotanypus sp.
Cryptochironomus sp.
Dicrotendipes sp.
Epoicocladius sp.
Eukiefferiella sp.
Harnishia sp.
Procladius sp.
Tanypus sp.
Tanytarsus sp.
Pentaneurini
Unidentified*
Culicidae
Chaoborus punctipennis
Diptera Total - 15
Ephemeroptera
Ephemeridae
Hexagenia limbata
Ephemeroptera Total - 1
Odonata
Gomphidae
Stylurus sp.
Macromiidae
Didymops sp.
Odonata Total - 2
Insecta Total - 18

Table 2.4.1 (Continued)

Taxa
Crustacea
Decapoda
Palaemonidae
Palaemonetes kadiakensis?
Crustacea Total - 1
Archnoidea
Hydracarina
Pionidae
Forelia sp.
Archnoidea Total - 1
Hirudinea
Glossiphoniidae
Unidentified*
Hirudinea Total - 1
Oligochaeta
Lumbriculidae
Unidentified*
Naididae
Dero digitata
Dero sp.
Tubificidae
Aulodrilus limnobius
Aulodrilus pigueti
Branchiura sowerbyi
Limnodrilus hoffmeisteri
Immature sp.1
Immature sp.2
Oligochaeta Total - 9
Nematoda
Unidentified*
Nematoda Total - 1

Table 2.4.1 (Continued)

Taxa
Mollusca
Pelecypoda
Corbiculidae
Corbicula manilensis
Sphaeriidae
Pisidium sp.
Sphaerium partumeium
Mollusca Total - 3
Taxa Total - 35

*Species unknown, may be more than one species but considered here as one.

Table 2.4.2 Total insect species by order and mean number per square meter (in parentheses) on transects in the Broad River Study Area in September 1974.

	B	C	D
Insecta			
Diptera	5 (2336)	7 (2499)	11 (116)
Ephemeroptera	0 (0)	1 (55)	1 (258)
Odonata	0 (0)	0 (0)	1 (5)
Total Taxa	5	8	12
Mean No. /m^2	(2336)	(2554)	(374)

was one of the three ubiquitous species of the baseline survey. New species of insects collected for the first time in the Broad River Study Area included the dipteran larvae, Epoicocladius sp. and Eukiefferiella sp. and one odonate, Didymops sp. Coleopterans were absent from the September 1974 samples (Table 2.4.1), as they have been from all samples since May 1973.

The Diptera and Ephemeroptera were the numerically predominant orders of insects during September 1974. The mean insect density at Transects B, C, and D were 2336, 2554, and 374/m^2 respectively (Table 2.4.2). The densities were within the range reported for the baseline survey.

2.4.3.2 Other Benthic Macroinvertebrates

There were no new species of oligochaetes identified, which had not been reported during the baseline survey (Table 2.4.1). Oligochaete density ranged from about 200 to 800/m^2 for Transects B, C, and D (Figure 2.4.1). Branchiura sowerbyi was present at all transects and was usually more abundant than all of the other species of oligochaetes combined (Figure 2.4.1).

One mollusc, Sphaerium partumeium, which had not been reported during the baseline survey, was found (Table 2.4.1). Gastropods (snails) were also absent from the September 1974 samples (Table 2.4.1), as they have been from all samples since November 1972. The density of pelecypod molluscs, represented primarily by Corbicula manilensis, was usually low except from Transect D (Table 2.4.3). At Transect D densities of molluscs ranged from 311 to 1675/m^2 while maximum densities at Transects B and C ranged from 0 to 104/m^2 (Table 2.4.3).

2.4.4 DISCUSSION

In an attempt to evaluate construction effects on the benthic macroinvertebrates, comparisons of species present, indicator organisms, and densities were made with data collected during the baseline survey.

There were several species of facultative, pollution tolerant and pollution sensitive organisms present. The facultative organisms included:

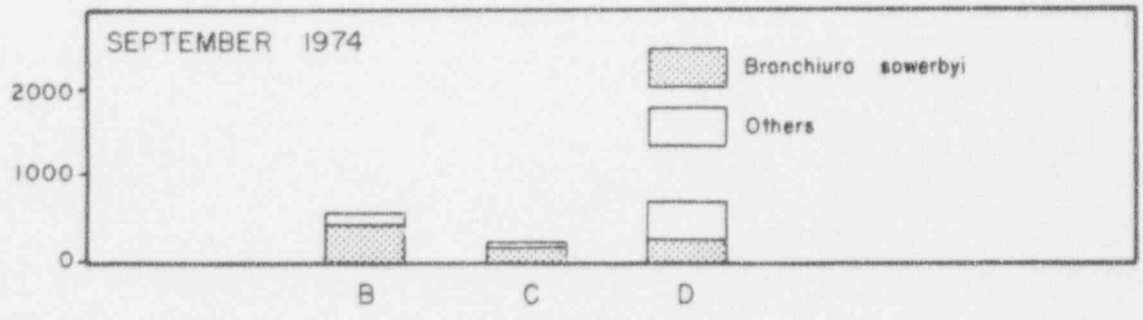


Figure 2.4.1 Mean number of oligochaetes (Branchiura sowerbyi and other species) per square meter on Transects B through D in the Broad River Study Area in September 1974

BY _____ DATE _____
CHECKED BY _____
FILE _____
REVISIONS BY _____ DATE _____

Table 2.4.3 Quantitative comparison (number per square meter) of pelecypod families Sphaeriidae and Corbiculidae at eleven collecting points along three transects in the Broad River Study Area in September 1974

	B			C			D				
	1	2	3	1	2	3	1	2	3	4	5
Sphaeriidae											
Sphaerium sp.	15	0	0	0	0	0	0	0	0	0	0
Pisidium sp.	0	0	0	0	0	15	0	0	0	0	0
Corbiculidae											
Corbicula manilensis	0	0	0	0	0	89	341	311	444	1674	474

Cryptochironomus sp. and Chaoborus punctipennis; the pollution sensitive organisms included: Tanytarsus sp. and Hexagenia limbata; and the pollution tolerant organisms included: Chironomus sp., Coelotanypus sp. and Procladius sp. Therefore, on the basis of indicator species, it appears that the study area is receiving waters moderately enriched organically, but no significant change has occurred.

Densities of insects in September 1974 (Table 2.4.2) were compared with those of September 1971 and November 1972 (baseline data) to minimize seasonal variation. The insect densities were within the seasonal range reported for Transects B and C; however, they were much lower at Transect D. The great density variation at Transect D may be partially due to its new location. Since there was little change in density reported for Transect B, which is just below the direct impact area, it is unlikely that the low insect density is related to construction effects.

Oligochaete densities of September 1974 were within the range reported in the baseline survey during September 1971 and November 1972 and Branchiura sowerbyi continued to be the numerically dominant oligochaete at all transects. Since there has been no significant change in the density or dominance of oligochaetes collected during similar times of the year, the effects of construction on the oligochaete community, if any, are negligible.

Molluscs densities were highest at Transect D and very low at Transects B and C during similar seasons of the baseline survey. The high density of Corbicula manilensis and absence of other molluscs at Transect D indicates some environmental stress; however, this condition prevailed during the baseline survey. The similarities of molluscs communities at various transects during the baseline survey and the recent survey (September 1974), indicates no major changes to the molluscs communities have occurred due to construction effects.

2.4.5 SUMMARY

Data collected to date on the species present, indicator organisms, and density of the benthic macroinvertebrate community of the Broad River Study Area indicate that, at present, no significant change has taken place.

2.5 FISH

2.5.1 INTRODUCTION

In September 1974 the first of a series of fisheries studies was conducted to monitor effects of construction on the fishes of the Broad River Study Area. By observing possible adverse effects of construction, attempts can be made to minimize their effect. The following biological functions were analyzed: species composition, distribution, relative abundance, length-weight relationships, standing crop estimates, age and growth, sex ratio, gonad condition, condition factors, and food habits.

2.5.2 METHODS AND MATERIALS

2.5.2.1 Collection

Electrofishing, seining, and backpack shocking methods were described in the baseline survey Section 3.6.2.1 or 3.6.2.1a of the addendum.

2.5.2.2 Age and Growth

Described in the baseline survey, Section 3.6.2.2.

2.5.2.3 Length-Weight Relationship

Described in Section 3.6.2.3 of the baseline survey.

2.5.2.4 Condition Factor

Described in Section 3.6.2.4 of the baseline survey.

2.5.2.5 Sex Ratios and Gonad Condition

Described in Section 3.6.2.5 of the baseline survey.

2.5.2.6 Standing Crop Estimate

Described in Section 3.6.2.6 and 3.6.2.6a of the baseline survey.

2.5.2.7 Food Habits

Described in Section 3.6.2.7 of the baseline survey.

2.5.3 FINDINGS AND DISCUSSION

2.5.3.1 Species Composition and Relative Abundance

Three new Notropis spp., (whitefin shiner, sandbar shiner, and spottail shiner [Table 2.5.1]), were collected in September. A new darter, the tessellated darter, was also collected. Cole (1967), cited by Bailey et al., (1970) removed this species from synonomy with the johnny darter (Etheostoma nigrum). The appearance of these four new species reflects the added sampling effort in the littoral area (Section 3.6.2.1a of the Baseline Addendum).

Two new species belonging to the sucker family (Catostomidae) were collected at both Transects B and D (Table 2.5.2). These species were the golden redhorse and highfin carpsucker. Pflieger (1971) has characterized the first as tolerant of moderate turbidity and the second as having limited distribution in Missouri because of its intolerance of turbidity. Turbidity is one of the more noticeable effects of construction, therefore, the presence of these species, along with black crappie, which is intolerant of turbidity, at Transects B and D indicates that turbidity is not excluding intolerant species.

Changes in the relative abundance of the five dominant species reported in the baseline survey, bluegill, gizzard shad, white crappie, redear sunfish and largemouth bass, were observed in September 1974. The largemouth bass was not among the dominant five species and the mosquitofish was ranked third. The latter species was associated almost exclusively with the littoral area (Table 2.5.3). Consequently, with increased sampling effort in that area, its rank shifted. The bluegill retained first ranking and increased from 34.1 to 37.8 percent. Gizzard shad retained its secondary position, but decreased from 19.4 to 15.4 percent. Both white crappie and redear sunfish were displaced one rank downward which appears to be associated primarily with the increased sampling effort in the littoral area. Largemouth bass dominance decreased significantly from fifth to eighth, with a percent abundance decrease

Table 2.5.1 Species composition and relative abundance of all fishes collected from the Broad River Study Area, September 1974.

Common Name	Scientific Name	No.	Percent
Bluegill	Lepomis macrochirus	379	37.8
Gizzard shad	Dorosoma cepedianum	154	15.4
Mosquitofish	Gambusia affinis	73	7.3
White crappie	Pomoxis annularis	64	6.4
Redear sunfish	Lepomis microlophus	55	5.5
Black crappie	Pomoxis nigromaculatus	51	5.1
Longnose gar	Lepisosteus osseus	41	4.1
Largemouth bass	Micropterus salmoides	27	2.7
Warmouth	Lepomis gulosus	23	2.3
Quillback	Carpiodes cyprinus	21	2.1
Channel catfish	Ictalurus punctatus	18	1.8
Shorthead redhorse	Moxostoma macrolepidotum	15	1.5
Whitefin shiner	Notropis niveus	10	1.0
Redbreast sunfish	Lepomis auritus	9	0.9
Carp	Cyprinus carpio	8	0.8
Sandbar shiner	Notropis scepticus	8	0.8
Brown bullhead	Ictalurus nebulosus	6	0.6
White catfish	I. catus	5	0.5
River carpsucker	Carpiodes carpio	5	0.5
Snail bullhead	Ictalurus brunneus	4	0.4
Tessellated darter	Etheostoma olmstedi	4	0.4
Golden redhorse	Moxostoma erythrurum	3	0.3
Highfin carpsucker	Carpiodes velifer	3	0.3
Silvery minnow	Hybognathus nuchalis	3	0.3
Spottail shiner	Notropis hudsonius	3	0.3
Yellow bullhead	Ictalurus natalis	2	0.2
Pumpkinseed	Lepomis gibbosus	1	0.1
Black bullhead	Ictalurus melas	1	0.1
Silver redhorse	Moxostoma anisurum	1	0.1
Striped jumprock	M. rupiscartes	1	0.1
Spotted gar	Lepisosteus oculatus	1	0.1
Swamp darter	Etheostoma fusiforme	1	0.1
Golden shiner	Notemigonus chrysoleucas	1	0.1
Margined madtom	Noturus insignis	1	0.1
Hybrid sunfish	Lepomis sp.	1	0.1
Total No.		1003	
Total Species		35	

Table 2.5.2 Species composition and relative abundance of fishes collected from four transects in the Broad River Study Area, September 1974.

Common Name	B		C		D		E	
	#	%	#	%	#	%	#	%
Bluegill	95	33.0	38	17.5	53	39.8	7	7.9
Gizzard shad	36	12.5	84	38.7	28	21.1	5	5.6
White crappie	37	12.8	26	12.0	1	0.8	-	-
Redear	22	7.6	9	4.1	18	13.5	-	-
Black crappie	48	16.7	-	-	1	0.8	2	2.2
Longnose gar	15	5.2	21	9.7	3	2.3	2	2.2
Largemouth bass	10	3.5	7	3.2	7	5.3	2	2.2
Warmouth	10	3.5	5	2.3	-	-	-	-
Quillback	4	1.4	5	2.3	7	5.3	5	5.6
Channel catfish	-	-	12	5.5	2	1.5	4	4.5
Shorthead redhorse	-	-	-	-	2	1.5	13	14.6
Whitefin shiner	-	-	-	-	1	0.8	9	10.1
Redbreast	-	-	6	2.8	-	-	3	3.4
Carp	1	0.3	-	-	-	-	7	7.9
Sandbar shiner	-	-	-	-	-	-	8	9.0
Brown bullhead	5	1.7	-	-	1	0.8	-	-
White catfish	1	0.3	3	1.4	1	0.8	-	-
River carpsucker	-	-	-	-	-	-	5	5.6
Snail bullhead	-	-	-	-	-	-	4	4.5
Tessellated darter	-	-	-	-	-	-	4	4.5
Golden redhorse	1	0.3	-	-	2	1.5	-	-
Highfin carpsucker	2	0.7	-	-	1	0.8	-	-
Silvery minnow	-	-	-	-	3	2.3	-	-
Spottail shiner	-	-	-	-	-	-	3	3.4
Yellow bullhead	-	-	-	-	-	-	2	2.2
Pumpkinseed	1	0.3	-	-	-	-	-	-
Black bullhead	-	-	1	0.4	-	-	-	-
Silver redhorse	-	-	-	-	-	-	1	1.1
Striped jumprock	-	-	-	-	-	-	1	1.1
Spotted gar	-	-	-	-	-	-	1	1.1
Golden shiner	-	-	-	-	1	0.8	-	-
Margined madtom	-	-	-	-	-	-	1	1.1
Hybrid sunfish	-	-	-	-	1	0.8	-	-
Total No.	288		217		133		89	
Total Species	15		12		18		21	

Table 2.5.3 Species composition and relative abundance of fishes collected from nine littoral collecting points in the Broad River Study Area, September 1974.

Common Name	BL-1		BL-2		BL-3		CL-1		CL-2		CL-3		DL-1		DL-2		DL-3	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Bluegill	46	86.8	33	97.1	45	93.8	25	89.3	4	57.1	30	93.8	-	-	2	14.3	1	100.0
Gizzard shad	-	-	-	-	-	-	1	3.6	-	-	-	-	-	-	-	-	-	-
Mosquitofish	-	-	-	-	-	-	-	-	1	14.3	-	-	60	100.0	12	85.7		
Redear	-	-	1	2.9	2	4.2	2	7.1	-	-	1	3.1	-	-	-	-	-	-
Largemouth bass	-	-	-	-	-	-	-	-	1	14.3	-	-	-	-	-	-	-	-
Warmouth	6	11.3	-	-	1	2.1	-	-	-	-	1	3.1	-	-	-	-	-	-
Swamp darter	1	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No.	53		34		48		28		7		32		60		14		1	
Total Species	3		2		3		3		3		3		1		2		1	

from 3.8 to 2.7.

Other shifts in relative abundances were noted but their significance is not clear because only one sampling period was involved and the number of species collected was small. A total of 1,003 specimens were collected including 34 species and a hybrid sunfish. Eight families of fishes were represented.

2.5.3.2 Age and Growth

High natural variability may account for the lower growth rate of bluegill and white crappie observed in September 1974 in contrast to the baseline survey (Table 2.5.4). Similarly, a slower growth rate was observed among gizzard shad after the first year of baseline survey. Another possible explanation for the slower growth of these species is that siltation resulting from construction activities may have adversely affected the food supply.

In the third year class, growth of redear sunfish surpassed values reported in the baseline survey. This species began feeding predominantly on pelecypods between the second to third year class (101-150 mm) (Sections 3.6.3.8 and 3.6.3.8a). Therefore, a change in the diet of this species and increased pelecypod population in the study area over the past three years may favor more rapid growth.

Largemouth bass was the other species that had a higher growth rate than that reported in the baseline survey. Increased numbers of bluegill, may have created a forage base which stimulated growth of age groups above the second year class.

2.5.3.3 Length-Weight Relationship

Table 2.5.5 contains regression equations for fishes collected in September 1974. When compared to August 1973, a general reduction in coefficient b for all species and most transects indicates a reduction in condition or well-being. However, small sample size may have biased the data. This general

Table 2.5.4 Mean back calculated total lengths and average growth increments of selected fishes from all Parr Reservoir Transects (B, C, D), September 1974.

Year Class	n*	Total Length (mm) at Annulus							
		1	2	3	4	5	6	7	8
Bluegill									
1973	35	55							
1972	45	48	77						
1971	18	49	75	96					
1970	2	49	78	106	132				
Mean Length		50	77	101	132				
Mean Increment		50	28	24	26				
Gizzard shad									
1973	8	109							
1972	6	118	193						
1971	23	121	187	237					
1970	2	124	204	242	299				
1969	3	132	194	250	302	351			
1968	2	110	154	195	237	270	302		
1967	1	96	167	212	282	342	396	410	
Mean Length		116	183	227	280	321	349	410	
Mean Increment		116	66	46	56	47	43	14	
White Crappie									
1973	12	77							
1972	8	80	116						
1971	11	78	125	[illegible]					
1970	4	75	110	143	171				
1969	2	72	100	142	188	222			
Mean Length		76	113	147	180	222			
Mean Increment		76	37	35	37	34			

Table 2.5.4 (Continued)

Year Class	n*	Total Length (mm) at Annulus							
		1	2	3	4	5	6	7	8
Redear sunfish									
1973	8	44							
1972	7	47	89						
1971	13	55	114	153					
1970	9	58	99	147	182				
1969	3	41	70	135	187	228			
1968	1	51	79	143	166	189	213		
1966	1	39	56	117	147	183	206	223	242
Mean Length		48	85	139	170	200	210	223	242
Mean Increment		48	36	55	34	33	24	17	19
Largemouth bass									
1973	3	105							
1972	2	114	174						
1971	2	98	168	234					
1970	5	120	187	256	316				
1969	3	130	200	276	332	373			
1968	1	138	202	264	363	416	435		
Mean Length		118	186	288	337	394	435		
Mean Increment		118	66	99	72	47	19		

* Number of fishes examined.

Table 2.5.5 Regression equations of length-weight relationships for fishes collected from the Broad River Study Area, September 1974.

Species	Transect	Equation
Bluegill	B	$W=3.610\times10^{-5}L^{2.838}$
	B (cove)	$W=1.556\times10^{-5}L^{2.955}$
	C	$W=1.161\times10^{-6}L^{3.526}$
	C (cove)	$W=4.202\times10^{-5}L^{2.777}$
	D	$W=2.697\times10^{-6}L^{3.371}$
	E	$W=2.502\times10^{-5}L^{2.934}$
Gizzard Shad	B	$W=1.200\times10^{-5}L^{2.937}$
	B (cove)	$W=1.140\times10^{-5}L^{2.960}$
	C	$W=9.560\times10^{-6}L^{2.973}$
	C (cove)	$W=7.637\times10^{-6}L^{3.024}$
	D	$W=1.486\times10^{-5}L^{2.911}$
	E	$W=2.047\times10^{-5}L^{2.857}$
White Crappie	B	$W=1.008\times10^{-5}L^{3.044}$
	B (cove)	$W=4.409\times10^{-6}L^{3.201}$
	C	$W=1.372\times10^{-6}L^{3.423}$
	C (cove)	$W=2.682\times10^{-5}L^{2.836}$
Black Crappie	B	$W=6.251\times10^{-6}L^{3.141}$
	B (cove)	$W=9.177\times10^{-6}L^{3.053}$
	C (cove)	$W=2.841\times10^{-5}L^{2.829}$
Redear	B	$W=1.454\times10^{-5}L^{3.016}$
	B (cove)	$W=2.554\times10^{-5}L^{2.894}$
	C	$W=9.365\times10^{-6}L^{3.080}$
	C (cove)	$W=1.094\times10^{-3}L^{2.040}$
	D	$W=4.777\times10^{-6}L^{3.249}$
Largemouth Bass	B	$W=3.115\times10^{-6}L^{3.250}$
	C	$W=2.687\times10^{-6}L^{3.321}$
	C (cove)	$W=1.554\times10^{-6}L^{3.375}$
	D	$W=1.941\times10^{-6}L^{3.346}$

Table 2.5.5 (Continued)

Species	Transect	Equation
Warmouth	B	$W=7.915\times10^{-5}L^{2.702}$
	B (cove)	$W=5.895\times10^{-5}L^{2.699}$
	C	$W=1.221\times10^{-4}L^{2.588}$
	C (cove)	$W=1.596\times10^{-4}L^{2.519}$
Redbreast	C (cove)	$W=1.413\times10^{-4}L^{2.534}$
Carp	E	$W=2.110\times10^{-6}L^{3.291}$
Golden Shiner	C (cove)	$W=1.531\times10^{-5}L^{2.843}$
Longnose Gar	C	$W=4.866\times10^{-8}L^{3.615}$
Shorthead Redhorse	E	$W=5.301\times10^{-5}L^{2.721}$
Quillback	D	$W=1.705\times10^{-6}L^{3.344}$
	E	$W=1.176\times10^{-8}L^{4.196}$
River Carpsucker	E	$W=4.565\times10^{-6}L^{3.195}$
Channel Catfish	B (cove)	$W=2.977\times10^{-4}L^{2.204}$
	C	$W=9.709\times10^{-6}L^{2.954}$
	C	$W=7.674\times10^{-5}L^{2.603}$
White Catfish	C (cove)	$W=3.106\times10^{-5}L^{2.801}$

reduction in condition factor was not as noticeable when compared with November 1972 data.

2.5.3.4 Condition Factor

Condition factors are subject to wide variability depending upon size of fish collected, sex, season, feeding activity, and numerous other factors. To reduce the bias, a large sample size (>40) is needed. During the construction survey, condition factors of species with fewer than 40 specimens did not differ greatly from those reported in the baseline survey. Likewise, condition factors of species with more than 40 specimens, for example, bluegill, gizzard shad, and black crappie, changed little from previous studies. The white crappie had a somewhat lower condition factor than that previously reported. Redear and largemouth bass, which had increased growth rates compared to baseline studies, also had higher condition factor values. Condition factors and sample size are summarized in Table 2.5.6.

2.5.3.5 Sex Ratio

Half of the species presented in Table 2.5.7 did not contain enough specimens for any estimate of sex ratios. The remaining species vary greatly from that reported in the baseline. There are many sources of variability, such as natural segregation of sexes, which may result in sample bias. Therefore, more data are needed to determine if the observed changes are true or merely artifacts.

2.5.3.6 Gonad Condition

As in previous fall baseline samples, all species had spawned prior to the September collection (Table 2.5.8).

2.5.3.7 Standing Crop

Data for rotenone samples are present in Table 2.5.9 and 2.5.10 for Cannons Creek and Frees Creek, respectively. The Cannons Creek Cove sample (September 1974) showed a reduction from November 1972 in both numbers/

Table 2.5.6 Mean condition factors of fishes collected from the Broad River Study Area, September 1974.

Common Name	Total Number	Condition Factor
Bluegill	299	1.8
Gizzard shad	102	0.9
White crappie	64	1.2
Redear	47	1.9
Black crappie	49	1.2
Longnose gar	41	0.3
Largemouth bass	27	1.4
Warmouth	18	2.0
Quillback	21	1.4
Channel catfish	17	0.7
Shorthead redhorse	15	1.1
Whitefin shiner	10	0.9
Redbreast	8	1.7
Carp	8	1.4
Sandbar shiner	8	0.9
White catfish	5	1.1
River carpsucker	5	1.4
Brown bullhead	6	1.4
Snail bullhead	4	1.1
Tessellated darter	4	0.9
Golden redhorse	3	0.8
Highfin carpsucker	3	1.5
Silvery minnow	3	1.0
Spottail shiner	3	0.8
Yellow bullhead	2	0.8
Pumpkinseed	1	1.7
Black bullhead	1	1.0
Silver redhorse	1	1.0
Striped jumprock	1	0.9
Spotted gar	1	0.3
Swamp darter	1	1.4
Golden shiner	1	0.9
Margined madtom	1	1.1
Hybrid sunfish	1	2.0

Table 2.5.7 Sex ratios of fishes collected from the Broad River Study Area, September 1974.

Species	Male	Female	Ratio
Bluegill	42	54	1/1.3
Gizzard Shad	24	43	1/1.8
White Crappie	10	24	1/2.4
Redear	16	39	1/2.4
Black Crappie	35	33	1/0.9
Warmouth	13	17	1/1.3
Largemouth Bass	12	12	1/1.0
Quillback	3	2	1/0.7
Channel Catfish	1	4	1/4.0
Shorthead Redhorse	0	6	0/6.0
Carp	4	4	1/1.0
White Catfish	2	4	1/2.0
River Carpsucker	3	2	1/0.7
Brown Bullhead	3	0	3/0.0

Table 2.5.8 Mean gonadal condition of mature female fishes from the Broad River Study Area, September 1974.

Common Name	Number	Average Condition
Bluegill	21	2.5*
Gizzard Shad	9	2.1
White Crappie	2	2.0
Redear	21	3.0
Black Crappie	5	2.0
Largemouth Bass	8	2.5
Warmouth	5	2.0
Shorthead Redhorse	6	2.7
Carp	3	3.0

*A gonadal condition of 2 indicates a resting stage, when sexual products have not yet begun to develop. A condition of 3 indicates maturation of sexual products, accompanied by a very rapid increase in gonadal weight.

Table 2.5.9 Standing crop estimates of the fishes from a shoreline rotenone sample of the Cannons Creek area of Parrk Reservoir, South Carolina, September 9-11, 1974.

Species	Number Collected	Grams Collected	Recapture Factor	Number/Hectare	Kg/Hectare
Bluegill	1554	6332	.435	9655	39.341
Gizzard shad	1085	7077	.333	8806	57.438
Warmouth	111	509	.500	600	2.751
Redear	101	1438	.556	492	6.989
Black crappie	88	2421	-	238*	6.543*
White crappie	79	1996	-	214*	5.395*
Tadpole madtom	34	96	-	92*	0.259*
White catfish	26	3172	.333	211	25.746
Golden shiner	22	89	-	59*	0.241*
Largemouth bass	14	2210	.250	151	23.892
Redbreast	12	66	-	32*	0.178*
Channel catfish	5	540	.250	54	5.838
Whitefin shiner	4	0.5	-	11*	0.001*
Hybrid sunfish	3	64	-	8*	0.173*
Black bullhead	2	16	-	5*	0.043*
Mosquitofish	2	0.6	-	5*	0.002*
Swamp darter	2	1.2	-	5*	0.003*
Brown bullhead	1	192	-	3*	0.519*
Highfin carpsucker	1	776	-	3*	2.097*
				20642	177.451

* Minimum estimate because no recapture data available.

Table 2.5.10 Standing crop estimates of the fishes from a shoreline rotenone sample of the Frees Creek area of Parr Reservoir, South Carolina, September 11-13, 1974.

Species	Number Collected	Grams Collected	Recapture Factor	Number/Hectare	Kg/Hectare
Bluegill	1313	2578	.611	5808	11.403
Gizzard shad	324	3462	.207	4230	45.203
Black crappie	226	1552	.500	1222	8.389
Warmouth	175	398	.667	709	1.613
White crappie	153	1750	1.000	414	4.730
Redear	54	565	.500	292	3.054
Channel catfish	8	20	-	22	.054
Golden shiner	7	10	-	19*	.027*
Mosquitofish	7	4	-	19*	.010*
Largemouth bass	5	737	.500	27	3.984
Tadpole madtom	2	4	-	5*	.011*
White catfish	1	0.2	.500	5	.001
				12771	78.480

* Minimum estimate because no recapture data available.

hectare and kg/hectare, but an increase in number of species from 14 to 18. The Frees Creek Cove sample (September 1974) showed the opposite trend when compared with November 1972 data. An increase in estimated number/hectare and kg/hectare was noted, with a decrease in the number of species from November 1972.

During the baseline survey, the gizzard shad was second and third in importance as a contributor to the standing crop at Transects C and B, respectively. In September 1974, however, more biomass was contributed by gizzard shad than any other species. This shift at both Cannons Creek and Frees Creek compares well with data reported by Jenkins (1967) for other South Carolina reservoirs, where gizzard shad commonly comprise more than half of the standing crop.

The mean value for both cove samples was 128 kg/hectare. This was lower than the November 1972 average of 132 kg/hectare. This relatively small deviation may be accounted for by the difference in sampling dates, resulting in additional growth for the November sample. The biomass increase in Frees Creek may be attributed to a more abundant gizzard shad population. This species is particularly mobile and such variation probably is a common factor influencing standing crop of both coves in the Broad River Study Area.

At present, the results of rotenone sampling in Frees Creek indicates no direct effect from construction.

2.5.3.8 Food Habits

No deviations from food habits reported in the baseline survey were noted in September 1974. However, information for the five dominant species in the baseline survey is reiterated below.

Bluegills fed on zooplankton initially and consumed more benthos with increasing age. Limited use of Pelecypoda was noted at every transect. Zonation between transects was attributed to different benthic assemblages.

Gizzard shad relied on UOM (unidentified organic matter). However, occasional chironomid larvae and other benthos were picked up while feeding on UOM. White crappie depended on both fish and benthos as a food source with mosquitofish being the predominant fish species ingested. All ages of redear sunfish fed at least occasionally on Pelecypoda, although they were utilized increasingly in older fish. The Asiatic clam was used more by this species than bluegills, who preferred Sphaerium sp. Largemouth bass utilized zooplankton when under 50 mm. After that time, fish, particularly Centrarchidae (sunfish), become a dominant food item. The only exception noticed was at Transect E, below the dam, where gizzard shad were utilized almost exclusively.

2.5.4 SUMMARY

The only data which indicates possible reduction in the fisheries quality of the Broad River Study Area were growth values for all age classes of bluegill and white crappie and age 1 gizzard shad. However, largemouth bass and redear sunfish had a significant increase in growth rate.

Most other parameters such as condition factor showed no change from the data reported in the baseline survey. Also, species distribution confirms assumptions that little change has occurred because species intolerant of turbidity were collected at Transects B and D.

The only parameter that changed significantly was the standing crop of the two cove samples. Biomass of Frees Creek Cove sample increased, while that of Cannons Creek decreased. This may indicate possible construction effects. It may also indicate variability in rotenone samples and possibly a decrease in productivity of Cannons Creek. In both samples, gizzard shad was the largest contributor to biomass. In the previous sample, bluegill had the highest biomass.

3.0 TERRESTRIAL SURVEY

3.1 PHOTOGRAMMETRIC ANALYSIS OF THE BROAD RIVER STUDY AREA

Changes in land use patterns have occurred within the Broad River Study Area over the past four years. These changes have been documented through comparison, photogrammetric analysis of 1970 SCS (1:20,000) black and white aerial photography with 1974 D&M (1:24,000) false-color infrared aerial photography. A map (included) was prepared showing the areas altered since 1970, the nature of the alteration, and the acreage of the land changed. For the percentage acreages of the 1970 survey, refer to Section 2.6 of the baseline survey.

Land use changes within the Broad River Study Area fall into five predominant forms: lumbering and logging activities, construction activities (including land clearing), roadway construction, transmission corridor construction and railroad construction. Each of these land uses creates distinct activity patterns which may be interpreted on aerial photographs. The following table illustrates the land use changes in acres and in percent of the total land change.

Activity	Acres	Percent of Total
Lumbering and logging	2,120.6	76
Construction (clearing)	551.9	20
Roadway	88.1	3
Transmission corridors	25.3	0.9
Railroad	15.6	0.5
TOTAL ACRES	2,801.5	100.4

As illustrated on the map (Figure 3.1.1, Baseline Biotic Survey), the predominant location of the construction activities was surrounding the plant site. There was, however, some activity in the form of lumbering and logging and roadway construction in the southern portion of Sumter National Forest amounting to 224.96 acres.

In addition to the photo interpretation for land use changes, analysis for insect and pathogen infestation was conducted. Throughout the study area no major outbreaks of infestation were observed. The predominant disease-causing pests and pathogens of South Carolina are listed in Table 3.1.1. However, the presence of these infestations on the site have not been documented.

Due to the dynamics of land use within the Broad River Study Area, this analysis is accurate through 19 April 1974. Logging and construction activities conducted since April have utilized more land, but aerial surveys have not been conducted for further photogrammetric analyses.

Table 3.1.1 Infestations of major South Carolina coniferous species occurring in the Broad River Study Area.*

Host Species	Pest or Pathogen
Loblolly Pine (*Pinus taeda*)	Seedling Diseases Fusiform Rust (*Cronartium fusiforme*) (*Thelephora terrestris*)
	Foliage Diseases Needle Rust (*Coleosporium* sp.) (*Ploioderm* [*Hypoderma*] *lethale*)
	Insect Southern Pine Beetle (*Dendroctonus frontalis*) Black Turpentine Beetle (*Dendroctonus terebrans*)
Virginia Pine (*Pinus virginiana*)	Seedling and Foliage Diseases Fusiform Rust (*Cronartium comptonme*) (*Cronartium appalachianum*)
	Insect Southern Pine Engraver (*Ips grandicouis*)
Longleaf Pine (*Pinus palustris*)	Foliage Disease Brown Spot (*Scirrhia acicola*)
	Insect Southern Pine Beetle (*Dendroctonus frontalis*)
Shortleaf Pine (*Pinus echinata*)	Stem Disease Pitch Canker (*Fusarium lateritium* f. *pini*)
	Root Disease Root Rot (*Fomes annosus*)
	Insect Core Borer (*Dioryctria amatella*)

*Data obtained from:

Baker, W. L. 1972. Eastern forest insects. U.S.D.A., Forest Service, Miscellaneous Publication No. 1175. 642p.

Hepting, G.L. 1971. Diseases of forest and shad tress of the United States. U.S.D.A., Forest Service, Agriculture Handbook Number 386. 658p.

3.2 BIRDS

3.2.1 INTRODUCTION

The data included in this report are the result of five quarterly sampling periods following the completion of a baseline survey on environmental conditions prior to construction at the proposed Summer Nuclear Station and the Fairfield Pumped-Storage Facility near Parr, South Carolina. The periods of biotic sampling were August 1973 and January, April, June, and September 1974. Information gathered during these periods will be compared to information reported in the baseline survey and addendum for the purpose of noting any changes which may be interpreted as impacts resulting from construction activities in the area.

3.2.2 METHODS AND MATERIALS

3.2.2.1 Strip Census

Six survey areas were established in the Broad River area for the purpose of conducting strip censuses. Two areas were established in each of three habitat types for comparative purposes. One area termed the "control" area, was located in an area removed from disturbances occurring from site preparation for the power plant and the other area, the "test" area, was located in close proximity to construction activities. In this manner, the effects of environmental changes on bird populations could be monitored. Areas 1C and 5B are located in pine habitats and represent the "control" and "test" sites, respectively. Areas 1B and 5C are located in deciduous tree habitats with 1B being the "control" and 5C the "test" area. The "test" sites 5B and 5C were established in January, 1974 near the area of construction of the nuclear power plant. The third habitat type common to this area is pine habitat that has been selectively cut for harvestable pine trees. A large portion of the Broad River area is vegetated with pine which are

periodically harvested for either pulpwood or saw timber. This practice will become increasingly common as much of the land under study will be selectively cut by many of the ex-land owners who retained timber rights when they sold their land. Area 7 ("control") was established in an area near the upper end of the proposed upper reservoir and was selectively cut during the summer of 1973. Area 4 ("test") which was selectively cut in the spring of 1974, is very near the construction site of the proposed nuclear plant.

The survey methods used during the strip census are the same as previously described in Section 5.6.2.3 of the baseline survey. Strip censuses were conducted during each of the five survey periods since the baseline survey.

3.2.2.2 Auto Survey

The auto surveys were discontinued after January 1974. They will be re-established at a later date after cutting and clearing operations in the area of the "test" survey routes have reached a stage where these will be sufficient change in habitat to show a change in avian species composition. The "test" survey routes are routes A, B and C, while the "control" route is route D. These routes along with the methods used during the auto survey are described in Section 5.6.2.2 of the baseline survey.

3.2.2.3 Waterfowl Survey

Waterfowl were surveyed along the Board River from the point where the Broad and Enoree Rivers join north of Blair, South Carolina, south to the Parr Shoals dam. The river was divided into seven survey sections which include three adjacent creeks and the Parr Reservoir. Methods employed are the same as those presented in Section 5.6.2.5 of the baseline survey.

3.2.3 FINDINGS

3.2.3.1 Effect of Timber Harvest

Timber harvest has become extensive in the Frees Creek Watershed.

This is partially related to the construction of the nuclear power plant and pumped-storage facilities. Many land owners retained timber rights when they sold their property to SCE&G and are presently exercising these rights. Paper companies also are removing timber from their properties in the Frees Creek Watershed and on many lands throughout the Piedmont Counties.

Between November 1970 and April 1974, approximately 2800 acres within the project area have been affected in some way by lumbering activities. Most of this area was selectively cut for pole-sized pine trees which results in trees smaller and larger than pole-sized pines being left on the site. Some of the area has been clear-cut which effectively removes all trees from the site.

3.2.3.2 Effect of Construction Activities

As of April 1974, 552 acres had been cleared for construction of the nuclear power plant. Eighty-eight acres had been cleared for roads and another 41 acres had been cleared for transmission line and railroad corridors.

Generally the changes in habitats by construction activity are more drastic than clear-cutting since natural vegetation is not allowed to come back into the area. Exceptions are the banks along roads and railroad cuts which have been dressed with grass to stabilize erosion. The current cover and food value of this grass is low for wildlife, but in time herbaceous vegetation will invade these areas and an increase in value will be apparent.

3.2.3.3 Results of Strip Censuses

Forty-one species of birds were observed in the three control sites during the course of this phase of the monitoring program. These species along with their season of occurrence are recorded in Table 3.2.1. The density (birds per acre) on these sites is given in Figure 3.2.1. The diversity (number of species per site) of birds is presented in Figure 3.2.2.

Table 3.2.1 Results of avian strip censuses conducted on control site from fall 1973 to fall 1974

	PINE					SELECTIVELY CUT PINE					DECIDUOUS				
	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fal
Bobwhite		11					13					8			
Yellow-billed Cuckoo	1			1							2			2	3
Whip-poor-will								1							
Ruby-throated Humingbird											1				
Common Flicker														1	
Red-bellied Woodpecker			2	4				1				2			
Downy Woodpecker				2	1						1		10	1	
Great-crested Flycatcher				3											
Acadian Flycatcher														1	2
Eastern Wood Pewee				1										3	
Blue Jay	7		1	6	9			1	2						1
Common Crow		2		1											
Carolina Chickadee	13		3		2				43	32	11	14	4	3	4
Tufted Titmouse	1		1								1			1	
Brown-headed Nuthatch	5		3	13	6			1	11	10	1	11			
Carolina Wren			1	6					1	2	4	1	13		8
Brown Thrasher				3										1	
Wood Thrush			1	1											
Hermit Thrush							3								
Blue-Gray Gnatcatcher													10	3	
Ruby-crowned Kinglet			2				1					2	14		
Golden-crowned Kinglet												18			
White-eyed Vireo													3		1
Yellow-throated Vireo													3		
Red-eyed Vireo													1	3	
Parula Warbler													11	1	
Myrtle Warbler			17					2							3
Pine Warbler	6	2	10	4	4			1	2		10				
Prairie Warbler								3	3						
Yellowthroat									2				11	2	
Hooded Warbler											6		1		
Warbler sp.			3												
Summer Tanager					1				1	1				3	
Cardinal	3			4	1		6	1			4	3	4	3	3
Indigo Bunting														2	
Purple Finch								2							
American Goldfinch												5			
Rufous-sided Towhee				5		2	2		2	1		5	3		1

Table 3.2.1 (continued)

	PINE					SELECTIVELY CUT PINE					DECIDUOUS				
	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall
Bachman's Sparrow													4		
White-throated Sparrow												15			
Fox Sparrow							6								
Song Sparrow												4			
Unidentified	12		5	6	3	1	2		2	1	18	6	20		1
Total	48	16	49	60	27	3	35	11	30	18	59	94	112	30	24

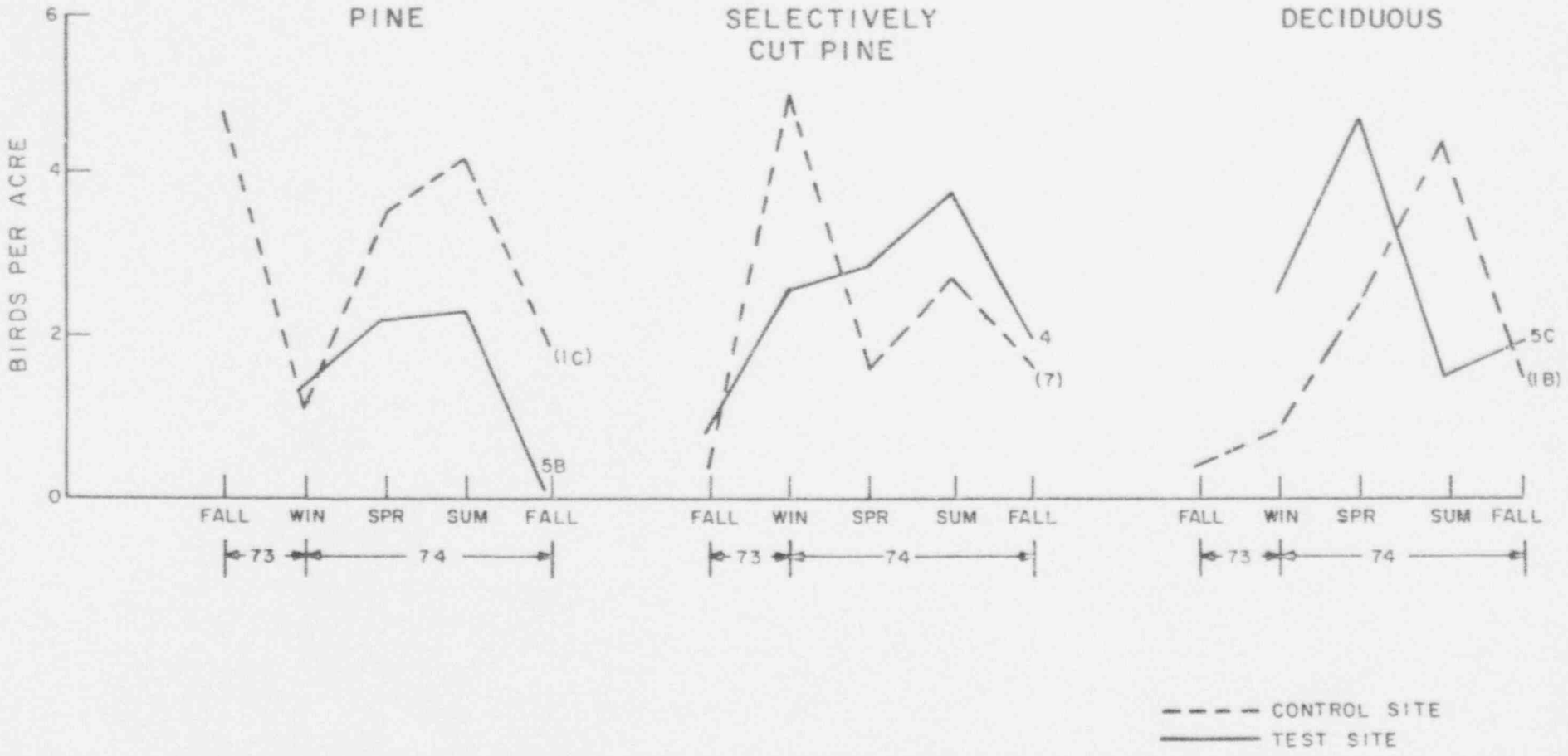


Figure 3.2.1 Avian density in selected habitats during strip censuses

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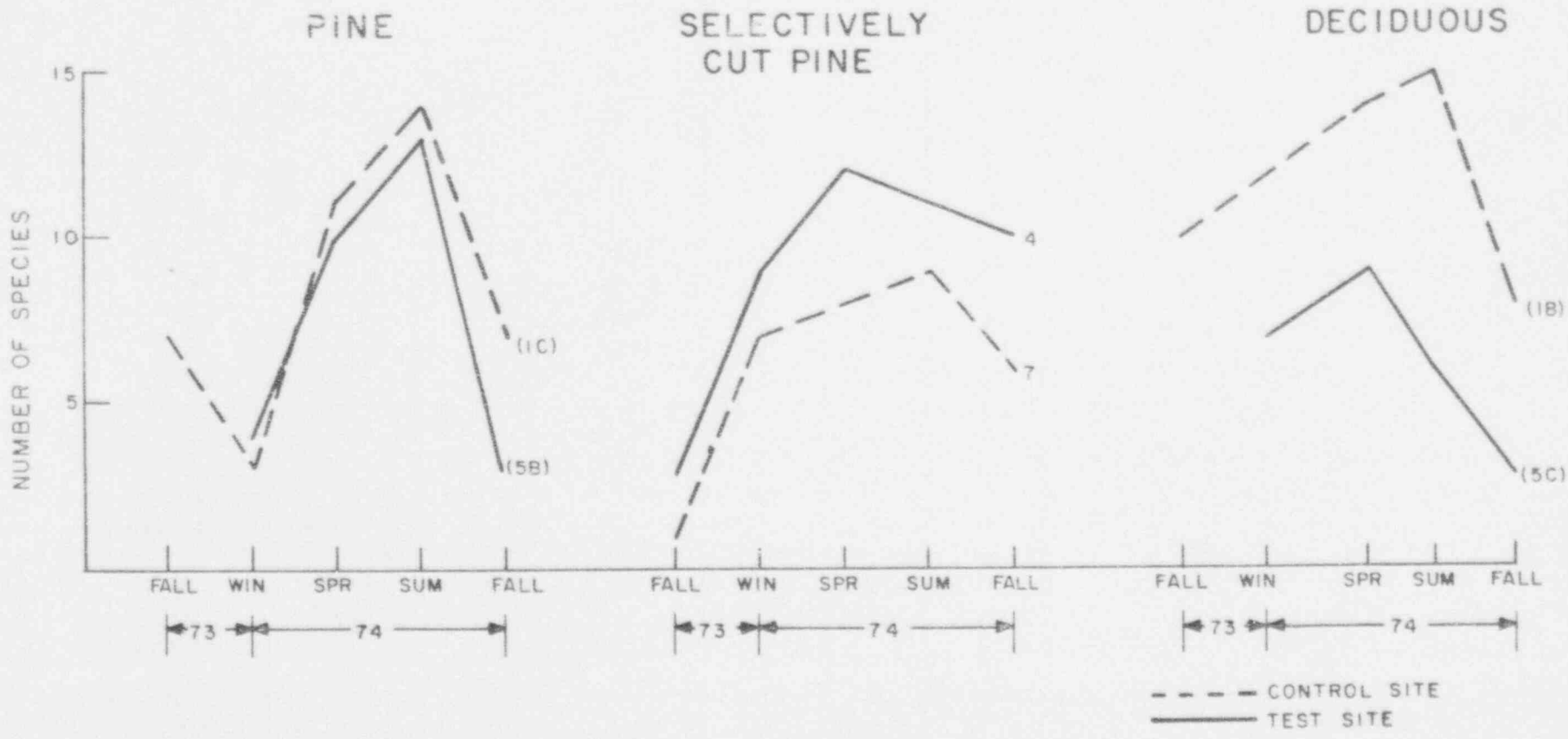

Figure 3.2.2 Avian diversity in selected habitats during strip censuses

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Eight species of birds were chosed as indicators of environmental change in the Addendum to the Baseline Biotic Survey. These eight indicator species are the following:

Mockingbird	Cardinal
Loggerhead Shrike	Pine Warbler
Eastern Meadowlark	Rufous-sided Towhee
Mourning Dove	Carolina Chickadee

Four of these species occurred in the control sites (Table 3.2.2).

Thirty-seven species of birds were observed in the three "test" sites during this portion of the monitoring program. The seasonal occurrence of these species is given in Table 3.2.3. The avian density occurring on the "test" sites is presented in the same figure (Figure 3.2.1) as the density of "control" site species for comparison purposes. In like manner, the diversity of species in the "test" sites are presented in Figure 3.2.2 along with that of the "control" site species. Five of the "indicator" species occurred in the "test" sites and their time and area of occurrence are recorded in Table 3.2.2.

3.2.3.4 Results of the Waterfowl Survey

Waterfowl were surveyed along the Broad River and adjacent creeks during August 1973 and January and June 1974. The ducks and shorebirds observed during these periods are listed in Table 3.2.4.

3.2.4 DISCUSSION

3.2.4.1 Effect of Timber Harvest

The act of harvesting timber from an area has immediate impact on whatever wildlife resides in the area. Generally the noise associated with harvesting drives most animals temporarily from the area. If only selected trees are harvested, obviously there will be some trees over or under

Table 3.2.2 Indicator species recorded by strip census on different habitats from fall 1973 to fall 1974

Species	PINE					SELECTIVELY CUT PINE					DECIDUOUS				
	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall
"CONTROL" SITES															
Cardinal	3			4	1		6	1			4	3	4	3	3
Carolina Chickadee	13		3		2				4	3	11	14	4	3	4
Rufous-sided Towhee				5		2	2		2	1		5	3		1
Pine Warbler	6	2	10	4	4			1	2		10				
Total	22	2	13	13	7	2	8	2	8	4	25	22	11	6	8
"TEST" SITES															
Cardinal				1	3		1	6	7			1	1	1	1
Carolina Chickadee		3	2	7	1		2	7	3	2		2	1	1	
Rufous-sided Towhee		2		2		3		1	4						
Pine Warbler			2				1		4						
Mockingbird				1											
Total	0	5	4	11	4	3	4	14	18	2	0	3	2	2	1

Table 3.2.3. Results of avian strip censuses conducted on "test" sites from fall 1973 to fall 1974

	PINE					SELECTIVELY CUT PINE					DECIDUOUS				
	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall	Win	Spr	Sum	Fall
Bobwhite				1										
Yellow-billed Cuckoo													1	2
Chuck-wills-widow														
Whip-poor-will														
Common Flicker							3			1				
Red-Bellied Woodpecker										1				1
Yellow-Bellied Sapsucker		1												
Hairy Woodpecker							1	1	1		1			
Downy Woodpecker										1				
Great Crested Flycatcher				1	1									
Acadian Flycatcher										1			6	
Blue Jay					3		1		1	5		2		
Carolina Chickadee		3	2	7	1		2	7	3	2	2	1	1	
Tufted Titmouse									2	6				
Brown-headed Nuthatch			1	3			1	3		5			2	
Carolina Wren		2	1	3		1		1			2	1		
Mockingbird				1										
Catbird								1						
Robin							40							
Wood Thrush														
Hermit Thrush		2					1							
Blue-Gray Gnatcatcher			5					2	11			4		
Golden-crowned Kinglet											1			
Ruby-crowned Kinglet														
Kinglet sp.							3				6			
White-Eyed Vireo			1											
Red-Eyed Vireo				2					1				1	
Myrtle Warbler												6		
Pine Warbler			2				1		4					
Prairie Warbler			4	2				9	3	1		2		
Yellowthroat			1					1						
Warbler Sp.												20		
Orchard Oriole				1										
Cowbird								1						
Summer Tanager			3	2		1		1	5	2		1		

Table 3.2.3 (continued)

	PINE					SELECTIVELY CUT PINE					DECIDUOUS			
	Fall	Win	Spr	Sum	Fall	Fall	Win	Spr	Sum	Fall	Win	Spr	Sum	Fall
Cardinal				1	3		1	6	7		1	1	1	1
Indigo Bunting				1										
Rufous-Sided-Towhee			2	2		3		1	4					
Unidentified		7	3			6	5	9	3	1	8	2	1	4
No. Species	0	5	10	13	3	3	9	12	11	10	7	9	6	3
Total No.	0	15	25	28	7	11	58	43	45	26	22	40	13	8

Table 3.2.4 Maximum waterfowl and shorebirds seen any one day along the boat survey route during three study periods

Common Name	Broad & Enoree River north of Blair, S.C.			Broad River from Blair South to Hellers Creek			Hellers Creek			Broad River from Hellers to Frees Creek		
	1973	1974		1973	1974		1973	1974		1973	1974	
	Aug*	Jan*	June	Aug*	Jan*	June	Aug*	Jan*	June	Aug*	Jan*	June
Great Blue Heron		1		3	1			2	1	2	1	
Common Egret										1		
Cattle Egret										1		
Green Heron	2								1	2		
Mallard		8										
Gadwall					2							
American Widgeon		2										
Pintail												
Blue-winged Teal							1					
Wood Duck	5	16		1	6		5	1		7		
Ringneck								2				
Bufflehead												
Unidentified Duck		8							3			
Spotted Sandpiper	5			5			1					
Belted Kingfisher	1	1		2	3		2	1	3	1	2	
Minimum #species	4	5		4	4		4	4	4	6	2	
# ducks	5	34		1	8		6	3	3	7		
# shorebirds	8	2		10	4		3	3	5	7	3	

* Two Day Observation

Table 3.2.4 (continued)

Common Name	Frees Creek 1973 Aug*	Frees Creek 1974 Jan*	Frees Creek 1974 June*	Cannons Creek 1973 Aug	Cannons Creek 1974 Jan*	Cannons Creek 1974 June	Parr Reservoir 1973 Aug	Parr Reservoir 1974 Jan*	Parr Reservoir 1974 June
Great Blue Heron	2	3	4	2	5		2	2	
Common Egret									
Cattle Egret			1						
Green Heron	3		3	2		2	3		
Mallard			10					3	
Gadwall									
American Widgeon									
Pintail								2	
Blue-winged Teal									
Wood Duck	6		16	6	2	3	5	5	
Ringneck		2			1			2	
Bufflehead								12	
Unidentified Duck	1							16	
Spotted Sandpiper	4						3		
Belted Kingfisher	3	4	4	3	4	1	3	2	
Minimum #species	5	3	6	4	4	3	5	7	
# ducks	7	2	26	6	3	3	5	40	
# shorebirds	12	7	12	7	11	3	11	4	

* Two Day Observation

the selected size or age class which can provide a degree of cover or food to wildlife. Generally, the removal of a certain tree class will give additional growing space to the trees not harvested. An understory of hardwood species may be released to eventually dominate an area when a previously dominant overstory of pines is removed. The resultant hardwood stand would offer a different habitat in terms of food and shelter to the area's wildlife.

The opening of a pine stand through selective harvesting would cause more sunlight to reach the forest floor, allowing more ground vegetation to become established which, according to the plant species present, would support more or different wildlife species in this area. An example of this fact is seen in Area 7 which was selectively cut during the summer of 1973. Figure 3.2.1 shows a great increase in birds per acre in this area during the winter survey of 1974. More than one-third (34%) of the birds observed in Area 7 at that time were bobwhite quail. In all probability, this species would not have been present in large numbers had not the area been thinned out during the previous summer by selective harvesting.

A clear-cut timber harvest in which all vegetation is removed quite obviously results in an immediate reduction in habitat value for all wildlife species. Fortunately this denuded situation does not exist for a long period of time. Through natural succession, many forbs and grasses will invade the clear-cut area soon after timber harvest. While the clear-cut area will be of little use to wildlife during the first year, this habitat will be most useful from the second to about the fifth year following clear-cutting. For example, ground nesting birds such as bobwhite quail will find clear-cut land very attractive during the second and third year following clear-cutting, but after that the undergrowth will generally become too thick for these birds to find food, escape predators and raise young. Song birds

such as meadowlarks, red-winged blackbirds and sparrows will find suitable food and cover in clear-cut areas for many years. Hawks and owls will generally thrive on the abundance of small rodents in recently clear-cut areas.

Areas 4 and 7 are the areas of main interest in determining the impacts of timber harvesting since they have been selectively cut at different times of the year. As has already been stated, Area 4 is also a "test" site as it is located in close proximity to the construction area for the nuclear power plant. No striking differences are apparent between these two sites in either density (Figure 3.2.1) or diversity (Figure 3.2.2) of birds besides the fact of the high density in the winter survey in Area 7 which has already been discussed. It is perhaps important to note that both density and diversity of avian populations have increased on both sites from fall 1973 to fall 1974. This may be partially due to selective harvesting, allowing the areas to be used by more avian species.

Timber harvesting may also affect the occurrence of waterfowl in the Broad River Area. The monitoring potentials of the waterfowl survey are very important and must not be overlooked. Once any large-scale timber harvest has occurred along the shore of the Parr Reservoir there will be substantial changes in the habitat which will especially affect shorebirds. Once the proposed pumped-storage facility has been established, there will be a great increase in aquatic habitat due to the formation of the Monticello Impoundment as the upper reservoir and the enlargement of the Parr Reservoir as the lower reservoir. The waterfowl survey will again be important in determining what impacts these changes will have on waterfowl in this area.

3.2.4.2 Effect of Construction Activities

The act of clearing and preparing land for the construction of something as large as a nuclear power plant has quite a disruptive impact on

the affected area. Generally all vegetation is removed, thus totally eliminating the existing habitats. Giant earth-moving equipment is employed to prepare the area for the different facilities to be constructed. This, together with the noise and activity associated with actual construction, will quite effectively expel all wildlife species from the area. Many of the more mobile individuals will leave the area entirely while others will move into adjacent habitats where they may find it difficult to compete with already established populations. Once the power plant is completed, there may be new habitats available to animals. Usually lawns and cleared areas are planted with grasses and maintained for appearance and security. Many seed-eating avian species will find this type habitat attractive. Transmission line corridors are a necessary addition to the area surrounding a power plant and these are usually kept in a constant state of early succession by mowing and spraying with herbicides. These corridors provide a tremendous amount of "edge" which is useful to a great many avian species. "Edge" is the habitat at the point where two habitats join. An example would be a transmission line corridor passing through a forested area. The forested area would provide food according to the plants present and would also provide cover from predators while the various grasses and forbs in the corridor would provide additional sources of food and open areas essential for the reproduction of many ground nesting birds. Thus the "edge" is the best part of two habitats.

When a disruptive force such as construction activity is introduced into an area, the usual result is a decline in avian density and diversity in adjacent areas. In studying Figure 3.2.1, it is apparent that the density of birds in the pine "test" site which is very near the construction area declined in comparison to the "control" pine site. A definite decline is noted in fall of 1974 where there were 1.95 birds per acre on the

"control" site but only 0.5 on the "test" site. A similar decline was apparent in the diversity (Figure 3.2.2) where the number of species present was seven on the "control" site and three on the "test" site. The numbers of species were very similar during all other seasons. Apparently an increase in construction activity during 1974 resulted in a decline of avian populations in the immediate area.

A decline in avian density and diversity is also apparent in the deciduous "test" site (5C). A distinct decline is noted in the summer 1974 survey where the "test" site had 1.5 birds per acre, while the "control" site (1B) had 4.4 birds per acre (Figure 3.2.1). A few months previous to this survey, the "test" site had twice as many birds per acre as the "control" site (4.4 and 2.2 birds per acre, respectively). A similar decline is noted in the diversity during this period (Figure 3.2.2). The "test" site had six species present while the "control" site had 15. The diversity of both the "test" and "control" sites declined in the fall survey, but the "test" site's avian density rose slightly during this period. It is quite likely that construction activity in the area of the "test" site caused the decline in avian density and diversity during the summer of 1974.

3.2.4.3 Effects of Other Environmental Factors

There are many factors which may influence avian populations in an area. The weather has a great effect on bird movement. Generally, more birds will be active on warm, sunny days than on cold, overcast days. A weather front moving through an area will also affect movement as birds usually do not move great distances in the presence of a low pressure area which may herald storm conditions. Migrating birds have been known to move with passing frontal conditions, i.e., thrushes are especially prone to move ahead of cold fronts when migrating south.

Changes in availability of food can influence avian populations inhabiting an area. If a fire sweeps through an area and kills all the understory hardwoods, if there is too much or too little rainfall, or if there is an early frost, it is likely there will be a lack of food for certain species of birds. These species will have to leave the deficient area and find food in another region. This may require moving many miles in search of food and may result in an abnormal number of birds congregating in an area of abundant food supply.

This discussion points out only a few environmental factors which have to be considered in determing causes of changes in avian populations. There are a multitude of additional factors which have not been discussed that are carefully considered before pinpointing any one factor or group of factors as the cause of any fluctuation in avian density or diversity at a site.

3.2.5 SUMMARY

The purpose of this study has been to determine what impacts the establishment of a nuclear power plant and a pumped-storage facility have had on the area surrounding the Broad River and Parr Reservoir area. Results show there has been a decline in numbers and number of species of birds in both pine and deciduous habitats near the construction site for the nuclear power plant. The density and diversity of birds in a selectively cut pine area near the construction site did not vary noticeably from a similar site located away from the activity. A large increase in bird density was noted in the latter site after the area had been selectively cut. This change was apparently due to new habitat made available by the selective harvest.

In order to better understand the changes that will be taking place in this area as construction of the power plant facilities proceeds, it will be necessary to continue the present studies and to re-establish the

auto census at a time when the preparation of the Monticello Impoundment (upper reservoir) has reached a more advanced stage.

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APPENDIX 2D

REPORT - BIOLOGICAL ASSESSMENT
PROPOSED DREDGE DISPOSAL AREA
FAIRFIELD PUMPED STORAGE PROJECT
FAIRFIELD COUNTY, SOUTH CAROLINA
FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY

Dames & Moore
Project No. 5182-066-09

TABLE OF CONTENTS

Section	Page
DESCRIPTION OF THE PROPOSED PROJECT	1
A. Introduction	1
B. Overview	2
C. Schedule of Dredging Operations	6
ENVIRONMENTAL SETTING	7
A. Fish	7
B. Benthic Macroinvertebrates	10
C. Aquatic Vegetation	12
D. Waterfowl, Wading and Shore Birds	13
THE ENVIRONMENTAL IMPACT OF THE PROPOSED ACTIVITY	15
A. General	15
B. Fish	15
C. Benthic Macroinvertebrates	16
D. Aquatic Vegetation	17
E. Waterfowl, Wading and Shore Birds	17
ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIVITY AND MEASURES TO AVOID OR MITIGATE DAMAGE DURING DEPOSITING FROM DREDGING OPERATIONS	18
ALTERNATIVES TO THE PROPOSED ACTIVITY	21
THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	25
ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED	26
TABLES	
FIGURES	
BIBLIOGRAPHY	

LIST OF TABLES

TABLE 1: Species composition and relative abundance of fishes collected near the Dredge Disposal Area in June, 1971, and January, 1972.

TABLE 2: Physical and chemical parameters taken at collecting stations in the Dredge Disposal Area of Parr Reservoir

TABLE 3: Density and species composition of benthic macroinvertebrates collected February 16-17, 1976, on the Broad River Study Area

TABLE 4: Aquatic vegetation found during a shoreline survey of the Broad River Study Area

TABLE 5: Waterfowl, wading and shore birds observed on Frees Creek, S. C.

LIST OF FIGURES

FIGURE 1: Regional Site Location Map

FIGURE 2: Site Vicinity Map

FIGURE 3: General Map of Project Area

FIGURE 4: Proposed Dredging and Disposal Area

FIGURE 5: Dredge Disposal Receiving Area/Aquatic Transect Location Map

FIGURE 6: Aquatic Sampling Stations in the Dredge Disposal Receiving Area

FIGURE 7: Parr Hydroelectric Project Pre-operational Sampling Locations and Scope of Hydrological Monitoring Programs (Revision 3/25/75)

DESCRIPTION OF THE PROPOSED PROJECT

A. Introduction

The purpose of this report is to provide a general overall description of South Carolina Electric & Gas Company's Parr Hydroelectric Project and comprehensive environmental information that is specific for dredge disposal locations that are components of the Fairfield Pumped Storage Facility. Fairfield Pumped Storage Facility is a part of the Parr Hydroelectric Project and is presently being constructed by South Carolina Electric & Gas Company (SCE&G). The information included within this report supplements the Dredging and Disposal Permit Request submitted by South Carolina Electric & Gas Company to the Charleston District Corps of Engineers in correspondence dated October 24, 1975.

Emphasis has been placed in this report on the dredge disposal areas required for dredging excavation of the 3800 foot tailrace canal that will connect the new 480 MW Fairfield Pumped Storage Powerhouse, presently being constructed, with the existing Parr Reservoir. With respect to the planned dredging and disposal areas, this report provides information concerning the following environmental considerations:

1. Present environmental setting
2. Environmental impact of the proposed activity
3. Alternatives to the proposed activity
4. Any adverse environmental effects of the proposed activity and measures to avoid or mitigate damage during depositing from dredging activity.
5. The relationship between local short term uses of man's environment and the maintenance and enhancement of long term productivity.
6. Any irreversible and irretrievable commitments of resources which would be involved in the proposed activity should it be implemented.

B. Overview

The Parr Hydroelectric Project that is presently being constructed is located in Fairfield and Newberry Counties, South Carolina, about 26 miles northwest of Columbia as shown on Figures 1 and 2. The site is along the Broad River near Parr, South Carolina, where South Carolina Electric and Gas Company presently owns and operates Parr Steam Plant, which is a fossil-fuel steam electric generating plant; Parr Gas Turbines, which are oil or gas fired electric generating gas turbines; and Parr Hydroelectric, which is a water powered turbine plant receiving water from Parr Reservoir.

The existing and new SCE&G owned facilities that are presently being extensively modified or constructed include the existing Parr Reservoir Dam, Parr Reservoir, Fairfield Pumped Storage Powerhouse Tailrace, Fairfield Pumped Storage Powerhouse, and Monticello Reservoir. The V. C. Summer Nuclear Station is being constructed near the Monticello Reservoir.

The Parr Reservoir Dam is a concrete overflow type that extends 2000 feet across the Broad River. The original concrete dam was approximately 35 feet high with a crest elevation of 257 MSL. During periods when the incoming Broad River flow exceeded 6000 CFS (496 acre feet per hour), which is the amount that can be passed through the Parr Hydroelectric Plant Turbines, water flowed over the top of the original dam. This dam is presently being raised by installing spillway crest gates that are hinged across the entire 2000 foot crest. With the new gates in a raised position, water will be impounded to elevation 266 MSL. When the gates are in the lowered position, the crest will again be 257 MSL. The normal position of the gates will be in the up position.

Parr Reservoir at elevation 257 has a surface area of approximately 1850 acres and extends approximately 8-1/2 miles upstream. With the previously mentioned gates in the raised position, an additional area of approximately 2550 acres will be flooded and the reservoir will extend approximately 13 miles upstream. The water storage capacity of Parr Reservoir will be increased approximately 29,000 acre feet.

The increased storage capacity of Parr Reservoir is required in order to provide the lower pool storage for the new 480 MW Fairfield Pumped Storage Facility. This facility is being constructed several miles upstream from Parr Dam as shown on Figure 3.

The purpose of the new Fairfield Pumped Storage Facility is to provide economical peaking power. This is achieved by utilizing off peak generating power from the most economical steam power electric generating plants, normally during late evening and night, to pump water from the lower pool (Parr Reservoir) through the Fairfield Pumped Storage Powerhouse to the upper pool (Monticello Reservoir). During periods of high electric demand, normally from early morning to mid afternoon, water from the upper pool will flow back into the lower pool after passing through the Fairfield Pumped Storage Powerhouse generators.

The daily exchange of water will be 29,000 acre feet. The time required to pump all of the water from the lower to the upper pool will be approximately 10 hours. The average flow in the Broad River coming into Parr Reservoir is 496 acre feet each hour. In ten hours only 4960 acre feet would enter which would not be sufficient to satisfy the pumping requirements; hence, the need for the crest gates across the existing Parr Dam.

During the pumped modes of operation, the 29,000 acre feet of water will pass from Parr Reservoir to the Fairfield Powerhouse via the Tailrace canal and from the powerhouse through four 26-foot diameter penstocks up to the new 6800 acre Monticello Reservoir. The water will be stored in Monticello Reservoir until generation is required. The water level in Parr Reservoir will drop from 266 MSL to approximately 256 MSL during the pumping operation. The water level in Monticello Reservoir will increase from 420.5 MSL to 425 MSL during the pumping operation. During generation, the cycle is reversed with the water level in Parr returning to 266 MSL and the water level in Monticello dropping to 420.5 MSL.

During the pumping or generating modes of Fairfield Powerhouse, water will be exchanged via the Fairfield Tailrace Canal. The canal has been designed with a cross sectional area such that the velocity of the water flowing within the canal during pumping or generation will not cause erosion or scouring. The approximate 5500 foot long canal is 1125 feet wide and approximately 10 feet deep where it opens into Parr Reservoir, and 660 feet wide and 86 feet deep where it closes at the face of Fairfield Pumped Storage Powerhouse (see Figure 4).

The 76-acre surface area that will be dredged for Fairfield Tailrace is approximately 75 percent under water. The average water depth is approximately five feet.

The depth of dredging from the river bed to the powerhouse will be on a gradual slope starting at the river at Elevation 250 and increasing over the next 3800 feet to Elevation 232 to a point beneath the existing cofferdam. The area upstream and between the existing cofferdam to the powerhouse will be excavated in the dry by other means.

The material being excavated consists principally of soft brown inorganic silt with some sand. Construction of the tailrace will involve dredging approximately 1,500,000 cubic yards of this material.

The bottom substrate in the proposed dredge disposal area No. 1 as shown on Figure 4 is presently comprised almost entirely of silt and muck. This is a result of the silt laden inflow from the Broad River "dropping out" as it entered the lower velocity confines of Parr Reservoir. This mode of silt deposition will continue after the Fairfield Facility goes into operation; therefore, any effort to selectively dredge or to purposefully construct a sand-gravel top layer on the dredged material for certain species of nest building centrarchids will be futile.

The bottom substrate of disposal area 2 is generally cleared woodland. A small portion of this area presently contains the diverted Frees Creek. Upon closure of Monticello Reservoir Dam B near June of 1976, this flow will cease. During dredged material placement in area 2, the runoff will return to the tailrace area being excavated.

The embankment retaining dredged material in area 2 will be constructed to approximate elevation 276 MSL and will form part of the permanent tailrace canal embankment. The slope of the embankment will not be less than two to one and will be constructed of compacted earth fill. The slope facing the tailrace will be protected with riprap or by other means as required. Dredged material will be added to this area not to exceed Elevation 276 MSL at the embankment. The top of this embankment will be used as a permanent roadway for maintenance of the north side tailrace slope. Following dredged material placement and drying out, the area will be graded to drain and planted over with suitable ground cover as recommended by the U.S. Soil Conservation Service.

The dredged material embankment for area 1 will be constructed to approximate elevation 260 MSL and crowned to elevation 261 MSL.

The embankment parallel to the south side of the tailrace excavation will be constructed of compacted earth fill with a slope not less than two to one. This embankment will be protected with riprap or by other means as required to prevent erosion of the embankment. The top width will be limited to the minimum requirements of the contractor's equipment.

The remaining embankment enclosing area 1 will be constructed with a slope not less than two to one and will receive slope protection as required. The top width of the remaining embankment enclosing area 1 will be limited to the minimum requirements of the contractor's equipment and will be constructed of compacted fill.

During placement of dredged material in area 1, the runoff will return to Parr Reservoir after passing through a rock fill outfall located near the southern end of the disposal area.

The embankments of area 1 will not be maintained after operation of the project has begun with the exception of required maintenance to prevent erosion of the portion of the embankment parallel to the tailrace canal. The intent of the embankments of area 1 is to retain the dredged material during excavation of the tailrace and after operation has begun.

The Broad River upstream of Parr Reservoir has historically been recognized as carrying a large amount of suspended solids. This is primarily due to the fact that the watershed consists of very soluble soils. SCE&G estimates that the annual solids load of the Broad River passing through Parr Reservoir is in excess of 500,000 cubic yards annually.

As a result of the heavy solids load of Broad River, a large portion of the existing Parr Reservoir has silted up over the years to within a few feet of the original dam crest elevation of 257 MSL. The present silting condition appears to be near equilibrium.

SCE&G is aware that future silting of the enlarged Parr Reservoir may occur during the periods when the crest gates are up and that future maintenance dredging may be required. SCE&G is also aware that during the daily operations of the pumped storage facility that part of the solid load

transported into Parr Reservoir by the incoming Broad River will be pumped up and into the Monticello Reservoir where settling out will occur; however, due to the 400,000 acre feet storage volume of Monticello this will not present a problem.

Due to the fact that the lower Parr Reservoir will likely experience high solids deposits, any effort to construct the dredged material embankments of area 1 to achieve an effective pool for maintaining or promoting aquatic development is not practical. The proposed embankments of area 1 will be constructed and maintained only to retain the dredged material.

C. Schedule of Dredging Operations

Dredging will commence in the fall of 1976. This will correspond to low water due to the traditional dry season, and the seasonal and cyclical activities of biological organisms which tend to be at their low point during this time of year.

ENVIRONMENTAL SETTING

The area of Parr Reservoir that will be affected by the proposed dredging operation is shown in Figure 4 as area 1. This area is located in the northern part of the reservoir about three miles upstream from Parr Dam. Area 3 (Figure 4) was also investigated as an alternate dredge disposal site in Parr Reservoir and, although this environmental description refers to area 1, the same information is applicable to area 3, due to the similarities of the areas.

The area in general is poor habitat for the aquatic resources due to the lack of vegetation, excessive turbidity and shallow water.

The shallow water is a result of natural causes and is due in part to the silt load that is carried by the Broad River and which is subsequently placed in these backwater areas. The excessive amounts of turbidity resulting from the silt load reduces light penetration, thereby eliminating, for the most part, the aquatic vegetation.

This part of the reservoir is not used to any extent by sport fishing enthusiasts since it is not very accessible by boat, and there is a general lack of sport fish present.

The description of the resources in the proposed dredge disposal area is based on sampling the benthic macroinvertebrates and summarizing data collected in previous years. These data include aquatic vegetation, fish and birds (waterfowl, wading and shore birds).

A. Fish

Fish are probably the most obvious component of the aquatic ecosystem. Thus it is important to know what species occur in the area and to understand certain aspects of their life history. The fisheries information is based on collections made by gill nets and electrofishing in the near vicinity of the proposed dredge disposal area (Transects A and A', Figure 5). These collections were made in June, 1971, and January, 1972; Table 1 summarizes the findings.

Species composition and relative abundance provide basic information about species diversity of the fish fauna and their numerical status in the fish community.

A total of 11 species of fish were collected during the two sampling periods. Gizzard shad was the most abundant species collected. Gizzard shad (24.5%), bluegill (19.6%), white crappie (14.7%), longnose gar (13.1%) and black crappie (9.8%) comprised about 82% of the fishes collected. Other species collected and listed in order of abundance include carp, redear sunfish, yellow bullhead, flat bullhead, channel catfish and largemouth bass.

The gizzard shad is ubiquitous throughout Parr Reservoir (Dames & Moore, 1974). This species is an important forage fish, forming an important link in the food chain of game fish and other piscivores. Because it has a high reproductive potential and rapid growth rate, this species tends to overpopulate some waters to the detriment of other fish populations. It is highly successful in Parr Reservoir because of its tolerance to excessive turbidity and waters supporting little or no vegetation and sparse benthic fauna. Food preference of the gizzard shad also favors its success in Parr Reservoir, since adults feed primarily on detritus (Hynes, 1972). Spawning of the gizzard shad occurs at temperatures of 64° to 75°F, and the eggs are scattered (Jester and Jensen, 1972).

The bluegill is also ubiquitous throughout Parr Reservoir, and was numerically the most abundant species collected in the baseline biotic survey (Dames & Moore, 1974). The bluegill is believed to be one of the primary sport fishes in the reservoir, and also is a major segment of the forage base. Bluegills spawn over an extended period of time, beginning when water temperatures reach 70°F and continuing until fall with the peak of spawning activity being in May. Bluegills forage on zooplankton and small insects.

The white crappie is also found throughout Parr Reservoir, and was numerically the third most abundant species collected in the baseline survey (Dames & Moore, 1974). The white crappie is considered to be an important segment of the sport fishery in Parr Reservoir. White crappie usually spawn from May through June, when water temperatures are from 64° to 68°F, and they spawn under a variety of conditions of bottom, water depth and vegetation. White crappie feed on zooplankton when they are small and insects when they are larger.

The longnose gar was collected throughout Parr Reservoir during the baseline biotic survey (Dames & Moore, 1974). This species is not considered a sport fish in Parr Reservoir. Larval and fingerling size gar feed on insect larvae, but adults feed almost exclusively on fish. Spawning occurs from late April throughout June.

The black crappie also occurs throughout the reservoir (Dames & Moore, 1974). This species follows the same pattern as the white crappie in spawning and feeding habits. The black crappie is less abundant than the white crappie, but is considered an important segment of the sport fishery and also contributes to the forage base.

The other species were collected in fewer numbers in the disposal area, but were found throughout the reservoir during the baseline biotic survey. These are all considered to be a segment of the sport fishery. In the baseline biotic survey, they were ranked in overall abundance as follows: redear sunfish - fourth, largemouth bass - fifth, carp - seventh, flat bullhead - eighth, channel catfish - twelfth, and yellow bullhead - twenty-two.

The data provided here generally indicates that the proposed dredge disposal area is not utilized to a great extent by the fish species that exist in Parr Reservoir and may be considered as an undesirable fish habitat for the following reasons: excessive turbidity, shallow water, and lack of aquatic vegetation. Excessive turbidity, which reduces light penetration in the water, thus reducing photosynthesis, tends to make the area an undesirable habitat. Only the more turbidity-tolerant species such as gizzard shad, longnose gar and some of the other species will inhabit the area.

There is a lack of aquatic vegetation in the proposed dredge disposal area. Table 4 shows the aquatic vegetation that is present in the Broad River and Parr Reservoir, and it should be pointed out that very few or none of the species exist in the proposed dredge disposal area. With the lack of vegetation, the area is undesirable for fish species to spawn and/or to forage in the area.

At times the water in the proposed dredge disposal area is very shallow and the area is almost dewatered due to natural causes. The depth of water is indicated in Table 2. This type of habitat is

undesirable for fish since they may be subject to rapid and drastic changes caused by air temperature fluctuation.

In summary, 11 species of fish representing five families were collected in previous years from the proposed dredge spoil receiving area. This area is not deemed important for fish species due to excessive turbidity, lack of aquatic vegetation, and shallow water.

B. Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled quantitatively in the dredge disposal area in February, 1976, with a 6-inch square Ekman dredge at three points from Stations 1 through 8 (Figure 6). At each station, point A was located approximately 40 feet from the north bank, point B was located approximately mid-distance between the north bank and the island, and point C was located approximately 40 feet from the island. The samples were washed in a U. S. Standard No. 30 wire mesh sieve. The organisms collected were preserved in formalin and identified in the laboratory.

In addition, since water quality can influence species composition or diversity of biota and can determine to some degree the population densities of specific organisms, a basic knowledge of physical and chemical characteristics is fundamental to a study of the benthic macroinvertebrates in the dredge spoil area.

Thus, selected physical and chemical parameters were measured at mid-water depth at each sampling point along the stations; these include *in situ* measurements of dissolved oxygen, temperature and conductivity. In addition, one water sample from each station was taken to the laboratory to determine the pH.

The results of all physical and chemical parameters, including a description of the benthic area, is presented in Table 2.

Benthic macroinvertebrates are important biological indicators of conditions within an aquatic system. Their analysis is fundamental to the examination of trophic relationships and the understanding of the aquatic system.

A total of 22 species representing 10 families of macroinvertebrates were collected in the proposed dredge disposal area (Table 3). The species composition by major taxonomic group was as follows: Diptera, 12; Annelida, 5; Mollusca, 2; Ephemeroptera, 1: Trichoptera, 1: Megaloptera, 1.

The insect species found in this survey that are considered ubiquitous to Parr Reservoir include: Diptera, (Chironomidae); Ablabesmyia sp.; Chironomus spp.; Coelotanypus sp.; Cryptochironomus sp.; Procladius sp.; Tanytarsus sp.; (Culicidae) Chaoborus punctipennis; Ephemeroptera, (Ephemeridae) Hexagenia limbata; and Megaloptera (Sialidae) Sialis sp. (Table 3). These species were found to be abundant in the biological surveys conducted in previous years (Dames & Moore, 1974).

The most abundant species collected in our samples were the Chironomidae, and they represented 44 percent of the benthic macroinvertebrates in the proposed dredge disposal area.

The next most abundant group of species were the Annelida, and they represented 35 percent of the total benthic fauna collected. The third most abundant species were the Ephemeroptera, and they represented about 18 percent of the total benthic fauna collected. Thus, as a whole, the three groups mentioned above accounted for 97 percent of the benthic fauna collected.

The density of organisms between sampling stations ranged from 472 at Station 1 to 1,528 at Station 6.

The index of diversity shows the similarity of each station. The numbers indicate that these stations are quite similar in numbers of organisms.

Cryptochironomus sp., Chaoborus punctipennis, and Sialis sp. are provisionally classified as facultative organisms with wide ranges of tolerance to environmental conditions while Chironomus sp., Coelotanypus sp., and Procladius sp. are pollution tolerant (Mason, et al. 1971). Ablabesmia sp. and Hexagenia limbata are provisionally classified as pollution sensitive by the same authors. Tanytarsus sp. is also pollution sensitive according to Brinkhurst, et al. (1968). The insects found

in the study area were predominantly facultative or pollution tolerant, with the exception of H. limbata, which was found in large numbers. Both Corbicula manilensis and Sphaerium sp. are facultative organisms tolerant of wide ranges in environmental conditions. On the basis of indicator species and diversity, it appears that the study area is receiving waters moderately organically enriched.

Turbidity, currents, substrate types, and deposition of silt are a few environmental factors that probably limit the insect diversity and density. These properties vary with location and tend to explain the differences in species composition and density among transects.

In summary, a total of 22 species of benthic macroinvertebrates were identified from the proposed dredge disposal area. Diptera, annelida and ephemeroptera were the most abundant species present.

Density ranged from 472/sq. meter at Station 1 to 1,528/sq. meter at Station 6.

The diversity index was comparable at each station.

C. Aquatic Vegetation

Aquatic vegetation plays an important role in an aquatic ecosystem since it is utilized by birds, fish and numerous invertebrates.

Specimens of emergent and submergent vegetation were identified. Emergent hydrophytes were defined as plants attached to the substrate and occurring on exposed or submerged soils. Submerged hydrophytes are plants attached to the substrate and occurring on submerged soils at all water depths. These plants are characterized by foliage that is completely submerged.

A total of 17 species of aquatic vegetation were identified growing in or near the proposed dredge disposal area (Table 4). Sixteen species were classified as emergent and one species was submergent.

Cattail (Typha latifolia) was the predominant emergent species occurring in dense colonies along the shoreline. Arrowhead (Sagittaria latifolia) also was dispersed throughout the area. Marsh willow (Salix

nigra) was an important woody hydrophyte growing in shallow water and on moist banks.

The relative abundance of aquatic vegetation near the dredge disposal area was generally very limited.

Turbidity limits light penetration in the water, which is probably the limiting factor in the growth of submergent vegetation in Parr Reservoir.

In summary, seventeen species of aquatic vegetation have been observed growing in the near vicinity of the proposed dredge disposal area. Emergent types predominated in shallow waters along the shoreline and moist banks. Cattail was the most common species.

D. Waterfowl, Wading and Shore Birds

Fifteen species of waterfowl, wading and shore birds have been observed in the Frees Creek area during surveys over the past four years (Table 5). The area which was surveyed as Frees Creek includes all water bodies north and south of Frees Creek which occur to the west of the Broad River. This survey area includes all the area presently under consideration as disposal ground for dredged material. The Frees Creek area has been utilized primarily by dabbling ducks rather than by diving ducks. Dabblers prefer fairly shallow, protected areas where they feed near the surface and can easily reach aquatic and marsh plants, as well as mast-bearing upland plants. Divers such as ringnecks, redheads, scaup and bufflehead are more common in the reservoir area where they congregate into "rafts" and feed on aquatic plants and aquatic insects and crustaceans.

The wood duck is the only duck that is a year-round resident in this section of South Carolina. This duck utilizes bottomland hardwoods for breeding and brood rearing. Large hardwood trees provide nesting cavities while young trees and shrubs provide cover and food. Frees Creek was assessed during biological baseline studies in 1972 and 1973 and determined to be fair to good breeding habitat but poor brood rearing habitat. This is due to an acceptable number of nesting cavities

and cover for adult birds but a general lack of sufficient ground cover and middle story vegetation to provide cover and food for young ducklings. Other creeks in the vicinity afforded better breeding and brood rearing habitat.

The anhinga, great blue heron, green heron and kingfisher are found along the shoreline of Frees Creek where they feed on fish, crayfish, and other crustaceans, amphibians and aquatic insects. Clearing activities associated with preparing Parr Reservoir for an increase in water level has removed all shoreline vegetation and thereby reduced the area's ability to support wading and shore birds.

Other shore birds found around Frees Creek are the killdeer, common snipe, spotted sandpiper and herring gull. The killdeer feeds almost entirely on insects which are found in recently disturbed fields and pastures. Killdeer have been observed only around Frees Creek and only since the summer of 1975 when clearing operations began exposing shore land. The common snipe frequents marshes covered with low vegetation where it feeds on insects, crustaceans, small fish and aquatic plants. The sandpiper is found in grassy marshes but feeds almost entirely on animal matter (crustaceans, insects, worms, and mollusks). The herring gull is only an occasional winter visitor to this part of the state and was observed feeding along the recently cleared shoreline of Frees Creek where it was probably scavenging for insects or plant material.

THE ENVIRONMENTAL IMPACT OF THE PROPOSED ACTIVITY

A. General

The Broad River carries a large amount of silt which is deposited in the upper reaches of Parr Reservoir. This turbidity reduces the overall productivity of Parr Reservoir since it reduces light penetration, thereby eliminating aquatic vegetation and plankton. Both of these are primary producers (aquatic vegetation is also a form of cover), which in turn build populations to support the higher forms of aquatic life such as the invertebrates and fish.

Water fluctuations in the reservoir will cause an impact on the resources. The water level rise in the reservoir will result in about 2,550 acres of new potential aquatic habitat, but this will probably not increase the overall biomass, since the water level fluctuation will influence the production of the primary producers (plankton) and the spawning characteristics of certain species of fish. The effects of water level fluctuations as well as the anticipated impact on specific components of the aquatic ecosystem are discussed in the following paragraphs.

B. Fish

At the proposed dredge disposal site, an impact to the fishery resources will occur by the actual placement of dredged material, thus taking this area out of production. This is considered to be minimal, representing only 7-1/2% of Parr Reservoir. The fluctuating water levels will tend to change the topography of the bottom conditions, especially those in the photic zone. This condition will reduce the spawning potential of the centrarchids. The centrarchids represent an important segment of the sport fishery in Parr Reservoir at the present time, and this will likely be reduced to some small degree.

The fluctuating water levels and concomitant increased turbidity will cause a greater sedimentation rate, thereby producing silt in the water column, which tends to block out light penetration in the photic zone.

In summary, the proposed dredging operations will remove a small part of Parr Reservoir from fishery production and, with fluctuating water levels during operation and concomitant turbidity, a predicted shift in the fish population from the centrarchid base to the more turbidity-tolerant species (which include gizzard shad, gar and carp) is likely to occur.

C. Benthic Macroinvertebrates

When the dredged material is deposited as planned, the benthic macroinvertebrate community will be covered up and it is unlikely that any organisms will be able to survive. This is the most apparent biological impact of the dredging process. Although this process probably does result in a large kill of the benthic organisms, the impact does not appear to be significant for localized dredging operations. Researchers have measured an immediate decrease in the benthic populations after dredging, but a fairly rapid repopulation did occur (Saila, et al. 1972). Slotta (1972) showed that former abundance levels of some species occurred within two weeks of deposition.

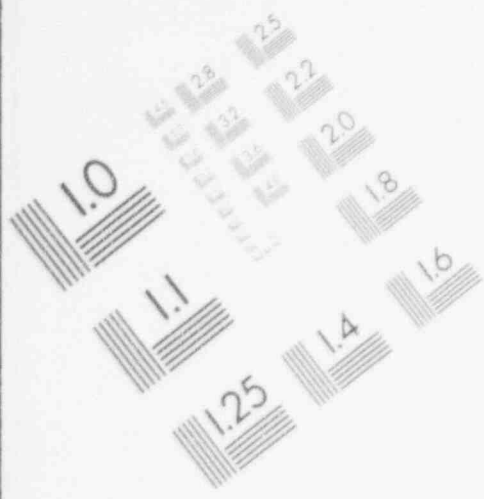
The ability of animals to withstand the adverse effects of burial in areas near the dredge site or in the disposal site depends primarily on their behavior and morphology. Some large species of pelecypods which can burrow have been shown to survive burial up to 21 cm of sediments (Saila, et al. 1972). On the other hand, sessile species are probably killed by burial of any magnitude (Saila, et al, 1972).

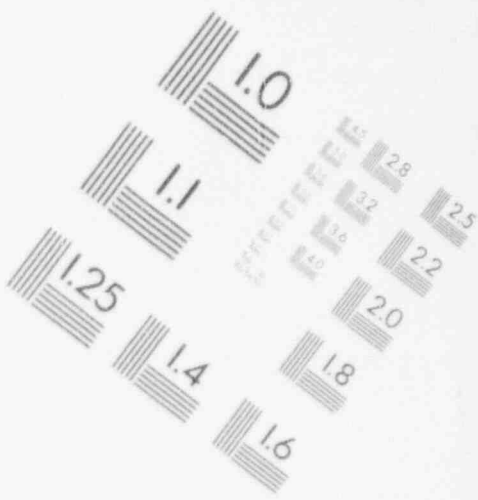
Other species required several years to occupy new habitat created by silt deposition. For example, Benson and Hudson (1975) reported that Hexagenia sp. population in a reservoir required 13 - 22 months to complete a single life cycle and required several years to fully occupy new habitat created by silt deposition. Fluctuation of water levels has an adverse effect on benthic organisms, and it has been shown that when drawdown in a reservoir does not occur, the abundance of benthic organisms may increase threefold in a short period of time.

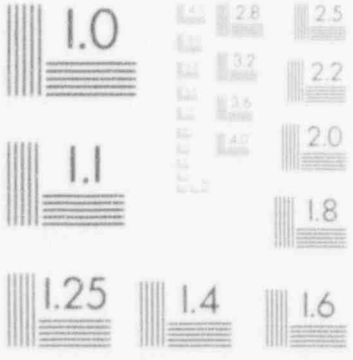
The benthic macroinvertebrates in the proposed dredge disposal area of Parr Reservoir will be impacted severely at the outset. However, it would be expected that the more tolerant species such as Hexagenia, sp. and many members of the Chironomidae family will recolonize the area within a period of time. Moreover, the proposed dredge disposal area represents a small area compared to Parr Reservoir as a whole, and the macroinvertebrate species present are found throughout the reservoir.

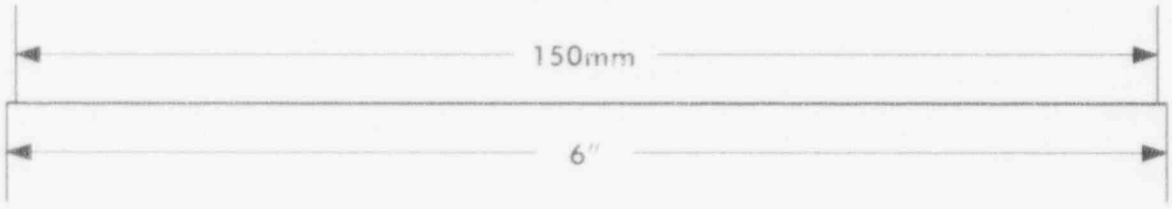
1

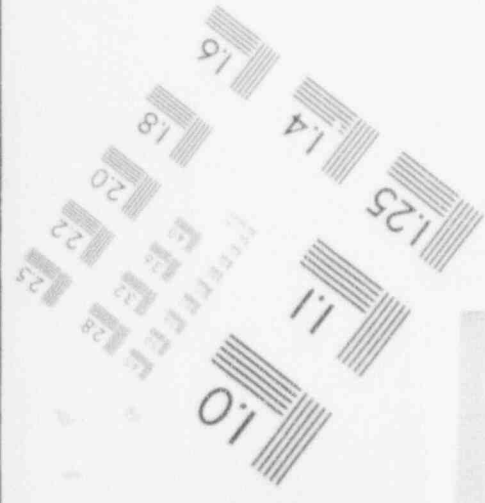
IMAGE EVALUATION TEST TARGET (MT-3)

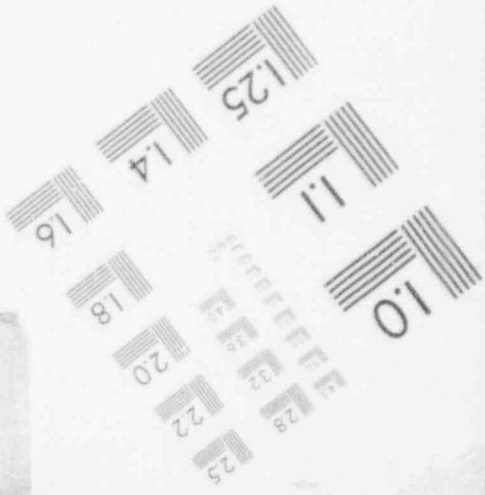












D. Aquatic Vegetation

When dredged material is deposited as planned, all aquatic vegetation in the impacted area will be covered up. However, new colonization by some emergents is likely to occur near the shoreline. Fluctuating water levels and concomitant turbidity along with an unstable substrate are the main limiting factors for submergent vegetation in the proposed dredge disposal areas.

E. Waterfowl, Wading and Shore Birds

The impact on vegetation and other land alterations in the Frees Creek area has caused an apparent change in species utilizing this area. No ducks have been recorded during the past two surveys. Whereas wood ducks were almost always present in this area in the past, the low water conditions last summer and the removal of shoreline vegetation this past winter appears to have made this area unattractive to this species. The great blue heron and belted kingfisher have always inhabited this section of the river and are still present in somewhat reduced numbers, which is quite likely due to the removal of essential shoreline vegetation. There appears to be an increase in shore birds in this area. Ring-billed gulls have been observed on other sections of the river in the past, and the occurrence of the herring gull in Frees Creek is not particularly significant. The occurrence of killdeer and a snipe may have some significance as these species have not been observed in the Broad River study area in the past and are presently found only in the Frees Creek area. These species are frequently found on recently disturbed land near water, and the recently cleared land surrounding Frees Creek is now attractive habitat to these species.

Therefore, it would appear that alterations to this area through present clearing operations or by adding dredged material will tend to decrease the area's usage by ducks and wading birds but increase its importance to certain shore birds.

ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIVITY AND MEASURES TO AVOID OR MITIGATE DAMAGE DURING DEPOSITING FROM DREDGING OPERATIONS

There will be some unavoidable adverse effects in the part of Parr Reservoir that will receive the dredged material. This area will be taken out of production for the aquatic resources, and will represent about 7½% of Parr Reservoir. This will reduce the carrying capacity and overall productivity of the reservoir.

The benthic macroinvertebrate community in the disposal area will be covered up, and it is unlikely that any organisms will survive.

The aquatic vegetation that is present in the area will be covered up, thereby reducing protective areas for any young fish which may exist and cover for any waterfowl and other birds. The habitat for fish species will be removed, thereby eliminating potential spawning areas and general habitat.

It should be pointed out that all of the adverse effects mentioned will be minimized to the extent feasible. Furthermore, programs are planned to monitor effects on the environment, and management of land resources to minimize and offset adverse impact and to improve existing conditions will be accomplished.

Monitoring programs have already begun. The purpose of the monitoring programs is to establish baseline conditions and site characteristics, and to monitor the baseline conditions during construction and operation of the facility in order to detect and take corrective measures against any unforeseen developments. In addition, the Land Management Program will utilize much of the data collected to assure that any adverse effects of construction and operation are minimized and that the natural environment is preserved and enhanced as much as is practicable.

The environmental monitoring programs of particular importance to the dredging activity include the hydrologic and biologic programs.

The hydrologic monitoring program includes surface water and groundwater physical and chemical measurements. The purposes of the water

monitoring programs will be (1) to evaluate baseline physical and chemical characteristics of the Broad River and Frees Creek before and during construction, (2) to monitor the quality of water in Monticello and Parr Reservoirs and the Broad River after construction, (3) to compare the quality of water in the impoundment reservoir and river with applicable standards to assure compliance with the regulations, and (4) to provide data for an evaluation of the impact of the project on the aquatic biota.

A water quality monitoring program is being conducted at selected locations on Parr Reservoir at the present time and will also include Monticello Reservoir after it is impounded. Mitigating measures would be provided if adverse effects are noted during construction or operation of the facility. Sampling and scope of examination are done in accordance with Figure 7 and include measurements of dissolved oxygen, pH, conductivity, temperature profiles, carbon dioxide, total dissolved solids, total alkalinity, total hardness, chloride, sulfate, phosphate, nitrate, BOD, COD, heavy metals, silica, calcium, magnesium, sodium and turbidity.

At the continuous water quality monitoring station in the Broad River downstream of Parr Reservoir, continuous monitoring of dissolved oxygen, temperature, stream flow, conductivity and pH is being performed. Identical continuous monitoring is being performed at stations on the Enoree and Tyger Rivers and the upper reaches of Parr Reservoir on the Broad River. Thus, a continuous record of the basic parameters of water quality entering and leaving the area is being developed. The monitoring stations were constructed and equipped by SCE&G in cooperation with the USGS and each station automatically reports data to a USGS receiving station in Columbia, South Carolina, on each hour.

To assist personnel in the Columbia water treatment plant in the early detection of musty odors in Broad River waters, odor samples in the water quality monitoring program are being taken each day and if any musty odors are detected, the Columbia water treatment plant personnel will be notified.

The current groundwater monitoring program provides data on the physical and chemical properties of the groundwater in the site vicinity.

The biological monitoring program includes assessing the ecological impact of construction and operation of the facility. The program

is designed to document the present biological conditions, provide a basis for selecting measures which could minimize any projected adverse effects and to evaluate the effects of construction and operation of the proposed facility on the biota. The program is being conducted in two phases -- pre-operational and operational. The objective of the pre-operational phase is to provide baseline information on the various aquatic and terrestrial biota in the site vicinity. The pre-operational aquatic and terrestrial monitoring programs commenced in the spring of 1971 and were completed in 1973. An ongoing program to evaluate the effects of construction is presently being conducted.

The aquatic program consists of sampling fish, benthic macroinvertebrates and plankton. Evaluations are planned regarding the construction and operational effects on these organisms. In the Land Management Plan feasibility studies are planned to include the potential to develop a sport fishery resource in the reservoirs.

The development of a fishing lake in the upper portion of the Monticello Reservoir, and in a 90-acre greentree reservoir to be constructed, is expected to provide a quality of sport fishing not presently found in Parr Reservoir.

At present, there is very little, if any, sport fishing in the area of the proposed dredge disposal area. The shallow water and obstructions found in the area make it undesirable for recreation; thus the loss of fishing recreation at the present time in Parr Reservoir will be more than offset by the proposed plans to include a stocked constant level 300-acre fishing lake at the upper end of Monticello Reservoir and other potential managed areas that will not be influenced significantly by the daily water fluctuation in Parr Reservoir.

The terrestrial program consists of habitat classification and wildlife surveys. The habitat classification consists of mapping the various vegetative types. Attention is being given to evaluation of any enhancement potential.

In summary, many of the adverse effects that may be associated with the proposed dredge and disposal operations will be minimized by the implementation of features in the Land Management Plan.

ALTERNATIVES TO THE PROPOSED ACTIVITY

Construction of the tailrace canal is essential to the operation of Fairfield Facility. Without the canal, the facility cannot operate.

The technique by which the tailrace canal is excavated and the areas on which the excavated material may be placed was examined by SCE&G.

The technique of excavating the tailrace canal by dredging was selected as being the most appropriate and the one that would require less utilization of irrecoverable resources. The details supporting this conclusion will not be included with this report owing to the objective of this report to address the location of dredge disposal areas.

The area surrounding the Fairfield Powerhouse and Tailrace is not one that offers abundant terrain suitable for utilization as a dredge disposal area. Ideally, the area should be lowlying and near the operating path of the dredge if economical dredging is to be achieved.

Dredge production (cubic yards per hour) is related to the barometric pressure, the discharge pressure and the conveying capacity.

The barometric pressure is not an item that can be manipulated in the Fairfield Tailrace; therefore, it will not be discussed.

The discharge pressure varies with the horizontal length of the discharge line, the straightness of the line and the vertical height to which the material must be pumped. As the discharge pressure is increased, the cubic yards per hour of production from the dredge is decreased. This is due to the fact that the maximum horsepower of the dredge pump is fixed, and therefore the cubic yards per hour of production must be decreased as the discharge pressure is increased or maintained by adding a booster pump into the discharge line.

The conveying capacity of the dredge varies with the velocity of the material being conveyed in the dredge discharge line. The discharge pressure influences the conveying capacity such that with a fixed length discharge line, an increase in pressure due to increased pump speed will increase the conveying capacity. With a fixed horsepower and pump speed increasing the length or elevating the point of discharge from the discharge line, will produce an increase in pressure, and a reduction of the conveying capacity will result.

Realizing the factors previously mentioned, the dredge areas 1 and 2 as shown on Figure 4 were selected for the Fairfield Tailrace excavation after considering the overall utilization of all resources and future requirements of the project.

Alternative disposal sites included the following:

a. Depositing part of the material into disposal area 3 as shown on Figure 4.

b. Depositing part of or the total amount of the material in disposal area 4 as shown on the attached Figure 4.

The storage capacity of each of these areas including areas 1 and 2 are as follows:

Area	Storage Capacity(c.y.)	Dredged Material Elevation	Acres
1	1,000,000	260	116.0
2	500,000	275	15.0
3	231,500	260	24.0
4	74,000	280	8.14
	400,000	290	40.0
	1,216,000	300	69.4
	2,500,000	310	98.7

Areas 1 and 3 are in the backwaters of Parr Reservoir (Broad River). They are shallow and are presently covered by silt and will continue to be covered by silt whether or not dredged material will be placed on them.

Area 2 is predominantly above water except for a construction drainage ditch transporting the diverted Frees Creek. After the closure is made on the Monticello Impoundment (Dam B), this area will be dry. The bottom substrate of this area is predominantly cleared woodland.

The tailrace embankment in this area will also serve as the disposal area embankment. The area behind this portion of the tailrace embankment must be filled in regardless of whether dredged material is added or not, and, due to this fact, this area was selected as a desirable disposal site. The capacity of this area is limited to 500,000 cubic yards of material at elevation 276 MSL. Upon completion of dredged material placement and after the dredged material has drained sufficiently to support equipment, this area will be graded to achieve permanent drainage and will be planted as recommended by the U.S. Soil Conservation Service.

Area 4 is predominantly above water except for a small wet weather stream. The bottom substrate is entirely cleared woodland. This area is presently diked off in the position shown in Figure 4. The embankment is compacted with earth fill and is approximately 40 feet wide at the top with slopes not exceeding two to one. The fill composing the embankment was originally placed as a haul road to accommodate earth moving operations and other construction activity associated with construction of the above water portions of the tailrace, relocation of a portion of a railroad paralleling the existing Parr Reservoir, and relocation of electrical transmission towers affected by the tailrace canal.

The selection of location for this haul road was with three purposes in mind. First, it provided an economical access route for the previously described construction activity; second, it would provide an available dredged material disposal area to accommodate possible over dredging required for initial construction of the tailrace, and third, it would provide a desirable disposal site for future maintenance dredging of the tailrace.

In the event that dredged material is deposited in this area, it will be dewatered, graded and planted with suitable ground coverage recommended by the U. S. Soil Conservation Service.

This area is not desirable for initial dredge disposal due to the elevation to which the dredged material must be pumped and the resulting requirement of a booster pump in series with the dredge pump. Use of area 4 for depositing the entire tailrace excavation will increase the cost of the tailrace dredge excavation by approximately $936,000. Additionally, since future maintenance dredging is anticipated, utilization of any part of the area will impair future operation of the project.

Area 3 was not considered as a desirable disposal area since it would require sound diking between the dredged material and tailrace and along the western edge adjacent to the Broad River. Area 1 will require similar diking, but the quantity per cubic yard of dredged material will be approximately one-half of that required for area 3.

Once the project goes into operation, areas 1 and 3 will be very undesirable for dredged material placement due to the daily varying water elevations. These areas must be used for initial placement of the tailrace

excavation or they will be for all practical purposes lost. Not using these areas will not produce a long lasting environmental advantage. The areas presently offer poor substrates for development and nourishment of aquatic life and will continue to offer the same regardless of whether dredged material is placed in them or not.

Based on the above considerations, areas 1 and 2 were selected for receiving the initial tailrace excavation dredged materials and are the areas for which a permit has been requested.

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term use of the environment includes some disruptive measures to the natural features, including the removal of about 7½% of Parr Reservoir from production as a fishery resource and general aquatic habitat, and the reduction of waterfowl habitat.

The long-term benefits in human consideration would be the implementation of certain features in the proposed Land Management Plan for land and water resources. These would include an improved fishery resource and a potential for greater recreational facilities, and would represent an enhancement of long-term productivity.

ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

Numerous resources will be utilized in the proposed dredging operation including land, water area, materials and supplies involved in the activity, human talent, skill and labor as well as capital. Some of these resource commitments are irreversible and irretrievable, such as construction materials and supplies.

Other resource commitments are temporary, such as the use of the dredge disposal area. When the lifetime of the project is completed, it would be possible to remove the deposited material from the disposal area and return it to its original position. Essentially this would return the area to its original condition; however, it is unlikely that this would be done. Thus, the elimination of a small part of Parr Reservoir will represent an irretrievable commitment of resources.

TABLE 1: Species composition and relative abundance of fishes collected near the Dredge Disposal Area in June, 1971, and January, 1972.

Family Common Name	Scientific Name	1971		1972	
		No.	%	No.	%
Lepisosteidae					
Longnose gar	*Lepisosteus osseus*	8	16.7	--	--
Clupeidae					
Gizzard shad	*Dorosoma cepedianum*	14	29.1	1	7.7
Cyprinidae					
Carp	*Cyprinus carpio*	--	--	1	7.7
Ictaluridae					
Yellow bullhead	*Ictalurus natalis*	3	6.3	--	--
Flat bullhead	*Ictalurus platycephalus*	--	--	1	7.7
Channel catfish	*Ictalurus punctatus*	--	--	1	7.7
Centrarchidae					
White crappie	*Pomoxis annularis*	7	14.5	2	15.4
Black crappie	*Pomoxis nigromaculatus*	6	12.5	--	--
Bluegill	*Lepomis macrochirus*	6	12.5	6	46.0
Redear	*Lepomis microlophus*	3	6.3	1	7.7
Largemouth bass	*Micropterus salmoides*	1	2.1	--	--
	TOTALS	48	100.0	13	100.0

TABLE 2: Physical and chemical parameters taken at collecting stations in the Dredge Disposal Area of Parr Reservoir

	Collecting Stations							
	1	2	3	4	5	6	7	8
Temperature(^{o}C)	17	16.5	17.7	16.8	16.5	16.2	1[illegible]	17.3
Dissolved oxygen (ppm)	9.7	8.9	9.6	9.7	9.8	9.8	9.3	9.6
Specific conductance (umho)	77	75	70	65	61	56	73	73
pH (pH units)	6.5	6.7	6.9	6.9	7.1	7.1	6.4	6.5
Depth (inches)	16 - 32	12 - 38	12 - 25	21 - 27	24 - 33	15 - 18	18 - 34	20 - 36
Substrate	Silt	Silt	Silt	Silt	Silt, sand	Sand, gravel	Silt	Silt

TABLE 3: Density and species composition of benthic macroinvertebrates collected February 16-17, 1976 on the Broad River Study Area.

Taxa	Stations							
	1	2	3	4	5	6	7	8
Insecta								
Ephemeroptera								
Ephemeridae								
Hexagenia limbata	114	71	314	271	314	343	-	-
Trichoptera								
Psycomyiidae								
Lype sp.	-	14	-	-	-	-	-	-
Megaloptera								
Sialidae								
Sialis sp.	-	-	-	-	-	-	14	-
Diptera								
Culicidae								
Chaoborus punctipennis	14	71	14	29	-	-	143	100
Ceratopogonidae								
Palpomyia sp.	29	-	14	14	-	-	-	43
Chironomidae								
Ablabesmyia sp.	29	14	14	-	29	29	-	-
Chironomus anthracinus type	57	214	86	43	-	-	57	-
Chironomus plumosus type	-	-	14	-	-	-	-	-
Coelotanypus sp.	86	86	57	114	57	-	429	457
Cryptochironomus sp.	14	29	14	-	-	-	-	14
Dicrotendipes sp.	14	-	-	-	-	-	-	-
Glyptotendipes sp.	-	-	-	-	-	-	100	586
Procladius sp.	-	14	14	14	-	14	-	43
Tanypus sp.	-	14	-	-	29	-	-	-
Tanytarsus sp.	-	14	-	-	-	14	57	14
Mollusca								
Pelecypoda								
Corbiculidae								
Corbicula manilensis	29	29	14	29	14	114	-	-
Sphaeriidae								
Sphaerium sp.	-	-	-	-	14	-	14	-

TABLE 3 (Continued)

Taxa	Stations							
	1	2	3	4	5	6	7	8
Annelida								
Oligochaeta								
Naididae								
Naidium breviseta	-	14	29	29	29	-	71	-
Tubificidae								
Aulodrilus sp.	-	-	-	-	-	71	-	-
Branchiura sowerbyi	-	186	-	629	114	757	-	-
Limnodrilus hoffmeisteri	-	-	14	114	86	129	-	-
Potamothrix vejdovskyi	86	-	-	186	114	57	-	-
Total/m^2	472	770	598	1472	800	1528	885	1257
Diversity indices ($\bar{d}$)	2.95	2.99	2.45	2.53	2.67	2.18	2.28	1.81

TABLE 4: Aquatic vegetation found during a shoreline survey of the Broad River Study Area

*Family Scientific Name Common Name	Growth Form	Location
Typhaceae		
Typha sp. Cattail	Emergent	Broad River
Najadaceae		
Potamogeton foliosus Leafy pondweed	Submergent	Broad River
Alismataceae		
Sagittaria latifolia Arrowhead	Emergent	Broad River
Cyperaceae		
Carex lupulina Hop sedge	Emergent	Broad River
Cyperus sp. Sedge	Emergent	Broad River
Scirpus sp. Bulrush	Emergent	Broad River
Cyperus acuminatus Sedge	Emergent	Frees Creek
Rhynchospora sp. Beak rush	Emergent	Frees Creek
Scirpus cyperinus Wool grass	Emergent	Frees Creek
Gramineae		
Agrostis stolonifera Bent grass	Emergent	Broad River
Juncaceae		
Juncus effusus Soft rush	Emergent	Broad River
Juncus pelocarpus Bog rush	Emergent	Broad River
Saururaceae		
Saururus cernuus Water-dragon	Emergent	Frees Creek
Salicaceae		
Salix nigra Marsh willow	Emergent	Broad River Frees Creek
Polygonaceae		
Polygonum sp. Smartweed	Emergent	Broad River

TABLE 4 Continued:

*Family Scientific Name Common Name	Growth Form	Location
Umbelliferae		
Hydrocotyle umbellata Water pennywort	Emergent	Frees Creek
Acanthaceae		
Dianthera americana Water willow	Emergent	Frees Creek

TABLE 5: Waterfowl, wading and shore birds observed on Frees Creek, S. C.

	1972		1973			1974		1975		1976
	Spr	Fall	Spr	Sum	Fall	Win	Sum	Win	Sum	Win
Pied-billed Grebe	-	1	-	-	-	-	-	-	-	-
Anhinga	-	-	-	-	-	-	-	1	-	-
Great Blue Heron	4	12	5	1	2	3	4	6	2	1
Green Heron	-	-	-	6	3	-	3	-	-	-
Mallard	2	-	14	2	-	-	10	20	-	-
Black Duck	7	12	-	-	-	-	-	41	-	-
Pintail	-	-	1	-	-	-	-	-	-	-
Wood Duck	-	28	13	4	6	-	16	5	-	-
Ring-necked Duck	-	-	-	-	-	2	-	-	-	-
Ruddy Duck	-	6	-	-	-	-	-	-	-	-
Killdeer	-	-	-	-	-	-	-	-	2	3
Common Snipe	-	-	-	-	-	-	-	-	-	1
Spotted Sandpiper	-	-	-	-	4	-	-	-	-	-
Herring Gull	-	-	-	-	-	-	-	-	-	1
Belted Kingfisher	-	3	2	4	3	4	4	2	-	1
Total No. of Individuals	13	62	35	17	18	9	37	75	4	7
Total No. of Species	3	6	5	5	5	3	5	6	2	5

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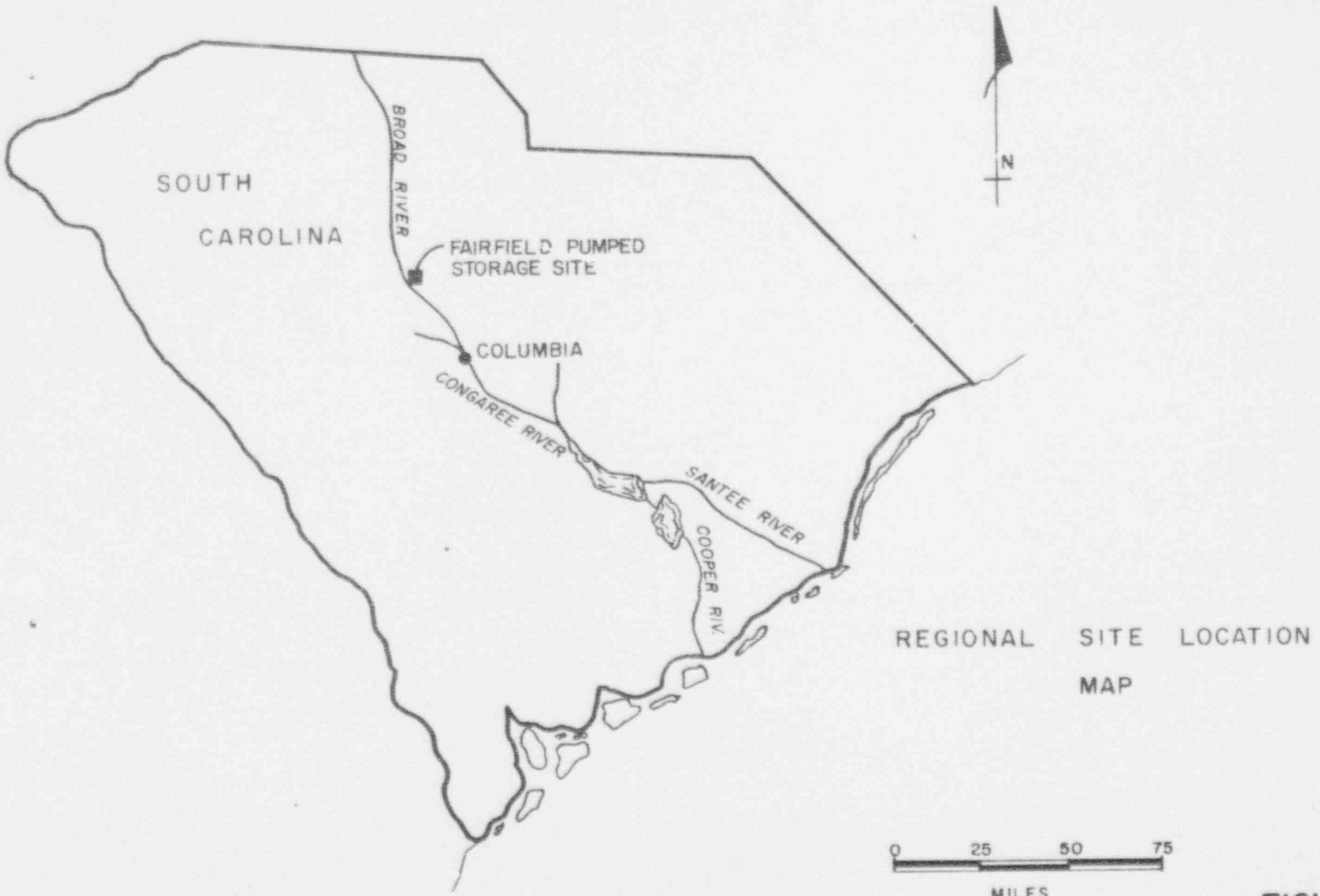

REGIONAL SITE LOCATION MAP

FIGURE I.

4-2-76

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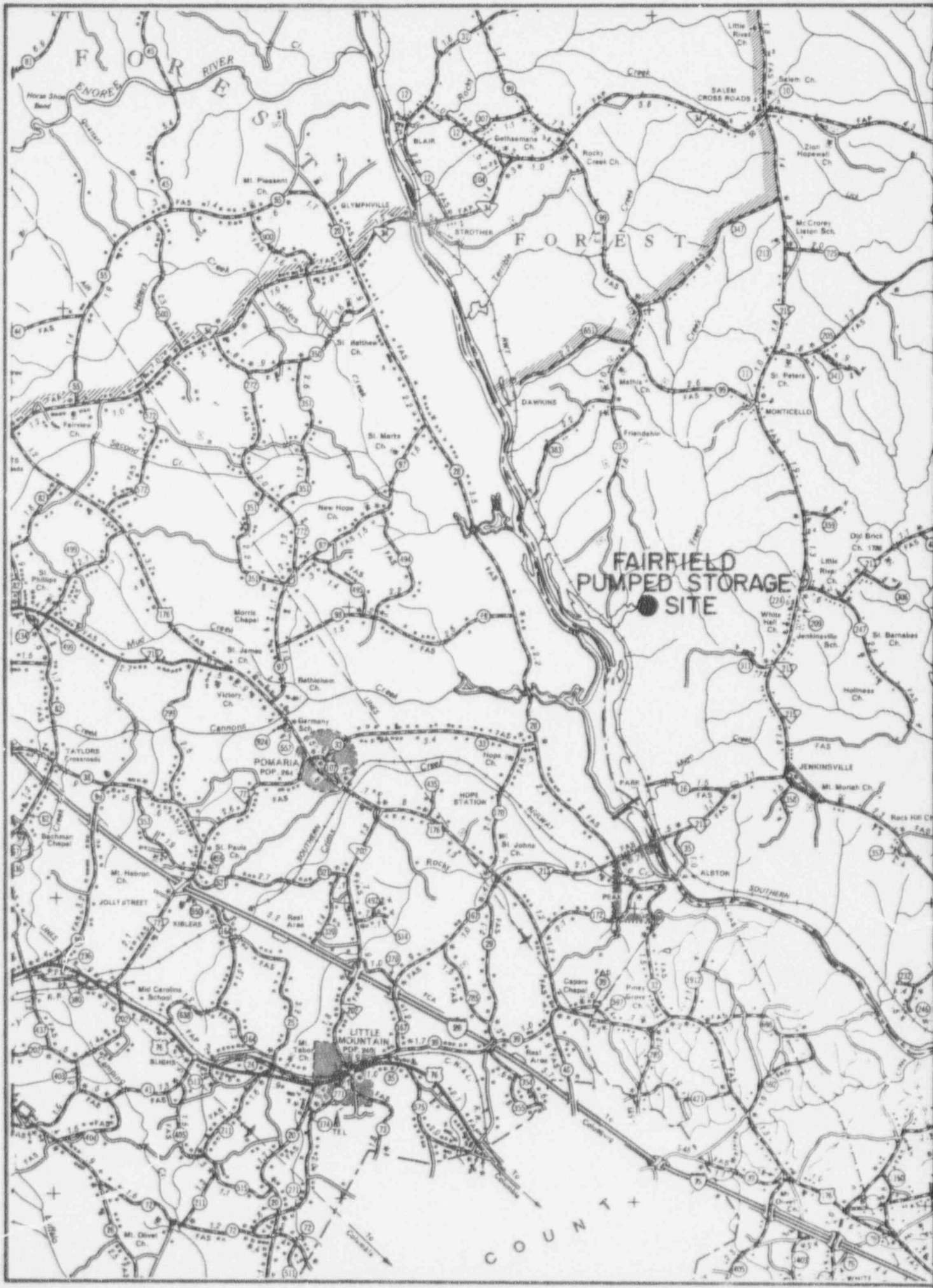
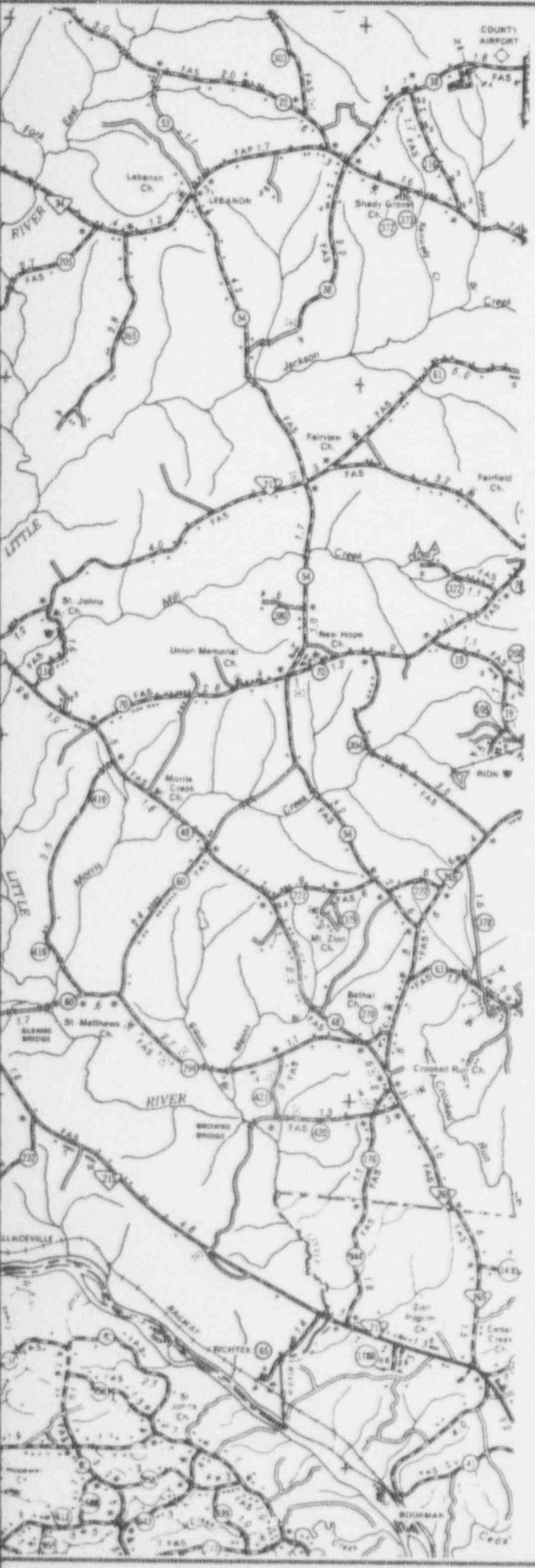

FAIRFIELD
PUMPED STORAGE
SITE
POMARIA
POP. 984
LITTLE MOUNTAIN
POP. 969
JENKINSVILLE
MONTICELLO
ALSTON
SALEM CROSS ROADS
GLYMPHVILLE
STROTHER
DAWKINS
HOPE STATION
JOLLY STREET
TAYLORS Crossroads
FOREST
COUNTY



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SITE VICINITY MAP

2 1 0 2

SCALE IN MILES

FIGURE 2

APRIL 1976

NOTES

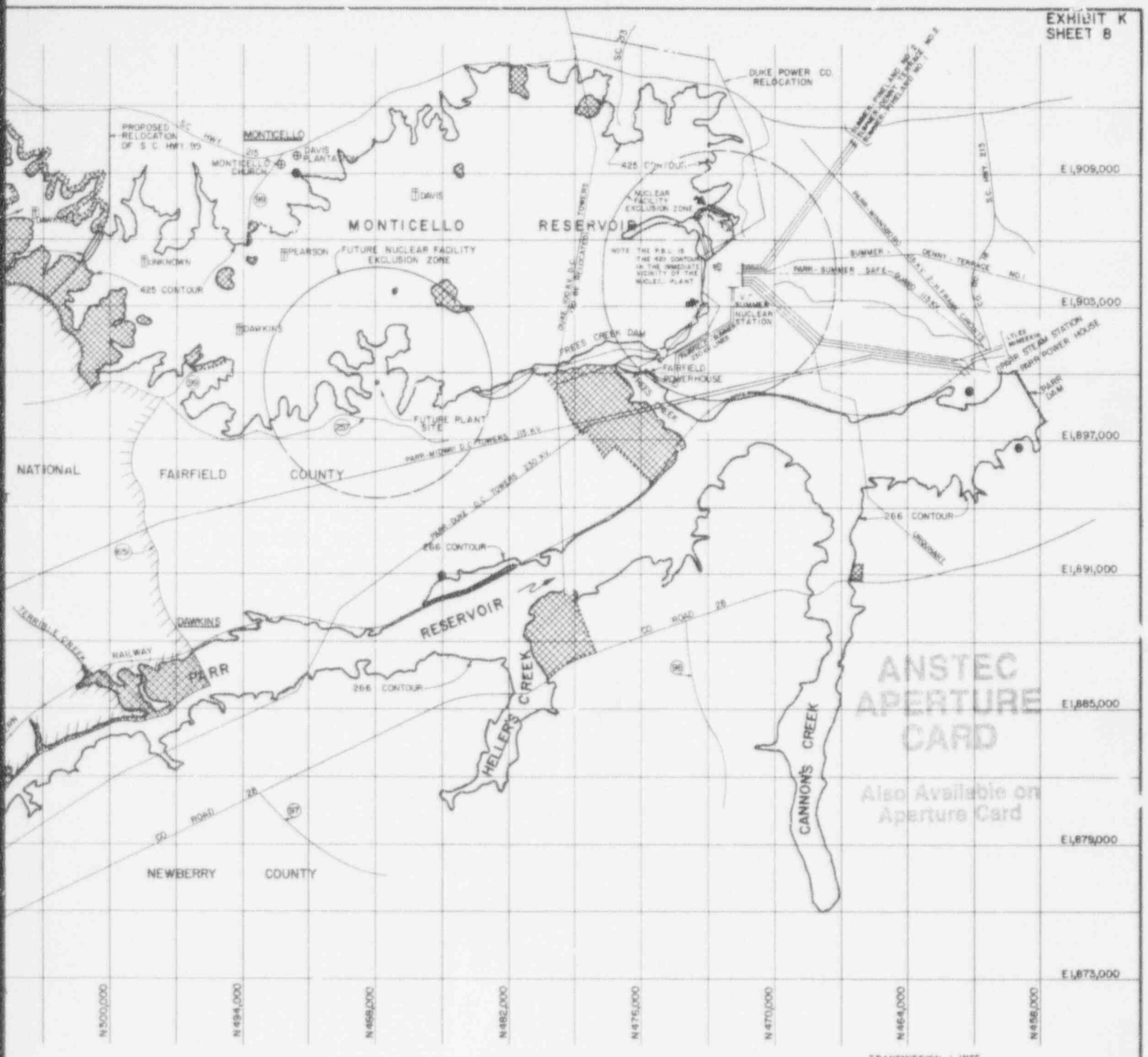
1. SOUTHERN RAILWAY RIGHT OF WAY PROPERTY IS EXCLUDED FROM THIS PROJECT.
2. ALL LAND FOR RECREATIONAL DEVELOPMENT IS INCLUDED IN PROJECT BOUNDARY AS INDICATED BY DOTTED P.B.L.
3. THE PROJECT BOUNDARY LINE WILL EXTEND INLAND A MINIMUM OF 25' FEET HORIZONTAL DISTANCE FROM THE 266' CONTOUR FOR THE LOWER RESERVOIR AND THE 425' CONTOUR FOR THE UPPER RESERVOIR. EXCEPTIONS TO THIS ARE SHOWN BY THE DOTTED PROPERTY BOUNDARY LINES, OR AS NOTED.
4. CO-ORDINATES SHOWN ARE BASED ON STATE GRID SYSTEM.
5. ELEVATIONS SHOWN ARE CORRECTED ACCORDING TO RECENT SURVEY BASED ON U.S.C. & G.S. DATUM (M.S.L.)

THIS DRAWING IS APPROVED AS CORRECT
THE AMENDED APPLICATION FOR A NEW
NO. 1894 MADE BY THE UNDERSIGNED T
JULY, 1972.

SOUTH CAROLINA ELECTRIC AND GA

BY D. C. Summer
SENIOR VICE-PRESIDENT

EXHIBIT K
SHEET 8



TRANSMISSION LINES
PROPOSED
EXISTING

- ARCHEOLOGICAL SITES
- CEMETERIES
- HISTORICAL SITES
- U.S. FORESTRY LAND TO BE FLOODED
- P.B.L. (PROJECT BOUNDARY LINE)
- RECREATIONAL LAND AREA
- SUMTER NATIONAL FOREST BOUNDARY

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K8

GENERAL MAP OF PROJECT AREA
SHEET 8 OF 8
PARR HYDROELECTRIC PROJECT NO. 1894
SOUTH CAROLINA ELECTRIC & GAS COMPANY

SCALE: 1"=2500'
0 2500 5000

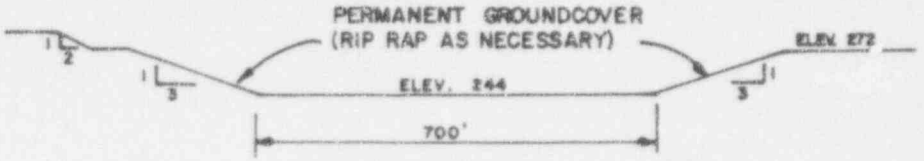
9406090201-31

THIS DRAWING IS A PART OF THE AMENDED APPLICATION FOR A NEW LICENSE FOR PROJECT NO. 1894 MADE BY THE UNDERSIGNED THIS 22ND DAY OF FEBRUARY 1972

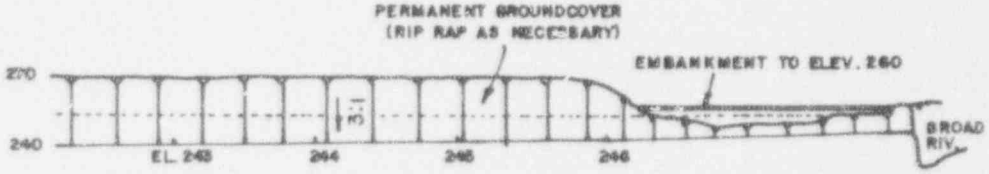
SOUTH CAROLINA ELECTRIC AND GAS COMPANY
BY W. C. Summer
SENIOR VICE-PRESIDENT

...D, AS A PART OF
...ICENSE FOR PROJECT
...S 17th DAY OF
... COMPANY

FIGURE 3
APRIL 1976



SECTION BB



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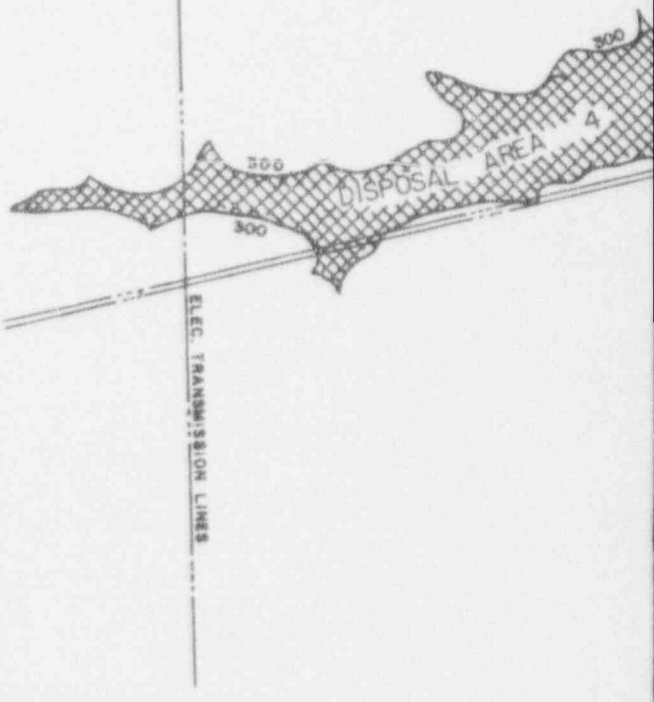

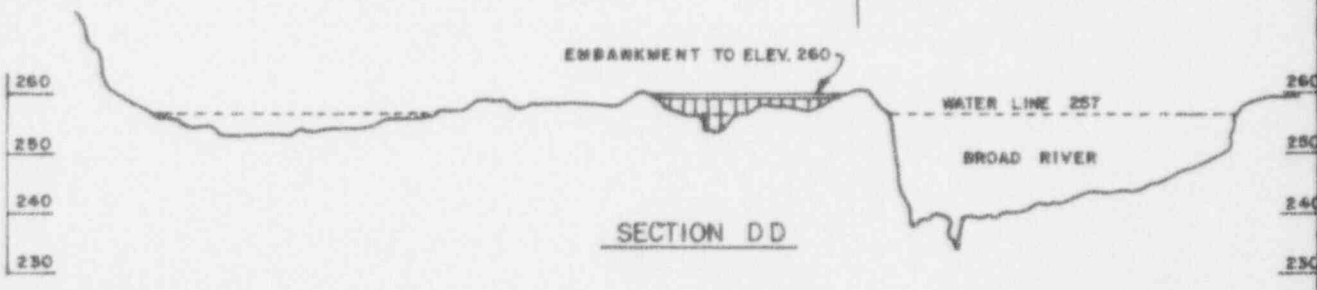

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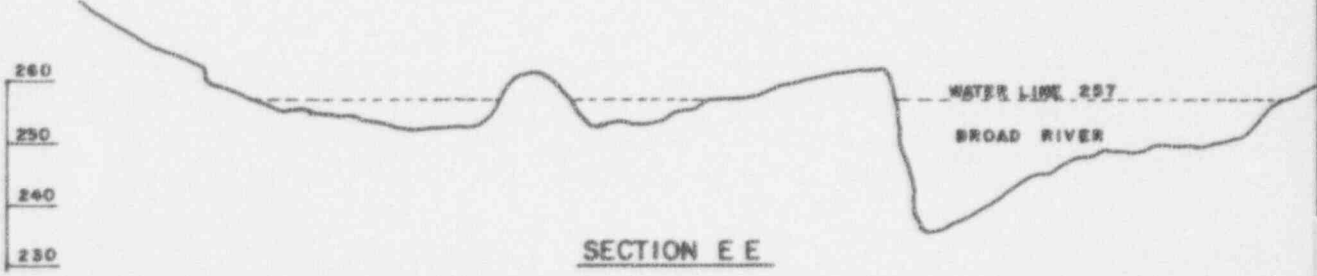

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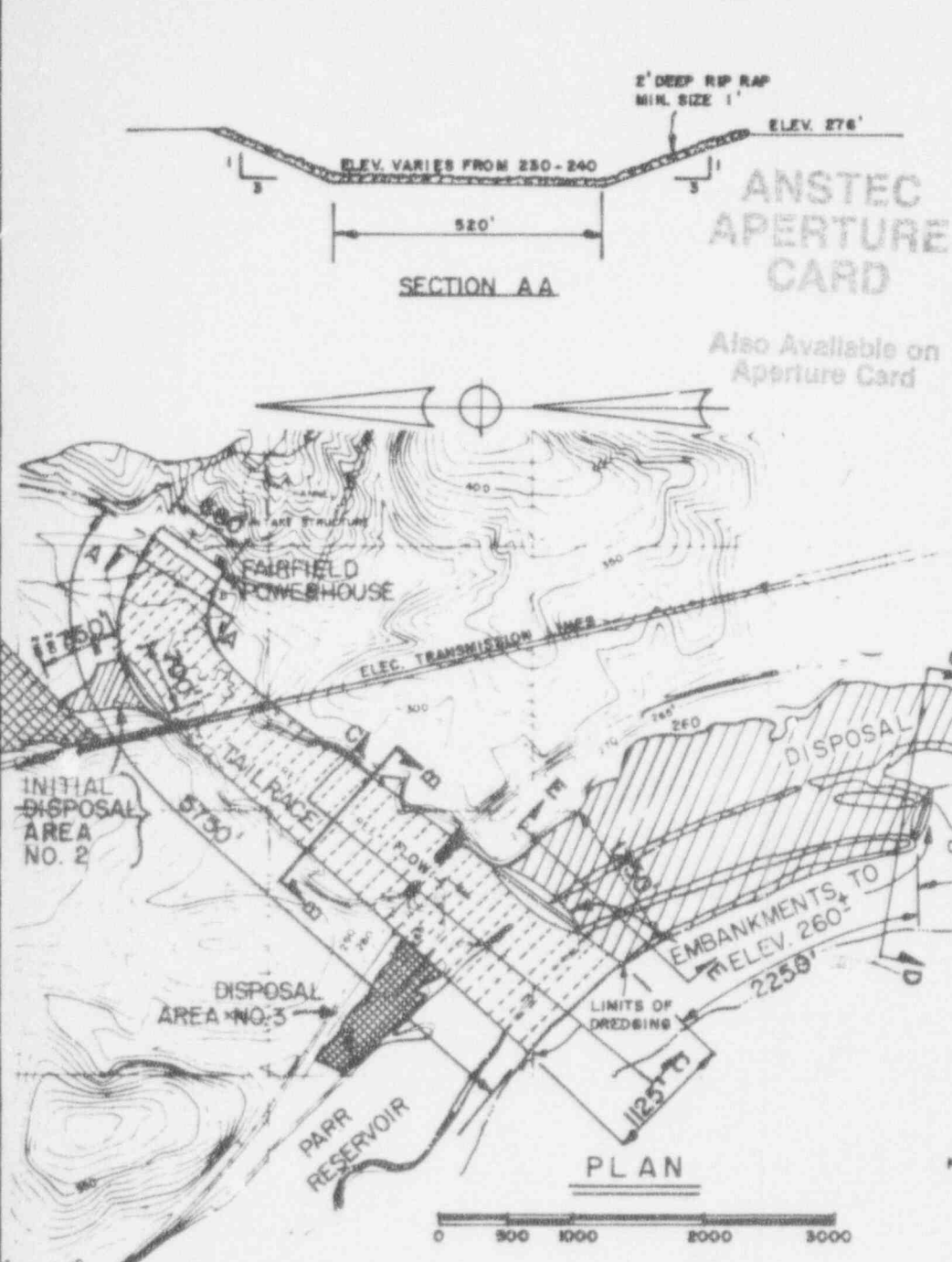

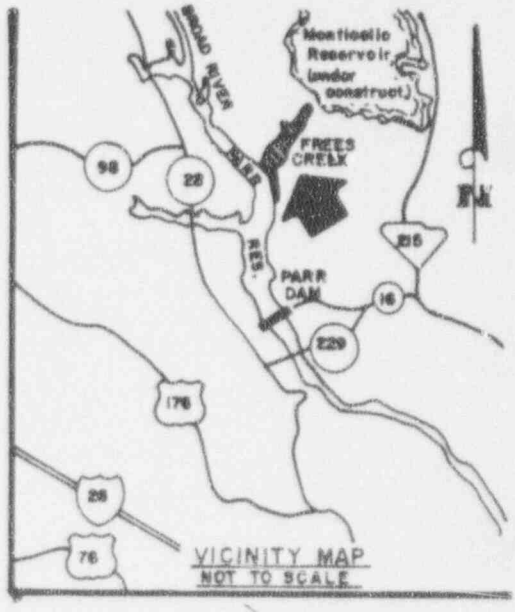

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NOTE: APPROXIMATELY 1,900,000 CUBIC YARDS OF SOLID MATERIALS TO BE DREDGED BY DREDGING MACHINE ON BARGE AND DEPOSITED AT DISPOSAL AREAS NO. 1 AND NO. 2.

PURPOSE: Dredge Tailrace Canal From Pumped Storage Facility To Broad River.

DATUM: Mean Sea Level

NAME AND ADDRESS OF ADJACENT PROPERTY OWNERS

1- South Carolina Electric & Gas Co.
P.O. Box 764, Columbia, S.C. 29218
Owns all adjoining property with the exception of that listed below.

2- Southern Railway Co.
1770 Andrews Rd.
Columbia, S.C. 29201
Owns right-of-way for existing railroad trestle.

260
250
240
230

PROPOSED DREDGING & DISPOSAL

IN: FREES CREEK & BROAD RIVER

AT: NEAR JENKINSVILLE, NORTH OF PARR DAM

COUNTY OF: FAIRFIELD STATE: S.C.

APPLICATION BY:

SOUTH CAROLINA ELECTRIC & GAS CO.

FIGURE - 4

DATE: MARCH 26, 1976

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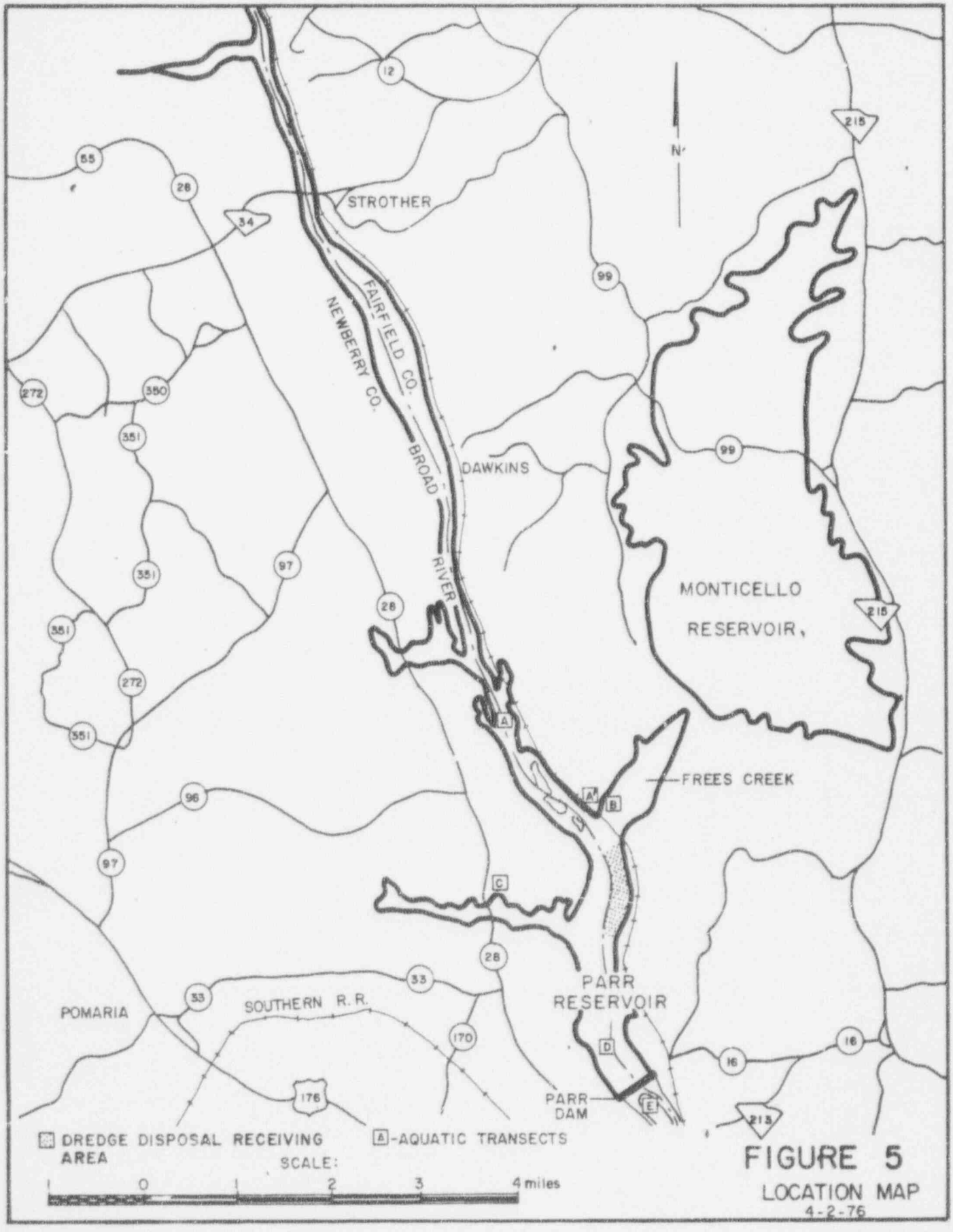
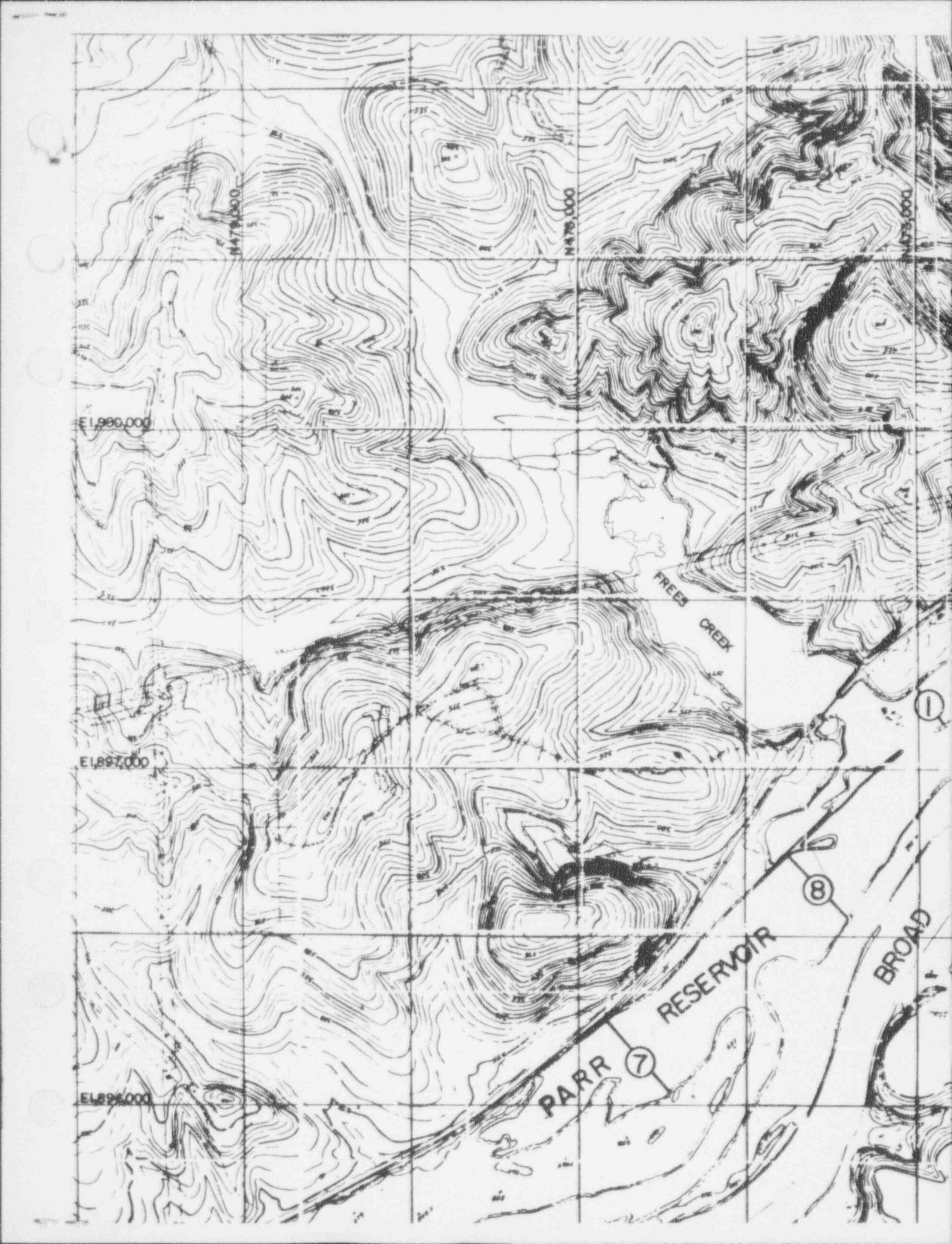


FIGURE 5
LOCATION MAP
4-2-76


N479,000
N477,000
N475,000
E1,900,000
E1,897,000
E1,894,000
FREES CREEK
PARR RESERVOIR
BROAD
1
7
8

ANSTEC APERTURE CARD
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9406090201-33

AQUATIC SAMPLING STATIONS IN THE DREDGE DISPOSAL RECEIVING AREA

FIGURE 6

APRIL, 1976

⑦ SAMPLING STATION

PARR HYDROELECTRIC PROJECT

PRE-OPERATIONAL SAMPLING LOCATIONS AND SCOPE OF HYDROLOGICAL MONITORING PROGRAM

REVISED 3/25/75

LOCATIONS

(1) BROAD RIVER AT HIGHWAY34 BRIDGE
(2) BROAD RIVER AT FREES CREEK TRESTLE
*(3) FREES CREEK ABOVE DIVERSION DAM
(4) FREES CREEK AT HIGHWAY 99
(5) BROAD RIVER AT PARR DAM
(6) BROAD RIVER AT HIGHWAY 213 BRIDGE
(7) BROAD RIVER AT RICHTEX
(8) BROAD RIVER AT I-20
** (9) SPRINGS WA, WB, WC (WEST OF MONTICELLO RESERVOIR)
**(10) SPRINGS EA, EB, EC (EAST OF MONTICELLO RESERVOIR)

NOTE: * RELOCATED AS ADDED
** CONTACT FAIRFIELD CONSTRUCTION SITE FOR SPRING LOCATIONS (779-8590 EXT. 357)

MONITORING PROGRAM

DAILY (MONDAY THROUGH FRIDAY)

LOCATION: STATION 5 ONLY
ANALYSES: ODOR, OBVIOUS OIL AND/OR GREASE, SEECHIE, pH, COND.

BI-WEEKLY (MONDAY & THURSDAY OR TUESDAY & FRIDAY)

LOCATION: STATIONS 1 THROUGH 6
ANALYSES: pH, D.O., COND., SED., T/H_2O, T/AIR, ODOR, OBVIOUS OIL AND GREASE

MONTHLY

LOCATION: STATIONS 1 THROUGH 5
ANALYSES: T/H_2O, T/AIR, pH, P-ALK, M.O.-ALK, Cl, COND., Ca-HARDNESS, Mg-HARDNESS, TOTAL-HARDNESS, COLOR, TURB., TOTAL SOLIDS, SUSPENDED SOLIDS, NH_3, PO_4, SiO_2, NO_3, SO_4, CO_2, C.O.D., B.O.D., D.O., SEECHIE, OIL & GREASE, ALUMINUM, BERYLLIUM, BORON, COBALT, MAGNESIUM, MANGANESE, MOLYBDENUM, SELENIUM, SILVER, STRONTIUM, TIN VANADIUM

Figure 7

QUARTERLY

LOCATION: STATIONS 1 THROUGH 10
ANALYSES: SAME AS MONTHLY BUT ADD:
ARSENIC, CADMIUM, CHROMIUM, COPPER, IRON,
LEAD, MERCURY, NICKEL, ZINC