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AUGUST · 1 · 1972

VOLUME I

1057-B

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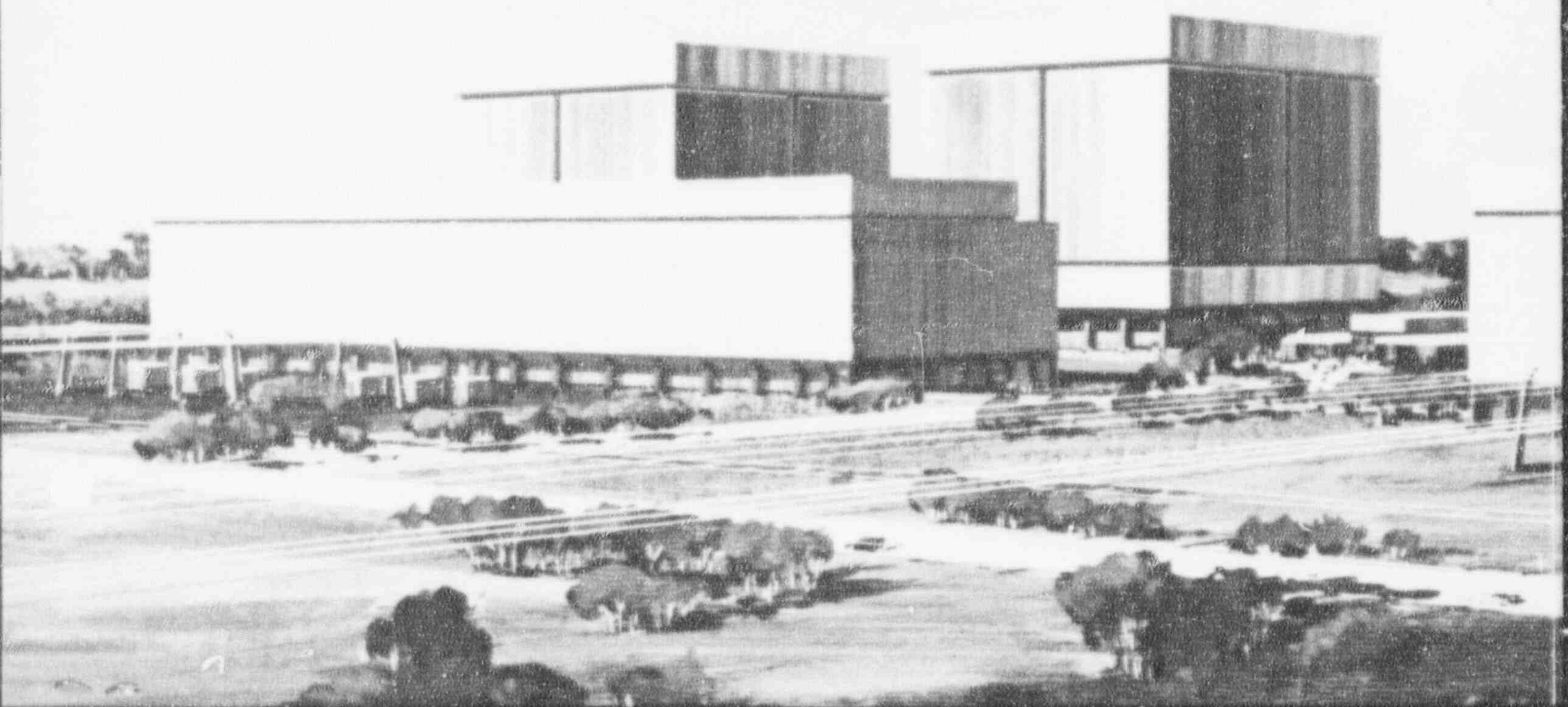

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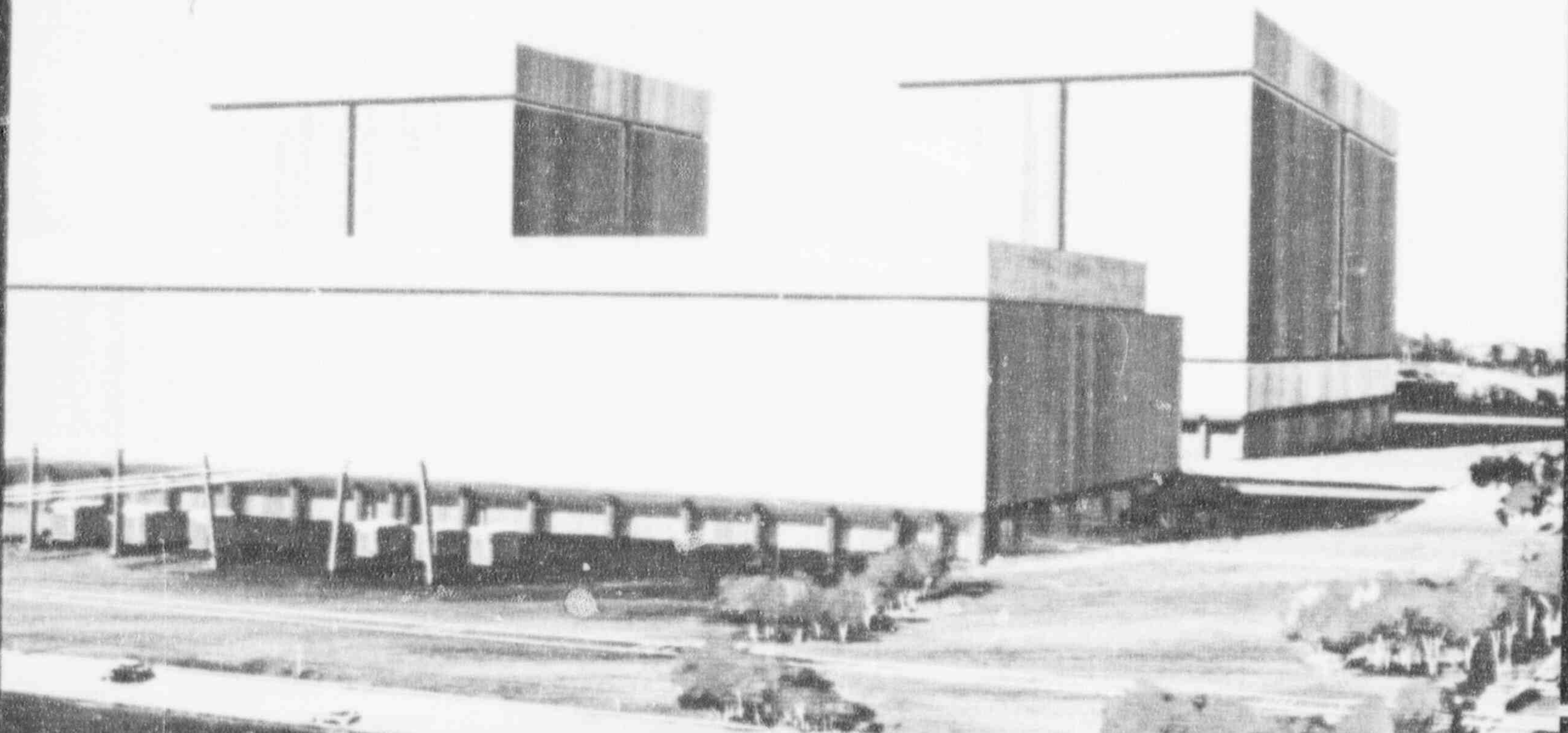


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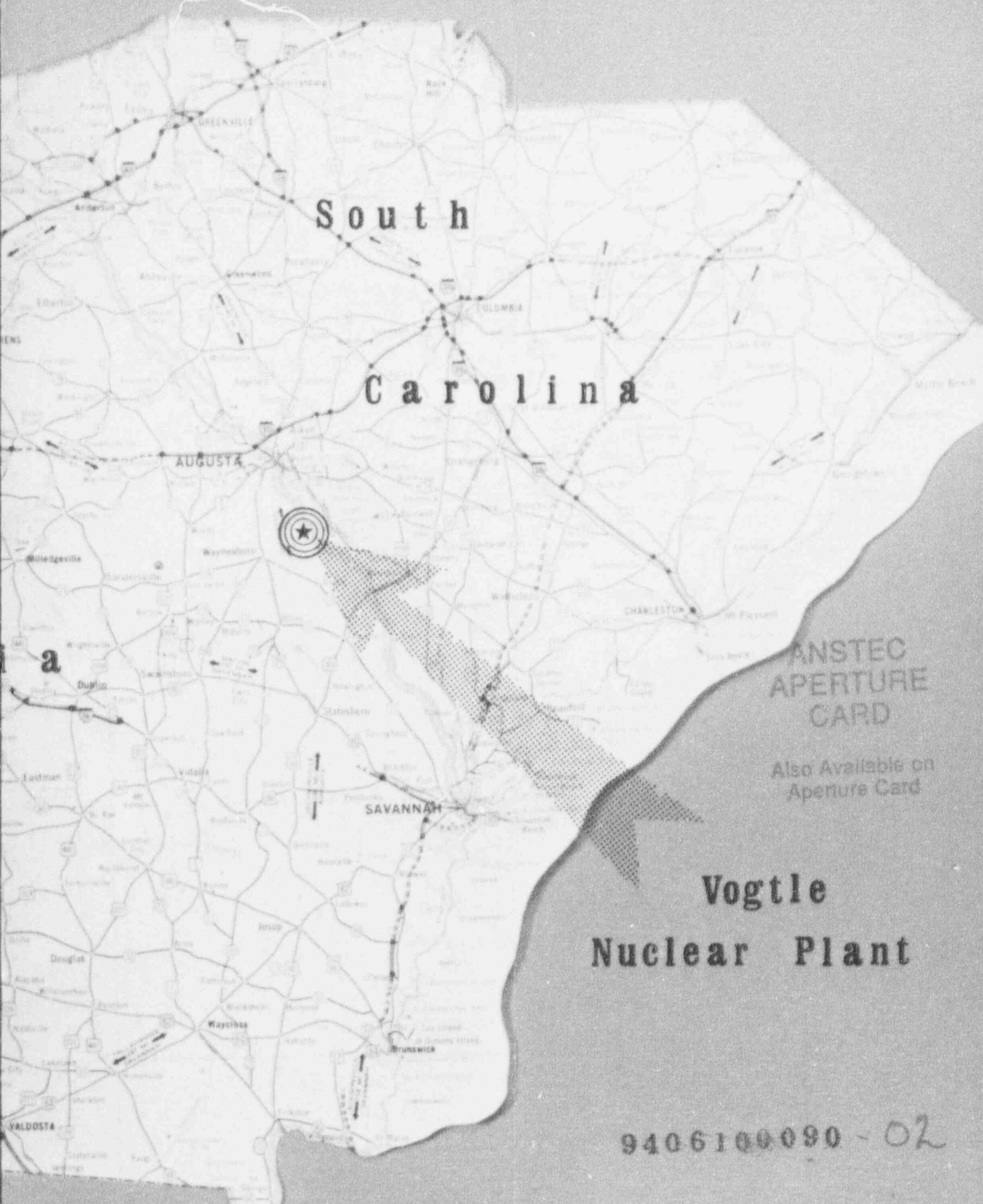

Vogtle Nuclear Plant

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1. INTRODUCTION

1.1 DESCRIPTION OF PROPOSED PLANT AND SITE

The Georgia Power Company (GPC) proposes to construct a nuclear-powered steam-electric generating plant on a 3177-acre site in Burke County, Georgia, to be known as the Alvin W. Vogtle Nuclear Plant (VNP). The plant will consist of 4 units, hereafter designated VNP-1, VNP-2, VNP-3, VNP-4. There will be 4 pressurized water reactors, each rated at 3425 MWt. Gross and net electrical output for each unit will be 1160 MWe and 1100 MWe respectively. Cooling will be provided by natural draft, closed-cycle cooling towers.

A detailed site description is included in Chapter 2 of this report. In general, the site is relatively remote from large population areas and is characterized by broad, flat areas that slope gently southward. The site is considered to be entirely suitable from an environmental viewpoint for the construction of this plant.

An existing 350 MW Combustion Turbine Plant occupies approximately 24 acres of 3177-acre site, approximately 4500 feet southeast of the proposed VNP-1 containment center. These turbines are separate from VNP and are not part of the application for construction of VNP by GPC.

The principal structures of the plant will be:

(1) Enclosure Buildings (which enclose the reactors and containment);

(2) Turbine Buildings (which house the turbine generators, condensers, and accessory equipment);

(3) Auxiliary Buildings (which house the radwaste system for handling of radioactive wastes, and other reactor auxiliary systems);

(4) Control Buildings (which house the control room, laboratories, test shop, and areas required for plant operations);

(5) Fuel Handling Buildings (which house the spent-fuel pool, the new-fuel storage area, and the fuel handling equipment);

(6) Diesel Generator Buildings (which house the emergency AC power supply for the plant);

(7) Main Cooling Towers (which cool the circulating water for the power conversion system);

(8) Nuclear Service Cooling Towers (which cool the nuclear service water);

(9) Intake Structure (which provides makeup water to the circulating water cooling towers, and dilution flow for the blowdown of the cooling towers and liquid radwaste system);

(10) Outfall Structure (which discharges diluted liquid radwaste and cooling tower blowdown);

(11) Switchyard (which contains the equipment for distribution of power);

(12) Meteorological Tower (which monitors and records various atmospheric weather parameters);

(13) Tanks (for storage of water and other fluids);

(14) Service Building (which contains administration and maintenance facilities for plant operation);

(15) Warehouse (which contains storage facilities for plant);

(16) Demineralizer Building (which contains equipment to provide demineralized water for plant services);

(17) Start-up Boiler (which provides steam for start-up of of the plant);

(18) Barge Slip (for shipments which arrive via the Savannah River).

1.2 REQUIREMENT FOR POWER

This section presents some of the reasons and causes which make it neccessary for GPC to add 4400 MWe of capacity to its system during the 4-year period of 1980-83, at the rate of 1100 MWe a year. These same reasons will be shown for the Southern Company system because these 4 units will be connected to 500 kV lines which make it feasible to supply large blocks of power to most areas within the Southern Company system. The reasons and causes for placing this capacity at this particular location are discussed in Section 8.4, and the reasons and causes for selecting nuclear-type generation, as opposed to some other type, are discussed in Section 8.3.

1.2.1 DEMAND CHARACTERISTICS

GPC is a public utility incorporated under the laws of the state of Georgia and is engaged in the generation, distribution, and sale of electricity. GPC serves almost 1,000,000 customers in a service area of about 57,000 square miles, constituting 97% of the land area of Georgia, with an installed generating capacity of 7,300 megawatts at the time of the most recent peak load, which occurred on July 24, 1972. GPC provides retail electric service to 646 cities and towns, and wholesale electric service to 50 municipal electric systems and 39 rural electric cooperatives.

The economic growth of the state of Georgia in the decade of 1959-1969 is shown on Table 1.2-1 and is compared to the growth in the entire United States.

Annual electrical energy (KWH) sales by GPC divisions for the period from 1960 to 1972 are given in Table 1.2-2. KWH sales by types of users are given for 1960 and 1972 in Table 1.2-2a. 1

Among the industrial customers, the major users of power are in order:

1. Textile mill products
2. Chemical and allied products
3. Food and kindred products
4. Stone, clay, and glass products
5. Government
6. Transportation equipment
7. Paper and allied products

The GPC territorial peak hour load, which occurred on July 24, 1972, between 2:00 and 3:00 P.M. CDT, was 7,411 MW. This excludes 272 MW of load supplied by the Southeastern Power Administration and wheeled by GPC to territorial customers and excludes 5 MW of load supplied by SEPA and wheeled by GPC to Crisp County Power Commission.

Table 1.2-1

Economic Growth of Georgia

	1969*	1959	10-Year Gain-% Ga.	10-Year Gain-% U.S.
Per Capita Personal Income - $	3,040	1,609	88.9	70.3
Total Personal Income - Millions $	14,108	6,222	126.7	95.0
Construction Contracts Awarded Millions $	1,657	692	139.5	85.9
Deposits, All Banks - Millions $	6,438	2,641	145.7	104.1
Bank Debits - Millions $	101,215	31,853	217.8	244.6
Nonfarm Employment - Thousands	1,522	1,030	47.8	31.6
Manufacturing Employment - Thousands	477	339	40.7	20.7
Nonmanufacturing Employment - Thousands	1,045	691	51.2	36.5

*Latest year for which comparable statistics are available.

Source: Statistics on the Developing South - Research Dept., Federal Reserve Bank of Atlanta.

Table 1.2-2

GEORGIA POWER COMPANY DIVISIONAL ANNUAL KWH SALES

YEAR	ATLANTA	ATHENS	AUGUSTA	COLUMBUS	MACON	ROME	VALDOSTA	GENERAL	TOTAL
1960	2,902,838,871	1,282,746,425	731,523,536	1,758,959,355	2,225,441,916	1,483,964,972	499,745,123	303,095,927	11,188,316,125
1961	3,051,575,262	1,375,506,614	760,398,350	1,520,657,133	2,380,186,761	1,562,573,642	898,086,932	435,234,288	11,984,218,982
1962	3,479,666,709	1,515,371,032	921,138,344	1,690,345,225	2,610,831,987	1,741,385,641	974,961,856	318,981,176	13,253,181,970
1963	3,725,888,638	1,555,701,518	1,041,621,967	1,755,365,529	2,684,411,080	1,796,920,920	1,005,229,819	558,189,453	14,223,328,924
1964	4,230,443,009	1,676,397,521	1,170,406,350	1,916,112,861	2,821,127,859	1,915,208,404	1,102,858,368	951,305,370	15,783,859,742
1965	4,839,593,394	1,871,018,236	1,369,337,098	2,160,204,996	3,204,702,163	2,163,186,698	1,242,324,161	929,954,216	17,780,320,962
1966	5,387,873,885	2,133,717,794	1,813,369,807	2,353,572,055	3,479,507,613	2,443,565,877	1,432,803,353	575,665,884	19,620,076,868
1967	5,828,533,676	2,428,012,813	1,958,469,103	2,505,618,466	3,695,687,599	2,620,542,653	1,549,881,512	340,087,670	20,926,833,492
1968	6,815,872,327	2,817,134,455	2,221,649,768	2,890,231,564	4,307,503,763	2,991,180,598	1,845,531,876	376,028,706	24,265,133,057
1969	7,817,748,137	3,119,255,621	2,499,231,913	3,152,855,645	4,782,092,673	3,330,407,806	2,025,596,912	105,484,489	26,832,673,196
1970	8,826,403,788	3,471,267,699	2,764,908,216	3,507,663,896	5,117,725,500	3,635,599,342	2,274,108,916	548,773,385	30,146,450,742
1971	9,456,556,284	3,657,497,091	2,932,925,572	3,715,195,143	5,442,820,257	3,971,649,763	2,420,357,231	211,245,851	31,808,247,192
1972	10,446,169,350	4,053,418,714	3,099,305,623	4,035,608,852	5,950,368,832	4,386,319,544	2,620,743,630	157,012,688	34,748,947,333
									272,561,588,585

Table 1.2-3 shows GPC dependable capacity during the above period. Table
1.2-4 shows GPC capacity vs. load for the last 10 years. Table 1.2-4a 1
shows GPC monthly peak hour demand from 1960 to 1972. Table 1.2-5 shows
the Southern Company system capacity vs. load for the last 10 years.
Table 1.2-5a shows the Southern Company system peak hour demand from 1960 1
to 1972. Table 1.2-6 is a tabulation of estimated peak load and planned
capacity for GPC's system in the years before the VNP units are planned
to be put in service and for 2 subsequent years. The Southern Company
system's projected loads and planned capacity at the time the VNP units
are planned to be put in service and for 2 subsequent years is shown on
Table 1.2-7. Planned generation additions for GPC's system are shown
in Table 1.2-8. Planned generation additions for the Southern Company
system is shown in Table 1.2-9. GPC's transmission and generating system
is shown in Figure 1.2-1. The VNP site is emphasized on this map to
indicate that it is relatively remote from GPC's other generating facilities.

Load duration curves for the years 1980-83 for the systems are on Figures 1.2-2 to 1.2-9. From these curves it can be seen that the installed nuclear capacity will very easily fit a base-load type of generation plan.

Table 1.2-2a

GPC Electric Energy Sales

	1960	1972
Residential	2,616,183,588 KWH	8,193,456,165 KWH
Commercial	2,099,474,594 KWH	7,686,138,735 KWH
Industrial	4,190,532,198 KWH	11,390,884,201 KWH
Wholesale (Mun. and EMC)	1,859,368,234 KWH	7,146,068,037 KWH
Other	345,872,311 KWH	332,400,195 KWH
TOTAL SALES	11,188,316,125 KWH	34,748,947,333 KWH

Table 1.2-3

GPC Dependable Capacity at Time of Most Recent Peak Load:

(a)	Hydro Plants	474 MW
(b)	Thermal Plants	6,826 MW
(c)	Net Firm Purchases and Sales of Capacity	739 MW
	Total Dependable Capacity	8,039 MW

TABLE 1.2-4

GPC SYSTEM CAPACITY VS. LOAD

1962 - 1972

Year	Capacity	Load	Reserve	% Reserve
1962	2,861 MW	2,659 MW	202 MW	7.6
1963	3,220 MW	2,882 MW	338 MW	11.7
1964	3,668 MW	3,082 MW	586 MW	19.0
1965	3,987 MW	3,409 MW	578 MW	17.0
1966	4,233 MW	3,940 MW	293 MW	7.4
1967	4,482 MW	4,034 MW	448 MW	11.1
1968	5,043 MW	5,100 MW	-57 MW	---
1969	5,631 MW	5,484 MW	147 MW	2.7
1970	6,321 MW	6,197 MW	124 MW	2.0
1971	6,552 MW	6,337 MW	215 MW	3.4
1972	8,039 MW	7,411 MW	628 MW	8.5

TABLE 1.2-4a

GPC-MONTHLY PEAK-HOUR DEMAND-MW

MONTH	1960	1961	1962	1963	1964	1965	1966	1967	1968
JAN.	1991.5	2072.2	2257.9	2470.3	2695.5	2820.4	3206.2	3391.5	4043.1
FEB.	1942.9	2082.0	2211.0	2382.8	2490.3	2816.1	3137.8	3488.5	3831.6
MAR.	1979.4	1970.2	2279.2	2211.4	2488.7	2749.4	3090.5	3220.6	3868.9
APR.	1870.2	1950.2	2181.2	2277.2	2384.7	2585.2	2850.1	3267.7	3446.0
MAY	2046.5	2107.6	2550.3	2475.4	2731.8	3007.8	2964.8	3715.7	3799.7
JUN.	2221.0	2329.2	2579.6	2800.1	3082.0	3160.7	3622.9	3872.0	4465.4
JUL.	2296.6	2496.6	2658.8	2712.5	2839.3	3251.7	3940.2	3804.3	4712.8
AUG.	2308.7	2532.1	2646.0	2881.5	2977.9	3409.3	3840.7	4034.5	5100.1
SEP.	2255.3	2415.7	2636.5	2759.1	2910.1	3240.4	3545.5	3589.4	4241.3
OCT.	2038.7	2140.5	2320.8	2327.1	2641.5	2884.2	3152.9	3356.6	3746.1
NOV.	1978.6	2136.5	2244.7	2421.7	2763.5	3057.5	3453.2	3727.5	4266.4
DEC.	2186.7	2243.5	2540.5	2691.3	2760.7	3088.3	3461.7	3663.4	4334.2

Annual Peak-Hour Load is underlined.

TABLE 1.2-4a (cont.)

GPC-MONTHLY PEAK-HOUR DEMAND-MW

MONTH	1969	1970	1971	1972
JAN.	4272.3	5409.3	5423.0	5634.7
FEB.	4232.7	5016.7	5386.6	5588.2
MAR.	4204.6	4353.2	5023.7	5105.2
APR	3748.3	5017.3	4704.8	5248.3
MAY	4370.8	5018.1	5236.3	5393.1
JUN.	5436.0	5713.1	6288.7	6590.3
JUL.	5483.7	5978.5	6180.9	7410.9
AUG.	5297.8	6142.4	6336.7	7295.8
SEP.	5013.2	6197.1	6045.6	7106.8
OCT.	4191.3	4522.2	5770.1	5328.6
NOV.	4479.3	5344.9	5380.0	5846.4
DEC.	4620.2	4909.3	5397.1	6153.0

Annual Peak-Hour Load is underlined.

TABLE 1.2-5

SOUTHERN COMPANY SYSTEM CAPACITY VS. LOAD

1962 - 1972

Year	Capacity	Load	Reserve	% Reserves
1962	6,442 MW	5,546 MW	296 MW	16.2
1963	6,923 MW	6,051 MW	872 MW	14.4
1964	7,437 MW	6,523 MW	914 MW	14.0
1965	8,300 MW	7,122 MW	1,178 MW	16.5
1966	9,108 MW	8,064 MW	1,044 MW	12.9
1967	9,499 MW	8,256 MW	1,243 MW	15.0
1968	10,791 MW	10,163 MW	628 MW	6.2
1969	11,464 MW	10,859 MW	605 MW	5.6
1970	12,739 MW	11,822 MW	917 MW	7.8
1971	13,261 MW	12,245 MW	1,016 MW	8.3
1972	15,528 MW	14,132 MW	1,396 MW	9.9

TABLE 1.2-5a

SOUTHERN SYSTEM-MONTHLY PEAK-HOUR DEMAND-MW

MONTH	1960	1961	1962	1963	1964	1965	1966	1967	1968
JAN.	3872.2	4165.6	4437.9	4882.0	5297.3	5509.1	6272.2	6605.0	7615.8
FEB.	3846.3	4086.3	4298.5	4708.4	4843.3	5567.7	6217.6	6647.5	7396.8
MAR.	3900.0	3878.2	4368.3	4357.0	4838.3	5410.1	5913.8	6215.2	7335.3
APR.	3786.0	3898.1	4325.9	4595.7	4826.0	5321.6	5764.0	6654.7	6975.1
MAY	4197.6	4251.9	5184.9	5133.7	5762.3	6207.9	6222.9	7508.6	7752.8
JUN.	4616.8	4678.2	5282.9	5842.4	6523.4	6584.7	7416.1	8256.4	9215.1
JUL.	4746.7	5047.6	5496.2	5682.8	6015.1	6791.4	8064.4	7978.3	9658.1
AUG.	4754.8	5145.9	5546.5	6050.7	6353.4	7121.6	7847.3	8111.0	10,162.8
SEP.	4626.1	4914.9	5426.7	5659.2	6299.1	6872.6	7325.3	7440.1	8653.2
OCT.	4073.9	4308.2	4758.3	4751.7	5594.7	5859.6	6319.5	6583.7	7800.7
NOV.	4039.1	4321.4	4493.9	4876.2	5497.6	5955.6	6678.7	7189.5	8108.1
DEC.	4376.3	4471.7	5129.3	5274.7	5429.8	6023.7	6819.2	7110.8	8250.9

Annual Peak-Hour Load is underlined.

TABLE 1.2-5a (cont.)

SOUTHERN SYSTEM-MONTHLY PEAK-HOUR DEMAND-MW

MONTH	1969	1970	1971	1972
JAN.	8073.4	9879.4	9839.4	10,252.6
FEB.	8105.5	9352.1	9884.5	10,320.4
MAR.	7938.7	8308.5	9293.2	9363.0
APR.	7313.6	9715.0	8916.1	9919.1
MAY	8949.3	9823.6	10,009.0	10,584.3
JUN.	10,858.6	11,447.9	12,229.2	12,718.8
JUL.	10,847.9	11,567.0	12,245.2	14,072.3
AUG.	10,299.5	11,821.7	12,210.3	14,131.9
SEP.	9995.5	11,796.8	11,572.4	13,681.9
OCT.	8476.7	8625.2	11,259.1	10,521.6
NOV.	8538.6	9788.5	9923.9	10,763.9
DEC.	6846.8	9167.1	10,087.0	11,247.6

Annual Peak-Hour Load is underlined.

TABLE 1.2-6

GPC SYSTEM CAPACITY VS. LOAD

1973 - 1985

Year	Capacity	Load	Reserve	% Reserves
1973	8,507 MW	8,228 MW	279 MW	3.4
1974	10,907 MW	9,028 MW	1,879 MW	20.8
1975	12,103 MW	10,028 MW	2,075 MW	20.7
1976	13,336 MW	11,028 MW	2,308 MW	20.9
1977	14,570 MW	12,228 MW	2,342 MW	19.2
1978	15,787 MW	13,628 MW	2,159 MW	15.8
1979	17,433 MW	15,128 MW	2,305 MW	15.2
1980	19,743 MW	16,728 MW	3,015 MW	18.0
1981	21,920 MW	18,528 MW	3,392 MW	18.3
1982	25,030 MW	20,528 MW	4,502 MW	21.9
1983	27,580 MW	22,728 MW	4,852 MW	21.3
1984	29,880 MW	25,128 MW	4,752 MW	18.9
1985	32,830 MW	27,828 MW	5,002 MW	18.0

TABLE 1.2-7

SOUTHERN COMPANY SYSTEM CAPACITY VS. LOAD

1973 - 1985

Year	Capacity	Load	Reserve	% Reserves
1973	17,595 MW	15,509 MW	2,086 MW	13.4
1974	20,815 MW	16,977 MW	3,838 MW	22.6
1975	22,788 MW	18,697 MW	4,091 MW	21.9
1976	24,714 MW	20,577 MW	4,137 MW	20.1
1977	27,007 MW	22,666 MW	4,341 MW	19.2
1978	29,580 MW	25,037 MW	4,543 MW	18.1
1979	32,495 MW	27,600 MW	4,895 MW	17.7
1980	35,808 MW	30,362 MW	5,446 MW	17.9
1981	39,685 MW	33,434 MW	6,251 MW	18.7
1982	44,045 MW	36,824 MW	7,221 MW	19.6
1983	48,295 MW	40,545 MW	7,750 MW	19.1
1984	53,145 MW	44,610 MW	8,535 MW	19.1
1985	58,395 MW	49,131 MW	9,264 MW	18.8

TABLE 1.2-8

GEORGIA POWER COMPANY
PLANNED GENERATION ADDITIONS

Year	Unit	Type	Capability - MW
1973	McManus C.T.	C.T.	316
	Vogtle C.T.	C.T.	328
1974	Hatch #1	Nuclear Steam	800
	Bowen #3	Fossil Steam	910
	Yates #6	Fossil Steam	363
	Yates #7	Fossil Steam	363
1975	Bowen #4	Fossil Steam	910
1976	Wansley #1	Fossil Steam	910
1977	Wansley #2	Fossil Steam	910
	Wallace Dam #1,2,5, & 6	Pumped Hydro	216
	Wallace Dam #3 & 4	Hydro	108
1978	Hatch #2	Nuclear Steam	803
	Unlocated	C.T.	450
1979	Wansley #3	Fossil Steam	910
	Rocky Mountain	Pumped Hydro	675
	Bartletts Ferry	Hydro	100
1980	VNP #1	Nuclear Steam	1100
	Wansley #4	Fossil Steam	910
	Unlocated	C.T.	300
1981	VNP #2	Nuclear Steam	1100
	Goat Rock	Hydro	67
	Unlocated	Fossil Steam	910
	Unlocated	C.T.	100
1982	VNP #3	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Fossil Steam	910
1983	VNP #4	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	350
1984	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	100
1985	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	750

TABLE 1.2-8

GEORGIA POWER COMPANY
PLANNED GENERATION ADDITIONS

Year	Unit	Type	Capability - MW
1973	McManus C.T.	C.T.	316
	Vogtle C.T.	C.T.	328
1974	Hatch #1	Nuclear Steam	800
	Bowen #3	Fossil Steam	910
	Yates #6	Fossil Steam	363
	Yates #7	Fossil Steam	363
1975	Bowen #4	Fossil Steam	910
1976	Wansley #1	Fossil Steam	910
1977	Wansley #2	Fossil Steam	910
	Wallace Dam #1,2,5, & 6	Pumped Hydro	216
	Wallace Dam #3 & 4	Hydro	108
1978	Hatch #2	Nuclear Steam	803
	Unlocated	C.T.	450
1979	Wansley #3	Fossil Steam	910
	Rocky Mountain	Pumped Hydro	675
	Bartletts Ferry	Hydro	100
1980	VNP #1	Nuclear Steam	1100
	Wansley #4	Fossil Steam	910
	Unlocated	C.T.	300
1981	VNP #2	Nuclear Steam	1100
	Goat Rock	Hydro	67
	Unlocated	Fossil Steam	910
	Unlocated	C.T.	100
1982	VNP #3	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Fossil Steam	910
1983	VNP #4	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	350
1984	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	100
1985	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	750

TABLE 1.2-9

SOUTHERN COMPANY SYSTEM
PLANNED GENERATION ADDITIONS

Year	Unit	Type	Capability - MW
1973	McManus C.T.	C.T.	316
	Vogtle C.T.	C.T.	328
	Crist #7	Fossil Steam	516
	Watson #5	Fossil Steam	520
1974	Hatch #1	Nuclear Steam	800
	Bowen #3	Fossil Steam	910
	Yates #6	Fossil Steam	363
	Yates #7	Fossil Steam	363
	Gaston #5	Fossil Steam	910
1975	Bowen #4	Fossil Steam	910
	Farley #1	Nuclear Steam	844
1976	Wansley #1	Fossil Steam	910
	Jackson County #1	Fossil Steam	518
1977	Wansley #2	Fossil Steam	910
	Wallace Dam #1,2,5, & 6	Pumped Hydro	216
	Wallace Dam #3 & 4	Hydro	108
	Farley #2	Nuclear Steam	844
	Martin Dam	Hydro	55
	Mitchell Dam	Hydro	20
	Crooked Creek	Hydro	117
1978	Hatch #2	Nuclear Steam	803
	Unlocated	C.T.	600
	West Jefferson #1	Fossil Steam	653
	Unlocated	Fossil Steam	516
1979	Wansley #3	Fossil Steam	910
	Rocky Mountain	Pumped Hydro	675
	Bartletts Ferry	Hydro	100
	West Jefferson #2	Fossil Steam	653
	Unlocated	C.T.	100
	Unlocated	Fossil Steam	516
1980	VNP #1	Nuclear Steam	1100
	Wansley #4	Fossil Steam	910
	Unlocated	C.T.	650
	West Jefferson #3	Fossil Steam	653

TABLE 1.2-9 - Continued

Year	Unit	Type	Capability - MW
1981	VNP #2	Nuclear Steam	1100
	Goat Rock	Hydro	67
	Unlocated	Fossil Steam	910
	Unlocated	C.T.	700
	Central, Ala. #1	Nuclear Steam	1100
1982	VNP #3	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Fossil Steam	910
	Central, Ala. #2	Nuclear Steam	1100
	Unlocated	C.T.	150
1983	VNP #4	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	950
1984	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	450
1985	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	Nuclear Steam	1100
	Unlocated	C.T.	850

1.2.2 POWER SUPPLY

Historically, GPC has served its load in its service area through its transmission system with some small assistance through purchased power from adjacent companies. With the exception of a 1,600 megawatt plant near Baxley, Georgia, (under construction) and a small fossil plant at Brunswick (McManus), the greater part of GPC's generating capacity is located in central and northwest Georgia. One of the primary considerations in location of generating facilities is the availability and cost of fuel. Since coal has historically been GPC's primary fuel for generating plants, and transportation is a major component of the cost of coal, GPC's generating facilities have been located in the direction of a plentiful supply of coal. Because there are no economically recoverable coal reserves in GPC's service area, GPC has secured its coal from Alabama, Tennessee and Kentucky.

Since the cost of nuclear fuel is not dependent on geographic location, generating facilities utilizing nuclear fuel may be located with greater emphasis on electric system economic considerations. A generating plant is needed in the eastern sector of GPC's service area to supply the area load and to improve system reliability. The necessary development of GPC's 1
500 kV transmission system concurrent with the construction of the first unit make this site well located to supply other loads on the GPC's system with the 3 additional units planned. The 4 units planned for this site are needed to meet the growing load in Georgia, which is increasing by approximately 11 percent annually.

The completion of VNP in 1983 is a vital part of GPC's effort to provide for electrical requirements of its customers reliably and economically. The delay of this plant would require that this energy and capacity be replaced from other sources.

If VNP is not built, greater use will be required of so-called peaking plants (principally combustion turbines using #2 fuel oil) to carry base loads. Extensive use of #2 fuel oil in such cases can cause severe logistic problems for fuel suppliers; large tankage volumes would be required at many locations, and transportation facilities would be taxed.

The coal available for use at older plants contains large quantities of ash which must be collected from the precipitators and furnaces and stored in ponds. Storage pond volume is not readily obtainable. Also, these older plants are located on smaller streams in major metropolitan areas. Since these units use once-through cooling, considerable quantities of heat are discharged into the streams.

Under the best of operational circumstances (requiring the overload usage of older plants with attendant pollution, as noted above), some of the energy to be produced by VNP could be generated at other units of the GPC system. Even this possibility is in doubt, however, for the Federal Power Commission is being asked to subordinate the use of the natural gas in steam electric generating plants to all other gas uses.

The extraordinary growth of demand for electric energy in GPC's service area has required that central blocks of new generation capacity be installed each year. The annual peak hour loads for both the GPC and the Southern Company systems for the period 1962-1972 and the hours of their occurrence are given in Table 1.2-10. The capabilities of the GPC and the Southern Company systems (by types of capacity) at the times of these peak loads are given in Tables 1.2-11 and 1.2-12, respectively. Planned capabilities for these systems for the period 1973-1985 are given in Tables 1.2-13 and 1.2-14. System peak hour demands and net purchases for 1962 through 1985 are given in Tables 1.2-15 and 1.2-16. Sources of purchased power for GPC and the Southern Company system for this same period are shown in Tables 1.2-15a and 1.2-16a, respectively. 1

The expected capabilities for future years as given on Tables 1.2-11 and 1.2-12 include the planned retirement of older units. Some of the older units will be converted to other forms of fuel (i.e., coal to oil) in the near future, and no definite dates have been set for their retirement. A list of all system units now in operation is given in Table 1.2-17.

TABLE 1.2-10

ANNUAL PEAK-HOUR LOADS

	Southern System			Georgia Power Company		
Year	Demand (MW)	Date	Occurred Hour Ending (Cent. Time)	Demand (MW)	Date	Occurred Hour Ending (Cent. Time)
1962	5,546.5	Aug. 7	11:00 AM	2,658.8	July 17	11:00 AM
1963	6,050.7	Aug. 7	11:00 AM	2,881.5	Aug. 7	11:00 AM
1964	6,523.4	June 22	11:00 AM	3,082.0	June 22	11:00 AM
1965	7,121.6	Aug. 27	11:00 AM	3,409.3	Aug. 27	11:00 AM
1966	8,064.4	July 14	11:00 AM	3,940.2	July 13	11:00 AM
1967	8,256.4	June 20	1:00 PM	4,034.5	Aug. 8	3:00 PM
1968	10,162.8	Aug. 23	2:00 PM	5,100.1	Aug. 23	2:00 PM
1969	10,858.6	June 26	3:00 PM	5,483.7	July 14	3:00 PM
1970	11,821.7	Aug. 31	4:00 PM	6,197.1	Sept. 1	4:00 PM
1971	12,245.2	July 14	2:00 PM	6,336.7	Aug. 20	3:00 PM
1972	14,131.9	Aug. 7	4:00 PM	7,410.9	July 24	3:00 PM

TABLE 1.2-11

GPC SYSTEM CAPABILITY AT TIME OF PEAK LOAD BY TYPES OF CAPACITY - MW

1962 - 1972

Year	Nuclear	Fossil	Hydro	Pumped Hydro	Combustion Turbines	Net Purchases	Total
1962	--	2,090	411	--	--	360	2,861
1963	--	2,334	441	--	--	445	3,220
1964	--	2,763	443	--	--	462	3,668
1965	--	3,041	442	--	--	504	3,987
1966	--	3,068	441	--	--	724	4,233
1967	--	3,383	447	--	--	652	4,482
1968	--	3,916	474	--	--	653	5,043
1969	--	4,438	474	--	--	719	5,631
1970	--	4,974	473	--	126	748	6,321
1971	--	4,980	474	--	341	757	6,552
1972	--	6,331	474	--	495	739	8,039

TABLE 1.2-12

SOUTHERN COMPANY SYSTEM CAPABILITY AT TIME OF PEAK LOAD BY TYPES OF CAPACITY - MW

1962 - 1972

Year	Nuclear	Fossil	Hydro	Pumped Hydro	Combustion Turbines	Net Purchases	Total
1962	--	4,896	1,186	--	--	360	6,442
1963	--	5,164	1,263	--	--	496	6,923
1964	--	5,613	1,257	--	--	567	7,437
1965	--	6,288	1,396	--	--	616	8,300
1966	--	6,614	1,428	--	--	1,066	9,108
1967	--	7,129	1,459	--	--	911	9,499
1968	--	7,928	1,868	--	29	966	10,791
1969	--	8,455	1,864	--	29	1,116	11,464
1970	--	9,430	1,863	--	255	1,191	12,739
1971	--	9,633	1,864	--	594	1,170	13,261
1972	--	11,769	1,866	--	747	1,146	15,528

TABLE 1.2-13

GPC SYSTEM PLANNED CAPABILITY BY TYPES OF CAPACITY - MW

1973 - 1985

Year	Nuclear	Fossil	Hydro	Pumped Hydro	Combustion Turbines	Net Purchases	Total
1973	--	6,318	475	--	1,139	575	8,507
1974	764	7,954	475	--	1,139	575	10,907
1975	800	8,864	475	--	1,139	825	12,103
1976	800	9,774	475	--	1,139	1,148	13,336
1977	800	10,684	583	216	1,139	1,148	14,570
1978	1,567	10,684	583	216	1,589	1,148	15,787
1979	1,603	11,594	683	891	1,589	1,073	17,433
1980	2,703	12,504	683	891	1,889	1,073	19,743
1981	3,803	13,414	750	891	1,989	1,073	21,920
1982	6,003	14,324	750	891	1,989	1,073	25,030
1983	8,203	14,324	750	891	2,339	1,073	27,580
1984	10,403	14,324	750	891	2,439	1,073	29,880
1985	12,603	14,324	750	891	3,189	1,073	32,830

TABLE 1.2-14

SOUTHERN COMPANY SYSTEM PLANNED CAPACITY BY TYPE OF CAPACITY - MW

1973 - 1985

Year	Nuclear	Fossil	Hydro	Pumped Hydro	Combustion Turbines	Net Purchases	Total
1973	--	13,503	1,875	--	1,391	826	17,595
1974	764	15,989	1,875	--	1,391	796	20,815
1975	1,607	16,899	1,875	--	1,391	1,016	22,788
1976	1,644	18,327	1,875	--	1,391	1,477	24,714
1977	2,451	19,237	2,235	216	1,391	1,477	27,007
1978	3,255	20,406	2,235	216	1,991	1,477	29,580
1979	3,291	22,485	2,335	891	2,091	1,402	32,495
1980	4,391	24,048	2,335	891	2,741	1,402	35,808
1981	6,591	24,958	2,402	891	3,441	1,402	39,685
1982	9,891	25,868	2,402	891	3,591	1,402	44,045
1983	13,191	25,868	2,402	891	4,541	1,402	48,295
1984	17,591	25,868	2,402	891	4,991	1,402	53,145
1985	21,991	25,868	2,402	891	5,841	1,402	58,395

TABLE 1.2-15

GPC SYSTEM PEAK HOUR DEMAND AND NET PURCHASES - MW

1962 - 1985

Year	Load	Net Purchases	Adjusted Load
1962	2,659	360	2,399
1963	2,882	445	2,437
1964	3,082	462	2,620
1965	3,409	504	2,905
1966	3,940	724	3,216
1967	4,034	652	3,382
1968	5,100	653	4,447
1969	5,484	719	4,765
1970	6,197	748	5,449
1971	6,337	757	5,580
1972	7,411	739	6,672
1973	8,228	574	7,654
1974	9,028	575	8,453
1975	10,028	825	9,203
1976	11,028	1,148	9,880
1977	12,228	1,148	11,080
1978	13,628	1,148	12,480
1979	15,128	1,073	14,055
1980	16,728	1,073	15,655
1981	18,528	1,073	17,455
1982	20,528	1,073	19,455
1983	22,728	1,073	21,655
1984	25,128	1,073	24,055
1985	27,828	1,073	26,755

TABLE 1.2-15a

GPC - Net Purchases - MW

Source No.	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	285	321	321	321	321	321	321	321	356	345	345
2	75	75	75	75	75	75	75	75	75	75	75
3	-	-	18	60	60	60	14	(10)	(35)	-	10
4	-	-	-	-	49	-	(48)	(24)	(113)	-	-
5	-	49	48	48	73	49	48	-	50	-	-
6	-	-	-	-	146	147	243	246	289	156	155
7	-	-	-	-	-	-	-	111	126	182	155
8	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	(1)	(1)
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
Total	360	445	462	504	724	652	653	719	748	757	739

Sources

1	SEPA	7	Mississippi Power & Light Company
2	S.C.E.&G.	8	Interruptible customers
3	Savannah Electric & Power Co.	9	Crisp County Power Commission
4	Duke Power Company	10	South Mississippi Electric Power Assn.
5	Florida Power Corp.	11	Alabama Electric Cooperative, Inc.
6	Tennessee Valley Authority		

TABLE 1.2-15a (continued)

GPC - Net Purchases - MW

Source No.	1973	1974	1975	1976	1977	1978	1979-85
1	345	345	595	918	918	918	918
2	75	75	75	75	75	75	-
6	156	156	156	156	156	156	156
9	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Total	575	575	825	1148	1148	1148	1073

Notes:

(1) There are no reserves associated with purchases from SEPA.

(2) Beginning in 1963, purchase from SCE&G is firm capacity and does not require system reserves.

(3) Firm purchases from non-associated companies (Sources No. 3,4,5,6, & 7) have reserves provided by the selling company.

(4) Interruptible customers provide increased system reserves, and as such, do not have additional reserves associated with them.

(5) Sales to Crisp County Power Commission, Alabama Electric Cooperative, Inc., and 4 MW of the sales to South Mississippi Electric Power Assn. (Sources No. 9, 10 & 11) are designated as protective capacity.

(6) Quantities in parentheses indicate sales.

TABLE 1.2-16

SOUTHERN COMPANY SYSTEM PEAK HOUR DEMAND AND NET PURCHASES - MW

1962 - 1985

Year	Load	Net Purchases	Adjusted Load
1962	5,546	360	5,186
1963	6,051	496	5,555
1964	6,523	567	5,956
1965	7,122	616	6,506
1966	8,064	1,066	6,998
1967	8,256	911	7,345
1968	10,163	966	9,197
1969	10,859	1,116	9,743
1970	11,822	1,191	10,631
1971	12,245	1,170	11,075
1972	14,132	1,146	12,986
1973	15,509	826	14,683
1974	16,977	797	16,180
1975	18,697	1,017	17,680
1976	20,577	1,478	19,099
1977	22,666	1,478	21,188
1978	25,037	1,478	23,559
1979	27,600	1,403	26,197
1980	30,362	1,403	28,959
1981	33,434	1,403	32,031
1982	36,824	1,403	35,421
1983	40,545	1,403	39,142
1984	44,610	1,403	43,207
1985	49,131	1,403	47,728

Table 1.2-16a

Southern Company System Net Purchases - MW

Source No.	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	285	321	321	321	321	321	321	321	395	395	395
2	75	75	75	75	75	75	75	75	75	75	75
3	-	-	18	60	60	60	14	(10)	(35)	-	10
4	-	-	-	-	100	-	(100)	(50)	(225)	-	-
5	-	100	100	100	150	100	100	-	100	-	-
6	-	-	-	-	300	300	500	500	575	300	300
7	-	-	-	-	-	-	-	225	250	350	300
8	-	-	53	60	60	55	56	55	56	55	73
9	-	-	-	-	-	-	-	-	-	(1)	(1)
10	-	-	-	-	-	-	-	-	-	(4)	(4)
11	-	-	-	-	-	-	-	-	-	-	(2)
Total	360	496	567	616	1066	911	966	1116	1191	1170	1146

Sources

1	SEPA
2	S.C.E. & G.
3	Savannah Electric & Power Co.
4	Duke Power Company
5	Florida Power Corp.
6	Tennessee Valley Authority
7	Mississippi Power & Light Company
8	Interruptible customers
9	Crisp County Power Commission
10	South Mississippi Electric Power Assn.
11	Alabama Electric Cooperative, Inc.

Table 1.2-16a (Continued)

Southern Company System Net Purchases - MW

Source No.	1973	1974	1975	1976	1977	1978	1979-85
1	395	395	645	1036	1036	1036	1036
2	75	75	75	75	75	75	-
6	300	300	300	300	300	300	300
8	73	73	73	73	73	73	73
9	(1)	(1)	(1)	(1)	(1)	(1)	(1)
10	(14)	(44)	(74)	(4)	(4)	(4)	(4)
11	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Total	826	796	1016	1477	1477	1477	1402

Sources

1	SEPA
2	S.C.E. & G
6	Tennessee Valley Authority
8	Interruptible customers
9	Crisp County Power Commission
10	South Mississippi Electric Power Assn.
11	Alabama Electric Cooperative Inc.

Table 1.2-16a (Continued)

Southern Company System Net Purchases - MW

Notes:

(1) There are no reserves associated with purchases from SEPA.

(2) Beginning in 1963, purchase from SCE&G is firm capacity and does not require system reserves.

(3) Firm purchases from non-associated companies (Sources No. 3,4,5,6, & 7) have reserves provided by the selling company.

(4) Interruptible customers provide increased system reserves, and as such, do not have additional reserves associated with them.

(5) Sales to Crisp County Power Commission, Alabama Electric Cooperative, Inc.,and 4 MW of the sales to South Mississippi Electric Power Assn. (Sources No. 9, 10 & 11) are designated as protective capacity.

(6) Quantities in parentheses indicate sales.

Plant
Barry Mt. Vernon, Ala.
Chickasaw Mobile, Ala.
Gadsden Gadsden, Ala.
Gorgas Walker County Near Parrish, Ala.
Greene County Demopolis, Ala.
Arkwright Macon, Ga.
Atkinson Smyrna, Ga.

TABLE 1.2-17

INITIAL OPERATION OF SOUTHERN COMPANY STEAM UNITS

Unit	Nameplate Capacity	Initial Operation	Commercial Operation
1	125	1:40AM February 11, 1954	
2	125	11:05AM June 18, 1954 (a)	
3	225	8:58AM June 8, 1959	12:01AM July 15, 1959
4	350	7:09PM CDT May 28, 1969	12:01AM CST December 31, 1969
5	700	11:13AM CDT July 24, 1971	12:01AM CDT October 19, 1971
1	40	May 14, 1941	
2	40	March 22, 1943	
3	40	10:58PM August 12, 1951	
1	60	April 7, 1949	
2	60	July 20, 1949	
1	20	September 19, 1917	Retired September 30, 1965
2	30	December 29, 1918 (b)	Retired September 30, 1965
3	20	August 20, 1924	Retired September 30, 1965
4	60	June 19, 1929	
5	60	January 16, 1944 (c)	
6	100	3:08PM April 23, 1951	
7	100	8:59AM July 14, 1952	
8	156.25	4:29PM May 3, 1956	
9	165.0	5:12PM May 10, 1958	12:01AM June 3, 1958
10	700	7:33AM CDT June 26, 1972	12:01AM CDT October 27, 1972
1	250	10:32AM May 4, 1965	12:01AM June 11, 1965
2	250	8:53AM April 21, 1966	12:01AM July 30, 1966
1	40	June 4, 1941	
2	40	May 22, 1942	
3	40	December 1943 (d)	
4	40	November 12, 1948	
1	60	August 30, 1930	
2	60	September 14, 1941	
3	60	6:09PM October 18, 1945	
4	60	November 14, 1948	

9406100090-03

Plant
Branch Milledgeville, Ga.
Bowen Taylorsville, Ga.
Hammond Rome, Ga.
McDonough Smyrna, Ga.
McManus Brunswick, Ga.
Mitchell Albany, Ga.
Yates Newnan, Ga.
Urquhart Augusta, Ga.

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY STEAM UNITS

Unit	Nameplate Capacity	Initial Operation	Commercial Operation
1	250	10:37AM April 13, 1965	12:01AM June 11, 1965
2	319	12:38PM April 24, 1967	12:01AM June 1, 1967
3	480.7	2:47AM CDT June 13, 1968	12:01 AM CDT July 12, 1968
4	490	3:46PM CDT May 15, 1969	1:37AM CDT June 27, 1969
1	700	8:24AM CDT July 4, 1971	12:01AM CDT October 21, 1971
2	700	9:14PM CDT June 23, 1972	12:01AM CDT September 26, 1972
1	100	12:01AM June 19, 1954	
2	100	9:37PM September 26, 1954	
3	100	11:14PM June 9, 1955	
4	500	3:28AM CDT June 26, 1970	12:01AM CST December 14, 1970
1	245	6:14PM July 19, 1963	12:01AM August 12, 1963
2	245	6:41AM May 1, 1964	12:01AM June 26, 1964
1	40	1:11AM November 18, 1952	
2	75	2:36PM May 15, 1959	10:59PM June 7, 1959
1	22.5	November 6, 1948	
2	22.5	March 15, 1949	
3	125.0	1:13AM April 18, 1964	12:01AM May 13, 1964
1	100	September 12, 1950	
2	100	November 19, 1950	
3	100	5:12PM August 17, 1952	
4	125	5:46AM June 22, 1957	
5	125	2:10PM May 11, 1958	
1	75	November 29, 1953	
2	75	February 10, 1954	

9406100090-04

Plant
Crist Pensacola, Fla.
Scholz Chattahoochee, Fla.
L. Smith Panama City, Fla.
Eaton Hattiesburg, Miss.
Sweatt Meridian, Miss.
Watson Gulfport, Miss.
Gaston Wilsonville, Ala.

Notes:
(a) Furnac
(b) Purcha
(c) Coil f
(d) Initia

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY STEAM UNITS

Unit	Nameplate Capacity	Initial Operation	Commercial Operation
1	22.5	January 10, 1945 Approx.	
2	22.5	June 13, 1949	
3	30.0	2:32AM September 1, 1952	
4	75.0	1:00PM June 29, 1959	1:00PM July 22, 1959
5	75.0	9:42AM April 17,1961	12:01AM June 1, 1961
6	320.0	12:54AM CDT May 12, 1970	11:59PM CDT May 31, 1970
1	40	10:05AM February 24, 1953	2:47PM March 17, 1953
2	40	10:22PM October 26, 1953	
1	125	4:05PM May 12, 1965	12:01AM June 1, 1965
2	180	12:10PM April 9, 1967	12:01AM June 1, 1967
1	22.5	10:55PM March 22, 1945	
2	22.5	1:42PM July 3, 1947	
3	22.5	3:45PM August 29, 1949	
1	40	10:25PM May 30, 1951	
2	40	12:38AM June 29, 1953	
1	75	7:14PM June 23, 1957	
2	75	9:00PM April 22, 1960	12 Noon May 22, 1960
3	112	2:56PM May 8, 1962	12:01AM June 6, 1962
4	250	3:54PM CDT May 27, 1968	12:01AM CDT July 20, 1968
1	250	3:33PM March 26, 1960	12:01AM May 1, 1960
2	250	8:59PM June 8, 1960	12:01AM July 1, 1960
3	250	2:08PM April 30, 1961	12:01AM June 1, 1961
4	250	9:28PM April 17, 1962	12:01AM June 1, 1962

e explosion February 12, 1956 - Back on line May 3, 1956.
sed from U. S. Government September 24, 1924.
ailure November 8, 1943
l operation September 9, 1943, followed by coil failures.

ALABAMA POWER COMPANY U

Weiss
Leesburg, Ala.

Henry
Ohatchee, Ala.

Logan Martin
Vincent, Ala.

Lay Dam (Old)

Lay Dam (New)
Clanton, Ala.

Mitchell
Verbena, Ala.

Jordan
Wetumpka, Ala.

Note: (a) Nameplate 13,

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY HYDRO PLANTS

it	Nameplate Capacity	Initial Operation	Accepted for Commercial Operation	Retired
1	29.25	9:56AM June 26, 1962	12:01AM July 5, 1962	
2	29.25	6:07PM May 23, 1961	12:01AM June 5, 1961	
3	29.25	7:55PM May 9, 1961	12:01AM June 5, 1961	
1	24.30	7:50AM March 30, 1966	12:01AM June 2, 1966	
2	24.30	2:34PM May 7, 1966	12:01AM June 2, 1966	
3	24.30	11:28AM June 14, 1966	12:01AM June 29, 1966	
1	42.75	1:56PM July 14, 1964	12:01AM August 10, 1964	
2	42.75	5:15PM July 8, 1964	12:01AM August 10, 1964	
3	42.75	3:06PM July 30, 1964	12:01AM August 10, 1964	
4	10.8 (a)	2:45PM April 14, 1914	August 1, 1914	9:10AM July 5, 1966
3	10.8	11:30PM July 14, 1914		7:35 February 27, 1967
2	10.8	2:33PM July 28, 1914		7:05AM May 2, 1967
1	10.8	11:27AM September 3, 1914		6:50AM June 1, 1967
5	10.8	11:08PM March 11, 1917		May 8, 1966
6	10.8	4:06PM December 28, 1921		12:01AM January 1, 1966
6	29.5	2:55PM February 20, 1967	12:01AM February 24, 1967	(Plant went commercial 12:01AM 5/14/68 and all const. generation ended)
5	29.5	12:30PM April 28, 1967	12:01AM May 1, 1967	
4	29.5	8:26PM September 30, 1967	12:01AM October 19, 1967	
3	29.5	10:32AM December 19, 1967	12:01AM December 22, 1967	
2	29.5	12:18PM February 23, 1968	12:01AM March 1, 1968	
1	29.5	11:10AM April 16, 1968	12:01AM April 20, 1968	
1	17.5	8:15PM April 7, 1923	August 15, 1923	
2	17.5	7:41PM May 25, 1923		
3	17.5	5:35PM August 14, 1923		
4	20.0	1:55PM November 13, 1949		
2	25.0	1:58AM September 1, 1928	January 1, 1929	
3	25.0	2:49PM September 15, 1928		
4	25.0	8:35PM October 11, 1928		
1	25.0	8:50PM November 13, 1928		

00kW

9406100090-06

ALABAMA (Continued)

Bouldin
Wetumpka, Ala.

Martin
Tallassee, Ala.

Yates
Tallassee, Ala.

Thurlow
Tallassee, Ala.

Smith
Jasper, Ala.

Bankhead
Northport, Ala.

Holt
Northport, Ala.

Failures

Jordan Unit #2 fa
Lay Unit #4 faile

GEORGIA POWER COMPANY

Burton
Terrora

Nacoochee
Tallulah

Clarksville, Ga.

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY HYDRO PLANTS

Unit	Nameplate Capacity	Initial Operation	Accepted for Commercial Operation
1	75.00	6:29PM June 26, 1967	12:01AM July 27, 1967
2	75.00	1:20PM July 22, 1967	12:01AM August 1, 1967
3	75.00	11:34AM August 10, 1967	12:01AM August 26, 1967
3	33.0	10:25PM August 29, 1926	January 1, 1927
2	33.0	10:15PM September 20, 1926	
1	33.0	10:00PM November 26, 1926	
4	55.2	4:10AM July 15, 1952	11:26PM July 15, 1952
2	16.0	3:00PM April 13, 1928	July 1, 1928
1	16.0	12:27 PM May 17, 1928	
2	25.0	5:57PM June 25, 1930	
1	25.0	9:08AM July 7, 1930	
3	10.0	1:55PM August 7, 1930	
1	78.75	9:45AM August 11, 1961	12:01AM September 5, 1961
2	78.75	2:54PM June 18, 1962	12:01AM July 5, 1962
1	45.125	2:50PM July 3, 1963	12:01AM July 12, 1963
1	40.0	11:07AM CDT August 4, 1968	12:01AM CDT August 15, 1968

iled May 30, 1942. Replaced February 13, 1943.
d February 14, 1944. Replaced January 20, 1945.

2-3,060 kW	1927
2-8,000	1925
2-2,400 kW	1926
6-12,000	1913

GEORGIA (Continued)

Tugalo
Yonah
Clarksville, Ga.

Lloyds Shoals
Jackson, Ga.
Morgan Falls
Dunwoody, Ga.

Bartletts Ferry
Harris, Ga.

Goat Rock
Harris, Ga.

Oliver Dam
Muscogee, Ga.

North Highlands
Muscogee, Ga.

Sinclair
Milledgeville, Ga.

U. S. Government
Allatoona

George

Note: (a) Rebuilt

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY HYDRO PLANTS

Unit	Nameplate Capacity	Initial Operation	Accepted for Commercial Operation
4-11,250 kW			1923
3- 7,500			1925
6- 2,400 kW			1911
7- 2,400			1904 (a)
3-15,000 kW			1926
1,20,000		3:30PM December 15, 1951	
2- 3,000 kW			1912
2- 5,000			
#5- 5,000		11:30AM December 18, 1955	
#6- 5,000		6:30PM February 16, 1956	
1	18,000	7:46AM July 18, 1959	
2	18,000	11:10AM August 12, 1959	
3	18,000	10:55AM August 27, 1959	
4	6,000	3:35PM November 19, 1959	
1	9,200	10:40AM February 22, 1963	
2	9,200	12:20PM March 22, 1963	
3	9,200	11:02AM January 25, 1963	
4	2,000	4:34PM January 3, 1963	
1	22,500	5:12PM February 17, 1953	
2	22,500	7:39PM February 7, 1953	
1			12:01AM EST February 3, 1950
2		7:51PM May 25, 1950	May 26, 1950
1		1963	June 29, 1963
2		July 10, 1963	July 18, 1963
3		10:45AM September 16, 1963	

for 60 cycle operation in 1923.

9406100090-07

Combustion Turbines

Barry A
Barry B

Demopolis 1
Demopolis 2

Arkwright 5A
Arkwright 5B

Atkinson 5A
Atkinson 5B

Bowen 6

McDonough 3A
McDonough 3B

McManus 3A
McManus 3B
McManus 3C

Mitchell 4A
Mitchell 4B
Mitchell 4C

McManus Diesel 1

L. Smith A

Standard Oil 1
Standard Oil 2
Pascagoula, Miss.

Sweatt A

Watson A

Gaston A

Vogtle 5A
Augusta, Ga.

TABLE 1.2-17 (Continued)

INITIAL OPERATION OF SOUTHERN COMPANY COMBUSTION TURBINES

Nameplate Capacity	Initial Operation	Commercial Operation
29.25	4:21PM CST November 15, 1971	12:01AM CST April 6, 1972
29.25	3:04PM CST December 28, 1971	12:01AM CST April 6, 1972
24.43	5:48PM CDT October 21, 1969	12:01AM CST November 20, 1969
24.43	6:29PM CST December 20, 1969	12:01AM CST December 31, 1969
15.29	2:46PM CDT July 21, 1969	12:01AM CDT August 6, 1969
15.29	1:00PM CDT August 26, 1969	12:10AM CDT September 20, 1969
39.36	7:00PM CDT June 11, 1970	12:01AM CDT July 10, 1970
39.36	2:06PM CDT June 14, 1970	12:01AM CDT July 10, 1970
39.4	1:21PM CDT May 11, 1971	12:01AM CDT May 29, 1971
39.4	11:35AM CDT May 7, 1971	12:01AM CDT May 29, 1971
39.4	8:37AM CDT May 7, 1971	12:01AM CDT May 29, 1971
52.1	4:06PM CST December 7, 1971	1:46PM CST January 9, 1972
52.1	4:05PM CST December 13, 1971	12:42PM CST January 13, 1972
52.1	5:53PM CST December 1, 1971	2:03PM CST January 28, 1972
39.4	1:12PM CDT April 29, 1971	12:01AM CDT May 29, 1971
39.4	8:07PM CDT May 26, 1971	12:01AM CDT June 12, 1971
39.4	8:32PM CDT May 6, 1971	12:01AM CDT May 29, 1971
2.0	January 28, 1964	
39.4	10:05PM CDT May 18, 1971	11:59PM CDT May 31, 1971
13.75	3:13PM July 10, 1967	12:01AM November 1, 1967
13.75	11:33AM July 13, 1967	12:01AM November 1, 1967
39.4	4:26PM CDT May 20, 1971	12:01AM CDT June 17, 1971
39.36	4:10PM CDT June 2, 1970	12:01AM CDT June 23, 1970
19.68	8:22PM CDT June 9, 1970	12:01AM CDT June 21, 1970
53.13	12:37PM December 4, 1972	

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1.2.3 RESERVE MARGIN

The initial step in planning future generation additions is to forecast the peak-hour demand for each year for the period under consideration. The forecasts are made by the individual operating companies using trends of the peak-hour loads for past years. The composite load for The Southern Company system is derived by adding each operating company forecast load and applying an appropriate diversity factor. The Southern Company system load is used to determine the total generating capacity additions and each operating company load is used to determine its proportion of these capacity additions.

The GPC loads for 1962-1972 are shown on Table 1.2-4; GPC forecast loads are shown on Table 1.2-6. The Southern Company system loads for 1962-1972 and forecast loads for 1973-1985 are shown on Tables 1.2-5 and 1.2-7, respectively.

The reserves of The Southern System Power Pool are established under the guideline of one-tenth (0.1) days/year loss of load probability. This evaluation takes into account the varying pattern of load, generating plant capabilities, the probability of simultaneous forced outages of generating units, the scheduled maintenance of generating units, and the firm contractual receipts and deliveries with neighboring utilities. It does not include emergency tie assistance from neighboring utilities.

The forced outage rates used for various types and sizes of units are shown on Table 1.2-18. It should be realized that individual unit forced outages may vary considerably from the average rates shown.

After the amount of generating capacity to be added has been determined, a generation mix analysis is made to choose the type of capacity additions that should be added. The total capacity additions may include base-load, both nuclear and fossil, mid-range, and peaking. The expected low operating cost of VNP Units 1-4 puts them in the base-load classification. The expected annual energy from VNP Units 1-4 has been included with annual energy from other nuclear units and is shown on load duration curves for GPC and The Southern Company system. These curves are Figures 1.2-2 through 1.2-9, inclusive, and show the need for base-load generation furnished by VNP Units 1-4.

The type and amount of generating capacity to be added, having been established, must be assigned to an operating company according to the needs of its service area. Thus, the requirements of GPC as well as The Southern Company system are taken into account. The units are assigned by calculating the peak-hour reserves for each operating company and for The Southern Company system. The reserves of each operating company, expressed as a per cent of peak-hour load, are made to approximate as nearly as possible the per cent reserves of the system. The expected reserves in per cent of load for GPC and The Southern Company system are shown on Tables 1.2-6 and 1.2-7, respectively. This procedure allows GPC and the other operating companies to generally serve their own load although this ability may vary from year to year as the pattern of unit additions varies. The establishment of a 500 kV transmission network allows the installation of large units at a site which can serve load on both an area and a system basis.

While the Federal Power Commission (F.P.C.) has not normally designated satisfactory capacity reserve levels for power systems, remarks by responsible F.P.C. officials have indicated that 20 percent is adequate. (See remarks F.P.C. Chairman Nassikas quoted at page 3, Electrical Week, January 18, 1971, and of its Bureau of Power Chief, quoted at page 4, Electrical Week, April 26, 1971.) As indicated in Table 1.2-6, VNP will enable GPC to operate within this range.

The net result of the reduction in reserves which would be brought about without VNP, further accentuated by the loss of natural gas as fuel and the probability of an unscheduled outage of one or more existing units, would be a decided increase in the probability that GPC will be unable to meet its load obligation after 1979, with consequent outages or black-outs.

When it has been determined that an operating company needs new generating capacity, all available sites (new and existing) are considered for suitability as alternates. Some of the factors in the consideration of a site are: (1) availability, (2) suitability for the type of generation to be added, (3) proximity to the load centers or bulk transmission network. Consideration of these factors along with others will leave only realistic alternate sites for further study. The economic comparison of alternate sites for a selected type of generation is made using bus-bar costs. For example, if base load type generation is to be added, a nuclear vs. fossil economic analysis is indicated. If the nuclear addition has an economic advantage in bus-bar costs, the total cost of a nuclear generation installation including transmission facilities is estimated for each alternate site. This allows a more complete economic analysis to be made before choosing the site.

The generating unit additions selected by the above process for GPC are shown on Table 1.2-8. The unit additions for The Southern Company system are shown on Table 1.2-9. The generating capabilities and reserves shown on all tables and illustrations are based upon these unit addition schedules. Unit additions for which final decisions have not been made are shown as "unlocated".

TABLE 1.2-18

GENERATOR FORCED OUTAGE RATES USED IN GENERATION EXPANSION PLANS FOR SOUTHERN COMPANY SYSTEM

Size of Unit MW	Forced Outage Rate By Service Years		
	1st Yr.	2nd Yr.	Mature
0-100 (fossil)	.015	—	—
101-300 (fossil)	.039	—	—
301-370 (fossil)	.044	—	—
520 (fossil)	.1375	.0825	.055
730 (fossil)	.185	.111	.074
760 Nuc (Hatch)	.1775	.1065	.071
810 Nuc (Farley)	.1825	.1095	.073
910 (fossil)	.2075	.1245	.083
1100 (fossil)	.235	.141	.094
1100 Nuc.	.215	.129	.086
Comb. Turb.	.06	—	—
Hydro.	.007	—	—

TABLE 1.2-18

GENERATOR FORCED OUTAGE RATES USED IN GENERATION EXPANSION PLANS FOR SOUTHERN COMPANY SYSTEM

Size of Unit MW	Forced Outage Rate By Service Years		
	1st Yr.	2nd Yr.	Mature
0-100 (fossil)	.015	—	—
101-300 (fossil)	.039	—	—
301-370 (fossil)	.044	—	—
520 (fossil)	.1375	.0825	.055
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1100 (fossil)	.235	.141	.094
1100 Nuc.	.215	.129	.086
Comb. Turb.	.06	—	—
Hydro.	.007	—	—

1.2.4 SYSTEM DEMAND AND RESOURCE CAPABILITY COMPARISON

The GPC and Southern Company System demand and resource capability with and without the VNP are given in Tables 1.2-19 through 1.2-22, and this same information is given graphically in Figures 1.2-10 to 1.2-13.

TABLE 1.2-19

GPC SYSTEM DEMAND AND RESOURCE CAPABILITY COMPARISON

1973 - 1985

Year	Peak Demand-MW	Generating Capability - MW With VNP Units	Generating Capability - MW Without VNP Units	Net Purchases-MW	Capability Resources - MW With VNP Units	Capability Resources - MW Without VNP Units
1973	8,228	7,933	7,933	574	8,507	8,507
1974	9,028	10,332	10,332	575	10,907	10,907
1975	10,028	11,278	11,278	825	12,103	12,103
1976	11,028	12,188	12,188	1,148	13,336	13,336
1977	12,228	13,422	13,422	1,148	14,570	14,570
1978	13,628	14,639	14,639	1,148	15,787	15,787
1979	15,128	16,360	16,360	1,073	17,433	17,433
1980	16,728	18,670	17,570	1,073	19,743	18,643
1981	18,528	20,847	18,647	1,073	21,920	19,720
1982	20,528	23,957	20,678	1,073	25,030	21,730
1983	22,728	26,507	22,107	1,073	27,580	23,180
1984	25,128	28,807	24,407	1,073	29,880	25,480
1985	27,828	31,757	27,357	1,073	32,830	28,430

TABLE 1.2-20

SOUTHERN COMPANY SYSTEM DEMAND AND RESOURCE CAPABILITY COMPARISON

1973 - 1985

Year	Peak Demand-MW	Generating Capability - MW With VNP Units	Generating Capability - MW Without VNP Units	Net Purchases-MW	Capability Resources - MW With VNP Units	Capability Resources - MW Without VNP Units
1973	15,509	16,769	16,769	826	17,595	17,595
1974	16,977	20,018	20,018	797	20,815	20,815
1975	18,697	21,771	21,771	1,017	22,788	22,788
1976	20,577	23,236	23,236	1,478	24,714	24,714
1977	22,666	25,529	25,529	1,478	27,007	27,007
1978	25,037	28,102	28,102	1,478	29,580	29,580
1979	27,600	31,092	31,092	1,403	32,495	32,495
1980	30,362	34,405	33,305	1,403	35,808	34,708
1981	33,434	38,282	36,082	1,403	39,685	37,485
1982	36,824	42,642	39,342	1,403	44,045	40,745
1983	40,545	46,892	42,492	1,403	48,295	43,895
1984	44,610	51,742	47,342	1,403	53,145	48,745
1985	49,131	56,992	52,592	1,403	58,395	53,995

TABLE 1.2-21

GPC SYSTEM RESERVE MARGIN

1973 - 1985

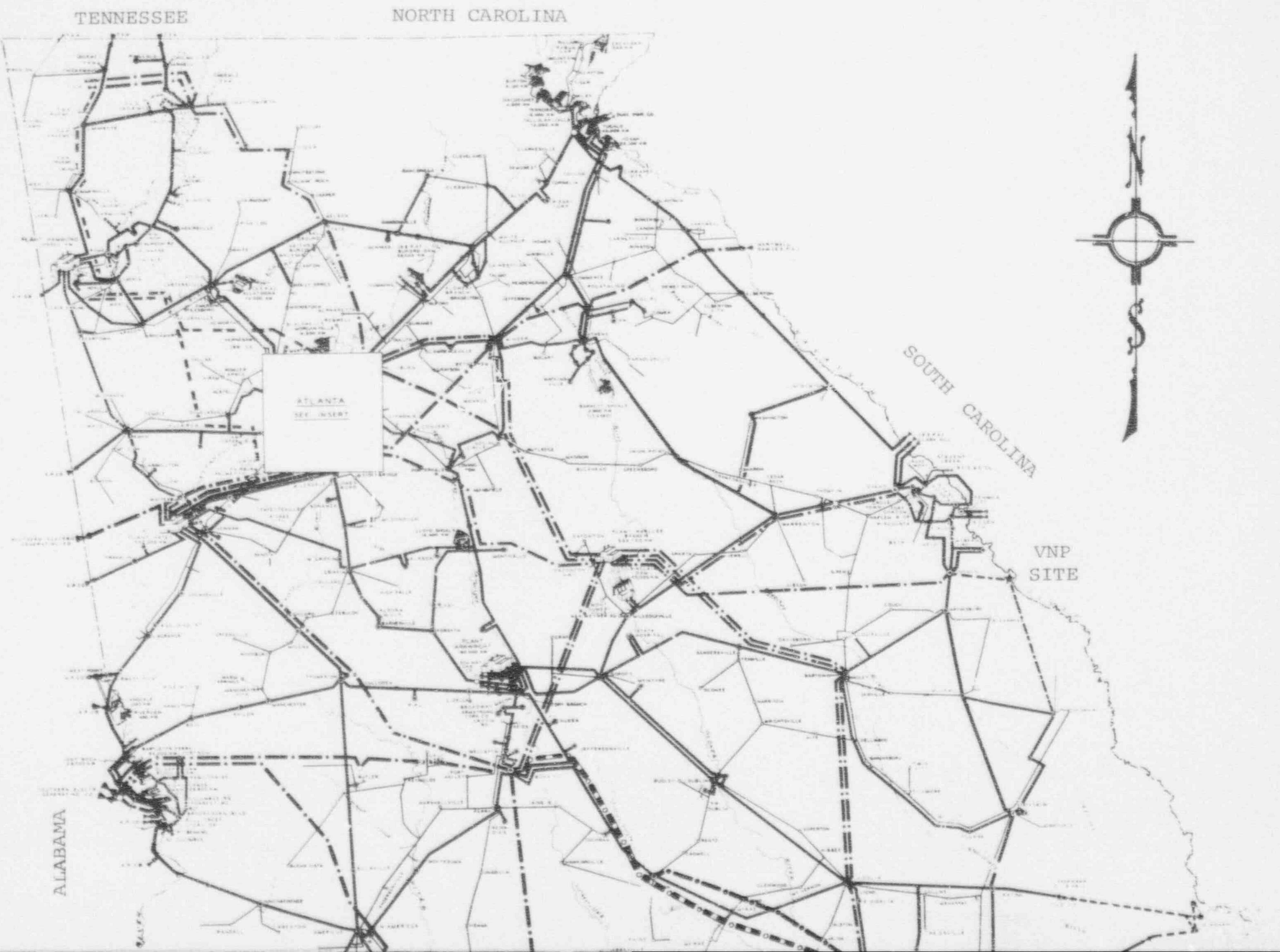
		Capability Resources with VNP			Capability Resources without VNP		
Year	Peak Demand-MW	Capability MW	Reserve MW	% Reserve	Capability MW	Reserve MW	% Reserve
1973	8,228	8,507	279	3.4	8,507	279	3.4
1974	9,028	10,907	1,879	20.8	10,907	1,879	20.8
1975	10,028	12,103	2,075	20.7	12,103	2,075	20.7
1976	11,028	13,336	2,308	20.9	13,336	2,308	20.9
1977	12,228	14,570	2,342	19.2	14,570	2,342	19.2
1978	13,628	15,787	2,159	15.8	15,787	2,159	15.8
1979	15,128	17,433	2,305	15.2	17,433	2,305	15.2
1980	16,728	19,743	3,015	18.0	18,643	1,915	11.4
1981	18,528	21,920	3,392	18.3	19,720	1,192	6.4
1982	20,528	25,030	4,502	21.9	21,730	1,202	5.8
1983	22,728	27,580	4,852	21.3	23,180	452	2.0
1984	25,128	29,880	4,752	18.9	25,480	352	1.4
1985	27,828	32,830	5,002	18.0	28,430	602	2.2

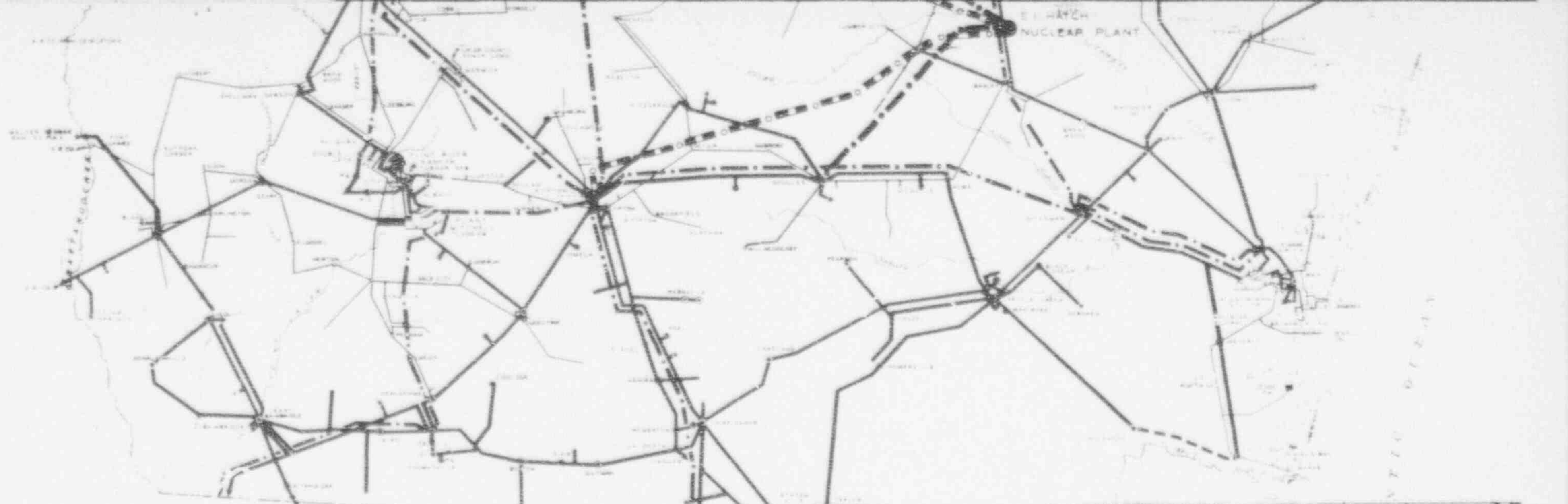
TABLE 1.2-22

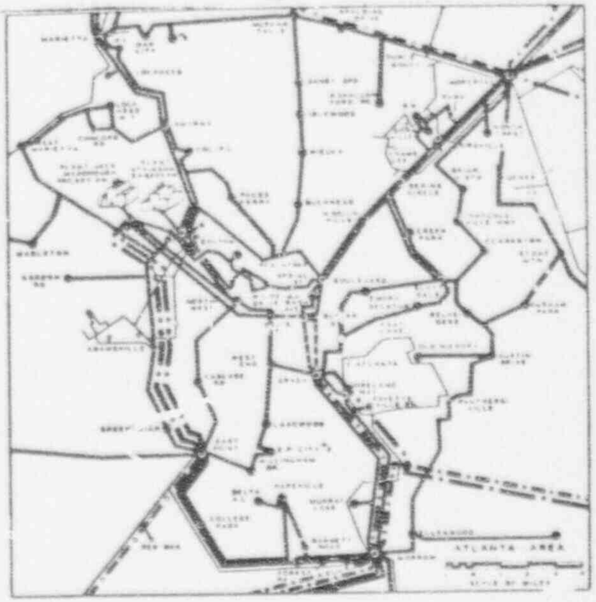
SOUTHERN COMPANY SYSTEM RESERVE MARGIN

1973 - 1985

Year	Peak Demand-MW	Capability Resources with VNP			Capability Resources without VNP		
		Capability MW	Reserve MW	% Reserve	Capability MW	Reserve MW	% Reserve
1973	15,509	17,595	2,086	13.4	17,595	2,086	13.4
1974	16,977	20,815	3,838	22.6	20,815	3,838	22.6
1975	18,697	22,788	4,091	21.9	22,788	4,091	21.9
1976	20,577	24,714	4,137	20.1	24,714	4,137	20.1
1977	22,666	27,007	4,341	19.2	27,007	4,341	19.2
1978	25,037	29,580	4,543	18.1	29,580	4,543	18.1
1979	27,600	32,495	4,895	17.7	32,495	4,895	17.7
1980	30,362	35,808	5,446	17.9	34,708	4,346	14.3
1981	33,434	39,685	6,251	18.7	37,485	4,051	12.1
1982	36,824	44,045	7,221	19.6	40,745	3,921	10.6
1983	40,545	48,295	7,750	19.1	43,895	3,350	8.3
1984	44,610	53.145	8,535	19.1	48,745	4,135	9.3
1985	49,131	58,395	9,264	18.8	53,995	4,864	9.9


TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
VNP SITE
ALABAMA
ATLANTA
SEE INSERT
N
S





GEORGIA POWER COMPANY

Generating Plants And Transmission

LEGEND

■○■	TRANSMISSION LINES 500 KV	
—·—	TRANSMISSION LINES 230 KV	1,915 MILES
—	TRANSMISSION LINES 115 KV	5,253 MILES
—	SUB-TRANSMISSION LINES 44 & 38 KV	3,810 MILES
⊙	TRANSMISSION SUBSTATION	404 MILES
○	SWITCHING STATION	17
●	DISTRIBUTION SUBSTATION	1,296
⋈	INTERCONNECTION WITH OTHER COMPANIES	
----	OTHER COMPANIES LINES	
······	UNDERGROUND CABLE	
— —	FUTURE LINES	

SCALE IN MILES:
10 0 10 20 30 40

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GENERATION, TRANSMISSION
AND PRIMARY DISTRIBUTION

FIGURE 1.2-1

1/10/73

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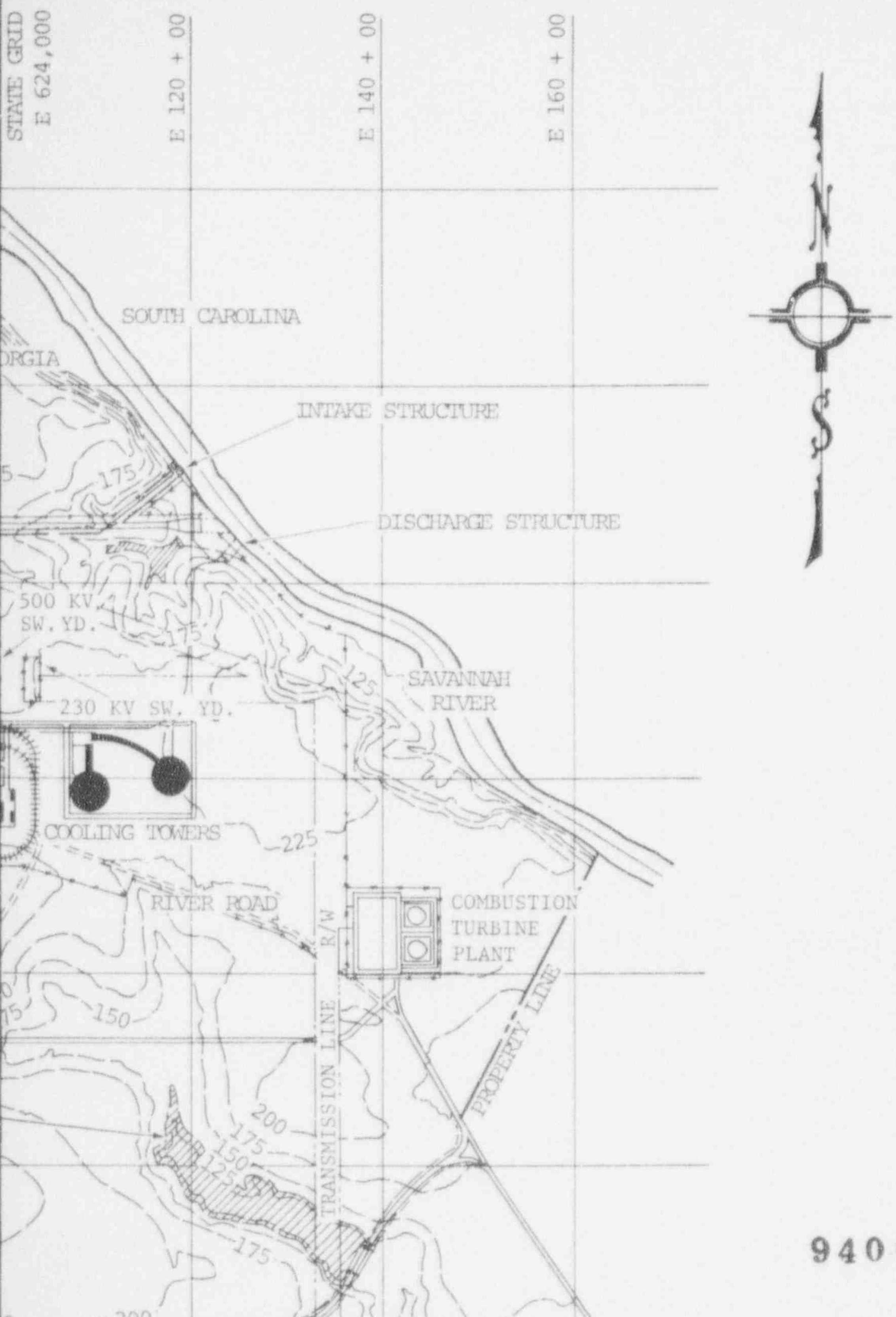
ANSTEC
APERTURE
CARD

Also Available on
Aperture Card


E 20 + 00
E 40 + 00
E 60 + 00
HANCOCK
LANDING
ROAD
E 80 + 00
PLANT GRID
E 100 + 00
N 140 + 00
PROPERTY LINE
TO HWY. 23
TRANSMISSION LINE
R/W
N 120 + 00
N 100 + 00
TRANSMISSION LINE R/W
500 KV
SW. YD.
N 80 + 00 PLANT GRID
N 1,143,000 STATE GRID
PROPERTY LINE
COOLING TOWERS
E 60 + 00
CONSTRUCTION SILT AND
DEBRIS DETENTION BASIN
E 40 + 00
E 20 +
METEOROLOGICAL
TOWER



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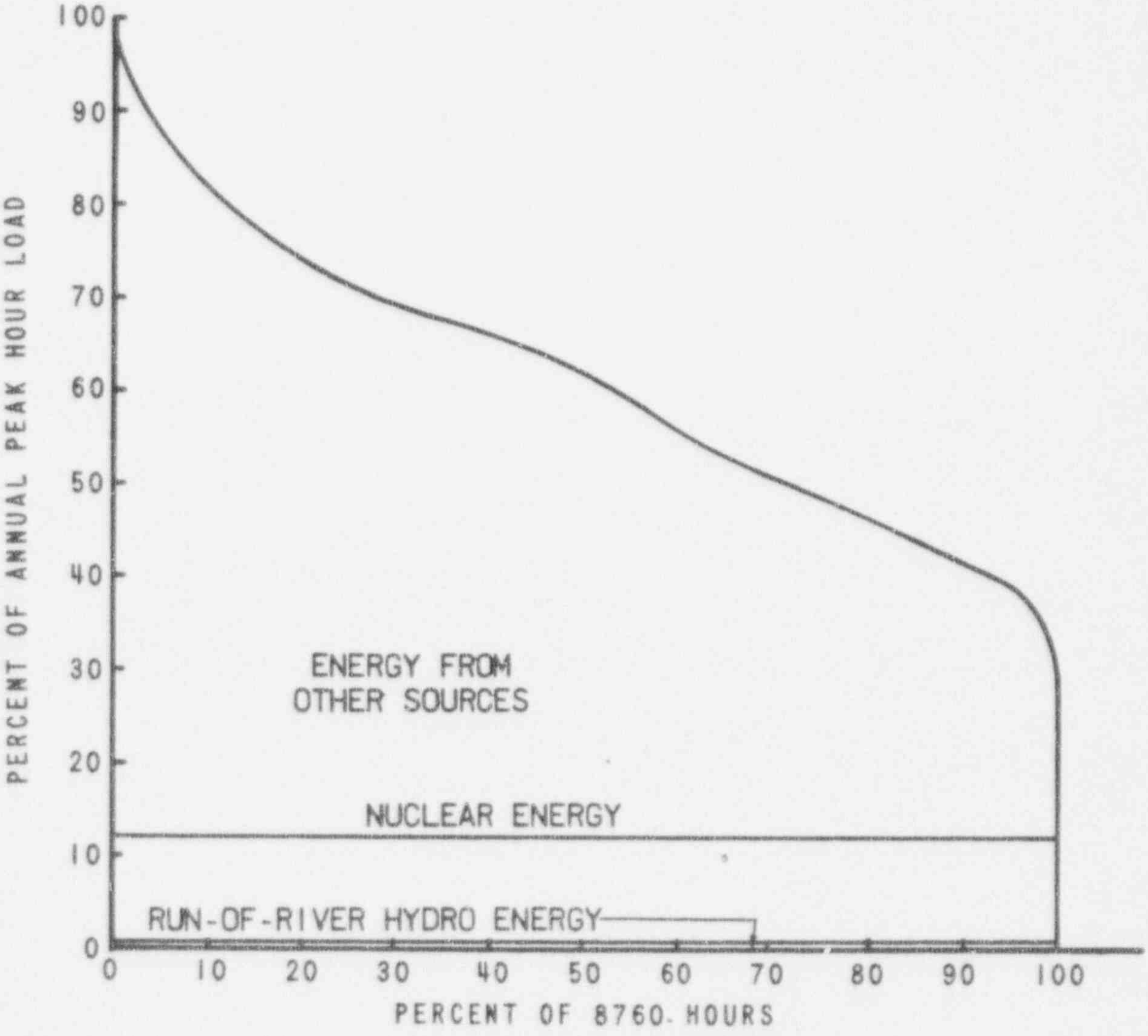
GENERAL ARRANGEMENT OF FACILITIES

FIGURE 2.1-3



GEORGIA POWER COMPANY
LOAD DURATION
1980

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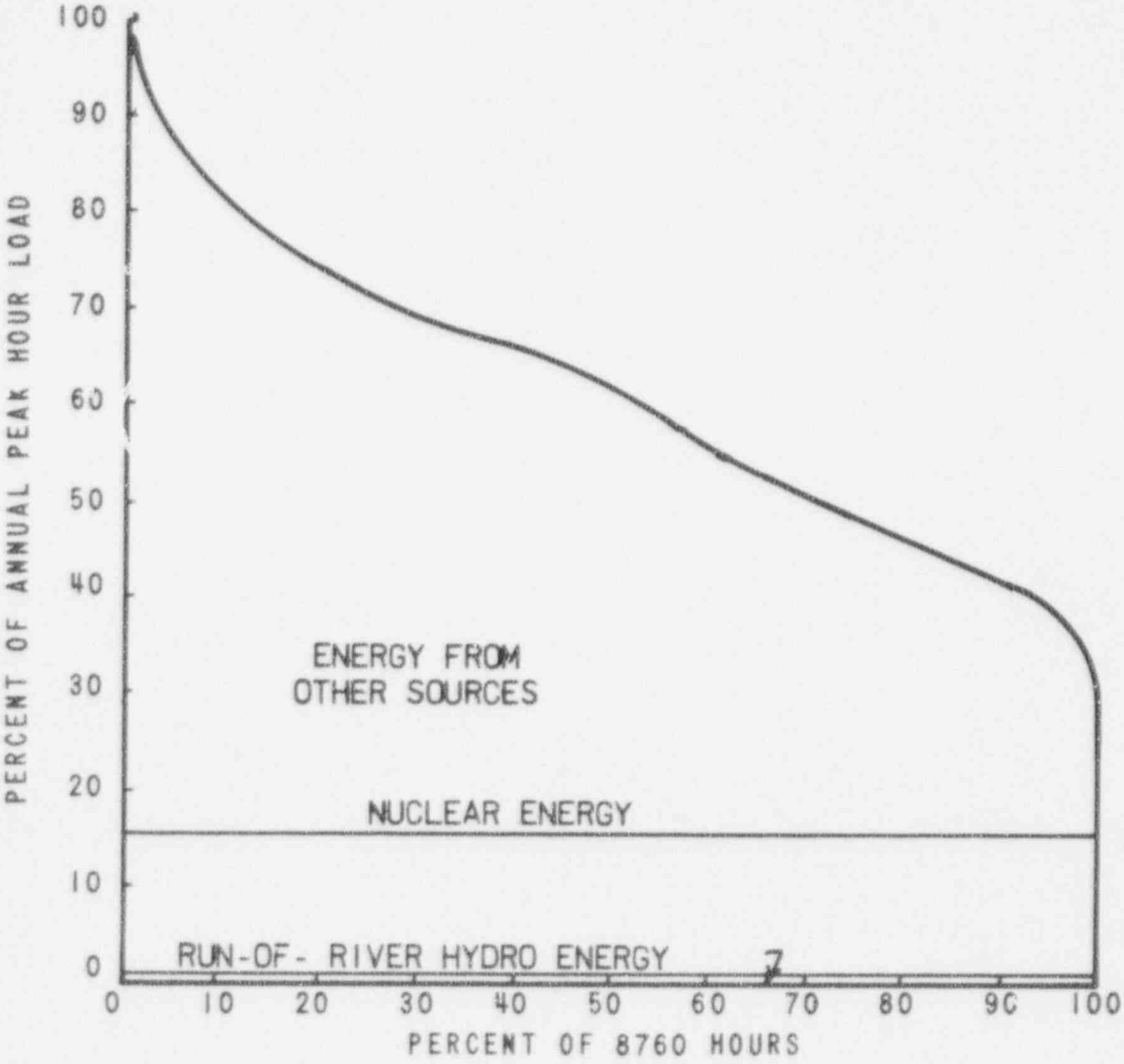
FIGURE 1.2-2



GEORGIA POWER COMPANY
LOAD DURATION
1981

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FIGURE 1.2-3

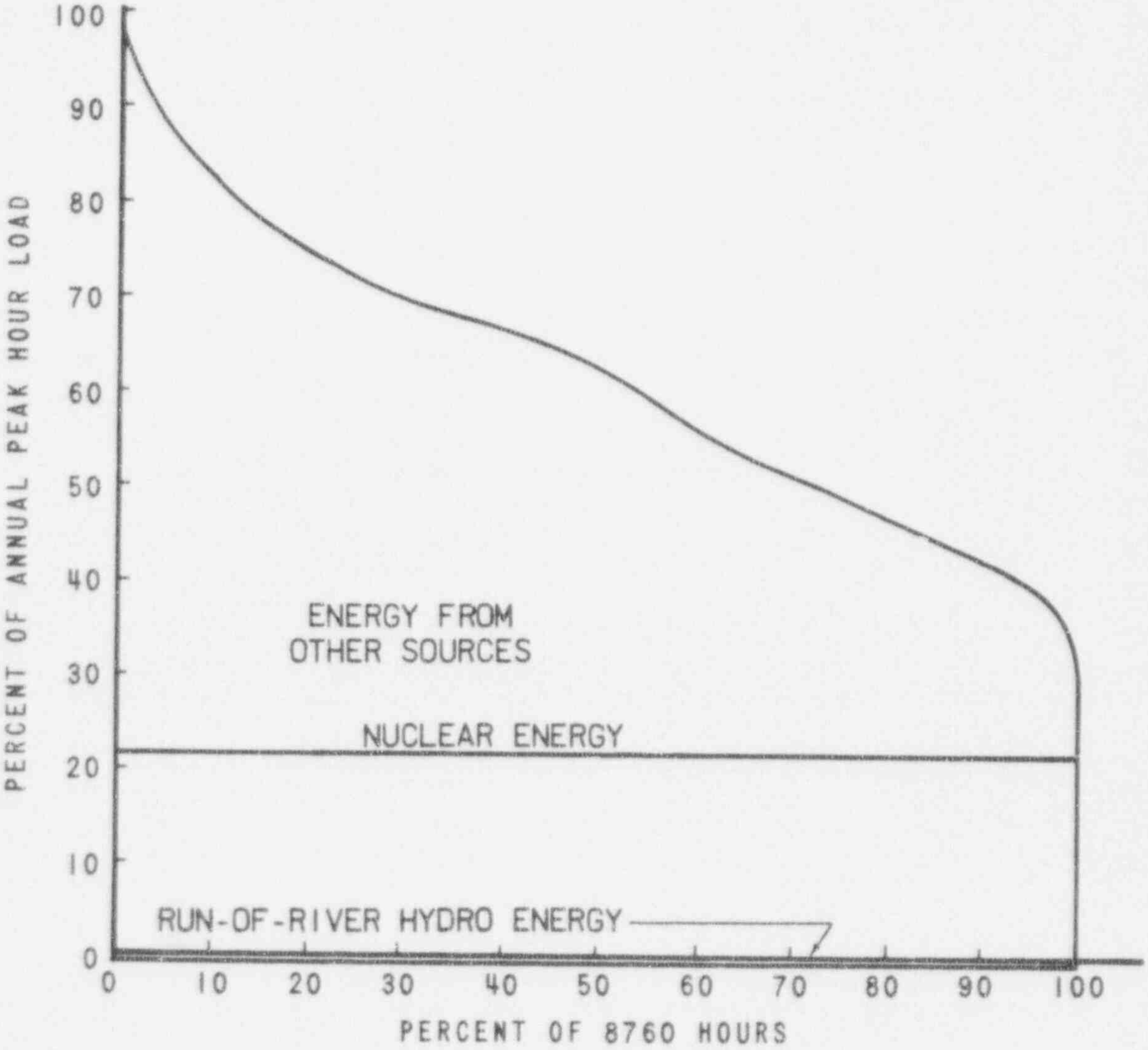

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FIGURE 1.2-4

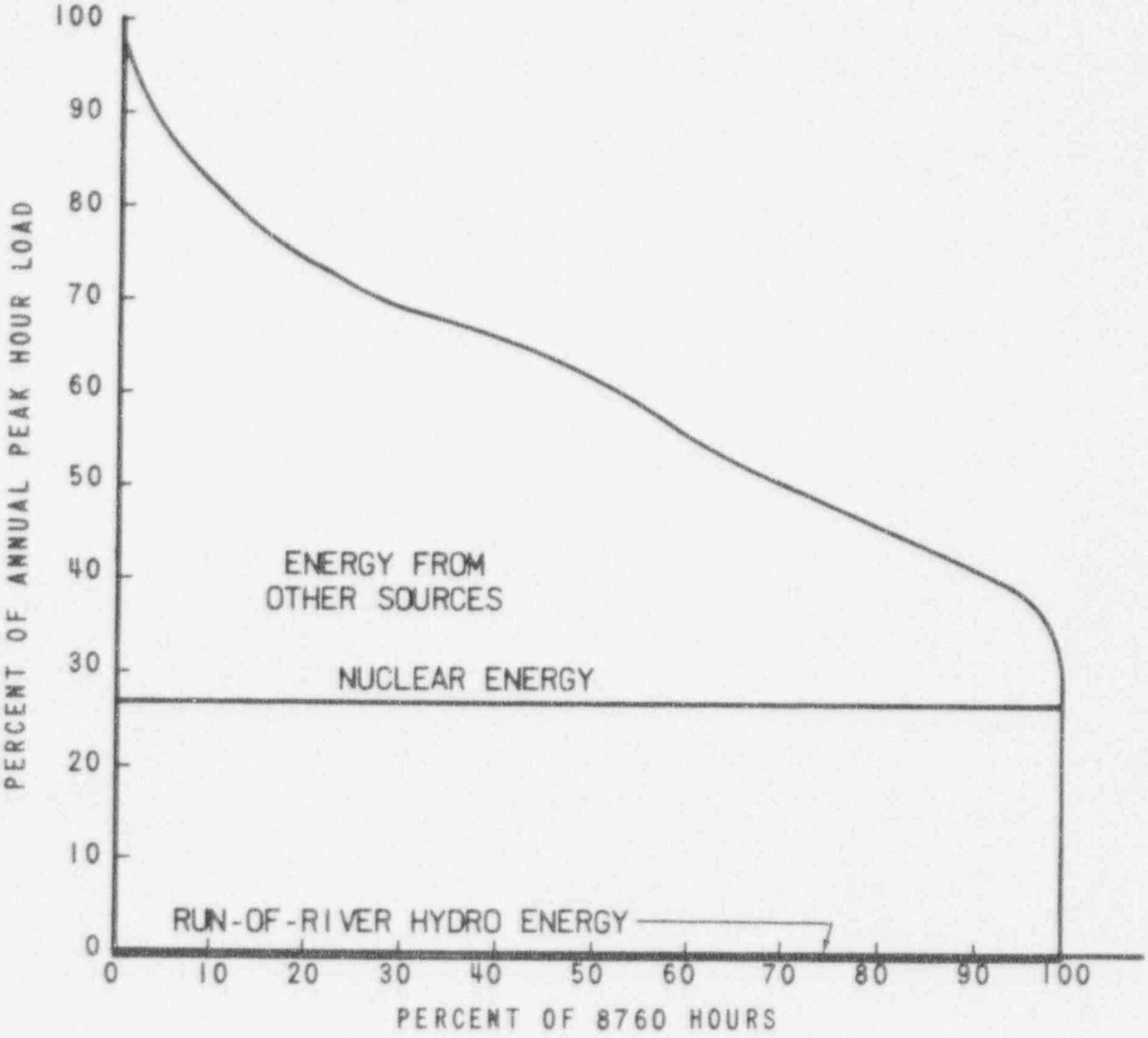

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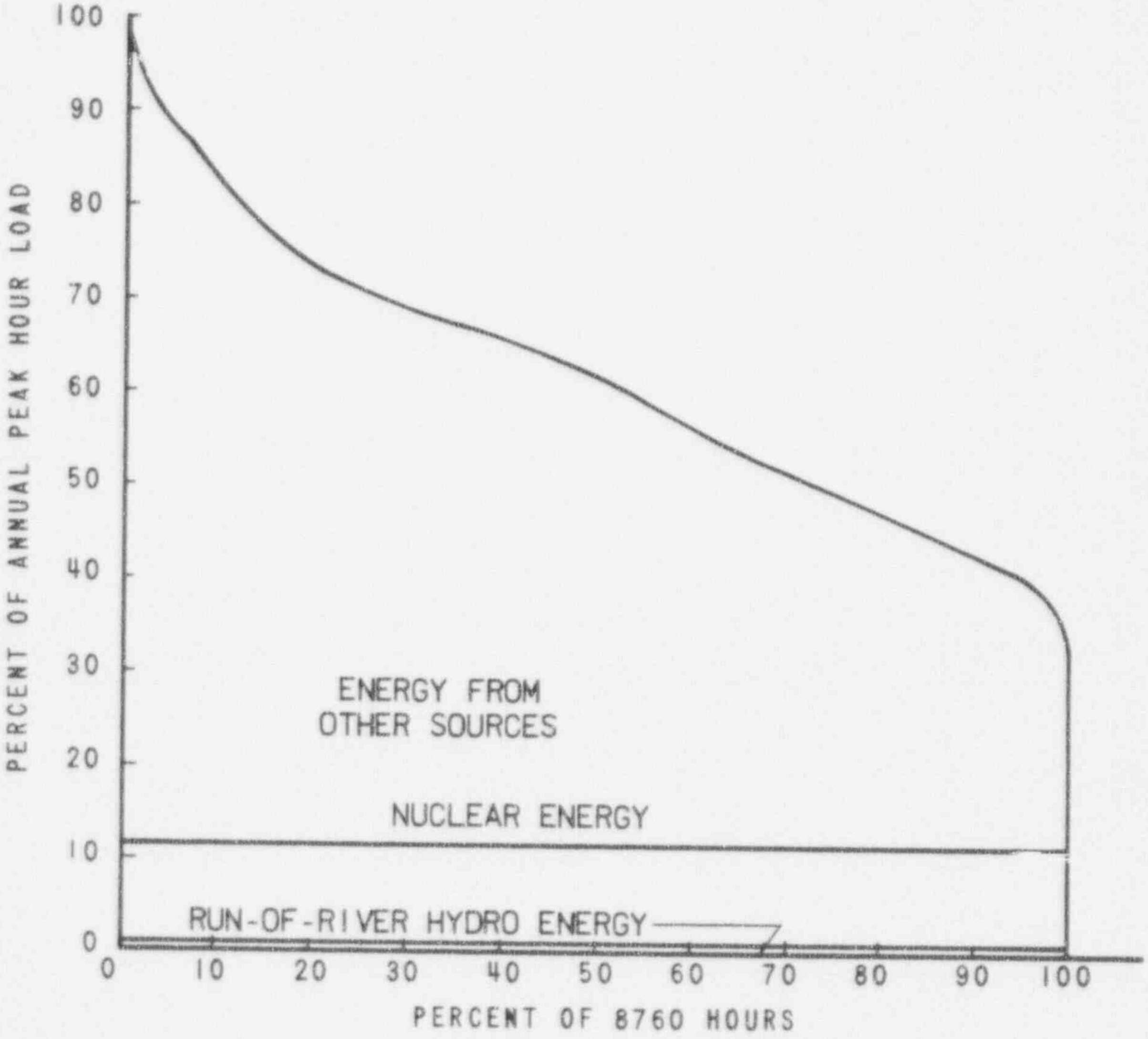
FIGURE 1.2-5



THE SOUTHERN COMPANY
LOAD DURATION
1980

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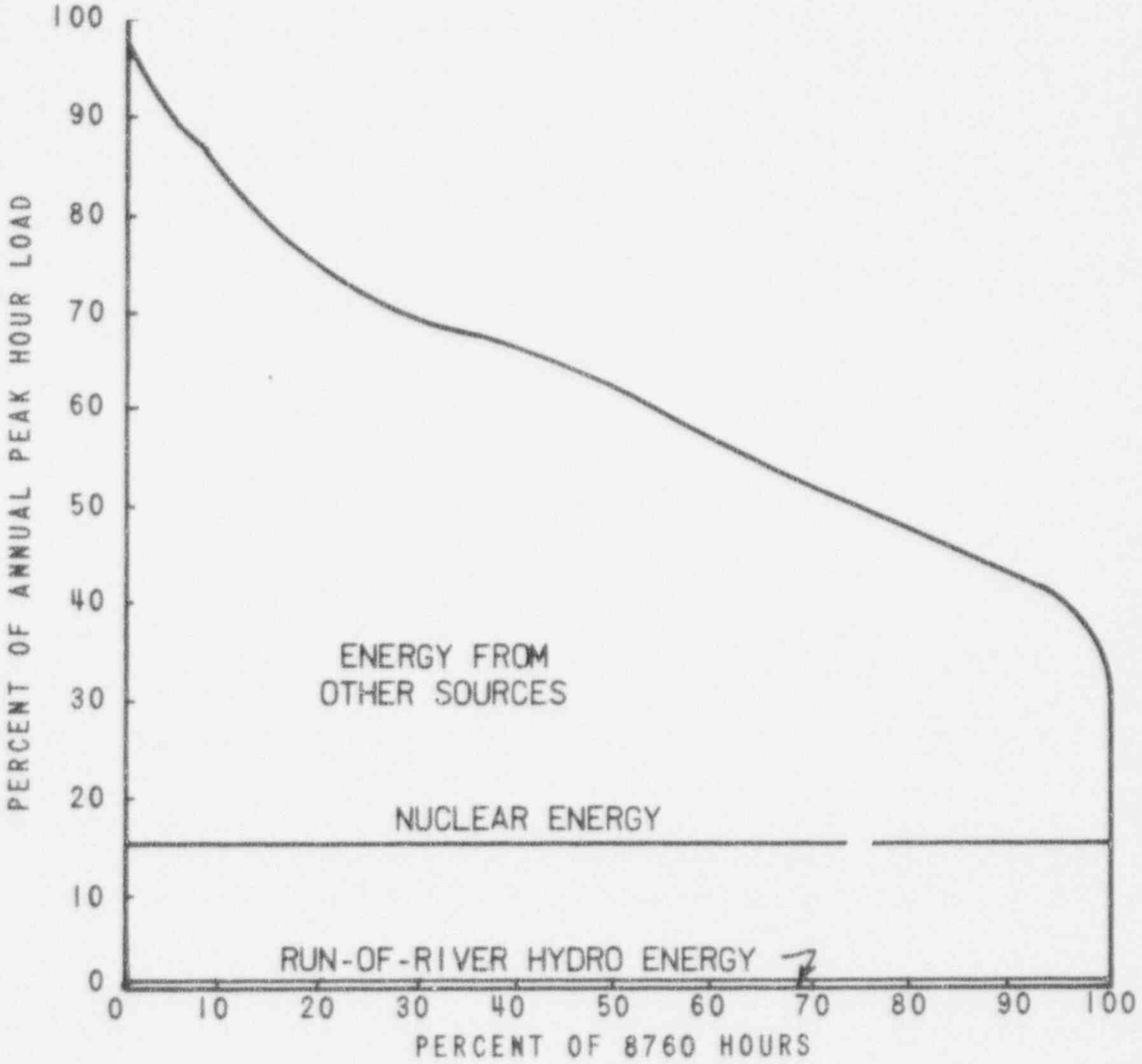
FIGURE 1.2-6



THE SOUTHERN COMPANY
LOAD DURATION
1981

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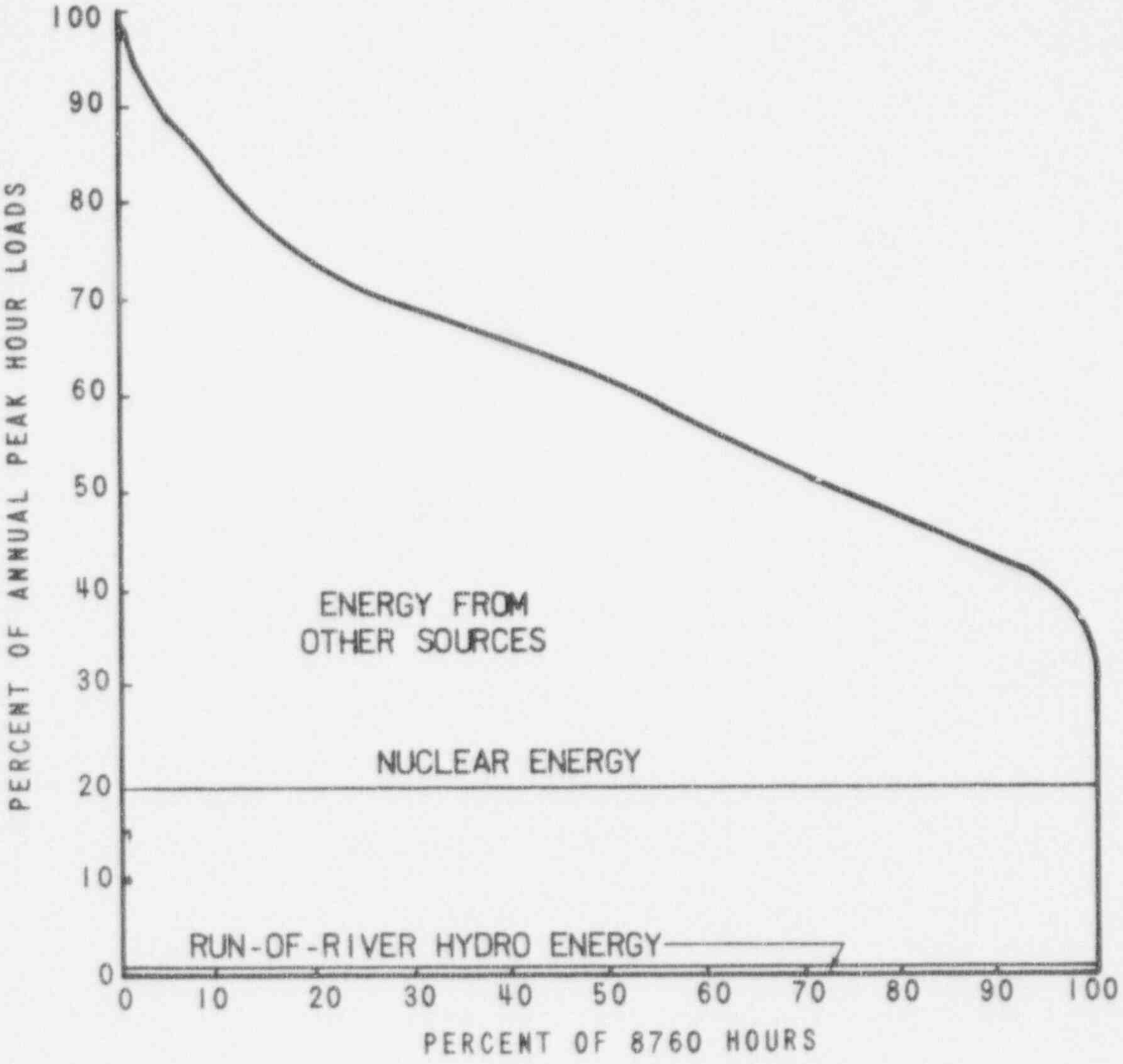
FIGURE 1.2-7



THE SOUTHERN COMPANY
LOAD DURATION
1982

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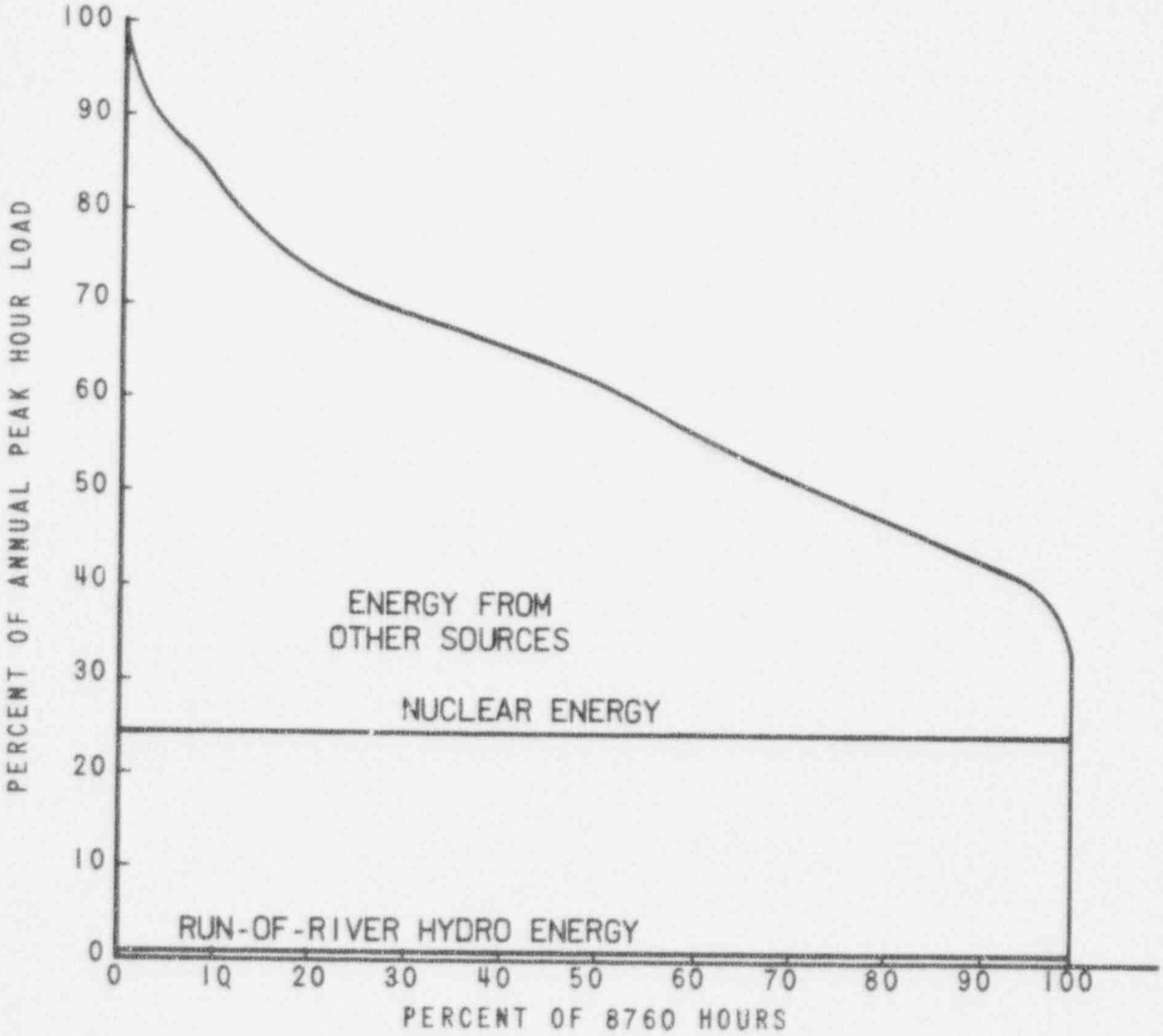
FIGURE 1.2-8



THE SOUTHERN COMPANY
LOAD DURATION
1983

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FIGURE 1.2-9

GPC SYSTEM DEMAND AND
RESOURCE CAPABILITY COMPARISON

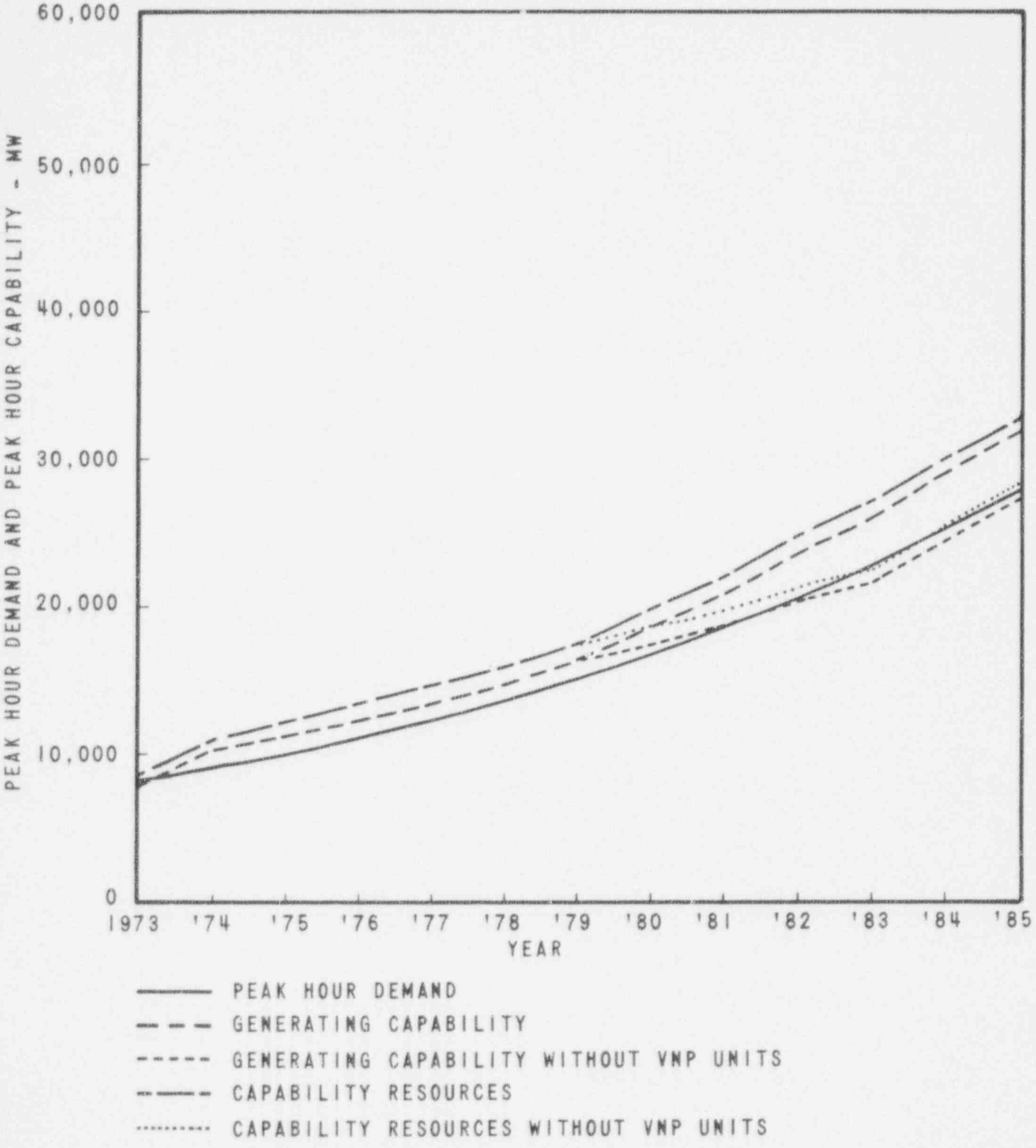

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FIGURE 1.2-10

SOUTHERN COMPANY SYSTEM DEMAND AND RESOURCE CAPABILITY COMPARISON

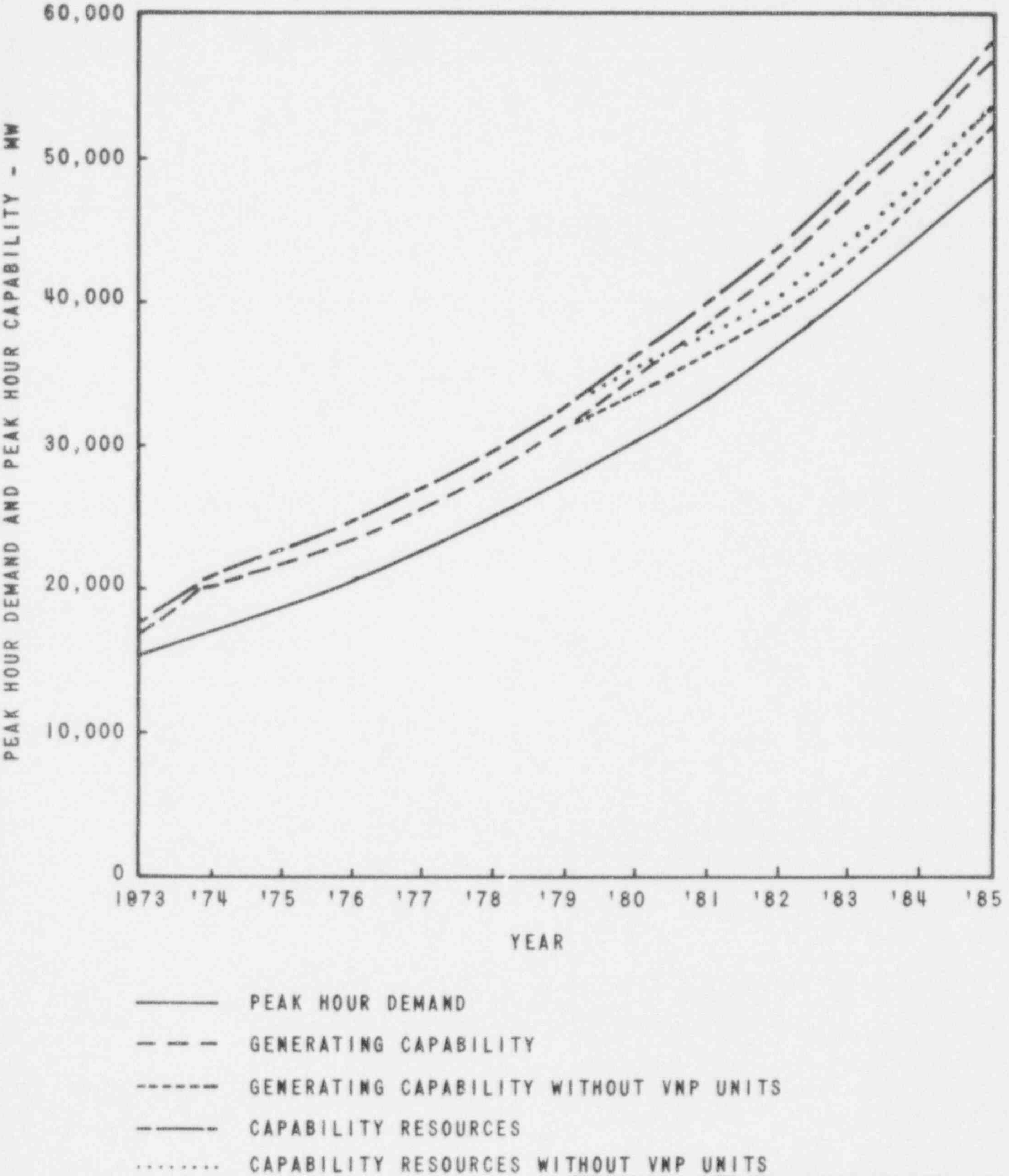

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FIGURE 1.2-11

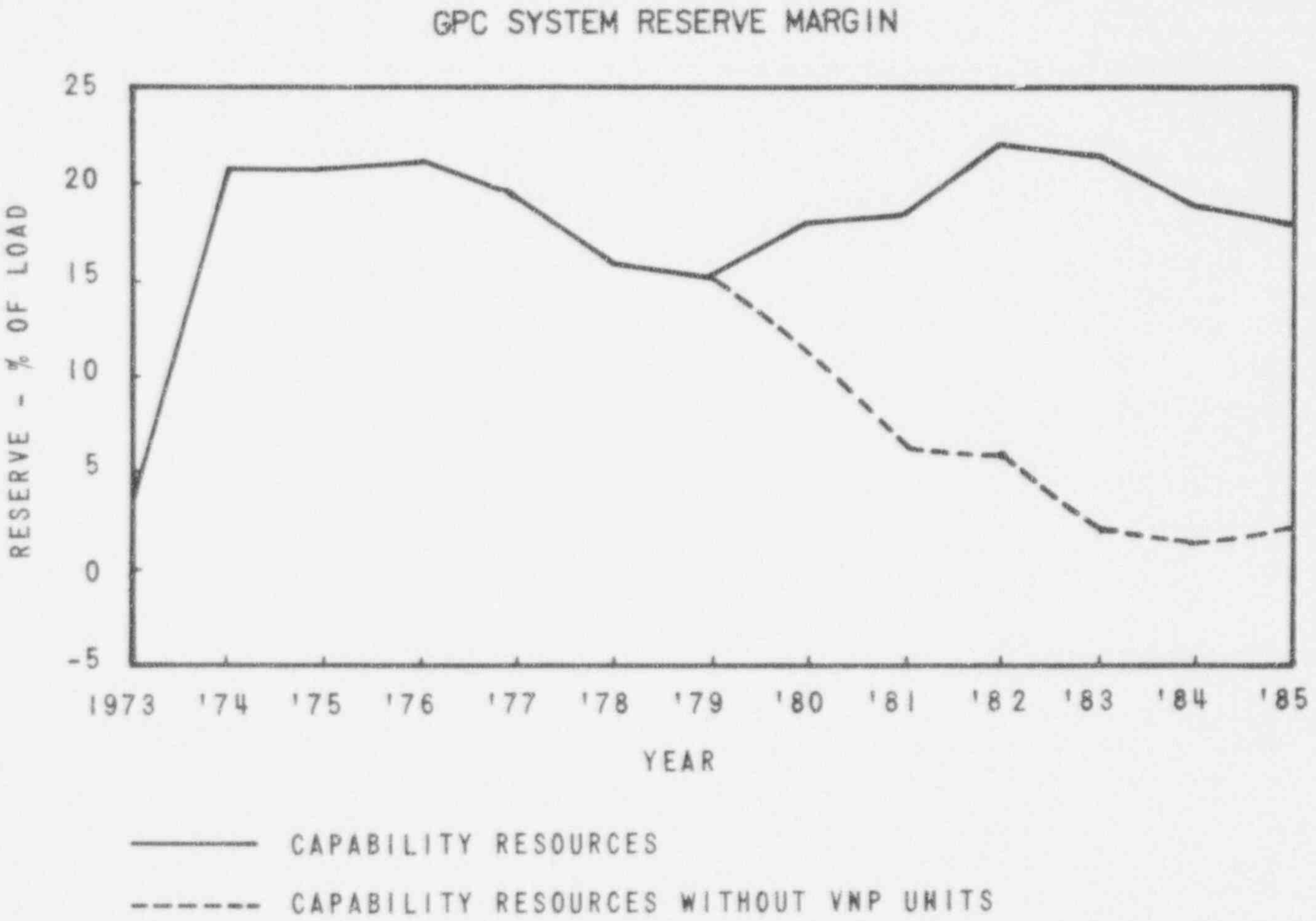

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FIGURE 1.2-12

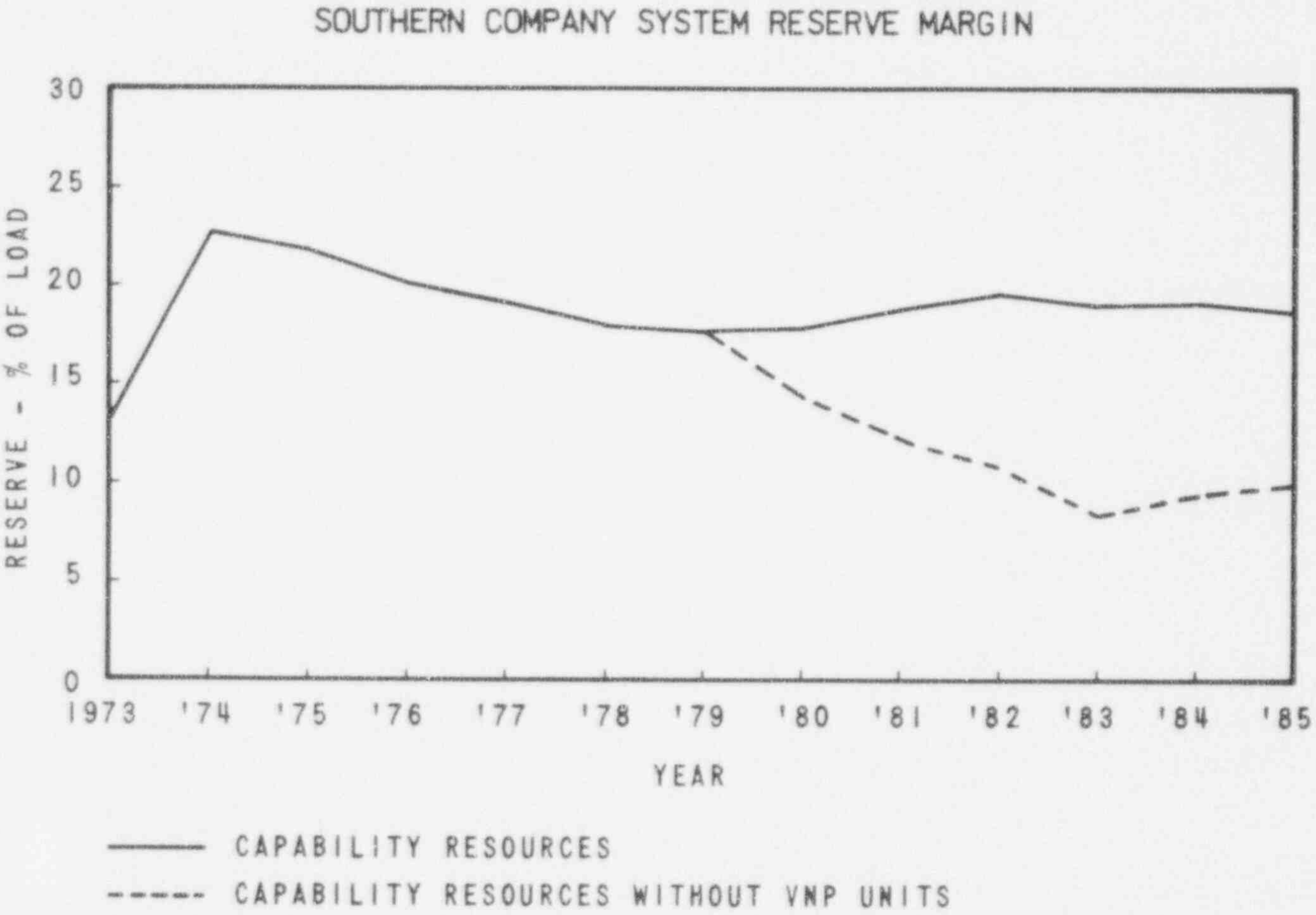

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FIGURE 1.2-13

1.3 PRIMARY OBJECTIVES OF VNP

The primary objective of the VNP is to produce electricity for the use of GPC's customers. There will be no secondary objective such as process steam, desalination, etc.

1.4 CONSEQUENCES OF DELAY

GPC is the principal supplier of electricity to the citizens and to the business-industrial community of Georgia. Its approximately 1 million direct customers reside, or operate businesses, in 154 of Georgia's 159 counties. GPC also supplies electricity to 50 municipalities and 39 rural electric corporations which redistribute the electricity to some 500,000 customers in the state. Obviously, the impact on the social and economic structures of the state would be staggering if GPC were unable to meet its load obligations.

If unable to meet its load obligations, GPC will be forced into a load shedding program. If it can be anticipated that load will exceed capacity, e.g. during extreme hot weather or during a period when several generating units are off due to forced outage, a manual load shedding program will be instituted. This will be done by stationing personnel at strategic substations where segments of load can be dropped in a planned, pre-determined sequence. Also, certain large industrial customers will be requested to curtail load on a voluntary basis; such customers will not be dropped without notice but will be requested to shut down if it becomes necessary. Once the system is stabilized, load will be restored manually. In case of an unforeseen emergency, GPC has an automatic load shedding program utilizing under-frequency relays. Load is automatically reduced 30 percent in 3 steps as follows: 1

(1) 10 percent load dropped when frequency reaches 59.5 cycles per second (cps);

(2) 10 percent more dropped when frequency reaches 59.2 cps;

(3) 10 percent more dropped when frequency reaches 58.8 cps.

As frequency increases, load is automatically restored.

GPC would be the largest single taxpayer of local impositions in Burke County, in which the site is located. GPC will contribute an increasingly large portion of the total public revenues of Burke County, and since these impositions are almost completely in the form of ad valorem taxes (see page 4.2-2), a delay in the construction will postpone the time that the county can begin to receive these revenues. 1

GPC and its site contractors will comprise the largest known employer in Burke County. The general area surrounding the site is principally rural, and it will benefit greatly from the approximately $75,000,000 annual payroll for the 3,800 site employees during the peak construction period. 1

As has already been discussed in Subsection 1.2.3 and shown in Tables 1.2-19 through 1.2-22, GPC and Southern Company reserves will be inadequate without the addition of the capacity of VNP. A delay in the VNP project would cause significant social and economic impacts to both the GPC and the Southern Company systems in the form of inadequate reserves and of some delay in, or loss of, income from the above-mentioned taxes and payroll.

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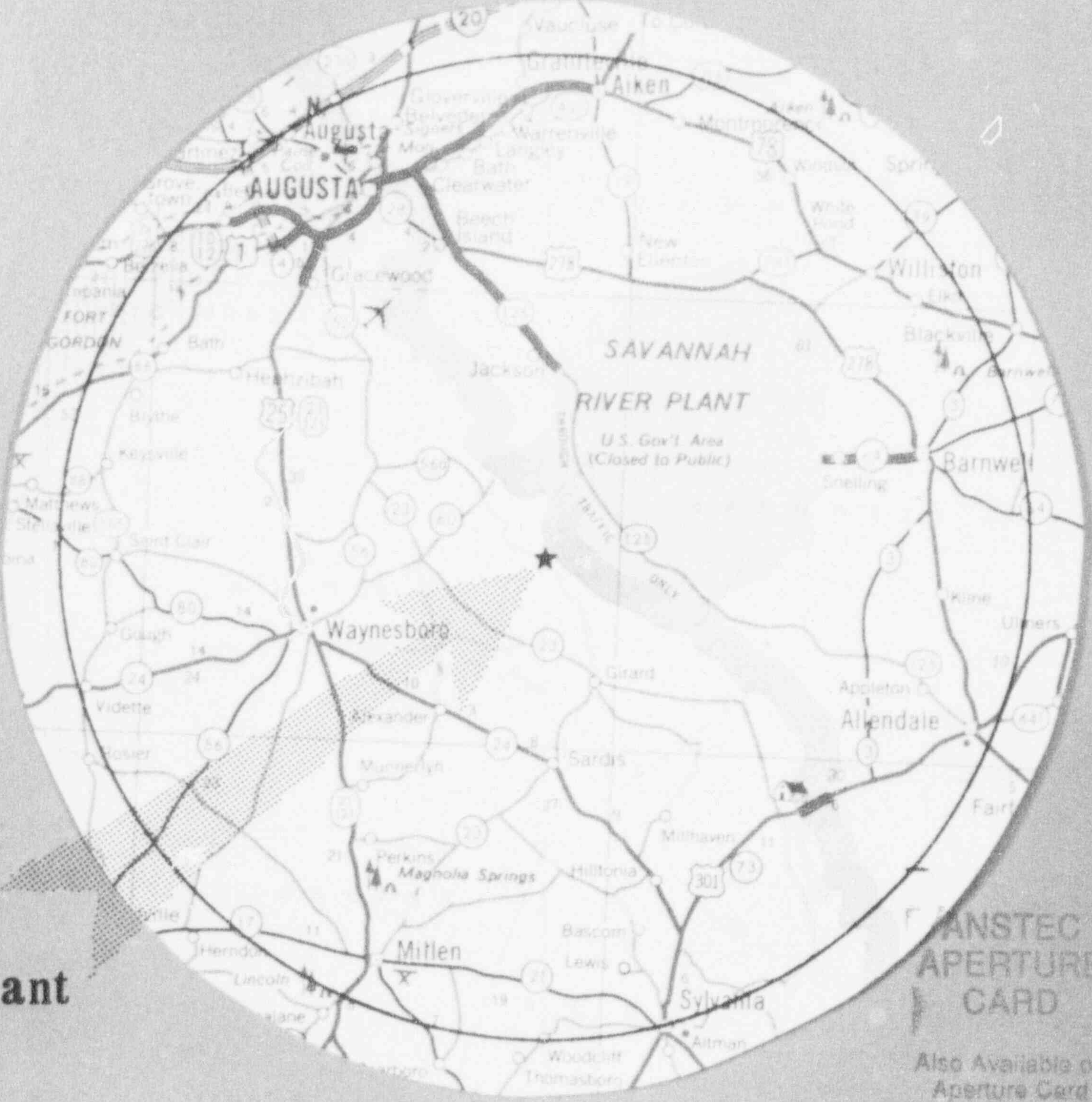
Vog

Nuclear



Vaucluse
Graniteville
Aiken
Gloverville
Belvedere
Augusta
AUGUSTA
Warrenville
Montmorenci
Langley
Bath
Clearwater
Beech Island
Windsor
White Pond
New Ellenton
Williston
Elko
Blackville
Barnwell
Snelling
Gracewood
FORT GORDON
Hephzibah
Blythe
Keysville
Matthews
Stellaville
Saint Clair
Jackson
SAVANNAH
RIVER PLANT
U.S. Gov't. Area
(Closed to Public)
Waynesboro
Gough
Vidette
Rosier
Alexander
Munnerlyn
Girard
Sardis
Kline
Ulmers
Appleton
Allendale
Fairfax
Millhaven
Perkins
Magnolia Springs
Hiltonia
Bascom
Lewis
Millen
Herndon
Lincoln
Sylvania
Oliver
Woodcliff
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Plant

VOGTLE NUCLEAR PLANT SITE
PRIOR TO JUNE, 1971

VOGTLE NUCLEAR PLANT SITE
AS OF JUNE 2, 1972

2. THE SITE

2.1 LOCATION OF PLANT

The VNP site is located on the southwest side of the Savannah River at approximately river mile 151,(1) approximately 23 river miles upstream from the intersection of the Savannah River and U.S. Highway 301, as shown on Figure 2.1-1. The site is located in the eastern sector of Burke County, Georgia, across the river from Barnwell County, South Carolina. This location is approximately 15 air miles east-northeast of Waynesboro, Georgia, and 26 air miles south-southeast of Augusta, Georgia.

The site, which is owned by the Georgia Power Company, consists of 3177 acres. Figure 2.1-2 characterizes the site environs and indicates the approximate site boundaries. The general plant arrangement is shown on Figure 2.1-3. The plant facilities will occupy approximately 1011 acres of the site as indicated below:

Main power block and cooling towers	310 acres
River intake, discharge, and barge facility	9 acres
Transmission right-of-way (on site)	250 acres
Roadway	80 acres
Meteorology tower and access road	27 acres
Construction debris basis	88 acres
Construction facilities	247 acres
TOTAL	1011 acres

The centers of the containments for each of the four units are located closer to the Savannah River than to any on-land property line. The approximate distances from the nearest bank of the Savannah River and from the nearest property line to the centers, the Universal Transverse Mercator Grid coordinates of the centers,(2) and the longitude and latitude of the centers are given below:

Unit	Distance From River Bank	Distance From Onland Boundaries	Long.-Lat. Coordinates	UTM Coordinates
1	3,600 ft.	5,125 ft.	33°08'30" 81°45'44"	Zone 17S MG N 3,666,902.8 m E 428,927.4 m
2	3,850 ft.	5,050 ft.	33°08'30" 81°45'48"	Zone 17S MG N 3,666,903.6 m E 428,823.8 m
3	4,550 ft.	5,000 ft.	33°08'31" 81°45'57"	Zone 17S MG N 3,666,906.5 m E 428,573.9 m
4	4,850 ft.	5,050 ft.	33°08'31" 81°46'01"	Zone 17S MG N 3,666,907.7 m E 428,470.3 m

An existing 350-MW Combution Turbine Plant occupies approximately 24 acres of the 3177-acre site, approximately 4500 feet southeast of the proposed VNP-1 containment center. The environmental effects of this plant are discussed in Subsection 2.8.4.

REFERENCES

1. Savannah River Below Augusta, Georgia and South Carolina, Navigation Charts U. S. Army Engineer District, Savannah, Corps of Engineers, Savannah, Georgia, 1966.
2. Universal Transverse Mercator Grid Table for Latitudes 0°-80°, Department of the Army, TM5-241-14, Washington, D. C. December, 1959.

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AREA MAP

FIGURE 2.1-1

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TRANSMISSION LINE R/W
FACILITY
CONST ACCESS ROAD
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RIVER
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4
BATCH PLANT AREA
TEMP. FENCE
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NEW CHAIN LINK FENCE	—×—×—
EXISTING FENCE	—×—×—
PROPERTY LINE OR MATCHLINE	—— — ——
ROUGH GRADE CONTOUR	———
EXISTING GROUND CONTOUR	— — —
DITCH FLOWLINE	—→—→—
SPOT GRADE	125
HIGH POINT FLOWLINE	H.P.R.
BEGINNING OF VERTICAL CURVE	B.V.C.
END OF VERTICAL CURVE	E.V.C.
POINT OF INTERSECTION	P.I.
SURVEY TRIANGULATION MONUMENT	◆
BEGIN CURVE	B.C.
END CURVE	E.C.
WORK POINT	W.P.

GENERAL NOTES

1. EXISTING TOPOGRAPHY REPRODUCED FROM ORIGINAL TOPOGRAPHIC DRAWINGS PROVIDED BY THE ENGINEERING DEPARTMENT OF GEORGIA POWER CO., ATLANTA, GEORGIA.
2. THE GRID SYSTEM SHOWN IS DESIGNATED "PLANT GRID SYSTEM". THE FOLLOWING FACTORS MAY BE APPLIED TO CONVERT TO THE STATE GRID SYSTEM.

PLANT NORTH + 1,135,000 = STATE NORTH
PLANT EAST + [illegible] = STATE EAST

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ENVIRONMENTAL REPORT

SITE PLOT PLAN
FIGURE 2.1-3

Amend. 2 11/26/73

2.2 HUMAN ACTIVITIES IN THE ENVIRONS

2.2.1 POPULATION

VNP will be in a sparsely populated region with approximately 230 permanent residents within a 5-mile radius. There are no towns of 2,000 or more within 10 miles of the site. According to the 1970 Census,(1,2) there are 5 towns of 10,000 or more within 60 miles of the site: Ft. Gordon, Georgia (15,589); Augusta, Georgia (58,864); North Augusta, South Carolina (12,883); Aiken, South Carolina (13,436); and Orangeburg, South Carolina (13,251). Figure 2.2-1 shows these towns and their distances from the site. Towns of over 20,000 that are within 100 miles of the site and other major towns in Georgia and South Carolina also are shown on Figure 2.2-1 (the population is based on the 1970 Census).

There will be no permanent residents on the VNP site. The nearest existing occupied house is about 3 air miles southeast of the center of the VNP-1 containment. The only town within a 10-mile radius of the site is Girard, Georgia, 8 air miles south-southwest of the site, with a 1970 population of 241(1) and an estimated 1977 population of 299.(3) The "population center", as defined in 10 CFR 100, is Augusta, Georgia, 26 air miles north-northwest of the site, with a 1970 population of 59.864 and a projected 1977 population of 81,892.

The population projections made for the area within a 60-mile radius of the VNP site were based on the 1970 Census data and county population projections developed by the Georgia and South Carolina Social Sciences Advisory Committee.(3,4) This was the latest information available at the time. The projections were made for the years 1977, 1987, 1997, and 2017, and they were broken down into 16-22 1/2° sectors, each of which is centered on a cardinal compass point, e.g. north, north-northeast, northeast, etc. Figures 2.2-2, 2.2-3, and 2.2-4 show these population projections out to a distance of 60 miles, and Figures 2.2-5 and 2.2-6 show the areas of Georgia and South Carolina to which these projections correspond.

Because of the remoteness of the VNP site from heavily populated areas, there are few human activities within a 5-mile radius of the VNP site. A survey by the Central Savannah River Area Planning & Development Commission(5) shows no public or private schools, hospitals, commercial plants, sports facilities, residential areas, parks, or recreation areas within the Georgia portion of the 5-mile radius from VNP. (The South Carolina part of the area described by this 5-mile radius falls wholly within the AEC Savannah River Plant (SRP) site, and the restricted nature of this property excludes any such land use.) The land included in the VNP site would most likely have been used for forestry had GPC not obtained it for a plant site.(15) The site itself is not currently zoned, and it is not expected to be zoned in the near future.(15) That portion of the site modified for construction purposes but not ultimately occupied by the plant will, after construction, be landscaped with appropriate vegetation under the guidance of the Burke County, Georgia, office of the Soil Conservation Service of the United States Department of Agriculture.(16) The site property not occupied by the plant itself and not disturbed by construction will be left as is. Neither state nor local governmental agencies have any present plans for public park areas in the immediate vicinity of the site.(15, 17) Recreational facilities within 25 miles of VNP are given in Table 2.2-1.

2.2.2 SCHOOLS

Most of the information in this subsection and in Subsections 2.2.3, 2.2.4, and 2.2.5 came from the Environmental Report of Allied-Gulf Nuclear Services for its Barnwell Nuclear Fuel Plant (Barnwell, South Carolina). Information obtained from other sources is noted.

The school nearest the VNP site is Girard Elementary School in Girard, Georgia, about 8 air miles south-southwest of the VNP site. This public school has a student body of just over 300 and a staff of 12.(5) Also nearby is the Cousin Elementary School in Sardis, Georgia, approximately 13 air miles southeast of VNP; it has about 325 students and a faculty of 15.(5) The Sardis-Girard-Alexander (SGA) High School, also in Sardis, has a student body of about 370 and a faculty of 20; although SGA does not play football, it does have a gymnasium, which is the sports facility nearest VNP.(5) With the additional schools in Waynesboro, the total enrollment in the Burke County public schools is just over 5000.(6) There is one private elementary school in Waynesboro with 98 students and 9 teachers.

Georgia counties adjacent to Burke County are Screven, Jenkins, and Richmond. Screven County, to the southeast of Burke County, contains 5 elementary schools, 2 secondary schools, and 1 combined school, with a total average daily attendance (ADA) of 3157.(6) (At present, the average daily attendance for a school is computed on a monthly basis by summing the number of days each student is present and dividing this total by the number of school days in the month; these monthly figures are then summed and averaged at the end of a school year.)(7) Jenkins County, to the south of Burke County, has 2 elementary schools and 2 secondary schools with a total ADA of 2011.(6) Jenkins County also has 1 private school with an enrollment of about 280 students and a faculty of 14. In Richmond County, northwest of Burke County, there are 42 elementary schools and 14 secondary

Table 2.2-1

RECREATIONAL FACILITIES WITHIN 25 MILES OF VNP(15,18)

STATE	COUNTY	FACILITY
Georgia	Burke	Exchange Club Fairgrounds, Waynesboro Jones Lake, Waynesboro Davis Road Park, Waynesboro 3 neighborhood parks, Waynesboro Andress Field, Waynesboro Waynesboro Country Club Fulcher Plantation Millers Mill Pond Savannah River Boat Club Windy Hill Ranch D.A.Y. Hunting Club Di-Sorre Plantation Scotts Lake Cakes Lake Saxtons Lake Boyds Pond Boll Weevil Plantation Timmermans Pond Bert Maxwell YMCA Camp
	Jenkins	Central of Georgia Park, Millen Magnolia Country Club Lincoln Park, Millen Magnolia Springs State Park Millen National Fish Hatchery
	Screven	Burton Ferry Boat Landing Georgia Welcome Station
	Richmond	Camp Lenwood Hayne Richmond County Boat Ramp Richmond County 4H Camp Goshen Plantation Golf Course New Savannah Bluff Lock and Dam Richmond Factory Pond
South Carolina	Allendale	Johnson's Landing Martin-Millett Community Center, Millett Willingham Plantation

schools with an ADA of approximately 33,000.(6) There are also 7 private schools with a total enrollment of about 2500 and a total of about 130 teachers. Schools of higher education in Richmond County include: the Augusta Area Technical School, with an average quarterly attendance of 1350 during the day and 3000 at night; Augusta College, enrollment 2877; Paine College, 800; and the Medical College of Georgia, 1100. South Carolina counties adjacent to Burke County are Aiken, Allendale and Barnwell. In Aiken County there are 55 public schools with an ADA of 23,000, and 7 private schools with an ADA of 1236. Barnwell County contains 12 public schools, ADA 4650, and a private school, Jefferson Davis Academy, 174. In Allendale County, there are 7 public schools, ADA 2778, and a private school, Allendale Academy, 68. Other schools in the area include the Aiken and Allendale branches of the University of South Carolina.

2.2.3 FARMING AND DAIRIES

Farming and dairying are major income producing activities in Burke County. Within a 5-mile radius of the VNP site, approximately 30 percent of the land is farmed, with the rest being wooded. Cash crops in the area include soybeans, corn, cotton, peanuts, and planted slash pine.(5) Specific data on agricultural production may be found in Appendix B of this report.

There are no dairies within a 5-mile radius of the VNP site.(8) The dairies nearest the site are: (1) Wardlaw Dairy, approximately 6 air miles south-southwest; (2) Mallard Dairy, approximately 6 air miles southeast; and (3) S.E. Dixon Dairy, approximately 12 air miles southeast. See Figure 2.2-7 for the locations of these dairies relative to the VNP site. All 3 are relatively small, having herds of about 100 cows each.(5) Statistics compiled on milk marketing under Federal Order No. 7 show that the 1971 daily average delivery per producer in Burke County was 2731.5 pounds of milk.(19)

Records of the American Dairy Association of Georgia show that there are no milk processing plants in Burke, Jenkins, Screven, or Richmond counties.(9) A Borden Company ice cream manufacturing plant is in Augusta. The American Dairy Association of South Carolina reports that milk processing facilities in Allendale, Barnwell, and Aiken counties include Keys Dairy, on U.S. Highway 78 near Gloverville, Haskell's Dairy, on South Carolina Highway 126 near Augusta, and Herndon's Dairy, on South Carolina Highway 778, 5 miles from Langley.(10)

2.2.4 INDUSTRIAL ACTIVITY

Burke County is not heavily industrialized. It contains four comparatively large manufacturing plants: Keller Industries, aluminum chairs, employment 519; Samson's Manufacturing, garments and drapes 234; Burke Manufacturing, garments and drapes, 170; and

Perfection Division, Hupp Corporation, air conditioning equipment, 160. In Screven County, White Stag, women's sportswear, employs 300; Empire Lumber, 60; Mobley Lumber, 46; and King Finishing, finished cloth, 175. In Jenkins County, there are 11 manufacturers employing 753 persons. The larger plants include: Coopers, Inc., underwear and knit shirts, 265; Thomson Co., slacks, 200; and Brigader Industries, mobile homes, 88. The metropolitan area of Richmond and Aiken counties contains the largest number of plants within 50 miles of the VNP site, 137 plants employing 29,000. These plants manufacture a wide range of products. Some of the larger facilities are: Graniteville Co., cotton textiles, employing 5700; Owens-Corning, fiberglass, 1200; Clearwater Finishing, textile, 1100; Babcock & Wilcox, clay refractories, 880; Murray Division of Beatrice Foods, bakery products, 860; Continental Can Co., paper products, 718; Kimberly-Clark, paper, 580; and Proctor and Gamble, detergents, 241. Other large manufacturing plants in South Carolina within the environs of the VNP site are: Davan Manufacturing division of Allendale Kayser Tower, ladies loungewear, 350; J. P. Stevens & Co., wool processing, 180; and Westport Industries, synthetic carpet yarns, 125; all these are in Allendale County. Among the larger plants in Barnwell County are: Barnwell Mills division of Deering Milliken, finished fabrics, 700; E.T. Barwick Industries, synthetic carpet yarn, 300; Shuron Continental division of Textron, Inc., ophthalmic lenses, 450; and Blackville Manufacturing, skirts and dresses, 206.

There are 3 nuclear facilities in the VNP area. They are discussed more completely in Section 2.8. The Savannah River Plant, which occupies land in both Aiken and Barnwell counties, employs about 5000 people. Allied-Gulf's Barnwell Nuclear Fuel Plant (BNFP) in Barnwell County has about 100 permanent employees, and Chem-Nuclear Services, adjacent to BNFP, has 7. The locations of these facilities relative to the VNP site are shown on Figure 2.2-8.

2.2.5 HOSPITALS

Burke County contains the following medical care facilities: Burke County Hospital, 52 beds (57 in an emergency), 60 percent occupancy; Pines Intermediate Care Home, 29 beds, 100 percent occupancy; Andress Nursing Home, 100 beds, 40 percent occupancy (expected to rise soon); Keysville Convalescent and Nursing Home, 85 beds, 100 percent occupancy. The first 3 of these facilities are in Waynesboro, Georgia, approximately 15 air miles west-soutwest of the VNP site. The fourth facility is located in Keysville, Georgia, approximately 28 air miles west-northwest of the site. The Thompson Hospital, Inc., a facility for alcoholics, is also located in Waynesboro, but there is no information on capacity or occupancy rate available from either the hospital or Georgia governmental agencies. In Screven County, there are the Screven County Hospital and the Sylview Nursing Home, both in Sylvania. In Jenkins County, there is a 30-bed hospital in the city of Millen. In South Carolina, there is a general hospital at Fairfax in Allendale County, a general hospital at Barnwell in Barnwell County, and a general hospital at Aiken in Aiken County. Barnwell County nursing homes include Pine Haven in Blackville, 1

Williston in Williston, and Barnwell County in Barnwell. A nursing home is in Allendale County, in Fairfax at the Allendale County Hospital. Nursing homes in Aiken County are Aiken Nursing Home in Aiken and Anne Maria Medical Care Nursing in North Augusta. The largest aggregation of medical facilities is in Richmond County. These include Regents Hospital, Saint Joseph's Hospital, Gracewood Hospital, and Talmadge Memorial Hospital. Nursing facilities in the county include Leiss, Circle Drive, Andress, White's Bayville, Beverly Manor, Jennings Manor, and Blair House nursing homes, and the Veterans Administration's Nursing and Intermediate Care Home.

2.2.6 WATER USE

The Savannah River is used for such recreational purposes as water skiing and fishing. No industrial or agricultural use of the river water below the VNP site is known that would be affected by operation of the plant, and only 2 public water systems utilize water from the river. Savannah, Georgia, approximately 151 river miles (11) downstream supplements its domestic well water supply from the river, and the Beaufort-Jasper (South Carolina) Water Authority takes water at a point approximately 103 river miles (11) downstream from the VNP site for sanitary water for most of Beaufort County, South Carolina. (12) Water sources within 5 miles of VNP include the Savannah River, Beaver Dam Creek, Daniels Branch, Toblers Creek, Sweet Water Creek, and numerous wells. At present, all water needs in the area are supplied through ground water sources. (15) The only discharges of any significance to the Savannah River in the vicinity of VNP are those from SRP. These discharges enter the river primarily through Upper Three Runs Creek, Lower Three Runs Creek, Four Mile Creek, and Steel Creek, all of which flow through SRP property. When BNFP becomes operational, it will discharge to Lower Three Runs Creek, also. There is commercial river traffic on the Savannah River in the VNP site region, composed primarily of tug-drawn barges moving between Savannah and Augusta. Legislation passed in 1950 requires that the navigation channel of the Savannah be maintained at a depth of 9 feet by the U.S. Army Corps of Engineers. Total amounts of cargo (in short tons) moved past the site in recent years are as follows: 1966, 57,351 tons; 1967, 95,956 tons; 1968, 88,951 tons; 1969, 109,423 tons; 1970, 135,574 tons;1971, 66,446 tons. (13) Tonnage data for 1972 are not yet available. The types and amounts of cargo shipped in 1971 are shown below. (13) In a speech to Augusta, Georgia, area businessmen, Col. Howard L. Strohecker, District Engineer, Savannah District, U. S. Army Corps of Engineers, noted the sharp tonnage decrease from 1970 to 1971 and speculated that this decrease might be largely due to competitively low railroad freight rates. (14) Barge owners in the Augusta area have complained that the navigation channel is not being maintained properly and that this prevents them from putting enough cargo on their barges to cover their costs. 1

CARGO SHIPPED 1971	AMOUNTS (SHORT TONS)
Logs	15,225
Basic chemicals and products	20,131
Nitrogenous chemical fertilizers	18,000
Phosphatic chemical fertilizers	1,963
Structural clay products	1,279
Miscellaneous non-metallic mineral products	8,808
Machinery, except electrical	400
Motor vehicles, parts, and equipment	90
Commodities	550
TOTAL	66,446

2.2.7 TRANSPORTATION

The nearest airport with scheduled passenger service is Bush Field near Augusta, Georgia, about 17 air miles north-northwest of VNP. There are other small municipal airfields in the area that are not used for scheduled service, the nearest being the Burke County Airport, about 16 air miles west-southwest of the site. The highway nearest VNP on which there is truck traffic is Georgia State Highway 23, about 5 air miles south-southwest. The nearest commercial railroad, a Central of Georgia line, passes about 12 air miles west of the site. There will also be a connecting rail spur built by GPC for transportation of materials and equipment to VNP (see Section 4.2). Figures 2.2-7 and 2.2-8 show U. S. highways, main state highways, and railraods within a 30-mile radius of VNP.

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(3) Lyle, C. V., Chief Economist, Southeast Region, Federal Water Pollution Control Administration, U. S. Department of the Interior, Georgia County Population Projections as Developed by the Georgia Social Sciences Advisory Committee, Georgia Social Sciences Advisory Committee, Atlanta, Georgia, February, 1968.

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(6) Wallace, M. Eugene, Jr., Coordinator, Statistical Services, Division of Planning, Research, and Evaluation, Georgia Department of Education, letter to R. A. Hammock, Copy Editor , Georgia Power Company, Atlanta, Georgia, November 30, 1971.

(7) Wallace,Dennis, Pupil Personnel Services, Dekalb County Board of Education, telephone conversation with L. W. Cook, Environmental Analyst, Georgia Power Company, Decatur, Georgia, June 9, 1972.

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(9) American Dairy Association of Georgia, Inc., telephone conversation with R. A. Hammock, Copy Editor, Georgia Power Company, Decatur, Georgia, November, 1971.

(10) American Dairy Association of South Carolina, Inc., telephone conversation with R. A. Hammock, Copy Editor, Georgia Power Company, Columbia, South Carolina, November, 1971

(11) Savannah River Below Augusta, Georgia and South Carolina, Navigation Charts, U. S. Army Engineer District, Savannah, Corps of Engineers, Savannah, Georgia, 1966.

(12) Effect of the Savannah River Plant on Environmental Radioactivity, AEC-SRP Semi-Annual Report, July through December, 1966, U. S. Atomic Energy Commission, Washington, D. C., 1967.

(13) Waterborne Commerce of the U. S., Corps of Engineers, Washington, D. C., 1967 - 1972. 1

(14) Christensen, Mike, "Where Are Those Barges on Georgia Riverfronts?", Atlanta Journal and Constitution, September 24, 1972.

(15) Starnes, Ron, Director of Planning, Central Savannah River Area Planning and Development Commission, letter to A. W. Harrelson, Junior Engineer, Georgia Power Company, Augusta, Georgia, November 8, 1972.

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(17) McKinney, Marilyn, Planning and Research Office of Georgia Natural Resources Department, telephone conversation L. W. Cook, Environmental Analyst, Georgia Power Company, Atlanta, Georgia, December 19, 1972.

(18) Ewing, Carol, Lower Savannah Regional Planning and Development Council, telephone conversation with L. W. Cook, Environmental Analyst, Georgia Power Company, Aiken, South Carolina, November, 1972.

(19) Greene, E. Hickman, Market Administrator, Compilation of Statistical Data, 1971, Georgia Marketing Area, Federal Order No. 7, Atlanta, Georgia, 1972.

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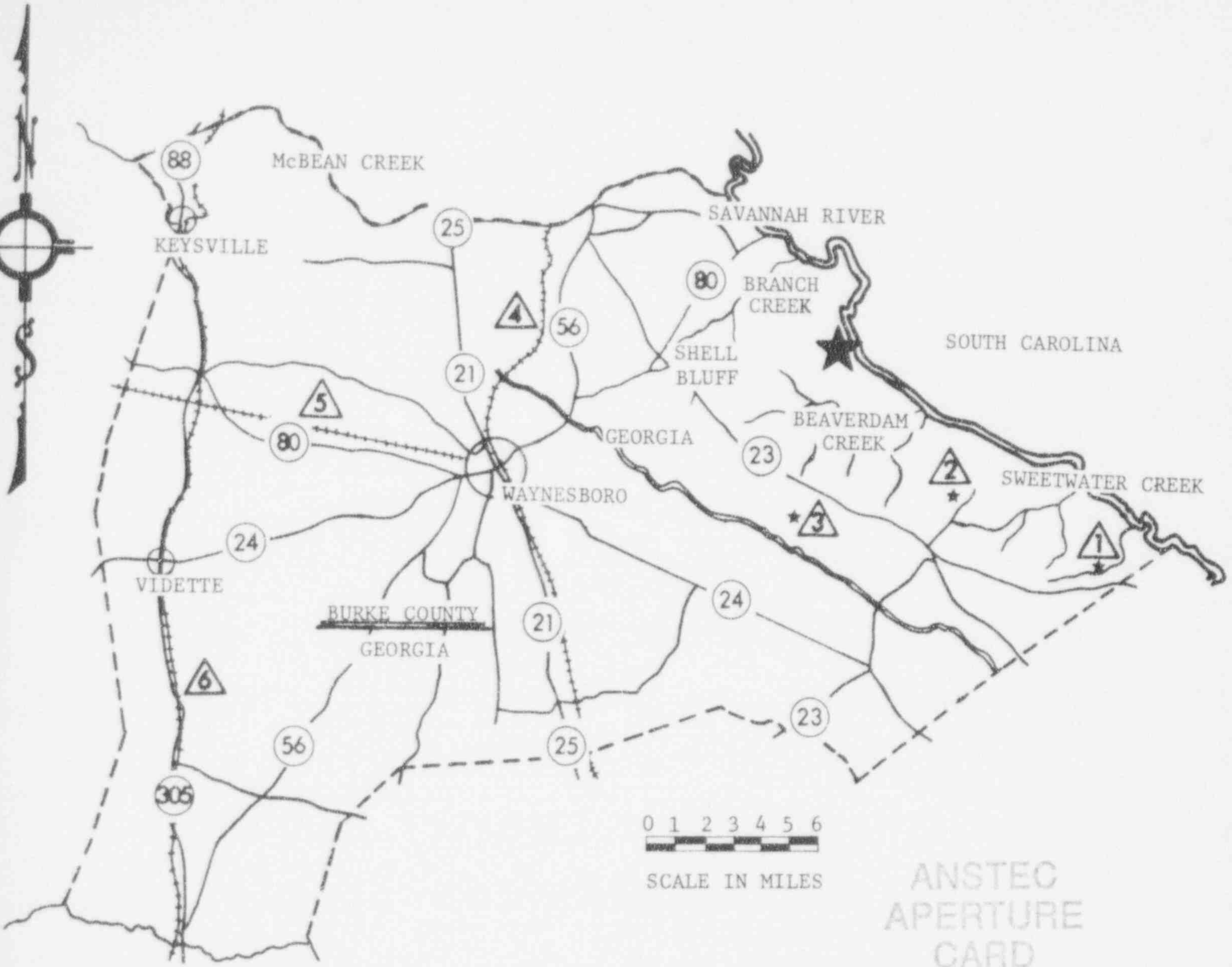

NOTES:

- △1 S. E. DIXON DAIRY FARM
- △2 MALLARD DAIRY FARM
- △3 WARDLAW DAIRY FARM
- △4 CENTRAL OF GEORGIA RY.
- △5 SAVANNAH - ATLANTA RY.
- △6 GEORGIA - FLORIDA RY.
- ○ INDICATES HIGHWAYS

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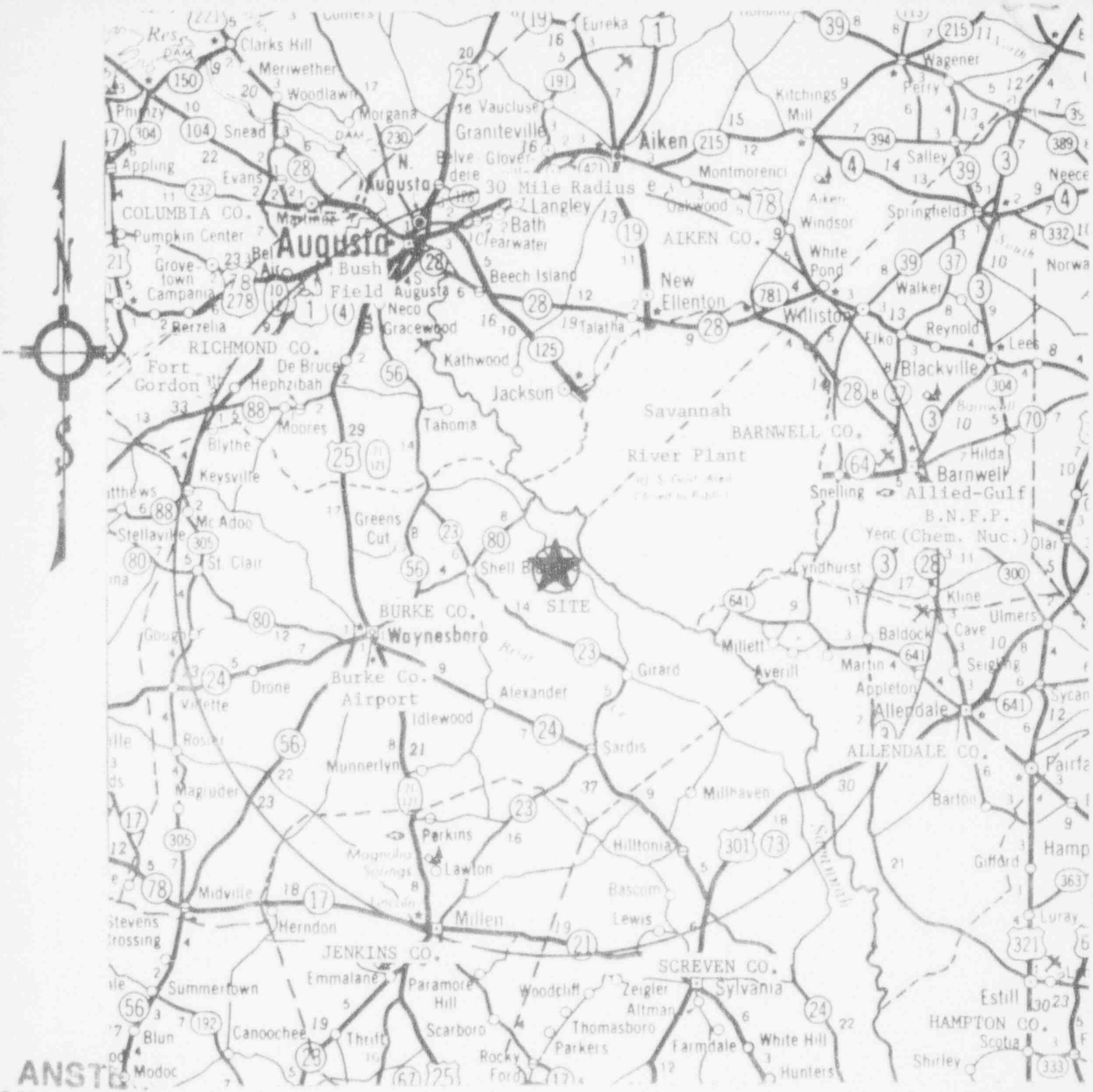
DAIRY FARM & RAILROAD LOCATIONS

FIGURE 2.2-7



SCALE IN MILES

0 5 10 15 30

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ENVIRONMENTAL REPORT

AREA MAP

FIGURE 2.2-8

2.3 HISTORIC SIGNIFICANCE

The VNP site itself is of no known historical significance, and there is no place of known historical significance within a 5-mile radius of the site on the Georgia side of the Savannah River.(1) On the South Carolina side, the 5-mile radius falls entirely within the Savannah River Plant reservation. Although little is known about this top-security area, it is generally believed that there is no place of known historical significance here, either; even if there were, such place would not be accessible to the general public.

Shell Bluff Landing and the Waynesboro, Georgia, Historical Museum are the nearest historical sites recognized by the Georgia Historical Commission.(1) Shell Bluff Landing was important during the era of steamboat river traffic, and it was fortified during the War Between the States.(2) Shell Bluff Landing is also the site of the original grave of Dr. Lyman Hall, one of the Georgia signers of the Declaration of Independence; his body was later reinterred in Augusta. The Waynesboro Historical Museum, which commemorates the early history of Burke County, is located in the Munnerlyn House, a restored pre-Revolutionary War structure. The National Register of Historic Places, corrected through the December 5, 1972, Federal Register, lists 6 historical sites in the nearby area: (1) the Birdsville Plantation, west of Millen, Georgia; (2) The Mackay House in Augusta, Georgia; (3) the Augusta Canal; (4) the shell mounds of Stallings Island, 8 air miles northwest of Augusta, in the Savannah River; (5) the Lawton Mounds, south of Johnston's Landing in Allendale County, South Carolina; (6) the Red Bluff Flint Quarries, southwest of Allendale, South Carolina. Of the mentioned sites, the one closest to VNP is Shell Bluff Landing, approximately 7 air miles north-northwest. Since none of these sites is on or near the VNP site, they will not be adversely affected by the construction or operation of VNP.

The Shell Bluff Landing area is also of some archaeological significance. Shell Bluff Landing takes its name from a large bed of fossils of the giant oyster Crassostrea gigantissima located there. It is thought that this bed was formed during the Eocene Age while the coastal plain of Georgia was submerged in the Atlantic Ocean.(2) Between the town of Shell Bluff and Boggy Gut Creek, there is the site of an Indian village,(1) which is
approximately 7-1/2 air miles north-northwest of VNP. An arrowhead esti-
mated to be 4,000 years old has been found at this site.(3) Since neither 1
of these sites is on or near the VNP site, neither one will be adversely
affected by the construction or operation of VNP. At the request of GPC,
an archaeological survey of the VNP site was completed under the direction 2
of the Georgia State Archaeologist and the Georgia Historical Commission and
submitted to the U.S. Atomic Energy Commission on August 15, 1973. The State
Archaeologist recommended that some excavations be performed in the area of a
cabin formerly owned by a Dr. Brown. These excavations were performed in 3
December 1973, and a report on the findings from these excavations has
recently been submitted to the U.S.A.E.C. In light of this report, the
State Archaeologist stated that he feels that GPC has fulfilled its

obligations regarding the archaeological resources of the VNP site.(5) Any 3
further excavation or exploration will be done at the recommendation of, 1
and coordinated with, Mrs. Mary G. Jewett, Director of the Georgia Historical
Commission.(4)

Final locations of the rights-of-way for the VNP transmission lines have not yet been selected. Information on the general locations of these routes may be found in Sections 3.2 and 5.4. In the final selection process, the Georgia Historical Commission will determine whether or not the actual rights-of-way will disturb any structure or site of historical or archaeological significance.

REFERENCES

(1) Townsend, Billy, Staff Historian, Georgia Historical Commission, historical information sent to Joan Baurer, Librarian, Georgia Power Company, Atlanta, Georgia, October, 1971.

(2) Leckie, George C., Georgia, A Guide to its Towns and Countryside, Tupper and Love, Atlanta, Georgia, 1954, p. 402.

(3) "Taking a Look at Long Ago", Atlanta Journal, December 17, 1971.

(4) Jewett, Mary G., Director, Georgia Historical Commission, letter to R. Pierce Head, Jr., Assistant to Executive Vice President, Georgia Power Company, Atlanta, Georgia, March 21, 1973. 1

(5) Larson, Lewis H., Jr., State Archaeologist, Georgia Historical Commission, letter to R. Pierce Head, Jr., Assistant to Executive Vice President, Georgia Power Company, Atlanta, Georgia, February 11, 1974. 3

2.4 GEOLOGY AND SEISMOLOGY

2.4.1 GEOLOGY

The topography of the VNP site consists of low rolling hills with elevations ranging from 200 feet to 280 feet in the immediately site vicinity. All streams and creeks in the area drain naturally into the Savannah River.

The site lies in the Georgia Coastal Plain, about 25 miles east of the Piedmont Province (Figure 2.4-1). Geologic formations at the site are consolidated but uncemented sediments ranging in age from Cretaceous to Quaternary (Recent), which were deposited on an eroded surface of the Triassic through Precambrian (?) basement complex rocks. The site is located above a Triassic basin as are the Savannah River Plant and the Barnwell Nuclear Fuel Plant (BNFP) across the river. At this point the basin is approximately 950 feet below ground surface, approximately 30 miles in length, 6 miles wide, and trending northeast. It is presumed to be bounded on the northwest and southeast by normal faults, with minor transverse faulting also expected to be present.

It is the general opinion of geologic consultants that the Triassic basin faults are inactive and have been for nearly 200 million years. Data from recent investigation indicate no faulting of the sediments above the Triassic basin complex, and there is no indication of fault problems within the site or the surrounding area.

Recent drilling at the site and across the river on the AEC's Savannah River Project property established correlation of the Georgia-South Carolina geologic formations. The correlation was established by means of Oligocene, Eocene, and Cretanceous formations with excellent agreement found in several lithologic units. This interstate correlation of formations refutes the possibility of a Post-Cretaceous "Savannah River" fault (Figure 2.4-2).

At the plant site, the geologic formations have been previously mapped as the Eocene Barnwell and McBean Formations and are underlain by the Cretaceous Ellenton and Tuscaloosa sediments. Microfossil work performed during this investigation indicates an Oligocene age for the upper sands, clays, and marl, so the "Barnwell" and "McBean" names will not be further used in this discussion. The upper unit is a red-brown, yellow and buff, fine to coarse-grained, massive to cross-bedded sand and sandy clay. This material lies on the surface over much of the site area (Figure 2.4-3). The second unit is yellow-brown to green, fine to coarse-grained glauconitie quartz sand, interbedded with green, red, yellow and tan clay, sandy clay marl limestone. This unit contains the shell zone and the "bearing horizon", both of which are discussed further below. The Cretaceous (?) sediments are mainly very dense, dark-gray to black, micaceous sands and clays (Table 2.4-1).

There are surface depressions in the site area which have been investigated and have been found to be caused by leaching of permeable calcareous materials from a sand and shell zone overlying the bearing horizon. They form from a gradual subsidence rather than sudden collapse, as in the case of sink holes, due to the generally dispersed nature of the material being leached.

The "bearing horizon" is a 60-70 foot thick, unjointed, hard clay marl with limestone nodules, which forms an aquiclude throughout the site area. Although it is highly calcareous, its very low permeability has prevented leaching from taking place. The solutioning of the near surface calcareous sands and shell beds is a very slow but continuing process which should offer no significant problems within the life of the plant. All Class I and heavy structures will be founded on the bearing horizon or on controlled fill founded on the bearing horizon and will not be affected by the continued but slow leaching in the upper bed.

Table 2.4-1

STRATIGRAPHIC UNITS IN THE VICINTY OF THE ALVIN W. VOGTLE NUCLEAR PLANT SITE[a]

System	Series		Formation	Description
Quaternary to Tertiary	Recent to Pleistocene		Recent Alluvium	Alluvial fill and terrace deposits in stream valleys, consisting of tans to gray sand, clay, silt, and gravel.
Tertiary	Miocene		Hawthorn Formation	Tan, red, and purple sandy clay, interbedded lenses of gravel, and numerous elastic dikes.
	Eocene	Jackson Age	Barnwell Formation	Red, brown, yellow, and buff fine to coarse massive to cross-bedded sand and sandy clay.
		Claiborne Age	McBean Formation	Yellow-brown to green, fine to coarse glauconitic quartz sand, interbedded with green, red, yellow, and tan clay, sandy marl or limestone, and lenses of siliceous limestone
Believed to be Cretaceous	Upper		Ellenton Formation	Dark-gray to black sandy lignitic micaceous clay containing disseminated crystals of gypsum. Medium to dark-gray coarse sand and white kaolin.
Cretaceous	Upper		Tuscaloosa Formation	Tan, buff, red, and white cross-bedded micaceous quartzite and arkosic sand and gravel, interbedded with red, brown, and purple clay and white kaolin.
Triassic	Upper		Newark Group	Gray, dark-brown and brick-red sandstone, siltstone, graywacke and claystone with included sections of fanglomerate or conglomerate.
Paleozoic and Precambrian			Basement Rock of the Carolina Slate Belt and Charlotte Belt	Granite, gneiss, chlorite-hornblende, and chlorite-tremolite schist, slate, and volcanic rocks.

---

[a] After Siple in USGS Water Supply Paper 1841.

2.4.2 SEISMOLOGY

Except for the area around Charleston, South Carolina, earthquakes in southeastern United States are characterized by low magnitudes and intensities although of moderate frequency. This is shown on Figure 2.4-4, Seismic Risk Map of the United States.

Historical records of earthquakes in eastern United States start as far back as 1663, when an earthquake was felt mainly in the northeastern United States and in Canada. Any similar occurrence affecting the southeastern coastal colonies would have also inspired written records and descriptions, but none exist.

One of the first recorded shocks in the Georgia area resulted from the New Madrid (Missouri) earthquake of 1811. Many Georgia residents commented on this shock and, from such descriptions as "... a few bricks shaken off some chimneys", the intensity of the shock can be estimated. This descriptions, would indicate an intensity of VI (Modified Mercalli Scale of 1931) and was typical of the stronger shaking experienced over much of Georgia from this quake.

Table 2.4-2 lists earthquakes with sufficiently high intensities to be of interest in this report (intensities of V (MM) or higher within 200 miles of the site). As seen from Figure 2.4-5, no earthquakes of an intensity higher than VI (MM) have been recorded within a 100-mile radius of the site.

The earthquake causing the highest intensity of shaking felt at the site occurred on August 31, 1886, near Charleston, South Carolina. At its epicenter, approximately 104 miles from the site, it had an intensity of X (MM). Witnesses in the area described the shock. Locations, distance, from the site, and typical descriptions are:

> <u>Ellenton</u> (3 miles): "Not much damage".
>
> <u>Jackson Station</u> (9 miles): Extremely violent and alarming". (No damage was reported here.)
>
> <u>Hephzibah</u> (21 miles): "Ceiling cracked and bricks fell from chimneys".

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> Bath (23 miles): "Extremely violent shock, producing general consternation and alarm; houses swayed, walls cracked, chimneys broken, clocks stopped".

> Such reports suggest an intensity of VI (MM) or a low VII (MM) (see Figures 2.4-6 and 2.4-7).

Using a low to moderate intensity of VII (MM) at the site as a guide, an operating basis earthquake (OBE) value of 12 g acceleration was obtained from the Hershberger Curve. For the Safe Shutdown Earthquake a SSE value of .20 g acceleration has been recommended. These values are identical to those used for BNFP.

In summary, the site area has not been subject to high seismic activity since deposition of Upper Cretaceous sediments. Shocks may be felt at the site from distance sources, but the intensity is expected to be no more than VI (MM) (see Figure 2.4-8).

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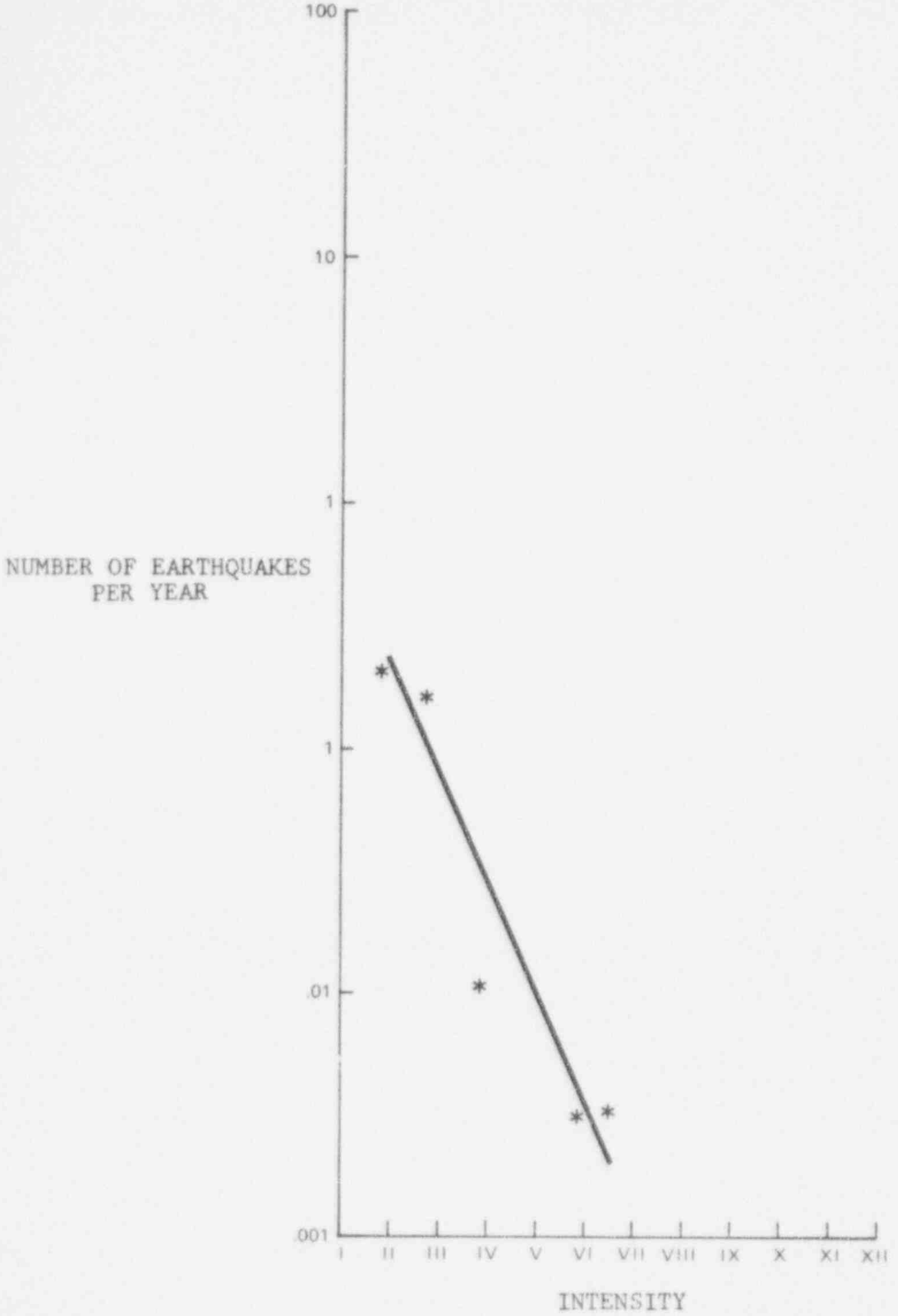
Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

TOWNS NEAR SITE REPORTING CHARLESTON
EARTHQUAKE AUGUST 31, 1886 SHOCK
FIGURE 2.4-7



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Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

EARTHQUAKE FREQUENCY IN VICINITY OF
VNP SITE

FIGURE 2.4-8

2.5 HYDROLOGY

2.5.1 FLOW OF SURFACE WATER

The VNP site is bordered on the east side by the Savannah River and on the south side by Beaverdam Creek. The AEC Savannah River Plant (SRP) is located directly across the Savannah River from the VNP site. There are 6 major creeks on the SRP property that flow into the Savannah River. Three of these creeks flow from Four Mile Branch:

(1) The uppermost of these, Upper Four Mile Creek, enters the Savannah River at river mile 152.2.

(2) The middle of these, Middle Four Mile Creek, enters the Savannah River at river mile 150.4.

(3) The lower of these, Lower Four Mile Creek, enters the Savannah River at river mile 147.8.

Upper Three Runs Creek enters the Savannah River upstream from the VNP site, at river mile 157.3. Pen and Steel Creek and Lower Three Runs Creek enter the Savannah River downstream from the VNP site at river mile 141.2 and river mile 129.1, respectively. The location of these creeks is shown in Figure 2.5-1.

The United States Geological Survey (USGS) maintains monitoring stations on the Savannah River. The nearest upstream station to the VNP site is at Augusta, Georgia (river mile 200), and the nearest downstream station to the VNP site is at Burtons Ferry Bridge (river mile 118). Data from both of these stations were utilized in determining the characteristics of the Savannah River. Except for periodic grab sampling, the USGS monitoring program at Burtons Ferry Bridge was discontinued at the end of September 1970. (1)

The Savannah River Basin is shown in Figure 2.5-2. The Savannah River flow data recorded at Burtons Ferry Bridge from January 1960, through September 1970, are shown in Table 2.5-1. Figure 2.5-3 is a graph of the monthly maximum and minimum flows for the same time period.

The Savannah River at the VNP site is normally about 340 feet wide at elevation 80 feet (MSL) and 13 feet deep, with an average velocity of 2 mph. The river flows along the toe of the bluff at the west side of the flood plain. The flood plain is about 7000 feet wide, with an average elevation of 85 feet (MSL). (2)

River elevation and velocity are plotted as a function of flow in Figure 2.5-3a. Figure 2.5-3b shows a river cross-section near the river intake. For the low flow of 5800 cfs, the top width is 345 feet, and the average velocity is 1.53 fps. 1

TABLE 2.5-1

SAVANNAH RIVER FLOW (cfs) AT BURTONS FERRY BRIDGE(1)

(22.5 river miles downstream from VNP)

YEAR	1960			1961			1962			1963		
MONTH	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
JAN	19200	10400	15610	8930	6160	7255	26800	8650	18760	18000	6700	10630
FEB	36400	20800	32440	18400	6640	9672	21700	7300	11860	16400	7730	119[illegible]0
MAR	35700	12100	24520	26200	7510	16130	24600	10800	17820	28600	7950	17980
APR	35700	14200	23490	32400	10700	24200	22100	13200	18270	23700	7000	10670
MAY	17600	7040	11250	22000	7200	10900	16000	6840	9399	22400	6640	15480
JUNE	9370	6540	7593	12200	6500	7414	14400	7040	9320	17100	6350	10130
JULY	10000	6540	7535	16400	6800	10650	7140	6350	6808	19200	6940	13260
AUG	11100	6640	8249	14800	7100	8817	7640	6350	6866	12400	6600	8787
SEPT	8710	6440	7261	16900	6400	9717	9040	6350	6834	9780	7510	8462
OCT	10100	6350	7253	6900	5700	6181	8600	6260	6812	11700	6900	7695
NOV	6160	7040	6478	7200	6200	6540	8410	6260	7032	8770	7200	7566
DEC	7840	6060	6685	23700	6300	13440	8060	7000	7215	15000	7400	10890

1

TABLE 2.5-1 (cont.)

SAVANNAH RIVER FLOW (cfs) AT BURTONS FERRY BRIDGE (1)

(22.5 river miles downstream from VNP)

YEAR	1964			1965			1966			1967		
MONTH	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
JAN	24600	8410	17850	29400	11800	21180	14600	7580	10130	12200	8020	10460
FEB	23200	17800	20040	17500	9450	12770	23200	8610	13290	12800	7700	9752
MAR	40600	19600	27080	30200	12500	19010	37000	12900	30180	16700	8090	11230
APR	71700	17900	46240	32700	10000	21870	11800	8640	9741	12000	6880	8155
MAY	46200	8030	29980	17100	8140	11770	15500	9570	12860	14000	6780	8282
JUNE	9920	7400	8418	22300	7760	13640	14400	7740	11020	22000	7410	15960
JULY	20200	7840	11140	14300	7950	9797	9460	7380	8041	15900	7940	10530
AUG	21200	8050	13310	13400	7750	10580	8850	7320	7988	15500	7480	9667
SEPT	34400	9040	20010	10300	7600	8836	8840	7110	7777	17000	7160	10580
OCT	25800	10100	20150	10200	7390	8121	7950	7140	7530	7810	6950	7252
NOV	21500	11100	14200	8750	7450	7934	7810	7240	7543	11800	7070	8632
DEC	29400	11800	21180	8790	7470	7940	9950	7460	7920	21400	11100	16320

TABLE 2.5-1 (cont.)

SAVANNAH RIVER FLOW (cfs) AT BURTONS FERRY BRIDGE(1)

(22.5 river miles downstream from VNP)

YEAR	1968			1969			1970		
MONTH	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
JAN	26500	18800	22200	18700	7250	10500	11100	7260	7954
FEB	19000	7550	10070	21100	10200	17050	10100	7260	8308
MAR	11500	7610	8643	17900	8060	12710	16900	7190	9695
APR	10500	7390	8535	36900	7960	18970	17900	7390	10070
MAY	10200	7320	8479	32400	9040	17910	8880	7000	7660
JUNE	17800	7340	10500	11000	7280	8366	7990	6890	7457
JULY	9830	7240	8075	9960	6930	7751	9230	7180	7685
AUG	10500	7240	8093	10200	6900	7910	8510	7360	7794
SEPT	7970	6970	7524	10100	7150	8092	7530	6840	7268
OCT	8380	7040	7459	8730	6710	7342			
NOV	9190	7040	7937	8390	6850	7434			
DEC	8650	7390	7870	10100	6860	7864			

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The temperature data collected in the mouths of Upper Four Mile Creek and Middle Four Mile Creek show temperature levels approximately 10° C higher than those observed on the Savannah River. Other tributaries of the Savannah River do not show this temperature increase. The plots of the Upper Four Mile Creek, Middle Four Mile Creek, Beaverdam Creek, and Lower Three Runs Creek temperature data are shown in Figures 2.5-9, 2.5-10, 2.5-11 and 2.5-12, respectively. The high Savannah River flows in January and February, 1972, caused river water to back up into the mouth of the creeks, and this altered the temperatures.

2.5.3 CHEMISTRY OF SURFACE WATER

Plots of dissolved oxygen data collected on the Savannah River at river miles 158, 151.8, 141, and 129 are included in Figures 2.5-5, 2.5-6, 2.5-7, and 2.5-8, respectively.

The weekly dissolved oxygen survey by GPC shows a decreasing trend in the Savannah River dissolved oxygen concentrations from river mile 158 to river mile 129.

Tables 2.5-3 and 2.5-4 contain summaries of chemical data collected from the Savannah River by GPC and USGS, respectively. The data in Table 2.5-3 were collected by GPC between river miles 150 and 158 from June 29, 1971, to February 3, 1972. The data in Table 2.5-4 were collected at Augusta, Georgia,between October, 1969, and September, 1970. The data in Table 2.5-3 were chosen as the reference data and are used in Chapter 3 (see Table 3.7-1). Table 2.5-5 contains chemical data collected from Beaverdam Creek. The data in these tables were determined in accordance with *Standard Methods for the Examination of Water and Wastewater*(7), and any discrepancies conform to the limits prescribed therein.

The Academy of Natural Sciences of Philadelphia, under contract with E.I. du Pont de Nemours and Company (primary contractors for operations at SRP), has been studying the Savannah River in the vicinity of the VNP site since 1951. In their summary report, (6) the Academy states that the chemicals often associated with organic enrichment show a general trend of increase from 1951 to 1968. The Academy also states that the Savannah River near the VNP site has shown a decrease in dissolved oxygen and an increase in chlorides since 1960.

Table 2.5-3

SAVANNAH RIVER
WATER QUALITY ANALYSIS
By GPC

Parameters	Maximum	Minimum	Average	Number of Samples	
Silica	9.4	5.8	7.5	10	
Iron	0.48	0.12	0.3	11	
Manganese	0.0	0.0	0.0	11	
Calcium	9.6	4.0	6.5	12	
Magnesium	5.8	0.5	3.5	11	
Sodium	9.8	4.2	7.3	11	
Potassium	2.7	1.1	1.9	11	
Carbonates	0.0	0.0	0.0	10	
Bicarbonates	36.6	22.0	28.8	10	
Sulfate	18.8	2.1	7.3	11	
Chloride	17.0	0.0	4.8	12	
Flouride	0.67	0.0	0.08	11	
Nitrate	0.48	0.0	0.28	10	
Phosphate	0.22	0.0	0.09	11	
Total Dissolved Solids	76.3	41.8	59.9	12	
Total Hardness as $CaCO_3$	38.0	20.0	30.8	12	
Alkalinity as $CaCO_3$					
Phenolphthalein	0.0	0.0	0.0	11	
Total	30.0	18.0	23.2	11	
pH, electrometric	7.4	6.4	6.8	12	
Conductivity, Micromhos	71.0	55.0	62.6	10	
Free CO_2	12.0	2.0	7.8	10	
Turbidity, JTU	42.0	4.25	21.77	12	
Color, Color Units	60.0	10.0	31.4	12	
Ammonia	0.56	0	0.21	5	1

NOTES:

1. Samples collected from 6/29/71 to 2/3/72.
2. All values are expressed as parts per million except as noted.

TABLE 2.5-4
SAVANNAH RIVER
Water Quality Analysis
By USGS

Parameters	Maximum	Minimum	Average	Number of Samples	
Discharge (cfs)	8530	6130	7056	9	
Specific Conductance(Micromhos)	61.0	51.0	55.2	9	
Color (PCU)	40.0	10.0	23.3	9	
Turbidity (JTU)	14.0	6.0	10.0	9	
Silica (mg/l)	12.0	7.6	10.2	7	
Calcium (mg/l)	3.4	2.7	3.0	9	
Magnesium (mg/l)	1.4	1.1	1.2	9	
Sodium (mg/l)	5.6	4.1	4.9	9	
Potassium (mg/l)	1.5	.8	1.3	9	
Sulfate (mg/l)	6.0	3.0	4.8	9	
Chloride (mg/l)	4.4	2.5	3.1	9	
Phosphate (mg/l)	1.0	.05	.23	9	
Alkalinity (mg/l)	21	16	18.3	9	
Hardness (mg/l)	14	10	12.3	9	
Dissolved solids (mg/l)	56	24	37.8	8	
Total Iron (mg/l)	0.750	0.100	0.366	9	1
Bio-chem. O_2 demand (mg/l)	2.8	.70	1.2	9	
Fecal coliform (MPN)	230,000	4,300	83,144	9	
Suspended solids (mg/l)	19	1	7.2	9	
Nitrate (mg/l)	.42	.14	.22	8	
Total Manganese (mg/l)	0.070	0.050	0.052	9	1
Sodium (mg/l)	5.6	4.0	4.9	9	
pH	7.2	6.4	6.7	8	
Temperature (Deg C)	21	6	14.7	9	
Dissolved Oxygen (mg/l)	13.0	7.6	9.8	9	
Ammonia Nitrogen (mg/l)	.4	.1	.25	4	

Note: 1. Samples collected from October 1969 to September 1970 at Augusta, Georgia.

TABLE 2.5-5

BEAVERDAM CREEK
Water Quality Analysis
By GPC

Parameters	Maximum	Minimum	Average	Number of Samples
Silica (ppm)	7.4	4.2	5.6	6
Iron (ppm)	.34	.12	.25	6
Manganese (ppm)	0.0	0.0	0.0	6
Calcium (ppm)	21.0	5.6	12.7	6
Magnesium (ppm)	11.9	1.5	5.0	6
Sodium (ppm)	7.6	1.7	2.8	6
Potassium (ppm)	1.9	0.0	.7	6
Carbonate (ppm)	0.0	0.0	0.0	5
Bicarbonate (ppm)	46.4	29.3	39.3	5
Sulfate (ppm)	6.5	0.0	3.7	6
Chloride (ppm)	21	2.0	6.5	6
Fluoride (ppm)	.5	0.0	.1	5
Nitrate (ppm)	.26	0.0	.09	5
Phosphate (ppm)	.20	0.0	.11	5
Total dissolved solids (ppm)	111.5	50.2	70.7	6
Total hardness as $CaCo_3$ (ppm)	58	30	41.2	6
Alkalinity as $CaCo_3$				
Phenolophthalein (ppm)	0.0	0.0	0.0	6
Total (ppm)	38	24	31.5	6
pH, electrometric	7.2	6.7	6.9	6
Conductivity (Micromhos)	100	51	67	6
Free CO_2 (ppm)	15.0	3.5	8.7	6
Turbidity (JTU)	6.5	1.5	4.1	5
Color, color units	45	6.0	32.2	6

NOTE: 1. Analysis run from 6/3/71 to 1/5/72

2.5.4 GROUND WATER

The VNP site is located on the Georgia Coastal Plain in Burke County near the Savannah River. The Coastal Plain consists of stratified sedimentary deposits with permeabilities varying from very high to practically impervious.

Two aquifers were found at the site, a shallow water table aquifer and the deep, confined Tuscaloosa aquifer. These 2 zones are separated by an effective aquiclude, a 60-to-70 feet thick, hard clayey marl referred to as the "bearing horizon."

An extensive investigation was performed to define the characteristics of the ground water at the site. A survey was made of local springs and water wells to determine location and depth to the ground water level and to provide samples for analyses of water quality, including chemical and solids content. Piezometers were placed in numerous drill holes to monitor ground water level fluctuations. Pumping, bailing, and pressure tests were undertaken in several drill holes to determine permeability characteristics of the subsurface strata.

Data on the confined aquifer were obtained from 10 piezometer installations (Figure 2.5-13). Data related to the shallow water table aquifer were obtained from 12 holes in which piezometers were installed and 9 springs, which are indicated on Figure 2.5-14. Results of the water quality analysis of samples obtained from these holes are found in Table 2.5-6. Water level data obtained from piezometer test holes are presented in Table 2.5-7. Information obtained from 14 water wells in the area is presented in Table 2.5-8, while water quality analysis of these wells is indicated in Table 2.5-10 Water quality analyses of springs and surface water are presented in Tables 2.5-9 and 2.5-11, respectively. The data shown in these tables are discussed in Paragraphs 2.4.13.2.1.1,"Ground Water Observation Points", and 2.4.13.2.1.4,"Water Quality", in the VNP-PSAR. The observation points are open to sands immediately above the marl (unconfined ground water) or immediately below the marl (combined ground water) as noted on the tables. The maximum depth from which water samples were taken and for which data are shown in the tables is 220 feet. The water quality data were determined in accordance with Standard Methods for the Examination of Water and Wastewater[7], and any discrepancies conform to the limits prescribed therein. 1

The nearest well to the plant site is a small domestic well at the home owned by Louise Rouse (as of September, 1971). It is 2000 feet southwest of the westernmost plant site property line (trends northwest-southeast). It is listed in Table 2.5-8 under identification number 10 and is shown on Figure 2.4-21 of the PSAR.

Permeability test data are presented in Tables 2.5-12 and 2.5-13.

The VNP site is located in an interfluvial high that is bounded by stream channels which have cut down to a relatively impermeable marl. This marl forms the aquiclude between the 2 aquifers. The streams, which act as interceptor drains for the ground water in the sands overlying the marl, include the Savannah River to the northeast, the Hancock Landing drainage to the north, tributaries of Beaverdam Creek to the west, and Beaverdam Creek to the south.

WATER QUALITY ANALYSES
OBSERVATION HOLES

(values in parts per million unless otherwise designated)

34[a] 10/6/71 17947 10/11/71	121 9/22/71 17840 9/27/71	135[b] 10/13/71 17980 10/14/71	124[c] 10/12/71 17978 10/14/71	129[c] 10/13/71 17979 10/14/71	142[c] 10/13/71 17981 10/14/71	143[c] 10/13/71 17982 10/14/71	24[b] 7/21/71	24[b] 10/6/71 17944 10/11/71
13.3	15.9	16.3	6.8	18.2	5.2	21.6	6.75	4.6
5.4	7.5	8.3	8.3	8.3	6.8	5.8	1.7	11.2
3.2	3.2	2.8	0.7	2.3	1.2	1.9	1.49	1.5
15.2	12.8	28.8	24.8	23.6	25.6	23.0	23.0	4.0
0.0	0.0	14.4	0.0	9.6	0.0	14.4		16.8
95.2	84.2	114.7	96.4	93.9	103.7	96.4		45.1
0.0		0.0	0.0	0.0	0.0	0.0		0.0
7.7	3.6	17.4	3.5	20.5	7.1	25.8	36.6	7.6
3.0	1.0	4.0	4.0	3.0	2.0	2.0	4.0	2.0
0.07	0.00	1.40	0.00	0.85	0.22	1.14	0.0	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.09
0.15	0.66	0.26	0.26	0.28	0.26	0.63		0.50
0.57	0.31	0.12	0.50	0.15	0.34	0.30	0.21	0.15
7.9	8.0	9.2	5.2	5.4	7.7	8.4	6.75	7.4
127.9	112.5	106.0	126.4	155.8	134.2	169.5	234.9	89.6
140	130	180	130	170	120	150	390.0	115
7.9	6.1	8.2	8.2	8.3	7.9	8.6	11.3	9.1
2	110	0	0	0	2.2	0	0.0	0
78.0	69.0	106.0	79.0	85.0	85.0	91.0	119.0	51.0
60.0	63.0	106.0	96.0	66.0	92.0	62.0	94.0	56.0
--	65	--	--	--	--	68	--	68

r system; flowing at the surface.
r system; not flowing at the surface.
ifer system (above the marl).

Observation Point
Date Samples
Laboratory No.
Data Analysis

Constituents

Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Carbonate (CO_3)
Bicarbonate (HCO_3)
Hydroxide (OH)
Sulfate (SO_4)
Chloride (Cl)
Nitrate (N)

Fluoride (F)
Total Phosphate (PO_4)
Iron (Fe)
Silica (SiO_2)

Total Dissolved Solids
Conductivity (micromhos)
pH
Free Carbon Dioxide
Total Alkalinity as $CaCO_3$
Total Hardness as $CaCO_3$
Temperature (°F)

a Open to the confined aquife
b Open to the confined aquife
c Open to the water table aqu

Point No.	Surface El.
	Observation
42	209.7
124	260.2
129	215.8
140	222.4
141	230.4
142	231.2
143	224.5
145	218.2
176	196.4
177	213.0
178	240.4
179	274.8
	Observation
24	216.0
26	203.0
27	210.0
29	193.0
31	211.0
32	214.0
34	86.0
42A	210.5
101A	210.8
121	88.0
135	200.5
144	103.23
147	226.2
	Observation
42B	210.4
42C	210.0

Table 2.5-7

WATER LEVEL MEASUREMENTS AT OBSERVATION POINTS

Elevation of Water Measured in Hole (week ending)								
/18/71	7/16/71	8/13/71	9/3/71	9/17/71	10/8/71	10/15/71	10/22/71	11/5/71
Points in Shallow Aquifer								
59.4	157.7	157.0	156.4	157.2	157.3		157.6	156.6
					162.1	161.9	162.2	162.3
					153.6	153.6	153.4	152.8
					160.5		160.7	159.4
					154.6	154.8	155.7	154.1
					152.4	152.5	152.6	153.2
					153.6	153.6	153.6	152.5
					196.7	194.7	196.7	195.0
						159.6	159.7	159.2
						162.9	160.7	161.0
						175.8	158.6	158.0
							Below 150.0	156.5
Points (Piezometers) in Artesian Aquifer								
18.3	117.1	117.5	117.8	117.3	117.6		117.7	117.2
01.2	101.0	100.2	101.9	101.2			102.2	102.7
83.9	86.0	85.3	83.2	83.0	82.6		84.0	82.5
06.6	102.2	101.0	101.6	101.2			98.5	97.8
	104.7	106.5	107.3	106.4	106.0		105.5	105.2
04.1	100.4	103.4	104.0		102.8		102.7	102.5
	102.0+		101.0+	101.0+				
		109.5	102.0	101.8	93.3		93.3	96.2
						116.9	117.2	116.0
					105.1	105.0	105.2	104.1
					116.4	118.2	116.8	114.9
Points (Piezometers) in Aquiclude (Marl)								
17.2		120.7	120.3	120.7			120.2	119.4
51.6	150.2	152.2	151.5	152.0			152.4	151.0

IDENTIFICATION NUMBER	OWNER OR TENANT	DRILLER (REPORTED)	YEAR DRILLE
1	Clayton Thomas	W. Shaw	1963
2	Burnis Coleman	Shaw (?)	1945-5
3	Clayborne Howard	J. Lager	1950-5
4	Sylvester Howard	Unknown	-
5	Unknown	Unknown	-
6	T.D. DeLaigle	Unknown	-
7	D.R. Kennedy	Unknown	Before 1940
8	Lucy Rouse	W. Shaw	Before 1955
9	Lerdy Rouse	W. Shaw	1952
10	Louise Rouse	Unknown	Before 1955
11	Daniel Grove Church	Unknown	-
12	Josephine Rouse	Unknown	Before 1960
13	Roman Powell	W. Brown (?)	Before 1960
14	Julian Roberts	Unknown	Unknown

Table 2.5-8
WATER WELL DATA

D	DEPTH (FEET)	CASING/HOLE DIAMETER (INCHES)	TYPE OF PUMP	DISCHARGE (GPM)	REMARKS
	300 (?)	2	Hand Pump	1	Information from C. Thomas; depth is doubtful. Reported driller penetrated 50 feet of "rock" before reaching good water, sand probably about 150 feet deep.
0	95	2 (est)	Hand Pump	-	Reported by Coleman; well destroyed would occasionally go dry.
5	Unknown	3	Myers Piston	5 (est)	Operated by 3/4 hp. elect. motor, automatic, 30 gal. pressure tank.
	-	4	Vertical Turbine	?	3/4 hp. electric motor.
	-	4	Jet Pump	-	Domestic Well - Owner not home
	60	4	Jet Pump	5 (est)	Owner reported, encountered "Hard shale at 20 feet, Oyster Shells just above shale, well provides plenty of water".
	Originally 285	3	Artesian Flow	20	Believed to be "McBean Station" well. Well open to the Tuscaloosa Formation.
	126	2	Dempster Piston Pump	5 (est)	L. Brown assisted in drilling well; reported "Set in sand just below shell bed". 3/4 hp. electric motor, automatic 30 gal. pressure tank.
	167	2	Hand Pump	1	Rouse reported well set in material below "80 feet of blue marl".
	-	2	Hand Pump	1	
	-	2	Hand Pump	1	
	Unknown	2	Hand Pump	-	Not operating; pump broken 2 years ago, and hasn't been repaired.
	200±	2	Dempster Piston Pump	5 (est)	3/4 hp. electric motor, automatic, 30 gal. pressure tank.
	50±	3	Flowing Well	3	3" standpipe 7 feet high, water flows from 3/4" tap 4 feet above ground.

Sample Identification
Date Samples
Laboratory No.
Date of Analysis

Constituents

Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Bicarbonate (HCO_3
Sulfate (SO_4)
Chloride (Cl)
Nitrate (N)

Fluoride (F)
Total Phosphate (
Iron (Fe)
Silica (SiO_2)

Total Dissolved S
Conductivity (micromho
pH
Free Carbon Dioxide
Total Alkalinity as Ca
Total Hardness as CaCO
Temperature (°F)

Table 2.5-9

WATER QUALITY ANALYSES
SPRINGS

(values in parts per million unless otherwise designated).

	SPG #1	SPG #2	SPG #3	SPG #5	SPG #6	SPG #7	SPG #4
	9/21/71	9/22/71	9/22/71	9/20/71	9/22/71	9/22/71	9/18/71
	17802	17835	17837	17811	17836	17838	17810
	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71
	1.6	1.6	2.0	3.0	10.8	2.1	2.3
	0.0	2.2	2.4	0.0	4.6	1.9	0.2
	0.29	0.25	0.0	0.54	0.33	0.0	0.50
	2.0	0.8	2.8	37.2	29.2	2.8	22.0
)	9.8	7.3	18.3	125.7	102.5	11.0	63.4
	2.5	3.0	1.0	1.0	0.5	5.0	1.0
	2.0	2.0	1.0	1.0	5.0	5.0	0.0
	0.0	0.00	0.00	0.21	0.56	0.00	1.7
	0.0	0.00	0.09	0.0	0.00	0.09	0.26
PO_4)	1.07	0.59	0.55	1.07	0.19	0.29	0.89
	0.17	0.11	0.08	0.06	0.04	0.96	0.06
	4.4	4.2	4.4	8.0	8.7	5.4	7.3
olids	21.8	20.0	28.0	147.9	136.8	32.3	83.8
s)	17	30	34	170	150	28	110
	6.4	6.1	6.0	7.2	6.0	6.1	7.1
	6	12	25	11	160	15	8
CO_3	8.0	6.0	15.0	103.0	84.0	9.0	52.0
3	7.0	11.0	17.0	99.0	92.0	15.0	56.0
	68	65	66	66	66	66	66

Sample Identification
Date Sampled
Laboratory No.
Date of Analysis

Constituents

Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Bicarbonate (HCO_3)
Sulfate (SO_4)
Chloride (Cl)
Nitrate (N)

Fluoride (F)
Total Phosphate (PO_4)
Iron (Fe)
Silica (SiO_2)

Total Dissolved Solids
Conductivity (micromhos)
pH
Free Carbon Dioxide
Total Alkalinity as $CaCO_3$
Total Hardness as $CaCO_3$
Temperature (°F)

Table 2.5-10

WATER QUALITY ANALYSIS
DOMESTIC WELLS

(values in parts per million unless otherwise designated)

Well #1	Well #3	Well #8	Well #10	Well #9	Well #6	Well #14	Well #14	Well #7
9/17/71	9/17/71	9/18/71	9/18/71	9/18/71	9/18/71	9/20/71	9/22/71	9/18/71
17803	17804	17806	17808	17807	17809	17812	17839	17805
9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71	9/21/71
2.0	2.2	1.9	2.2	3.3	6.0	3.8	3.6	2.9
0.2	1.0	1.9	1.7	3.2	2.7	2.4	1.7	1.7
0.29	0.33	0.42	0.46	1.41	4.48	2.41	2.0	0.50
26.8	28.8	28.0	39.6	46.8	55.2	50.4	51.2	50.8
78.1	95.2	98.8	118.3	152.5	128.1	156.2	158.6	159.8
0.6	0.0	0.0	7.5	4.8	5.2	4.9	4.9	5.3
0.0	0.0	0.0	0.0	2.0	6.0	0.0	3.0	0.0
0.42	0.0	0.0	0.0	0.0	7.8	0.0	0.00	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.17	0.00	0.0
0.60	0.66	0.79	0.46	0.44	1.70	1.00	0.35	0.92
0.18	0.06	0.07	0.10	0.07	0.06	0.27	0.24	0.11
6.9	7.3	8.6	15.5	14.8	6.1	13.4	15.5	11.8
96.6	111.75	115.8	156.3	191.2	191.3	195.9	201.4	193.8
115	120	130	165	200	260	205	220	200
7.5	7.7	7.6	7.6	7.5	7.3	7.4	6.2	6.9
5.5	3	4	4.5	10	11	10	150	30
64.0	78.0	81.0	97.0	125.0	105.0	128.0	130.0	131.0
68.0	76.0	78.0	106.0	130.0	149.0	136.0	135.0	134.0
72	--	--	--	69	--	67	68	68

Sample Location
Date Sampled
Laboratory No.
Date of Analysis

Constituents

Sodium (Na)
Magnesium (M
Potassium (K
Calcium (Ca)

Carbonate (C
Bicarbonate
Sulfate (SO_4
Chloride (Cl
Nitrate (N)

Fluroide (F)
Total Phosph
Iron (Fe)
Silica (SiO_2

Total Dissol
Conductivity (mic
pH
Free Carbon Dioxi
Total Alkalinity
Total Hardness as
Temperature

Location 1 -
Location 2 -
Location 3 -
Location 4 -

WATER QUALITY ANALYSIS
SURFACE WATER

(values in parts per million unless otherwise designated)

	Location 1 9/20/71 17813	Location 2 5/7/71	Location 3 6/3/71	Location 3 10/14/71 17985 10/14/71	Location 4 10/14/71 17986 10/14/71
	1.8	2.9	1.9	1.9	2.2
g)	2.2	9.1	2.9	8.8	5.4
)	0.48	1.2	0.17	0.5	0.3
	9.2	9.6	8.4	8.0	16.8
O_3)	0.0	0.0	0.0	0.0	0.0
(HCO_3)	18.3			31.7	29.3
)	0.77	5.2	2.6	2.8	1.5
)	2.0	4.0	2.0	1.0	2.0
	0.0	0.79	0.75	0.39	0.44
	0.0			0.00	0.00
ate (PO_4)	1.05			0.16	0.26
	0.66	0.36	0.12	0.24	0.09
)	6.5	10.1	5.6	5.4	4.9
ved Solids	38.4	72.9	50.6	53.0	96.7
romhos)	37	60.0	57.0	50	90
	6.6	7.4	7.2	6.9	9.4
de	8	3.0	3.5	6	0
as $CaCO_3$	15.0	30.0	28.0	26.0	58.0
$CaCO_3$	32.0	68.0	35.0	56.0	64.0
(°F)	76	--	--	69	--

Tributary to Daniels Branch
Daniels Branch at road culvert
Beaverdam Creek at River Road Bridge
Mathes Pond

Table 2.5-12

FIELD PUMP-IN PERMEABILITY TESTS

Depth Interval Tested (feet)	Differential Head (feet)	Water Inflow (gpm)	Return Flow (gpm)	Net Intake (gpm)	Period of Test (Minutes)	Calculated Permeability (ft/yr)
Exploration Hole #157						
138-128	76.6	5.25	5.25	0.0	5	0.0
120-110	65.2	0.75	0.0 (?)	0.75	5	56.0
120-110	76.6	0.60	0.3	0.3	8	21.1
110-100	65.2	0.34	0.3	0.04	14	3.0
140-120	65.2	5.0	5.0	0.0	5	0.0
120-100	65.2	0.84	0.75	0.09	11	3.8
152.7-184.1 (silty sand)	65.2	1.0	0.83	0.17	15	4.9
152.7-184.1 (silty sand)	76.6	1.42	1.42	0.0	5	0.0
Exploration Hole #170						
150.5-130.5	87.7	-0.12 (?)	0.0	0.0	8	0.0
150.5-130.5	99.3	0.05 (?)	trace	0.0	4	0.0
140.5-120.5	87.7	0.14	0.12	0.02	12	0.6
140.5-120.5	99.3	0.08	0.10	0.0	6	0.0
130.5-110.5	87.7	0.04	trace	0.0	11	0.0
124.5-104.5	87.7	0.0 (?)	trace	0.0	10	0.0
159.5-180.0 (silty sand)	87.7	5.2	4.5	0.7	10	22.3
Exploration Hole #180						
125-105	67.1	0.64	0.61	0.03	9	1.2
115- 95	67.1	0.62	0.52	0.10	10	4.2
105.85	67.1	0.60	0.60	0.0	10	0.0
99.5-77.5	67.1	0.54	0.54	0.0	10	0.0
142.0-155 (silty sand)	67.1	0.71	0.66	0.05	10	3.0

Table 2.5-13

WELL PERMEAMETER TESTS
(NOV. 3, 1971)

EXPLORATION HOLE #183

Time (Clock)	Accum. Minutes	Water Volume (Gallons)	
		Increment	Accum.
14:51	0	Begin Test	
:52	1	0.267	0.267
:53	2	0.267	0.534
:54	3	0.200	0.734
:55	4	0.267	1.001
:57	6	0.333	1.334
:59	8	0.400	1.734
15:01	10	0.400	2.134
:03	12	0.400	2.534
:05	14	0.400	2.934
:07	16	0.333	3.267
:10	19	0.600	3.867
:13	22	0.533	4.400
:16	25	0.466	4.866
:19	28	0.466	5.332
:22	31	0.400	5.732
:25	34	0.466	6.198
:28	37	0.400	6.598
:31	40	0.400	6.998
:34	43	0.400	7.398
:37	46	0.400	7.798
:40	49	0.400	8.198
:43	52	0.267	8.465
:46	55	0.400	8.865
:49	58	0.400	9.265
:52	61	0.267	9.532
:55	64	0.267	9.799
:58	67	0.200	9.999
16:01	70	0.200	10.199
:04	73	0.333	10.532
:06	75	0.266	10.798

EXPLORATION HOLE #184

Time (Clock)	Accum. Minutes	Water Volume (Gallons)	
		Increment	Accum.
13:11	0	Begin Test	
:12	1	0.731	0.831
:13	2	0.800	1.531
:14	3	0.133	1.664
:15	4	0.133	1.797
:17	6	0.533	2.330
:19	8	0.067	2.397
:21	10	0.266	2.663
:23	12	0.266	2.929
:25	14	0.333	3.292
:27	16	0.200	3.462
:30	19	0.466	3.928
:33	22	0.400	4.328
:36	25	0.466	4.794
:39	28	0.400	5.194
:42	31	0.400	5.494
:45	34	0.466	5.960
:48	37	0.366	6.326
:51	40	0.400	6.726
:54	43	0.400	7.126
:57	46	0.400	7.526
14:00	49	0.400	7.926
:03	52	0.400	8.326
:06	55	0.400	8.726
:09	58	0.400	9.126
:12	61	0.400	9.526
:15	64	0.400	9.926
:18	67	0.400	10.326
:21	70	0.400	10.726
:23	72	0.266	10.992
:23	72	0.266	10.992

The water table aquifer system beneath the plant is thus hydraulically isolated on an interfluvial high. The ground water is replenished by natural precipitation which percolates to the water table and then moves laterally to one of the interceptor streams.

The possibility of accidental spillage of a contaminant during the operation of the plant should not present a significant problem. Only the water table aquifer would be affected, and this lies largely within the exclusion radius of the plant. Water movement indicates that spillage at the plant site would eventually find its way to Mathes Pond, where it could be intercepted.

The safe yield of the Tuscaloosa aquifer in the Coastal Plain has been estimated to be five billion gallons per day. These estimates do not allow for depletion of the large amount of water in storage. Estimated water in storage is about 21 billion acre-feet, providing a large ratio of volume of water in storage to the estimated safe yield. This would allow the rate of withdrawal from the aquifer to exceed the safe yield for years, or even centuries (U.S.G.S. Water Supply Paper 1669-W).

Only a small percentage of the total ground water capacity of the Tuscaloosa aquifer is now extracted. Within a radius of 30 miles of the plant site, the major extractions are at the Savannah River Plant and in Augusta, each area extracting less than 5000 gpm. The Tuscaloosa aquifer is full, and ground water is discharging to the Savannah River. It is evident that the ground water extractions from the Tuscaloosa aquifer may be increased several fold without exceeding the estimated safe yield. The nominal maximum amount of ground water extracted at the plant site, 4000 gpm, is conservatively within the capacity of the aquifer.

A conservative estimate of the maximum interference effects on other wells caused by pumping at the plant site assumes that for the period of operating the wells, the water is all withdrawn from storage, no effective recharge, and the storage coefficient determined by the pumping tests is valid. After a period of 40 years, the drawdown from each well, pumping at 2000 gpm, would be:

Distance from pumping well (feet)	1	500	1000	10,000
Drawdown (feet)	45.8	26.8	24.8	17.6

The area of influence would be negligible beyond a distance of 20,000 feet (drawdown less than 2 feet). Considering recharge effects, the area effected would be considerably less. It is doubtful that any significant amount of drawdown would extend beyond the influence of the Savannah River, or 2500 feet distant. Nevertheless, for design purposes, no allowance will be made for recharge effects.

REFERENCES

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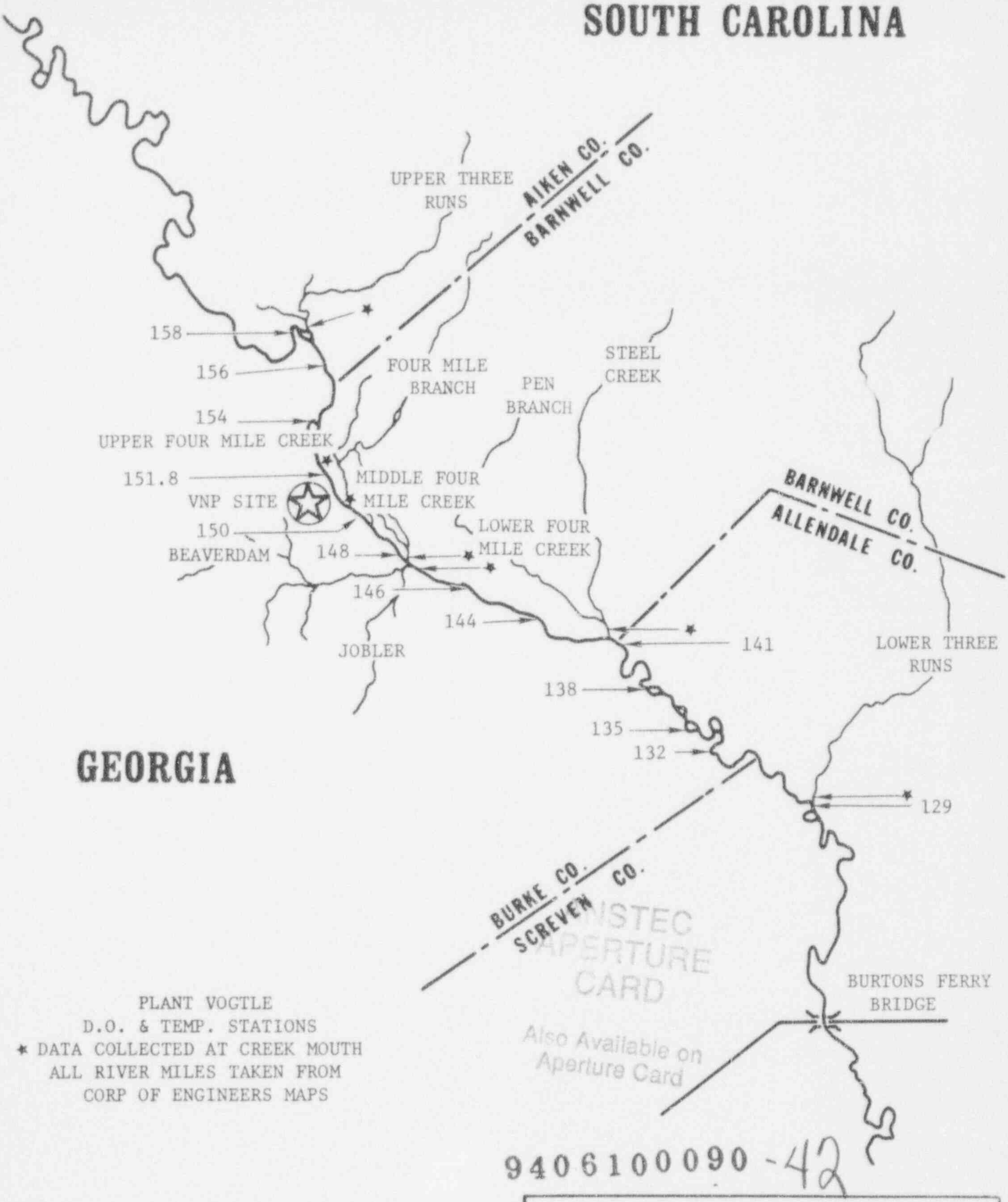
(3) Water Resources Data for Georgia 1970, United States Department of the Interior, Atlanta, Georgia, 1971, p. 43.

(4) Inman, E.J. Flow Characteristics of Georgia Streams, United States Department of the Interior, Atlanta, Georgia, 1971, pp. 33-34.

(5) Reservoir Regulations Manual, Savannah River Basin, U. S. Army Engineers, Savannah District, 1968.

(6) Summary of Studies on the Savannah River 1951-1970 for E. I. du Pont de Nemours and Company, Academy of Natural Sciences of Philadelphia, 1970. Mimeographed.

(7) Standard Methods for the Examination of Water and Wastewater, 13th edition, American Public Health Association, Washington, D.C., 1971. 1



PLANT VOGTLE
D.O. & TEMP. STATIONS
★ DATA COLLECTED AT CREEK MOUTH
ALL RIVER MILES TAKEN FROM
CORP OF ENGINEERS MAPS

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D.O. & TEMPERATURE STATIONS

FIGURE 2.5-1

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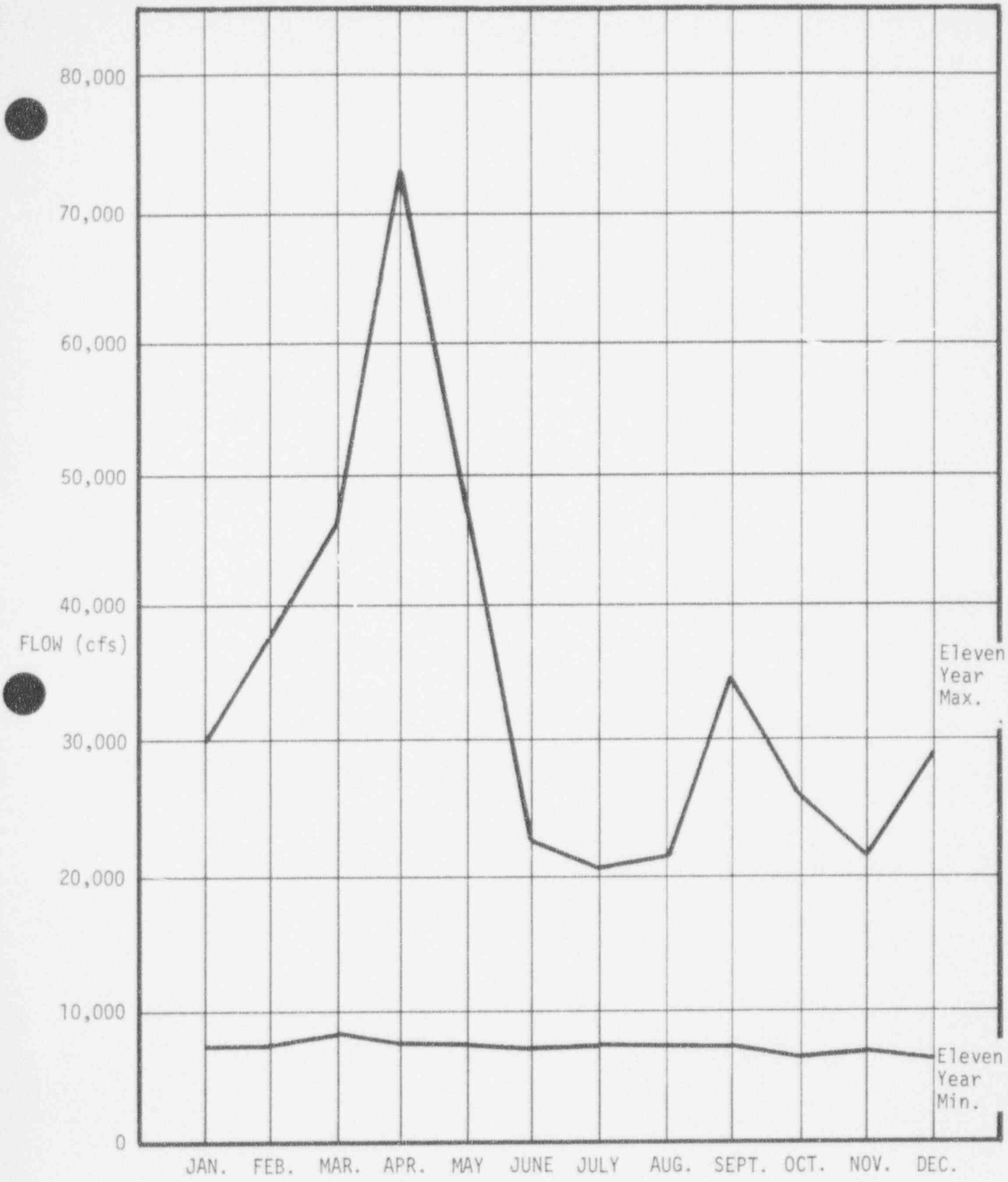

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FLOW DATA

Source: Water Resource
Data for Georgia
1960-1970

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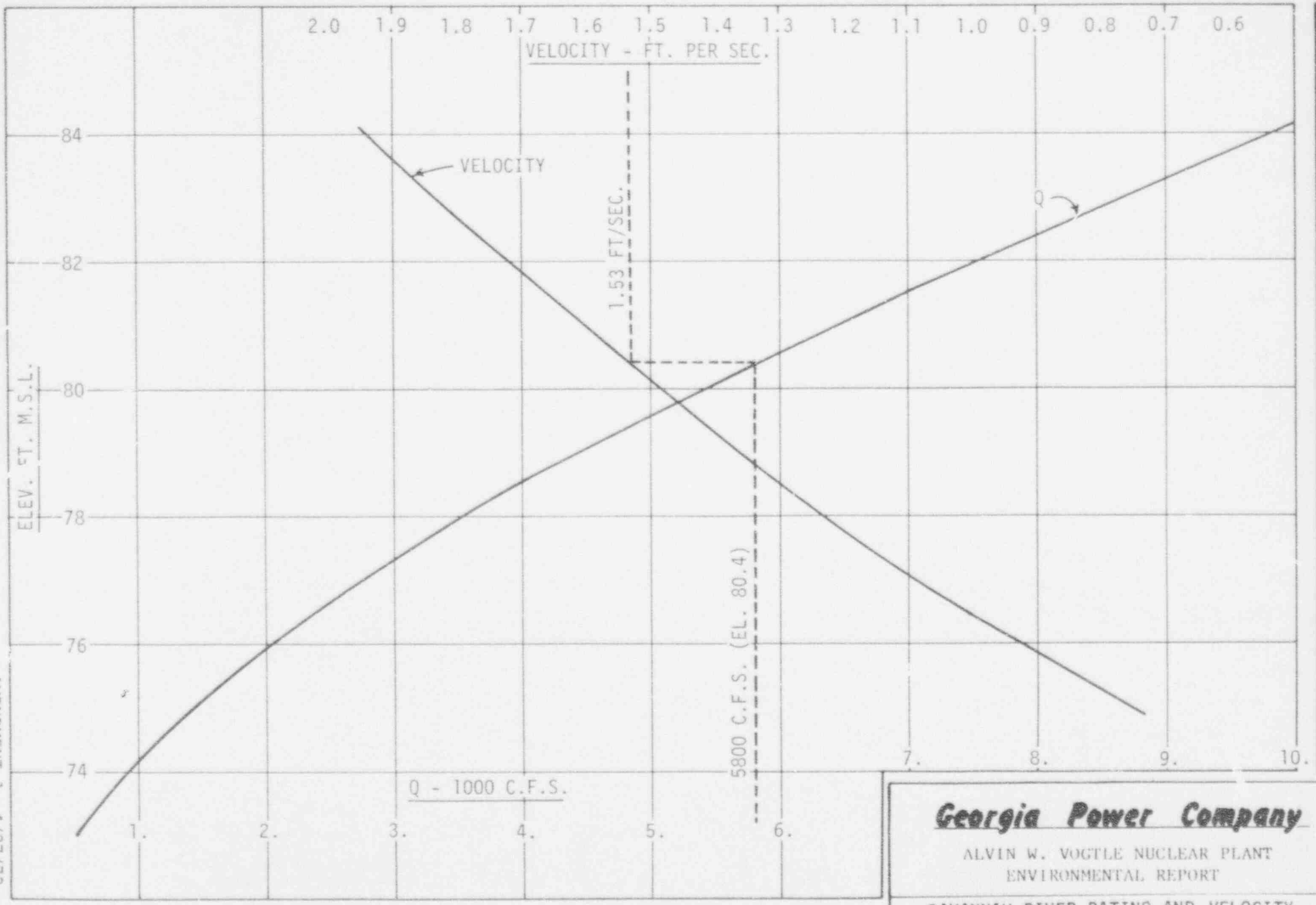
ENVIRONMENTAL REPORT

SAVANNAH RIVER AT BURTONS FERRY BRIDGE
(22.5 river miles downstream from VNP)

AMEND. 1 4/27/73 FIGURE 2.5-3



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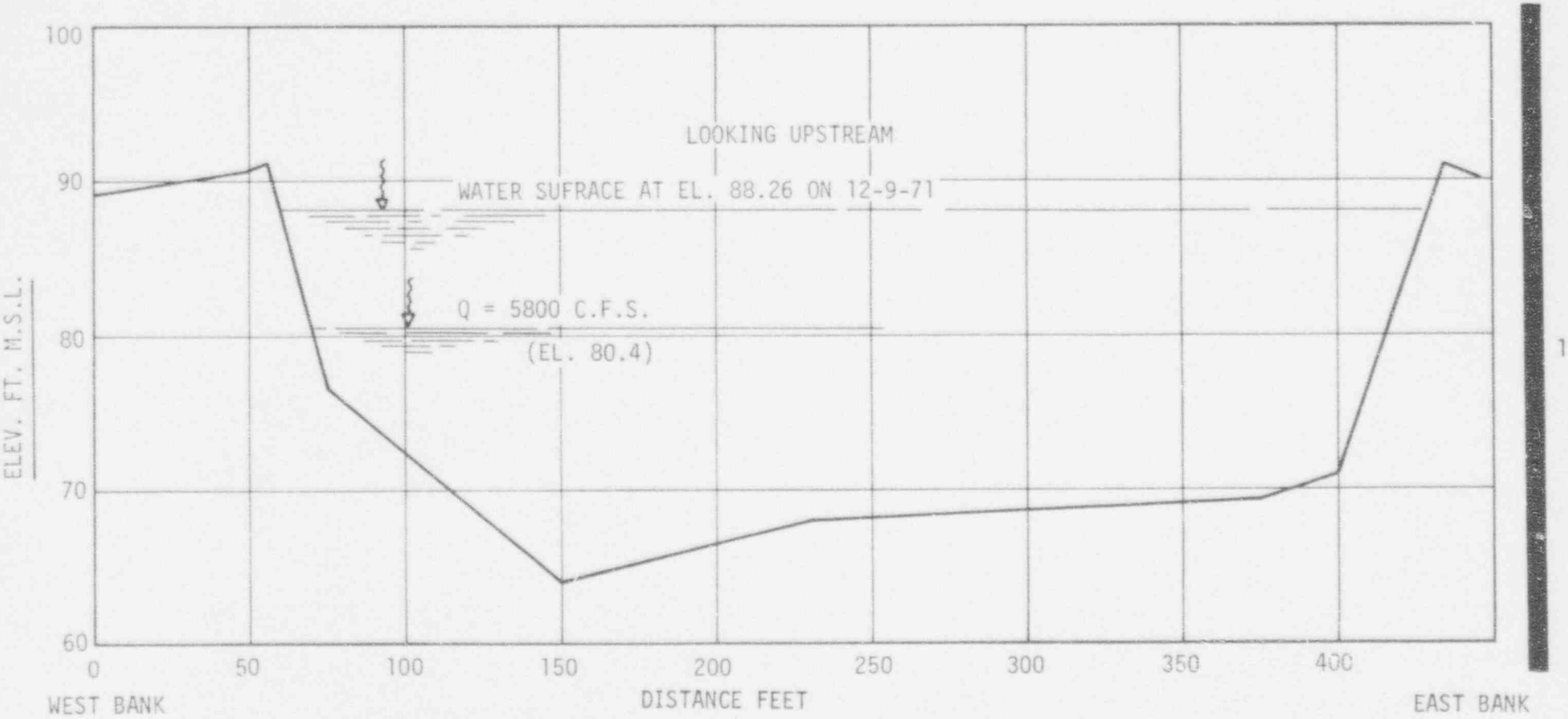
SAVANNAH RIVER RATING AND VELOCITY
CURVE AT RIVER MILE 151.8

Amend. 1 4/27/73 FIGURE 2.5-3a



1

SCALE: HORIZ.-1"=50' VERT.-1"=10'

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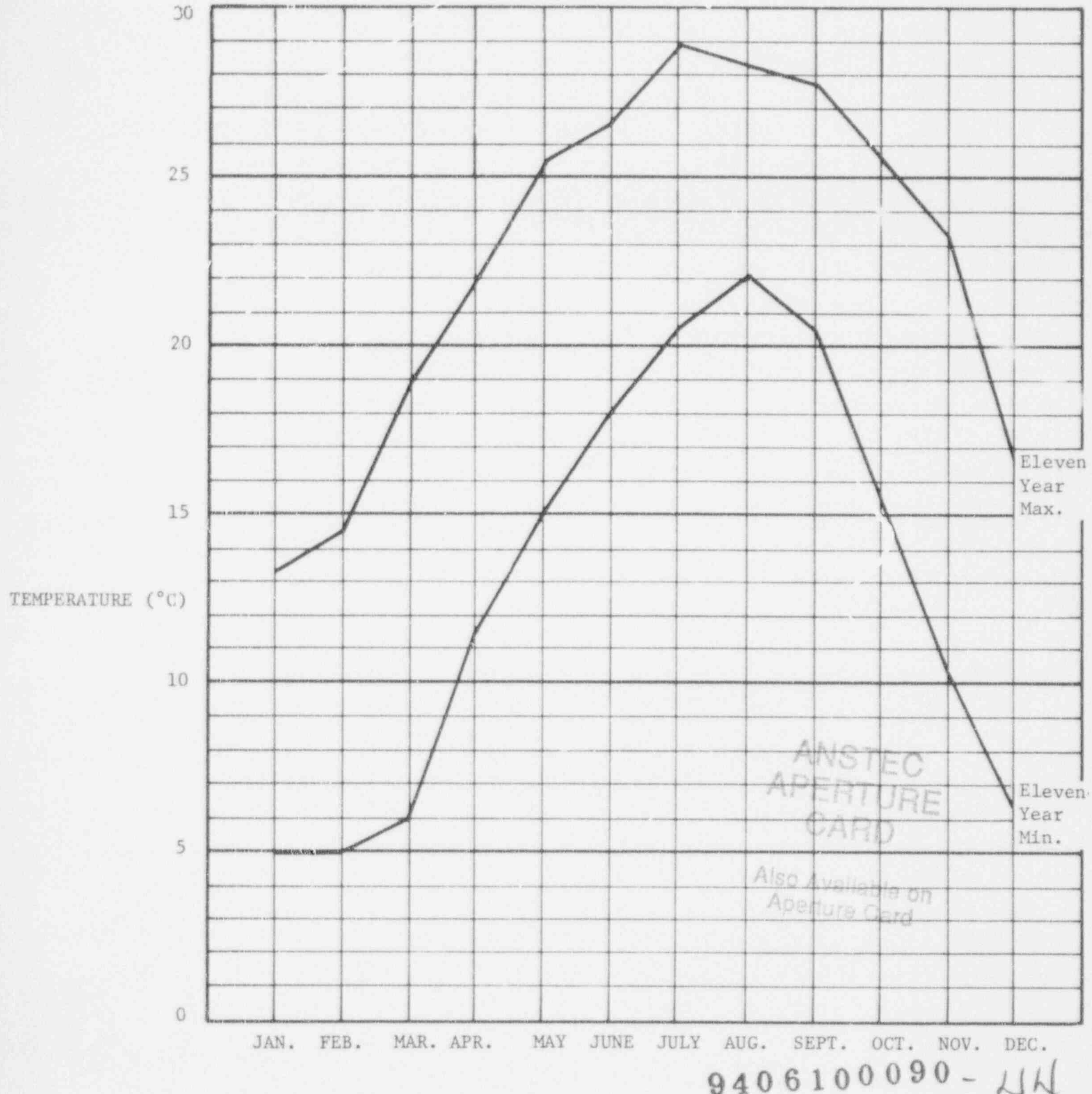
CROSS SECTION OF THE SAVANNAH RIVER
LOOKING UPSTREAM AT RIVER MILE 151.8

Amend. 1 4/27/73 FIG. 2.5-3b



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TEMPERATURE DATA

Source: Water Resource Data for Georgia 1960-1970

Georgia Power Company

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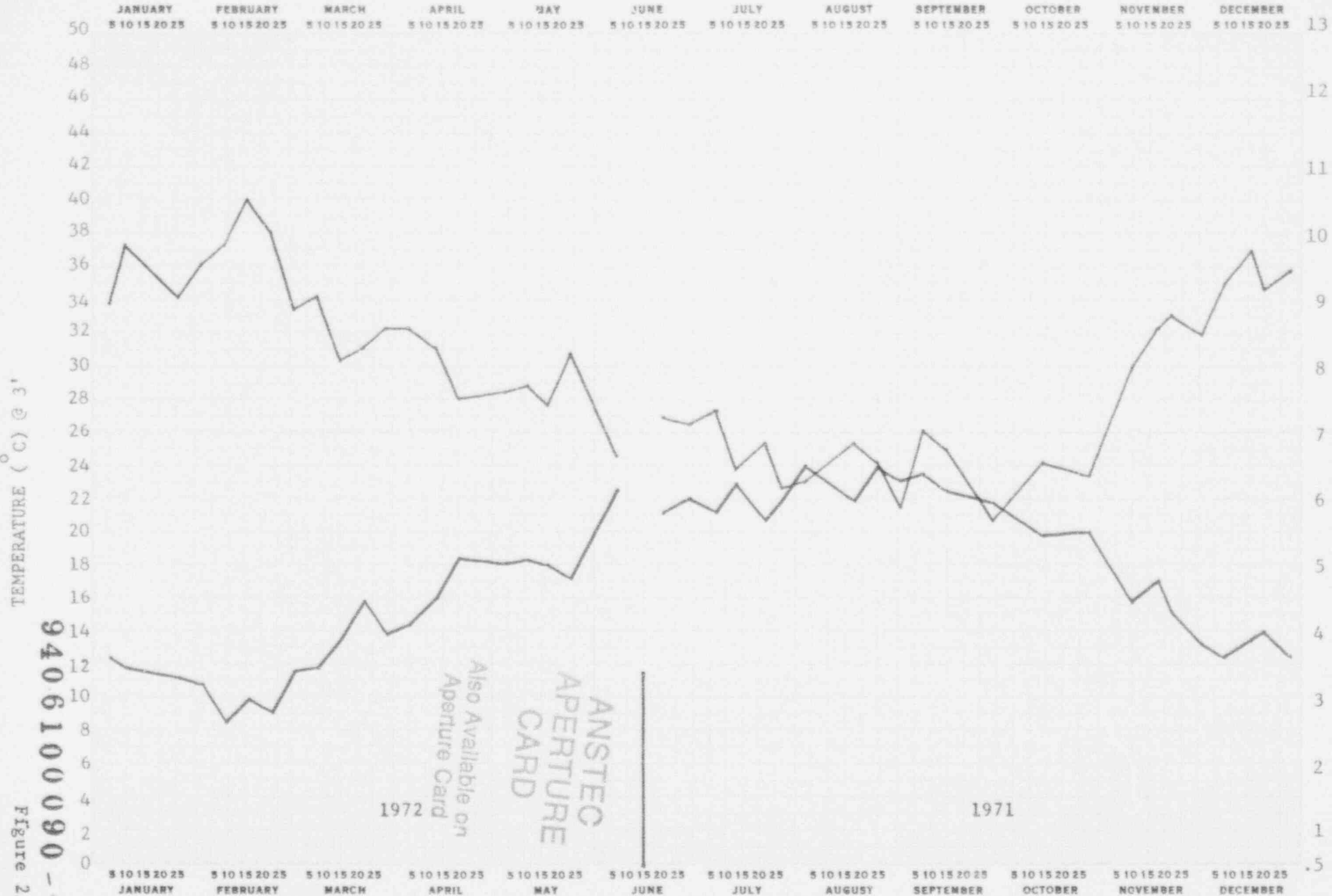
ENVIRONMENTAL REPORT

SAVANNAH RIVER AT BURTONS FERRY BRIDGE
(22.5 river miles downstream from VNP)
FIGURE 2.5-4



STATION RIVER MILE 158 ON SAVANNAH RIVER

Figure 2.5-5

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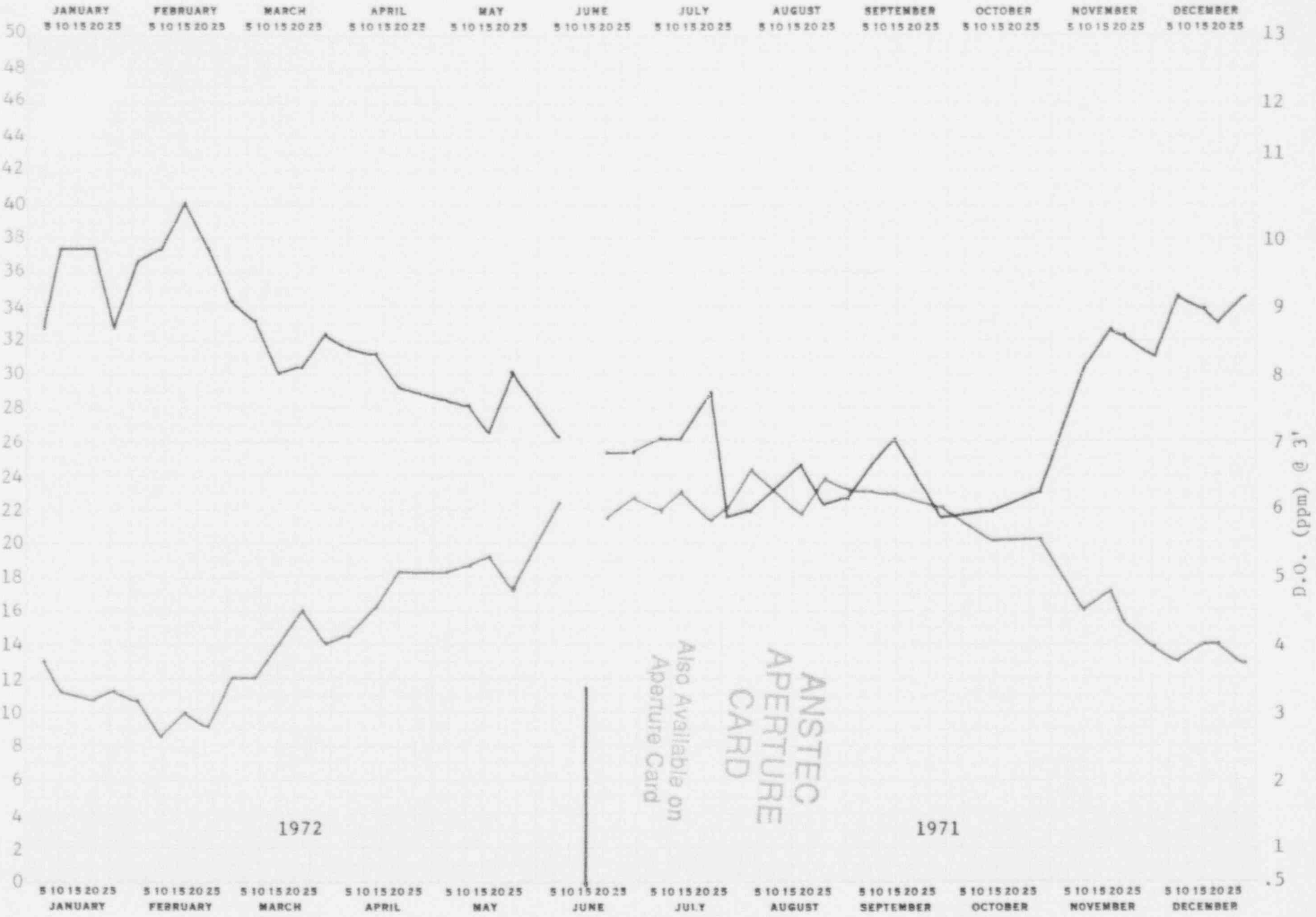

STATION RIVER MILE 151.8 / HANCOCK LANDING ON SAVANNAH RIVER

Figure 2.5-6

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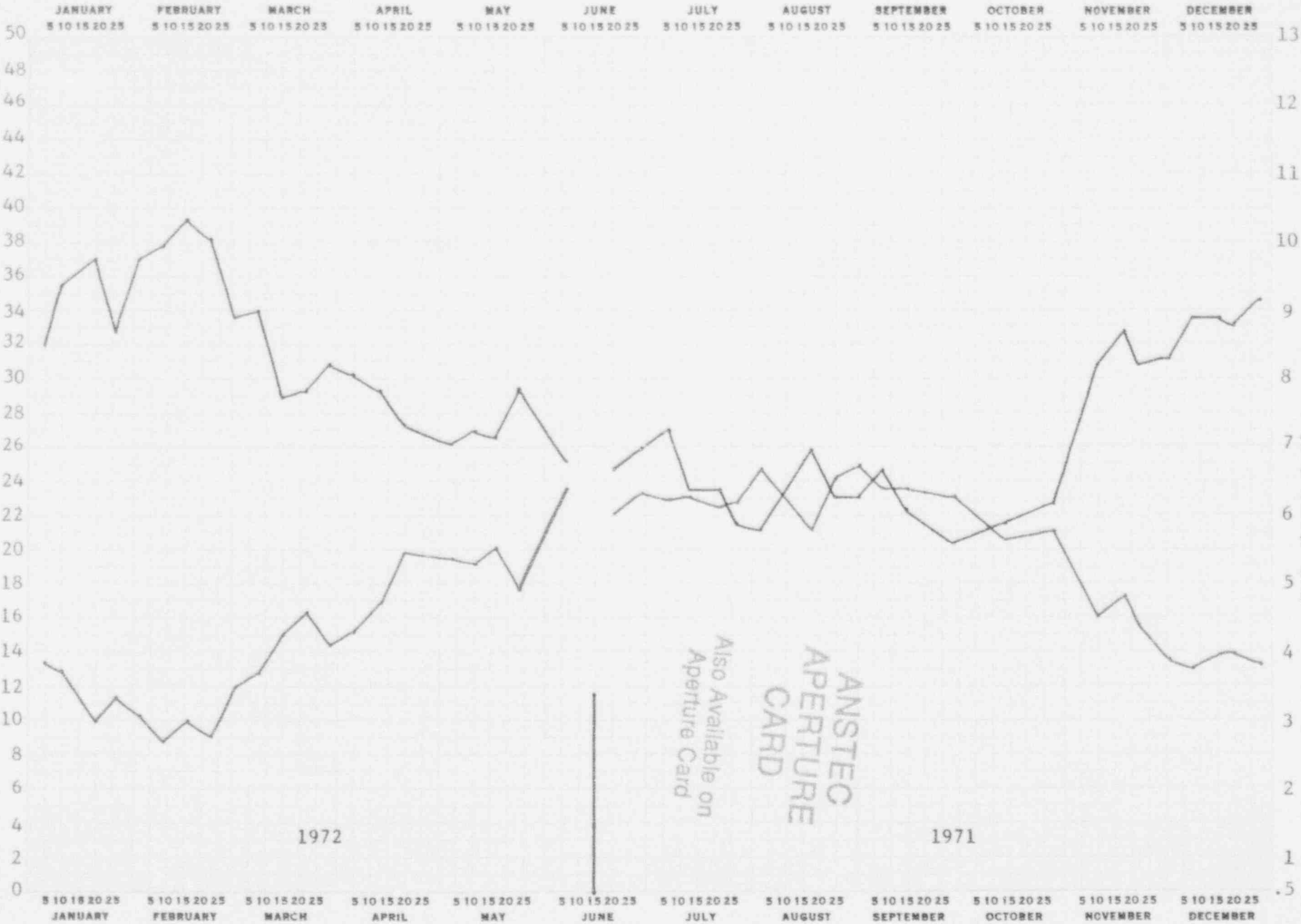

STATION RIVER MILE 141 ON SAVANNAH RIVER

Figure 2.5-7

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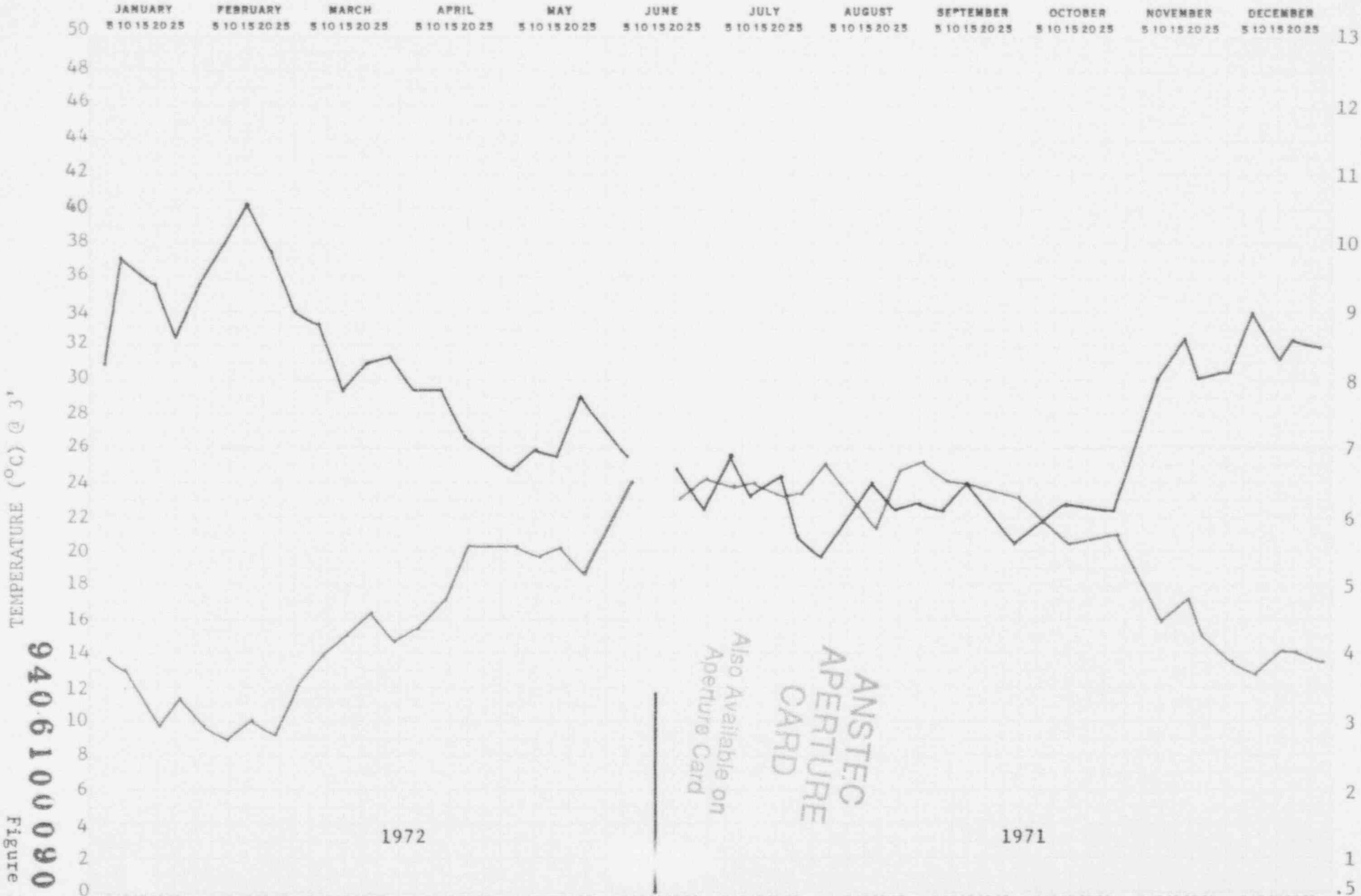

STATION RIVER MILE 129 ON SAVANNAH RIVER

Figure 2.5-8

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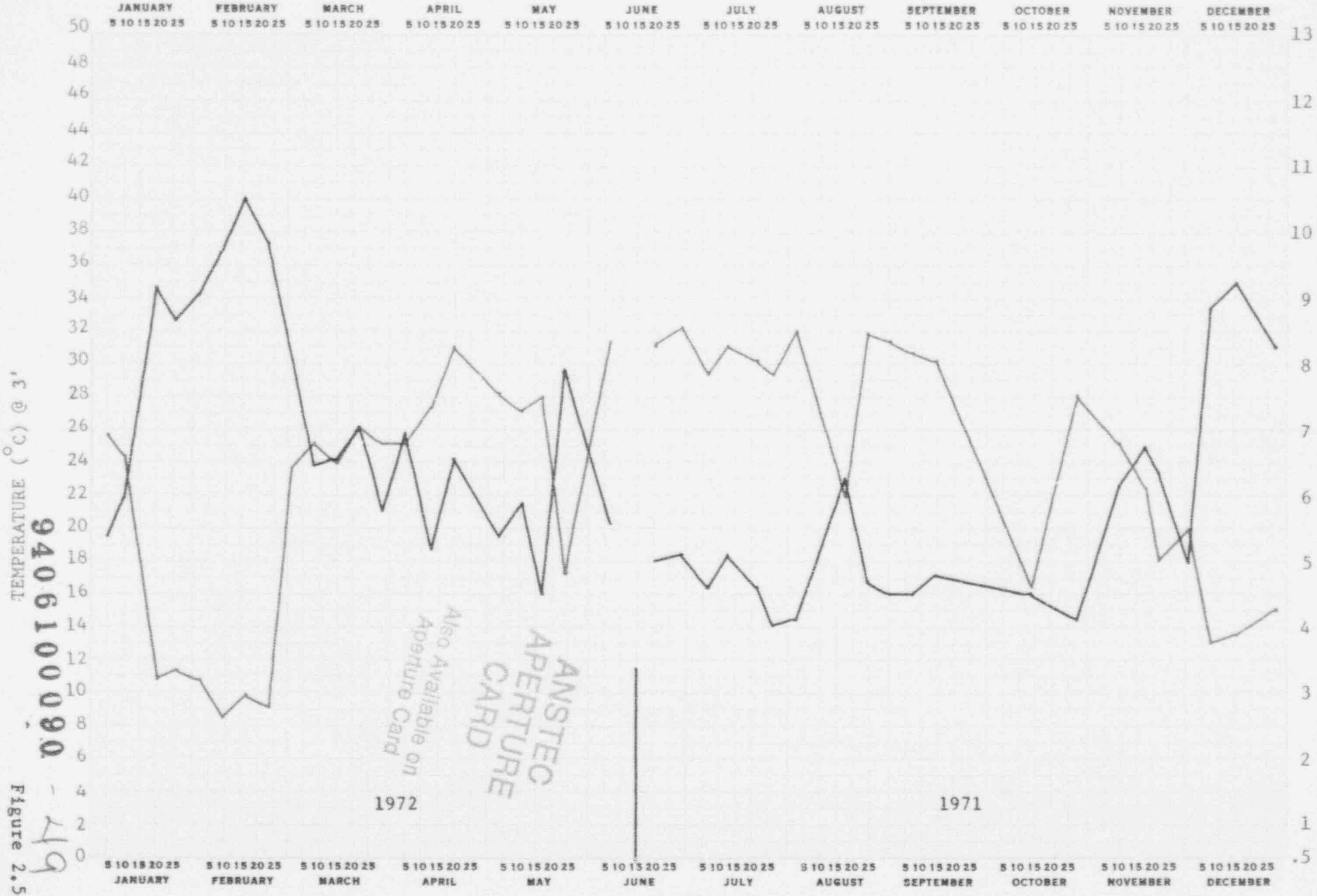
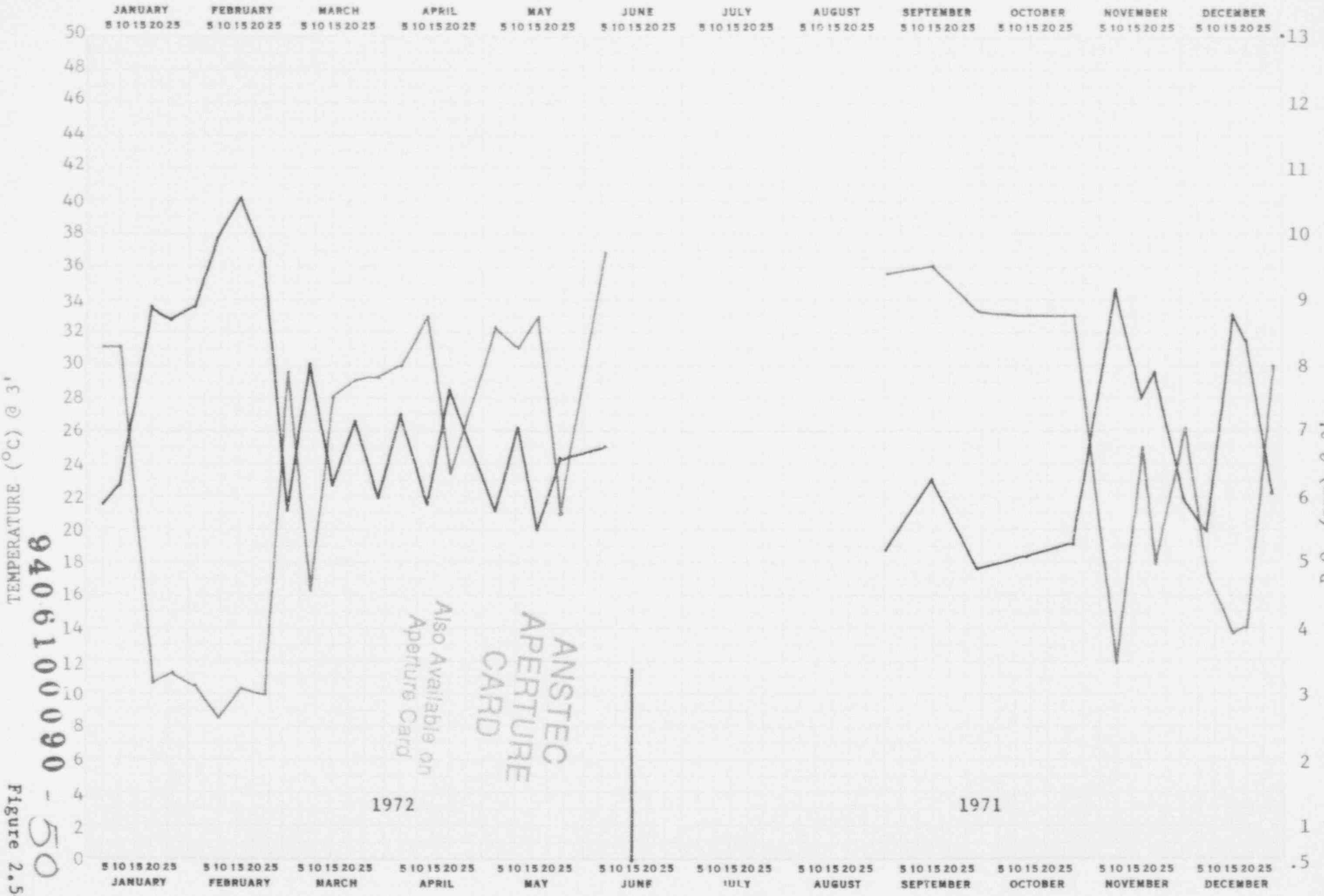


STATION UPPER FOUR MILE CREEK ON SAVANNAH RIVER

Figure 2.5-9

9406100090 - 49



STATION MIDDLE FOUR MILE CREEK ON SAVANNAH RIVER

Figure 2.5-10

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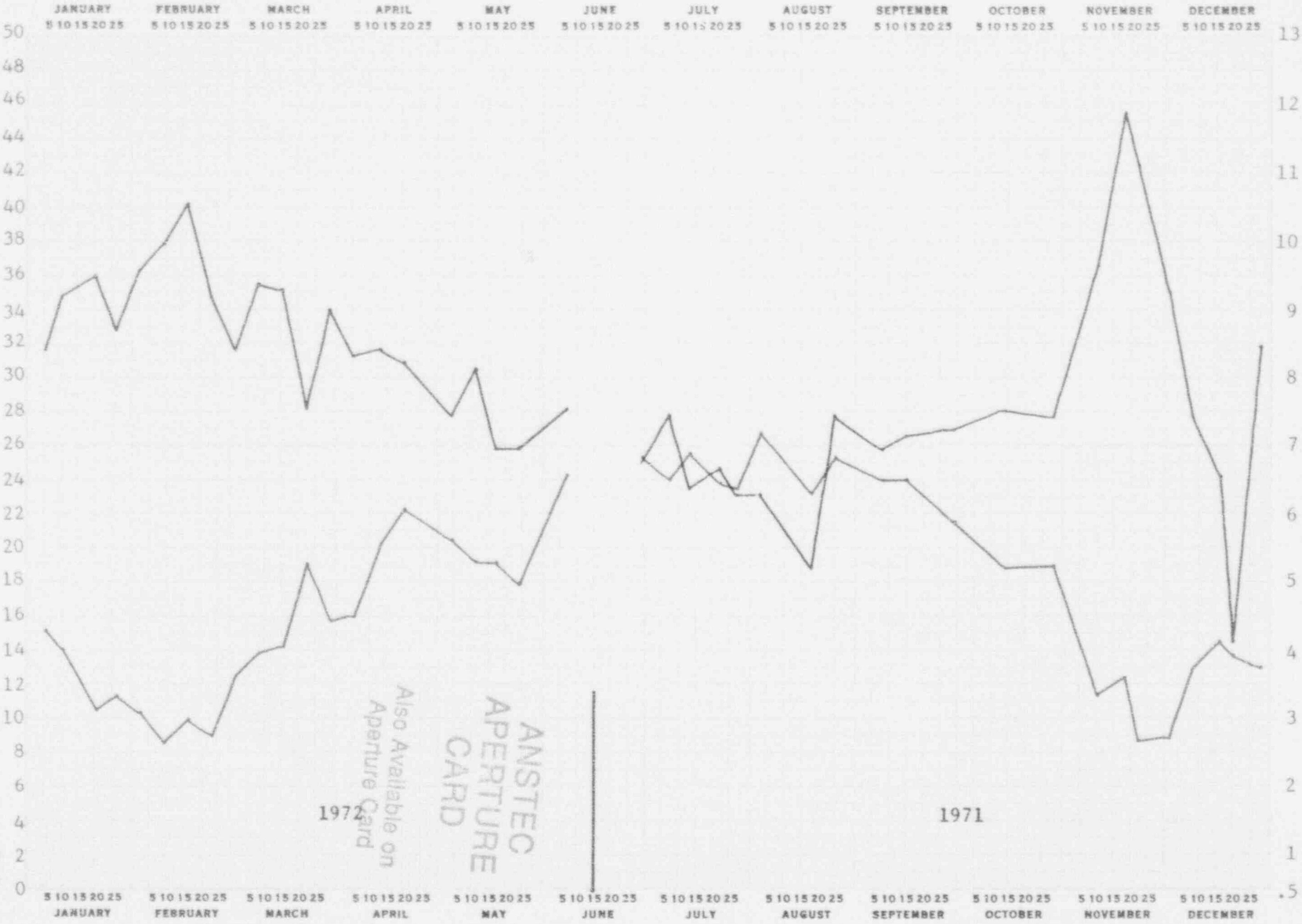

STATION BEAVER DAM CREEK ON SAVANNAH RIVER

Figure 2.5-11

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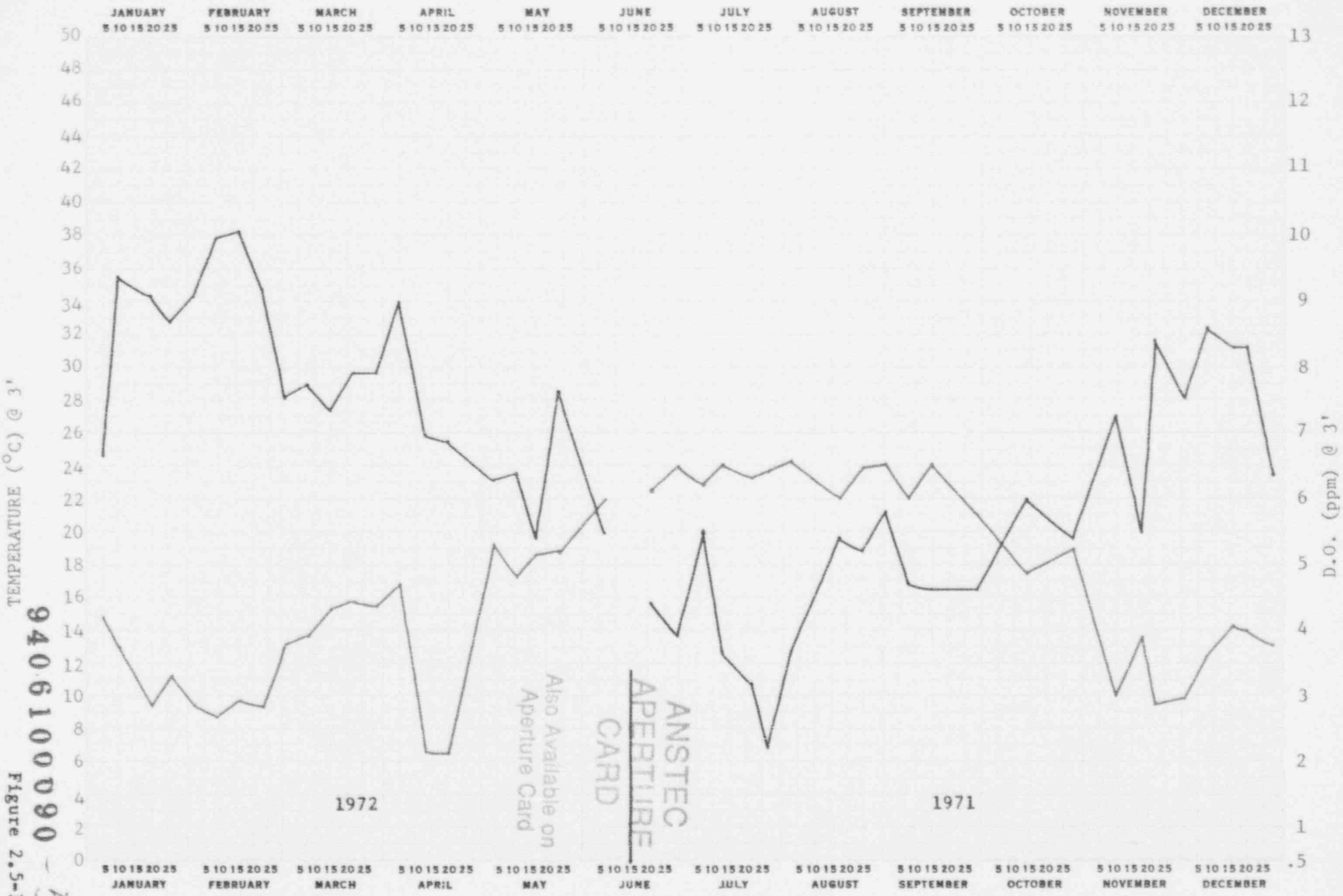

STATION LOWER THREE RUNS CREEK ON SAVANNAH RIVER

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Figure 2.5-12

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2.6 METEOROLOGY

2.6.1 REGIONAL METEROLOGY

2.6.1.1 General Climate

The general climate(1) in the region of VNP is characterized by mild short winters, long periods of mild sunny weather in the autumn, somewhat more windy but mild weather in spring, and long hot summers. Heaviest precipitation in the winter and early spring is associated with low pressure systems moving eastward and northward through the Gulf States, drawing in the moist air from the South, especially from the Gulf of Mexico. In summer, heaviest precipitation is due to thunderstorms.

The site is in the plateau area known as the Piedmont, between the Appalachian Mountains and the Atlantic Ocean, generally 150-250 feet above sea level in this region, cut by the valley of the Savannah River, 2-5 miles wide near the site.

The region is sheltered to a significant extend by the Appalachian Mountains to the Northwest from the cold air masses sweeping down through the continental interior in winter. The cold air that does reach this area is considerably warmed by the descent to the relatively low elevations of this region, as well as by convectional heating. Morning frost conditions are frequent in this area in winter, but daily mean temperatures below freezing are uncommon. The temperature rarely stays below freezing all day. Warm, moist air masses from the Gulf or the Atlantic receive little modification, so that this area experiences relatively high precipitation in winter and summer.

The site is far enough inland that the strong winds due to the occasional tropical storms and hurricanes that affect this area are much reduced. The frequency of strong winds is discussed in paragraph 2.6.2.2. Heavy precipitation associated with tropical storms is fairly common in late summer, (see paragraph 2.6.2.2).

The site lies in a region of relatively low tornado activity in the U.S. However, the frequency is higher at the site than in the neighboring regions. It is not certain to what extent the relatively higher number of reports in this region (compared to the mountainous areas to the northwest) is due to topographical causes or to the variation of population density and the greater visibility of tornadoes in flatter country.

The area is subject to a relatively high incidence of stagnating anticyclones, associated with high air pollution potential, especially in autumn (see paragraph 2.6.2.2).

2.6.1.2 Severe Weather

Severe weather in this region is associated mainly with thunderstorms which produce strong winds, heavy precipitation and hail. The frequency and intensity of thunderstorms for purposes of this report, are represented by the frequency and intensity of the severe weather conditions associated with them. These are discussed separately below. For comparison with other locations where the detailed statistics may not be available, the frequency of thunderstorms reported by Augusta Airport may be of some value. As given in the local climatological data (Table 2.6-1)(2) the weather at the airport is coded as thunderstorms on 54 days each year on the average with a maximum of 13 in the month of July.

2.6.1.2.1 Heavy Precipitation (3,4)

Unusually heavy precipitation sustained over several hours in this region is associated with the remnants of occasional tropical hurricanes, which although their winds are much reduced in this inland area, can cause heavy precipitation. For shorter periods, heaviest rates of precipitation are due to thunderstorms.

Snow is infrequent, and heavy snow is very rare. The greatest monthly total snowfall in one 20-year period at Augusta was 3.3 inches. The greatest 24 hour total on record was 10.5 inches in February 1914.

Maximum precipitation amounts recorded at Augusta during intervals of 5 minutes to 24 hours, for the peroid 1903-1961 are shown in the following table:(2)

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Minutes					Hours				
5	10	15	30	60	2	3	6	12	24
1.24	1.84	2.11	2.68	3.08	3.98	4.46	5.83	7.79	9.82

Additional statistics concerning rainfall rate are given in paragraph 2.6.3.2.

2.6.1.2.2 Hail

The incidence of the number of occurrences of heavy hail greater than 3/4 inch in the area, is approximately 7 in 13 years, or once in two years, for a one degree (latitude and longitude) "square" (see Figures 2.6-1 and 2.6-2). Cross checking procedures were used to eliminate duplication.

2.6.1.2.3 Ice Storms

Freezing rain, though rare, can cause ice loading in this region. Based on a 10 year period of record the number of days with freezing rain at Augusta, by month, were: December (6 days); January (10 days); February (2 days); and March (1 day). Thus, freezing rain may be expected about twice a year in Augusta. Significant ice-loading occurs less frequently.

2.6.1.2.4 Tornadoes(5)

The probability of a particular point being affected by a tornado is a function of the number of tornadoes occurring, on the average, in a given area, and the average area covered by a tornado.

Based on a 40 year record, the number of tornadoes for the 2 degree square in which the site is located is between 1 and 2 per year. In 1955-1967, the average number of tornadoes for the 1 degree square including the site was about 1 1/2 per year, corresponding to approximately 6 per year for the 2 degree square (see Figures 2.6-3 and 2.6-4). This apparent increase is typical for this kind of data, and arises in part from increased public awareness of tornadoes and more complete reporting. Since even the latter frequency is likely to be an underestimate of the true frequency, a reasonable conservative estimate is that the true frequency is twice that reported for the latter period, that is about 3 per year for the 1 degree square.

A typical tornado is about a quarter of a mile wide, is in contact with the ground for about 10 miles, and covers an area of about 2 1/2 square miles. The 1 degree square at this latitude has an area of approximately 4000 square miles. A conservative estimate of the probability of a given point being affected by a tornado in a given year is therefore approximately:

$$\frac{2\ 1/2 \times 3}{4000} = \frac{1}{500}$$

that is, a given point can be expected to be affected by a tornado once in 500 years, on the average.

2.6.1.2.5 Strong Winds

The frequency of strong winds, 50 knots or greater, has been analyzed in WBTM FCST 12,(3) for the 13 year period 1955-1967 and is shown in Figure 2.6-5. Total number of windstorms by one degree squares is shown in Figure 2.6-6. For this area, the frequency is estimated at approximately 7 per year per two degree square.

2.6.1.2.5.1 Probabilities of Strong Wind Speeds Due to Tornadoes. The probability of a given point being exposed to strong winds due to tornadoes was estimated considering the joint probability of the following 3 events:

1. the path of the tornado encompasses the site,
2. the wind speed exceeds a specified value within the path, and
3. the area covered by wind speeds greater than the specified value includes the point considered if the path of the tornado encompasses the site.

The joint probability is the product of the individual probabilities of these (presumed) independent events.

The above individual probabilities were estimated from observations, mainly in the Midwest and South Central United States, reported by Fujita.(6) Using the frequency of tornadoes in the VNP site area and allowing a factor of two for under estimation of tornado frequency, the probabilities, expressed in terms of recurrence period (inverse of the probability) are as follows:

Maximum Wind (mph)	Recurrence Period (years)
150	3,200
175	4,000
200	5,000
225	20,000
250	130,000
275	3,000,000

2.6.2 LOCAL METEROLOGY

2.6.2.1 Data Sources

Two sources of meteorological data have been used for studying conditions at the VNP site. The Augusta Airport (Bush Field) data were primarily for determining climatological means of temperature, humidity, precipitation, wind, and visibility near the site. Evaluations of atmospheric diffusion conditions are based on records of atmospheric stability, wind speed, and wind direction from a data collection program conducted by the Savannah River Laboratory (SRL).(7) In this program, records were taken on an instrumented TV tower utilizing sensitive instruments located at multiple elevations on the tower during a 2-year period from March, 1966 through February, 1968. The types and locations of SRL tower instruments used in this evaluation are given in Table 2.6-2. Locations of the Augusta Airport and the TV tower used by SRL are shown in relation to the site in Figure 2.6-7.

Using a 5 year period of record (1959-1963) from the Augusta Airport, summaries for each pertinent meteorological parameter have been compiled and tabulated. Useful meteorological data in the immediate area of the plant will be available after at least one complete year of data has been compiled from the on-site meteorological instrumentation. A year's data should be available by December, 1973. The meteorological instruments were installed in May, 1972. Due to equipment problems, the tower did not become operational until November, 1972.

Table 2.6-2

SRL Tower Weather Sensors Used for this Report

Elevation Above Grade	Measured Parameter	Type of Instrument
120'	Wind Speed & Direction	Climet--Model 001-1 Climet--Model 012-7
10'	Lower Temperature	Platinum resistance thermometer in aspirated shield
120'	Upper	Platinum resistance thermometer in aspirated shield

2.6.2.2 Normal and Extreme Values of Meteorological Parameters

Augusta Airport is approximately 18 miles northwest of the site, and climatological observations made there can be considered to be representative of conditions at the site. The ground elevation at Bush Field is 136 feet above sea level, and at the site it is approximately 200 feet. The difference in elevation and the difference in location are of minor significance. Normals, means and extremes of meteorological data published by the Environmental Data Service of the National Oceanic and Atmospheric Administration for the Augusta Airport are given in Table 2.6-1.

2.6.2.2.1 Wind

The mean wind speed for each month in miles per hour and the most frequent wind direction ("prevailing wind direction") are listed in Table 2.6-1. Fastest monthly average winds occur in winter, 7 to 8 miles per hour, and the slowest in summer, 5 to 6 miles per hour. Monthly, seasonal and annual wind roses are shown in Figures 2.6-8, 2.6-9 and 2.6-10, respectively, based on 5 years of Augusta Airport records. The speed of the fastest mile of wind during a 20 year period is 62 miles per hour. Strong winds are associated with thunderstorms, and lower maximum speeds (about 35 mph) are observed in the autumn. This is consistent with the observation that hurricane winds do not extend inland to this distance from the Atlantic Ocean. Thom(8) has fitted extreme winds to a statistical distribution, allowing the extrapolation to higher wind speeds. At the site, it is estimated that speeds of approximately 85 mph occur once in 50 years, and speeds of approximately 95 mph occur once in 100 years.

These estimates are derived from weather bureau wind observations and include thunderstorm gusts. For estimating recurrence intervals for higher wind speeds (associated wind tornadoes) a different technique is used as described in paragraph 2.6.1.2.

2.6.2.2.2 Temperature

Monthly averages, for the 30 year climatological period 1931-1960, of the daily maximum, daily minimum, and daily mean (the arithmetic average of maximum and minimum) are listed in Table 2.6-1. Figure 2.6-11 gives the monthly averages and the average of the daily maximum and minimum of dry bulb temperature for the 5 year period of Augusta data. The normal daily maximum ranges from 59°F in December and January to 91°F in July and August. The minimum ranges from 35°F in December to 70°F in July. An extreme maximum of 106°F has been recorded in July, 1952, and a minimum temperature of 3°F has been recorded in February, 1899.

Based on a 6 year record, the average number of days in a month on which temperatures of 90°F and above occur is listed in Table 2.6-1 ranging up to approximately 2/3 of the days in July. The temperature remains below freezing all day on the average one day each January. About 2/3 of the days in December, January and February have minimum temperatures below freezing.

Figures 2.6-12 and 2.6-13 show the monthly averages and average of the daily maxima and minima of wet bulb temperature and dew point temperature, respectively.

2.6.2.2.3 Water Vapor

Normal relative humidities at 4 synoptic hours are given in Table 2.6-1. They illustrate the relatively humid climate, with normal afternoon humidities around 45% in winter and 50-60% in summer. The autumn is the least humid period. Figure 2.6-14 shows the average monthly relative humidity along with the average of this daily maxima and minima during the month based on 5 years (1959 to 1963) of Augusta data.

Absolute humidities have been computed based on dry bulb temperature and relative humidity data from Augusta Airport. As shown in Figure 2.6-15 the average ranges from a maximum of 1.9×10^{-5} gm/cc in summer to a minimum of 5.6×10^{-6} gm/cc in December.

2.6.2.2.4 Precipitation

The normal total monthly precipitation, the maximum and minimum observed in a month, the maximum in 24 hours, all for a 20 year period, are listed in Table 2.6-1. The precipitation is fairly uniform throughout the year. Figure 2.6-16 gives monthly average and 24 hour maximum precipitation. Annual and seasonal precipitation wind roses based on 5 years of

Augusta Airport data are shown in Figure 2.6-17. The maximum precipitation amount during periods of 30 minutes to 10 days to be expected for various return intervals is given in the table below.(9, 10)

Recurrence Interval	30 minutes	1 hour	6 hours	Rainfall Amount 24 hours	2 days	10 days
1 year	1.3	1.6	2.3	3.3	-	-
5 years	1.8	2.3	3.5	5.0	5.7	7.7
10 years	2.1	2.6	4.1	5.7	6.5	9.0
50 years	2.5	3.2	5.3	7.5	8.5	11.5
100 years	2.8	3.5	5.8	8.0	9.0	13.0

2.6.2.2.5 Fog

Heavy fog, with visibility less than 1/4 mile occurs on roughly 10% of days throughout the year with a minimum frequency of about one a month in spring. Figure 2.6-18 summarizes the visibility data from 5 years of data at the Augusta Airport. The frequency of various bisibility conditions taken from the Augusta data is

Visibility Less Than (Miles)	% of Total Hours
1/2	1.21
1	2.32
2	4.62
3	7.87
4	12.00

2.6.2.2.6 High Air Pollution Potential

The region is one of relatively high incidence of slow moving anticyclones, resulting in high air pollution potential, especially in autumn. Korshover(11) has reported on the climatology of stagnating anticyclones east of the Rocky Mountains, covering the period 1936-1970. In the site area, he estimates there are approximately 10 "stagnation days" per year.

Another useful indication of the incidence of high air pollution in the VNP site area is given by a recent analysis of high air pollution potential forecasts by the National Environmental Research Center of the Environmental Protection Agency, which showed approximately 50 days of forecast high air pollution potential in the VNP region in the period August 1, 1960 to April 3, 1970. These forecasts are based mainly on expected wind speed, atmospheric stability, and the expected duration of conditions that cause accumulation of pollutants over a large area. For comparison, the maximum frequency of high air pollution potential forecast days is in West Virginia where 80 days were forecast in the same period. For the New York City region, about 20 days were forecast.

2.6.2.2.7 Atmospheric Stability

Vertical temperature data, which can be used to determine atmospheric stability at low levels, are available from the SRL meteorological program discussed in Subsection 2.6.2. Using these data, joint occurrence of wind direction and wind speed are tabulated for each of 7 vertical temperature difference categories in Table 2.6-3.

Table 2.6-3

JOINT FREQUENCY TABLES OF WIND SPEED (33') AND DIRECTION BY STABILITY GROUP (SRL DATA)

LAPSE RATE (DEG F/100 FT) LESS THAN OR EQUAL TO -1.0

SPEFD	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	0	0	1	1	1	0	0	1	1	3	0	1	1	0	0	0	9	.2
2 MPH	9	8	14	4	7	6	6	8	3	14	12	12	11	18	13	5	138	2.3
3 MPH	15	22	21	14	13	15	24	33	27	28	31	33	33	21	21	20	373	6.4
4 MPH	30	47	53	29	27	32	23	41	38	48	58	54	63	40	32	21	636	10.8
5 MPH	50	68	74	60	46	28	43	54	47	70	79	58	73	56	29	21	856	14.6
6 MPH	43	71	111	54	47	23	36	58	53	67	75	49	61	57	28	17	850	14.5
7 MPH	48	74	101	69	47	15	25	39	54	62	71	53	72	39	17	14	800	13.6
8 MPH	34	41	109	59	28	20	18	37	42	51	60	53	51	42	19	10	674	11.5
12 MPH	32	78	150	99	54	21	32	35	45	70	104	122	175	97	25	12	1151	19.6
18 MPH	0	9	41	15	3	4	2	6	14	19	25	66	124	35	3	0	366	6.2
24 MPH	0	0	3	0	0	0	0	0	1	0	0	1	9	1	1	0	16	.3
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	4	.1
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	261	418	674	404	272	164	209	312	325	432	515	501	680	404	180	122	5873	100.0
PERCENT	4.4	7.1	11.5	6.9	4.6	2.8	3.6	5.3	5.5	7.4	8.8	8.5	11.6	6.9	3.1	2.1	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 6.6

LAPSE RATE (DEG F/100 FT) GREATER THAN -1.0 BUT LESS THAN OR EQUAL TO -0.9

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	.7
2 MPH	0	2	3	0	0	3	1	0	1	0	0	0	0	1	0	0	11	3.6
3 MPH	0	2	2	0	0	1	0	0	2	2	2	2	1	0	0	1	15	4.9
4 MPH	0	0	4	0	2	0	3	3	3	5	2	1	3	2	0	0	28	9.1
5 MPH	1	6	9	3	1	2	3	4	8	6	3	2	1	2	1	0	52	16.1
6 MPH	7	4	5	5	6	1	6	6	5	7	2	0	1	0	0	0	55	17.9
7 MPH	1	1	5	5	1	0	0	3	3	6	3	3	0	0	1	1	33	10.7
8 MPH	5	4	9	3	1	1	4	3	3	4	3	3	3	0	0	0	46	15.0
12 MPH	3	2	7	3	4	1	2	10	4	3	6	4	5	1	0	1	56	18.2
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1.6
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1.3
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	17	21	45	21	15	9	20	30	29	34	21	15	15	8	3	4	307	100.0
PERCENT	5.5	6.8	14.7	6.8	4.9	2.9	6.5	9.8	9.4	11.1	6.8	4.9	4.9	2.6	1.0	1.3	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 6.4

Table 2.6-3 (Continued)

JOINT FREQUENCY TABLES OF WIND SPEED (33') AND DIRECTION BY STABILITY GROUP (SRL DATA)

LAPSE RATE (DEG F/100 FT.) GREATER THAN -0.9 BUT LESS THAN OR EQUAL TO -0.8

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	1	1	0	0	0	0	0	0	2	0	0	0	0	1	0	0	5	3.4
2 MPH	0	1	0	1	0	0	1	1	1	0	0	0	1	0	0	0	5	3.4
3 MPH	1	2	4	1	1	0	0	0	1	0	0	0	0	0	0	0	10	6.9
4 MPH	0	0	1	1	1	0	2	1	2	2	1	2	0	0	1	0	14	9.7
5 MPH	0	3	2	3	2	4	0	1	1	2	2	1	1	1	2	0	25	17.2
6 MPH	1	0	2	2	2	0	0	5	3	0	3	1	0	3	1	1	22	15.2
7 MPH	0	6	2	0	1	0	3	1	4	1	2	0	0	0	0	0	20	13.8
8 MPH	0	2	2	1	0	1	1	1	0	1	1	1	3	1	0	0	15	10.8
12 MPH	0	1	0	1	1	0	1	1	1	2	2	4	3	1	5	0	29	20.0
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	3	16	19	10	6	5	8	11	14	8	11	9	8	7	9	1	145	100.0
PERCENT	2.1	11.0	13.1	6.9	4.1	3.4	5.5	7.6	9.7	5.5	7.6	6.2	5.5	4.8	6.2	.7	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 5.8

LAPSE RATE (DEG F/100 FT.) GREATER THAN -.8 BUT LESS THAN OR EQUAL TO -.3

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	0	3	0	1	0	1	5	1	0	0	1	0	0	1	0	0	13	1.7
2 MPH	2	4	4	0	2	1	5	2	2	3	1	1	3	0	0	1	31	4.2
3 MPH	0	0	6	2	6	3	3	5	4	4	4	1	3	1	3	1	46	6.2
4 MPH	4	5	8	3	1	9	8	10	6	3	10	3	1	1	3	4	79	10.6
5 MPH	4	10	13	8	8	8	3	17	13	11	9	8	1	3	6	0	122	16.4
6 MPH	0	14	19	10	7	9	12	17	9	18	8	6	6	5	0	0	146	19.7
7 MPH	8	19	10	3	5	2	7	13	8	7	13	13	6	3	7	0	124	16.7
8 MPH	4	3	8	8	5	0	4	7	7	13	5	22	5	5	2	3	96	12.9
12 MPH	3	3	5	2	2	0	3	5	4	9	11	11	10	4	1	0	73	9.8
18 MPH	0	0	8	0	0	0	0	0	0	0	1	0	0	0	0	0	4	.5
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	2	9	1.2
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	31	61	76	32	36	33	50	77	53	68	63	65	35	28	24	11	743	100.0
PERCENT	4.2	8.2	10.2	4.3	4.8	4.4	6.7	10.4	7.1	9.2	8.5	8.7	4.7	3.8	3.2	1.5	100.0	

AVERAGE SFEED FOR THIS TABLE EQUALS 5.8

Table 2.6-3 (Continued)

JOINT FREQUENCY TABLES OF WIND SPEED (33') AND DIRECTION BY STABILITY GROUP (SRL DATA)

LAPSE RATE (DEG F/100 FT) GREATER THAN -.3 BUT LESS THAN OR EQUAL TO +.8 1

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	0	1	0	3	0	0	3	1	5	2	2	3	1	0	1	1	23	1.5
2 MPH	5	5	3	4	1	3	7	7	7	8	5	1	6	0	4	4	70	4.5
3 MPH	4	9	21	5	12	10	20	12	9	22	9	6	7	3	6	3	158	10.2
4 MPH	7	25	17	26	25	14	29	38	33	25	24	19	14	5	14	5	320	20.7
5 MPH	13	25	35	27	21	15	18	28	34	37	33	28	21	15	18	7	375	24.3
6 MPH	14	24	40	29	13	6	12	29	24	36	27	26	15	16	14	8	333	21.6
7 MPH	7	10	23	10	7	3	8	13	13	8	12	21	16	11	10	8	180	11.7
8 MPH	0	5	7	1	2	1	0	4	3	6	10	7	3	6	2	2	59	3.8
12 MPH	1	1	7	2	0	0	0	1	1	3	1	3	0	0	3	0	23	1.5
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	.1
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	.2
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	51	105	153	107	81	52	97	133	129	147	123	114	83	59	73	38	1545	100.0
PERCENT	3.3	6.8	9.9	8.9	5.2	3.4	6.3	8.6	8.3	9.5	8.0	7.4	5.4	3.8	4.7	2.5	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 4.6

LAPSE RATE (DEG F/100 FT) GREATER THAN .8 BUT LESS THAN OR EQUAL TO 2.2 1

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	1	0	0	3	0	1	1	2	2	3	0	2	1	1	0	1	18	1.7
2 MPH	2	6	2	3	3	6	2	8	13	9	0	2	4	3	1	6	70	6.8
3 MPH	2	4	5	3	10	3	11	8	11	10	12	12	5	4	3	3	106	10.3
4 MPH	4	14	24	19	12	14	18	24	23	15	11	12	9	6	4	5	214	20.7
5 MPH	7	29	32	30	20	14	21	37	42	18	16	11	17	10	8	10	322	31.2
6 MPH	4	20	21	39	11	11	6	14	21	12	11	14	10	4	7	6	211	20.4
7 MPH	3	11	0	5	2	2	1	6	0	2	6	7	3	4	3	4	65	6.3
8 MPH	1	1	2	1	1	0	0	0	1	0	3	3	2	1	0	3	19	1.8
12 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	7	.7
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	24	85	92	103	59	51	60	99	113	69	59	63	51	35	31	38	1032	100.0
PERCENT	2.3	8.2	8.9	10.0	5.7	4.9	5.8	9.6	10.9	6.7	5.7	6.1	4.9	3.4	3.0	3.7	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 4.2

Table 2.6-3 (Continued)

JOINT FREQUENCY TABLES OF WIND SPEED (33') AND DIRECTION BY STABILITY GROUP (SRL DATA)

LAPSE RATE (DEG F/100 FT) GREATER THAN 2.2

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	3	4	2	1	2	2	2	5	0	4	1	3	3	2	1	1	36	4.1
2 MPH	12	14	5	6	4	6	5	7	10	9	12	4	7	10	9	6	126	14.5
3 MPH	10	11	11	13	9	13	11	17	17	16	11	18	14	5	9	4	189	21.7
4 MPH	4	12	13	10	13	13	16	14	14	14	6	5	4	6	8	5	157	18.0
5 MPH	3	14	25	25	19	16	19	18	12	8	5	9	6	6	9	3	197	22.6
6 MPH	1	3	24	31	14	2	5	6	3	2	1	4	7	2	2	2	109	12.5
7 MPH	1	0	5	22	5	0	1	1	1	0	2	4	1	4	1	1	49	5.6
8 MPH	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	2	5	.6
12 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	.2
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	34	58	86	108	66	52	59	68	57	53	38	47	44	35	40	25	870	100.0
PERCENT	3.9	6.7	9.9	12.4	7.6	6.0	6.8	7.8	6.6	6.1	4.4	5.4	5.1	4.0	4.6	2.9	100.0	

AVERAGE SPEED FOR THIS TABLE EQUALS 3.5

1

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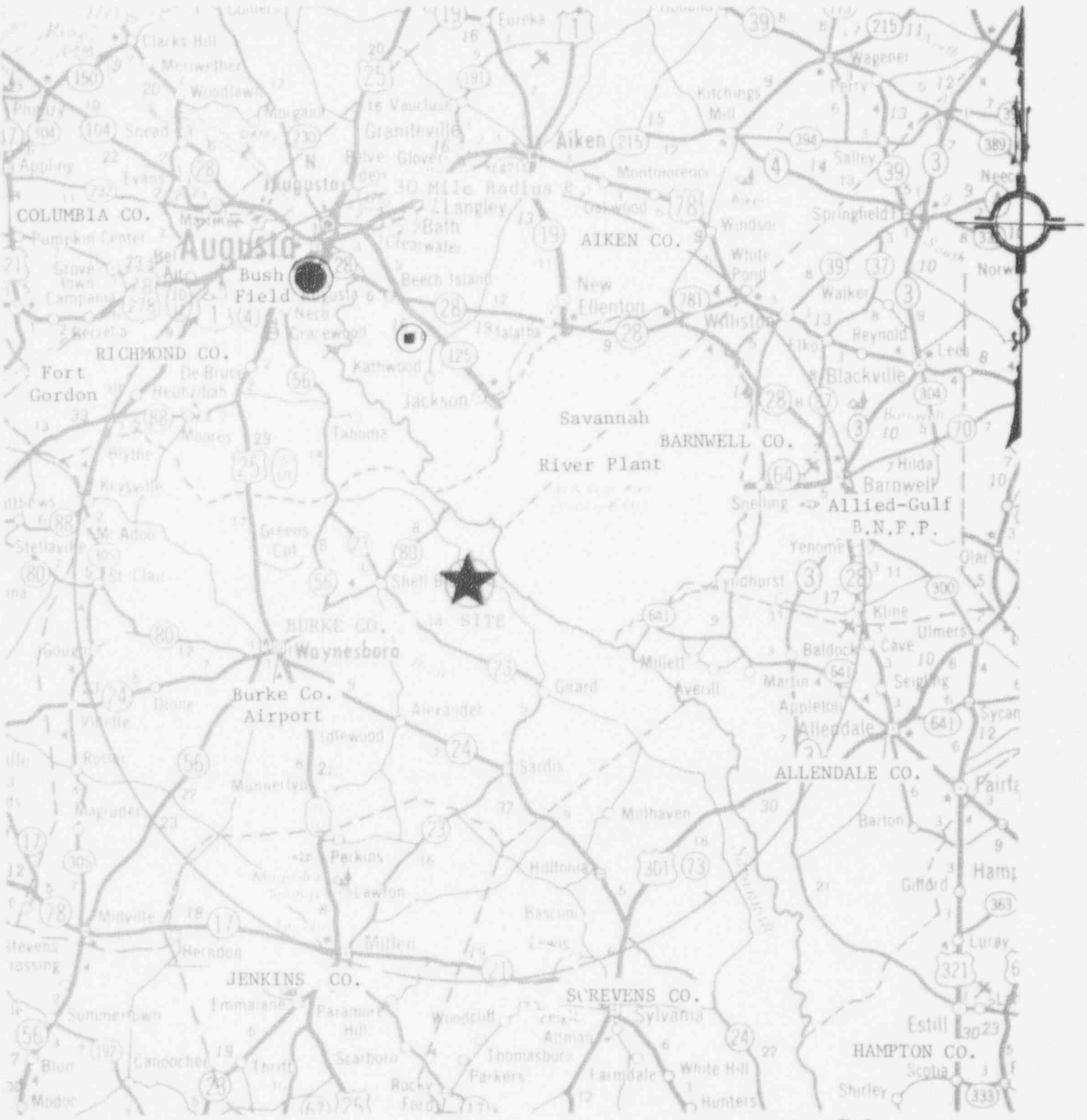

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FIGURE 2.6-7

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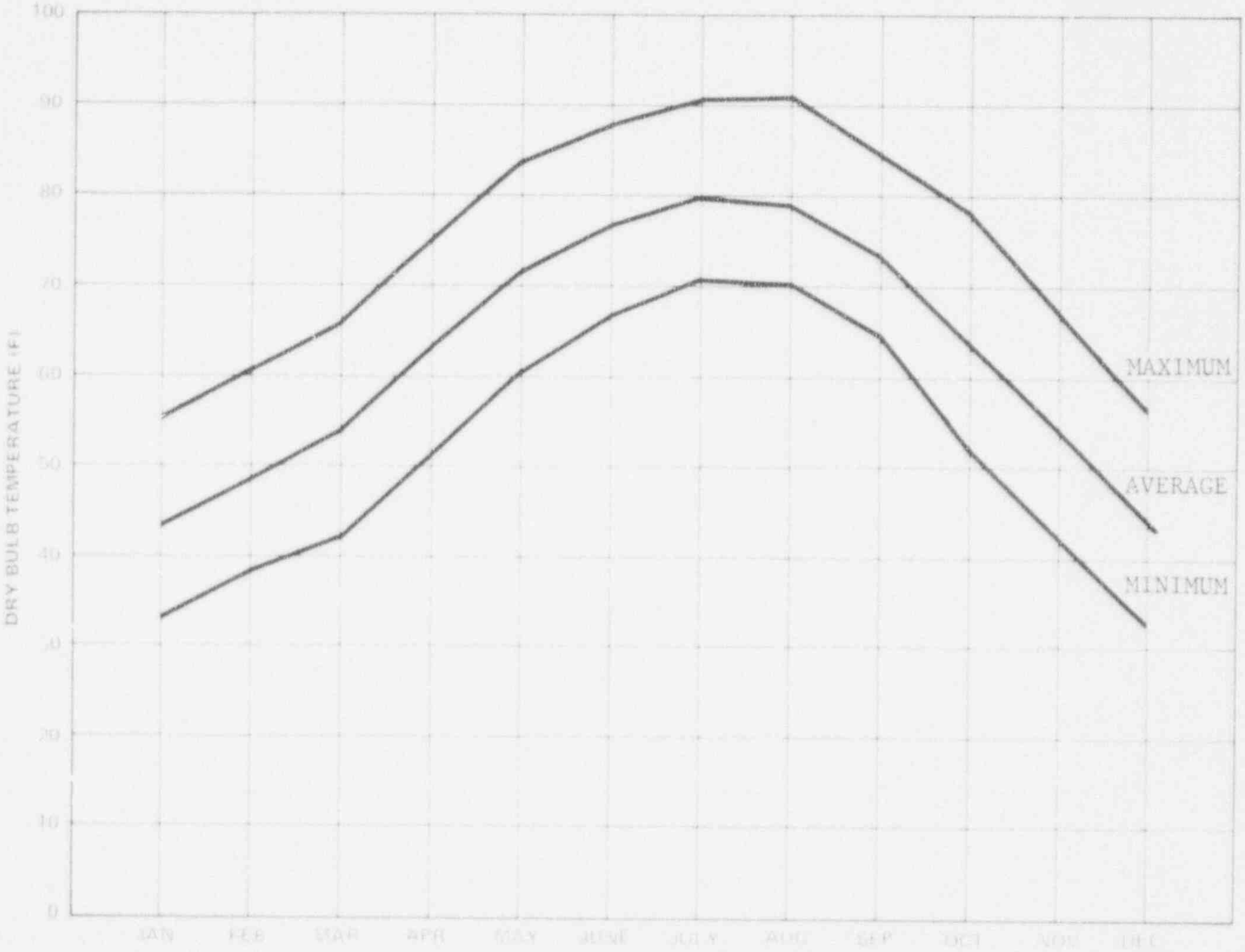

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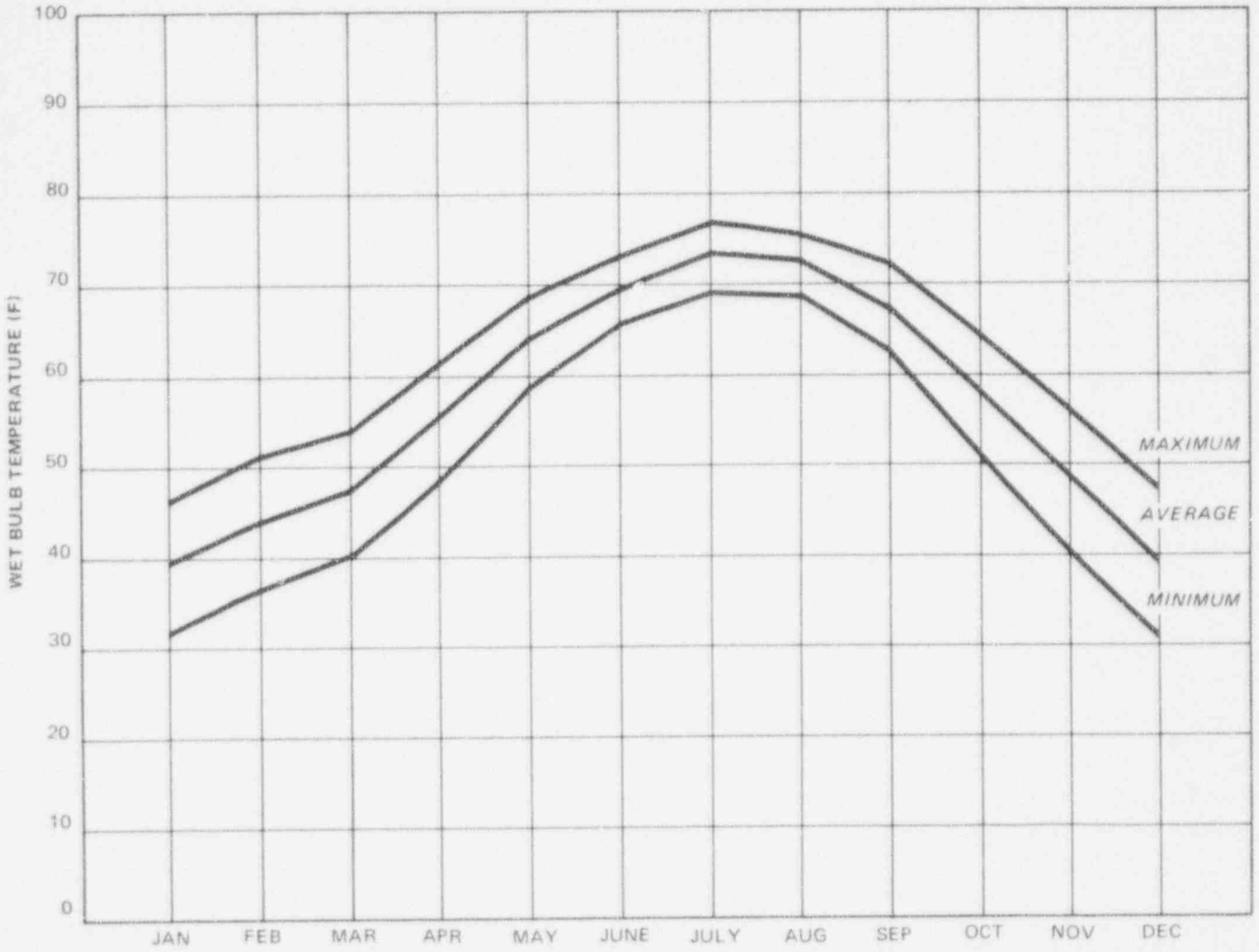
MONTHLY AVERAGE AND AVERAGE DAILY EXTREMES OF DRY BULB TEMPERATURE

FIGURE 2.6-11



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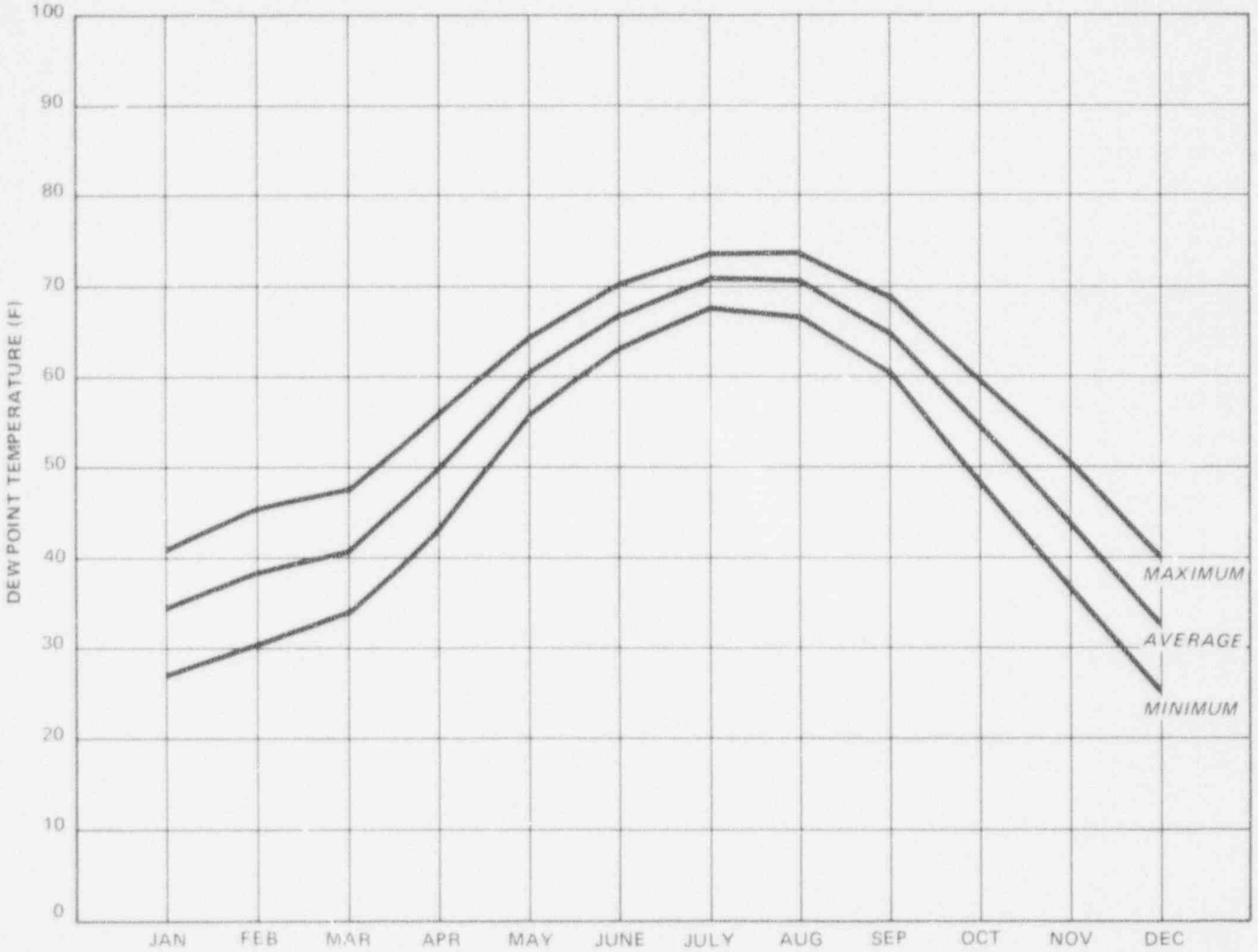
MONTHLY AVERAGE AND AVERAGE DAILY
EXTREMES OF WET BULB TEMPERATURE

FIGURE 2.6-12



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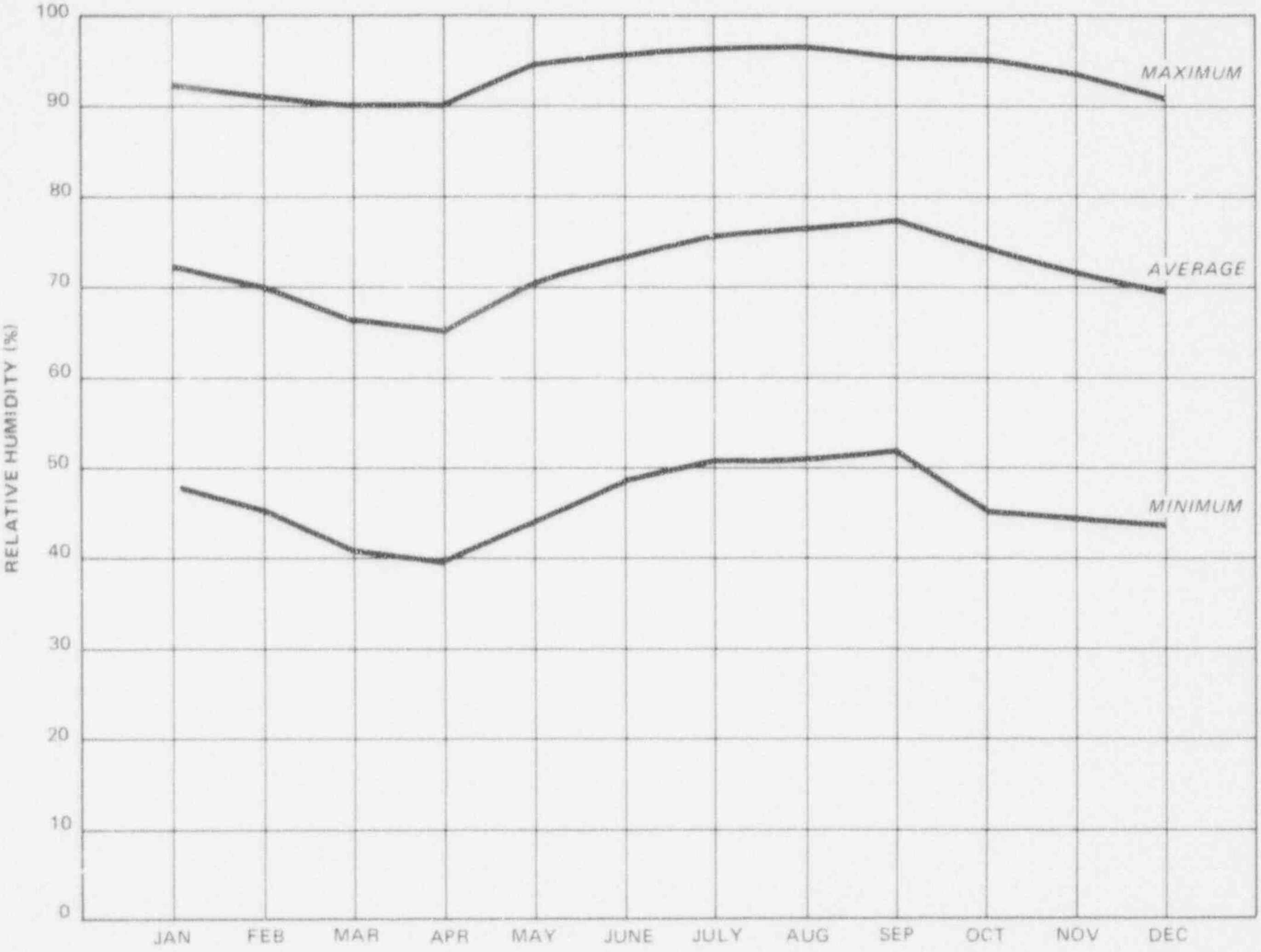
MONTHLY AVERAGE AND AVERAGE DAILY
EXTREMES OF DEW POINT TEMPERATURE

FIGURE 2.6-13



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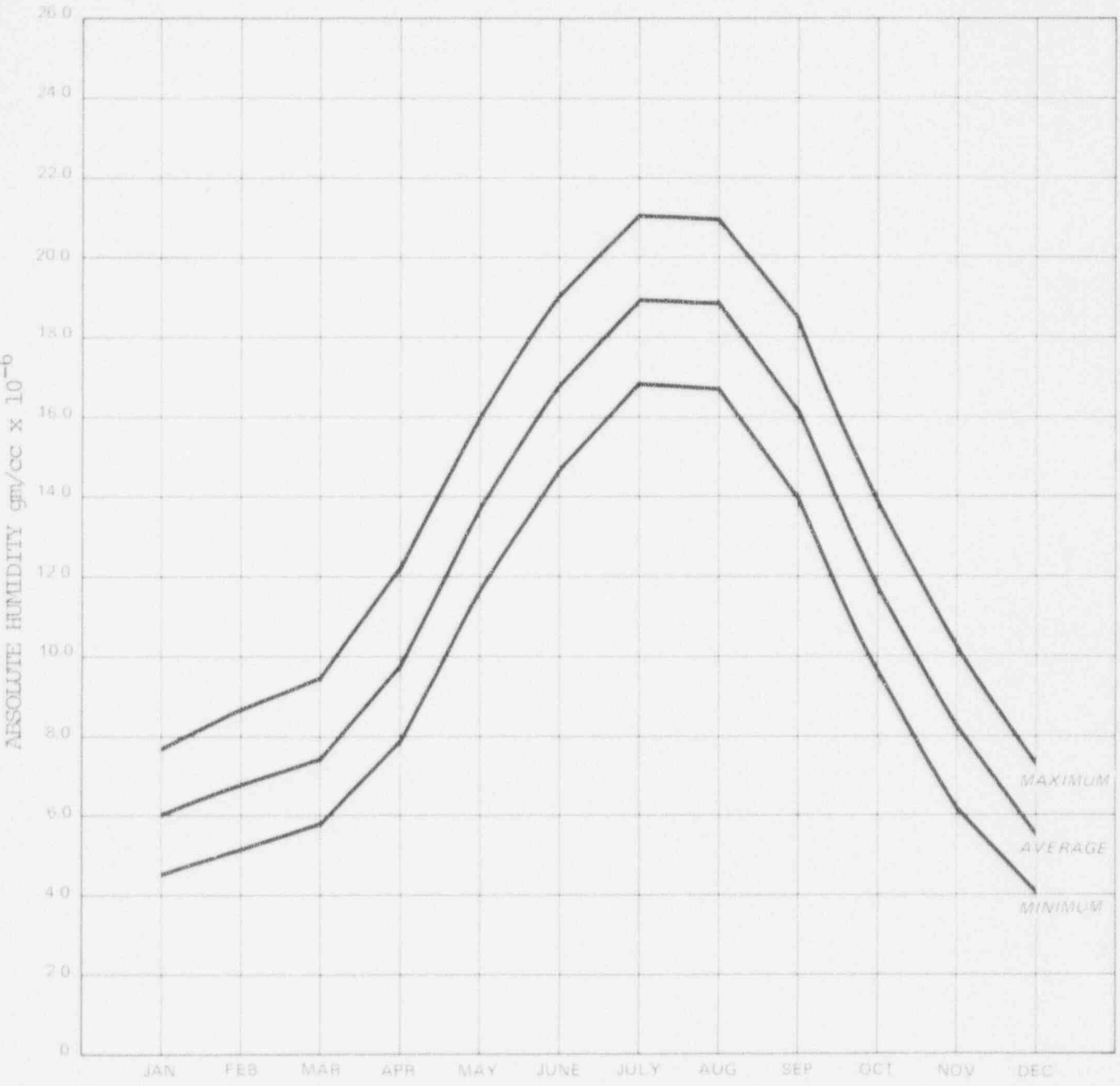
MONTHLY AVERAGE AND AVERAGE DAILY
EXTREMES OF RELATIVE HUMIDITY

FIGURE 2.6-14



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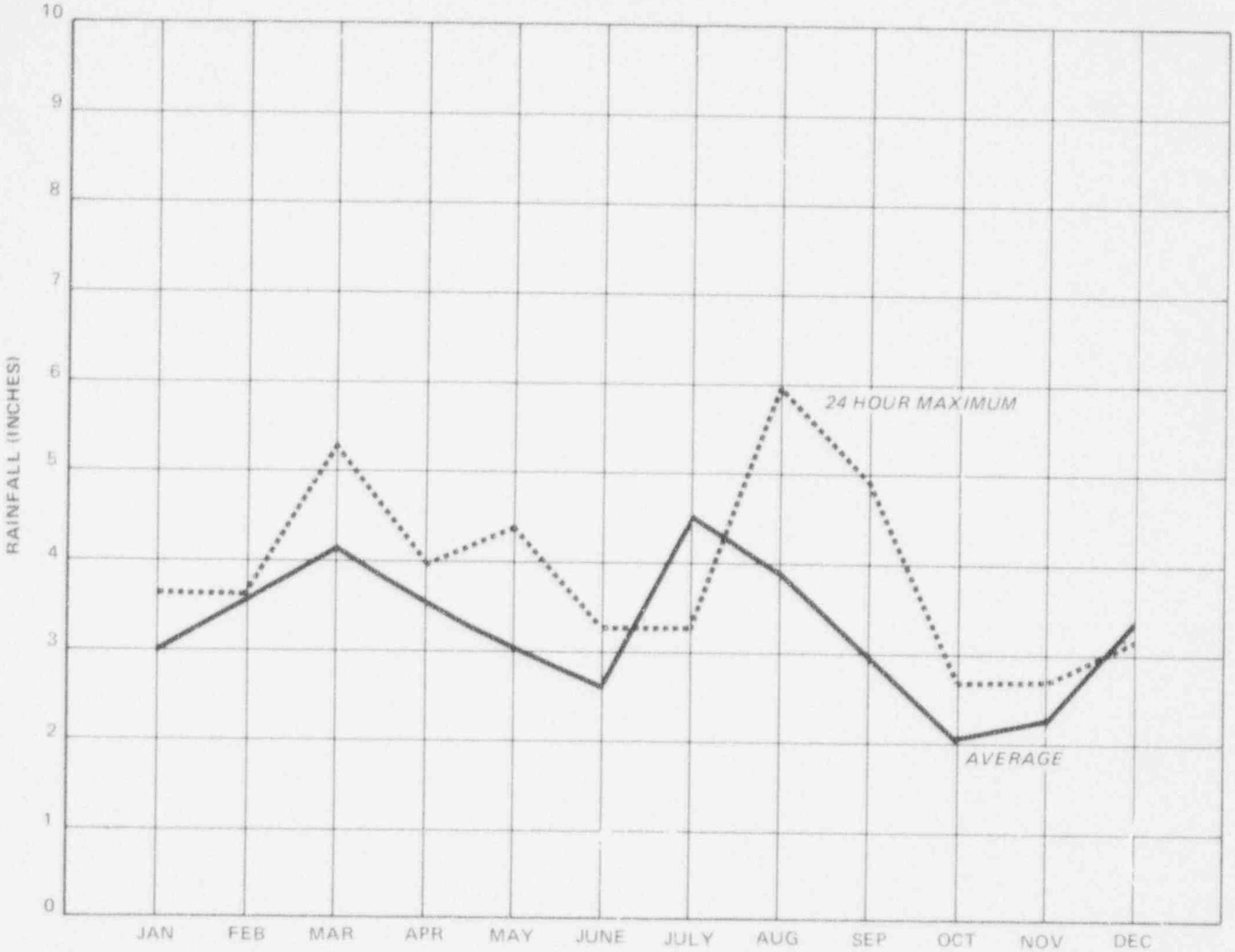
MONTHLY AVERAGE AND AVERAGE DAILY
EXTREMES OF ABOSLUTE HUMIDITY

FIGURE 2.6-15



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MONTHLY AVERAGE AND 24 HOUR
MAXIMUM PRECIPITATION

FIGURE 2.6-16

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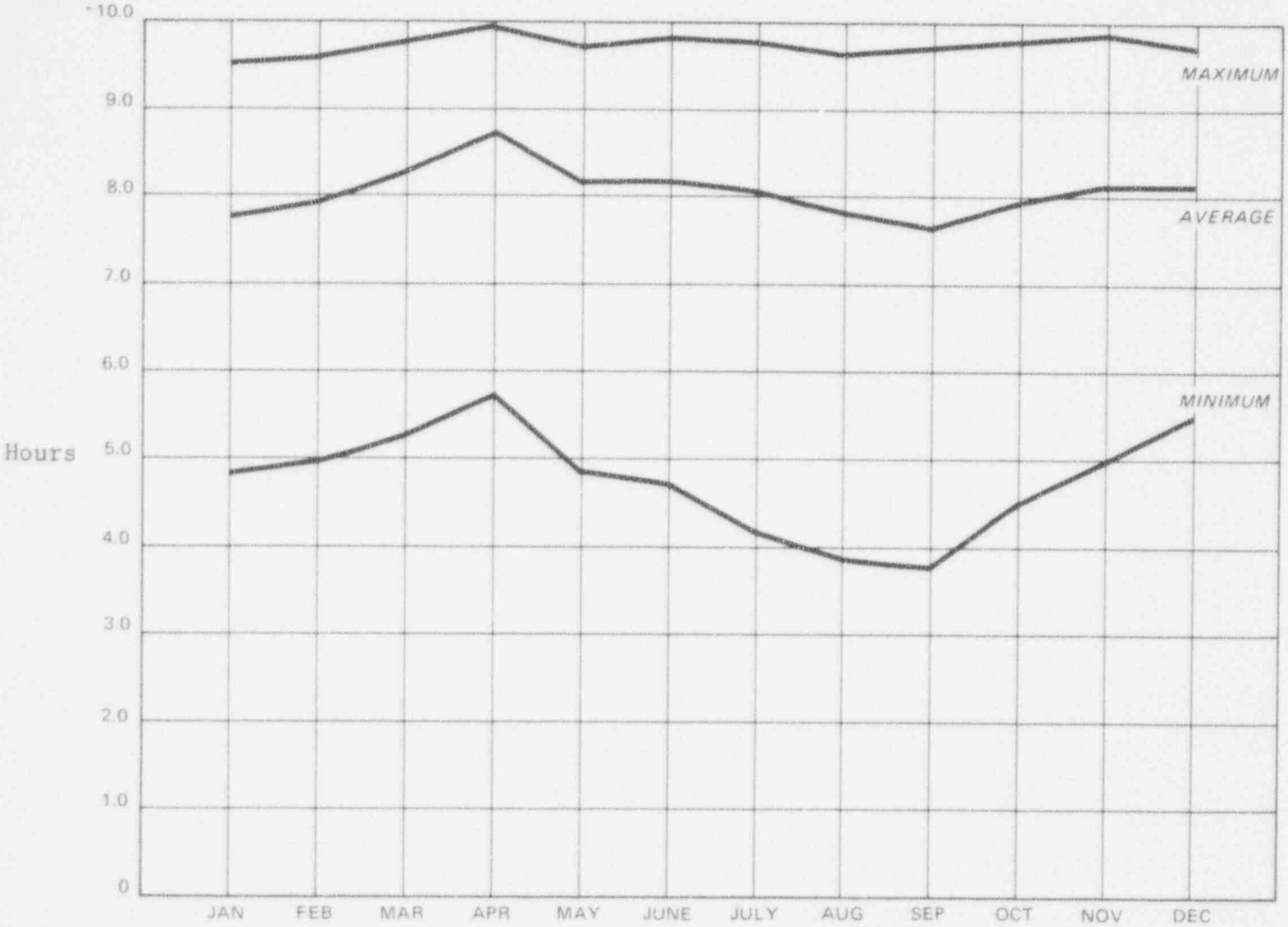

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MONTHLY AVERAGE AND AVERAGE DAILY
EXTREMES OF VISIBILITY

FIGURE 2.6-18

2.7 BIOTA

Numerous ecological and environmental studies have been conducted in the area surrounding the VNP site. Many of these studies have been in relation to the Savannah River Plant (SRP). In this section information is derived from publications of personnel at SRP, Savannah River Ecological Laboratory (SREL), and the Academy of Natural Sciences of Philadelphia (ANSP). Data gathered by GPC in its environmental surveys also are presented and discussed. Where suitable, publications of other individuals and groups are summarized. Since it is not possible to supply a complete review of all the available literature, we have summarized the more pertinent studies and referred to additional studies.

The VNP site is an integral part of the area or region surrounding it, and as such the biota of the region and not just the site must be discussed. In this section we discuss the biota of both the site and the region surrounding the site. This is expecially the case with terrestrial fauna and aquatic flora and fauna.

For purposes of clarity, tables for each subsection of Section 2.7 are included at the end of the respective subsections in the order in which they are discussed.

2.7.1 VEGETATION

A map of plant communities was drawn from aerial photographs taken in 1971 prior to any work on the site by GPC. This map (Figure 2.7-2) represents the area as it was when acquired by GPC. The 275 foot wide transmission line right of way, 30 acre weather tower clearing (circle on left of map) and 100 foot wide right of way for the relocation of a county road are shown under the shading on the map. These areas are included in the total stand acreage. An overlay, Figure 2.7-1, shows additional physical effects of the plant.

Transects (strips) were arranged through the communities so that a minimum of about 1 percent of the area was sampled. The transects were 33 feet wide and every tree in the transect greater than 4 inches diameter breast high (dbh) was tallied. Understory plots of at least .01 acre were sampled in most communities for vegetation less than four inches dbh. Figure 2.7-3 shows the location of transects and understory plots. The study was conducted by GPC foresters.

Tables designated 2.7-1 through 2.7-13 provide quantitative data for the plant communities on the site. The last digit in the table number corresponds to the community number used in the discussion and on Figure 2.7-2. The first column gives the density of trees in the understory and the remaining columns provide information about canopy species. Basal area is the sum total of cross section area of tree trunks measured at dbh. Data on pulpwood volume are presented in cords (cds) per acre and data on sawtimber are presented in boardfeet (bd. ft.) per acre. Commercial value of pulpwood and sawtimber also is given where applicable. The accompanying tables, designated by the letter "A" are summaries of the raw field data and are not expressed in terms of unit area. Tables without the "A" designation have been converted to unit area. These tables show the size class distribution within each stand, which provides information about the age of the stand. Table 2.7-14 gives the percent cover by understory vegetation and acreage of plant communities and other physical features of the site. Table 2.7-15 lists the common trees of the site and Table 2.7-16 lists the understory vegetation.

We have attempted to describe, as closely as possible, the site as it was when acquired by GPC. All of the present old-fields were under cultivation at that time; therefore, no attempt was made to quantify old-field vegetation.

Vegetation on the site can be placed in three general categories: 1) pine-dominated communities, 2) hardwood-dominated communities, and 3) old field and recently cleared communities. The communities can be further subdivided on the basis of species composition. Fifteen distinct communities and a pond are on the site.

Pine communities are identified as those with pure pine stands and those in which pines are very abundant. Most of the site (1978 of 3100 acres) is characterized by a sandhill community. The soil is poor and sparsely covered with pines and small hardwood. The site can best be characterized by those who have seen it. One man commented,"If the land was flat you could see all the way across the site". Another said, "the land is so poor that you have to stand on a sack of fertilizer to raise an umbrella".

Community #1, (Tables 2.7-1, 1A) on Figure 2.7-2 is a Sandhill-Upland Hardwood-Pine community. Turkey Oak and Longleaf Pine are the most abundant trees greater than or equal to 4 inches dbh. Pine sawtimber was removed by the previous owner. The understory is mostly Turkey Oak saplings but Water Oak, Bluejack Oak, Post Oak and Longleaf Pine are also important. There is 80 percent cover by understory vegetation. There are approximately 44 canopy trees and 2131 understory trees per acre for a total of 2175 trees per acre.

The total basal area of trees greater than 4 inches dbh is 10.46 square feet per acre. About eighteen of the species from Table 2.7-16 are common in this community.

Community #2, (Tables 2.7-2, 2A) is similar to #1 except that planted Slash Pine is the most abundant canopy tree followed by Longleaf Pine. Eighty percent cover is furnished by understory vegetation. Turkey Oak is abundant in the understory here but only about half as dense as in Community #1. Slash Pine, Longleaf Pine, Post Oak and Sassafras also are abundant. There are 55 canopy trees and 1355 understory trees per acre or a total of 1410 trees per acre. The total basal area of trees greater than 4 inches dbh is 11.22 square foot per acre. Pine sawtimber was removed by the previous owner. Understory species are similar to stand #1.

Community #3 (Table 2.7-3, 3A) is a Branch Hardwood Community. Blackgum is the most abundant canopy species. Water Oak, Red Maple, Yellow Poplar and Sweetbay also are abundant. Yellow Poplar, Red Maple and Sweetbay are the only species in the understory and cover is 100 percent. Although there were fewer trees per acre in this community than in Communities #1 and #2 (794.6 in the canopy and understory combined) the total basal area of canopy trees was greater (71 square feet per acre).

In Community #4, (Tables 2.7-4, 4A) is a Branch Hardwood Community. Black Gum is abundant here and was not seen in stand #3. Sweetbay, Yellow Poplar, and Hornbeam are the only trees in the understory and cover is 100 percent. There are 198 canopy trees and 550 understory trees per acre for a total of 748 trees per acre. The total basal area of canopy trees is 106.7 square feet per acre. All species of hardwood sawtimber were removed from a small area near the county road by the previous owner. There are twenty-nine common shrubs and vines in this community.

Community #5 (Tables 2.7-5, 5A) is also a Branch Hardwood Community but has many more understory species than communities #3 and #4. No one species greater than 4 inches dbh dominates the community (although Black Gum, Hickory, Ash and White Oak are more important here than in communities #3 and #4). White Oak, Southern Red Oak, Water Oak, Blackjack Oak, Sweetgum, Red Maple and Hickory are important understory species and cover is 100 per cent. There are 98 canopy trees and 1085 understory species per acre for a total of 1183 trees per acre. The total basal area of canopy trees was 38.12 square feet per acre. Shrubs and vines are similar to Communities #3 and #4. In this community there is a 3.9 acre pond (#14 on Figure 2.7-2). The bank is quite steep and vegetation grows almost to the water's edge. There are few emergent aquatic plants in the pond.

Community #6 (Tables 2.7-6, 6A) is designated Cove Hardwood because it faces the river and is different from the above three hardwood communities. There are only eight common tree species and the most abundant are Water Oak, Hickory and Sweetgum. The understory of Water Oaks, Hickories, shrubs and vines forms medium cover and is almost parklike. There are 101 canopy trees and 800 understory trees per acre for a total of 901 trees per acre. The total basal area of canopy trees is 70.27 square feet per acre. There was light removal of hardwood sawtimber by the previous owner.

Community #7 (Tables 2.7-7, 7A) is ten to fifteen year old planted Slash Pine with few other trees. There are 222.1 canopy trees and 17 understory trees per acre for a total of 239.1 trees per acre. The total basal area of canopy trees is 43.08 square feet per acre. The merchantible pine pulpwood was removed by the previous owner. Sixteen species from the shrub and vine list (Table 2.7-16) were seen here. The parklike understory is sparsely covered (40 percent) with shrubs, vines and annuals and is typical of pine plantations.

Community #8 (Table 2.7-8) is a one to two year old Slash Pine plantation which was planted on an 8' x 8' spacing in a field. There was poor initial survival of the pines and heavy grass cover now exists. There are 400 trees per acre.

The Bluff-Hardwood Community (#9) (Tables 2.7-9, 9A) along the river is dominated by Hickory and Northern Red Oak. In some places the bluff meets the river and in other places there is a narrow floodplain. White Oak, Northern Red Oak, Water Oak, Ash and Mulberry are the understory species. There are 61 canopy trees and 1800 understory trees per acre for a total of 1861 trees per acre. The total basal area of canopy trees is 41.66 square feet per acre. Seventeen common shrub and vine species were noted. Seventy percent cover is provided by understory vegetation. There was light removal of hardwood sawtimber by the previous owners.

Community #10 (Tables 2.7-10, 10A), Bottomland Hardwood or River Swamp, lies in the floodplain of the Savannah River. The floodplain is very narrow on this side of the river. Although Black Gum is the most numerous tree, Tupelo Gum has the largest basal area. Black Gum and Sycamore are the only understory tree species. There are 136 canopy trees and 600 understory trees per acre for a total of 736 trees per acre. The total basal area of canopy trees is 81.01 square feet per acre. Seven species of shrubs and vines were commonly seen in this community. The understory is sparse (30 percent cover) and has a parklike appearance. There was light removal of Cypress and hardwood sawtimber by the previous owner.

Community #11 (Tables 2.7-11, 11A) a Sandhill-Longleaf Pine Community, is pine dominated but differs from Communities #1 and #2 by having much greater density of Longleaf Pine and lesser density of oak species. Common understory vegetation includes eight species from Tables 2.7-16 and Turkey Oak, Black Oak, Post Oak, and Water Oak saplings. Eighty percent cover is furnished by understory vegetation. There are 117 canopy trees and 500 understory trees per acre for a total of 617 trees per acre. The total basal area of canopy trees is 24.1 square feet per acre.

Community #12 (Tables 2.7-12, 12A), a Sandhill-Longleaf Pine Community is a monoculture of Longleaf Pines. There are 176 canopy trees and 1000 understory trees per acre and a total basal area of 22.53 square feet per acre in the canopy. Understory trees furnish 80 percent cover. Sawtimber was removed by the previous owner. Sparse ground cover is composed of broomsedge, grasses and "weeds".

In Community #13, (Tables 2.7-13, 13A) Longleaf Pine is the only tree species over 4 inch dbh. Seven species from Table 2.7-16 were identified and the understory trees are Longleaf Pine, Blackgum, Plum, Northern Red Oak, and Bluejack Oak which furnish 80 percent cover. There are 62 canopy trees and 2000 understory trees per acre for a total of 2062 trees per acre. The total basal area of canopy trees is 13.14 square feet per acre. Pine sawtimber was removed by the previous owner.

Community #15 is a sandhill area (281.4 acres) which was cleared by the previous owner in preparation for row planting of Slash Pine. Presently the vegetation consists of annual and perennial "weeds" and grasses, Turkey Oak, Sassafras and Persimmon sprouts.

On the site are 440 acres of old-field (Community #16). This land was under cultivation prior to purchase by GPC in 1971. Old-fields are abandoned agricultural land whose recovery from previous disturbance is predictable. This recovery is termed ecological succession, since recovery proceeds in a succession of stages. During the first years after abandonment, herbaceous species, expecially composites, usually are the dominant vegetation. Table 2.7-17 lists the density, frequency and biomass of old-field plants in a one-year old-field on the SRP (1). The old-fields on the VNP site should be similar to the one described in Table 2.7-17 at this time. As succession proceeds, the weed species are replaced by grasses such as broomsedge (Andropogon spp.) which form a dense, low sward. Recovery then proceeds through a pine stage and finally to a hardwood stage. On most sites hardwood is the stable ecosystem endpoint. The actual species present, the density of plants and the time required to proceed from one state to the next are dependent upon the previous cultivation, the size of the area, the area, the presence of seed sources and other factors. Young forests may be reestablished on small plots in less than 20 years, but it may require 100-200 years for full recovery to occur. The dynamics of the succession process with description of the dominant plant species, the quantities of plant biomass per area and time, and the community production can be found in Odum (2) and Golley (3).

TABLE 2.7-1

VEGETATION OF THE VNP SITE

COMMUNITY: Sandhill - Upland Hardwood - Pine

ACREAGE: 1183.6

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Longleaf Pine	169	12	2.15	0.28	0	336	0	$3,360	
Loblolly Pine	7	1	0.32	0.06	0	75	0	750	
Shortleaf Pine	0	2	0.32	0.05	0	55	0	550	
Post Oak	231	6	1.47	0	0	0	0	0	
Blackjack Oak	0	1	0.19	0	0	0	0	0	
Bluejack Oak	215	1	0.24	0	0	0	0	0	
Turkey Oak	1077	13	2.85	0	0	0	0	0	
Water Oak	385	1	0.42	0	0	0	0	0	
Northern Red Oak	31	1	0.34	0	0	0	0	0	
Southern Red Oak	0	1	0.60	0	0	0	0	0	
Black Oak	8	1	0.26	0	0	0	0	0	
Hickory	8	3	1.04	0	0	0	0	0	
Black Gum	0	0.4	0.19	0	0	0	0	0	
Persimmon	0	0.2	0.06	0	0	0	0	0	
Dogwood	0	0.1	0.01	0	0	0	0	0	

TABLE 2.7- 1A

Size class distribution for a 0.13 acre understory plot (< 4"dbh) and a 13.78 acre strip (≥ 4" dbh).

Sandhill - Upland Hardwood - Pine Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Longleaf Pine	22	67	38	28	18	10	4	3	0	0	0	0	0	1	0	0	0	0	0
Loblolly Pine	1	1	1	2	1	0	2	3	1	0	0	0	0	0	0	0	0	0	0
Shortleaf Pine	0	4	8	4	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Post Oak	30	21	12	15	9	10	2	2	4	3	0	1	0	0	0	0	0	0	0
Blackjack Oak	0	7	2	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0
Bluejack Oak	28	9	4	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Turkey Oak	140	80	32	20	13	17	10	9	0	2	1	0	1	0	1	0	0	0	0
Water Oak	50	7	5	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Northern Red Oak	4	5	1	2	0	1	0	0	0	1	2	0	0	0	1	0	0	0	0
Southern Red Oak	0	2	1	2	1	1	0	0	1	0	0	0	1	1	0	0	0	0	1
Black Oak	1	5	2	1	1	1	2	0	0	0	0	0	1	0	0	0	0	0	0
Hickory	1	10	4	3	4	3	1	6	4	2	0	1	1	0	0	0	0	0	0
Black Gum	0	0	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0
Persimmon	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Dogwood	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 2

VEGETATION OF THE VNP SITE

COMMUNITY: Sandhill - Upland Hardwood - Planted Slash Pine

ACREAGE: 713

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume cds/acre	Volume bf/acre	Stand Total Volume cds	Stand Total Volume bd.ft.	Stand Value Pulpwood	Stand Value Sawtimber
Slash Pine	171	24	2.54	0.09	0	64	0	$ 640	
Loblolly Pine	0	3	0.58	0.09	0	61	0	610	
Longleaf Pine	114	10	3.46	0.73	0	525	0	5,250	
Shortleaf Pine	0	0.2	0.03	0.01	0	4	0	40	
Turkey Oak	500	5	1.30	0	0	0	0	0	
Post Oak	371	4	0.81	0	0	0	0	0	
Bluejack Oak	0	3	0.47	0	0	0	0	0	
Water Oak	14	3	0.65	0	0	0	0	0	
Southern Red Oak	0	0.3	0.04	0	0	0	0	0	
Blackjack Oak	0	0.3	0.06	0	0	0	0	0	
Black Gum	0	0.8	0.64	0	0	0	0	0	
Hickory	0	0.9	0.58	0	0	0	0	0	
Dogwood	0	0.3	0.05	0	0	0	0	0	
Black Cherry	0	0.2	0.01	0	0	0	0	0	
Persimmon	14	0	0	0	0	0	0	0	
Sassafras	171	0	0	0	0	0	0	0	

TABLE 2.7- 2A

Size class distribution for a .07 acre understory plot (< 4"dbh) and a 6.59 acre strip (≥ 4" dbh).

Sandhill - Upland Hardwood - Planted Slash Pine Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Slash Pine	12	122	23	10	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Loblolly Pine	0	13	0	5	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Longleaf Pine	8	12	4	8	7	7	8	11	3	1	2	0	1	0	0	0	0	0	0
Shortleaf Pine	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turkey Oak	35	12	4	1	2	7	5	0	0	2	0	0	0	0	0	0	0	0	0
Post Oak	26	9	5	5	0	2	2	1	0	1	0	0	0	0	0	0	0	0	0
Bluejack Oak	0	10	2	2	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0
Water Oak	1	11	6	1	0	2	1	1	1	0	0	0	0	0	0	0	0	0	0
Southern Red Oak	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blackjack Oak	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Gum	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0
Hickory	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dogwood	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black Cherry	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persimmon	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sassafras	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7-3

VEGETATION OF THE VNP SITE

COMMUNITY: Branch Hardwood

ACREAGE: 74.9

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
White Oak	0	6	3.69	0.10	117	8	8823	$ 24	198.52
Northern Red Oak	0	2	0.25	0	0	0	0	0	0
Water Oak	0	23	10.21	1.41	368	106	27712	$318	623.52
Southern Red Oak	0	0.9	0.08	0	0	0	0	0	0
Hickory	0	5	2.34	0.13	147	10	11046	$ 30	248.54
Red Maple	200	17	6.29	0.94	82	71	6144	$213	138.24
Post Oak	0	2	0.29	0	0	0	0	0	0
Black Gum	0	88	30.16	3.10	887	233	66732	$699	2,502.45
Yellow Poplar	450	30	10.61	0.56	660	42	49673	$126	1,862.74
Sweetbay	100	13	3.36	0.58	0	44	0	$132	0
Pond Pine	0	2	1.27	0	124	0	9346	0	560.76
Loblolly Pine	0	4	0.79	0.04	0	3	0	$ 30	0
Cypress	0	0.7	0.30	0	0	0	0	0	0
American Holly	0	3	0.57	0.08	0	6	0	$ 18	0
Dogwood	0	3	0.45	0	0	0	0	0	0
Elm	0	3	0.35	0	0	0	0	0	0

TABLE 2.7- 3A

Size class distribution for a 0.02 acre understory plot (< 4" dbh) and a 1.15 acre strip (≥ 4" dbh).

Branch Hardwood Community.

SPECIES	SIZE CLASS - INCHES																	
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
White Oak	0	1	0	0	2	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Northern Red Oak	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Oak	0	6	1	2	1	4	1	4	2	1	2	1	0	1	0	0	0	0	0
Southern Red Oak	0	1	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Hickory	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Maple	4	3	3	5	0	1	2	1	2	2	1	0	0	0	0	0	0	0	0
Post Oak	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Gum	0	19	10	14	13	16	6	10	5	4	1	1	0	1	0	0	1	0	0
Yellow Poplar	9	14	2	3	3	4	0	3	1	0	2	0	0	1	0	0	0	0	1
Sweet Bay	2	5	1	1	2	2	3	1	0	0	0	0	0	0	0	0	0	0	0
Pond Pine	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Loblolly Pine	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cypress	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
American Holly	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dogwood	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Elm	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 4

VEGETATION OF THE VNP SITE

COMMUNITY: Branch Hardwood

ACREAGE: 63.5

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Sweetgum	0	26	16.41	0.99	1480	63	94240	$189	3,534.00
Red Maple	0	8	2.77	0.45	49	28	3101	$ 84	69.77
Sweetbay	450	10	1.67	0.09	0	6	0	$ 18	0
Dogwood	0	6	1.01	0	0	0	0	0	0
Post Oak	0	1	0.19	0	0	0	0	0	0
Southern Red Oak	0	1	0.27	0	0	0	0	0	0
Water Oak	0	12	9.29	0.29	896	18	57025	$ 54	1,283.06
Black Gum	0	74	39.12	2.97	2583	189	164493	$567	3,701.09
Yellow Poplar	50	29	14.95	1.28	1426	81	90823	$243	3,405.86
Cypress	0	9	6.61	0	624	0	39747	0	1,490.51
Amer. Holly	0	2	0.53	0.09	0	6	0	$ 18	0
Elm	0	2	0.69	0.23	0	15	0	45	0
Sycamore	0	1	0.54	0.15	0	9	0	$ 27	0
Hickory	0	4	6.05	0.12	208	7	13228	$ 21	297.63
Blackcherry	0	2	2.82	0	264	0	16835	0	378.79
Persimmon	0	2	0.28	0	0	0	0	0	0
Loblolly Pine	0	6	3.24	0.09	221	6	14051	$ 60	0
Hornbeam	50	3	0.26	0	0	0	0	0	0

TABLE 2.7- 4A

Size class distribution for a 0.02 acre understory plot (< 4" dbh) and a 1.01 acre strip (≥ 4" dbh).

Branch Hardwood Community.

SPECIES	SIZE CLASS - INCHES																	
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Sweetgum	0	1	5	2	0	2	2	4	2	2	3	0	0	2	0	0	0	0	1
Red Maple	0	3	0	1	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
Sweet Bay	9	3	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dogwood	0	3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Post Oak	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern Red Oak	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Oak	0	1	1	4	0	2	1	0	0	0	0	1	1	0	0	0	0	0	1
Black Gum	0	5	5	13	3	12	1	7	6	9	2	5	3	1	2	0	0	0	0
Yellow Poplar	1	4	2	4	1	5	1	5	1	2	0	1	0	0	1	0	0	1	0
Cypress	0	0	0	0	0	1	1	1	2	1	0	3	0	0	0	0	0	0	0
American Holly	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Elm	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Sycamore	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hickory	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1
Black Cherry	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Persimmon	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loblolly Pine	0	1	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Hornbeam	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 5

VEGETATION OF THE VNP SITE

COMMUNITY: Branch Hardwood

ACREAGE: 70.5

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume cds/acre	Volume bf/acre	Stand Total Volume cds	Stand Total Volume bd.ft.	Stand Value Pulpwood	Stand Value Sawtimber
White Oak	117	13	8.91	0.56	574	39	41501	$117	933.77
Southern Red Oak	83	8	2.24	0.38	0	27	0	$ 81	0
Turkey Oak	0	0.5	0.22	0.06	0	4	0	$ 12	0
Water Oak	200	7	1.40	0.21	0	15	0	$ 45	0
Northern Red Oak	0	0.5	0.14	0	0	0	0	0	0
Laurel Oak	0	0.5	0.34	0.09	0	6	0	$ 18	0
Post Oak	0	4	1.53	0.18	42	13	2939	$ 39	66.13
Blackjack Oak	100	3	1.75	0	90	0	6344	0	142.74
Sycamore	0	0.5	1.00	0	96	0	6810	0	255.38
Sweetgum	133	8	3.38	0.18	220	12	15555	$ 36	583.31
Persimmon	17	0.5	0.10	0.02	0	1	0	$ 3	0
Red Maple	167	6	1.90	0.07	84	5	5950	$ 15	133.88
Ash	17	11	3.08	0.09	108	6	7599	$ 18	170.98
Poplar	17	1	0.32	0.07	0	5	0	$ 15	0
Hickory	167	12	4.78	0.30	166	21	11720	$ 63	263.70
Black Willow	0	2	0.24	0	0	0	0	0	0
Dogwood	33	0	0	0	0	0	0	0	0
Black Gum	17	12	4.08	0.42	24	30	1685	$ 90	63.19
Elm	0	0.5	0.47	0	39	0	2724	0	61.29
Loblolly Pine	0	3	0.89	0.10	43	7	3047	$ 70	182.82
Longleaf Pine	0	1	0.60	0.03	47	2	3369	$ 20	202.14

TABLE 2.7-5 con't

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume cds/acre	Volume bf/acre	Stand Total Volume cds	Stand Total Volume bd.ft.	Stand Value Pulpwood	Stand Value Sawtimber
Shortleaf Pine	17	2	0.29	0.08	0	6	0	$60	0
Slash Pine	0	2	0.46	0.08	0	6	0	$60	0

TABLE 2.7- 5A

Size class distribution for a 0.06 acre understory plot (< 4" dbh) and a 1.97 acre strip (≥ 4" dbh).

Branch Hardwood Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
White Oak	7	5	1	1	3	0	2	1	4	3	0	2	1	1	0	1	0	0	1
Southern Red Oak	5	2	4	2	2	1	1	0	3	0	0	0	0	0	0	0	0	0	0
Turkey Oak	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Water Oak	12	7	3	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Northern Red Oak	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laurel Oak	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Post Oak	0	2	2	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0
Blackjack Oak	6	1	0	1	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Sycamore	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Sweetgum	8	5	0	2	0	1	1	1	0	1	2	1	1	0	0	0	0	0	0
Persimmon	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Maple	10	1	5	2	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Ash	1	4	3	4	4	0	1	0	2	1	2	0	0	0	0	0	0	0	0
Poplar	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hickory	10	3	4	1	5	2	1	2	0	3	1	1	0	0	0	0	0	0	0
Black Willow	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dogwood	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Gum	1	3	5	4	3	1	2	1	2	3	0	0	0	0	0	0	0	0	0
Elm	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Loblolly Pine	0	2	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Longleaf Pine	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Shortleaf Pine	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Slash Pine	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 6

VEGETATION OF THE VNP SITE

COMMUNITY: Cove Hardwood

ACREAGE: 15.3

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Water Oak	500	47	37.98	1.70	3392	26	52018	$78	1,170.41
Northern Red Oak	0	3	0.40	0	0	0	0	0	0
Hickory	300	18	14.26	0.77	1000	12	15336	$36	345.06
Sweetgum	0	18	7.99	0.51	357	8	5471	$24	205.16
Ash	0	3	1.29	0.34	0	5	0	$15	0
Basswood	0	6	4.65	0	371	0	5695	0	213.56
Sugar Maple	0	3	3.13	0	0	0	0	0	0
Black Gum	0	3	0.57	0	0	0	0	0	0

TABLE 2.7- 6A

Size class distribution for a 0.01 acre understory plot (< 4" dbh) and a 0.342 acre strip (≥ 4" dbh).

Cove Hardwood Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Water Oak	5	1	0	0	3	0	5	0	1	2	0	1	0	0	0	0	2	0	1
Northern Red Oak	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hickory	3	0	0	0	1	3	0	0	0	0	1	0	0	0	0	0	0	0	1
Sweetgum	0	0	0	1	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0
Ash	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Basswood	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Sugar Maple	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Black Gum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 7

VEGETATION OF THE VNP SITE

COMMUNITY: Slash Pine Plantation

ACREAGE: 148.7

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Slash Pine	17	195	35.76	5.82	0	867	0	$8,670	0
Loblolly Pine	0	17	4.57	0.96	0	142	0	$1,420	0
Longleaf Pine	0	6	2.23	0.54	0	80	0	800	0
Shortleaf Pine	0	0.8	0.19	0.04	0	6	0	60	0
Post Oak	0	2	0.18	0	0	0	0	0	0
Water Oak	0	0.5	0.07	0	0	0	0	0	0
Turkey Oak	0	0.8	0.08	0	0	0	0	0	0

TABLE 2.7-7A

Size class distribution for a .06 acre understory plot (< 4" dbh) and a 3.95 acre strip (≥ 4" dbh).

Ten to fifteen year old Slash Pine Plantation.

SPECIES	SIZE CLASS - INCHES											
	<4	4	5	6	7	8	9	10	11	12	13	>13
Slash Pine	1	186	185	219	108	54	16	4	0	0	0	0
Loblolly Pine	0	17	13	12	6	6	3	4	3	3	1	0
Longleaf Pine	0	5	2	4	0	3	3	5	1	2	0	0
Shortleaf Pine	0	0	0	2	0	1	0	0	0	0	0	0
Post Oak	0	3	2	1	0	0	0	0	0	0	0	0
Water Oak	0	1	0	1	0		0	0	0	0	0	0
Turkey Oak	0	2	1	0	0		0	0	0	0	0	0

TABLE 2.7- 8

VEGETATION OF THE VNP SITE

COMMUNITY: Planted Slash Pine (1 - 2 years old)

ACREAGE: 9.5

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Slash Pine	400	0	0	0	0	0	0	0	0

TABLE 2.7-9

VEGETATION OF THE VNP SITE

COMMUNITY: Bluff Hardwood

ACREAGE: 60.5

SPECIES	Stems/Acre (Understory)	Stems/Acre ($\geq$4" dbh)	Basal Area Sq. Ft./Acre ($\geq$ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Sweetgum	0	3	1.68	3.06	93	187	5701	$561	213.79
Hickory	0	18	11.43	0.64	628	39	38727	$117	871.36
Slash Pine	0	2	0.21	0	0	0	0	0	0
Loblolly Pine	0	2	1.88	0	240	0	14830	0	889.80
Cypress	0	2	0.53	0	0	0	0	0	0
Northern Red Oak	100	11	16.77	0.27	1786	16	108971	$ 48	2,451.85
Turkey Oak	0	2	1.20	0	72	0	4392	0	98.82
Water Oak	200	6	2.02	0.37	0	22	0	$ 66	0
White Oak	1200	0	0	0	0	0	0	0	0
Elm	0	8	1.52	0.07	0	4	0	12	0
Ash	200	3	2.17	0.10	175	6	10654	$ 18	239.72
Yellow Poplar	0	2	0.83	0.17	0	10	0	$ 30	0
Sugar Maple	0	2	1.42	0	89	0	5421	0	121.97
Mulberry	100	0	0	0	0	0	0	0	0

TABLE 2.7- 9A

Size class distribution for a 0.01 acre understory plot (< 4" dbh) and a 0.65 acre strip (≥ 4" dbh).

Bluff Hardwood Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Sweetgum	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Hickory	0	1	1	0	0	1	1	0	2	4	1	1	0	0	0	0	0	0	0
Slash Pine	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loblolly Pine	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cypress	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Red Oak	1	0	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	2
Turkey Oak	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Water Oak	2	1	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0
White Oak	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elm	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ash	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Yellow Poplar	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Sugar Maple	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mulberry	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 10

VEGETATION OF THE VNP SITE

COMMUNITY: Bottomland Hardwood (River Swamp)

ACREAGE: 54.8

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Ash	0	17	10.97	0.46	566	25	31181	$ 75	701.57
Black Gum	500	56	9.08	1.13	639	62	35197	$186	1,319.89
Tupelo Gum	0	14	19.83	0.50	160	27	88425		3,315.94
Hickory	0	14	10.46	0.71	616	39	33937	$117	763.58
Water Oak	0	9	12.32	0.29	1073	16	59134	$ 48	1,330.52
Black Willow	0	1	0.19	0	0	0	0	0	0
Red Maple	0	1	1.53	0	99	0	5433	0	122.24
Sycamore	100	6	5.25	0	463	0	25512	0	956.70
Hackberry	0	4	0.88	0.17	0	9	0	$ 27	0
Cypress	0	9	8.97	0	1063	0	58583	0	3,514.98
Elm	0	4	1.34	0.21	0	11	0	$ 33	0
Sweetgum	0	1	0.19	0	0	0	0	0	0

TABLE 2.7- 10A

Size class distribution for a 0.01 acre understory plot (< 4" dbh) and a 0.70 acre strip (≥ 4" dbh).

Bottomland Hardwood (River Swamp) Community.

SPECIES	SIZE CLASS - INCHES																	
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Ash	0	0	0	1	2	2	0	1	1	3	1	1	0	0	0	0	0	0	0
Black Gum	5	7	9	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tupelo Gum	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	1
Hickory	0	0	0	0	0	0	3	1	1	2	1	1	1	0	0	0	0	0	0
Water Oak	0	0	0	0	0	1	1	0	0	1	0	2	0	0	0	0	0	0	1
Black Willow	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Maple	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Sycamore	1	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0
Hackberry	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cypress	0	0	0	0	1	0	0	0	0	0	1	1	1	2	0	0	0	0	0
Elm	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Sweetgum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 11

VEGETATION OF THE VNP SITE

COMMUNITY: Sandhill - Longleaf Pine

ACREAGE: 17.3

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume		Stand Total Volume		Stand Value	
				cds/acre	bf/acre	cds	bd.ft.	Pulpwood	Sawtimber
Longleaf Pine	0	109	17.89	1.72	110	30	1902	$300	114.12
Turkey Oak	50	5	2.74	0	0	0	0	0	0
Southern Red Oak	0	3	3.47	0	0	0	0	0	0
Black Oak	200	0	0	0	0	0	0	0	0
Post Oak	50	0	0	0	0	0	0	0	0
Water Oak	200	0	0	0	0	0	0	0	0

TABLE 2.7- 11A

Size class distribution for a 0.02 acre understory plot (< 4" dbh) and a 0.774 acre strip (≥ 4" dbh).

Sandhill - Longleaf Pine Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Longleaf Pine	0	35	20	14	9	3	1	0	1	1	0	0	0	0	0	0	0	0	0
Turkey Oak	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
Southern Red Oak	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Black Oak	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Post Oak	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Oak	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 12

VEGETATION OF THE VNP SITE

COMMUNITY: Sandhill-Longleaf Pine

ACREAGE: 7.0

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume cds/acre	Volume bf/acre	Stand Total Volume cds	Stand Total Volume bd.ft.	Stand Value Pulpwood	Stand Value Sawtimber
Longleaf Pine	1000	176	22.53	1.84	0	13	0	$130	0

TABLE 2.7- 12A

Size class distribution for a 0.01 acre understory plot (< 4" dbh) and a .522 acre strip (≥ 4" dbh). Sandhill-Longleaf Pine Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Longleaf Pine	10	52	16	19	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2.7- 13

VEGETATION OF THE VNP SITE

COMMUNITY: Sandhill - Longleaf Pine

ACREAGE: 17.1

SPECIES	Stems/Acre (Understory)	Stems/Acre (≥ 4" dbh)	Basal Area Sq. Ft./Acre (≥ 4" dbh)	Volume cds/acre	Volume bf/acre	Stand Total Volume cds	Stand Total Volume bd.ft.	Stand Value Pulpwood	Stand Value Sawtimber
Longleaf Pine	100	62	33.14	6.09	0	104	0	$1,040	0
Black Gum	1400	0	0	0	0	0	0	0	0
Plum	100	0	0	0	0	0	0	0	0
Northern Red Oak	300	0	0	0	0	0	0	0	0
Bluejack Oak	100	0	0	0	0	0	0	0	0

TABLE 2.7- 13A

Size class distribution for a 0.01 acre understory plot (< 4" dbh) and a 0.45 acre strip (≥ 4"dbh).

Sandhill-Longleaf Pine Community.

SPECIES	SIZE CLASS - INCHES																		
	<4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20
Longleaf Pine	1	3	0	2	3	3	4	7	5	1	0	0	0	0	0	0	0	0	0
Black Gum	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Red Oak	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluejack Oak	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.7 - 14

PERCENT OF COVER BY UNDERSTORY VEGETATION AND ACREAGE OF PHYSICAL FEATURES OF THE VNP SITE WHEN ACQUIRED BY GEORGIA POWER COMPANY

	COMMUNITY	% COVER	ACREAGE
1.	Sandhill-Upland Hardwood-Pine	80	1183.6
2.	Sandhill-Upland Hardwood Planted Slash Pine	80	713.0
3.	Branch Hardwood	100	74.9
4.	Branch Hardwood	100	63.5
5.	Branch Hardwood	100	70.5
6.	Cove Hardwood	100	15.3
7.	Slash Pine Plantation (10-15 yrs. old)	40	148.7
8.	Slash Pine Plantation (1-2 yrs. old)	no understory	9.5
9.	Bluff Hardwood	70	60.5
10.	Bottomland Hardwood (River Swamp)	30	54.8
11.	Sandhill-Longleaf Pine	80	17.3
12.	Sandhill-Longleaf Pine	80	7.0
13.	Sandhill-Longleaf Pine	80	17.1
14.	Pond	-	3.9
15.	Cleared Sandhill	-	281.4
16.	Old Fields (1 yr. old)	-	440.0
17.	County Roads (30' R/W)	-	16.1

TABLE 2.7 - 15

Common trees of the VNP site

COMMON NAME	SCIENTIFIC NAME
Turkey Oak	Quercus laevis
Bluejack Oak	Quercus incona
Blackjack Oak	Quercus marilandica
Water Oak	Quercus nigra
Northern Red Oak	Quercus borealis
Post Oak	Quercus stellata
Black Oak	Quercus velutina
Southern Red Oak	Quercus rubra
White Oak	Quercus alba
Laurel Oak	Quercus laurifolia
Sweetgum	Liquidambar styraciflua
Black Gum	Nyssa sylvatica
Tupelo Gum	Nyssa aquatica
Slash Pine	Pinus caribaea
Longleaf Pine	Pinus palustris
Shortleaf Pine	Pinus echinata
Loblolly Pine	Pinus taeda
Pond Pine	Pinus rigida var. serotina
American Hornbeam	Carpinus caroliniana
American Holly	Ilex opaca
Basswood	Tilia spp.
Black Walnut	Juglans nigra
Black Willow	Salix nigra
Hickory	Carya spp.
Ash	Fraxinus spp.
Sugar Maple	Acer saccharum
Sassafras	Sassafras albidum
Cypress	Taxodium spp.
Elm	Elmus spp.
Yellow Poplar	Liriodendron tulipifera
Red Maple	Acer rubrum
Sycamore	Platanus occidentalis
Persimmon	Diospyros virginiana
Dogwood	Cornus florida
Sweetbay	Magnolia virginiana
Black Cherry	Prunus serotina

TABLE 2.7 -15 con't

Plum	Prunus spp.
Hackberry	Celtis occidentalis
Boxelder	Acer negundo
Red Mulberry	Morus rubra
Swampbay	Persia palustris
Blacklocust	Robinia pseudoacacia

TABLE 2.7 - 16

Common shrubs and vines of the VNP site

COMMON NAME	SCIENTIFIC NAME
Grape	Vitis spp.
Muscadine	Vitis rotundifolia
Poison Oak	Toxicodendron quercifolium
Poison Ivy	Toxicodendron radicans
Poison Sumac	Rhus vernix
Southern Wax Myrtle	Myrica cerifera
Sumac	Rhus spp.
Virginia Creeper	Parthenocissus quinquefolia
Farkleberry	Vaccinium spp.
Blackberry	Rubus spp.
Dewberry	Rubus spp.
Hawthorn	Crataegus spp.
Plum	Prunus spp.
Greenbriar	Smilax spp.
Gallberry	Ilex glabra
Blackhaw	Viburnum spp.
Hazel Alder	Alnus rugosa
Honeysuckle	Lonicera spp.
Wild Azalea	Rhododendron nudiflorum
Southern Decumaria	Decumaria barbara
Virginia Sweetspire	Itea virginica
Rattam	Berchemia spp.
Devils Walkingstick	Aralia spinosa
Amer. Beautyberry	Callicarpa americana
Buckeye	Aesculus spp.
Bumelia	Bumelia spp.
Pawpaw	Asimina parviflora
Baccharis	Baccharis spp.
Serviceberry	Amelanchier arborea
Carolina Buckthorn	Rhamnus caroliniana
Dog Hobble	Levcotheum spp.
Common Buttonbush	Cephalanthus occidentalis
Fern	Polypodiceae
Cane	Arundinaria tecta
Beggarlice	Lappula spp.
Wiregrass	Sporobolus sp.
Spanish Moss	Tillandsia sp.
Dog Fennel	Eupatorium capillifolium
Sedge	Andropogon virginicus
Goldenrod	Solidago sp.
Rabbit Tobacco	Gnaphalium obtusifolium
Legumes	Leguminosae

Table 2.7-17

SPECIES OF OLD-FIELD PLANTS IN A ONE YEAR OLD-FIELD ON SRP (1)

Common Name	Scientific Name	Average Density per m^2	Maximum Density per m^2	% Frequency	Peak Standing Crop g/m^2
Fescue	*Festuca sciurea*	2.0	8.0	15.0	0.60
Love grass	*Eragrostis hirsuta*	0.1	3.0	3.8	1.35
Sand grass	*Triplasis prupurea*	16.0	153.0	16.3	30.19
Three-awn	*Aristida tuberculosa*	2.2	12.0	2.5	0.12
Three-awn	*Aristida oligantha*	0.7	7.0	1.3	10.02
Three-awn	*Aristida purpurascens*	4.3	32.0	21.3	2.98
Bermuda grass	*Cynodon Dactylon*	115.2	1275.0	70.0	123.02
Fall witch grass	*Leptoloma cognatum*	2.1	35.0	18.8	2.56
Panic grass	*Panicum commutatum*	1.1	15.0	3.8	0.14
Sandbur	*Cenchrus pauciflorus*	13.6	102.0	16.3	9.80
Broom sedge	*Andropogon virginicus*	0.4	5.0	16.3	0.24
Beard grass	*Andropogon ternarius*	0.3	3.0	1.3	2.48
Johnson grass	*Sorgum halepense*	2.7	18.0	2.5	11.23
Galingale	*Cyperus compressus*	1.9	35.0	18.8	2.82
	Bulbostylis cappilaris	0.3	3.0	1.3	0.004
Path rush	*Juncus tenuis*	2.5	25.0	1.3	0.04
Red sorrel	*Rumex acetosella*	0.4	4.0	26.3	3.80
Lamb's quarter	*Chenopodium album*	0.2	2.0	1.3	0.02
	Froelichia floridana	9.6	263.0	5.0	3.42

Table 2.7-17 (Cont.)

Common Name	Scientific Name	Average Density per m^2	Maximum Density per m^2	% Frequency	Peak Standing Crop g/m^2
Carpet weed	*Mollugo verticillata*	2.2	92.0	10.0	0.09
	Stipulicida setacea	0.1	1.0	1.3	0.001
Catchfly	*Silene antirrhina*	0.1	1.0	1.3	0.04
Pepper grass	*Lepidium virginicum*	0.2	2.0	10.0	6.02
Sickle-pod	*Cassia Tora*	23.5	182.0	62.5	1.37
	Cassia Deeringiana	0.1	1.0	1.3	0.07
Rattlebox	*Crotalaria sagittalis*	4.7	68.0	11.3	11.6
Tick-trefoil	*Desmodium tortuosum*	6.2	187.0	12.5	0.41
Bush clover	*Lespedeza cuneata*	5.6	80.0	5.0	8.20
Japanese clover	*Lespedeza striata*	4.1	114.0	17.5	13.68
Wild bean	*Strophostyles helvola*	0.7	13.0	2.5	13.37
	Croton glandulosus	0.1	1.0	1.3	0.02
St. John's wort	*Hypericum gentianoides*	2.5	11.0	51.3	1.55
	Oenothera laciniata	0.3	1.0	6.3	1.67
Toad flax	*Linaria canadensis*	3.0	7.0	23.8	1.08
	Girardia fasciculata	0.3	3.0	3.8	0.11
Trumpet creeper	*Campsis radicans*	0.3	3.0	1.3	1.78
Buttonwood	*Diodia teres*	24.4	185.0	45.0	10.82
Mexican clover	*Richardia scabra*	0.3	3.0	1.3	0.03
	Specularia perfoliata	0.7	10.0	3.8	0.60
	Haplopappus divaricatus	0.6	5.0	27.5	23.90

Table 2.7-17 (Cont.)

Common Name	Scientific Name	Average Density per m^2	Maximum Density per m^2	% Frequency	Peak Standing Crop g/m^2
Golden aster	*Heterotheca subaxillaris*	1.8	10.0	71.3	161.34
Daisy	*Erigeron ramosus*	0.3	5.0	15.0	0.74
Horseweed	Leptilon canadensis	25.7	285.0	90.0	118.20
	Gnaphalium purpureum	0.8	8.0	23.8	2.08
Cudweed	*Gnaphalium obtusifolium*	0.3	3.0	3.8	0.47
Dog-fennel	*Eupatorium capillifollium*	1.1	7.0	35.0	1.45

2.7.2 INSECTS

The potential number of species of insects on the VNP site at any one time is in the thousands. No attempt has been made to survey the insects on the plant site. Insects in the herb stratum of a field of sericea lespedeza (Lespedeza cuneata) were surveyed in 1959-1960 on SRP (4). In this study 39,825 adult insects were examined and a total of 479 species were identified. The following is summary of this study which is quoted from Menhinick (4) with only minor changes:

> Density and biomass of arthropods
>
> A general account of the seasonal changes in the desity of arthropods in the lespedeza field is given below.
>
> Winter and spring. During the months of December to April only a very few species were present in the lespedeza field. Cicadellidae, Pentatomidae, Curculionidae, and lepidopterous larvae were the main phytophagous forms; they were probably feeding on the understory plants, since the dominant lespedeza had not yet started growth. Spiders were the most numerous predators.
>
> Insect density increased after emergence of young lespedeza shoots during March. Phytophagous forms increased from $0.02/m^2$ on March 1 to $0.17/m^2$ on April 1, and to $1.00/m^2$ on May 1. Most of the common families were present by May 1. Melanoplus nymphs (several species, Acrididae) and Stictocephala diminuta (Membracidae) were common. Dorymyrmex pyramicus (Formicidae) and attid spiders were the most abundant omnivores and predators at this time.
>
> By May 15 there were 6.17 phytophagous $forms/m^2$ and many of the characteristic summer species appeared for the first time. Oecanthus quadripunctatus (Gryllidae), Conocephalus saltans (Tettigoniidae), and Melanoplus spp. (Acrididae) nymphs occurred in large numbers and made up most of the total biomass. Alydus eurinus and Alydus pilosulus (Coreidae), which were to remain common throughout the summer, were first noted as abundant on May 15. Lygaeidae, Miridae, Membracidae, Formicidae, and Araneida were common.

Summer. From June 1 to October 15 total density and biomass of arthropods remained approximately constant with fluctuations occurring primarily on the species level. A brief account of species composition is as follows:

ORTHOPTERA, which made up over half of the total biomass at this season, were represented by numbers of Oecanthus quadripunctatus (Gryllidae, June 15-October 1), Melanoplus biliteratus (Acrididae, May 15-December 1), and Melanoplus femur-rubrum (March 15-November 1). Many of the Orthoptera had two generations per season. Oecanthus nymphs were collected May 15-June 15 and August 1-August 15; Conocephalus nymphs were found May 15-June 15 and August 1-August 15; Schistocerca nymphs, June 1-August 15; and Melanoplus nymphs, May 1-September 15.

HEMIPTERA were prominent both in numbers and biomass. Thyata custator (Pentatomidae) was common May 15 and September 15-November 1. Pentatomidae nymphs were collected in large numbers May 15-June 1 and on September 15-October 15. Geocoris uliginosus (Lygaeidae, May 1-October 15), Nysius californicus (Lygaeidae, May 1-June 1), Adelphocoris rapidus (Miridae, with peaks in May 15 and September 15), and Psallus sp. (Miridae, May 15-October 15) were present in large numbers. Alydus pilosulus was one of the most common large species (Coreidae, May 1-November1); Alydus eurinus occurred at the same time but at lower densities. Predaceous Hemiptera included Zelus cervicalis (Reduviidae, June 15-October 1) with nymphs in August 1-October 15 and Sinea diadema (Reduviidae, May 15-November 1) with nymphs in May 1-15 and July 1-September 1.

HOMOPTERA were the most abundant primary consumers, but their total biomass was small. Cicadellidae included large numbers of Scaphytopius acutus, Acertogollia sanguinolenta, Gyponana sp., and Deltocephalus sonorus present all summer. Acanalona bivittata (July 15-October 15) and nymphs of Phyllloscelis sp. (June 15-August 15) were the commonest Fulgoridae. Membracidae were present all summer with Stictocephala diminuta and Vanduzes laeta occurring in largest numbers.

COLEOPTERA included large numbers of Maecolaspis flavida (Chrysomelidae, June 1-October 1) and Pantomorus godmani and Pantomorus taeniatulus (Curculionidae, common August 15-November 1) with P. taeniatulus being the most abundant, Bothrotes fortis (July 1-October 1) accounted for the large biomass of Tenebrionidae during this time. Chauliognathus marginatus, (Cantharidae)which occurred on flowers, was present August 1-September 1. Predaceous Coleoptera included Phyllobaenus pubescens (Cleridae) and Calleida fulgida (Carabidae) which were present all summer.

DIPTERA having an individual dry weight of one [milli-]gram or more were uncommon and were represented mainly by Asilus sp.(Asilidae, July 1-October 1), Phthiria unimaculata (Empididae, July 1-September 15), and Culex sp. (Culicidae, November 1 only).

HYMENOPTERA were represented by a large number of species containing only one or two individuals each. Epyris sp. (Bethylidae, June 1-September 15) and Spilochalcis flavopicta (Chalcidae, April-November 15) were common hymenopterous parasites. Ants (Formicidae) included very large numbers of Dorymyrmex pyramicus and Trachymyrmex septen-trionalis that occurred throughout the summer with Dorymyrmex being most common. Nectar feeders appeared in the field between July 1 and September 1. Megachile mendica (Megachilidae), Apis mellifera and Bombus fraternus (Apidae) constantly visited the flowers.

Larvae of LEPIDOPTERA and miscellaneous small adult moths were common throughout the summer, SPIDERS were also common throughout the summer and made up a large proportion of the total predators.

Fall. As the lespedeza leaves dried and dropped to the ground, the number of phytophagous insects declined from the summer level of about 6.7/m^2, to 4.6/m^2 on October 15 and to 3.7/m^2 on November 1. However, total biomass remained at the summer level (40 mg/m^2) due to continued dominance of large grasshoppers and

Hemiptera. In contrast, both numbers and biomass of predators declined in the fall. Melanoplus (four species, Acrididae), Thyanta custator (Pentatomidae), Alydus eurinus and A. pilosulus (Coreidae), Culex sp. (Culicidae), Pantomorus godmani and P. taeniatulus (Curculionidae), Gyponana sp. and Scaphytopius acutus (Cicadellidae) and Vanduzea leata (Membracidae) were the common forms at this time.

Frost occurred in the first half of November. On November 15 there were only 0.18 arthropods/m^2, composed primarily of Melanoplus sp. (Acrididae), Gyponana sp. (a large cicadellid), and a few predaceous spiders.

Species-area relationships

The total number of species of adult insects was low during the winter. The number of species increased throughout the spring, reaching a peak of about 125 species per 2500 sweep-strokes (an area of approximately 460m^2) during the summer. Numbers decreased to winter levels between the 1st and 15th of November. Herbivores made up about 80 per cent of the total species and were primarily responsible for the trend observed for all species. Species of sucking herbivores (mainly Hemiptera and Homoptera), chewing herbivores (Orthoptera and Coleoptera), and nectivores (mainly Diptera and Hymenoptera) increased during the spring. Sucking herbivores continued to increase during the summer, but nectivores decreased during the period; chewing herbivores decreased after September. The number of carnivorous species increased after May 15 and between 10-18/460m^2 during the summer. Between three and seven species of omnivores/460m^2 were present at this time.

The number of species in weight classes was also examined. Species weighing 1-9 mg dry weight/individual numbered around 80 species/460 m^2 during the summer. Those weighing 10-500 mg/individual gradually declined from a peak of 39/460m^2

> in June to $22/460m^2$ in November after which they dropped sharply. Not all species in the 0.40-0 9 mg/individual weight class were identified (Microhymenoptera and Microdiptera were the main exceptions); and, hence, this weight class was not comparable to the higher weight classes. The few species considered in this group remained at about $12/460\ m^2$ throughout the summer. Weight classes of herbivores considered separately showed the same general trends as did weight classes of all trophic groups considered together. Other trophic groups were not numerous enough to permit comparison to weight classes.

More important than a detailed analysis of the insect community is the occurrence of possible insect pest species on the site. A preliminary survey of the plant site was made for insect pest species and no high levels of incidence were noticed. The most important pest species that are likely to be present in the area are discussed below:

1) Southern Pine Bettle (Dendroctonus frontalis): This is the most important insect pest of southern pine trees. The range of this pest has remained fairly stable since the late 1800's and includes the VNP site. The insect bores under the bark of trees and girdles trees of various sizes so that millions of dollars of green timber may be killed. Population buildups often are violent and hard to predict. Not many pine beetles would be found on the site due to the low density of pine trees.

2) Ips Engraver Beetle (Ips spp.): This beetle is not as spectacular as the pine beetle, but is always present in pine trees and may do considerable damage. The beetle attacks weakened trees and each year activity increases with the advent of hot, dry weather in summer and fall.

3) Black Turpentine Beetle (Dendroctonus terebrans): This is a serious and persistent pest capable of killing the best trees in a pine stand. It is especially abundant after disturbances such as heavy cutting, particularly following logging in wet weather on low, poorly drained areas.

4) Eastern Tent Caterpillar (Malacosoma americana): These caterpillars build tents composed of layers of silky web in various kinds of deciduous trees. Wild cherry trees are the favorite hosts. Large number of caterpillars inhabit the tent, eat leaves of the trees, and thus weaken but seldom kill, the tree.

Other insect pests of southern pine trees are discussed in Bennett and Ostmark (5).

2.7.3 AMPHIBIANS AND REPTILES

Amphibians and reptiles of the area are listed in Table 2.7-18.(6) Relative abundance based on two years of fairly extensive pitfall trapping at SRP is indicated for each species. Species are ranked in order of decreasing abundance as follows: Most common, very common, common, fairly common, uncommon, rare. Animals ranking in the first three categories are included in the discussion of habitat and feeding habits. Table 2.7-19 provides additional information on the relative abundance of the reptiles of SRP; (7) this information is based on a study conducted during June-October, 1965. The data was collected by road censusing and trapping. Table 2.7-20 provides information on the relative abundance of 16 species of frogs captured in pitfall traps on SRP. (8) Trapping was conducted around the permanent pond from January 3, 1969, to December 31, 1970; trapping around the temporary pond was from June 23, 1969, to December 31, 1970.

Habitat and feeding preferences of the more common species of amphibians and reptiles are discussed in the following paragraphs. Information is summarized primarily from Conant (9) and Zim and Smith (10).

Marbled Salamander

Habitat Preference - Occurs in variety of habitats, ranging from moist sandy areas to dry hillsides. Burrower.

Feeding Habits - Will eat earthworms and other invertebrates.

Red-Spotted Newt

Habitat Preference - Aquatic state - ponds, small lakes marshes, ditches, quiet portions of streams, and other shallow permanent or semipermanent bodies of water. Adults - open water or crawling on bottom or through vegetation. Often remain active all winter and may be observed through ice. Terrestrial efts, although avoiding direct sunlight, often walk about in open on forest floor in broad daylight. After summer showers in mountainous regions, sometimes seen by scores or 100's.

Feeding Habits - Includes insects, leeches, worms, tiny mollusks and crustaceans, young amphibians, and frog's eggs.

Mole Salamander

Habitat Preference - Burrower, but occasionally found under logs or other objects in damp places.
Feeding Habits - Will eat earthworms and other invertebrates.

Dusky Salamander

Habitat Preference - Occur in brooks, near springs and in seepage areas. Most common along edges of small woodland streams where stones, pieces of wood and miscellaneous debris provide shelter and food. Seldom wanders far from water.
Feeding Habits - Earthworms, small slugs, isopods, soft bodied insect larvae, etc.

Slimy Salamander

Habitat Preference - Moist wooded ravines or hillsides are favorite habitats.
Feeding Habits - Feed on large variety of invertebrates, such as earthworms and many kinds of insects.

Dwarf Salamander

Habitat Preference - Low swampy areas, where it hides under all types of shelter.
Feeding Habits - Probably insects.

Eastern Spadefoot Toad

Habitat Preference - Species of the forested East and Southeast, usually found in areas characterized by sandy or other loose soil.
Feeding Habits - Insects and worms.

Spring Peeper

Habitat Preference - Woodlands, being especially abundant in areas of brushy second growth or cutover woodlots if these are near small, temporary or semipermanent ponds or swamps. Seldom seen except in breeding season, but do occasionally prowl thru woods by day in damp or rainy weather.
Feeding Habits - Chiefly insects.

Southern Toad

Habitat Preference - Common toad of South and particularly abundant in sandy areas. Becomes active at twilight, foraging well into night. Daylight hours are spent chiefly in hiding, often in burrows of the toad's own making.

Feeding Habits - Chiefly insects.

Green Treefrog

Habitat Preference - Swamps, borders of lakes and streams, floating vegetation, or almost any place well supplied with water or dampness.

Feeding Habits - Chiefly insects.

Barking Treefrog

Habitat Preference - High climber and burrower, but also uses other habitats between these 2 extremes. In hot, dry weather often takes shelter in sand or soil beneath roots or clumps of grass or other vegetation.

Feeding Habits - Chiefly insects.

Squirrel Treefrog

Habitat Preference - Found in gardens, weed or brush tangles, woods, trees - almost anywhere close to moisture, food and a hiding place.

Feeding Habits - Includes insects.

Chorus Frog

Habitat Preference - Habitats include pine flatwoods, wet meadows, roadside ditches, moist woodland, etc.

Feeding Habits - Chiefly insectivorous

Eastern Narrow-Mouthed Toad

Habitat Preference - Wide variety of habitats, but all have 2 things in common - shelter and moisture. Borders of swamps and small streams. Under boards, logs, etc. in vegetable debris, abandoned sawdust piles, etc.
Feeding Habits - Chiefly insects such as small beetles, termites and especially ants.

Bullfrog

Habitat Preference - Aquatic and preferring larger bodies of water than most other frogs - lakes, ponds, bogs, sluggish portions of streams, cattle tanks, etc; usually seen at water's edge or amidst vegetation or snags in or under which it can hide. Small streams are used where better habitats are lacking.
Feeding Habits - Includes insects mainly - also small birds and turtles, small frogs.

Oak Toad

Habitat Preference - Abundant in southern pine woods. Hides under all manner of objects, but is much more active by day than other toads.
Feeding Habits - Chiefly insects.

Cricket Frog

Habitat Preference - Chiefly lowlands, coastal plain bogs and ponds and river-bottom swamps. Follows river valleys northward into most upland regions.
Feeding Habits - Chiefly insects.

Green Frog

Habitat Preference - Abundant - found chiefly wherever there is shallow water - in springs, rills, creeks and ditches and along edges of ponds and lakes. In many regions, however, it is characteristically a frog of brooks and small streams.
Feeding Habits - Chiefly insects.

Leopard Frog

Habitat Preference - In all types of shallow fresh-water habitats and even entering slightly brackish marshes along coast. Ventures well away from water in summer, when weeds and vegetation provide shelter and shade.
Feeding Habits - Chiefly insects.

Snapping Turtle

Habitat Preference - Fresh water habitat - any permanent body of fresh water, large or small, is a potential home; even enters brackish waters.
Feeding Habits - Omnivorous - food includes various small aquatic invertebrates, fishes, reptiles, birds, mammals, carrion, and vegetation.

Stinkpot

Habitat Preference - Very abundant in many bodies of water, but not often observed except in shallow, clear-water lakes, ponds, and rivers. Bottom-crawlers. Still water preferred. Slanting boles of relatively slender trees are occasionally ascended by several species of turtles in wooded swamps, along watercourses, or at edges of marshes, where horizontal basking places are at at premium.
Feeding Habits - Turtles eat insects, worms, grubs, shellfish, fish and some plants. Some largely herbivorous.

Eastern Mud Turtle

Habitat Preference - Essentially an aquatic reptile, but wanders away from water more often than Stinkpot. Shallow water preferred ditches, wet meadows, small ponds, marshes, etc. Has a strong tolerance for brackish water, and is often abundant at inner edges of tidal marshes and on many offshore islands.
Feeding Habits - Larvae of water insects and small water animals.

Eastern Box Turtle

Habitat Preference - Although essentially terrestrial, these turtles sometimes soak themselves by the hour (or day) in mud or water. During hot, dry weather, they burrow beneath logs or rotting vegetation, but sharp summer showers usually bring them out of hiding, often in numbers.

Feeding Habits - Box turtles are omnivorous, and are fond of fruits, berries, etc.

Pond Slider

Habitat Preference - One of the most abundant groups in ponds, rivers and streams of Southeast.

Feeding Habits - Largely vegetarian, also will eat raw meat, fish shellfish, worms, insects, etc.

Chicken Turtle

Habitat Preference - An inhabitant of still water - ponds, marshes, sloughs, and ditches. Frequently walks on land

Feeding Habits - See Pond Slider

Fence Lizard

Habitat Preference - Often seen on rail fences or on rotting logs or stumps. Often called "pine lizard" because of its frequent occurence in open pine woods. Aboreal tendencies.

Feeding Habits - Chiefly insectivorous, but also eat spiders and other arthropods, and even smaller lizards, baby mice, etc.

Six-lined Racerunner

Habitat Preference - Open and well-drained areas are preferred-those covered with sand or loose soil; fields, open woods, thicket margins, rocky outcrops.

Feeding Habits - Feed on insects, worms,snails.

Brown Water Snake

Habitat Preference - A species chiefly of quiet waters, and a characteristic resident of the great swamps and rivers of the South. Accomplished swimmer and climber, ascending trees to heights of 20 ft. or more.

Feeding Habits - Includes frogs, salamanders, fish and crayfish, in or near water.

Red-bellied water snake

Habitat Preference - Great river swamps and numerous other aquatic habitats of the Southeast. Often wanders well away from water in hot, humid weather.

Feeding Habits (see Brown Water Snake)

Banded Water Snake

Habitat Preference - Occupies virtually all types of freshwater habitats, and also occurs on many offshore, coastal islands.

Feeding Habits - (see Brown Water Snake)

Brown Snake

Habitat Preference - Resident of bogs and marshes, of river-bottom swamp, and environs of ponds and sloughs, but also occurring in upland hammocks and pineland.

Feeding Habits - Includes slugs, earthworms and soft bodied insects.

Eastern Hognose Snake

Habitat Preference - Sandy areas are favorite habitat.

Feeding Habits - Toads are principal food - Frogs and tadpoles and some insects also eaten.

Black Racer

Habitat Preference - Thickets near open fields, trees.
Feeding Habits - Rodents, small birds, lizards, snakes, frogs and insects.

Rat Snake

Habitat Preference - Black rat snake (E. obsoleta obsoleta) - occurs at sea level and to considerable altitudes in parts of Appalachian mountain chain. Habitats range from rocky, timbered hillsides to flat farmlands of the Coastal Plain. Excellent climber, sometimes establishing residence in cavities high up in hollow trees.
Feeding Habits - Rodents, small birds, and lizards.

Cottonmouth

Habitat Preference - Southern lowlands, swamps, lakes and rivers, rice fields and ditches. Suns itself on branches, logs, or stones at water's edge and sometimes wanders away from normal habitat in search of food.
Feeding Habits - Includes fish, frogs, salamanders, snakes, lizards, small turtles, baby alligators, birds and small mammals.

Canebrake Rattlesnake

Habitat Preference - Cane thickets and swamplands of South.
Feeding Habits - Includes mice, lizards, snakes and frogs.

American Alligators (Alligator mississippiensis) have been sited on the Savannah River by GPC personnel and alligator tracks have been observed by GPC biologists on the shore of Mallard's Pond. The alligator is considered an endangered species.(18) Mallard's pond and adjacent land will be protected during the construction of VNP.

Table 2.7-18

AMPHIBIANS AND REPTILES OF THE AREA(6)

Common Name	Scientific Name	Relative Abundance
Salamanders		
Mole Salamander	*Ambystoma talpoideum*	very common
Marbled Salamander	*Ambystoma opacum*	common
Spotted Salamander	*Ambystoma maculatum*	uncommon
Tiger Salamander	*Ambystoma tigrinum*	uncommon
Red-spotted Newt	*Notopthalmus viridescens*	very common
Dusky Salamander	*Desmognathus fuscus*	very common
Slimy Salamander	*Plethodon glutinosus*	very common
Eastern Mud Salamander	*Pseudotriton montanus*	uncommon
Red Salamander	*Pseudotriton ruber*	uncommon
Two-lined Salamander	*Eurycea bislineata*	uncommon
Long-tailed Salamander	*Eurycea longicauda*	uncommon
Dwarf Salamander	*Manculus quadridigitatus*	very common
Toads and Frogs		
Eastern Spadefoot Toad	*Scaphiopus holbrooki*	common
Southern Toad	*Bufo terrestris*	most common
Oak Toad	*Bufo quercicus*	common
Cricket Frog	*Acris gryllus*	very common
Spring Peeper	*Hyla crucifer*	common
Green Treefrog	*Hyla cinerea*	very common
Barking Treefrog	*Hyla gratiosa*	common

Table 2.7-18 (Cont.)

Common Name	Scientific Name	Relative Abundance
Pine Woods Treefrog	Hyla femoralis	uncommon
Squirrel Treefrog	Hyla squirella	common
Chorus Frog	Pseudacris nigrita	common
Ornate Chorus Frog	Pseudacris ornata	fairly common
Eastern Narrow-mouthed Toad	Gastrophryne carolinensis	very common
Bullfrog	Rana catesbeiana	common
Green Frog	Rana clamitans	common
Leopard Frog	Rana pipiens	common
Pickerel Frog	Rana palustris	rare
Gopher Frog	Rana areolata	uncommon
Turtles		
Snapping Turtle	Chelydra serpentina	very common
Stinkpot	Sternothaerus odoratus	very common
Eastern Mud Turtle	Kinosternon subrubrum	very common
Eastern Box Turtle	Terrapene carolina	common
Pond Slider	Pseudemys scripta	most common
Cooter	Pseudemys floridana	uncommon
Chicken Turtle	Deirochelys reticularia	common
Spotted Turtle	Clemmys guttata	rare
Lizards		
Green Anole	Anolis carolinensis	fairly common
Fenoe Lizard	Sceloporus undulatus	common

Table 2.7-18 (Cont.)

Common Name	Scientific Name	Relative Abundance
Six-lined Racerunner	*Cnemidophorus sexlineatus*	common
Ground Skink	*Lygosoma laterale*	fairly common
Five-lined Skink	*Eumeces fasciatus*	fairly common
Broad-headed Skink	*Eumeces laticeps*	fairly common
Eastern Glass Lizard	*Ophisaurus ventralis*	uncommon
Slender Glass Lizard	*Ophisaurus attenduatus*	uncommon
Snakes		
Brown Water Snake	*Natrix taxispilota*	very common
Red-bellied Water Snake	*Natrix erythrogaster*	common
Banded Water Snake	*Natrix sipedon*	common
Glossy Water Snake	*Natrix rigida*	rare
Black Swamp Snake	*Seminatrix pygaea*	rare
Brown Snake	*Storeria dekayi*	common
Red-bellied Snake	*Storeria occipitomaculata*	fairly common
Eastern Hognose Snake	*Heterodon platyrhinos*	common
Southern Hognose Snake	*Heterodon simus*	uncommon
Mud Snake	*Farancia abacura*	rare
Rainbow Snake	*Abastor erythrogrammus*	rare
Black Racer	*Coluber constrictor*	most common
Corn Snake	*Elaphe guttata*	fairly common
Eastern Kingsnake	*Lampropeltis getulus*	fairly common
Rat Snake	*Elaphe obsoleta*	common
Scarlet Snake	*Cemophora coccinea*	fairly common

Table 2.7-18 (Cont.)

Common Name	Scientific Name	Relative Abundance
Southeastern Crown Snake	Tantilla coronata	rare
Copperhead	Ancistrodon contortrix	uncommon
Cottonmouth	Ancistrodon piscivorous	common
Canebrake Rattlesnake	Crotalus horridus	common
Pigmy Rattlesnake	Sistrurus miliarius	rare
Eastern Garter Snake	Thamnophis sirtalis	uncommon
American Alligator	Alligator mississipiensis	uncommon

Table 2.7-19

NUMBER OF REPTILES COLLECTED ON THE SRP BY ROAD CENSUSING AND TRAPPING BETWEEN JUNE 19 AND OCTOBER 15, 1965.(7)

Common Name	Number Collected
Turtles	
Common snapping turtle	10
Stinkpot	14
Eastern mud turtle	45
Striped mud turtle	4
Spotted turtle	1
Eastern box turtle	36
Florida cooter	9
Yellow-bellied turtle	119
Chicken turtle	46
Lizards	
Carolina anole	43
Northern fence lizard	56
Eastern slender glass lizard	9

Table 2.7-19 (Cont.)

Common Name	Number Collected
Eastern glass lizard	4
Six-lined racerunner	68
Ground skink	54
Five-lived skink and broad-headed skink	17
Southeastern five-lived skink	6
Snakes	
Florida green water snake	8
Red-bellied water snake	13
Banded water snake	46
Brown water snake	10
Midland brown snake	12
Red-bellied snake	14
Eastern ribbon snake	8
Eastern garter snake	15
Eastern earth snake	4
Eastern hognose snake	49

Table 2.7-19 (Cont.)

Common Name	Number Collected
Southern ringneck snake	1
Eastern mud snake	5
Northern black racer	216
Eastern coachwhip	83
Eastern rough green snake	21
Corn snake	48
Black rat snake	16
Northern pine snake	36
Eastern king snake	29
Scarlet kingsnake	4
Scarlet snake	40
Southeastern crowned snake	13
Eastern coral snake	1
Southern copperhead	32
Eastern cottonmouth	33

Table 2.7-19 (cont.)

Common Name	Number Collected
Carolina pygmy rattlesnake	4
Canebrake rattlesnake	92
American alligator	11

Table 2.7-20

RELATIVE ABUNDANCE (AS PERCENT OF TOTAL) OF 16 SPECIES OF FROGS CAPTURED IN PITFALL TRAPS AROUND PERMANENT AND TEMPORARY AQUATIC HABITATS IN SOUTH CAROLINA, U.S.A.(8)

	RELATIVE ABUNDANCE (%)	
SPECIES	Permanent	Temporary
Rana pipiens	46.2	7.6
R. clamitans	15.6	0.2
R. catesbeiana	4.5	0.9
R. areolata	0.2	1.6
R. palustris	0.4	0
Bufo terrestris	18.0	40.0
B. quercicus	-	1.5
Scaphiopus holbrooki	1.6	34.2
Gastrophryne carolinensis	1.5	6.0
Acris gryllus	9.7	1.2
Pseudacris nigrita	1.2	1.9
P. ornata	0.4	0.9
Hyla crucifer	0.6	1.3
H. gratiosa	0.1	0.1
H. cinerea	0.1	0.1
H. squirella	-	2.5

2.7.4 BIRDS

Several sources of information on birds of the area are available. National Audubon Society Christmas Bird Counts are made at Augusta, Georgia (11), and Aiken, South Carolina (12). These counts provide a species list and the number of individuals of each species observed during the count period in December. Norris (13) conducted an intensive survey of the birdlife of the SRP area in 1955-1958. This report provides a species list of the 213 bird species of the SRP area, limited information on breeding and habitat preference, the resident status of the species and comments on the relative abundance of the species. Norris (14) also reported the results of 2 breeding bird censuses taken in the SRP area in 1957; one census was taken in the floodplain of Upper Three Runs Creek, and the other was taken in 3 "Carolina Bays" (shallow depressions normally containing water). Hamilton (15) published an account on the birds of Screven County, Georgia. These studies do not present quantitative data on the birds of the area, but the information in the reports is quite useful.

Table 2.7-21 lists the common birds of the area. This table includes 100 of the 213 bird species listed by Norris (13) and the resident status of each species. Species that probably breed in the area can be determined from the resident status; permanent residents and summer residents usually breed in the area. No rare or endangered species are included in this table (see below for more complete discussion of rare and endangered species).

Table 2.7-22 is the 1971 Audubon Christmas Count taken at Augusta, Georgia (11), and Table 2.7-23 is the count taken at Aiken, South Carolina (12). These two counts give a good indication of the relative abundance of the permanent and winter resident birds of the area.

In the following paragraphs, information regarding the more common bird species of the area is summarized. Information that is summarized includes habitat preference, relative abundance in the area, resident status, predominant food of each species and nesting habits. This summary was prepared from several different sources including Norris (13), Hamilton (15), Peterson (16), and Zim and Gabrielson (17).

Pied-billed Grebe

Habitat Preference - Ponds, creeks and marshes
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Crustaceans, small fishes, insects
Nesting habits - In shallow water; floating among vegetation in quiet water (lakes and ponds)

Great Blue Heron

Habitat Preference - Ponds, Carolina bays, streams
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Fish, crustaceans, frogs and mice
Nesting habits - High in trees or cliffs near water

Mallard

Habitat Preference - Wooded swamps, marshes, along freshwater
Relative Abundance - Common in colder months
Resident Status - Winter visitor
Food - Pondweeds, aquatic insects, mollusks
Nesting habits - near water, on ground among high grass

Black Duck

Habitat Preference - Ponds, bays
Relative Abundance - Fairly common as autumnal visitor
Resident Status - Winter visitor
Food - Pondweeds, aquatic insects, mollusks
Nesting habits - Nest usually on ground in grass or brush; often far from water

Wood Duck

Habitat Preference - Forested bottomlands and woodland streams
Relative Abundance - Common
Resident Status - Permanent resident
Food - Wildrice, pondweeds, acorns, seeds, fruits, some insects.
Nesting habits - Nests up to 60 ft. above ground; in a hole in tree or stump. Breeds in wooded swamp and rivers.

Ring-necked Duck

Habitat Preference - Wooded lakes, also rivers, ponds, bays, settling basins.
Relative Abundance - Fairly common
Resident Status - Winter visitor
Food - Seeds, stems and roots of aquatic plants; some minnows, small frogs, snails and insects.
Nesting habits - Breed in marshes

Turkey Vulture

Habitat Preference - Sky
Relative Abundance - Common
Resident Status - Permanent resident
Food - Carrion
Nesting habits - Nests on ground, rock ledges, or hollow logs in secluded places, near water or in woods.

Black Vulture

Habitat Preference - Sky
Relative Abundance - Very common
Resident Status - Permanent resident
Food - Carrion
Nesting habits - Nests on the ground, placing their eggs under rocks, in crevices, or under and in the trunks of fallen logs.

Cooper's Hawk

Habitat Preference - Wooded areas
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Mainly wild birds and poultry, some mammals, other vertebrates and insects.
Nesting habits - Nests usually in trees (pine preferred) 25-65 Ft. high. Rarely on ground.

Red-tailed Hawk

Habitat Preference - Woodlands, pastures, swamps
Relatiave Abundance - Fairly common
Resident Status - Permanent resident
Food - Mainly rodents, some reptiles and poultry.
Nesting habits - Nests in tall trees, 20-80 ft. up; in forest areas or in small groves. Breed in dry woodlands.

Red-shouldered Hawk

Habitat Preference - River swamp and in certain flood plain forest areas.
Relative Abundance - Common
Resident Status - Permanent resident
Food - Small mammals, birds, snakes, frogs, fish, insects, crawfish, snails
Nesting habits - Breeds in moist woodlands and river timber

Marsh Hawk

Habitat Preference - Old fields
Relative Abundance - Common
Resident Status - Winter visitor
Food- Primarily rodents, other small mammals
Nesting habits - Breed in meadows and bushy marshes

Sparrow Hawk

Habitat Preference - Open fields
Relative Abundance - Fairly common - summer; very common winter
Resident Status - Permanent resident
Food - Largely insects, some rodents, lizards, and small birds
Nesting habits - Nests in cavities of trees, cliff embankments, 7-80 ft. up; often in farms or orchards.

Bobwhite

Habitat Preference - Farming country
Relative Abundance - Common
Resident Status - Permanent resident
Food - Corn and grain, ragweed, lespedeza, acorns and weed seeds.
Nesting habits - Nests on ground in grass tangles, open fields, hedgerows

American Coot

Habitat Preference - Lakes, bays and open waters
Relative Abundance - Fairly common
Resident Status - Winter resident
Food - Occasionally eat small birds; primarily eat vegetable matter and aquatic invertebrates
Nesting habits - Generally build nests of floating vegetation in flooded fresh water reed beds. Breed in marshes.

Common Snipe

Habitat Preference - Marshes, bogs, moist areas of old fields
Relative Abundance - Fairly common
Resident Status - Winter resident
Food - Mostly small invertebrates, mainly insects
Nesting habits - in brush or grass on raised areas in the marsh

Ring-billed Gull

Habitat Preference - Primarily inland lakes
Relative Abundance - Common
Resident Status - Winter resident
Food - Carrion, garbage, occasionally fish
Nesting habits - on the ground at the upper edge of beeches

Mourning Dove

Habitat Preference - Fields
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Wheat, corn, grass, and weed seeds
Nesting habits - Nests in trees (pines preferred) 2-45 ft. above ground, in uplands, sometimes in wet lowlands. Breeds in fields, oak forests, and pine-scrub oaks in sandy barrens

Barred Owl

Habitat Preference - Flood plain timber and other swamp-forest situations
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Small mammals, birds, reptiles, amphibians, fishes, insects
Nesting habits - White pine wood, mixed woods - hollow cavities in trees or old nests

Belted Kingfisher

Habitat Preference - Ponds, larger streams
Relative Abundance - Common
Resident Status - Permanent resident
Food- Mainly fish, some crustaceans and frogs
Nesting habits - Nests at end of burrows in banks or bluffs, usually not more than 10 ft. up, usually near water.

Yellow-shafted Flicker

Habitat Preference - Primarily densely timbered hammock or swamp-forest areas.
Relative Abundance - Fairly common- Breeding season; common to abundant - winter
Resident Status - Permanent resident
Food - Ants, beetles, and other insects; wild fruits and seds
Nesting habits - Nests in cavity 10-24 in. deep in trees, snags, poles, 6 in. - 60 ft. high.

Pileated Woodpecker

Habitat Preference - Hammocks, floodplain forests and river swamp areas.
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Beetles and other insects
Nesting habits - Drilled holes in dead limbs and trunks

Red-headed Woodpecker

Habitat Preference - open country, often in town
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Beetles, ants and other insects; acorns, other wild fruits and seeds
Nesting habits - Excavations in trees, posts, poles 5-80 ft. up.

Red-bellied Woodpecker

Habitat Preference - Hammocks, floodplain forest, and river swamp areas
Relative Abundance - Common
Resident Status - Permanent resident
Food - Beetles and other insects
Nesting habits - Drilled holes in dead limbs and trunks

Yellow-bellied Sapsucker

Habitat Preference - Broadleaf or mixed forest areas, including swamps
Relative Abundance - Fairly common
Resident Status - Winter visitor
Food - Ants, beetles, other insects and their eggs; wood and sap; wild fruit
Nesting habits - Nest in cavity in dead or live tree, 8-40 ft. up, in woods or orchards.

Downy Woodpecker

Habitat Preference - Broadleaf and mixed forests
Relative Abundance - Common
Resident Status - Permanent resident
Food- Ants, and boring insects, spiders, and snails; some fruit and seeds.
Nesting habits - Nests in dead limb. 5-50 ft. up in woodlands and orchards.

Blue Jay

Habitat Preference - Variety of wooded habitats (including old house sites, woodlots and pine-scrub oak areas)
Relative Abundance - Common
Resident Status - Permanent resident
Food - Acorns, beechnuts, corn and other grain; some insects, insect eggs, and young birds
Nesting habits - Nests in a fork of tree, 5-50 ft. up. Prefers evergreen forests, but often in suburbs, farms and villages.

Common Crow

Habitat Preference - Pine forests, open mixed woodlands
Relative Abundance - Abundant
Resident Status - Permanent resident
Food - Corn and other grains, weed seeds, wild fruits; grasshoppers and other insects.
Nesting habits - Nests in trees (preferably pine woods), height 10-70 ft.

Carolina Chickadee

Habitat Preference - Relatively open wooded areas, including edge situations
Relative Abundance - Common
Resident Status - Permanent resident
Food - Moths, caterpillars and other insects, seeds and berries
Nesting habits - fence posts and decayed stumps of small saplings.

Tufted Titmouse

Habitat Preference - Open woods (such as oak forest and other broadleaf or mixed growth in upland areas) dense swamp-forest areas.
Relative Abundance - Common
Resident Status - Permanent resident
Food - Ants, bugs and other insects; some seeds and fruits
Nesting habits - Nest in deserted woodpeckers holes or stumps 2-85 ft. up.

Brown-headed Nuthatch

Habitat Preference - Open pine woods, pine-broadleaf areas
Relative Abundance - Common
Resident Status - Permanent resident
Food - Insects, pine seeds
Nesting habits - cavities in fence posts, etc.

Carolina Wren

Habitat Preference - Tangles and brushy undergrowth
Relative Abundance - Common
Resident Status - Permanent resident
Food - Insects, seeds, some small vertebrates
Nesting habits - Build retort-shaped nests often with long, flasklike entrance tunnels entering through the sides. Use cavities in broken and dead trees, old woodpecker holes and crevices in cliffs and buildings

Mockingbird

Habitat Preference - Towns, rural country, edges.
Relative Abundance - Abundant
Resident Status - Permanent resident
Food - Beetles, grasshoppers, other insects, some wild fruits in season, grape and holly preferred.
Nesting habits - Nests in shrubs, thickets, vines, near houses; 1 -15 ft. up, rarely higher

Catbird

Habitat Preference - Thickets
Relative Abundance - Common-spring
Resident Status - Winter visitor
Food - Beetles, grasshoppers, other insects; some wild fruit in season
Nesting habits - Nests in shubbery, thickets, 1-10 ft. up, rarely 25 ft. high. Prefers dense lowlands.

Brown Thrasher

Habitat Preference - House sites, thickets, edge habitats
Relative Abundance - Common
Resident Status - Permanent resident
Food - Beetles, grasshoppers, caterpillars, etc. Also some acorns and wild fruit
Nesting habits - Nests in bushes, vines, brush, and low trees. Height 0-12 ft.

Robin

Habitat Preference - Woods, open country, towns
Relative Abundance - Fairly common
Resident Status - Winter visitor
Food - Garden and field insects, worms; cultivated and wild fruits
Nesting habits - Nests in tree crotch or among branches, 5-70 ft. up; in woods, open country, on buildings in rural areas.

Hermit Thrush

Habitat Preference - Broadleaf and mixed woods, hammocks, floodplain forests.
Relative Abundance - Fairly common
Resident Status - Winter visitor
Food - Beetles, ants, caterpillars, other insects; some wild fruits and weed seeds.
Nesting habits - Nests on or near ground in pine or hemlock woods

Eastern Bluebird

Habitat Preference - Open woodland
Relative Abundance - Abundant
Resident Status - Permanent resident
Food - Chiefly insectivores, but may eat fruit
Nesting habits - Breeds in semi-open country; nests in cavities

Blue-gray Gnatcatcher

Habitat Preference - Hammocks, floodplain forests, other moist sites with broadleaf trees; also drier habitats such as scrub oak and pine scrub oak
Relative Abundance - Common to abundant
Resident Status - Summer resident
Food - Mainly small insects - beetles, flies, caterpillars, moths
Nesting habits - Nests on a branch or in a crotch in tree near water. Height 10-70 ft.

Golden-crowned Kinglet

Habitat Preference - Broadleaf and mixed forests
Relative Abundance - Common
Resident Status - Winter resident
Food - Insects - flies, beetles, plant lice, insect eggs
Nesting habits - Nest in coniferous trees, partly suspended from twigs, 4-60 ft. up.

Water Pipit

Habitat Preference - Nearly cosmopolitan birds of wet meadows and grasslands
Relative Abundance - Common
Resident status - Winter visitor
Food - Insectivores
Nesting habits - Breed in Arctic

Loggerhead Strike

Habitat Preference - Relatively open country
Relative Abundance - Common
Resident Status - Permanent resident
Food - Insects; grasshoppers, beetles; some small rodents and birds
Nesting habits - Nests in thorny hedges or low trees

White-eyed Vireo

Habitat Preference - Shrubbery and undergrowth of moist broadleaf forests
Relative Abundance - Common
Resident Status - Summer resident
Food - Mostly insects and their larvae; small amounts of berries
Nesting habits - Nests deep and intricately constructed cups, slung from their rims between horizontal forks, 3-90 ft. up; in forests or forest edges, or even in ornamental trees in city

Myrtle Warbler

Habitat Preference - Woods, brush
Relative Abundance - Fairly common
Resident Status - Winter visitor
Food - Mainly common insects, but takes poison ivy, bayberry and other fruits in winter
Nesting habits - Coniferous trees in heavy woods, 5-40 ft. high

Pine Warbler

Habitat Preference - Pinelands
Relative Abundance - Common
Resident Status - Permanent resident
Food - Mainly insectivores
Nesting habits - Customary nest is an open cup in a tree or bush - may be in a crotch or suspended at the rim in a horizontal fork.

Palm Warbler

Habitat Preference - Edge habitats and relatively open country
Relative Abundance - Common
Resident Status - Winter resident
Food - Mainly insectivores
Nesting habits - Same as Pine Warbler. Breeds in spruce and tamarack bogs

Yellowthroat

Habitat Preference - Low vegetation in swamps, stream-beds, marshes, and clearings
Relative Abundance - Common
Resident Status - Permanent resident
Food - Insects; cankerworms, weevils, leafhoppers, caterpillars, etc.
Nesting habits - Nests on or near ground, usually in clumps of grass, in moist location

House Sparrow

Habitat Preference - About cities, towns, and farms
Relative Abundance - Common
Resident Status - Permanent resident
Food - Corn, oats, wheat and other grain; weed seeds; some insects during spring and summer
Nesting habits - Nest in any available place; in buildings, structures, eaves; over 5 ft. high

Eastern Meadowlark

Habitat Preference - Open fields
Relative Abundance - Common
Resident Status - Permanent resident
Food - Insects in summer, seeds in winter
Nesting habits - Nests on ground under a dome of grass; breeds in meadows and prairies.

Red-winged Blackbird

Habitat Preference - Fields, marshes, swampy spots
Relative Abundance - Very common
Resident Status - Permanent resident
Food - Weed and marsh plant seeds, grain; some fruit and insects in season
Nesting habits - Nests attached to low bushes, reeds, usually in swamps, usually less than 15 ft. high

Common Grackle

Habitat Preference - Woods, swamps, fields
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Grain and weed seeds; some wild fruit; beetles, grasshoppers, crickets, etc.
Nesting habits - Nests in colonies, most often in coniferous trees; sometimes in bushes. Height 5-80 ft.

Cardinal

Habitat Preference - Numerous habitats including edge growth and moist hammocks, about old house sites, in sandy oak barrens
Relative Abundance - Abundant
Resident Status - Permanent resident
Food - Grape, holly, blackberry; wild seeds and many kinds of insects
Nesting habits - Nests in thick bushes or vines, 2-10 ft. high, rarely up to 30 ft.

American Goldfinch

Habitat Preference - treetops in woods or open country or town
Relative Abundance - Abundant in winter
Resident Status - Permanent resident
Food - Mainly weed seeds, grain and wild fruit; occasionally plant lice and caterpillars
Nesting habits - Nests in trees or bushes, 5-35 ft. high

Rufous-sided Towhee

Habitat Preference - Shrubby edge vegetation and pine-oak forests, other habitats
Relative Abundance - Common
Resident Status - Permanent resident
Food - Wild fruits and weed seeds; insects, worms and spiders
Nesting habits - Nests usually on ground, sometimes in bushes or saplings, 0-10 ft. high; open brushy places, barren slashes and edges.

Savannah Sparrow

Habitat Preference - Fields, meadows, prairies
Relative Abundance - Abundant in winter
Resident Status - Winter resident
Food - Seeds, insects
Nesting habits - Breeds in meadows and prairies

Vesper Sparrow

Habitat Preference - Fields, meadows, prairies
Relative Abundance - Common
Resident Status - Winter visitor
Food - Weed seeds of many kinds; some grain; various insects
Nesting habits - Nests on ground in dry upland fields, meadows and prairies, along dry roadsides

Slate-colored Junco

Habitat Preference - Oak-pine areas
Relative Abundance - Common
Resident Status - Winter visitor
Food - Ragweed, crabgrass and other weed seeds; some caterpillars, and other insects
Nesting habits - Nests on or very near ground in fallen trees, logs, upturned roots; under overhanging banks, along wood roads, in coniferous country

Chipping Sparrow

Habitat Preference - Fields and field edges
Relative Abundance - Fairly common; numbers increase in winter
Resident Status - Permanent resident
Food - Weed seeds, oats, and timothy; leafhoppers and other common insects
Nesting habits - Nests in trees and bushes; in shrubbery near houses, height 3-35 ft; rarely on ground

Field Sparrow

Habitat Preference - Fields, overgrown pastures
Relative Abundance - Fairly common
Resident Status - Permanent resident
Food - Largely weeds seeds, crabgrass, pigweed, sedge, etc., some insects
Nesting habits - Nests on ground or low bushes, 10 ft. up or less; in fields, overgrown pastures

White-throated Sparrow

Habitat Preference - Shrub and cane-grown areas in moist, more or less forested tracts, including hammocks and floodplain forests
Relative Abundance - Abundant
Resident Status - Winter visitor
Food - Ragweed, pigweed, knotweed, other weed seeds; some grain and many kinds of insects.
Nesting habits - Nests usually on ground in hedgerows and woodland undergrowth; in spruce belt.

Song Sparrow

Habitat Preference - Relatively open, brushy habitats, both moist and relatively dry
Relative Abundance - Very common
Resident Status - Winter visitor
Food - Seeds of weeds and grasses; beetles, caterpillars and other insects
Nesting habits - Nests on ground or in low bushes; in grass thickets or saplings; height up to 8 ft; rarely 15 ft.

Several rare or endangered species of birds may inhabit the area(18). Sightings of the Bald Eagle (Haliaeetus leucocephalus) in Screven County, Georgia, were reported in 1941 and 1957 (15). Three observations of the Bald Eagle in the SRP area were reported in 1959(13). One observation of a Peregrine Falcon (Falco peregrinus) was reported in 1959, and a Kirtland's Warbler (Dendroica Kirtlandii) was observered once in 1960(13). An Ivory-billed Woodpecker (Campephilus principalis) sightining in 1907 in Screven County, Georgia, was reported by Hamilton (15). None of these rare or endangered species should be found on the VNP site. After an on-site inspection of the site, Mr. Robert Manns, National Audubon Society Southeastern States Field Representative, reported:(19) "No suitable habitat was indicated to me for the Bald Eagle or Osprey. There is little or no chance of the Ivory-billed Woodpecker or Backman's Warbler, both endangered species, in the area . . . No Red-cockaded Woodpecker colonies or individuals were sighted, and, indeed, there is hardly any pine present worthy of the attention of that particular species."

Table 2.7-21

THE MORE COMMON BIRDS OF THE AREA(13)

Common Name	Scientific Name	Resident Status*
Pied-billed Grebe	*Podilymbus podiceps*	P.R.
Great Blue Heron	*Ardea herodias*	P.R.
Little Blue Heron	*Florida caerulea*	S.V.
Common Egret	*Casmerodius albus*	P.R.
Mallard	*Anas platyrhynchos*	W.V.
Black Duck	*Anas rubripes*	W.V.
Wood Duck	*Aix sponsa*	P.R.
Ring-necked Duck	*Aythya collaris*	W.V.
Hooded Merganser	*Lophodytes cucullatus*	W.V.
Turkey Vulture	*Cathartes aura*	P.R.
Black Vulture	*Coragyps atratus*	P.R.
Cooper's Hawk	*Accipiter cooperii*	P.R.
Red-tailed Hawk	*Buteo jamaicensis*	P.R.
Red-shouldered Hawk	*Buteo lineatus*	P.R.
Marsh Hawk	*Circus cyaneus*	W.V.
Sparrow Hawk	*Falco sparverius*	P.R.
Bobwhite	*Colinus virginianus*	P.R.
King Rail	*Rallus elegans*	S.R.
American Coot	*Fulica americana*	W.R.
Common Snipe	*Capella gallinago*	W.R.
Spotted Sandpiper	*Actitis macularia*	T.V.
Ring-billed Gull	*Larus delawarensis*	W.R.

Table 2.7-21 (Cont.)

Common Name	Scientific Name	Resident Status*
Mourning Dove	*Zenaidura macroura*	P.R.
Yellow-billed Cuckoo	*Coccyzus americanus*	S.R.
Barred Owl	*Strix varia*	P.R.
Chuck-Will's-Widow	*Caprimulgus carolinensis*	S.R.
Common Nighthawk	*Chordeiles minor*	S.R.
Chimney Swift	*Chaetura pelagica*	S.R.
Ruby-throated Hummingbird	*Archilochus colubris*	S.R.
Belted Kingfisher	*Megaceryle alcyon*	P.R.
Yellow-shafted Flicker	*Colaptes auratus*	P.R.
Pileated Woodpecker	*Dryocopus pileatus*	P.R.
Red-headed Woodpecker	*Melanerpes erythrocephalus*	P.R.
Red-bellied Woodpecker	*Centurus carolinus*	P.R.
Yellow-bellied Sapsucker	*Sphyrapicus varius*	W.V.
Downy Woodpecker	*Dendrocopos pubescens*	P.R.
Eastern Kingbird	*Tyrannus tyrannus*	S.R.
Great Crested Flycatcher	*Myiarchus crinitus*	S.R.
Acadian Flycatcher	*Empidonax virescens*	S.R.
Eastern Wood Pewee	*Contopus virens*	S.R.
Rough-winged Swallow	*Stelgidopteryx ruficollis*	S.R.
Purple Martin	*Progne subis*	S.R.
Blue Jay	*Cyanocitta cristata*	P.R.
Common Crow	*Corvas brachyrhynchos*	P.R.
Carolina Chickadee	*Parus carolinensis*	P.R.

Table 2.7-21 (Cont.)

Common Name	Scientific Name	Resident Status*
Tufted Titmouse	*Parus bicolor*	P.R.
Brown-headed Nuthatch	*Sitta pusilla*	P.R.
Carolina Wren	*Thryothorus ludovicianus*	P.R.
Mockingbird	*Mimus polyglottos*	P.R.
Catbird	*Dumetella carolinensis*	W.V.
Brown Thrasher	*Toxostoma rufum*	P.R.
Robin	*Turdus migratorius*	W.V.
Wood Thrush	*Hylocichla mustelina*	S.R.
Hermit Thrush	*Hylocichla guttata*	W.V.
Veery	*Hylocichla fuscescens*	T.V.
Eastern Bluebird	*Sialia sialis*	P.R.
Blue-gray Gnatcatcher	*Polioptila caerulea*	S.R.
Golden-crowned Kinglet	*Regulus strapa*	W.R.
Ruby-crowned Kinglet	*Regulus calendula*	W.R.
Water Pipit	*Anthus spinoletta*	W.V.
Loggerhead Shrike	*Lanius ludovicianus*	P.R.
White-eyed Vireo	*Vireo griseus*	S.R.
Yellow-throated Vireo	*Vireo flavifrons*	S.R.
Red-eyed Vireo	*Vireo olivaceus*	S.R.
Prothonotary Warbler	*Protonotaria citrea*	S.R.
Swainson's Warbler	*Limnothlypis swainsonii*	S.R.
Black-throated Blue Warbler	*Dendroica caerulescens*	T.V.
Myrtle Warbler	*Dendroica coronata*	W.V.

Table 2.7-21 (Cont.)

Common Name	Scientific Name	Resident Status*
Pine Warbler	*Dendroica pinus*	P.R.
Prairie Warbler	*Dendroica discolor*	S.R.
Palm Warbler	*Dendroica palmarum*	W.R.
Ovenbird Warbler	*Seiurus aurocapillus*	T.V.
Northern Water-Thrush	*Seivrus noveboracensis*	T.V.
Louisiana Water-Thrush	*Seiutus motacilla*	S.R.
Kentucky Warbler	*Oporornis formosus*	S.R.
Yellowthroat	*Geothlypis trichas*	P.R.
Yellow-breasted Chat	*Icteria virens*	S.R.
Hooded Warbler	*Wilsonia citrina*	S.R.
American Redstart	*Setophaga ruticilla*	T.V.
House Sparrow	*Passer domesticus*	P.R.
Bobolink	*Dolichonyx oryzivorus*	T.V.
Eastern Meadowlark	*Sturnella magna*	P.R.
Red-winged Blackbird	*Agelaius phoeniceus*	P.R.
Orchard Oriole	*Icterus spurius*	S.R.
Common Grackle	*Quiscalus quiscula*	P.R.
Scarlet Tanager	*Piranga olivacea*	T.V.
Summer Tanager	*Piranga rubra*	S.R.
Cardinal	*Richmondena cardinalis*	P.R.
Blue Grosbeak	*Guiraca caerulea*	S.R.
Indigo Bunting	*Passerina cyanea*	S.R.
Painted Bunting	*Passerina ciris*	S.R.

Table 2.7-21 (Cont.)

Common Name	Scientific Name	Resident Status*
American Goldfinch	*Spinus tristis*	P.R.
Rufous-sided Towhee	*Pipilo erythrophthalmus*	P.R.
Savannah Sparrow	*Passerculus sandwichensis*	W.R.
Vesper Sparrow	*Pooecetes gramineus*	W.V.
Bachman's Sparrow	*Aimophila aestivalis*	P.R.
Slate-colored Junco	*Junco hyemalis*	W.V.
Chipping Sparrow	*Spizella passerina*	P.R.
Field Sparrow	*Spizella pusilla*	P.R.
White-throated Sparrow	*Zonotrichia albicollis*	W.V.
Song Sparrow	*Melospiza melodia*	W.V.

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*P.R. = permanent resident
S.V. = summer visitant-nonbreeding
W.V. = winter visitant-usually regular
S.R. = summer resident-regular; breeding or presumably breeding
T.V. = transient visitant

Table 2.7- 22

1971 AUDUBON CHRISTMAS BIRD COUNT[11]

Augusta, Georgia, 33° 26' N 82° 00' W (all points within a 15-mile diameter, center intersection of Routes 1 and 78, to include Forest Hills Hospital grounds, Pendleton King Park, Brickyard Ponds, Savannah River bottoms, Levee, Municipal Airport and adjacent field: swamps and ponds 50%, mixed and pine woods 25%, field and pastures, 15%, parks and residential 10%). Dec. 18; 4:30 a.m. to 6:30 p.m. Total, 86 species; about 12,798 individuals.

Common Name	Number	Common Name	Number
Pied-billed Grebe	34	Fish Crow	4
Great Blue Heron	8	Carolina Chickadee	51
Black-crowned Night Heron	5	Tufted Titmouse	5
Mallard	2	Brown-headed Nuthatch	4
Black Duck	2	Brown Creeper	1
Pintail	1	House Wren	3
Green-winged Teal	7	Winter Wren	1
Blue-winged Teal	2	Carolina Wren	56
Am. Widgeon	111	Mockingbird	67
Wood Duck	3	Brown Thrasher	31
Ring-necked Duck	150	Robin	28
Turkey Vulture	3	Hermit Thrush	13
Black Vulture	1	Eastern Bluebird	20
Cooper's Hawk	1	Blue-gray Gnatcatcher	10
Red-tailed Hawk	20	Golden-crowned Kinglet	52
Red-shouldered Hawk	9	Ruby-crowned Kinglet	215
Marsh Hawk	1	Water Pipit	3
Sparrow Hawk	26	Cedar Waxwing	101
Bobwhite	7	Loggerhead Shrike	18
Common Gallinule	1	Starling	2892
Am. Coot	295	White-eyed Vireo	1
Killdeer	419	Solitary Vireo	3
Am.Woodcock	2	Black-and-white Warbler	1
Common Snipe	10	Orange-crowned Warbler	2
Ring-billed Gull	1	Myrtle Warbler	281
Mourning Dove	48	Pine Warbler	8
Screech Owl	4	Palm Warbler	27
Barred Owl	4	Yellowthroat	13
Belted Kingfisher	2	House Sparrow	48
Yellow-shafted Flicker	58	Eastern Meadowlark	433
Pileated Woodpecker	6	Red-winged Blackbird	3018
Red-bellied Woodpecker	16	Rusty Blackbird	36
Red-headed Woodpecker	2	Common Grackle	2076
Yellow-bellied Sapsucker	27	Brown-headed Cowbird	66
Hairy Woodpecker	2	Cardinal	186
Downy Woodpecker	8	Purple Finch	27
Eastern Phoebe	16	Am. Goldfinch	403
Blue Jay	56	Rufous-sided Towhee	107
Common Crow	32	Savannah Sparrow	31

Table 2.7-22 (Cont.)

Common Name	Number
Vesper Sparrow	2
Slate-colored Junco	78
Chipping Sparrow	25
Field Sparrow	48
White-throated Sparrow	396
Fox Sparrow	11
Swamp Sparrow	167
Song Sparrow	328

Table 2.7-23

1971 AUDUBON CHRISTMAS BIRD COUNT(12)

Aiken, S. C. 33° 35' N 81° 40' W (all points within a 15-mile diameter, center Cochton; urban and suburban 5%, swamps, marshes and small waters 10%, field and pastures 27%, pine woods 35%, mixed and deciduous woods 23%) - Dec. 25, 7 a.m. to 8 p.m. Total 71 species (1 additional race); about 3609 individuals.

Common Name	Number	Common Name	Number
Pied-billed Grebe	7	Eastern Bluebird	18
Great Blue Heron	1	Golden-crowned Kinglet	82
Cattle Egret	2	Ruby-crowned Kinglet	130
Turkey Vulture	16	Cedar Waxwing	10
Black Vulture	10	Loggerhead Shrike	9
Cooper's Hawk	1	Starling	489
Red-tailed Hawk	2	Myrtle Warbler	41
Red-shouldered Hawk	2	Pine Warbler	19
Sparrow Hark	15	Palm Warbler	34
Bobwhite	3	Yellowthroat	5
Am. Coot	4	House Sparrow	30
Killdeer	2	Eastern Meadowlark	30
Am. Woodcock	2	Red-winged Blackbird	340
Mourning Dove	14	Rusty Blackbird	3
Screech Owl	1	Common Grackle	360
Great Horned Owl	1	Brown-headed Cowbird	700
Barred Owl	1	Cardinal	71
Belted Kingfisher	2	Purple Finch	17
Yellow-shafted Flicker	39	Am. Goldfinch	82
Pileated Woodpecker	3	Rufous-sided Towhee	77
Red-bellied Woodpecker	10	Savannah Sparrow	6
Red-headed Woodpecker	8	Vesper Sparrow	8
Yellow-bellied Sapsucker	16	Slate-colored Junco	95
Hairy Woodpecker	1	Chipping Sparrow	6
Downy Woodpecker	14	Field Sparrow	89
Red-cockaded Woodpecker	3	White-crowned Sparrow	2
Eastern Phoebe	3	White-throated Sparrow	141
Blue Jay	47	Fox Sparrow	11
Common Crow	56	Swamp Sparrow	7
Carolina Chickadee	68	Song Sparrow	132
Tufted Titmouse	32		
White-breasted Nuthatch	9		
Brown-headed Nuthatch	39		
Brown Creeper	4		
House Wren	1		
Carolina Wren	18		
Mockingbird	24		
Catbird	3		
Brown Thrasher	14		
Robin	60		
Hermit Thrush	7		

2.7.5 MAMMALS

A list of the mammals of the area is presented in Table 2.7-24(20-23). This list is based on mammal studies conducted at SREL in the SRP area(20-22) with additional information from Golley.(23) In the discussion of mammals that follows, only common names are used; scientific names can be found in Table 2.7-24. No rare or endangered mammal species is included in this list or is known to be in the area.(18) Information on habitat preference, feeding habits, breeding, behavior and abundance is summarized primarily from Golley(23) for each species in the following paragraphs.

Bobcat

Habitat Preference - river bottom swamps and dense brush.
Feeding Habits - carnivore - rabbits, mice, birds, opossum, turtles.
Breeding - throughout the year with a peak in spring, 1 -4 per litter.
Behavior - nocturnal, highly secretive, not an unusally mobile animal but does require undisturbed (by man) regions.
Abundance - probably low; statewide.

White-tailed Deer

Habitat Preference - brushy stage of deciduous forest develpment but highly adaptable to farmlands, deep forest and swamp.
Feeding Habits - browsers; greenbriar, sweet gum, tulip poplar, etc. but also nuts, mushrooms and berries.
Breeding - Dec. - 2 per doe in spring.
Behavior - well-adapted to man, crepuscular.
Abundance - about 15 -20 per square mile.
Miscellaneous - continuing an increase in the state through protection and management; a highly popular game animal.

Feral Swine

Habitat Preference - swamps and marshes but less frequently in uplands and pinelands.
Feeding Habits - omnivorous; roots, tubers, insects, acorns, seeds.
Breeding - year round, 4 - 5 per litter.
Behavior - its rooting habit can be highly destructive to fragile vegetation (i.e., dune vegetation)
Abundance - about 10 per square mile but can reach high densities particularly on the coastal plain.

Opossum

Habitat Preference - deciduous forests in bottomland and along stream margins. Needs hollow trees or stumps.
Feeding Habits - mainly insects (about 60% of diet) but almost anything.
Breeding - fairly prolific - 2 litters per year, about 7 young per litter.
Behavior - nocturnal, scavenger and/or predator.
Abundance - quite common throughout the state.

Southeastern Shrew

Habitat Preference - moist situations near swamps but also woods and open fields; mainly in the ground litter.
Feeding Habits - earthworms; however, may have a profound dampening effect on insect populations by eating larvae in the litter and soil (all shrews).
Breeding - ?
Behavior - ? ; because of its preference for the litter layer it is not often seen.
Abundance · uncommon (contemporary trapping techniques may be inefficient).
Miscellaneous - high metabolic rate and therefore high food consumption.

Least Shrew

Habitat Preference - old fields; particularly the broomsedge stage of succession.
Feeding Habits - insects, earthworms, centipedes, snails.
Breeding - in the north 5 to 6 per litter; March - November.
Behavior - same as Southeastern Shrew.
Abundance - limited trapping success, however owl pellets contain large numbers of skulls.

Short-tailed Shrew

Habitat Preference - moist deciduous forests but also moist fields; litter layer.
Feeding Habits - insects, earthworms, snails.
Breeding - several litters each year; 1 - 8 per litter.
Behavior - highly active yet secretive.
Abundance - found throughout the state.
Miscellaneous - extremely high metabolic rate; poison produced by submaxillary glands aids in subduing prey the size of mice.

Star-nosed Mole

Habitat Preference - wet meadows and marshes, stream banks.
Feeding Habits - mainly earthworms, roots, tubers.
Breeding - ?
Behavior - uses both surface and underground runways.
Abundance - its presence in Georgia is "open to question".

Eastern Mole

Habitat Preference - pastures and fields
Feeding Habits - earthworms and insects
Breeding - very little predation (except snakes) therefore, low reproductive capacity; 1 litter each year, 2 - 5 per litter.
Behavior - "swims" through the soil in search of food.
Abundance - ? statewide distribution.

Hoary Bat

Habitat Preference - "natural" vegetation; roosts in trees and shrubs not caves.
Feeding Habits - ? insects.
Breeding - in the north, winters in Georgia. 2 young per year.
Behavior - solitary
Abundance - statewide.
Miscellaneous - one of the largest (13" wingspan) in Georgia.

Cottontail Rabbit

Habitat Preference - "edge"; the border between two community types affording thick ground cover; fields.
Feeding Habits - a grazer mostly (grasses and weeds) but does browse (green briar, twigs of shrubs).
Breeding - Feb. - Aug.; 3 - 4 litters each year; 4 - 6 per litter (prolific).
Abundance - common but evidence indicates a population decline due to succession in most of Georgia.
Behavior - crepuscular.
Miscellaneous - in terms of numbers bagged it is an extremely important game animal.

Marsh Rabbit

Habitat Preference - near a water source, i.e., coastal lowlands, brackish marshes and floodplain.
Feeding Habits - marsh grass, cane, leaves, shrubs.

(continued)

Marsh Rabbit

Breeding - Feb. - Aug.; about 3 per litter.
Abundance - coastal plain; greatest populations in the brackish marshes of the Savannah and Altamaha Rivers. "Quite abundant".
Behavior - will not hesitate to use water as an escape route.

Swamp Rabbit

Habitat Preference - floodplains of rivers and creeks, and beaver ponds.
Feeding Habits - emergent aquatic vegetation; grasses, sedges.
Breeding - year around, 3 per litter.
Behavior - crepuscular; will not hesitate to use water as escape route (i.e., swimming).
Abundance - about 6 per 100 acres of bottomland.
Miscellaneous - larger than either <u>Sylvilagus</u> <u>floridanus</u> or <u>Sylvilagus</u> <u>palustris</u>. (about 5 - 6 pounds).

Fox Squirrel

Habitat Preference - Both mature pines and hardwoods with more "open" conditions than those favored by <u>Sciurus</u> <u>carolinensis</u>. Also prefers soybean and corn fields nearby.
Feeding Habits - Acorns (white especially) and other nuts plus buds, fruits, fungi.
Breeding - 2 seasons: Nov. - March and May - Oct., 2 - 3 per litter.
Behavior - active early and late morning and late afternoon, builds leaf nests and inhabits tree cavities.
Abundance - very few in mountains, some in Piedmont, mostly in the floodplain. 1 per 6 - 7 acres.
Miscellaneous - four different color phases.

Gray Squirrel

Habitat Preference - oak - hickory forests, bottomlands.
Feeding Habits - Hickory nuts and acorns, buds, roots, fruits and leaves.
Breeding - 2 seasons: Mid-Jan. and June. 2 - 3 per litter.
Behavior - same as <u>Sciurus</u> <u>niger</u>.
Abundance - variable from locality to locality but may reach high densities of 1 per acre.
Miscellaneous - albinism and melanism not uncommon.

Flying Squirrel

Habitat Preference - forest habitats from mixed hardwoods to the turkey oak hills.

(continued)

Flying Squirrel

Feeding Habits - acorns and other mast but also insects and small birds and eggs.
Breeding - 2 seasons: later winter and late spring. 3 - 4 per litter.
Behavior - nocturnal, quite sociable and 3 to 4 will den together; doesn't build nest.
Abundance - fairly low in Piedmont, more abundant in coastal plain in the turkey oak.

Southeastern Pocket Gopher

Habitat Preference - long-leaf pine forests - fire association; it regenerates herbs for food.
Feeding Habits - roots of herbaceous plants and some leaves.
Breeding - year around with peaks in March and July-August. 2 per litter. Some females may produce two litters per year.
Behavior - uses burrows recognized by a sand mound and a tunnel below. Cuts roots to proper size to transport them in the cheek pouches.
Abundance - no information for the Southeast.
Miscellaneous - large head and long claws on front feet. Savannah River acts as a barrier and none are found in South Carolina.

Beaver

Habitat Preference - along rivers, streams or in lakes.
Feeding Habits - prefers sweetgum and pine but will eat willow, alder, yellow poplar, bluebeech and grape vine and some aquatics.
Breeding - October - March with a gestation period of 3 months. 2 - 4 per litter.
Abundance - fairly common and increasing due to protection and reintroduction. About 5 per colony.
Miscellaneous - will inhabit burrows along river banks without a "lodge". Sandy soil areas discourage dams and lodge building.
Behavior - mostly nocturnal.

Rice Rat

Habitat Preference - salt and freshwater marshes with a dense cover of grass or sedge.
Feeding Habits - grasses and sedges, insects and crabs, small birds.

(continued)

Rice Rat

Breeding - March - November, 5 per litter.
Behavior - May become a significant predator on marsh wren nests.
Abundance - Seems to boom and bust, .5 to 7.0 per acre.

Harvest Mouse

Habitat Preference - abandoned fields in the late herbaceous or early broomsedge stage, roadside ditches, honeysuckle thickets, wet meadows.
Feeding Habits - granivorous
Breeding - 3 per litter throughout summer.
Behavior - excellent climbers; sometimes nest above ground in grass clumps; antagonism with cotton rats and their populations are inverse in any one area.
Abundance - about 12 per acre.

Old-field Mouse

Habitat Preference - dry sandy habitat like beaches or sandy floodplains; most common in the herbaceous stage of sandy old-fields.
Feeding Preference - seeds and insects.
Breeding - throughout the year with a peak in Dec. and Jan. 3 per litter.
Abundance - 3 - 5 per acre.
Behavior - an able digger that constructs an extensive burrow system, nocturnal.

Wood Mouse

Habitat Preference - Oak - hickory forests with dense herbaceous understory, river bottom forests.
Feeding Habits - herbivorous; seeds of berries, grasses, oaks, and conifers and some insects.
Breeding - throughout the year with a summer decrease. 4 per litter.
Behavior - nocturnal, nest in hollows or ground burrows.
Abundance - 3 - 10 per acre. boom and bust.
Miscellaneous - restricted to mountains and Piedmont. May hybridize with Peromyscus gossypinus.

Cotton Mouse -

Habitat Preference - river - bottom woodlands subject to periodic inundation or less frequently in upland hardwood forests.
Feeding Habits - seeds and nuts in winter and invertebrates in summer (more carnivorous than Peromyscus leucopus).

(continued)

Cotton Mouse

Breeding - same as Peromyscus leucopus
Behavior - nests in fallen logs, crevices, hollow cavities - propensity to use cotton as nesting material.
Abundance - restricted pretty much to lower Piedmont and coastal plain - again cyclic .3 - 3.0 per acre.

Golden Mouse

Habitat Preference - woodlands with dense undergrowth such as the edge between lowland swamp and drier uplands or along small streams or rivers.
Feeding Habits - seeds, fruits, herbaceous material (sumac, wild cherry, dogwood).
Breeding - same as other Peromyscus.
Behavior - builds a globular nest several feet above the ground and several feeding platforms. Quite sociable.
Abundance - .3 - 2.0 per acre; high in winter, low in summer. Statewide distribution.

Cotton Rat

Habitat Preference - requires sufficient cover density to discourage overhead predation; well-developed broomsedge fields but also honeysuckle or blackberry thickets or marshy areas.
Feeding Habits - herbaceous plants (lespedeza) and grasses (broomsedge) and roots and tubers.
Breeding - March - December. 5 per litter.
Behavior - very shallow burrow systems and surface nests.
Abundance - 1 - 8 per acre; cyclic.
Miscellaneous - live only a short time in the wild, a complete population turnover in 6 months.

Eastern Woodrat

Habitat Preference - in the coastal plain its habitat is dense vegetation bordering lowland swamps or rivers; in the mountains it is rockslides, cliffs and caves.
Feeding Habits - twigs, nuts, and seeds of hardwoods and animal food when available.
Breeding - throughout the year, 2 - per litter.
Behavior - nests in a large "house" of trash. Collects and stores all kinds of tin, paper, glass, etc. Shelter important because it is neither fossorial or arboreal.
Abundance - not known in Georgia; however, the potential for increase is probably not as high as for other cricetid rodents.
Miscellaneous - has not been collected in Piedmont.

Pine Mouse

Habitat Preference - most commonly in pine or hardwoods, but also in field terraces overgrown with honeysuckle or greenbriar or broomsedge fields.
Feeding Habits - bulbs, roots and tubers but also seeds and fruits.
Breeding - probably throughout the year. 3 - 4 per litter.
Behavior - fossorial; nests below surface with burrows or runways usually under litter layer.
Abundance - very low in most areas studied.

Muskrat

Habitat Preference - wherever food and water are available, i.e., farm ponds, rivers, streams and marshes.
Feeding Preference - roots, stems, leaves of aquatic plants but crayfish, clams, fish may be taken in winter.
Breeding - throughout the year, about 2 litters per year, 7 per litter.
Behavior - will build a lodge in marshes but depends on bank burrows; otherwise, several may occupy the same burrow system.
Abundance - Mountains and Piedmont but only along major rivers in the coastal plain; absent in the coastal counties. 9 per acre of marsh but lower in streams and ponds.

Norway Rat

Habitat Preference - human dwellings where grain sources are available or garbage dumps and salt marshes.
Feeding Habits - everything and anything
Breeding - year around with peaks in spring and fall. 5 litters per year, 7 per litter.
Behavior - a serious pest on grain and a disease carrier; nocturnal; nests made of chewed debris well concealed in considerable shelter.
Abundance - variable, depending on food sources; 7 per block of city or to an extreme of 197 per block.

Roof Rat

Habitat Preference - barns and buildings in South Georgia. No feral populations have been found.
Feeding Habits - corn and peanut hay.
Breeding - year around, 6 per litter.
Behavior - generally builds nest in walls or loft of barn.
Abundance - upwards of 50 per barn if food is available.
Miscellaneous - subordinate to Norway rat and decreases with infestation of Norway rats.

House Mouse

Habitat Preference - feral in herb and broomsedge stages of old field or in human dwellings.
Feeding Habits - almost anything; feral population usually eat seeds of <u>lespedeza</u>.
Breeding - very prolific; throughout the year; 4 - 7 per litter.
Behavior - highly mobile in the field; aggressive interactions often determine population levels.
Abundance - 3 - 4 per acre in the field.

Red Fox

Habitat Preference - "open" habitat such as upland terraces, field mixed with edges.
Feeding Habits - mainly rabbits and small mammals but almost anything.
Breeding - Jan. - Feb., 1 litter per year, 4 - 5 per litter.
Behavior - mainly crepuscular or nocturnal; fairly mobile during food searches; digs a den.
Abundance - most prevalent in mountains and Piedmont and only "spotty" in the coastal plain.
Miscellaneous - more carnivorous than the gray fox.

Gray Fox

Habitat Preference - mixture of woods and fields with bottomlands.
Feeding Habits - rabbits and small mammals mainly but in summer insects and fruit make up 50% of the diet.
Breeding - Dec. - March, 5 per litter.
Behavior - crepuscular or nocturnal; dens in cavities not dug dens.
Abundance - ? ; a guess would be 2 - 3 per square mile.

Black Bear

Habitat Preference - wooded areas (not virgin) with expanses of land undisturbed by man.
Feeding Habits - omnivorous; berries, nuts, roots, mice, insects, etc.
Breeding - sexual maturity - 3 years; breed every other year Mar. - June; 2 - 3 cubs.
Behavior - nocturnal and withdrawn.
Abundance - greatest concentration in Okefenokee Swamp with some in mountains and Okmulgee River area.

Raccoon

Habitat Preference - fairly wide range of tolerance for types; mixed fields and woods, lowlands, salt and fresh water marshes.
Feeding Habits - omnivorous; fruits, nuts plus some fish, insects, birds and small mammals.
Breeding - Feb. - Aug., 3 per litter.
Behavior - nocturnal; likes cavities in trees; very little intraspecific aggression.
Abundance - variable, 6 - 8 per square mile.
Miscellaneous - popular game animal; high percentage of mortality that occurs is due to hunting.

Long-tailed Weasel

Habitat Preference - mixed fields and woods
Feeding Habits - highly carnivorous; rats, mice, rabbits, small birds, snakes, insects.
Breeding - April - May, 6 per litter.
Behavior - quick and nervous, an instinct to kill; nests in a burrow.
Abundance - 2 per 5 -30 acres.

Mink

Habitat Preference - semi-aquatic, along streams, ponds, or salt and fresh water marshes.
Feeding Habits - mice and rats, fish, frogs, snakes, birds; insects.
Breeding - March, 1 litter per year, 7 per litter.
Behavior - similar to weasel.
Abundance - low in the Piedmont and mountain regions but higher in coastal plain and salt-marshes.

Striped Skunk

Habitat Preference - agricultural land or open waste land.
Feeding Habits - omnivorous; small mammals, insects, fruit, carrion.
Breeding - early spring, 4 - 7 per litter.
Behavior - nocturnal; nests in old mammal burrows or under buildings, several skunks may congregate in one nest.
Abundance - state wide occurrence.

Spotted Skunk

Habitat Preference - agricultural or wasteland - avoids heavy timber or wetlands.

(continued)

Spotted Skunk

Feeding Habits - may feed more on vertebrates than the striped skunk but clearly omnivorous.
Breeding - early spring - 4 - 5 per litter.
Behavior - dens under buildings or deserted mammal burrows; climbs well and may den in a tree; nocturnal.
Abundance - quite common; however, does not occur on the eastern coastal plain.

River Otter

Habitat Preference - rivers and salt marshes.
Feeding Habits - mainly fish but also crustacea, birds, insects, clams.
Breeding - Feb., 3 - 4 per litter born in April.
Behavior - excellent swimmer and diver.
Abundance - fairly common on the coastal plain, but absent in the northern Piedmont or mountains.

Gentry, et al.(24) conducted a 27-day study of small mammals in the SRP area. Small mammals were trapped in three different habitat types -- drier upland hardwood slopes, lowland hardwood-swamp forest and old-fields. During the trapping period, 124 small mammals were captured. Sixty (48 percent) were short-tailed shrews; 27 (21 percent), cotton mice; 21 (17 percent), southeastern shrews; and 12 (10 percent), golden mice; 3 (2 percent), eastern woodrats; and 1 (1 percent), eastern mole. Five of the 12 golden mice were captured in trees. The eastern woodrat and eastern mole captures were incidental.

In another study of small mammals in the vicinity of SRP, Golley, et al.(22) collected 12 of 15 potentially trappable species. Species collected were the southeastern shrew, least shrew, short-tailed shrew, harvest mouse, old-field mouse, cotton mouse, golden mouse, rice rat, cotton rat, easterr woodrat, pine mouse and house mouse. Species expected but not trapped included the flying squirrel, Norway rat and roof rat. The flying squirrel was not collected in the study but was known to be abundant at SRP. The Norway rat and roof rat were known to be present before the site was vacated, but have not been observed since that time. The broomsedge-vine habitat and the lespedeza habitat were found to support the largest number of small mammals and the forest habitats the least. Lowest population levels were found in the pine habitats with a slightly higher level in the hardwood habitats. Granivores (e.g., harvest mouse, old-field mouse, cotton mouse) were most abundant in the early stages of succession. Herbivores (e.g., rice rat, eastern woodrat, pine mouse) were most numerous in the broomsedge-vine stage of succession and declined to low levels in the forest stages. Insectivores (e.g., all shrews) were found in low levels in all successional stages; however, this may have been due to the sampling method employed. Peak density of the old-field mouse was determined to be approximately 12 animals per hectare (2.5 acres); peak density of the cotton rat was approximately 19 animals per hectare. Data were not sufficient to determine density of the other species.

The furbearer populations of the SRP area were studied from 1954 - 1962.(21) During this study 522 animals were trapped. Of the total trapped gray foxes comprised 54 percent; raccoons, 21 percent; bobcats, 11 percent; red foxes, 9 percent; striped skunks, 3 percent; and opossums, 3 percent. The numbers of each species trapped varied from year to year, but no significant difference was found.

Jenkins and Provost(20) reported on the status of the larger vertebrates of the SRP area. Their study was conducted in 1960 - 1961 and their report summarizes their work and other studies done in the SRP area. Density information from their report is summarized below.

Cottontail rabbit: Density of approximately 29 per 100 acres: largest numbers were found in the upland areas few were found in the sandhills or in the dense swamps.

Marsh rabbit: Occurred in low numbers in the swamp.

Squirrels: Gray squirrel was the most abundant squirrel in the area; probably 4 or 5 gray squirrels to each fox squirrel on the upland terraces; no fox squirrels were observed in the swamps; a density of more than one squirrel per acre was estimated in the better swamp habitat.

Foxes: Density was roughly estimated to be 1-4 foxes per square mile; gray fox much more numerous than the red fox.

Bobcat: Population probably around 2-3 per square mile in the better swamp habitat.

Black bear: At least 5 bears reported living on the SRP floodplain.

Raccoons: Density of approximately one per ten acres (64 per square mile).

Opossum: Approximately same density as raccoon population.

Beaver: Not numerous on the SRP but at least 15 colonies were scattered throughout the area; no quantitative data on colonies but an established colony could be expected to contain 2 adults, 3 yearlings, and 3 kits during the fall and winter months.

Other: Estimated 75-100 on the SRP site.

Skunks: Common, but not exceptionally abundant; ratio of approximately 3 spotted skunks to 1 striped skunk; greater concentrations on lowland swamp areas and adjacent ridges.

Mink: Present; no data collected.

Muskrats: No signs of animals found.

Deer: Greatest concentration in areas bordering the Savannah River swamp; approximately 1500 animals on entire site.

Feral hogs: Density ranges from 1 per 60 acres to 1 per 2000 acres.

While Jenkins and Provost(20) reported no signs of muskrats in the SRP area, Golley(23) indicates that this mammal has been reported from Screven County and Richmond County, Georgia. The SRP area and the VNP site are the southernmost edge of the range of the muskrat. Its occurrence in the area is a definite, but not absolute possibility.

The hoary bat has been reported from Richmond County, Georgia; this migratory species is probably a winter resident in Georgia.(23) Other species of bats also probably could be found in the area, including the little brown Myotis (Myotis lucifugus), silver-haired bat (Lasionycteris noctivagans), red bat (Lasiurus borealis), big brown bat (Eptesicus fuscus), Seminole bat (Lasiurus seminolus), eastern yellow bat (Lasiurus intermedius), evening bat (Nycticeius humeralis), eastern big-eared bat (Plecotus rafinesquei) and Mexican freetail bat (Tadarida brasiliensis).(25)

Table 2.7-24

MAMMALS OF THE AREA (20-23)

Common Name	Scientific Name
Opossum	Didelphis marsupialis
Southeastern Shrew	Sorex longirostris
Least Shrew	Cryptotis parva
Short-tailed Shrew	Blarina brevicauda
Star-nosed Mole	Condylura cristata
Eastern Mole	Scalopus aquaticus
Hoary Bat	Lasiurus cinereus
Cottontail Rabbit	Sylvilagus floridanus
Marsh Rabbit	Sylvilagus palustris
Swamp Rabbit	Sylvilagus aquaticus
Fox Squirrel	Sciurus niger
Gray Squirrel	Sciurus carolinensis
Flying Squirrel	Glaucomys volans
Southeastern Pocket Gopher	Geomys pinetis
Beaver	Castor canadensis
Rice Rat	Oryzomys palustris
Harvest Mouse	Reithrodontomys humulis
Old-field Mouse	Peromyscus polionotus
Wood Mouse	Peromyscus leucopus
Cotton Mouse	Peromyscus gossypinus
Golden Mouse	Ochrotomys nuttalli

Table 2.7-24 (Cont.)

Common Name	Scientific Name
Cotton Rat	*Sigmodon hispidus*
Eastern Woodrat	*Neotoma floridana*
Pine Mouse	*Pitymys pinetorum*
Muskrat	*Ondatra zibethica*
Norway Rat	*Rattus norvegicus*
Roof Rat	*Rattus rattus*
House Mouse	*Mus musculus*
Red Fox	*Vulpes fulva*
Gray Fox	*Urocyon cinereoargenteus*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
Spotted Skunk	*Spilogale putorius*
River Otter	*Lutra canadenis*
Bobcat	*Lynx rufus*
White-tailed Deer	*Odocoileus virginianus*
Feral swine	*Sus scrofa*

2.7.6 STUDIES ON THE FLORA AND FAUNA OF THE SAVANNAH RIVER

Since 1951, the Academy of Natural Sciences of Philadelphia (ANSP), under contract with E. I. duPont de Nemours & Company, has been studying the biological and chemical aspects of the Savannah River between river miles 123 and 162. The first baseline study was carried out in 1951-1952 and since that time a continuous program of study has been conducted by ANSP. The program has consisted of three phases:

(1) Detailed surveys of the biological, chemical, physical and bacteriological aspects of the Savannah River were conducted in 1951-1952, 1955-1956, 1960, 1965 and 1968 (26-30). Stations are located at river miles 123, 138, 144 and 162. Sampling of algae, plankton, protozoa, aquatic invertebrates and fishes usually is carried out in May-June and August-September. Details of sampling methods, data analysis and presentation, results and conclusions can be found in the reports. A summary of all the studies has been made for du Pont (31).

(2) Cursory surveys which are usually conducted four times a year. In these studies, aquatic insects usually are considered, and either the algae, fish or non-insect invertebrates also are considered. Details of the methods and results can be found in the yearly summary reports which are made to E. I. du Pont de Nemours and Company.(33-36)

(3) Diatometer studies which continuously record possible changes in the river as reflected by changes in the diatom community. These studies were begun in 1953. Results of these studies are made to E. I. du Pont de Nemours and Company in quarterly reports. A selection of the quarterly reports were made available to GPC by SRP (37-45). Details of the studies can be found in these reports.

2.7.7 ALGAE, PLANKTON AND PROTOZOA

Approximately 400 different species of algae have been identified in the Savannah River between river miles 123 and 162.(28) Table 2.7-25 lists the more common species reported in 1968.(30) A detailed species list can be found in Patrick, et al.(28) Results of the algal studies have indicated that since 1951 there has been a reduction in the number of species--particularly in 1968--and a general increase in the organic load in this reach of the river.(31)

Phytoplankton counts--expressed as organisms per liter--for stations located at river miles 162, 144, 138 and 132 are shown in Table 2.7-26 for the period 1951-1968.(28,30) The two most common organisms collected in these samples in 1968 were two diatoms Melosira and Asterionella.(30) The organisms composing the samples consisted primarily of scuffed-up bottom forms and some forms that are discharged from the reservoir behind Clark Hill Dam. There is considerable patchiness in the phytoplanton distribution, with the greatest number of organisms being found in the areas where the current is slow and the water less turbid.(28)

In Table 2.7-26 the low number of organisms per liter in 1951 and 1952 was prior to the construction of Clark Hill Dam. Since Clark Hill Dam has been in operation, there has been an increase in the number of organisms. One explanation for this increase is that since Clark Hill Dam has been in operation, there has been a decrease in the suspended solid load in the river below the dam. Also, some organisms are probably discharged from the dam and continue as plankton in the downstream river.(28)

The results of plankton sampling in 1959-1962 on the Savannah River at North Augusta, S. C., (river mile 201) and Port Wentworth, Ga., (near Savannah, Ga.) were reported by Williams.(46,47) The most abundant diatoms at North Augusta were Melosira distans alpigena, Melosira ambigua, and Navicula sp.; the most abundant diatoms at Port Wentworth were Melosira distans alpigena, Cymatosira beligica, and Coscinodiscus denarius.(46) At Port Wentworth the average green flagellate algae count for July 1960 through September 1961 was reported as 83 counts/ml.(46) The average number of rotifiers per liter at Port Wentworth was 1.3; at North Augusta 3.0.(47) The most abundant rotifers were Keratella, Polyarthra, and Trichocerca.(47) At Port Wentworth, crustacean nauplii were found to average 0.4 counts per liter per sample and copepods 0.2 counts per liter per sample.(46) Copepods averaged 0.2 counts/liter/sample at North Augusta; cladocerans, 0.1 counts/liter/sample; and no crustacean nauplii were observed.(46)

Forty-eight species of rotifers have been identified by the Academy of Natural Sciences of Phildelphia. A species list can be found in Patrick, et al.(28) This study probably concentrated on sessile forms rather than planktonic forms. Bdeloid rotifers were the more commonly found.

Diatometer studies indicated for the period January through March 1971, that there was no evidence of organic pollution load at river mile 132 or river mile 162.(45) There was evidence of slight toxic pollution for March 1971 at both locations.(45) In terms of species observed, 144 species of diatoms were observed at river mile 162, and 154 species at river mile 132.(45)

Protozoa associated with substrate have been studied since 1951. Approximately 440 species have been identified; a detailed species list can be found in Patrick, et al.(28) All major groups (i.e., ciliates, flagellates, and sarcodinids) were well represented. Since the operation of Clark Hill Dam, there has been an increase in the number of species of protozoa.(31) Study of the protozoan species have indicated an increase in the organic load of this portion of the Savannah River.(31)

Table 2.7-25

ALGAE OF THE SAVANNAH RIVER(28,30)

Group	No. Species	More Common Species
Green Algae	62	*Oedogonium* sp. *Stigeoclonium lubricum* *Tetraspora gelatinosa* *Spirogyra* sp.
Blue-green Algae	41	*Microcoleus vaginatus* *Microcoleas lyngbyaceous* *Schizothrix calcicola* *Oscillatoria retzii*
Red Algae	7	*Batrachospermum* sp. *Compsopogon coeruleus*
Diatoms	291	*Navicula mutica* *Navicula lateropunctata* *Navicula germainii* *Navicula confervacea* *Nitzschia palea* *Eunotia monodon* *Achanthes biporoma* *Achanthes lanceolata* *Melosira varians* *Bacillaria paradoxa*
Yellow-green Algae	1	*Vaucheria* sp.

Table 2.7-26

PLANKTON ORGANISMS PER LITER FOR THE SAVANNAH RIVER(28,30)

	River Mile 162	River Mile 144	River Mile 138	River Mile 132
1951	100	100	100	100
1952	100	100	100	100
1955	1,471	3,860	5,147	4,412
1956	2,335	2,075	770	8,670
1960	2,021	4,394	843	409
1965	600	1,050	875	975
1968	620	2,725	1,610	2,975

Note: The numbers presented above give an order of magnitude of frequency of the plankton. However, the numbers should not be considered as being significant, since the numbers are based on relatively few analyses and the reproducibility of the results was not tested.(28)

2.7.8 AQUATIC PLANTS

Georgia Power Company biologists and consultants have identified 8 different aquatic vascular plants in the Savannah River between river miles 128 and 162. Samples were collected at stations SL 1, SL 2, SL 3 and SL 4 (Figure 5.5-2). The distribution of these plants along the river is spotty. Largest concentrations are found in areas of less current, i.e., in oxbows, behind sand bars, and around spur dikes. All the plants are rooted except Lemna which, although having rootlets, floats on the surface and comes into the river from tributary creeks. Sagittaria, Typha, and Pontederia were not found at SL 2 and SL 3. Anacharis was more abundant at SL 4 than at the other stations. The sessile plants are listed below and ranked according to their abundance in October 1972.

Scientific Name	Common Name	Rank
Myriophyllum	Water milfoil	1
Sagittaria	Duck potato	4
Ceratophyllum	Hornwort	1
Pontederia	Pickerel weed	5
Anacharis	Water weed	3
Alternanthera	Alligator weed	2
Typha	Cattail	5

Rank: 1= most abundant, 2 = very abundant, 3 = abundant, 4= not abundant, 5 = scarce,

2.7.9 AQUATIC INVERTEBRATES

Over 360 species of invertebrates have been identified in the Savannah River between river miles 123 and 162. (28) Table 2.7-27 is a summary of these results. A complete species list of aquatic invertebrates is in Patrick, et al. (28)

Table 2.7-28 lists the more common aquatic invertebrates and gives an indiction of their relative abundance. This table is based on sampling by GPC personnel for the period October 1971 through February 1972. Samples were taken in the river from river miles 145 to 159. Table 2.7-28 was compiled from Tables 2.7-29, -30, and -31. The data represent a compilation of 89 samples taken during this period. This data should be considered as preliminary since a more complete analysis will be possible when one year's data have been collected. An index of diversity (HBAR) and an index of redundancy (RED) are included on these tables. Formulas used to calculate these indices are:

$$(1)\quad \mathrm{HBAR} = \sum_{i=1}^{ns} p_i \log p_i$$

where $p_i = \frac{n_i}{N}$;

N = Total number of individuals;

n_i = number of individuals in species i;

ns = number of species.

$$(2)\quad \mathrm{RED} = \frac{H_{max} - \mathrm{HBAR}}{H_{max} - H_{min}}$$

HBAR is a measure of the species distribution of the individuals of a community, and RED is a measure of the dominance of one or more species. HBAR can range from zero to about nine but is usually in the range of zero to four. In general an HBAR of less than one indicates a polluted system; 1 to 2.5 indicates slight pollution; 2.5 to 4 indicates clean water. H_{max} is calcualted as is HBAR but the assumption is made that all species have the same number of individuals, i.e., ten species with ten individuals each. This is maximum possible diversity. H_{min}

is the lowest possible diversity, i.e. for the same ten species there would be one individual in each of nine species and 91 individuals in the tenth species. Redundancy is highest (1.00) with a large number of individuals in one species and lowest (0.00) with one individual per species. In general, as HBAR increases, RED decreases. With sufficient preoperational studies these indices can be used to indicate changes in the communities (invertebrate) that may occur after plant operation begins.

Bottom fauna over most of the river bed are very sparse. This is probably because the river bottom consists mainly of shifting sand. The greatest number of typical river benthic organisms is found in the slow water, especially in mud deposits. Organisms which drift in the current colonize stationary debris in the river and are sampled by the use of artificial substrates. The benthic sampling program uses a modified Petersen dredge to sample bottom organisms, and drift organisms are sampled with the Dendy multiplate and rock filled baskets similar to those used by EPA. This combination maximizes the kinds of habitat sampled. Occasional qualitative littoral sampling is planned.

Five stations were chosen to monitor benthic communities at Plant Vogtle. (Figure 5.5-2) Station SR1 was chosen as an upstream control station. Station SR2 was chosen because of the unique habitat in the ox-bow. Station SR3 monitors a heated discharge from the SRP, across the river from the VNP site. Station SR4 monitors Beaver Dam Creek which drains a large portion of the VNP site, and is in the vicinity of the proposed dicharge. The exact location of the discharge has not been selected. Station SR5 is well below the plant site and there are no tributary streams in the immediate vicinity. Samples are taken at 6 week intervals. After nine sampling periods, the data will be reviewed and the sampling program will be altered if necessary.

Benthic stations 1 and 5 each have two styrofoam floats· one on each side of the river. Each float (Figure 2.7-4) supports two rock filled baskets, six Dendy multiplates and one diatometer with eight slides. Each time the artifical substrates are collected, five dredge samples of bottom sediment are collected. These dredge samples are usually taken at equal distances across a transect of the river. Localized deposits of mud are richer in fauna than the sandy bed and additional samples are taken in this substrate when possible. Stations 2, 3 and 4 have one float on the Georgia bank. Five dredge samples are collected in the vicinity of each float.

Artifical substrates are covered with a recovery bag or other device before the samples are removed from the water to reduce the loss of organisms during the recovery process. Samples are preserved immediately in a solution which contains at least 10% formaldehyde. All samples are initially washed in a U.S. No. 30 sieve.

Analysis of insect fauna studies in 1970 by the Academy of Natural Sciences of Philadelphia indicated that at river mile 162 there is a high organic pollution load on the river. (36) However, at river mile 132 the insect fauna, though showing some enrichment, is better balanced and healthier. (36)

Many aquatic invertebrates, especially the insects, have one year life cycles. Most non-insects spend the entire life cycle in water. Insects usually lay their eggs in the water in late spring and summer shortly after the adults have emerged. The eggs soon hatch and the larvae live in the water until the following spring when they emerge as adults. A brief natural history discussion follows for the common invertebrates of the Savannah River near VNP.

Scud - Hyallela

Habitat Preference - Mostly confined to the substrate in a wide variety of unpolluted streams, lakes, ponds, brooks, etc. (48)
Feeding Habits - Omnivorous, general scavengers. They will consume all kinds of plant and animal matter. Only rarely do they attack and feed on living animals. (48)
Breeding - Breeding takes place between February and October, depending on water temperature. Each female averages 15 broods in 152 days of breeding season. (48)

Leech - Hirudinea

Habitat Preference - Ponds, marshes, lakes, and slow streams where plants, stones and debris afford concealment.
Feeding Habits - Blood suckers, scavengers and predators.
Breeding - Most leeches enclose eggs in a cocoon which is deposited on or in the substrate between May and August. Some species produce batches of eggs for periods of five to six months, and empty cocoons may be found as late as October or November.

Midges - Chironomidae

Habitat Preference - Larvae occur everywhere in aquatic vegetation and on the bottom of all types of bodies of fresh water. (48)
Feeding Habits - Larvae chiefly herbivorous and feed on algae, higher aquatic plants, and organic detrius. (48) Some are predaceous. (51)

Midges - Chironomidae con't

Breeding - Some species may have a number of generations each year, and may emerge as adults in such numbers as to become pests around lake and stream-side resorts. (48,51)

Planeria - <u>Dugesia</u>

Habitat Preference - May be found on or under stones in water with velocity up to 80-100 cm/sec. (50)
Feeding Habits - Living, dead or crushed animal matter. (48)
Breeding - Sex organs develop in cool months, lay eggs in May and June. Organs degenerate with warm weather - other reproduction by fission all year long. (48)

Aquatic Earthworms - Oligochaeta

Habitat Preference - Mud and debris of pools, ponds, streams and lakes. (48)
Feeding Habits - Mud, leaves, etc. which settle out of the water. (48)
Breeding - Cocoons of embryos are deposited on rocks, vegetation, debris in late summer and early fall. (48)

Snails - <u>Physa</u> and <u>Gyraulus</u>

Habitat Preference - Shallow area of reasonably clean, alkaline streams and lakes. In greatest abundance near moderate amounts of aquatic vegetation and organic debris. (48,52)
Feeding Habits - Living algae on submerged surfaces. Also dead algae and dead animal material. (48)
Breeding - Oviposition occurs in spring and may continue into summer and early fall. (48)

Dance Flies - Empididae

Habitat Preference - Adults frequent moist situations. Some species live along seashore. Larvae are aquatic. (51)
Feeding Habits - Adults feed on small invertebrates at water's edge, larvae have been known to feed on larvae of <u>Simulium</u> in swift streams. (51)

Dance Flies - Empididae con't

Breeding - The immature stages of most groups, where known, breed in damp earth, decaying wood or vegetation, usually in wooded areas or under bark of trees.(51)

Black Flies - Simuliidae

Habitat Preference - Larvae occur in the shallows of swift water. They are tightly attached to rocks and vegetation. Adults live near the stream or river. (48)

Feeding Habits - Plankton and organic debris strained from water by anterior fans. (48)

Breeding - May be from one to several generations per year, and adults be present in such numbers during certain times of the year as to be unbearable. Females produce irritating bites on warm blooded animals, and may cause great damage to livestock(48)

Caddisfly - Cheumatopsycle

Habitat Preference - Larvae live in retreats constructed of a net spun in the current of smaller and warmer rivers than Hydropsyche. (49)

Feeding Habits - Diatoms, algae and higher plants.

Breeding - Adults crawl into water and lay eggs on or under sticks or stones. (49)

Caddisfly - Hydropsyche

Habitat Preference - Larvae build tubelike retreat concealed in a crevice or camouflaged by bits of wood, vegetation or other material. Most often found in larger, cooler streams than the Cheumatopsyche (49,51)

Feeding Habits - Feed on a preponderance of diatoms, other algae, and higher plant. (48)

Breeding - Adults attach eggs to submerged objects. (51)

Caddisfly - Neureclipsis

Habitat Preference - Larvae build retreats such as silken

Caddisfly - <u>Neureclipsis</u> con't

tunnels on aquatic plants or burrow into sandy stream beds. Most abundant in rivers of moderate to rapid flow.(49)

Feeding Habits - Diatoms, algae and higher plants. (48)

Breeding - Adults attach eggs to submerged objects. (51)

Caddisfly - <u>Oecetis</u>

Habitat Preference - The larvae build a case which is constructed of sand grains cemented together.(53) Abundant in streams flakes in well-aerated water.(49)

Feeding Habits - Predaceous on other invertebrates. (53)

Breeding - Adults attach eggs to submerged objects. (51)

Table 2.7-27

SUMMARY OF AQUATIC INVERTEBRATES OF SAVANNAH RIVER$^{(28)}$

Group	Number of species	More common representative(s)
Sponges	3	Spongilla fragilis
Flatworms	1	Dugesia tigrina
Nemertean worms	1	Prostoma rubrum
Rotifers	48	Bdeloid rotifers
Bryozoans	4	Plumatella repens Fredericella sultana
Segmented worms	16	Limnodrilus hoffmeisterii
Clams	11	Elliptio hopetonensis Lampsilis dolabraeformis
Snails	5	Physa heterostropha Physa columnella
Water fleas	2	
Aquatic sow bugs	1	Ascellus communis
Scuds	3	Hyalella azteca
Fresh water shrimps	3	Palaemonetes paludosus
Crayfishes	1	Procambarus pubescens
Stoneflies	13	Perlesta placida Taeniopterix nivalis
Mayflies	33	Heptagenia Isonychia Stenonema
Dragonflies, damselflies	27	Ischnura

Table 2.7-27 (Cont.)

Group	Number of species	More common representative(s)
True bugs	21	
Dobsonflies	1	*Corydalus cornutus*
Caddisflies	18	*Chimarra* *Cheumatopsyche* *Hydropsyche*
Aquatic beetles	88	Elmidae
Two-wing flies	59	Chironomidae

Table 2.7-28

COMMON AQUATIC INVERTEBRATES OF THE SAVANNAH RIVER BETWEEN RIVER MILES 145 AND 159

	Relative Abundance
Coelenterata	
Hydrozoa: *Hydra*	1
Platyhelminthes	
Turbellaria	
Tricladia	
Planariidae: *Dugesia*	149
Unidentified Turbellarian	1
Aschelminthes	
Nematoda	31
Bryozoa	
Phylactolaemata: *Pectinatella*	Present
Annelida	
Polychaeta: *Manyunkia*	4
Oligochaeta	2088
Hirudinea: Species 1	42
Species 2	171
Arthropoda	
Arachnida	
Acarina	
Acari: Hydracarina	25
Crustacea	
Cladocera	1
Eucopepoda	1
Amphipoda	
Talitridae: *Hyallela*	160
Isopoda	
Asellidae: *Asellus*	3
Insecta	
Coleoptera	
Dytiscidae: *Oreodytes*	21
Elmidae: *Ancyronyx*	3
Stenelmis	1
Other Elmidae	4

Table 2.7-28 (Cont.)

	Relative Abundance
Diptera	
Chironomidae	5310
Empididae	150
Simuliidae	105
Unidentified Dipteran	1
Ephemeroptera	
Baetidae: *Baetis*	1
Leptophlebia	1
Pseudocloeon	1
Unidentified Baetidae	1
Ephemeridae: *Brachycercus*	1
Caenidae: *Caenis*	4
Ephemerellidae: *Ephemerella* sp. 1	2
Ephemerella sp. 2	1
Heptageniidae: *Heptagenia* sp. 1	10
Heptagenia sp. 2	4
Stenonema	34
Siphlonuridae: *Isonychia*	2
Tricorythidae: *Tricorythodes*	1
Unidentified Ephemeropteran	1
Odonata	
Agrionidae: *Argia*	1
Agrion	1
Ischnura	4
Plecoptera	
Nemouridae: *Taeniopteryx*	6
Unidentified Nemouridae	1
Perlidae: *Acroneuria*	3
Perlesta	1
Perlodidae: *Isogenus*	6
Unidentified Plecopteran	1
Trichoptera	
Hydropsychidae: *Cheumatopsyche*	158
Diplectrona	2
Hydropsyche	519
Macronemum	2
Hydroptilidae: *Ochrotrichia*	3
Leptoceridae: *Oecetis*	9
Philopotamidae: *Chimarra*	100
Psychomyiidae: *Cyrnellus*	50
Neureclipsis	139
Unidentified Trichopteran	1

Table 2.7-28 (Cont.)

	Relative Abundance
Neuroptera	
Sisyridae: Climacia	1
Mollusca	
Unidentified Mollusca	2
Gastropoda	
Basommatophora	
Physidae: Physa	403
Planorbidae: Gyraulus	117
Mesogastropoda	
Bulimidae: Amnicola	6
Pelecypoda	
Heterodonta	
Sphaeriidae: Musculium	21
Pisidium	1

Data based on survey by GPC personnel. Data is preliminary and subject to minor revisions. See text for explanation of table.

Table 2.7-29

Aquatic Invertebrate Sampling Data for October 1971

Station	1	2	3	4	5	Total
Dugesia	12	7	33	2	92	146
Turbellarian		1				1
Nematoda	10	3	11			24
Manyunkia	2					2
Oligochaeta	664	298	123	182	242	1509
Leech sp. 1		3		9	30	42
Leech sp. 2	45		25	23	77	170
Hydracarina	2		6	2	4	14
Copepoda		1				1
Hyallela		55				55
Oreodytes	1	4				5
Ancyronyx			3			3
Elmidae		2			2	4
Chironomidae	180	455	136	173	200	1144
Empididae	92		39	11	2	144
Simuliidae				1	98	99
Dipteran			1			1
Baetidae					1	1
Caenis		3				3
Heptagenia sp. 1	1					1
Stenonema	1		3	9	8	21
Isonychia			1	1		2
Ephemeropteran			1			1
Argia					1	1
Nemouridae					1	1
Plecopteran					1	1
Cheumatopsyche	10		57	8	39	114
Diplectrona			2			2
Hydropsyche	122		206	28	66	422
Macronemum			1		1	2
Parapsyche	1		1			2
Oecetis	1	1	1	5		8
Chimarra	8		53	6	21	88
Neureclipsis	24	1	70	28	16	139
Molluscan	2					2
Physa	21	4	9	24	334	392
Gyraulus	1	1		3	112	117
Amnicola	1				5	6
Musculium	2				19	21
No. Samples	7	6	7	6	7	33
No. Species	22	15	21	17	23	39
No. Individuals	1203	839	782	515	1372	4711
HBAR	2.25	1.57	3.17	2.63	3.31	3.15
RED	0.52	0.63	0.30	0.39	0.28	0.42

Data is preliminary and subject to minor revision.

Table 2.7-30

Aquatic Invertebrate Sampling Data for January 1972

Station	1	2	3	4	5	Total
Dugesia	2					2
Nematoda		1	1			2
Oligochaeta		60		4	5	69
Hydracarina				1		1
Hyalella		2		1	1	4
Oreodytes				1		1
Chironomidae	314	386	764	299	977	2740
Empididae			2			2
Simuliidae	1		1	1	3	6
Baetis	1					1
Pseudocloeon					1	1
Heptagenia sp. 1				2	5	7
Stenonema	1		1	3	4	9
Taeniopteryx				2	2	4
Acroneuria	1		1			2
Cheumatopsyche	1		10	8	20	39
Hydropsyche	14		12	18	34	78
Chimarra			1	1	9	11
Cyrnellus			7	10	7	24
No. Samples	7	7	7	7	7	35
No. Species	8	4	10	13	12	19
No. Individuals	335	449	800	351	1068	3003
HBAR	0.45	0.63	0.38	1.03	0.65	0.68
RED	0.91	0.71	0.92	0.80	0.85	0.86

Data is preliminary and subject to minor revision.

Table 2.7-31

Aquatic Invertebrate Sampling Data for February 1972

Station	1	2	3	4	5	Total
Hydra			1			1
Dugesia			1			1
Nematoda	2	1	1	1		1
Manayunkia	2					2
Oligochaeta	80	142	170	12	6	510
Leech sp. 2			1			1
Hydracarina	1	2	5	1	1	10
Cladocera			1			1
Hyallela	3	76	20	2		101
Asellus	1		2			3
Oreodytes	1	12	2			15
Stenelmis					1	1
Chironomidae	134	288	312	198	494	1426
Empididae	3		1			4
Leptophlebia	1					1
Brachycercus		1				1
Caenis		1				1
Ephemerella sp. 1	1	1				2
Ephemerella sp. 2		1				1
Heptagenia sp. 1		1			1	2
Heptagenia sp. 2				2	2	4
Stenonema	1			2	1	4
Tricorythodes		1				1
Agrion	1					1
Ischnura		1	2	1		4
Acroneuria					1	1
Taeniopteryx				2		2
Perlesta	1					1
Isogenus				6		6
Cheumatopsyche					5	5
Hydropsyche				14	5	19
Ochrotrichia	1		2			3
Oecetis		1				1
Chimarra				1		1
Cyrnellus	2		13	10	1	26
Trichopteran		1				1
Climacia					1	1
Physa	4		7			11

Table 2.7-31 (Cont.)

	1	2	3	4	5	Total
Pisidium			1			1
No. Samples	1	7	6	1	6	21
No. Species	17	15	17	13	12	39
No. Individuals	239	530	542	252	519	2181
HBAR	1.73	1.72	1.68	1.38	0.43	1.64
RED	0.68	0.60	0.64	0.71	0.94	0.72

Data is preliminary and subject to minor revision

2.7.10 FISHES

Table 2.7-32 lists the species of fishes of the Savannah River that have been collected between river miles 123 and 162.(28) Anadromous species included in this list are Blueback herring, Hogchokers, Hickory shad, American shad, Needlefish, and Striped bass. Catadramous species consist only of the American eel. White mullet migrate upstream more than 150 miles, but do not utilize the fresh water areas as spawning or nursery grounds. All other species listed are resident fishes. A more complete listing of the fishes of the entire Savannah River drainage is in Dahlberg and Scott.(54)

The Savannah River was recently re-opened for sport fishing after being closed to prevent harvest of food fish contaminated by mercury. A creel census is now possible, and is certainly in order. Hopefully, this data will be available from state agencies soon. An existing commercial fishery for American and Hickory shad can be evaluated only by gross catch. No recent study has been done to determine the status of this fishery or the degree of utilization of the Savannah River by adult and juvenile clupeids. There is a commercial fishery for Channel catfish in the Savannah River, but apparently the bulk of this catch is marketed locally, and no catch records are available.

The fish study conducted by GPC is designed to enact as nearly a complete population inventory as is possible in a high flow stream without exerting obvious stress on the population. Consequently, no rotenone studies are planned. The wide range of gear used will enable GPC to sample all types of habitat, and will relieve selectivity. All sampling efforts will be kept as small as possible and still yield representative catches. At this time, GPC is sampling fish forms in the Savannah River on 1/2 mile fixed range stations at river miles 153 and 128. These stations include the following habitat types found in the Savannah River; oxbows, eddies behind dikes, mid-channel, front of sand bars (spoil piles), back of sand bars, and tributary streams. It should be noted that since this river channel is maintained by dredging, normal sand bar habitat is extremely limited. Samples of adult, juvenile, and planktonic fish forms are being taken at six week intervals with electroshockers, seines, trawls, gill nets, and drift nets. After nine sampling periods, the data collected will be reviewed and the sampling program will be altered if necessary. Length and weight measures are recorded on all adult fish caught. Stomachs are taken from representative specimens. Analysis of gut contents data will be used to help define food web structure. Scales are taken from representative specimens and will be used to define year class composition.

Gill net data on fishes taken to date by GPC personnel are presented in Tables 2.7-33, -34, and -36. Standard errors are given for length and weight means of species having five or more individuals. HBAR and RED are given for each data set and were explained in Subsection 2.7.9.

Gill net samples for September were taken in oxbows with separate panels of 2, 3, 4 and 5 inch stretched mesh monofilament gill nets 200 feet long. These nets were set in a saturation pattern with the 5 inch netting downflow followed by 4, 3, and 2 inch netting. The nets were fished at night for 8 hours.

In May the same technique was used except that 300 foot multifilament panels were used. Monofilament nets were adopted because it was felt that the almost invisible webbing would be more efficient. Panels were shortened to 200 feet in an effort to decrease impact on the biota as well as time needed to process samples.

Electrofishing samples are taken in oxbows and mid channel with a boat mounted Smith/Root Type VI Electrofisher. Each station is subjected to 2000 seconds of effort every six weeks. A Smith/Root Type V back pack mounted Electrofisher is utilized in shallow, backwater areas. Seine samples are taken with 1/4 inch bar mesh 60 foot bag seines. Each station effort consists of not less than three 50 meter hauls. This effort is confined to bars formed by spoil piles placed behind numerous dikes, and is also limited by river level. Seine samples can be taken only during low water periods. Trawl samples are taken with a Cobb Midwater Trawl (modified).• This trawl functions well in mid-channel water, and will sample pelagic juvenile fish forms. Assessment of juvenile clupeid populations will be possible with this type of gear. Drift net samples are taken with 1 meter # 00 mesh nets set in mid-channel for 15 minutes. Each station is sampled 4 times; twice at the surface and twice on the bottom. Drift net samples yield information on fish eggs and larvae as well as additional data on invertebrate populations.

By agreement with the Georgia Natural Resources Commission, Game and Fish Division, all non-game fish taken during this survey are destroyed. All viable game fish are released; non-viable game fish are destroyed or turned over to charitable organizations.

Table 2.7-32

FISHES OF THE SAVANNAH RIVER[28]

Scientific Name	Common Name
Amia calva	Bowfin
Lepisosteus osseus	Longnose gar
Lepisosteus oculatus	Spotted gar
Lepisosteus platyrhincus	Florida gar
Alosa aestivalis	Blueback herring
Alsoa mediocris	Hickory shad
Alosa sapidissima	American shad
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Threadfin shad
Esox americanus	Redfin pickerel
Esox niger	Chain pickerel
Umbra pygmaea	Eastern mudminnow
Cyprinus carpio	Carp
Hybognathus nuchalis	Silvery minnow
Hybopsis bellica	Alabama chub
Hybopsis rubrifrons	Rosyface chub
Notropis chalybaeus	Ironcolor shiner
Notropis cummingsae	Cumming's shiner
Notropis hudsonius	Spottail shiner
Notropis leedsi	Leed's shiner
Notropis maculatus	Taillight shiner

Table 2.7-32 (Cont.)

Scientific Name	Common Name
Notropis niveus	Snowy shiner
Notropis petersoni	Coastal shiner
Notemigonus crysoleucas	Golden shiner
Carpiodes carpio	River carpsucker
Carpiodes cyprinus	Quillback
Carpiodes velifer	Highfin carpsucker
Erimyzon oblongus	Creek chubsucker
Erimyzon sucetta	Lake chubsucker
Noturus gyrinus	Tadpole madtom
Noturus insignis	Margined madtom
Noturus leptacanthus	Speckled madtom
Ictalurus catus	White catfish
Ictalurus punctatus	Channel catfish
Ictalurus natalis	Yellow bullhead
Ictalurus nebulosus	Brown bullhead
Ictalurus platycephalus	Flat bullhead
Aphredoderus savanus	Pirate perch
Gambusia affinis	Mosquitofish
Anguilla rostrata	American eel
Morone saxatilis	Striped bass
Elassoma zonatum	Banded pygmy sunfish
Micropterus coosae	Redeye bass
Micropterus salmoides	Largemouth bass

Table 2.7-32 (Cont.)

Enneacanthus gloriosus	Bluespotted sunfish
Lepomis auritus	Redbreast sunfish
Lepomis cyanellus	Green sunfish
Lepomis macrochirus	Bluegill
Lepomis marginatus	Dollar sunfish
Lepomis megalotis	Longear sunfish
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Chaenobryttus gulosus	Warmouth
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Centrarchus macropterus	Flier
Perca flavescens	Yellow perch
Etheostoma fusiforme	Swamp darter
Etheostoma olmstedi	Tessellated darter
Percina caprodes	Logperch
Percina nigrofasciata	Blackbanded darter
Minytrema melanops	Spotted sucker
Opsopoedus emiliae	Pugnose minnow
Lapidesthes sicculus	Brook silverside
Fundulus notti	Starhead minnow
Trinectes maculatus	Hogchoker
Mugil curema	White mullet

Table 2.7-33

NUMBER, LENGTH, AND WEIGHT OF COMMON FISH SPECIES OF SAVANNAH RIVER, STATION 2, MAY, 1972

Species	Number	Length Min. - Max. (mm)	Mean Length ±1 S. E. (mm)	Weight Min. - Max. (kg)	Mean Weight ±1 S. E. (kg)	Weight Total (kg)
Gizzard Shad	133	120 - 400	212.4 + 6.5	0.10 - 0.90	0.21 + .02	27.80
Channel Catfish	24	230 - 705	506.0 ∓ 21.7	0.30 - 4.00	1.86 ∓ .21	44.60
Spotted Sucker	20	365 - 500	480.5 ∓ 8.8	0.70 - 1.50	1.05 ∓ .06	20.90
Long-Nose Gar	12	395 - 940	654.6 ∓ 57.9	0.20 - 2.80	1.02 ∓ .28	12.20
Carpsucker	9	385 - 600	438.9 ∓ 23.7	0.70 - 2.00	1.07 ∓ .15	9.60
White Catfish	9	300 - 390	340.0 ∓ 9.7	0.50 - 1.00	0.64 ∓ .05	5.80
Redear Sunfish	0	170 - 240	193.9 ∓ 8.3	0.10 - 0.30	0.14 ∓ .02	1.30
Yellow Bullhead	6	250 - 350	308.3 ∓ 15.5	0.30 - 0.60	0.45 ∓ .05	2.70
Warmouth	6	185 - 205	195.0 ∓ 5.0	0.10 - 0.20	0.13 ∓ .02	0.80
Brown Bullhead	5	295 - 325	308.0 ∓ 6.1	0.50 - 0.50	0.50 ∓ .00	2.50
White Sucker	5	375 - 500	418.0 ∓ 21.5	0.70 - 1.60	0.96	4.80
American Shad	4	480 - 560	520.0	1.00 - 1.70	1.28	5.10
Bowfin	4	500 - 530	517.5	1.40 - 1.50	1.43	5.70
Bluegill	2	140 - 195	167.5	0.10 - 0.30	0.20	0.40
Florida Gar	1	600 - 600	600.0	0.70 - 0.70	0.70	0.70
Striped Bass	1	860 - 860	860.0	10.00 - 10.00	10.00	10.00
Round Flyer	1	290 - 290	290.0	0.20 - 0.20	0.20	0.20
Golden Shiner	1	235 - 235	235.0	0.10 - 0.10	0.10	0.10
Hifin Carpsucker	1	500 - 500	500.0	1.40 - 1.40	1.40	1.40

No. Species = 19
No. Individuals = 257
HBAR = 2.72
RED = 0.43

Data is preliminary and subject to minor revision.

Table 2.7-34

NUMBER, LENGTH, AND WEIGHT OF COMMON FISH SPECIES OF SAVANNAH RIVER, STATION, STATION 4, MAY, 1972

Species	Number	Length Min. - Max. (mm)	Mean Length ±1 S. E. (mm)	Weight Min. - Max. (kg)	Mean Weight ±1 S. E. (kg)	Weight Total (kg)
Gizzard Shad	106	125 - 385	259.2 + 7.1	0.10 - 0.70	0.23 + .01	24.70
Channel Catfish	16	385 - 640	504.7 ∓ 19.5	0.60 - 3.50	1.65 ∓ .21	26.40
Spotted Sucker	9	380 - 465	425.6 ∓ 10.2	0.70 - 1.20	0.99 ∓ .06	8.90
White Sucker	8	390 - 495	451.9 ∓ 13.3	0.70 - 1.50	1.18 ∓ .11	9.40
Carp	7	360 - 680	505.0 ∓ 40.8	0.90 - 5.40	2.27 ∓ .59	15.90
Pickeral	7	450 - 540	492.9 ∓ 16.4	0.70 - 1.40	0.90 ∓ .10	6.30
Long-Nose Gar	6	375 - 770	610.8 ∓ 74.3	0.10 - 2.30	1.30 ∓ .38	6.20
Redear Sunfish	6	185 - 260	210.0 ∓ 11.9	0.10 - 0.50	0.23 ∓ .06	1.40
Warmouth	3	190 - 200	193.3	0.10 - 0.20	0.13	0.40
Redbreast	3	180 - 195	185.0	0.10 - 0.30	0.17	0.50
Carpsucker	2	465 - 495	480.0	1.50 - 2.00	1.75	3.50
Bowfin	2	560 - 600	580.0	2.10 - 2.50	2.30	4.60
Brown Bullhead	2	310 - 320	315.0	0.50 - 0.50	0.50	1.00
Bluegill	2	250 - 320	285.0	0.50 - 0.50	0.50	1.00
American Shad	1	545 - 545	545.0	1.20 - 1.20	1.20	1.20
Black Crappie	1	210 - 210	210.0	0.10 - 0.10	0.10	0.10
White Catfish	1	340 - 340	340.0	0.60 - 0.60	0.60	0.60
Yellow Bullhead	1	255 - 255	255.0	0.20 - 0.20	0.20	0.20
White Mullet	1	360 - 360	360.0	0.60 - 0.60	0.60	0.60

No. Species	19
No. Individuals	185
HBAR =	2.57
RED =	0.50

Data is preliminary and subject to minor revision.

Table 2.7-35

NUMBER, LENGTH, AND WEIGHT OF COMMON FISH SPECIES OF SAVANNAH RIVER, STATION 2, SEPTEMBER, 1972

Species	Number	Length Min. - Max. (mm)	Mean Length ±1 S. E. (mm)	Weight Min. - Max. (kg)	Mean Weight ±1 S. E. (kg)	Weight Total (kg)
Gizzard Shad	75	155 - 410	344.3 ± 3.9	.10 - 1.10	.48 ± .02	36.30
Long Nose Gar	50	450 - 695	547.6 ± 8.2	.20 - .80	.42 ± .03	20.90
Spotted Sucker	28	215 - 510	437.5 ± 16.5	.10 - 1.60	1.14 ± .08	31.90
Channel Catfish	9	290 - 785	511.1 ± 58.9	.20 - 5.80	2.04 ± .71	18.40
Black Crappie	6	200 - 295	247.0 ± 15.0	.10 - .80	.25 ± .11	1.50
Striped Bass	4	420 - 600	506.3	.70 - 2.00	1.28	5.10
White Mullet	4	335 - 440	406.3	.50 - .90	.80	3.20
Bowfin	2	605 - 800	702.5	1.80 - 4.40	3.10	6.20
Carp	2	700 - 710	705.0	5.10 - 5.20	5.15	10.30
Florida Gar	1	475 - 475	475.0	.30 - .30	.30	.30

No. Species = 10
No. Individuals= 181
HBAR = 2.27
RED = 0.37

Data is preliminary and subject to minor revision.

Table 2.7-36

NUMBER, LENGTH, AND WEIGHT OF COMMON FISH SPECIES OF SAVANNAH RIVER, STATION 4, SEPTEMBER, 1972

Species	Number	Length Min. - Max. (mm)	Mean Length ±1 S. E. (mm)	Weight Min. - Max. (kg)	Mean Weight ±1 S. E. (kg)	Weight Total (kg)
Gizzard Shad	69	275 - 415	385.5 ± 11.5	.20 - .90	.54 ± .02	37.00
Long-Nose Gar	44	475 - 760	579.8 ± 3.9	.20 - .90	.51 ± .03	22.60
Spotted Sucker	13	330 - 495	434.2 ± 8.6	.50 - 1.40	1.01 ± .06	13.10
Bowfin	6	275 - 540	477.5 ± 43.2	.30 - 1.60	1.25 ± .20	7.50
Black Crappie	4	175 - 300	295.0	.10 - .50	.23	.90
Carpsucker	4	370 - 450	412.5	.80 - 1.10	1.03	4.10
Chain Pickeral	3	355 - 550	468.3	.20 - 1.10	.73	2.20
Channel Catfish	3	410 - 495	443.0	.70 - .80	.77	2.30
White Catfish	3	200 - 470	311.7	.10 - 1.60	.63	1.90
Brown Bullhead	2	275 - 290	282.5	.20 - .30	.25	.50
Golden Shiner	2	230 - 230	230.0	.20 - .20	.20	.40
Florida Gar	1	485 - 485	485.0	.50 - .50	.50	.50
Flier	1	185 - 185	185.0	.10 - .10	.10	.10
Warmouth	1	140 - 140	140.0	.10 - .10	.10	.10

No. Species = 14
No. Individuals =161
HBAR = 2.48
RED = 0.43

Data is preliminary and subject to minor revision.

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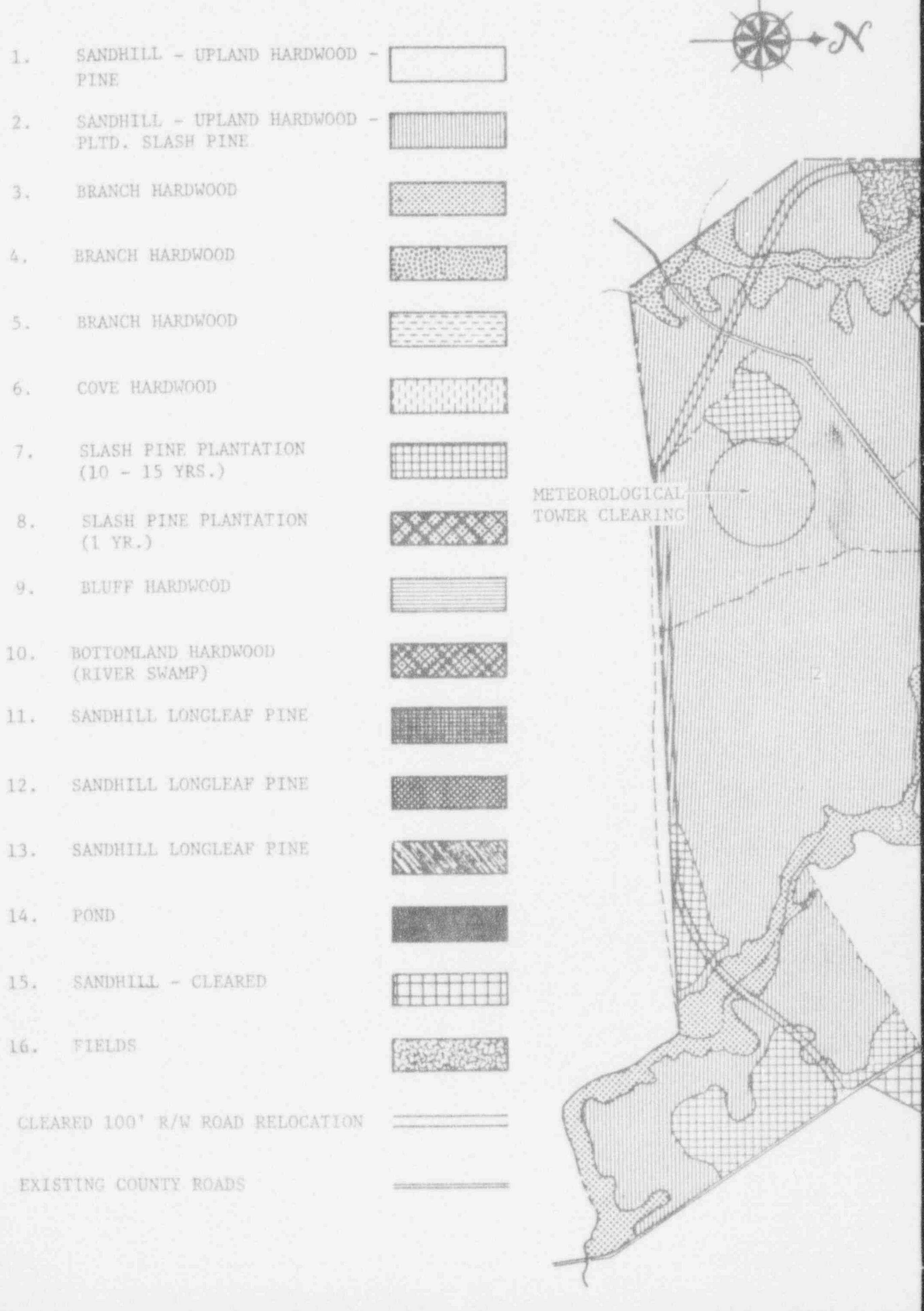
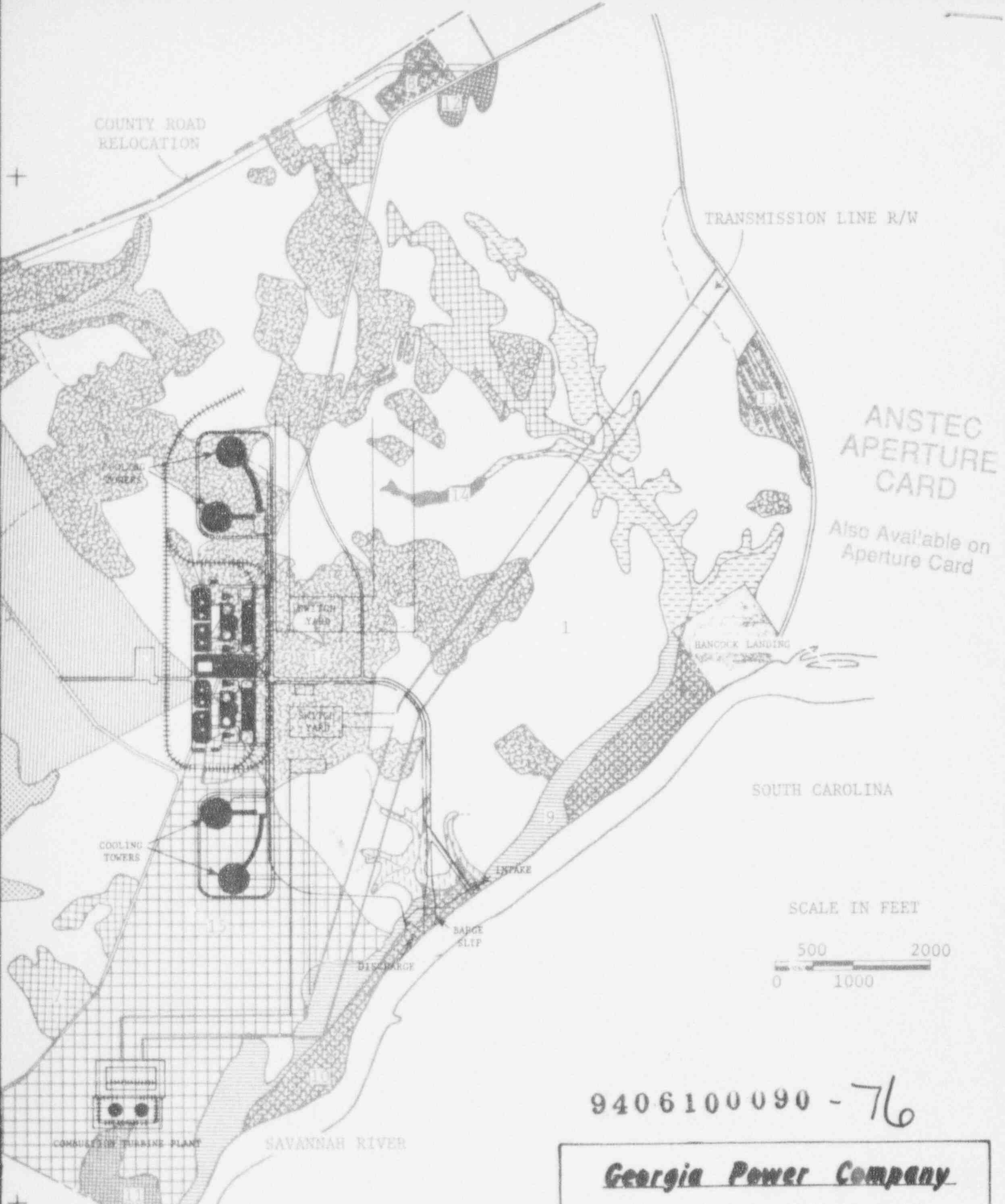

N
1. SANDHILL - UPLAND HARDWOOD - PINE
2. SANDHILL - UPLAND HARDWOOD - PLTD. SLASH PINE
3. BRANCH HARDWOOD
4. BRANCH HARDWOOD
5. BRANCH HARDWOOD
6. COVE HARDWOOD
7. SLASH PINE PLANTATION (10 - 15 YRS.)
8. SLASH PINE PLANTATION (1 YR.)
9. BLUFF HARDWOOD
10. BOTTOMLAND HARDWOOD (RIVER SWAMP)
11. SANDHILL LONGLEAF PINE
12. SANDHILL LONGLEAF PINE
13. SANDHILL LONGLEAF PINE
14. POND
15. SANDHILL - CLEARED
16. FIELDS
CLEARED 100' R/W ROAD RELOCATION
EXISTING COUNTY ROADS
METEOROLOGICAL TOWER CLEARING
2
3



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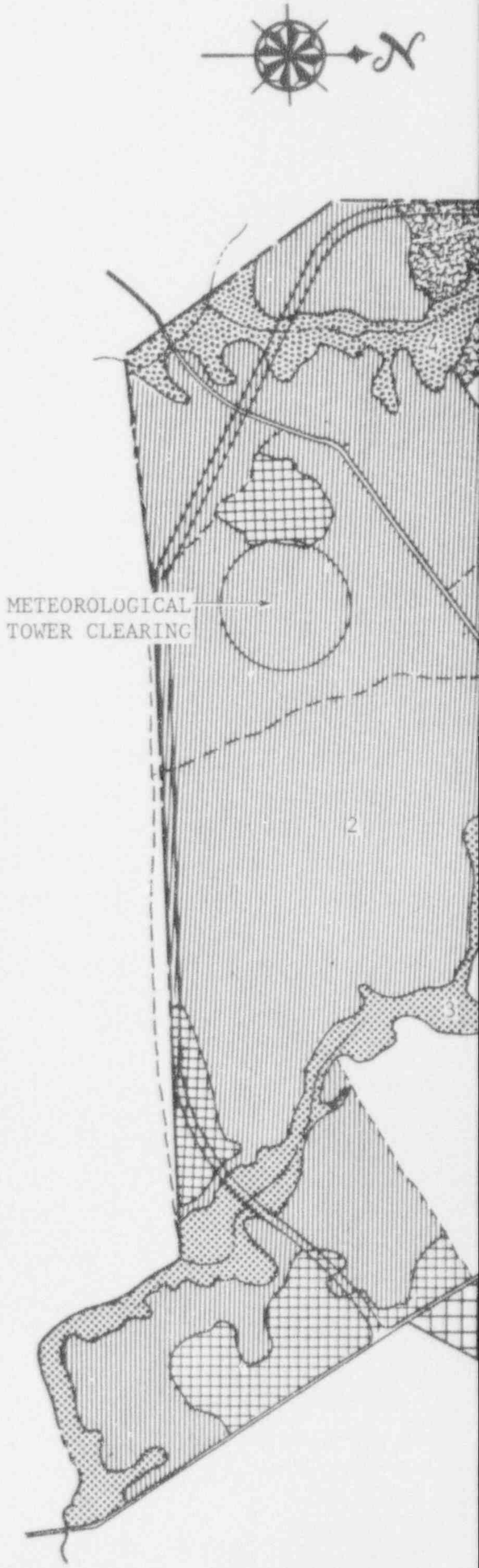
Georgia Power Company

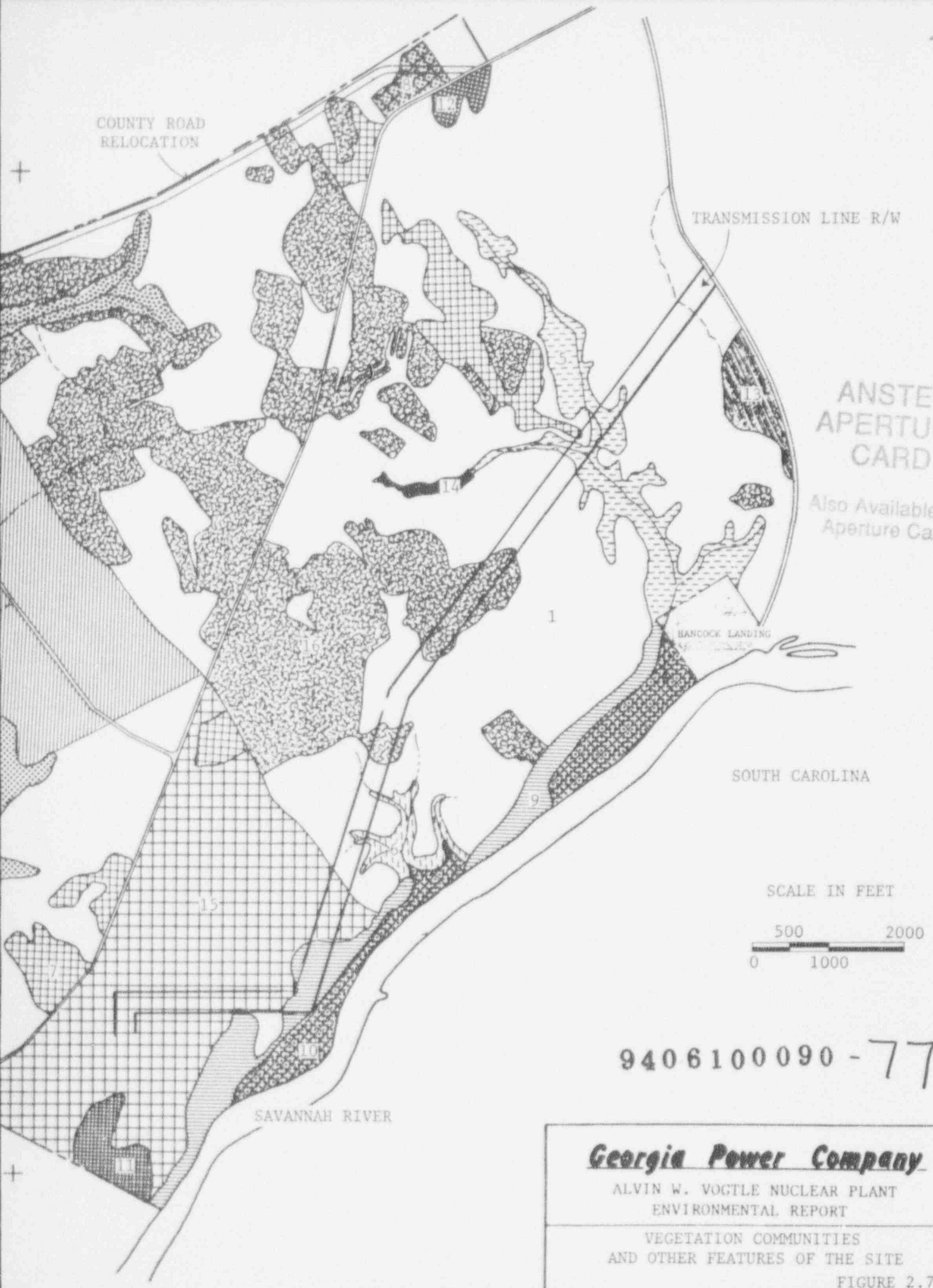
ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

OVERLAY SHOWING PHYSICAL EFFECTS OF THE PLANT ON THE LAND AREA.

FIGURE 2.7-1

1.	SANDHILL - UPLAND HARDWOOD - PINE	□
2.	SANDHILL - UPLAND HARDWOOD - PLTD. SLASH PINE	▥
3.	BRANCH HARDWOOD	▒
4.	BRANCH HARDWOOD	░
5.	BRANCH HARDWOOD	┅
6.	COVE HARDWOOD	▚
7.	SLASH PINE PLANTATION (10 - 15 YRS.)	▦
8.	SLASH PINE PLANTATION (1 YR.)	▩
9.	BLUFF HARDWOOD	▤
10.	BOTTOMLAND HARDWOOD (RIVER SWAMP)	▩
11.	SANDHILL LONGLEAF PINE	▓
12.	SANDHILL LONGLEAF PINE	▓
13.	SANDHILL LONGLEAF PINE	▧
14.	POND	■
15.	SANDHILL - CLEARED	⊞
16.	FIELDS	░
	CLEARED 100' R/W ROAD RELOCATION	═
	EXISTING COUNTY ROADS	─





9406100090 - 77

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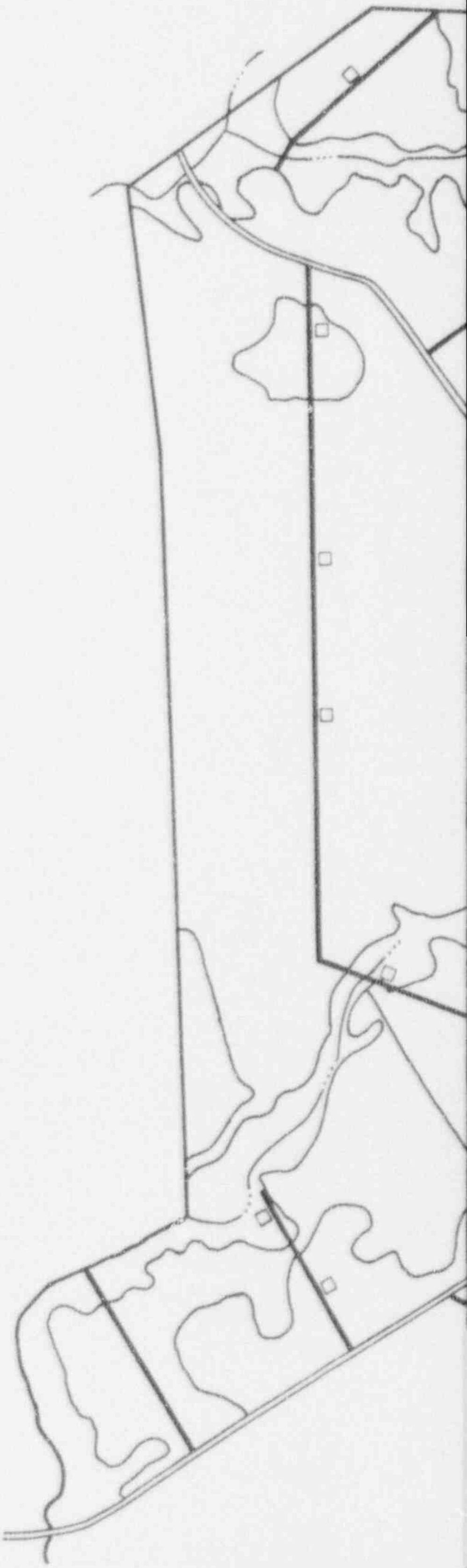
ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

VEGETATION COMMUNITIES
AND OTHER FEATURES OF THE SITE

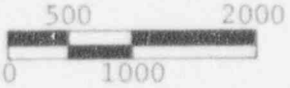
FIGURE 2.7-2

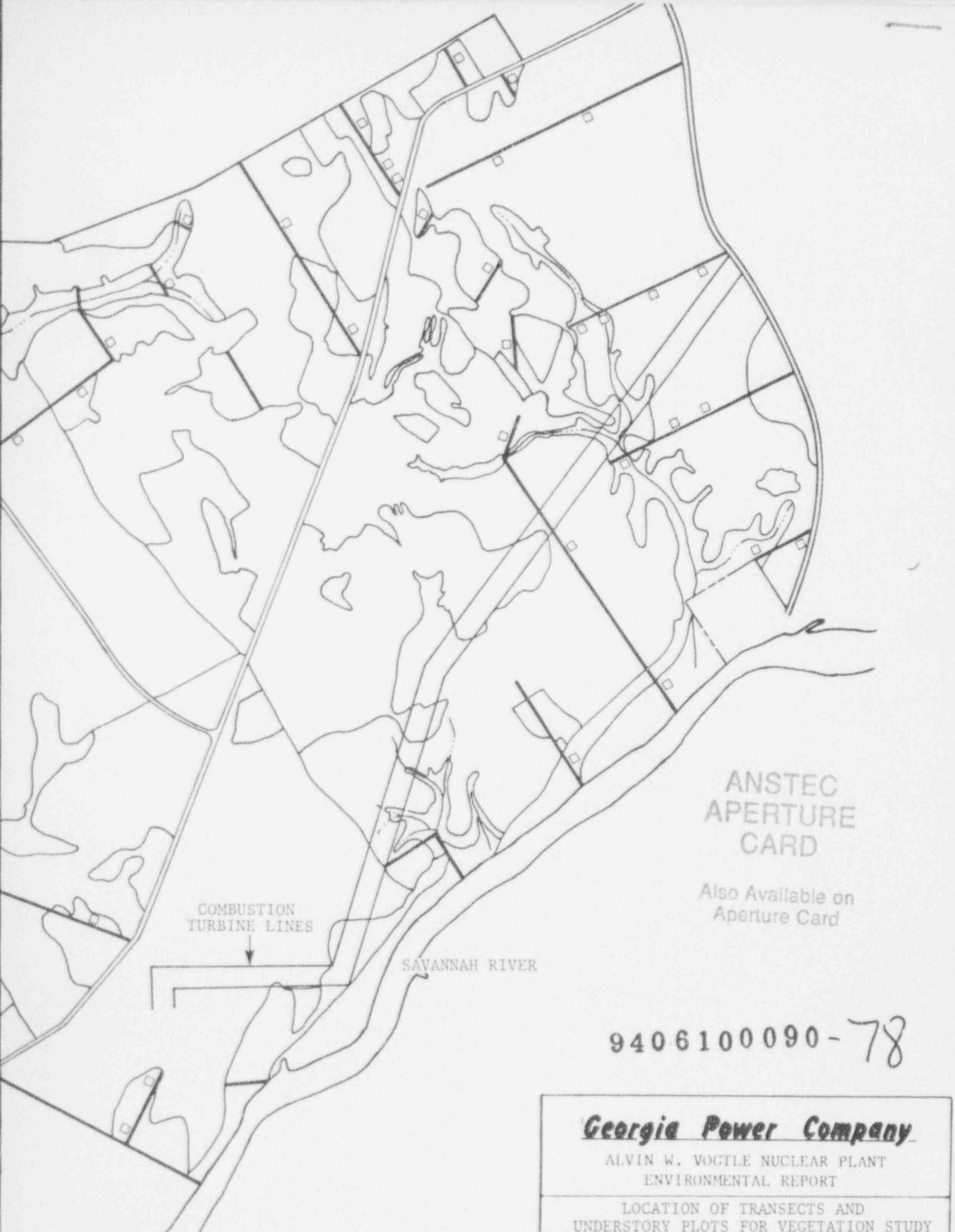


NOTES:

1. COUNTY ROADS ═
2. TRANSECTS (33" WIDE) ━
3. UNDERSTORY PLOT (.01 Ac.) □

SCALE IN FEET





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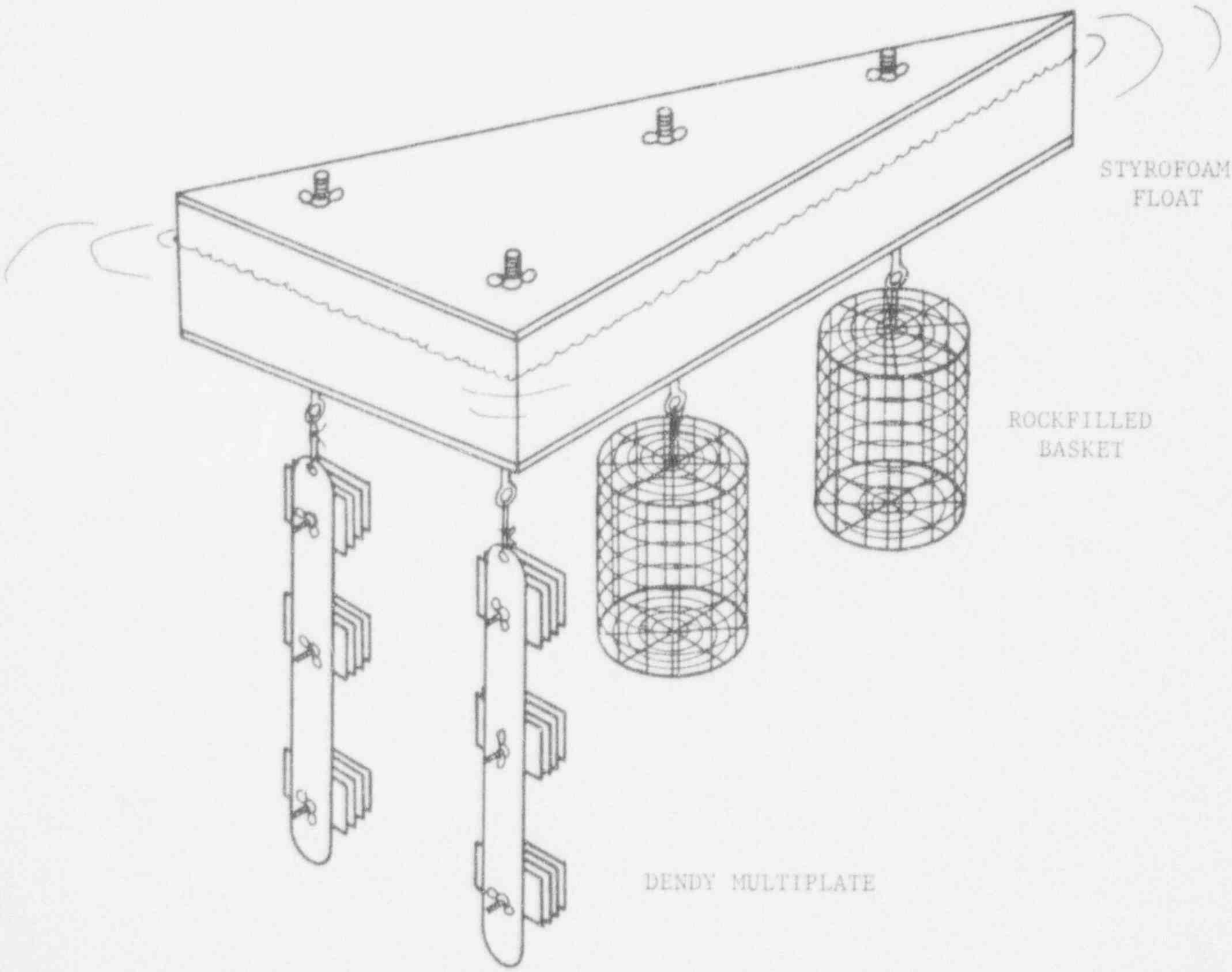
Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

LOCATION OF TRANSECTS AND
UNDERSTORY PLOTS FOR VEGETATION STUDY

FIGURE 2.7-3



Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

ARTIFICIAL SUBSTRATE FLOAT -
DIATOMETER IS NOT SHOWN

FIGURE 2.7-4

2.8 OTHER ENVIRONMENTAL FEATURES

2.8.1 SAVANNAH RIVER PLANT

The Savannah River Plant (SRP), built and operated for the Atomic Energy Commission by E. I. du Pont de Nemours and Company, occupies an area of 312 square miles on the South Carolina side of the Savannah River, 22 miles southwest of Augusta, Georgia.

The information and data contained in the following paragraphs of Section 2.8.1 were taken from Effect of the Savannah River Plant on Environmental Radioactivity, Semiannual Report, January through June, 1971 (DPSPU 71-30-16), except as noted.

SRP production facilities are located across the Savannah River from VNP, and include a fuel preparation area, 3 reactors, 2 fuel separation areas, and a heavy water production plant. These facilities release very low level radioactive gaseous and liquid wastes to the environment.

A continuous monitoring program to determine the concentration of radioactive material in a 1200-square mile area outside SRP has been in operation since 1951. Concentrations of radioactive materials in the atmosphere were measured by bi-weekly analyses of air filters collected at 5 monitoring stations near the plant perimeter and 10 stations around a circle of about a 25-mile radius from the center of the plant. Figure 2.8-1 shows the location of these environmental monitoring stations. Four additional air monitoring stations at Savannah and Macon, Georgia, and at Columbia and Greenville, South Carolina, serve as reference points for determining background radioactivity levels. Figure 2.8-2 shows the location of these distant air monitoring stations. The radioactivity in air, determined from filter analyses, is shown in Table 2.8-1.

The monitoring system used by SRP provides a means of differentiating between fallout and SRP releases. The influence of weapons tests on the amount of filterable beta activity in the air from 1961 to 1971 is given in Figure 2.8-3. The small amount of filterable beta radioactivity released to the atmosphere at SRP, primarily from the fuel separation areas, was obscured by the fallout. Deposition of fallout during January through June 1971 averaged 37 nCi/m^2 at the plant perimeter locations and 36 nCi/m^2 at the 25-mile radius locations. Deposition at each sampling location is presented in Table 2.8-2.

TABLE 2.8-1

RADIOACTIVITY IN AIR (FILTER ANALYSIS)

pCi/m^3

	Alpha Emitters (multiply by 10^{-3})			Nonvolatile Beta Emitters			Iodine-131				
	CG: 70			CG: 100			CG: 100				
	Sensitivity of Analysis: 0.3			Sensitivity of Analysis: 0.006			Sensitivity of Analysis: 0.02			Specific Radionuclides in Composite Samples	
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg		
Plant Perimeter Sampling Point											
A	1.3	0.5	0.8	0.70	0.10	0.35	ND	ND	ND	$^{89,90}Sr$	0.01
B	2.1	.7	1.0	.69	.06	.31	ND	ND	ND	^{137}Cs	0.01
C	1.6	6	0.9	.74	.09	.34	ND	ND	ND	$^{141,144}Ce$	0.07
D	1.3	.4	1.0	.86	.08	.41	0.02	ND	ND	$^{103,106}Ru$	0.10
E	1.0	.5	0.8	.68	.08	.34	0.08	ND	ND	$^{95}Zr-^{95}Nb$	0.18
All points			0.9			0.35			ND	^{7}Be	0.23
25-Mile-Radius Sampling Point											
Aiken Airport	1.7	0.4	0.8	0.67	0.06	0.31	ND	ND	ND		
Aiken State Park	1.6	.4	.8	.75	.08	.30	ND	ND	ND		
Allendale	1.5	.5	1.1	.67	.09	.32	ND	ND	ND	$^{89,90}Sr$	0.01
Barnwell	1.8	.5	1.3	.66	.08	.32	0.05	ND	ND	^{137}Cs	0.01
Bush Field	1.3	.7	1.0	.76	.08	.33	ND	ND	ND	$^{141,144}Ce$	0.07
Langley	1.6	.7	1.4	.86	.09	.36	ND	ND	ND	$^{103,106}Ru$	0.09
Sardis	1.2	.4	0.8	.68	.06	.31	ND	ND	ND	$^{95}Zr-^{95}Nb$	0.17
Waynesboro	1.4	.7	1.0	.75	.09	.35	ND	ND	ND	^{7}Be	0.24
Williston	1.5	.4	1.0	.71	.08	.32	ND	ND	ND		
Highway 301	1.3	ND	1.0	.73	.09	.32	ND	ND	ND		
All Points			1.0			0.32			ND		
Distant Sampling Points											
Columbis, S.C.	2.4	ND	1.1	0.93	0.06	0.34				$^{89,90}Sr$	0.01
Greenville, S.C.	1.2	0.5	0.8	.65	.06	.34				^{137}Cs	0.02
Macon, Ga.	1.8	ND	.8	.66	.04	.28				$^{141,144}Ce$	0.08
Savannah, Ga.	1.8	ND	.7	.73	.03	.32				$^{103,106}Ru$	0.09
All Points			0.8			0.32				$^{95}Zr-^{95}Nb$	0.19
										^{7}Be	0.26

ND = Less than sensitivity of analysis.

Radion
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103,10

^{95}Zr -

^{58,60}C

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23

5

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13

3

Taken from Personal Communication
between Savannah River Plant and
Georgia Power Company.

TABLE 2.8-2

TOTAL FALLOUT DEPOSITED,
SAVANNAH RIVER PLANT, JANUARY - JUNE 1971.

uclides 2 >30 days)	To Streams					To K-Area Containment Basin	
	1966	1967	1968	1969	1970	1969	1970
^{4}Ce	19.6	16.6	34.6	5.4	2.7	7.8	4.3
^{6}Ru	0.9	1.0	1.8	0.5	0.1	1.3	1.7
^{95}Nb	7.0	4.8	8.1	3.6	2.8	1.3	7.4
^{65}Zn	7.4	7.1	4.5	1.5	0.5	0.6	-
o	4.6	1.1	1.2	0.2	0.2	0.7	0.1
^{89}Sr	6.1	8.4	28.9	8.8	8.3	45.6	38.4
^{90}Sr	4.3	4.6	5.2	3.3	2.9	3.6	1.6
^{37}Cs	36.7	46.9	41.2	20.0	20.6	2.7	8.1
^{91}Y	17.3	18.6	30.9	9.7	9.8	-	-
^{35}S	121.0	153.3	171.4	64.4	25.7	75.6	13.4
^{47}Pm	8.5	15.8	11.6	14.6	4.5	-	-
m$^{(a)}$	40,927	30,839	30,248	23,569	14,341	23,415	19,891

ritium releases from sources other than disassembly basin averaged ^{N}14,000 Ci each year.

REACTOR AREA WIER RELEASES TO STREAMS
AND K-AREA RELEASES TO THE CONTAINMENT BASIN

uclides 2 <30 days)	To Stream					To K-Area Containment Basin	
	1966	1967	1968	1969	1970	1960	1970
^{9}Np	27.9	36.4	20.2	25.7	0.5	1.0	0.2
^{1}Cr	627.9	235.8	83.0	68.5	15.9	295.4	6.9
^{0}La	1.6	4.2	8.8	1.3	0.3	17.8	11.2
^{1}I	3.0	13.3	9.2	5.0	2.2	14.4	3.2
^{2}P	10.2	4.1	2.4	0.7	0.8	-	-

Monthly measurements of environmental gamma radiation were made with thermoluminescent dosimeters. The data presented in Table 2.8-3 are characteristic of measurements observed by SRP at these stations for the past several years.

SRP releases low-level radioactive wastes to the Savannah River from its reactor facilities. SRP continuously samples the river water above and below its plant and analyzes the samples weekly. Sampling locations are shown in Figure 2.8-4. Table 2.8-4 shows the radioactivity for Savannah River water for January through June 1971. The upstream measurements in this table were attributed to natural radioactivity and worldwide fallout from nuclear weapons tests; the downstream measurements also reflect the operation of the SRP reactors. Table 2.8-5 indicates the average concentration of radionuclides in the Savannah River for the same period. The data in Table 2.8-6, obtained through personal communication between SRP and GPC, show the reactor area weir releases to streams and K-area releases to the containment basin for radionuclides with half-lives greater than 30 days and less than 30 days for 1966 through 1970. Figures 2.8-5, 2.8-6, 2.8-7, 2.8-8, and 2.8-9, also obtained through personal communication with SRP, show the concentration of tritium, ^{131}I, ^{137}Cs, ^{90}Sr, and nonvolatile beta, respectively, in river water for the indicated number of years.

Communities near SRP get domestic water from deep wells or surface streams. Table 2.8-7 gives the radioactivity in public water supplies in the vicinity of SRP. There is no evidence of SRP contributed radioactivity to the drinking water supplies, since the concentrations of alpha activity (1.1 pCi/liter) and beta activity (5 pCi/liter) were the same as observed before SRP startup.

Fish in the Savannah River were monitored by fish traps upstream, adjacent to, and downstream from SRP effluents. Concentrations of specific radionuclides ^{137}Cs, ^{89}Sr, ^{90}Sr, are presented in Table 2.8-8.

Radioactive contamination of growing plants was examined through the selection of Bermuda grass because of its importance as a pasture grass for dairy herds and its availability during all seasons of the year. The radioactivity present in the samples is presented in Table 2.8-9. Gamma-emitting radionuclides in the samples (except beryllium-7) were accumulated from fallout. Alpha emitters averaged 0.2 pCi/g at both locations during the last half year of 1970. Gamma ray emitters averaged 38.4 and 32.4 pCi/g, respectively, as compared to 11.1 and 9.9 pCi/g for the last half year of 1970.

Table 2.8-3

ENVIRONMENTAL GAMMA RADIATION
milliroentgens per 24 hours

THERMOLUMINESCENT DOSIMETER MEASUREMENT

Location	Maximum	Minimum	Average
Plant Perimeter			
A	0.25	0.11	0.20
B	.27	.08	.16
C	.20	.13	.16
D	.19	.12	.16
E	.20	.11	.18
All →			0.18
25-Mile Radius			
Aiken Airport	0.18	0.08	0.15
Aiken State Park	.15	.12	.14
Allendale	.19	.11	.15
Barnwell	.20	.16	.18
Bush Field	.25	.12	.19
Langley	.23	.14	.17
Sardis	.21	.14	.17
Waynesboro	.21	.08	.15
Williston	.20	.14	.17
Highway 301	0.25	0.12	0.20
All →			0.17

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16) p. 8

Table 2.8-4

RADIOACTIVITY IN SAVANNAH RIVER WATER, JANUARY - JUNE 1971

Sampling Points	Alpha radioactivity[a] (pCi/liter)				Nonvolatile beta radioactivity[b] (pCi/liter)			
	January-June 1971			July-December 1970	January-June 1971			July-December 1970
	Maximum	Minimum	Average	Average	Maximum	Minimum	Average	Average
1 Mile upstream from Upper Three Runs Creek (control)	0.4	ND	ND	ND	12	ND	4	4
8 Miles downstream from Lower Three Runs Creek	.6	ND	ND	ND	13	ND	6	7

a. AEC radiation protection standard: 10 pCi/liter. Sensitivity of analysis: 0.2 pCi/liter.

b. AEC radiation protection standard: 3 nCi/liter. Sensitivity of analysis: 4.0 pCi/liter.

ND, less than the sensitivity of analysis:

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16) p. 7

Table 2.8-5

AVERAGE CONCENTRATION OF RADIONUCLIDES IN SAVANNAH RIVER WATER
JANUARY - JUNE 1971

Radionuclides	Concentration (pCi/liter)			
	Sensitivity of analysis	Control (1 Mile upstream from Upper Three Runs Creek)	Highway 301 (8 miles downstream from Lower Three Runs Creek)	Percent AEC standard at Highway 301
Tritium	600	680	5800	0.19
Sulphur-35	5.0	ND	ND	$<$ 0.01
Chromium-51	4.3	ND	ND	$<$ 0.001
Manganese-54	0.4	ND	ND	$<$ 0.0004
Cobalt-60	1.4	ND	ND	$<$ 0.005
Zinc-65	1.1	ND	ND	$<$ 0.001
Strontium-89	0.3	ND	ND	0.02
Strontium-90	0.01	0.6	0.7	0.30
Zirconium-niobium-95	0.5	ND	ND	$<$ 0.001
Ruthenium-103,-106	3.2	ND	ND	$<$ 0.03
Iodine-131	0.2	ND	ND	$<$ 0.07
Cesium-134,-137	0.6	ND	0.2	0.001
Barium-lanthanum-140	1.6	ND	ND	$<$ 0.01
Cerium-141,-144	2.5	ND	ND	$<$ 0.02
Neptunium-239	2.2	ND	ND	$<$ 0.002

ND,nondectectable, less than sensitivity of analysis.

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-[illegible]). p. 13

Sampling points	Alpha[a]
Plant Perimeter	
A	3.5
B	4.3
C	4.3
D	3.3
E	3.1
Average	3.7
25-Mile Radius	
Aiken Airport	2.9
Aiken State Park	6.6
Allendale	3.7
Barnwell	4.5
Bush Field	4.0
Langley	4.9
Sardis	5.6
Waynesboro	3.1
Williston	3.0
Highway 301	2.1
Average	4.0

a Multiply by 10^{-2}.

b. A naturally occuring radionuclid
ND, less than the sensitivity of ana

Taken fr
River Pl
activity
June, 19

TABLE 2.8-6

REACTOR AREA WEIR RELEASES TO STREAMS AND K-AREA RELEASES TO THE CONTAINMENT BASIN

Radionuclide Concentration
(nCi/m^2)

rontium- 89	Strontium- 90	Cesium- 137	Cerium- 141,-144	Zirconium- niobium -95	Ruthenium- 103,-106	Iodine- 131	Beryllium- 7^b
1.3	0.8	1.8	10.2	10.8	6.1	ND	40.2
1.0	0.7	1.7	13.9	13.4	6.8	ND	48.4
2.0	0.8	2.1	15.3	14.7	7.1	ND	54.3
1.8	0.7	1.6	13.0	10.1	6.5	0.5	39.3
1.8	0.8	1.9	13.4	14.9	6.1	ND	47.7
1.6	0.8	1.8	13.2	12.8	6.5	.1	46.0
1.4	.9	2.1	14.9	20.6	6.5	ND	48.2
1.3	.8	1.8	10.3	13.7	5.6	ND	39.3
1.5	.7	1.6	11.5	15.2	5.8	ND	40.5
1.1	.5	1.2	7.8	10.7	5.1	ND	27.3
0.6	.8	1.9	14.8	16.9	6.0	ND	51.4
1.6	1.0	2.4	13.4	17.4	7.1	ND	53.7
1.1	.6	1.7	9.6	15.5	5.9	ND	33.3
1.6	.8	2.0	11.7	16.2	6.3	ND	41.7
1.5	.7	1.8	10.3	13.4	5.5	ND	40.7
0.5	.7	1.2	7.2	7.8	5.8	ND	25.1
1.2	.8	1.8	11.2	14.7	6.0	ND	40.1

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m "Effect of the Savannah
nt on Environmental Radio-
Semi-annual Report, January -
1" (DPSPU 71-30-16) p. 11

Table 2.8-7

RADIOACTIVITY IN PUBLIC WATER SUPPLIES
(pCi/liter)

April, 1971

	Alpha Emitters CG: 10 Sensitivity of Analysis: 0.2 April	Nonvolatile Beta Emitters CG: 3000 Sensitivity of Analysis: 4.0 April	Tritium CG: 3,000,000 Sensitivity of Analysis: 400 April	Source of Water
Aiken	2.7	6	750	Stream & well
Allendale	ND	ND	ND	Deep well
Augusta	0.3	ND	650	River
Barnwell	0.5	ND	ND	Deep Water
Bath	1.8	6	ND	Lake
Blackville	0.5	ND	ND	Deep well
Clearwater	0.7	ND	650	Lake
Jackson	8.2	18	ND	Deep well
Langley	3.6	7	430	Stream
New Ellenton	1.3	ND	ND	Deep well
North Augusta	0.4	ND	500	River
Sardis	ND	4	ND	Deep well
Waynesboro	ND	8	580	Stream
Williston	2.2	4	ND	Deep well
Average[a]	1.6	6		

a. If values are less than sensitivity of analysis, averages are calculated using the value of the sensitivity of the analysis.

ND, less than the sensitivity of analysis.

CG= concentration guides

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16). p. 12

Table 2.8-8

RADIOACTIVITY IN SAVANNAH RIVER FISH, JANUARY-JUNE 1971

Location	Number		Type of sample	Concentration (pCi/g wet weight)					
				Cesium 137				Strontium-89, 90	
	Bream	Cat-fish		Bream[a]		Catfish[b]		Bream and Catfish	
				Maximum	Average	Maximum	Average	Maximum	Average
Above plant boundary	18	75	Bone	NA	NA	NA	NA	23	12
			Flesh	25	3.2	15	3.6	NA	NA
Adjacent to plant	14	27	Bone	NA	NA	NA	NA	21	13
			Flesh	18	6.3	21	6.6	NA	NA
Below plant at Highway 301	89	22	Bone	NA	NA	NA	NA	9	8
			Flesh	20	4.5	11	4.9	NA	NA

a. Shellcracker, bluegill, and redbreast (*Lepomis*).

b. Predominantly yellow cat (*Ictalurus*).

NA, no analysis.

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16).

Table 2.8-9

RADIOACTIVITY ON VEGETATION, JANUARY - JUNE 1971

Radionuclides	Sensitivity of analysis	Concentration (pCi/g dry weight)			
		Plant perimeter (7 locations)		25-Mile radius (7 locations)	
		Maximum	Average	Maximum	Average
Alpha emitters	0.10	1.1	0.2	0.7	0.2
Cesium-137	.3	3.8	1.6	1.1	0.8
Cerium-141, - 144	1.0	27.5	13.0	14.1	10.4
Ruthenium-103,-106	1.4	4.4	3.1	5.0	2.8
Beryllium -7[a]	3.0	35.5	16.3	23.1	14.6
Zirconium-niobium 95	.5	11.0	4.4	5.2	3.8

a A natural radionuclide.

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16) p. 11

Milk samples, as shown in Table 2.8-10, were taken from 4 dairies within a 25-mile radius of SRP. Analysis was performed bi-weekly for tritium and radioiodine, quarterly for ^{90}Sr and monthly for ^{137}Cs. Iodine -131 was less than the sensitivity of the analysis (5 pCi/liter) throughout the period of study. Tritium in local milk, when present, was assumed to be associated with SRP operations.

2.8.2 BARNWELL NUCLEAR FUEL PLANT

The Barnwell Nuclear Fuel Plant (BNFP), owned and operated by Allied-Gulf Nuclear Services, is being constructed 7½ miles west of the town of Barnwell, South Carolina. The site, contiguous to the eastern boundary of the AEC Savannah River Plant, is being designed and constructed for the purpose of separating reusable uranium and plutonium from the waste products in spent nuclear fuel used by light-water cooled commercial power reactors.

The information and data contained in the following paragraphs of Subsection 2.8.2 were taken from the Barnwell Nuclear Fuel Plant Environmental Report, November 5, 1971.

It should be noted that only gaseous and solid wastes will eventually leave the BNFP. Systems, with backups for confining the radioactive liquids are an integral part of the plant. Therefore, discharge of any radioactive liquid into the Savannah River will be precluded.

Table 2.8-11 lists the estimated annual releases of radioactive isotopes through the main BNFP stack. "Two fission products, krypton-85 and tritium, will not be retained at BNFP, and will be vented almost quantitatively. The safe release of krypton-85 and tritium is based on air dilution and dispersion. Means will be provided to temporarily curtail venting of these effluents during unfavorable meteorological conditions."

The quantities and characteristics of solid wastes generated at the BNFP will vary with the types and quantities of fuel processed. Table 2.8-12 gives information on quantities and pertinent characteristics. All solid waste will be stored at the BNFP site, but will be segregated and packaged in a manner which would permit retrieval and transfer to a Federal Repository. Packaging of solid waste in concrete storage containers to prevent leakage and the mounding of the burial area to minimize percolation of water down over the containers will virtually eliminate leaching by water and the migration of radionuclides in the ground.

Table 2.8-10

RADIOACTIVITY IN MILK FROM LOCAL DAIRIES, SAVANNAH RIVER PLANT JANUARY - JUNE 1971

Sampling points	Concentration (pCi/liter)							
	Tritium[a]			Strontium-90[b]		Cesium-137[c]		
	Maximum	Minimum	Average	March	June	Maximum	Minimum	Average
Aiken	960	ND	460	7	7	20	10	16
Barnwell	5,500	1,000	2,800	NS	11	26	16	21
North Augusta	4,700	350	1,500	NS	17	30	8	20
Waynesboro	1,900	390	1,000	8	NS	20	9	15
Major Distributors[d]	1,400	200	730	8	8	22	10	17

a. Sensitivity of analysis - 200 pCi/liter; AEC Standard - 3000 nCi/liter.

b. Sensitivity of analysis - 1.0 pCi/liter; AEC standard - 300 pCi/liter.

c. Sensitivity of analysis - 5.0 pCi/liter; AEC standard - 20 nCi/liter.

d. Milk produced in local dairies but sold by major distributors.
NS = No sample

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16)p. 12

Taken from Barnwell Nuclear Fuel
Plant Environmental Report,
November 5, 1971.

Table 2.8-11

AVERAGE ANNUAL POTENTIAL EXPOSURES AT SITE BOUNDARY -100 METER MAIN STACK

X/Q @ 2350 Meters = 1.5×10^{-3}

Radionuclide	Exposure Mode	Conversion Factor (Rem per Ci sec/m^3)	Annual Release (Ci)	Annual Dose (mrem)
Kr-85	External Irradiation of whole body	3.5×10^{-4}	1.4×10^{7}	0.074
	External Irradiation of skin	3×10^{-2}		6.3
H-3	Internal Irradiation of whole body	5×10^{-2}	5.8×10^{5}	0.44
I-131	Irradiation of Child's Thyroid thru Grass/Cow/ Milk Chain	3.3×10^{5}	3.8×10^{-1}	1.9
I-129	Irradiation of Child's Thyroid thru Grass/Cow/ Milk Chain	4.8×10^{6}	4.7×10^{-2}	3.4
Sr-90	Irradiation of Bone from Isotopes Deposited on Food	1.05×10^{4}	2.8×10^{-1}	0.0444
Cs-137	Irradiation of Whole Body from Isotopes Deposited on Food	10^{3}	3.8×10^{-1}	0.006
Cs-134	Irradiation of Whole Body from Isotopes Deposited on Food	2.0×10^{3}	6.0×10^{-1}	0.018
Pu-238	Irradiation of Bone from inhaled Dusts	7.3×10^{5}	4.1×10^{-3}	0.045
Pu-239,240	Irradiation of Bone from Inhaled Dusts	7.9×10^{5}	1.0×10^{-3}	0.012
Pu-241	Irradiation of Bone from Inhaled Dusts	2.1×10^{4}	1.7×10^{-1}	0.053
Am-241	Irradiation of Bone from Inhaled Dusts	2.5×10^{5}	1.0×10^{-3}	0.004
Cm-242	Irradiation of Bone from Inhaled Dusts	1.2×10^{4}	1.2×10^{-1}	0.022
Cm-244	Irradiation of Bone from Inhaled Dusts	2.0×10^{5}	1.2×10^{-2}	0.036

FOOTNOTES:

Kr-85	Calculation assumes semi-infinite cloud. A factor of two is used in the whole body case to allow for occupancy time and the shielding provided by a house. The skin dose calculation applies for the radiation transmitted through a 0.7 mg/cm^2 outer layer of skin.
H-3	Calculated using ICTP bilogical parameters with a quality factor of unity.
I-129 I-131	Calculation assumes concentration through the grass/cow/milk food chain.
Sr-90 Cs-134 Cs-137	Calculation is based on fallout contaiminated food and assumes equilibrium (after several half-lives) with 2/3 of the food being uncontaminated.
Pu Am Cm	This is the average dose over a 50 year period.

Table 2.8-12

SOLID WASTE

	Radioactivity Level		Annual Amounts
	Beta-Gamma	Alpha	cu ft
Undissolved fuel element hulls	High*	Low	15,000 - 30,000
Other fuel element parts and discarded equipment**	Low	Low	6,000 - 10,000
Laboratory waste, small tools, gloves, clothing, etc.	Low	Medium	8,000 - 43,000

* The high beta-gamma activity is due primarily to the neutron induced activity in the fuel cladding and hardware.

** All discarded equipment will be decontaminated prior to disposal.

Taken from Barnwell Nuclear Fuel
Plant Environmental Report,
November 5, 1971.

2.8.3 CHEM-NUCLEAR SERVICES, INC. (1)

Chem-Nuclear Services, Inc., in Barnwell, South Carolina, manages the disposal of noxious chemicals and low level radioactive materials. Chem-Nuclear receives and handles both liquid and solid radwastes at Barnwell. Liquids are solidified prior to burial using either cement or polymeric materials. Hydrogeological examinations of the subsoils at the site were performed by the Law Engineering Company of Atlanta and demonstrate subsurface conditions essentially the same as for BNFP and SRP, with the ion exchange and permeability data on Chem-Nuclear's subsoil excellent for storage of radwaste. Chem-Nuclear's license for burial of such materials was obtained in March 1971. There are no planned releases of radioactivity at the Chem-Nuclear site.

2.8.4 COMBUSTION TURBINE PLANT

The existing Combustion Turbine Plant located near VNP is for peaking service and is designed for operating approximately 500 to 1000 hours per year.

The turbine plant uses #2 fuel oil. Its principal environmental effects come from combustion products and noise.

The combustion products are dispersed into the atmosphere and diluted through stacks to comply with the ground level ambient air quality standards of the State of Georgia. (2)

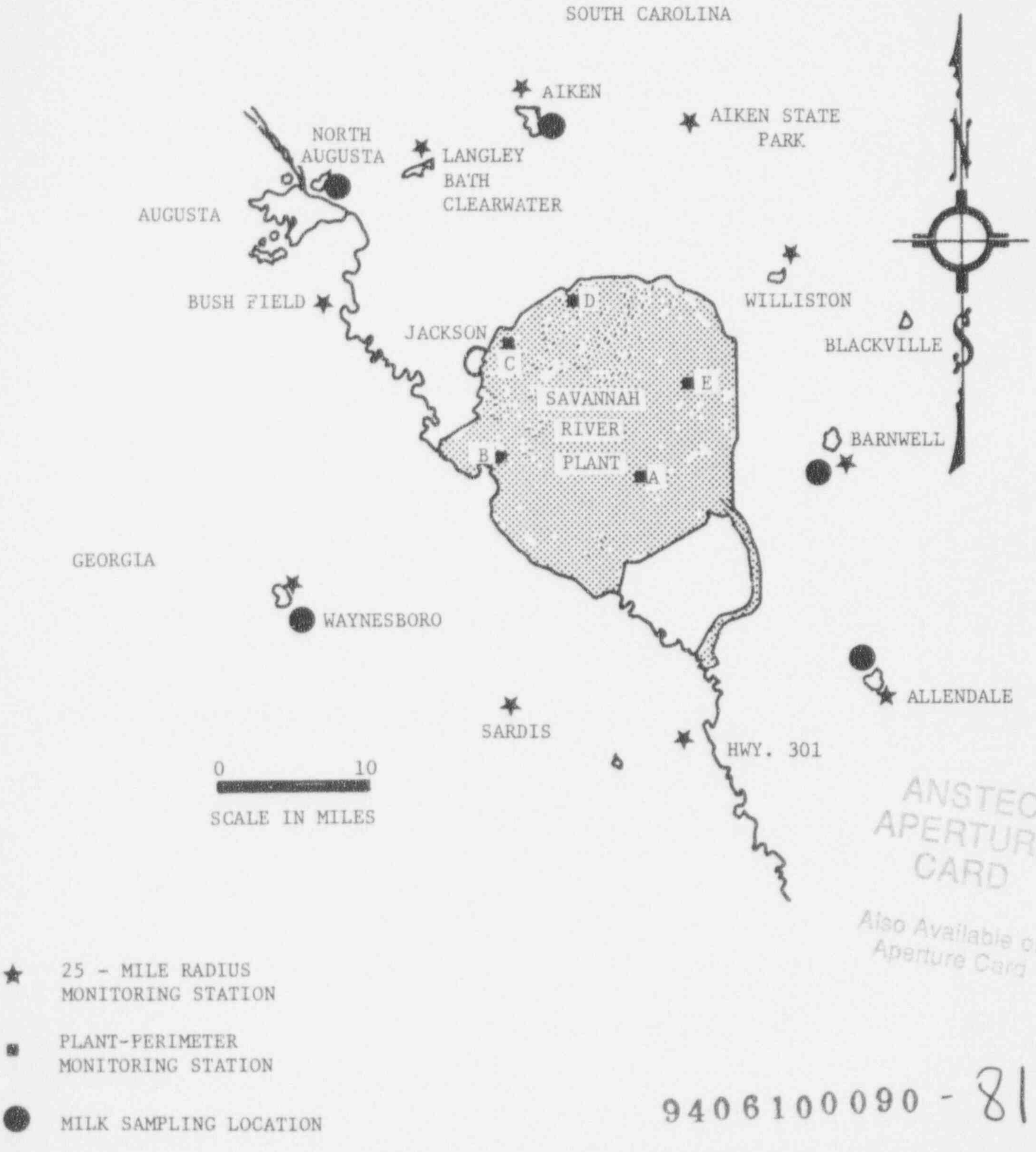
The noise from the turbine plant is reduced by silencing equipment to a level at the property boundary which falls into the "Discretionary-Normally Acceptable" category, as defined in the Department of Housing and Urban Development circular 1390.2. (3)

REFERENCES

(1) Chem-Nuclear Services, Inc., Personal Communication with Georgia Power Company, April 12, 1972.

(2) Georgia Department of Public Health, Rules and Regulations for Air Quality Control, "Chapter 270-5-24", Atlanta, Georgia, 1972.

(3) Circular 1390.2, U. S. Department of Housing and Urban Development, Washington, D. C., August 4, 1971.



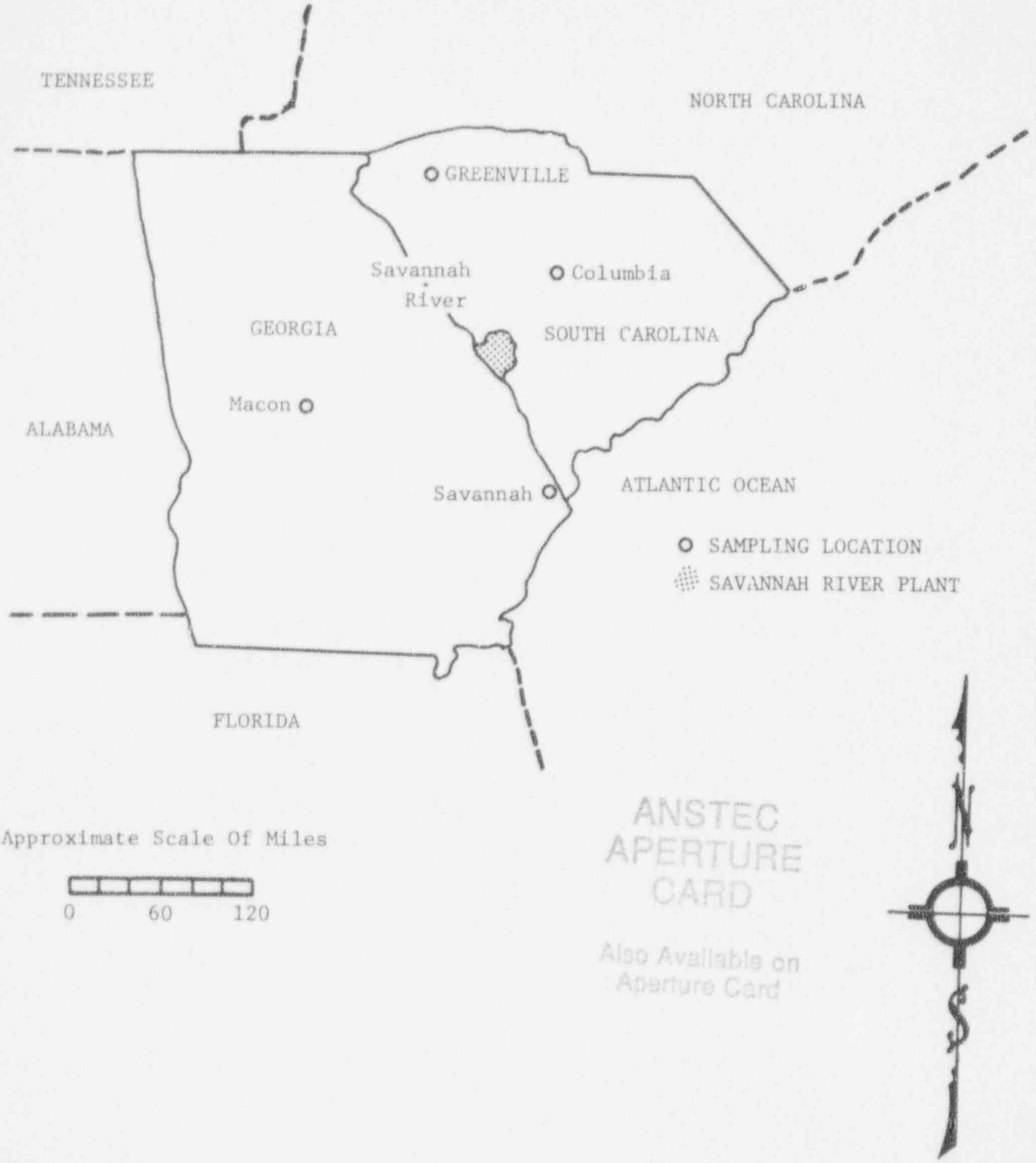
Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

SAMPLING LOCATIONS
SAVANNAH RIVER PLANT

FIGURE 2.8-1

Taken from "Effect of the Savannah River Plant on Environmental Radioactivity Semi-annual Report, January - June, 1971" (DPSPU 71-30-16) p. 2



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DISTANT AIR MONITORING STATIONS,
SAVANNAH RIVER PLANT.

FIGURE 2.8-2

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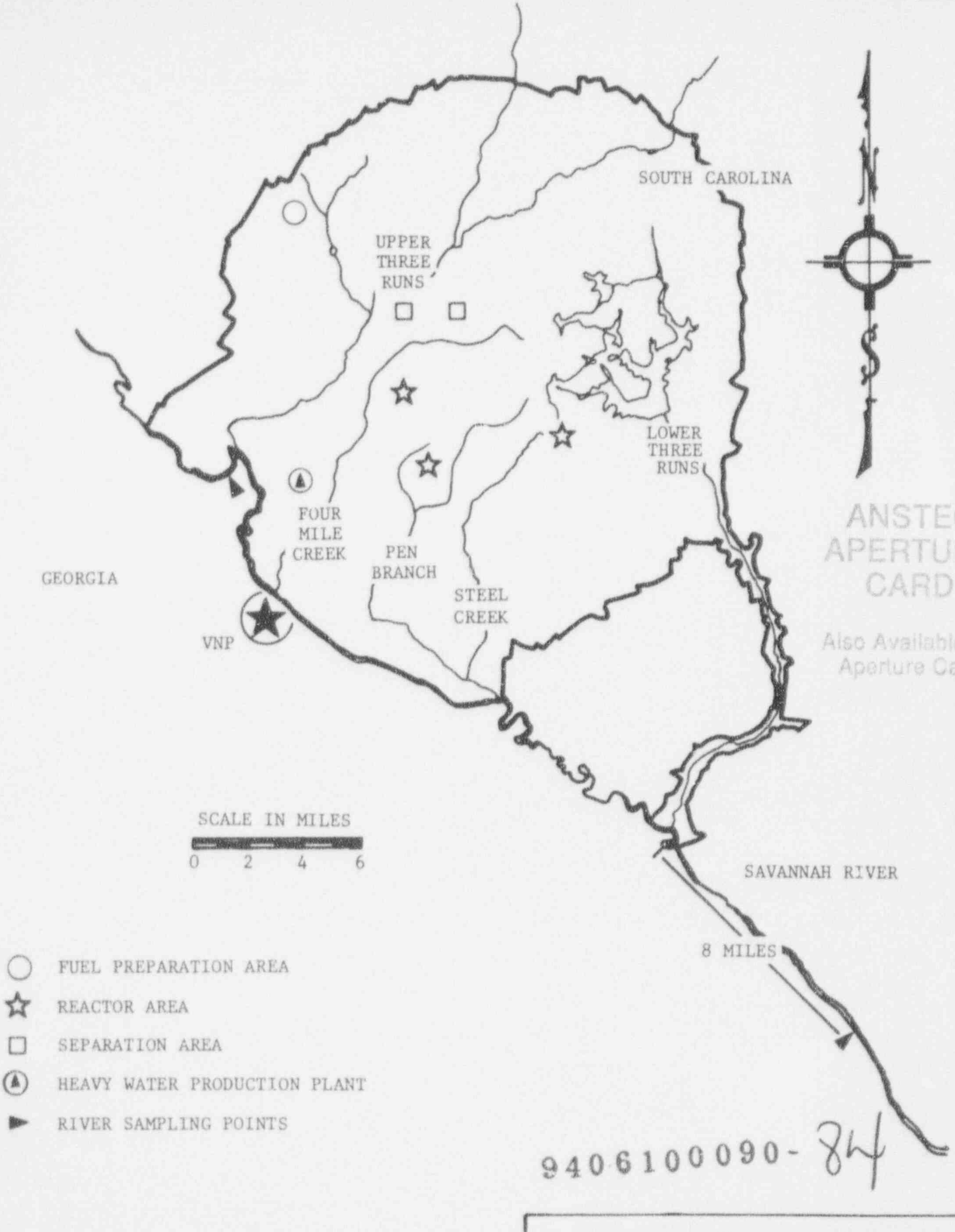

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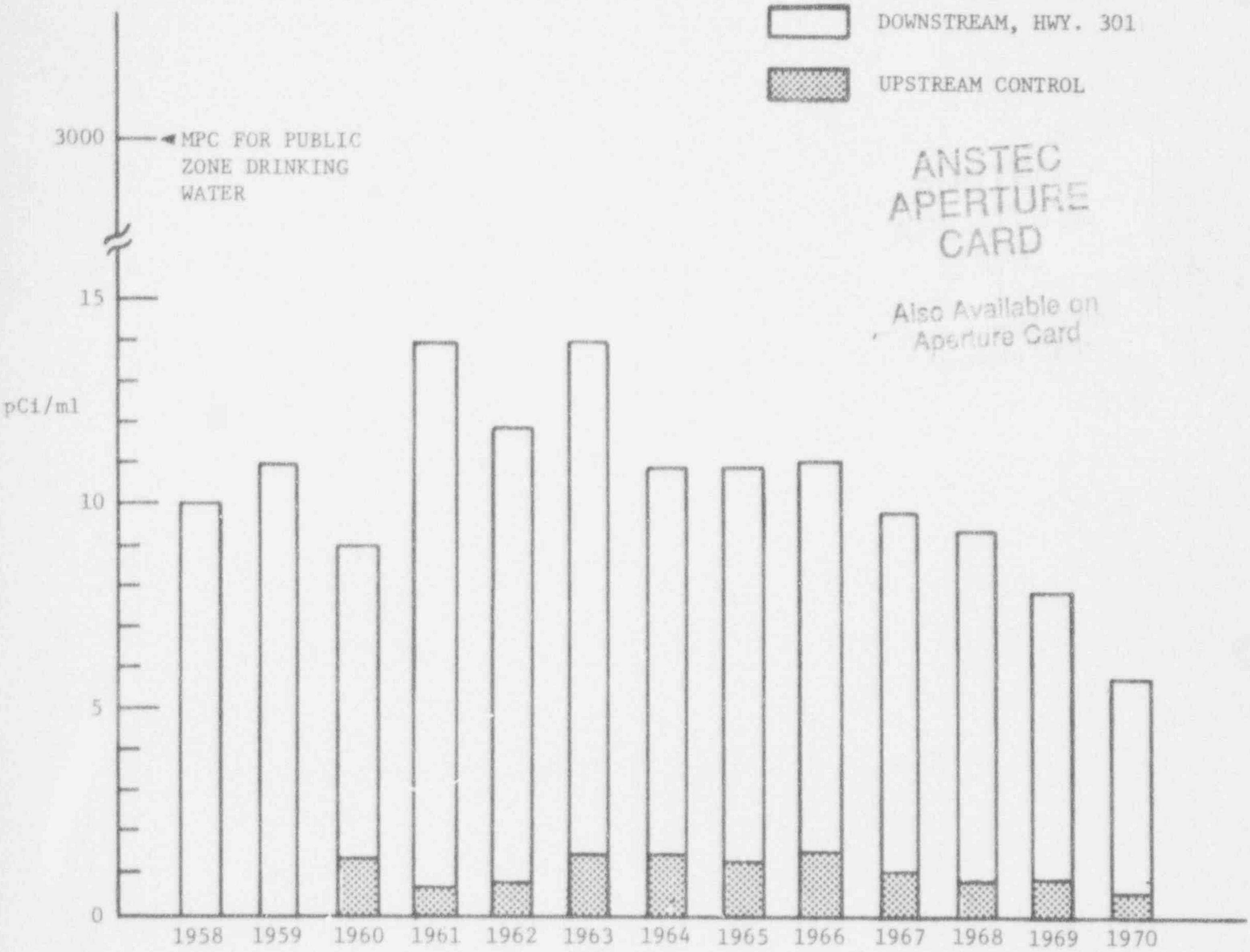
SRP PRODUCTION AREAS
AND EFFLUENT STREAMS

FIGURE 2.8-4



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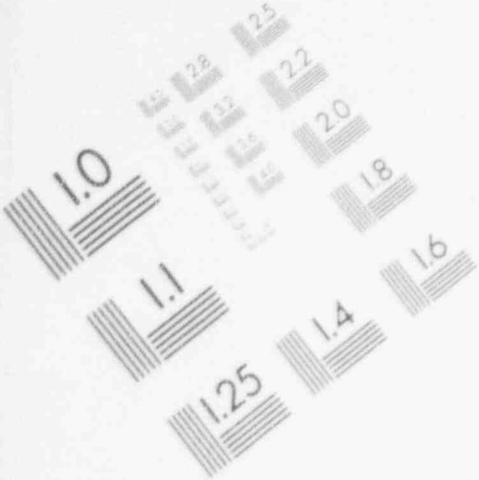
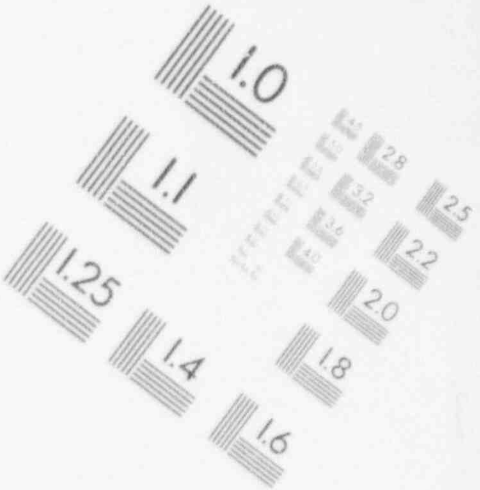
TRITIUM IN RIVER WATER

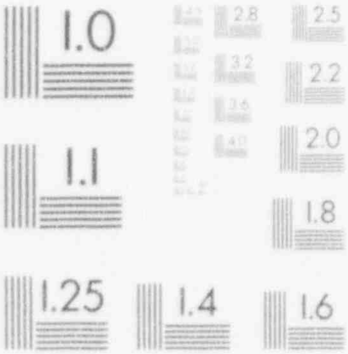
FIGURE 2.8-5

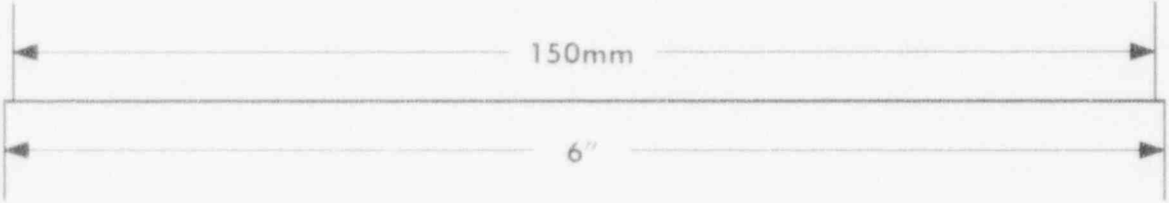
1

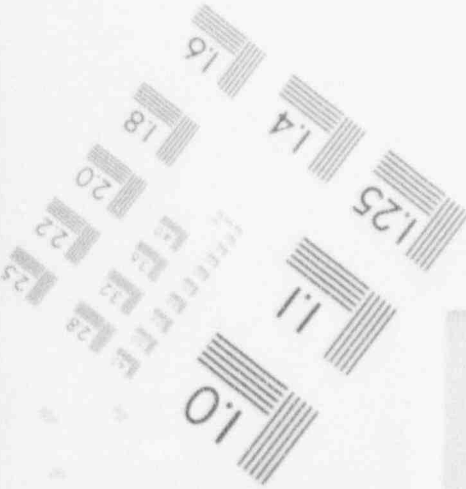
IMAGE EVALUATION
TEST TARGET (MT-3)











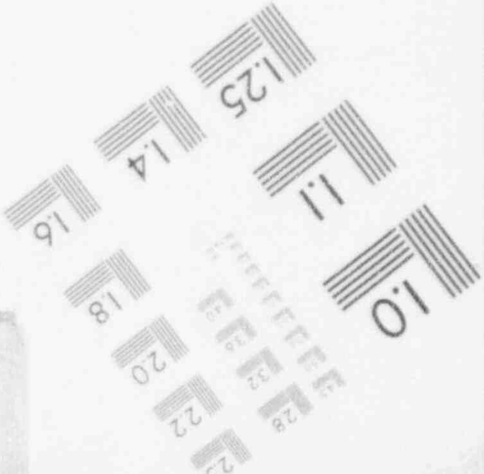


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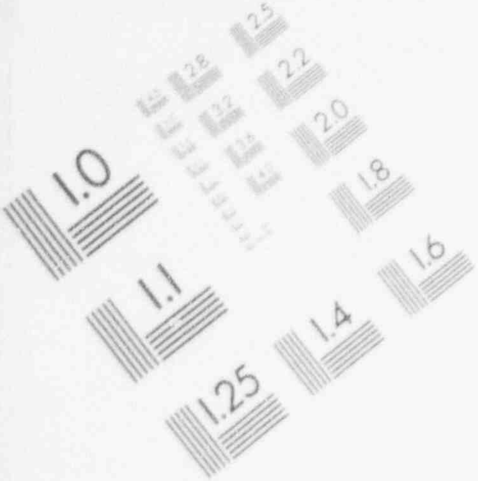
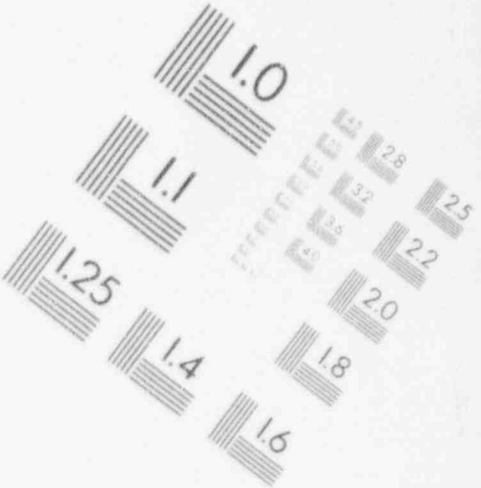
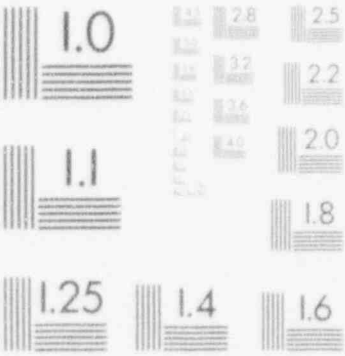
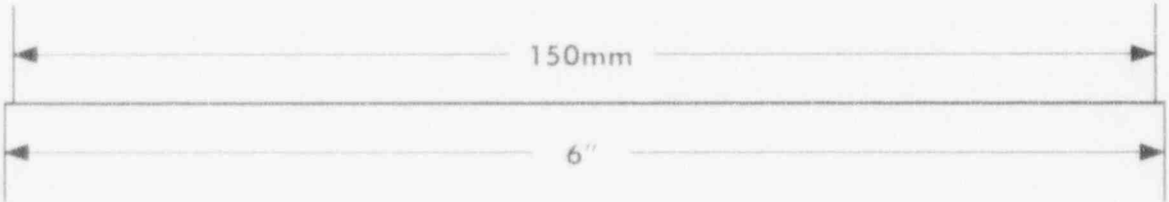
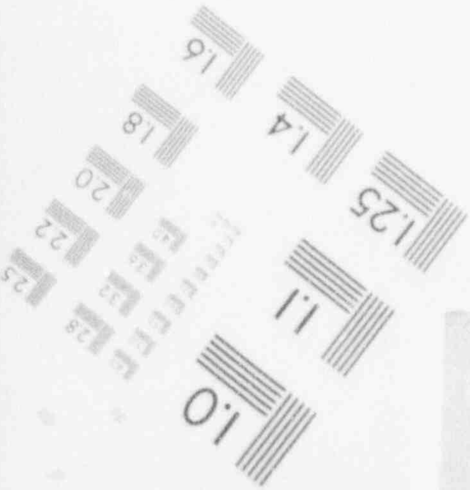
IMAGE EVALUATION
TEST TARGET (MT-3)

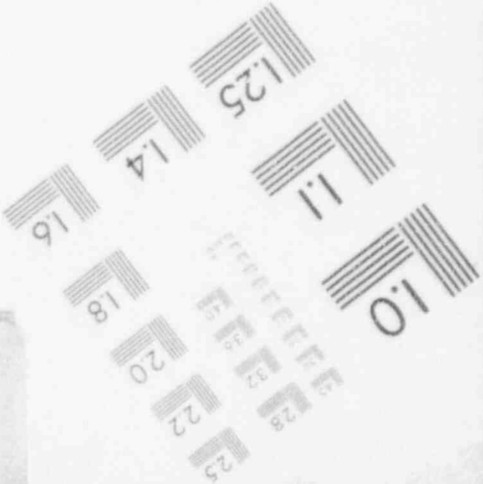


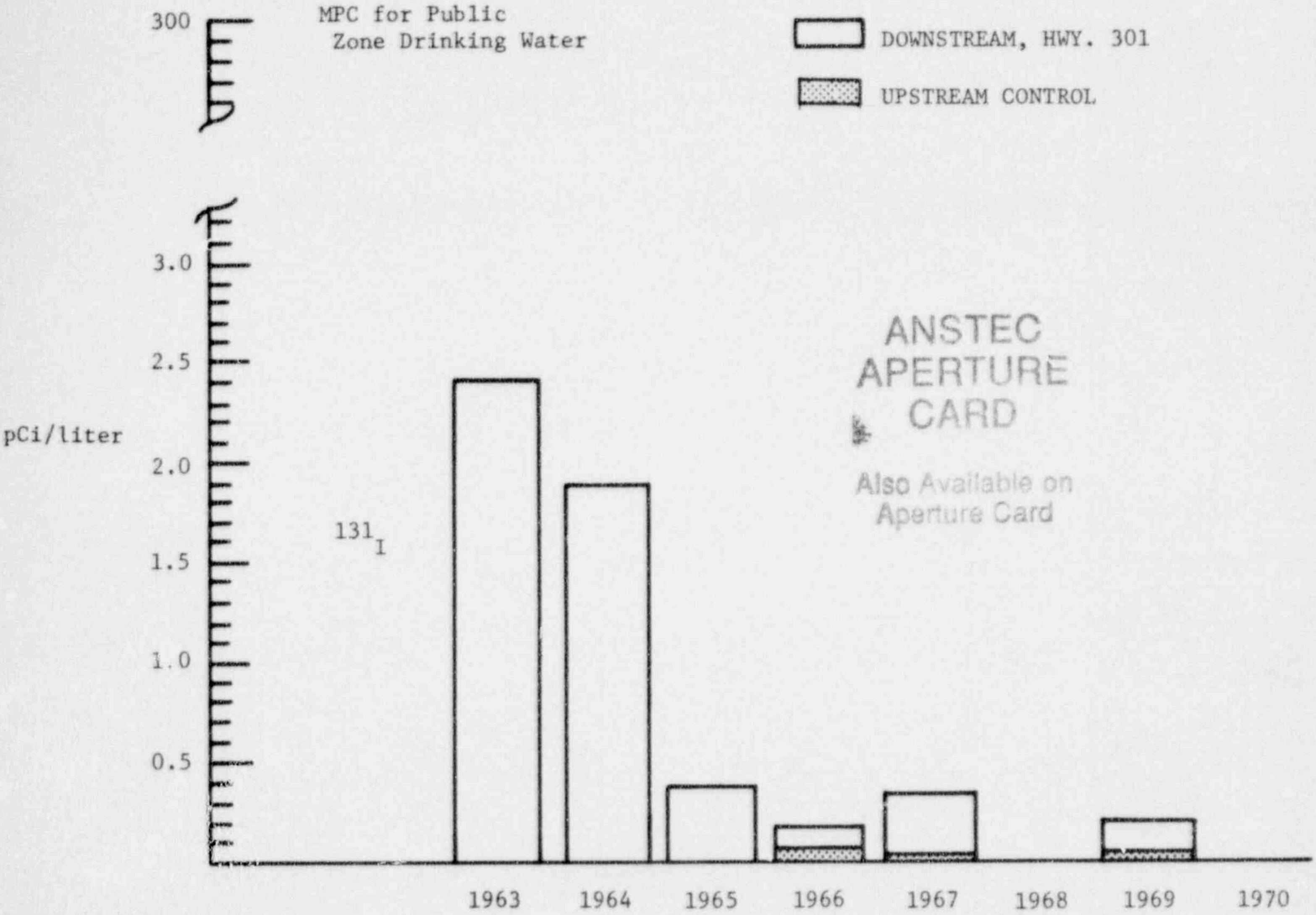












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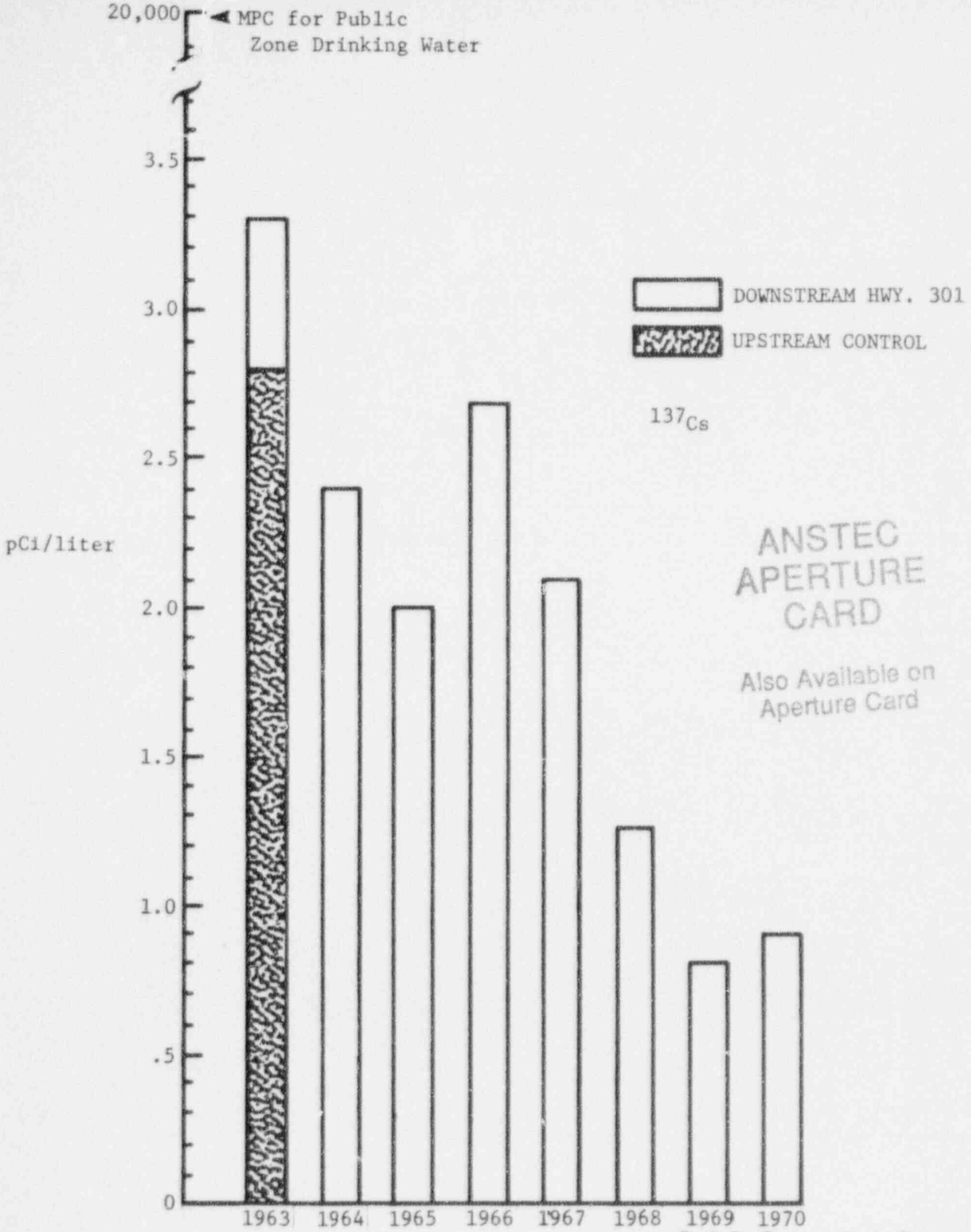
^{131}I IN RIVER WATER

FIGURE 2.8-6



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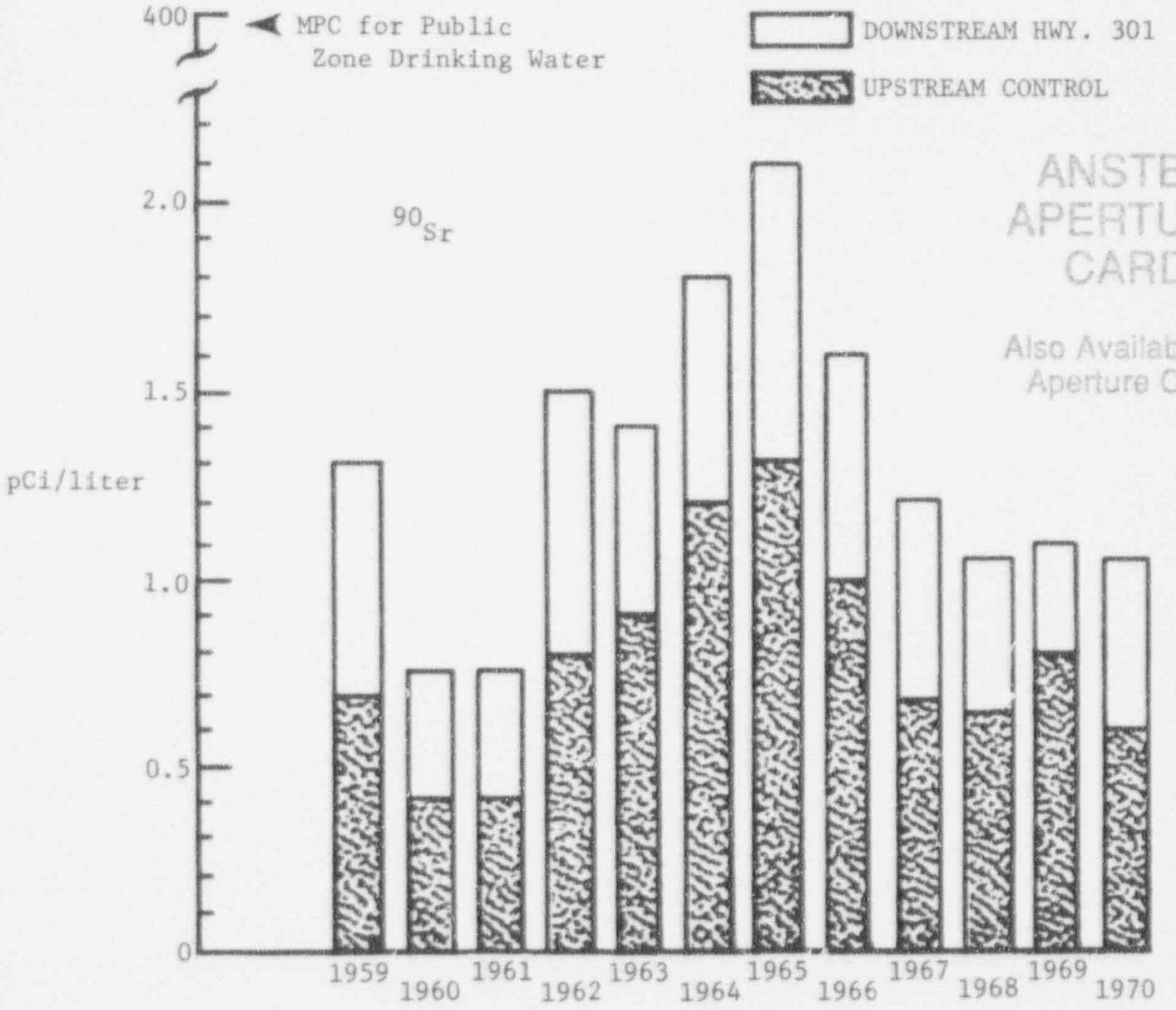
^{137}Cs IN RIVER WATER

FIGURE 2.8-7



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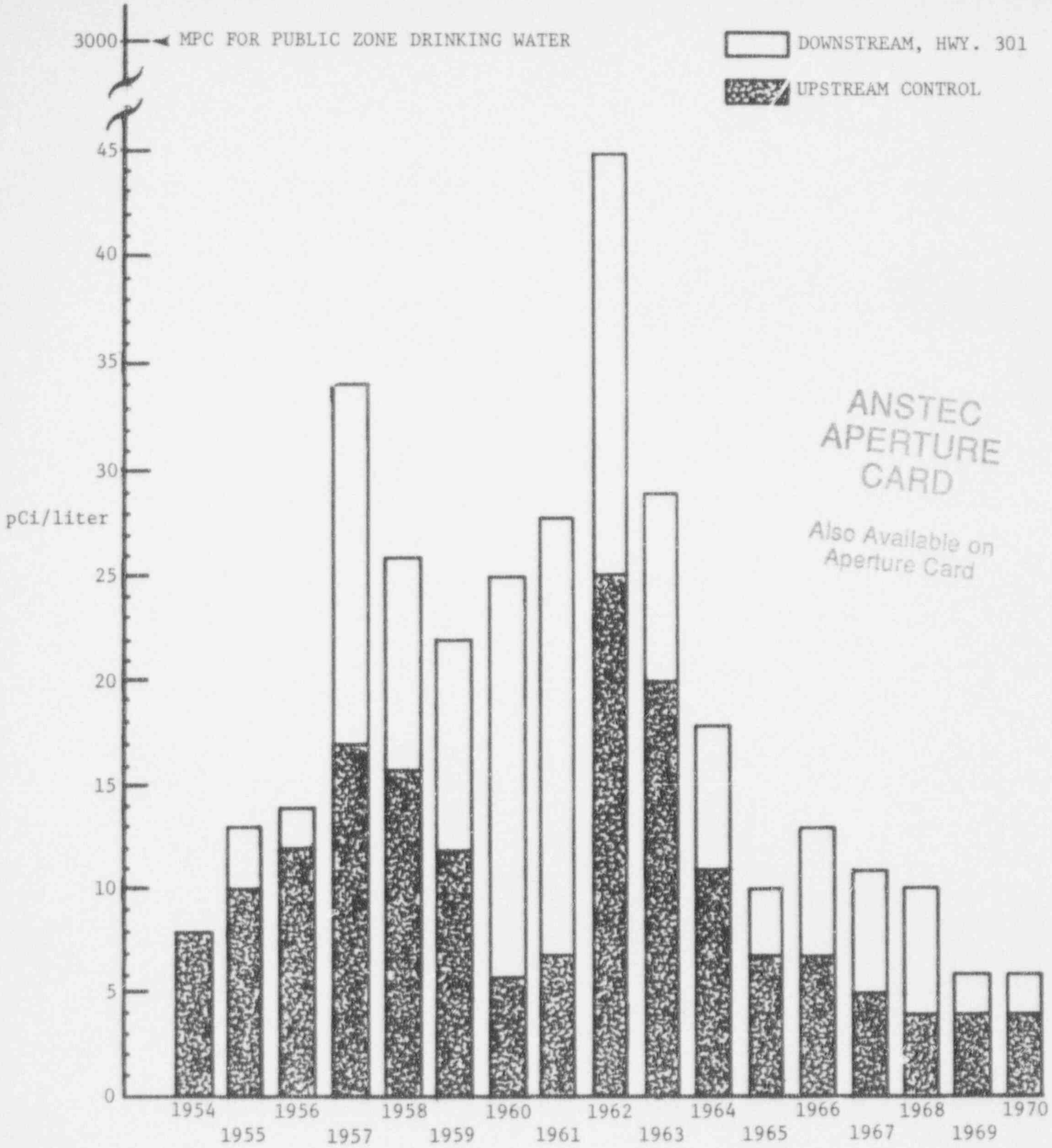
^{90}Sr IN RIVER WATER

FIGURE 2.8-8



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ENVIRONMENTAL REPORT

NONVOLATILE BETA IN RIVER WATER
FIGURE 2.8-9

Alvin W. Vogtle
NUCLEAR
PLANT

APPLICANT'S
ENVIRONMENTAL
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3. THE PLANT

3.1 EXTERNAL APPEARANCE OF PLANT

External design for VNP relates directly to the site and surrounding area and is based on an analysis of existing environmental characteristics.

Colors and materials are indigenous to the area and will blend harmoniously with the vegetation and earth color. Visual impact of the plant will also be considerably reduced by design consideration for the rolling topography and forest land. Simple forms, materials, textures, color, and landscaping will enhance the visual quality of the plant and minimize the environmental effect.

The design philosophy is to integrate the various site components into a clean, functional, and attractive complex. This is reflected in the artist's rendering, which is the frontispiece of this report.

3.1.1 ESTHETIC CRITERIA

Primary goals of the esthetic criteria are to ensure that the plant facilities and grounds are visually pleasing and compatible with the surrounding environment within the constraints and limits imposed by the function and scale of the project. Since what is, or is not, visually pleasing is a subjective matter that varies widely among individuals, the following design objectives were selected in an attempt to obtain a design pleasing to the largest segment of population.

-- Organize the various site components (structures, equipment, parking, railroad spurs, etc.) in a neat, functional manner with a minimum of visual clutter.

-- Integrate and enhance the visual appearance of the plant by modifying the various structural and equipment forms and by applying appropriate textural and color treatments.

-- Use landscaping and earth massing techniques, where possible, to complement plant appearance.

3.1.2 SOURCES OF PUBLIC EXPOSURE

Since there are no towns close by, the Savannah River and Georgia State Highway 23 are the 2 areas from which the public will normally view the plant. Topography, distance, plant colors, materials, textures, trees, and shrubs impede the view to the degree that it is difficult, if not impossible, to see the plant from either area.

Figure 3.1-1 is a plan view of the lines-of-sight from which the profiles in Figures 3.1-2 and 3.1-3 were made. The profiles are from several typical vantage points on the river and the highway. These profiles, which are described below, do not include trees and shrubs that raise the sight line and, therefore, obstruct the view of the plant from the highway or river.

Profile 1 - View from Savannah River

This is a typical line-of-sight from the river. A relatively gradual slope of the terrain falls off to a 100-foot drop along the river bank. The plant is not visible on this line.

Profile 2 - View from Savannah River

This is virtually the only point along the river from which the power block is visible. As shown in the profile, only the top 25 to 30 feet of the containment enclosures are visible on this line. The top 200 to 250 feet of the closest hyperbolic cooling towers are visible. The declination resulting from line of site and distance reduces the visual impact, since the cooling towers are pleasing to the eye.

Profile 3 - View from Savannah River

This is another typical line of sight from the river. The power block is not visible on this site line. The top 250 to 350 feet of the closest hyperbolic cooling towers are visible. As in Profile 2, the visual impact is reduced.

Profile 4 - View from Georgia State Highway 23

This profile is typical of those points on the highway where the line of sight is virtually unobstructed. These views are from great distances with many changes in grade levels and some intervening forests. From these points, the top 100 feet of the containment enclosure and the top 20 feet of the turbine buildings are visible, as are the top 400 feet of the closest hyperbolic cooling tower. The distance between the plant and the viewers ranges from 5 to 6 miles. As in Profile 2, distances and various interruptions to the line of sight modify the visual impact.

Profile 5 - View from Georgia State Highway 23

This profile is typical of those points along the highway where the sight angle is at the minimum. The plant is not visible at these points, and only the top 100 to 150 feet of the hyperbolic cooling towers are visible. As in Profile 2, distance, trees, and various interruptions to the line of slight reduce the visual impact.

3.1.3 SPECIFIC FEATURES

All plant structures are as far below grade as plant functions permit. This provides a low plant profile. The plant arrangement and structure design establish a continuity rather than a collection of various building forms.

3.1.3.1 Auxiliary, Fuel Handling, and Control Building Complex

This complex comprises the central structures of the power block, and its horizontal composition between the 2 containment enclosures enhances the visual quality of the block. The structural system and design parameters dictate thick, poured-in-place, concrete walls, which allow attractive, modular treatment. This treatment is reflected in the other plant buildings and is used to define doorways, other openings, and details. This complex is not visible on the 5 lines-of-sight.

3.1.3.2 Enclosure Buildings

Each power block incorporates 2 reactor enclosure buildings. These form the vertical elements in the composition of the power block. They are steel structures with metal siding; all exterior metal columns and decking are covered by a long-life protective coating of a color selected to match the environment. From a distance, only simple sculptural profiles are discernible.

3.1.3.3 Turbine Building

The turbine building completes the power block complex. It is a horizontal structure that has a lower profile than the enclosure buildings. This steel structure, with its exposed metal columns, siding, and details, is finished to match the enclosure buildings and to retain the aesthetic tie with other buildings in the complex. The turbine building is not visible on the 5 lines-of-sight.

3.1.3.4 Hyperbolic Cooling Towers

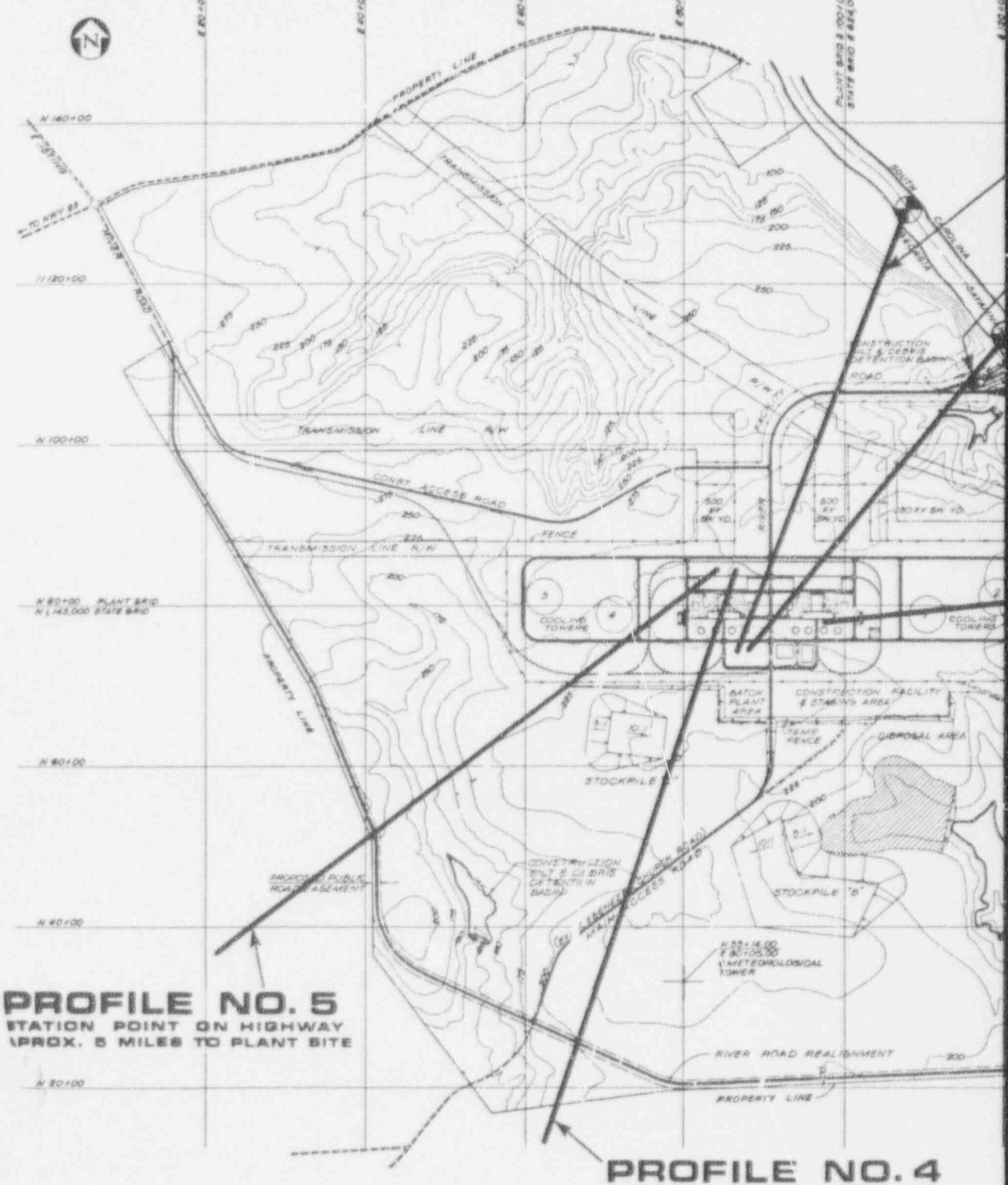
Each power block complex includes 2 hyperbolic cooling towers, These graceful structures are constructed of formed concrete, with a continuous horizontal opening at grade to complement the tapered, vertical lines of these sculptural cylinders. When the complex is complete, these aesthetic structures will be visible from quite a distance, as noted in the descriptions of each profile view.

3.1.3.5 Other Structures

The service building, demineralizer building, and the warehouse are some of the other structures. They all reflect the design, materials, and color themes established in the power block. None are visible on the lines-of-sight.

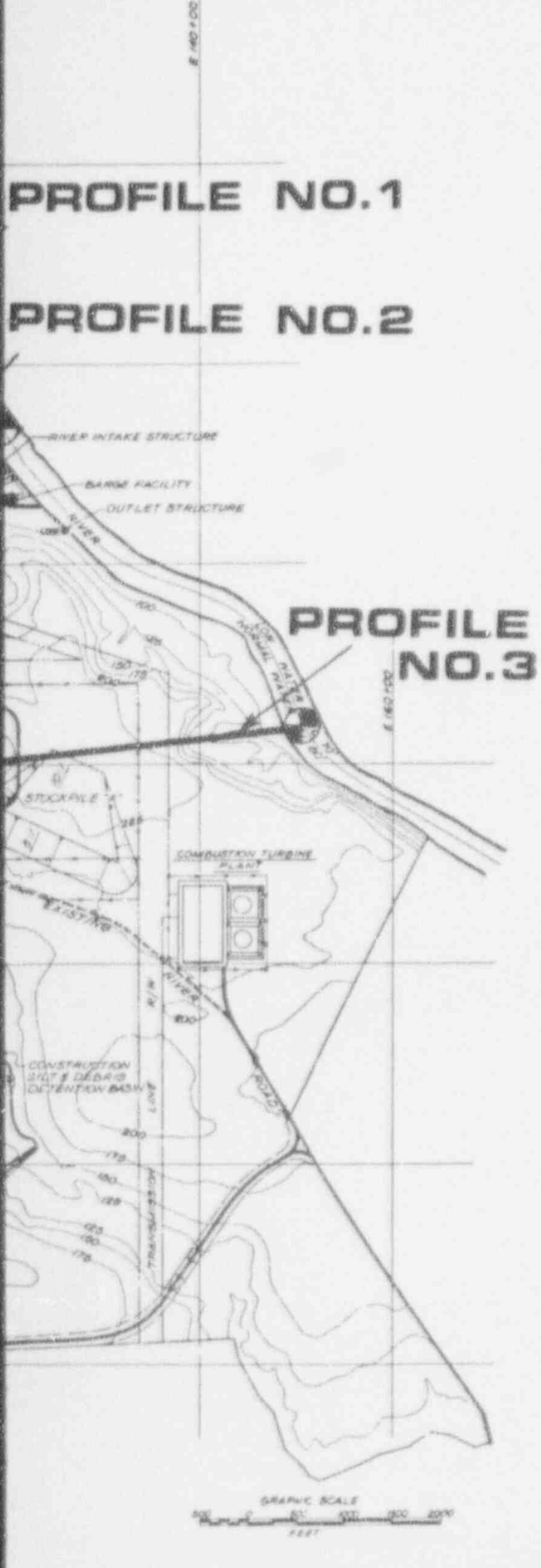
3.1.4 CONCLUSIONS

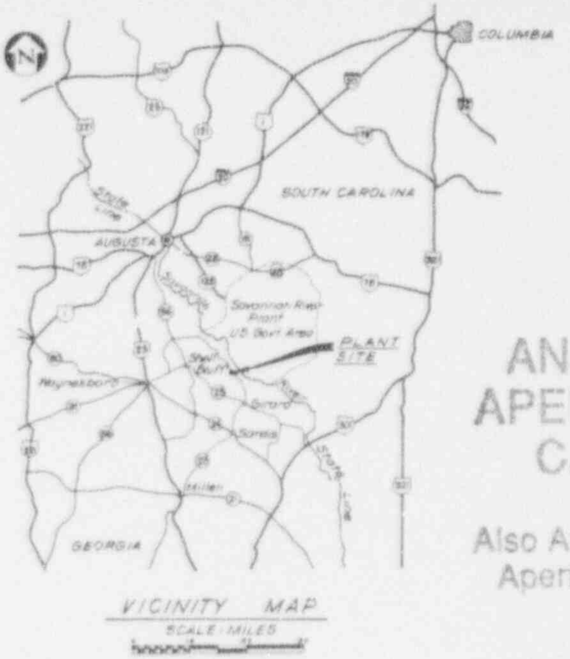
Viewed from a distance, the plant has a simple profile that blends with the environment. Visual impact is minimized by topography, design, and distance from public thoroughfare and towns. Viewed onsite, the design details of texture, color, and lines form a harmonious continuity.



PROFILE NO. 5
STATION POINT ON HIGHWAY
APROX. 5 MILES TO PLANT SITE

PROFILE NO. 4
STATION POINT ON HIGHWAY
APROX. 5 MILES TO PLANT SITE





VICINITY MAP

LEGEND

NEW ASPHALT CONCRETE ROAD	———
NEW CHAIN LINK FENCE	—•—•—
EXISTING FENCE	—×—×—
PROPERTY LINE OR MATCH LINE	—·—·—
ROUGH GRADE CONTOUR	———
EXISTING GROUND CONTOUR	— — —
DITCH FLOW LINE	—→—→—
SPOT GRADE	125
HIGH POINT FLOWLINE	H.P. FL
BEGINNING OF VERTICAL CURVE	B.V.C.
END OF VERTICAL CURVE	E.V.C.
POINT OF INTERSECTION	P.I.
SURVEY TRANSGULATION MONUMENT	⊕
BEGIN CURVE	B.C.
END CURVE	E.C.
WORK POINT	W.P.

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GENERAL NOTES

1 EXISTING TOPOGRAPHY REPRODUCED FROM ORIGINAL TOPOGRAPHIC DRAWINGS PROVIDED BY THE ENGINEERING DEPARTMENT OF GEORGIA POWER COMPANY, ATLANTA, GEORGIA.

2 THE GRID SYSTEM SHOWN IS DESIGNATED "PLANT GRID SYSTEM". THE FOLLOWING FACTORS MAY BE APPLIED TO CONVERT TO THE STATE GRID SYSTEM.

PLANT NORTH + 1,135,000 = STATE NORTH
PLANT EAST + 614,000 = STATE EAST

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ENVIRONMENTAL REPORT

PLAN VIEW
LINES OF SIGHT

FIGURE 3.1-1

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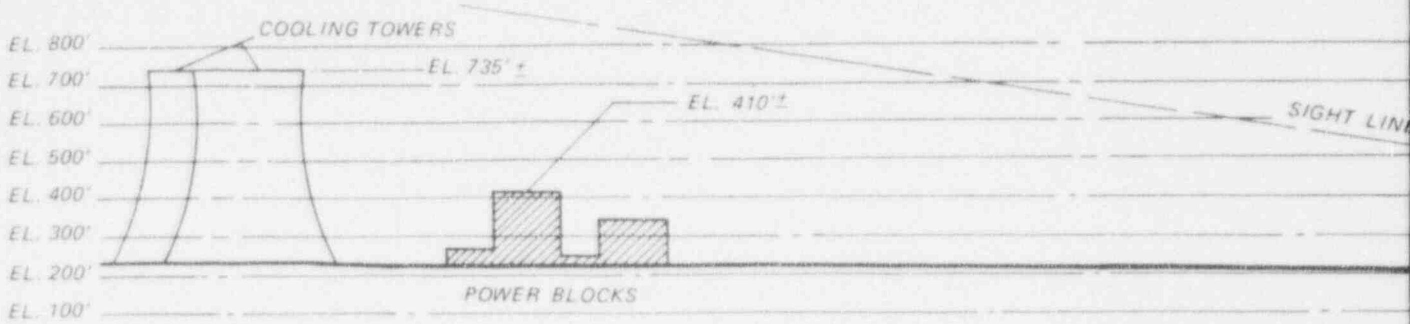
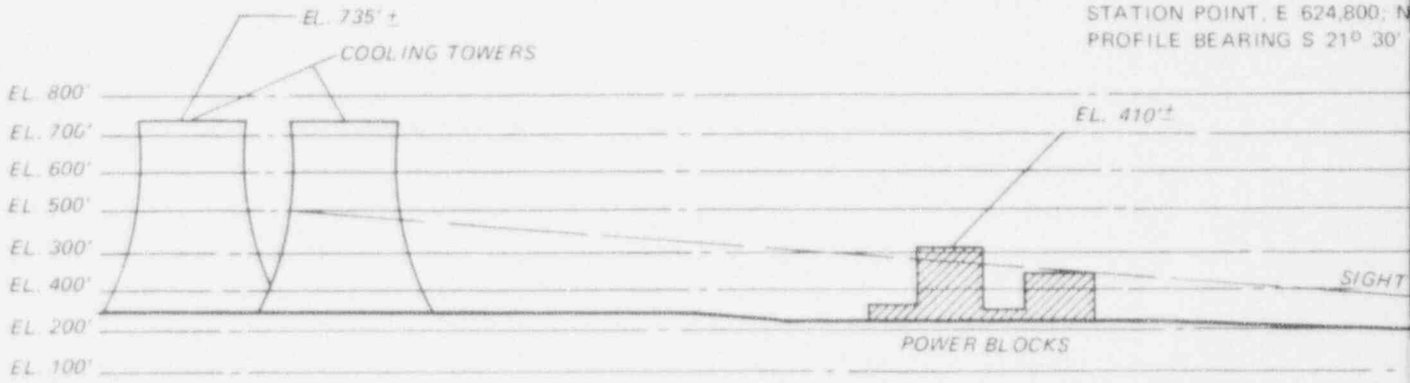
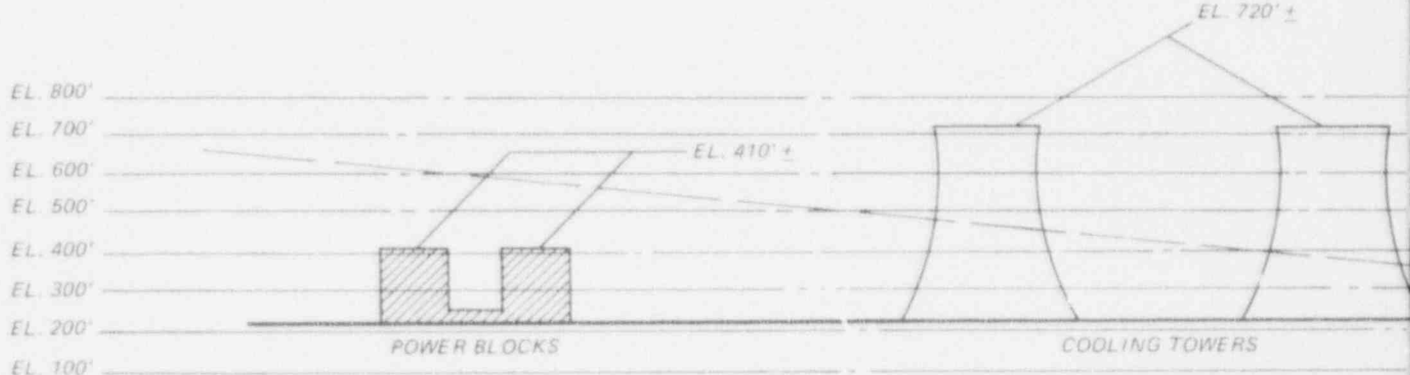


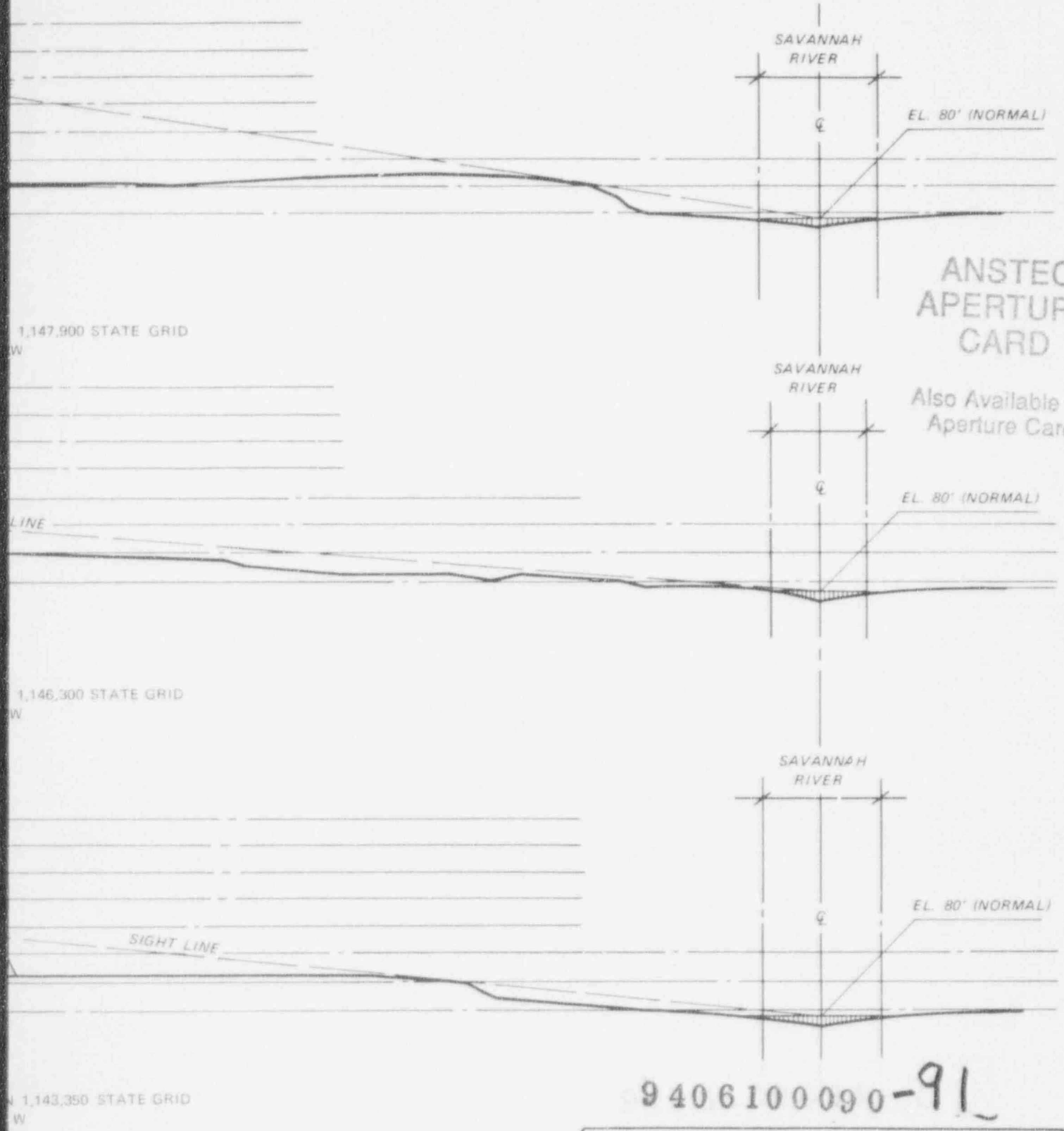
PROFILE NO. 1
SCALE 1" = 500'
STATION POINT, E 624,800; N
PROFILE BEARING S 21° 30'



PROFILE NO. 2
SCALE 1" = 500'
STATION POINT, E 626,020; N
PROFILE BEARING S 39° 00'



PROFILE NO. 3
SCALE 1" = 500'
STATION POINT, E 629,100;
PROFILE BEARING S 82° 30'



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ENVIRONMENTAL REPORT

LINE-OF-SIGHT PROFILES
FROM SAVANNAH RIVER

FIGURE 3.1-2

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 1

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RECORDS AND REPORTS MANAGEMENT BRANCH

3.2 TRANSMISSION LINES

VNP-1, VNP-2, VNP-3 and VNP-4 will utilize eight (8) 500,000 volt (500kV) transmission lines to integrate the power output of the plant into the GPC system, according to present plans. Off-site power for operation of the safety features of VNP and also for start-up power will be supplied by three (3) 230,000 volt (230 kV) transmission lines.

The three 230 kV lines will be constructed prior to operation of VNP-1. These lines will be used to integrate the power output of the Combustion Turbine Plant into the GPC system and also for GPC system support purposes.

The transmission facilities for VNP will consist of 2 electrically separate switchyards, one for VNP-1 and VNP-2 and one for VNP-3 and VNP-4. All of the power output of the plant will be transmitted at 500 kV.

The transmission lines, terminating substations, and proposed construction schedule for the VNP plant are: 1

1. VNP-Goshen (Augusta Area) 500 kV Line 1. This line, 20 miles in length, will be constructed in 1978-79 for operation of VNP-1.
2. VNP-Klondike 500 kV Line. This line, approximately 145 miles in length, will be constructed in 1978-79 for operation of VNP-1.
3. VNP-Plant Hatch 500 kV Line. This line, approximately 92 miles in length, will be constructed in 1978-79 for operation of VNP-1.
4. VNP-Evans (Augusta Area) 500 kV Line 1. This line, approximately 70 miles in length, will be constructed in 1979-80 for operation of VNP-2.
5. VNP-Goshen (Augusta Area) 500 kV Line 2. This line, approximately 20 miles in length, will be constructed in 1980-81 for operation of VNP-3.
6. VNP-Gainesville 500 kV Line. This line, approximately 150 miles in length, will be constructed in 1980-81 for operation of VNP-3.
7. VNP-Evans (Augusta Area) 500 kV Line 2. This line, approximately 70 miles in length, will be constructed in 1981-82 for operation of VNP-4.

8. VNP-Bonaire 500 kV Line. This line, approximately 120 miles in length, will be constructed in 1981-82 for operation of VNP-4. 1

Transmission lines utilized for off-site power requirements of the engineered safety features of the plant are:

1. VNP-Goshen 230 kV Line. This line was constructed in 1972 for operation of the Combustion Turbine Plant and will be utilized for an off-site power source.

2. VNP-Waynesboro 230 kV Line 1. It is presently planned to construct this line in the 1975-77 period. It will be used to further integrate the power output of the Combustion Turbine Plant into the GPC system and for system support purposes. When necessary, it will be utilized as a VNP off-site power source.

3. VNP-Waynesboro 230 kV Line 2. It is presently planned to construct this line in the 1977-78 period. It will be used for GPC system support purposes. When necessary, it will be utilized as a VNP off-site power source.

The transmission lines are shown in Figure 5.4-1.

There are no specific authorizations or approvals required by federal, state or local authorities for transmission line construction in Georgia. Crossings of state and/or federal highways require approval of the Highway Division of the Georgia Transportation Department. Approval from the U.S. Corps of Engineers is required for transmission lines crossing navigable waters. Crossings of railroads require approval of the specific railroad being crossed. No applications for the VNP lines have been filed. Necessary applications will be filed in a timely manner so that approval may be secured to accommodate construction schedules. 1

3.3 REACTOR AND STEAM-ELECTRIC SYSTEM

VNP consists of 4 units, each comprised of a Westinghouse pressurized water reactor and a General Electric turbine generator. The architect/engineer for the plant is Bechtel Engineering Corporation. The pressurized water reactor (PWR) is a water-cooled and water-moderated nuclear system which utilizes UO_2 in a ^{235}U fuel cycle for the production of power. Each reactor is rated at 3411 MWt, with the design thermal power for each unit being 3425 MW (this includes the heat produced in the coolant pumps). The equivalent electrical output is 1172 MW/unit. The turbine generator is a tandem compound 6-flow reheat unit with 38-inch last stage buckets designed for steam condition at 965 psia, 1191.2 H with one stage of reheat, 3.5 inches Hg abs. exhaust pressure and 0 percent makeup while extracting for normal feedwater heating and for steam generator feed pump turbine operation.

3.4 WATER USE

VNP will withdraw 37,000 gpm maximum and 22,000 gpm normally, per unit, from the Savannah River for heat dissipation and dilution use. Details of this system are shown in Figure 3.7-1 and discussed in Sections 3.5 and 3.7.

Makeup water for VNP will be drawn primarily from wells, the secondary source being the Savannah River. Three 2000 gpm deep well pumps will supply normal makeup water to the nuclear service cooling tower basins, the well water storage tank, the fire protection tanks, the potable water storage tank, and the water treatment areas. The flows for this system are shown in Figure 3.7-1. This system is also described in PSAR Sections 2.4 and 9.4. As a secondary source of water to the nuclear service cooling tower basins, one 1000 gpm deep well pump per basin serves as a standby. Water can also be drawn from the Savannah River to serve the nuclear service cooling tower basins.

3.4.1 SYSTEM DESCRIPTION

Three plant makeup water well pumps, each 1000 feet apart and approximately 1000 feet from the plant, serve all 4 units' makeup water requirements. Two wells act as 100 percent capacity of the 4 units while the third acts as an installed spare. The normal makeup flow to the nuclear service cooling tower basins is approximately 300 gpm per unit, and the flow required to fill one 300,000 gallon fire protection tank in 8 hours is 625 gpm. The water treatment area makeup requirements are about 200 gpm per unit, and the potable water demand is approximately 300 gpm for 4 units. The total required for all units is about 2000 gpm or about equal to the flow from one of the 3 wells. As a secondary source of nuclear service makeup water, 8 standby wells, each rated at 1000 gpm, are located within the plant. Each of the well pumps serves 1 nuclear service cooling tower basin. Should neither normal nor standby makeup wells be available, makeup from the river is available.

3.5 HEAT DISSIPATION SYSTEM

3.5.1 MAIN CIRCULATING WATER SYSTEM

The main circulating water system is a closed loop system providing cooling water for the main condenser and plant heat exchangers.

The main condenser is 2-pass, single-pressure design, with 3 shells with a total surface area of 725,000 square feet. Condenser tubes are 45 feet, 1 inch O.D., 18 BWG Inhibited Admiralty, except tubes in the air cooling section, which are 304 SS, 22 BWG.

The condenser is sized to maintain 4.45 inches Hg. Abs. at design conditions of a heat load of 7942 x 10^6 Btu per hour, a circulating water flow of 460,800 gallons per minute (gpm), a velocity in tubes at 7.5 feet per second, a circulating water unit inlet temeprature of 90°F, and condenser heat transfer surface 85 percent clean. The design heat load includes steam from the main turbine exhaust, steam generator feed pump turbines exhaust, high pressure turbine steam seal system, feedwater heater drains, and turbine low stage extraction.

The following tabulation shows the items of the main condenser on the circulating water side and the estimated annual corrosion rate for each item:

ITEM	COMPOSITION		ANNUAL CORROSION RATE
Tubes	Admiralty	70% Copper 30% Zinc	2126.9 lb 712.9 lb
Tube sheet	Muntz metal	60% Copper 40% Zinc	29.3 lb 15.5 lb
Air cooler tubes	Stainless steel		Less than .0044 lb
Water boxes	Epoxy coated carbon steel		None

1

It is anticipated that 70 percent of the copper and zinc will plate out on cooling tower and other circulating water system components, leaving the remaining 30 percent to be removed by the cooling tower blowdown to the river.

Two main circulating pumps (vertical volute type) will supply cooling water to the condenser from 1 natural draft cooling tower (1 per unit). These pumps are designed to pump approximately 460,800 gpm at a total head of approximately 100 feet through conduits approximately 1200 feet long for VNP-1 and -4 (1500 feet long for VNP -2 and -3). 1

3.5.2 PLANT HEAT EXHANGER COOLING SYSTEM

The Plant Heat Exchanger Cooling System is composed of the 2 following systems: (1) the cooler portion of the Circulating Water System, and (2) the closed loop Turbine Plant Cooling Water System.

The cooler portion of the Circulating Water System is composed of: Auxiliary Building Air Conditioner Condensers, Turbine Generator Lube Oil Coolers, Circulating Water Pump Lube Oil Coolers, Turbine Building Air Conditioners Condensers, Generator Hydrogen Coolers, Generator Stator Coolers, and Turbine Plant Closed Loop Heat Exchangers. These closed loop heat exchangers are the heat exchangers for the Turbine Plant Cooling Water System. The total quantity of cooling water is estimated to be 14,000 gpm for all of the cooler portion of the Circulating Water System. The total heat load rejected to the cooler portion of the Circulating Water System is estimated to be 210 x 10^6 Btu per hour.

The closed-loop Turbine Plant Cooling Water System is composed of: Air Compressor After Coolers, Feedwater Sample Cooler, Steam Generator Steam Sample Primary Coolers, Isotlated Phase Cooler, Letdown Chillers, Feed Pump Turbine Drive Lube Oil Coolers, Condensate Pump Lube Oil Coolers, Heater Drain Pump Lube Oil Coolers, and Electro-Hydraulic Fluid Coolers.

3.5.3 MAIN CIRCULATING WATER SYSTEM NATURAL DRAFT TOWERS

Ultimately, the main circulating water system for each unit will dissipate its total heat load of approximately 7,942 x 10^6 Btu/hr (at maximum calculated unit capacity) to the atmosphere by 1 natural draft tower. A flow diagram for the plant make-up water system is given in Figure 3.7-1. Discussion of other methods of heat dissipation is given in Section 8.5. Figure 3.5-1 gives further information about effluent temperatures at VNP. The arrangement and location of the cooling towers are shown in Figure 2.1-3. The towers are designed to have an internal concrete support structure with cement asbestos fill material. The estimated loss of fill material due to leaching and erosion is estimated to be 450 pounds/year of asbestos, 2065 pounds/year of cement, and 1237 pounds/year of silica flour. 1
It is expected that the eroded asbestos will be distributed by the percent of blowdown plus the percent of drift loss with the greatest portion remaining in the recirculated cooling water.(4) 2

The design of each turbine plant circulating water system provides for a variable rate of blowdown flow, up to 5500 gpm, automatically controlled to maintain 4 to 8 cycles of concentration.

The makeup flow is also variable, up to 22,000 gpm, depending on the evaporation rate of the turbine plant cooling tower, which varies with turbine load and seasonally with the ambient humidity. Makeup and blowdown for the nuclear service system are provided by the main wells and river discharge systems, adding less than 2 percent of the foregoing flow rates. 1

Specifications for each cooling tower are:

Design wet bulb:* 78°F @ 51% relative humidity 2
Approach: 12°F
Range: 34.5°F
Water to Tower: 124.5°F 1
Water from Tower: 90.0°F
Water flow: 474,800 gpm (1058 cfs)
Volume of Water: 1,012,000 cubic feet
Drift: .03% = 143 gpm guaranteed 2
.015% = 71.5 gpm expected
Evaporation: 3.45% = 16,400 gpm 1
Air Flow: 176,500,000 lb/hr
Exit Air Temperature: 109°F 2
Exit Air Velocity: 10.4 ft/sec.

*Based on 16 years of hourly records (1949 - 1964) from the Augusta, Georgia, Airport, which were obtained from the National Climatic Center on magnetic tape, the number of hours where wet bulb temperatures exceed 78°F is 49 hours per year. The maximum reported during this period was 82°F. 1

The sizes and lengths of the conduit pipes between the condensers and the cooling towers are as follows:

Unit	Diameter	Length
1, 4	10 ft.	1180 ft./unit
2, 3	10	1500
1, 2, 3, 4	7	240
1, 2, 3, 4	5	180

The volumes and lengths of the open-channel conduit from the cooling towers to the circulating water pumps are: 1

Unit	Volume	Length
1, 4	98,000 cu. ft./unit	270 ft./unit
2, 3	350,600	750

Rate of deposition of the silt is approximately 2.5 lb/min. Assuming an average density of 110 lbs./cu.ft., this deposit will build up at the rate of 1 inch per year in the basin of the cooling tower (assuming a diameter of approximately 440 feet for the basin). 2 Frequency of removal will depend on the plant operators who will make the decision as to how deep they will allow the silt to build up.

Removal of the silt will be accomplished by scraping it into windrows and removing it by skiploader or other mechanical means. Disposal will be on the plant site in a designated spoil area, probably the same spoil area as that used for excess material from the power block excavation and site grading.

The level of total dissolved solids in the circulating water system will be controlled by cooling tower blowdown. The blowdown flows through a combination mixing chamber and energy dissipater and is discharged through a submerged diffuser to the Savannah River. In normal operation, the circulating water system will be held at 4 cycles of concentration, which requires a blowdown of approximately 5,500 gpm per unit. Makeup water for tower evaporation, 1 drift, and blowdown comes from the Savannah River. Six pumps (1 per unit and 2 spares) each rated at 22,000 gpm will supply this water. Two 15,000 gpm pumps (one is an installed spare) are provided in the intake structure for diluting the periodic discharge of radwaste if such dilution is required to meet 10 CFR 20 concentrations in the discharge to the river. Under normal operating conditions with a total cooling tower blowdown flow of 22,000 gpm (4 times 5,500) and the flow from 1 dilution pump, a total flow of 37,000 gpm is available for radwaste dilution, and radwaste can be discharged from 2 units. Dilution of plant effluent for temperature will be accomplished by utilizing a small portion of the Savannah River as a mixing zone. The length of this mixing zone will be defined by GPC and the Georgia Department of Natural Resources, Environmental Protection Division. This definition will be based on requirements set forth in Sections 730-3-.06 and 730-3-.10 of the "Water Use Classifications" and in "Water Quality Standards" issued by the Georgia Department of Natural Resources, Environmental Protection Division. The analysis of the thermal plume shape was completed for the most extreme cases; all others will result in a lesser effect.

The criteria for this analysis included: 1

A. Minimum guaranteed river flow rate is 5,800 cfs. In a letter to Mr. G. B. Dougherty of Southern Services, Inc., dated January 7, 1972, the Savannah District of the U. S. Army Corps of Engineers stated: "The Savannah River Basin Reservoir Regulation Manual establishes a minimum release of 5,800 cfs from New Savannah Bluff Lock and Dam. However, it should be noted

2

that during normal operation the plans call for a minimum release of 6,300 cfs which can be relied on about 70 percent of the time".

B. The maximum winter temperature conditions are:

Blowdown 80°F
River at 40°F

C. The maximum summer temperature conditions are:

Blowdown at 93°F maximum
(Above 90°F 0.4 percent of the time)

River at 79°F

(The maximum temperature of record at Burtons Ferry Bridge is 86°F. The plume for the 93°F blowdown into the 86°F river would be much smaller than the plume for the 93°F blowdown into the 79°F river.)

Blowdown temperatures were calculated using the cooling tower curve shown on Figure 3.5-1 and weather observation data collected at Augusta, Georgia, and obtained from the National Climatic Center, Asheville, North Carolina (October 1968 to September 1970).

River water temperatures were taken in the Savannah River at the Burtons Ferry Bridge (22.5 river miles downstream from the site) by the U.S. Department of Interior Geological Survey and were recorded in their publication, Water Resources Data For Georgia (1969 and 1970 editions).

Four distinct cases were analyzed for resulting plume shape.

Case 1 - Blowdown flow of 22,000 gpm and no dilution water flow at winter design conditions (Figures 3.5-4 & 3.5-5).

Case 2 - Blowdown flow of 22,000 gpm and no dilution water flow at summer design conditions (Figures 3.5-6 & 3.5-7). 1

Case 3 - Blowdown flow of 22,000 gpm and dilution flow of 15,000 gpm at winter design conditions (Figures 3.5-8 & 3.5-9).

Case 4 - Blowdown flow of 22,000 gpm and dilution flow of 15,000 gpm at summer design conditions (Figures 3.5-10 & 3.5-11).

For each of the above cases an elevation and plan view of the plume was provided. These views are shown on Figures 3.5-4 through 3.5-11.

For the purposes of this plume analysis the flows from the nuclear service cooling towers, steam generator blowdown, turbine building drains, neutralizer discharge, radwaste discharge, and sanitary waste were not included. It is assumed that their effect is insignificant relative to the turbine plant cooling tower blowdown and dilution pump flows.

A description of the results obtained by the analysis follows.

3.5.3.1 Thermal Plume Analysis of VNP Cooling Tower Blowdown

3.5.3.1.1 Introduction

A study has been performed to determine thermal plume configuration for the blowdown from the cooling tower at VNP when the blowdown is discharged into the Savannah River. The blowdown discharge system is located near the right bank of the river at about river mile 151.

The thermal plume was analyzed for both the winter and summer climatological conditions. The analysis was based on cooling tower blowdown without dilution and with in-plant dilution added in the mixing chamber. For the analysis a low river flow only was considered since it will represent the critical condition.

The analysis was made by the use of three-dimensional mathematical models. The results of the analysis are presented in the form of vertical rise isotherms and horizontal isotherms for each case analyzed.

3.5.3.1.2 Basic Data

Minimum flow in the Savannah River of 5800 cfs at the site was used in analyzing the thermal plume mixing and dispersion in the river for both summer and winter conditions. The corresponding water surface in the river is at elevation 80 feet. The water surface width at this stage is about 330 ft, and the water depth is about 10 ft.

River water temperature at Burtons Ferry Bridge for the years 1969-1970. ranged from 79°F in summer to 40°F in winter. Since no river water temperature records are available at the site, the water temperature at Burtons Ferry was used in this study. 1

Blowdown temperature was computed using climatological records at Augusta, Ga., for the year 1969-1970. A maximum summer temperature of 93°F and a maximum winter temperature of 80°F were used in this study.

Blowdown flow rate with 4 units operating will be about 22,000 gpm (49 cfs). During certain conditions, dilution water of 15,000 gpm (33.4 cfs) may be added, resulting in a total blowdown rate of 37,000 gpm (82.4 cfs). The temperature of the diluted discharge will be about 87°F in summer and 64°F in winter.

3.5.3.1.3 Blowdown Discharge System

The blowdown discharge system consists of a mixing chamber and conduits that connect the chamber with the coooling tower and a diffuser located on the river bottom. Water from the cooling tower basins discharges into a structure which acts as a mixing chamber and energy dissipater. Outflow will then be discharged into the river through the diffuser ports. The diffuser diameter is 48 inches with 24 ports spaced at 30 inches center-to-center and jet diameter of 8 inches measured at the vena contracta. The total length of the diffuser is 60 ft and would extend about 80 ft into the river from the low water edge.

The porta are oriented to discharge at an angle of 22.5° from the horizontal with the center of the jet about 1.5 ft above the river bottom. This orientation is selected to prevent scouring of the river bottom and to prevent the warm water effluent from reaching the bottom. 1

3.5.3.1.4 Method of Analysis

The blowdown water will result in increased river temperatures in the vicinity and downstream of the diffuser. The extent and magnitude of the heat-affected zone depends primarily on the rate of discharge, the excess temperature of the blowdown over the ambient temperature, the velocity of discharge, the diffuser port size, and the magnitude of the river flow. 2 The near-field is described as the region where the jet momentum and the buoyancy are responsible for causing the dilution. For this region a three-dimensional mathematical model developed by Keh and Fan (1) was used to determine the plume's dilution and size. 1 The river velocity, which is about 1.75 fps, will cause a deflection of the plume in the flow direction. The orientation of the plume downstream from the diffuser was determined from the method developed by Shirazi and Davis (2).

The far-field in this analysis is assumed to begin where the ambient river turbulence dominates the mixing. For the far-field analysis, a dispersion model developed by Elwin (3) was used to simulate the dispersion of a continuous thermal source in a steady state uniform flow.

The basic building block of the model is the generalized fluid element. For steady state conditions, the general three-dimensional heat equation for each element written in a differential form relates the sum of heat exchange at the element's surface to the rate of heat inflow and the rate of heat outflow by the various mass transfer mechanisms.

The dispersion model consists of a three-dimensional array of elemental equations which, when coupled with appropriate boundary conditions, may be 2 solved through a progressive simultaneous solution of the system. The model considers longitudinal advection of the flow, lateral, longitudinal, and vertical dispersion, and surface heat dissipation. The boundary conditions include no heat transfer through the banks or bottom of the river. Although surface heat loss can be accounted for in this model, it was deemed small and was neglected in this study.

The temperature profile at the point where the near-field jet velocity becomes equal to the ambient stream velocity was used as the upstream boundary condition for the far-field model.

3.5.3.1.5 Results

River temperatures were analyzed for the addition of blowdown discharge from 1 VNP with 4 units operating for both winter and summer conditions and with and without dilution water. The results of the near-field analysis are shown 2 in 2 figures for each condition analyzed. The first figure of each pair shows the vertical temperature rise isotherms. The lowest isotherm shown is 5°F. The second figure of each pair shows the estimated horizontal boundary of the 5°F isotherm.

For winter climatological conditions without dilution, the 5°F isotherm extends about 20 ft downstream from the diffuser with a maximum estimated width of about 64 ft, as shown in Figures 3.5-4 and 3.5-5. For the summer conditions without dilution, the 5°F isotherm will extend about 7 ft downstream 1 from the diffuser and will be about 61 ft wide, as shown in Figures 3.5-6 and 3.5-7. It should be noted that in both cases, the 5°F isotherm will not reach the surface or the bottom of the river.

Temperature rise isotherms for the winter condition with dilution are shown in Figures 3.5-8 and 3.5-9. The 5°F isotherm will extend about 11 ft downstream and will be about 62 ft wide. For the summer condition, the temperature rise isotherms with dilution are shown in Figures 3.5-10 and 3.5-11. The 5°F isotherm will extend about 4 ft downstream and will be about 61 ft wide.

For winter conditions the far-field isotherms are very similar for both cases, with and without in-plant dilution. In both cases, the 1°F isotherm extends approximately 2200 ft downstream from the diffuser and is about 60 ft wide. Without in-plant dilution, the 1°F isotherm reaches the surface at about 45 ft downstream and the bottom at 55 ft downstream from the diffuser, as shown on Figure 3.5-15. The 2°F isotherm does not reach the surface or the bottom in either case. 2

For summer conditions, the 1°F isotherm does not reach the surface or touch the bottom either with or without in-plant dilution. Without in-plant dilution, the 1°F isotherm extends about 60 ft downstream with a maximum width of 70 ft, as shown in Figures 3.5-13 and 3.5-14. With in-plant dilution, the maximum extent is about 25 ft downstream with a width of about 60 ft, as shown in Figures 3.5-16 and 3.5-17.

The results of this thermal plume study illustrate the small area of the Savannah River affected by the VNP discharge. However, the mixing zone requested from the Environmental Protection Division of the Georgia Department of Natural Resources may be somewhat larger than that shown on the 1 above-mentioned figures.

3.5.3.1.6 References

1. Keh, R. C. and Fan, L. M., "Mathematical Models for the Prediction of Temperature Distributions Resulting from the Discharge of Heated Water into Large Bodies of Water," for the Water Quality Office, Environmental Protection Agency, October 1970. 1

2. Shirazi, M. A. and Davis, L. R., "Workbook of Thermal Plume Prediction - Submerged Jets", Vol. 1, U.S. Environmental Protection Agency, Corvallis, Oregon, August 1972.

3. Elwin, E. H., "Uniform Flow Dispersion Model for a Thermal Source", presented at the ASCE National Environmental Engineering Meeting, St. Louis, Missouri, October 18-22, 1971. 2

4. Bishop, William V., Sales Representative, Research-Cottrell, Inc., Hamon Cooling Tower Division, letter to A. H. Gibson, Southern Services, Inc., Atlanta, Georgia, September 3, 1973.

3.5.4 RIVER INTAKE STRUCTURE

The makeup water system at the Savannah River consists of a concrete intake structure and an intake canal. The general site location of the intake structure is shown in Figure 2.1-3. A detailed sketch of the intake structure is shown in Figure 3.5-2. Figure 3.5-2a shows the general arrangement of the intake structure and canal. The intake canal is approximately 400 ft long. The bottom width is 20 feet, and the side slope is 2:1. The canal bottom and sides will be covered with riprap to prevent erosion. The velocity in the intake canal for the 4 units in operation will be less than 0.5 fps.

The intake structure consists of several identical cells. The number of cells is dependent on the total water flow required for makeup and dilution. Each cell consists of a trash rack in front of the intake structure and a vertical traveling screen downstream of the trash rack. Each cell has slots for stoplogs upstream of the traveling screen and slots for stoplogs and a fine stationary screen downstream of the traveling screen. Provision is made for the installation of a mechanical trash rack rake. The stationary fine screen will be used only when the traveling screen has been removed for maintenance.

The trash rack is made of flat vertical bars with a cross-section of 3-1/2 inches by 1/2 inch. The bars are spaced 3 inches center-to-center. 2

When 2 makeup pumps and 1 dilution pump are operating simultaneously for each 2 units, and the river water surface is at elevation 80 ft, the velocities are as follows:

Velocity through trash rack	< 0.5 fps
Velocity through traveling screen	< 1.0 fps

By limiting the velocities to those above, impingement of fish is expected to be negligible. Width of the traveling water screen baskets is 10 ft. Speed of the traveling screen is 10 ft per minute. The traveling screen mesh is annealed type 304 stainless steel. Trash collected by the rake and the traveling screens is returned to the river.

Intake structure pumps are discussed in Subsection 3.5.3.

Provisions are being made for chlorination at the discharge of the makeup water pumps to control slime growth in the makeup piping.

3.5.5 RIVER OUTFALL STRUCTURE

Figure 3.5-3 shows a detailed sketch of the river outfall structure. Figure 2.1-3 shows the general site location of the outfall structure. Two outfall lines from the mixing chamber will discharge into the Savannah River. Each line will be 450 ft long and will have a 60-ft-long diffuser at the end. For the blowdown of 4 units, the maximum blowdown flow will be 22,000 gpm, and with 1 dilution pump in operation, the flow will be 37,000 gpm. Average velocity of the water discharging through the nozzles of the diffuser will be 12 fps. Only one of these lines will be used at a time. 2

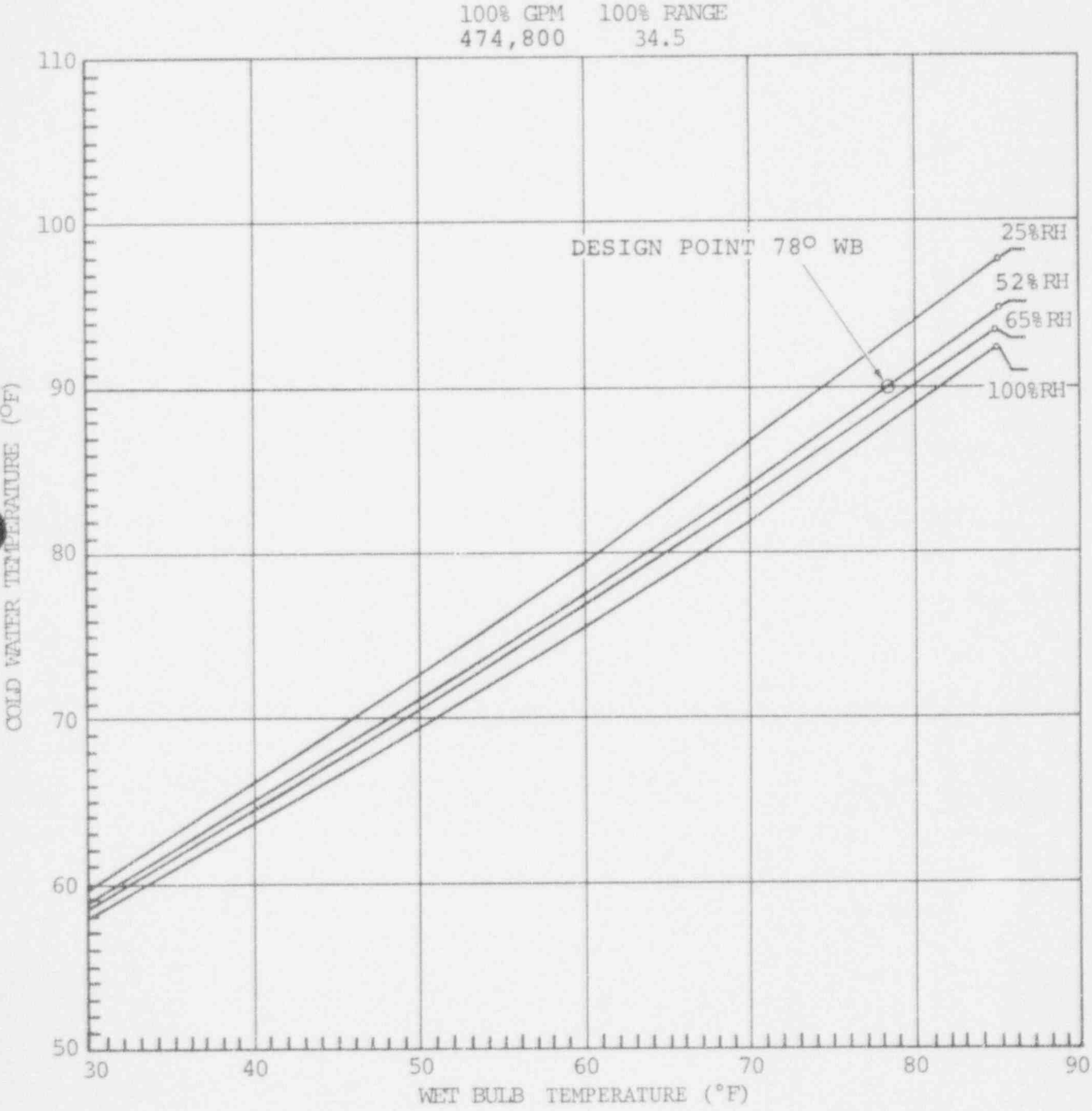
3.5.6 NUCLEAR SERVICE COOLING TOWERS

Each unit of VNP will have 2 nuclear service cooling towers. Normally, only 1 tower is in operation, except for a 1-day period during reactor shutdown. Each tower is 96 feet in diameter by 44 feet high. Air flow is 9,560,000 pounds per hour, and exit air velocity is 1525 feet per minute for each tower. Fan power is 500 horsepower per tower. Design specifications require that motor noise levels not exceed those listed in NEMA Standard MG1-12.49C and IEEE No. 85. The tower vendor will comply with the design specifications and will furnish an estimate of total noise level for the towers. The towers will meet the noise standards of the U. S. Occupational Safety and Health Administration at the site boundaries. 1

REFERENCES

(1) Predicted Performance Curves for Alvin W. Vogtle Station - Unit No. 1, One Crossflow Natural Draft Tower/Unit; The Marley Company, Mission, Kansas, CRV-72-351.

PREDICTED PERFORMANCE CURVES
FOR
ALVIN W. VOGTLE STATION - UNIT NO. 1
ONE CROSSFLOW NATURAL DRAFT TOWER UNIT



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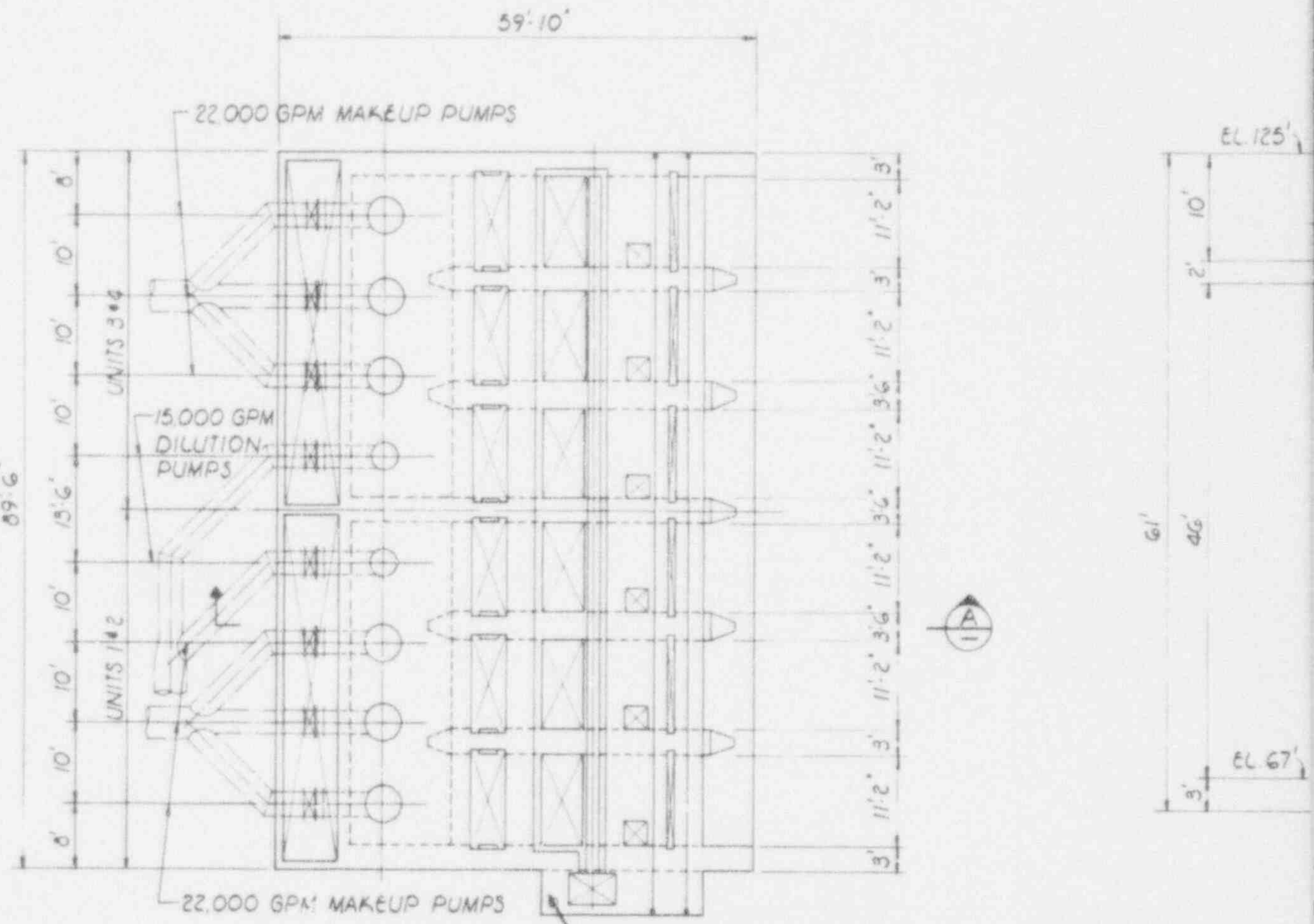
COOLING TOWER PERFORMANCE CURVES(1)

Amend. 1 4/27/73

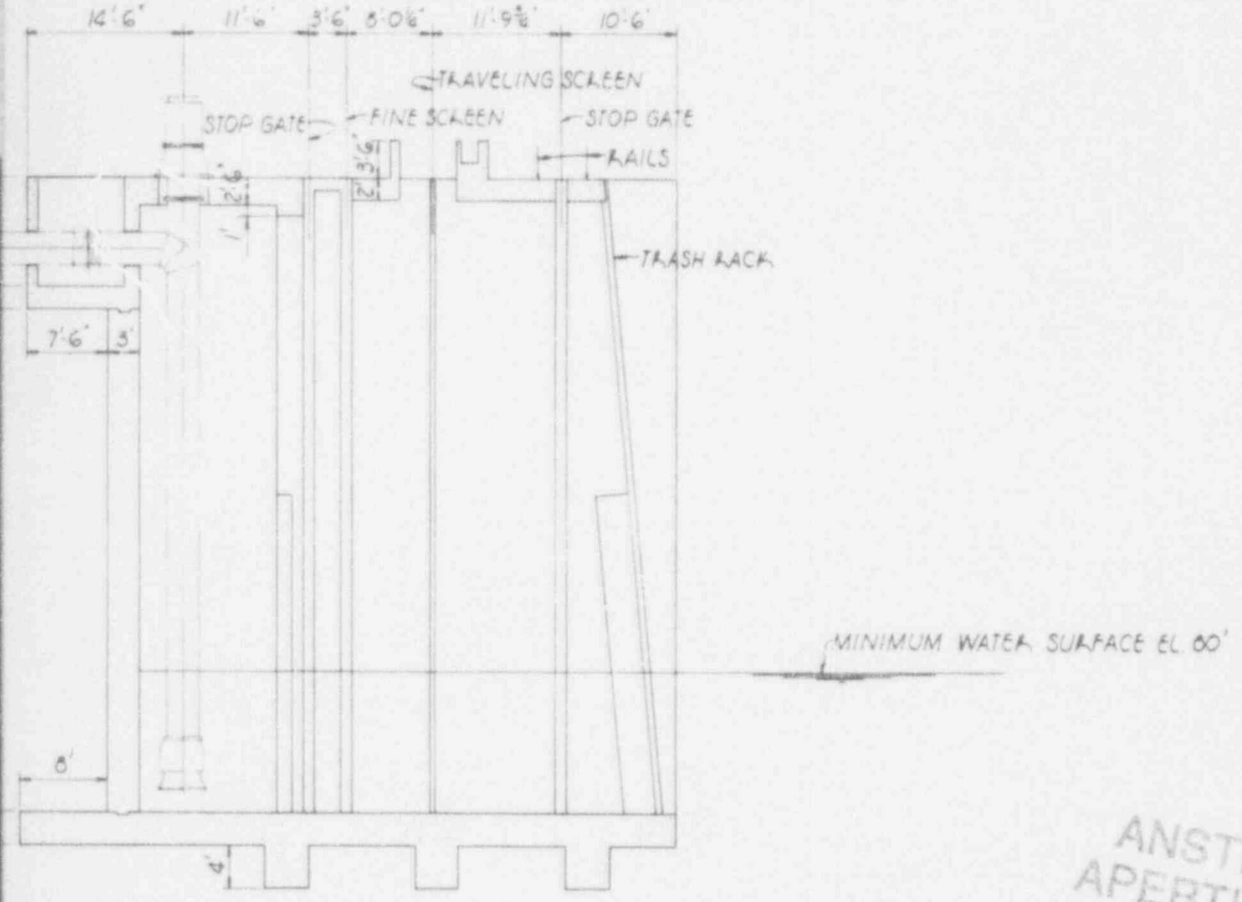
Figure 3.5-1



P L A N

RIVER MAKEUP INTAKE STRUCTURE

3/32" = 1'-0"



SECTION Ⓐ
1/8" = 1'0"

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RIVER INTAKE STRUCTURE

FIGURE 3.5-2

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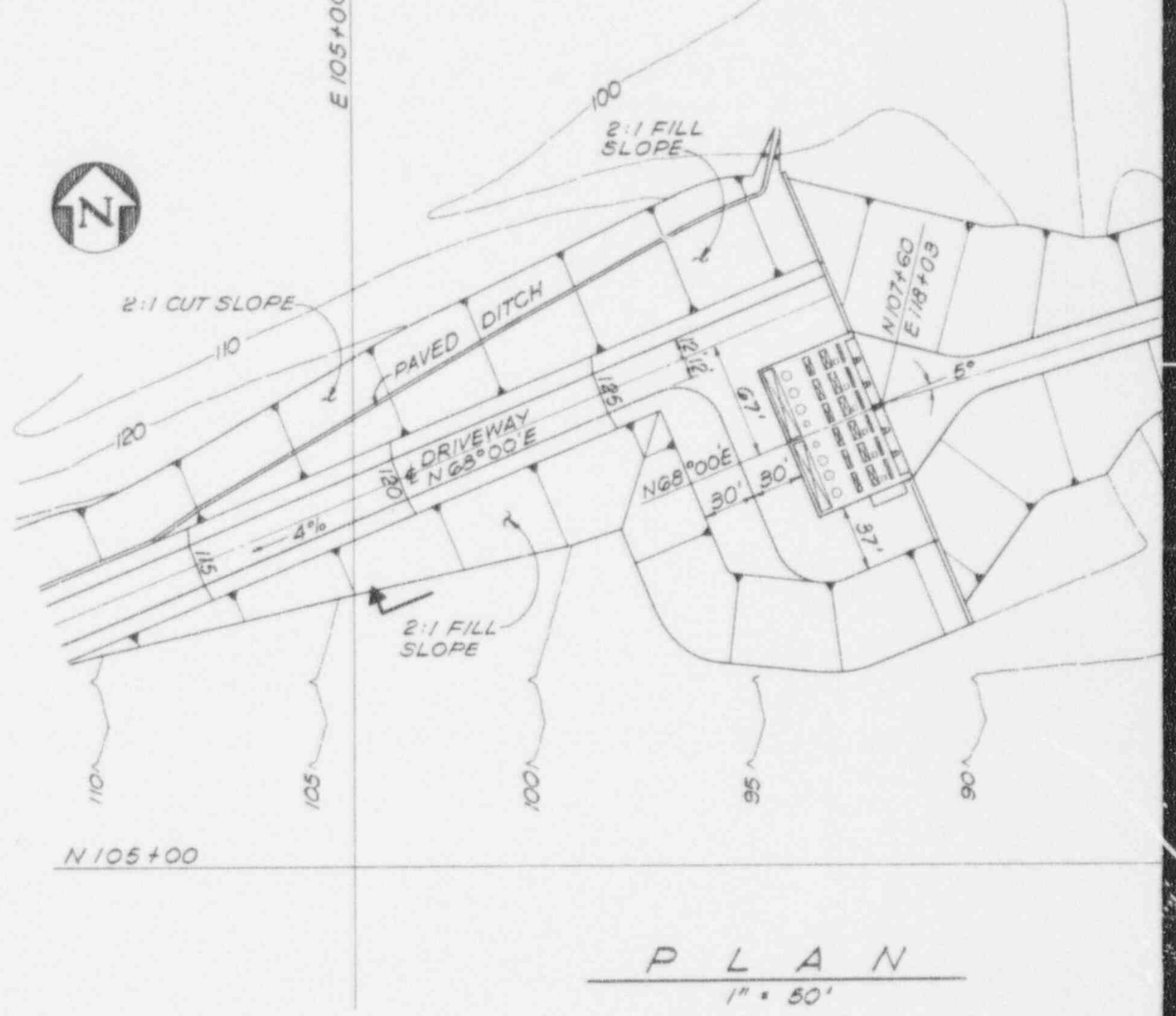
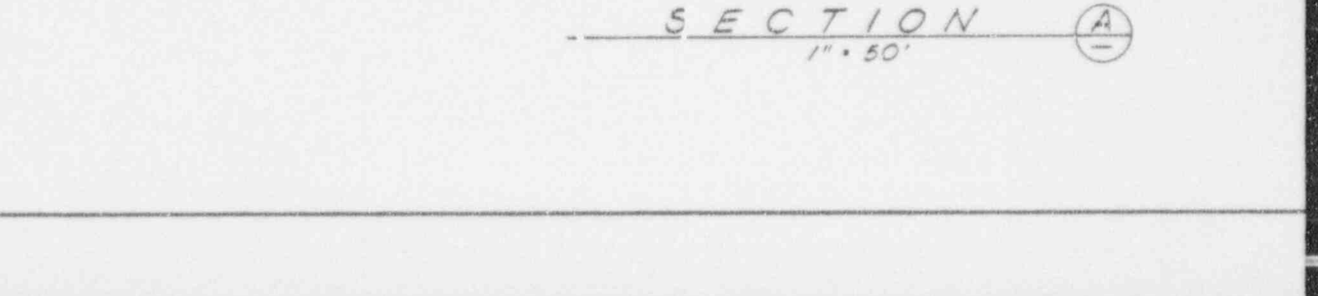


PLAN

1" = 50'



SECTION Ⓐ

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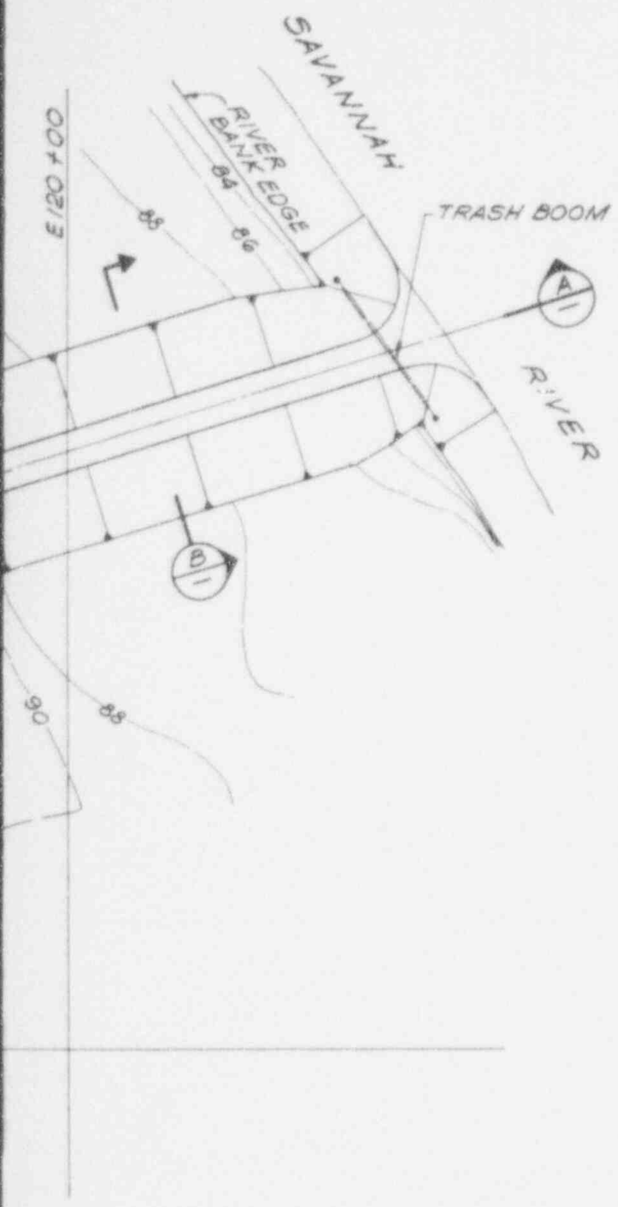
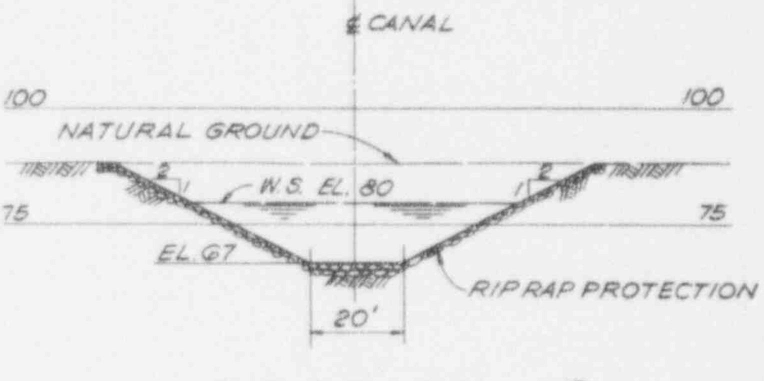
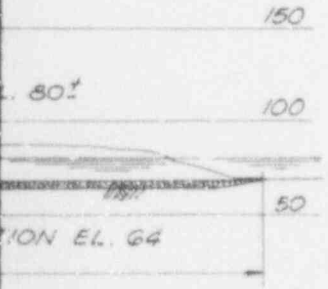




SECTION B
1" = 20'



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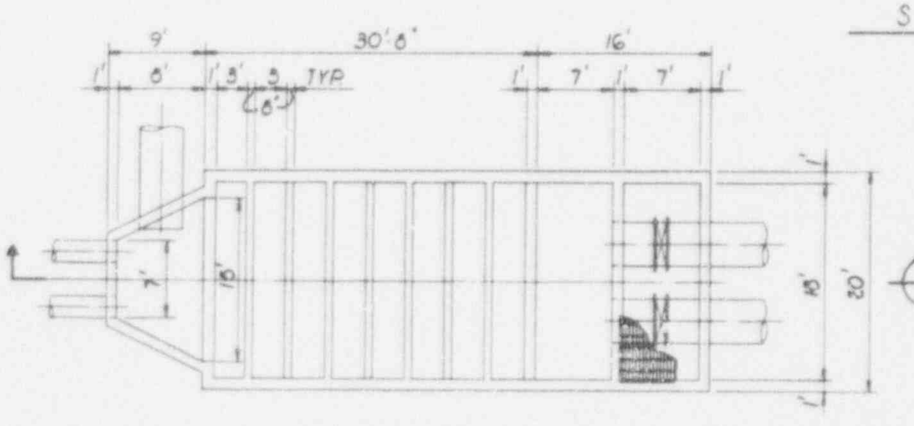
RIVER INTAKE STRUCTURE
AND CANAL
FIGURE 3.5-2A

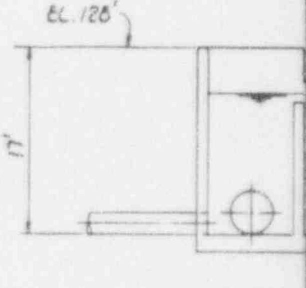
Amend. 2 11/26/73

PLAN - OUTFALL STRUCTURE
1" = 20'

SECTION
1" = 20'



PLAN - MIXING CHAMBER
⅛" = 1'-0"



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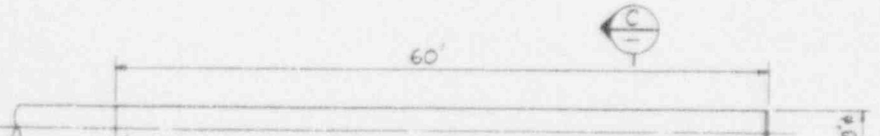
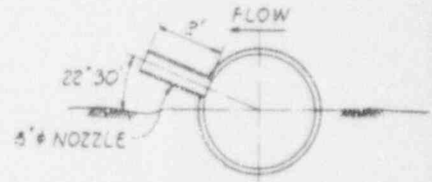
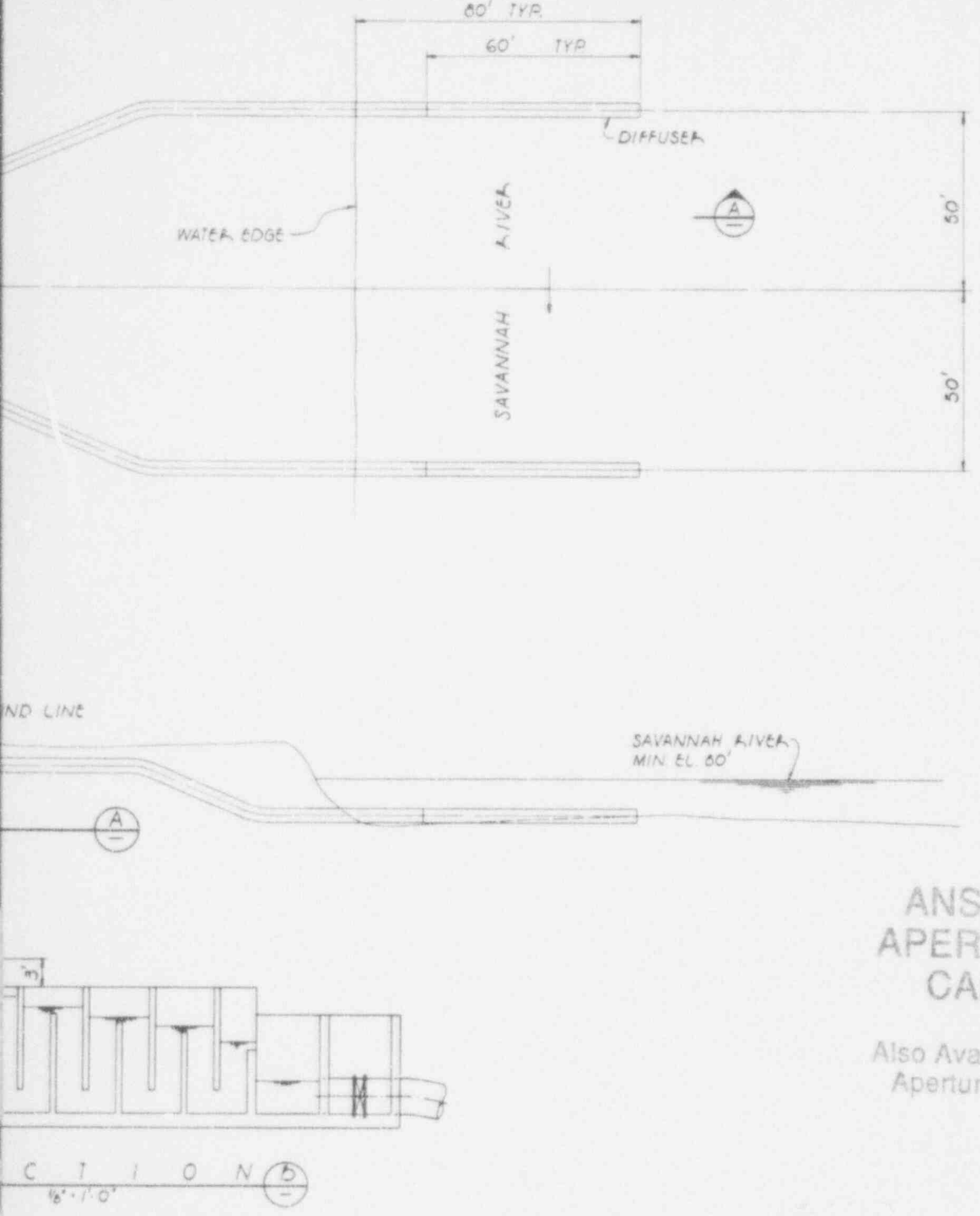


PLAN - DIFFUSER
⅛" = 1'-0"



SECTION C
⅜" = 1'-0"



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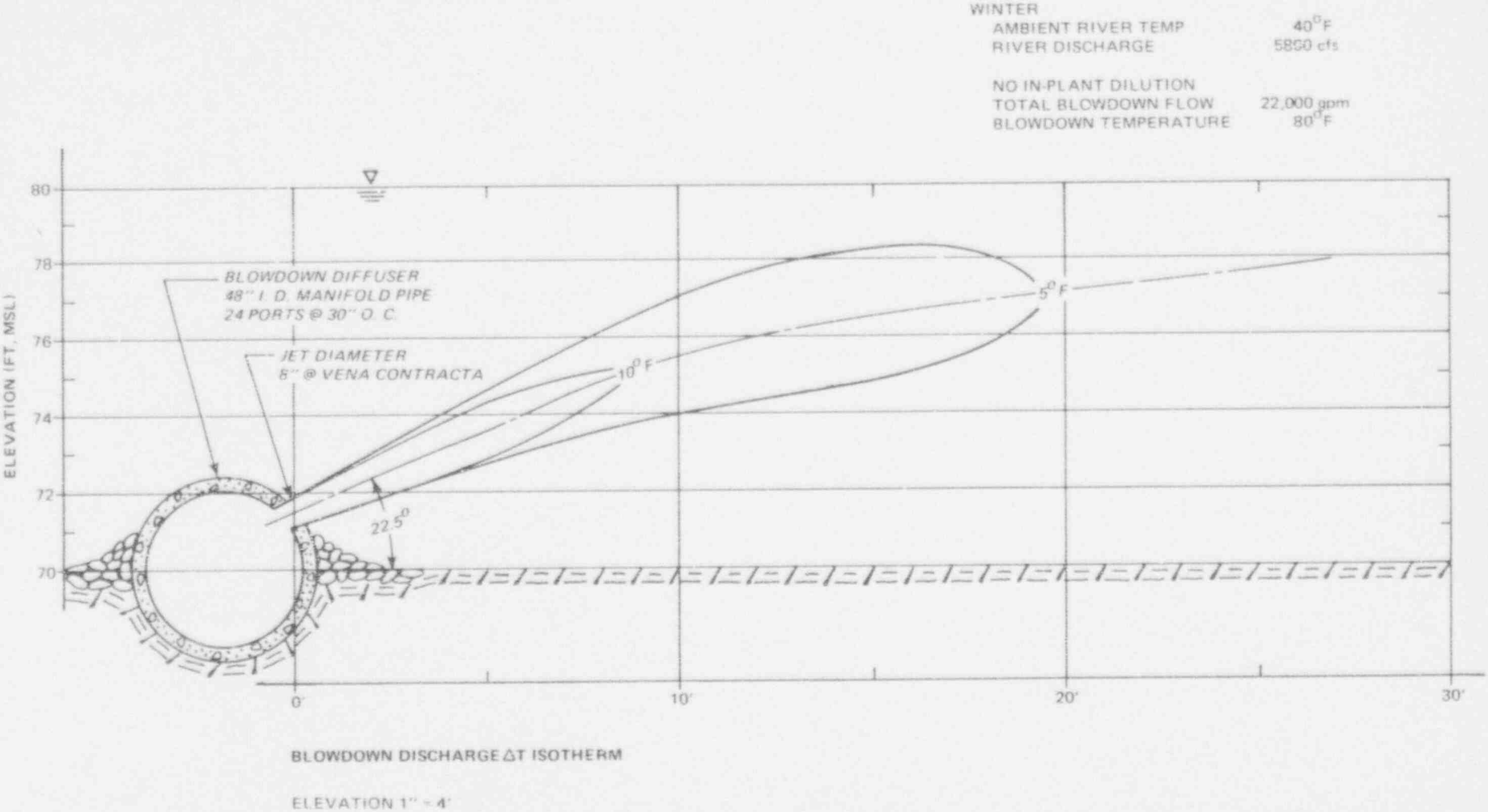
OUTFALL STRUCTURE TO
THE SAVANNAH RIVER

FIGURE 3.5-3



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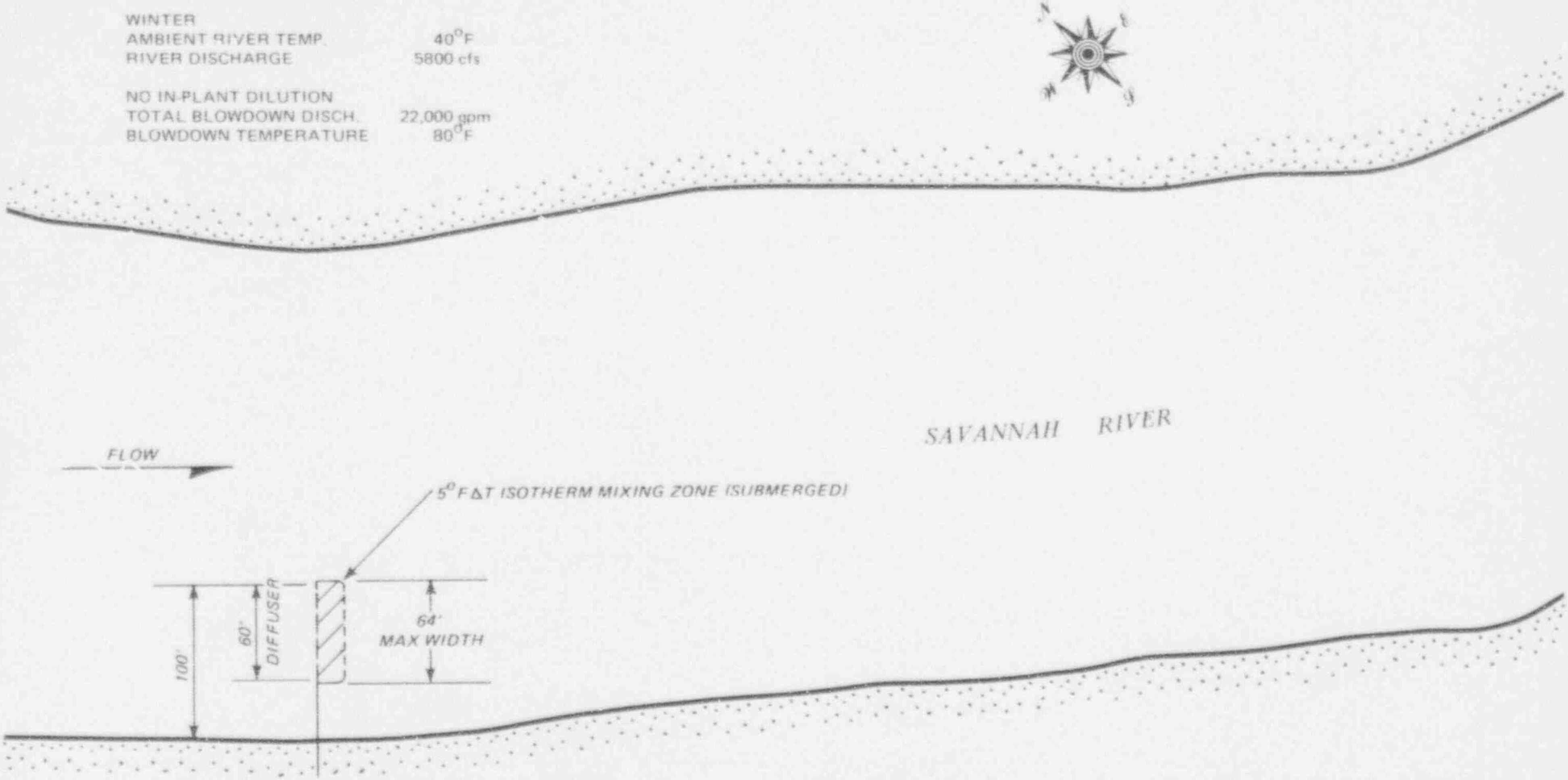
PLANT EFFLUENT THERMAL PLUME
CASE 1: ELEVATION

FIGURE 3.5-4



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BLOWDOWN DISCHARGE 5°FΔT ISOTHERM MIXING ZONE

PLAN 1" = 100'

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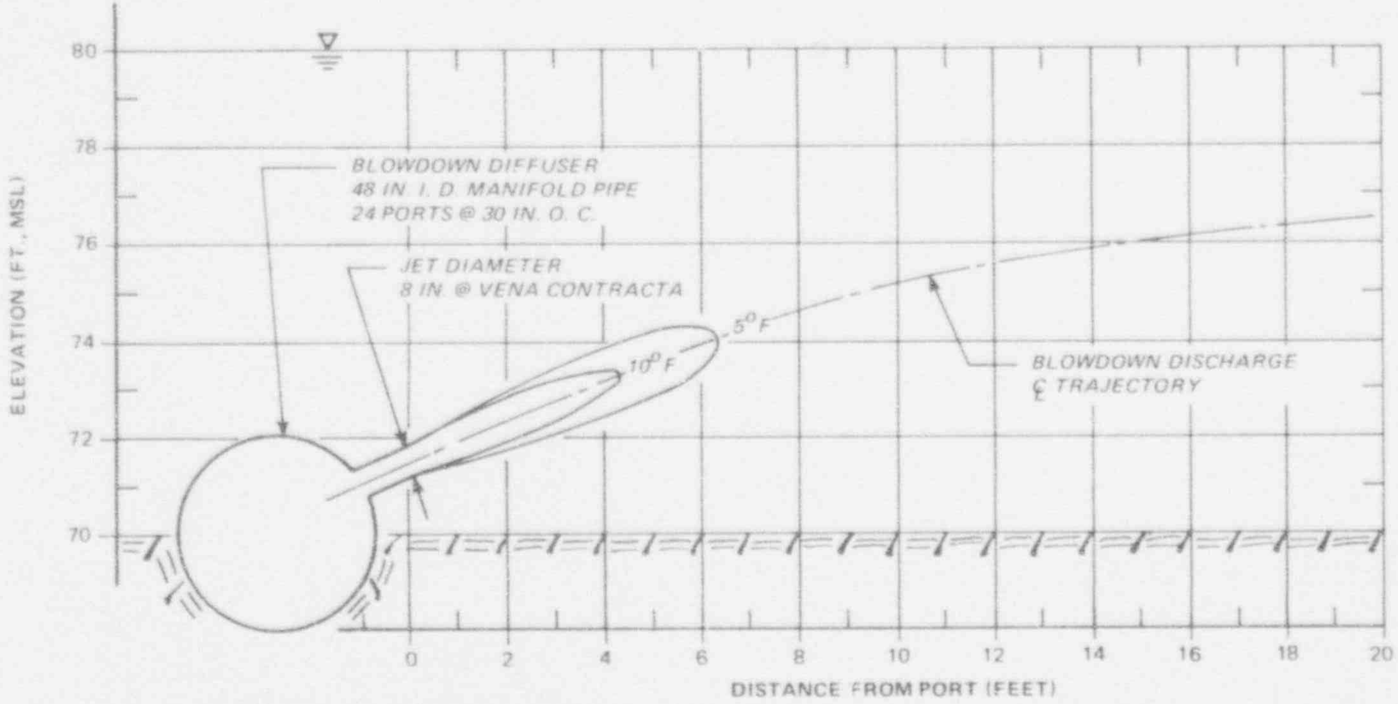
PLANT EFFLUENT THERMAL PLUME
CASE 1: PLAN

FIGURE 3.5-5

4/27/73 Amendment 1

SUMMER

AMBIENT RIVER TEMP.	79°F
RIVER DISCHARGE	5800 cfs
NO IN-PLANT DILUTION	
TOTAL BLOWDOWN FLOW	22,000 gpm
BLOWDOWN TEMPERATURE	93°F



BLOWDOWN DISCHARGE Δ T ISOTHERM

ELEVATION 1" = 4'

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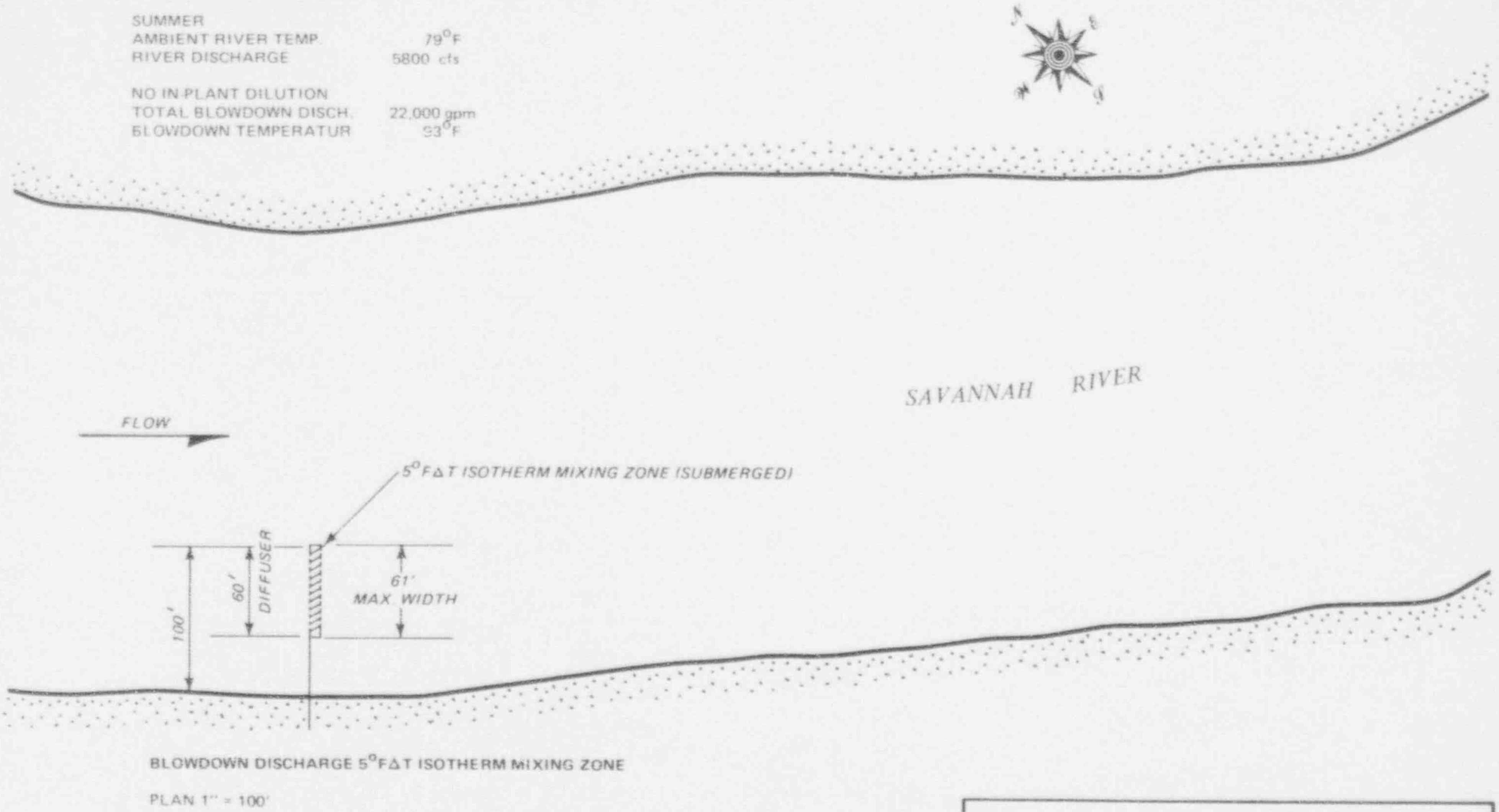
PLANT EFFLUENT THERMAL PLUME
CASE 2: ELEVATION
FIGURE 3.5-6

4/27/73 Amendment 1



BLOWDOWN DISCHARGE 5°FΔT ISOTHERM MIXING ZONE

PLAN 1" = 100'

1

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ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL PLUME
CASE 2: PLAN

FIGURE 3.5-7

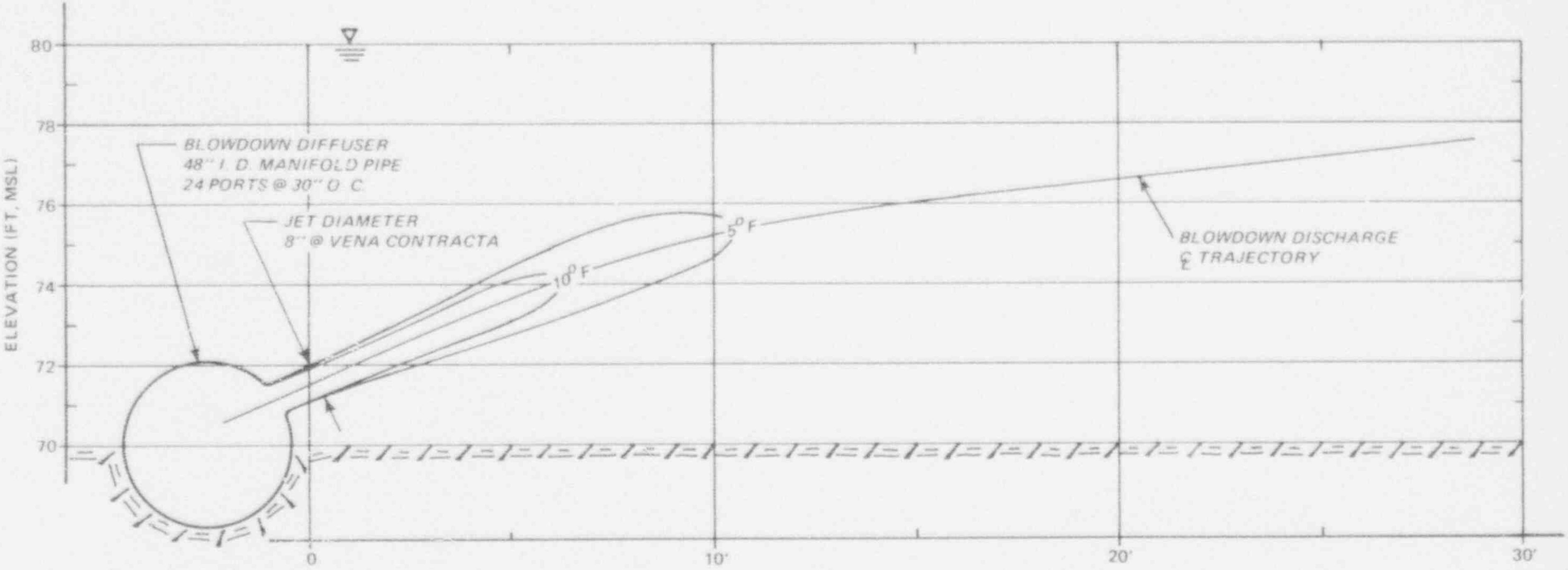
4/27/73 Amendment 1

WINTER

AMBIENT RIVER TEMP.	40°F
RIVER DISCHARGE	5800 cfs

WITH IN-PLANT DILUTION

TOTAL BLOWDOWN DISCH.	37,000 gpm
BLOWDOWN TEMPERATURE	63.8°F



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BLOWDOWN DISCHARGE ΔT ISOTHERM

ELEVATION 1" = 4'

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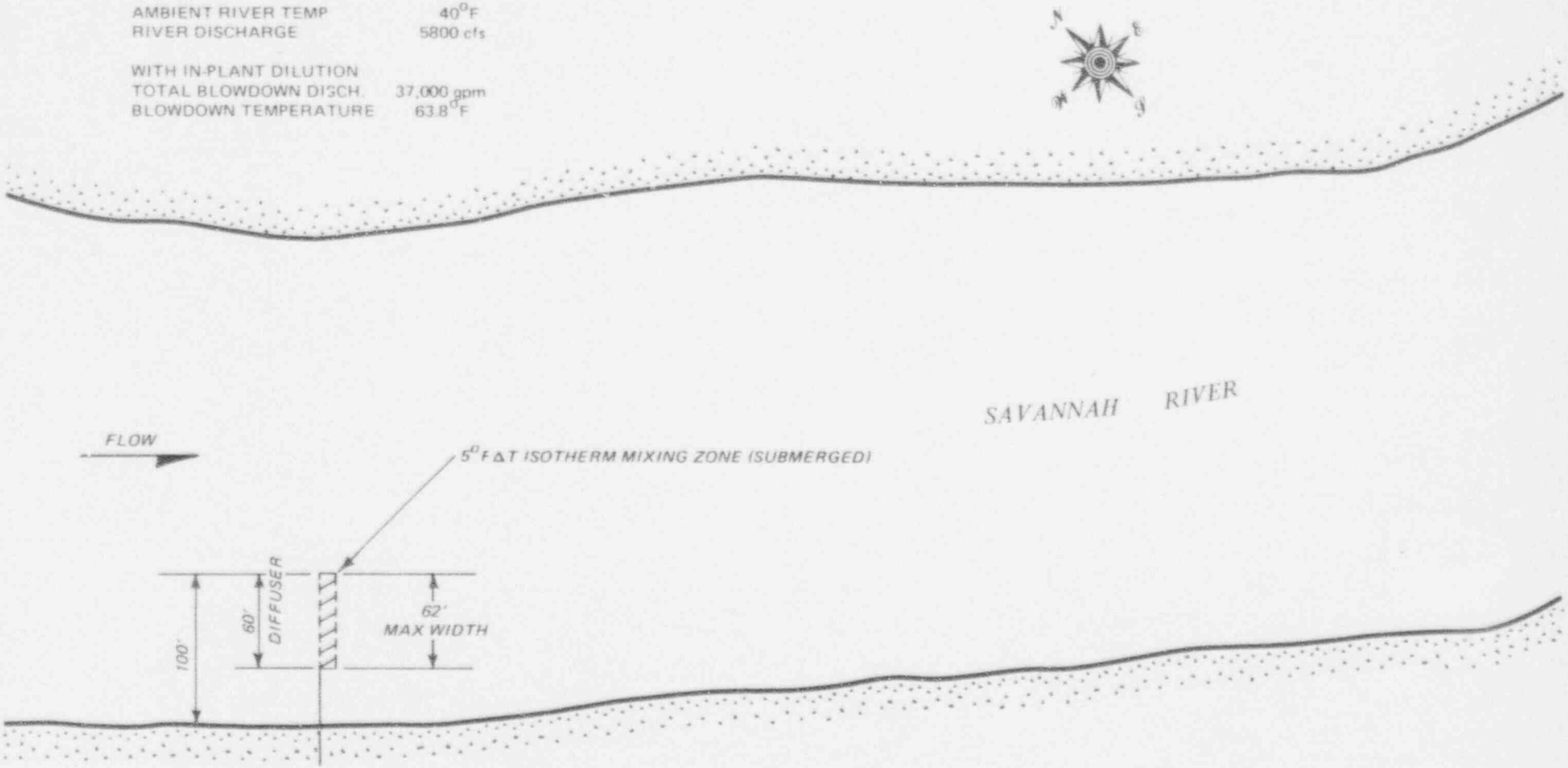
PLANT EFFLUENT THERMAL PLUME
CASE 3: ELEVATION

FIGURE 3.5-8

WINTER
AMBIENT RIVER TEMP 40°F
RIVER DISCHARGE 5800 cfs

WITH IN-PLANT DILUTION
TOTAL BLOWDOWN DISCH. 37,000 gpm
BLOWDOWN TEMPERATURE 63.8°F



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BLOWDOWN DISCHARGE 5°F T ISOTHERM MIXING ZONE

PLAN 1" = 100'

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ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL PLUME
CASE 3: PLAN
FIGURE 3.5-9

SUMMER

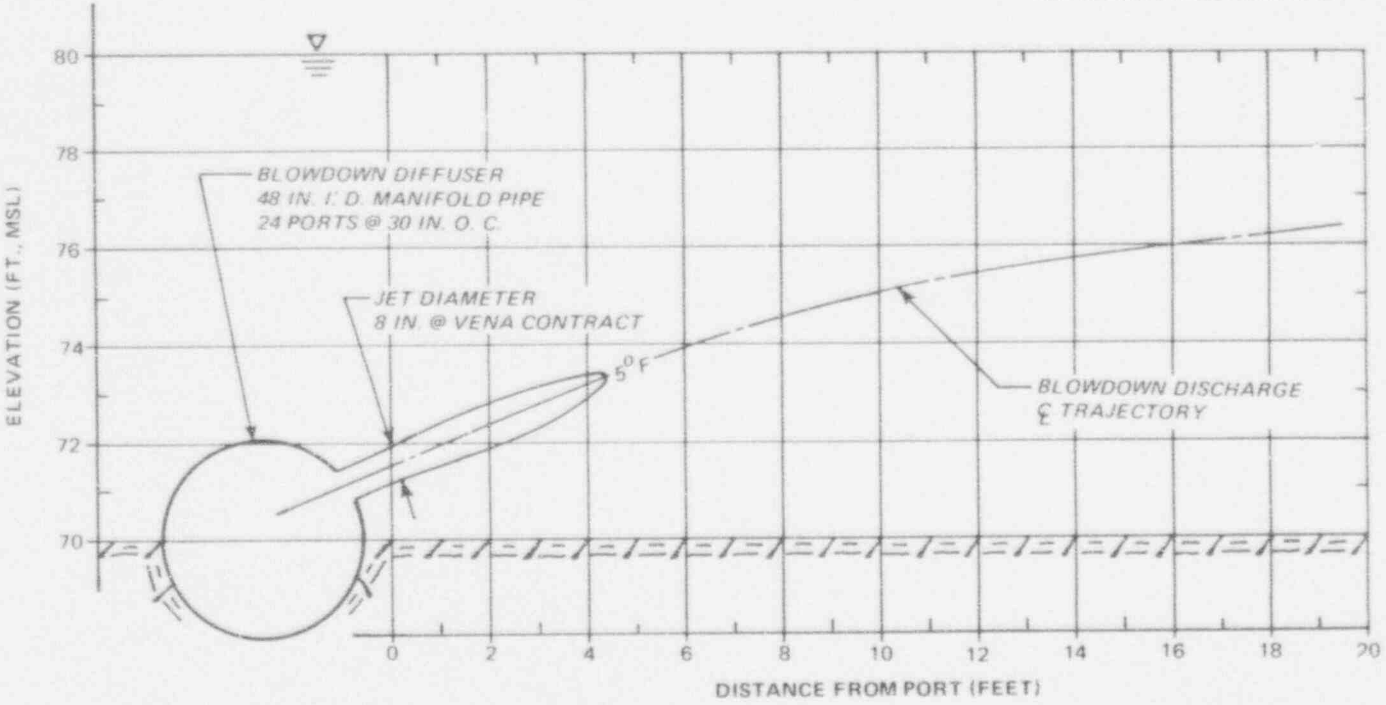
AMBIENT RIVER TEMP 79°F

RIVER DISCHARGE 5800 cfs

WITH IN-PLANT DILUTION

TOTAL BLOWDOWN FLOW 37,000 gpm

BLOWDOWN TEMPERATURE 86.1°F



BLOWDOWN DISCHARGE ΔT ISOTHERM

ELEVATION 1" = 4'

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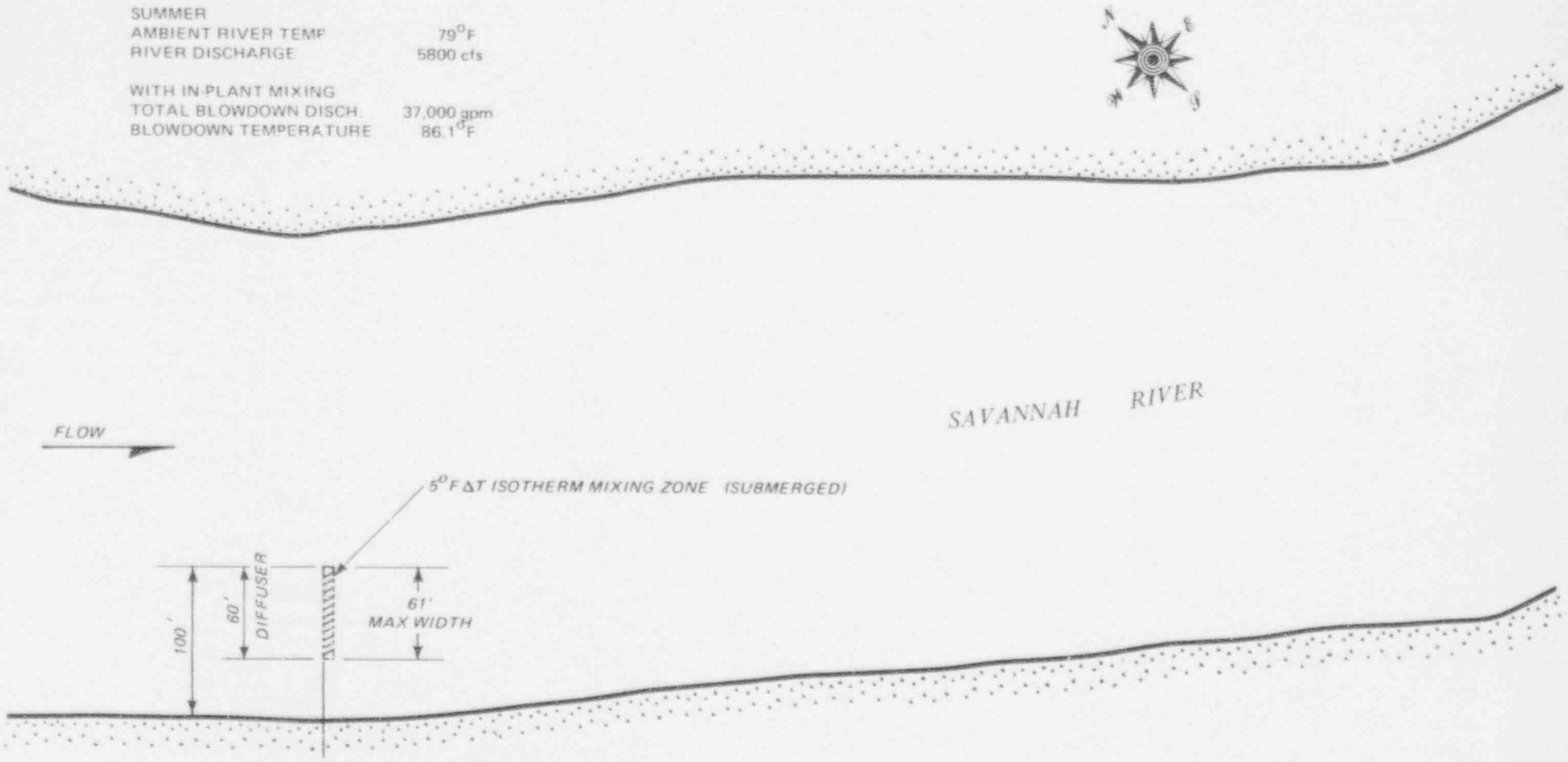
PLANT EFFLUENT THERMAL PLUME
CASE 4: ELEVATION

FIGURE 3.5-10



BLOWDOWN DISCHARGE 5°FΔT ISOTHERM MIXING ZONE

PLAN 1" = 100'

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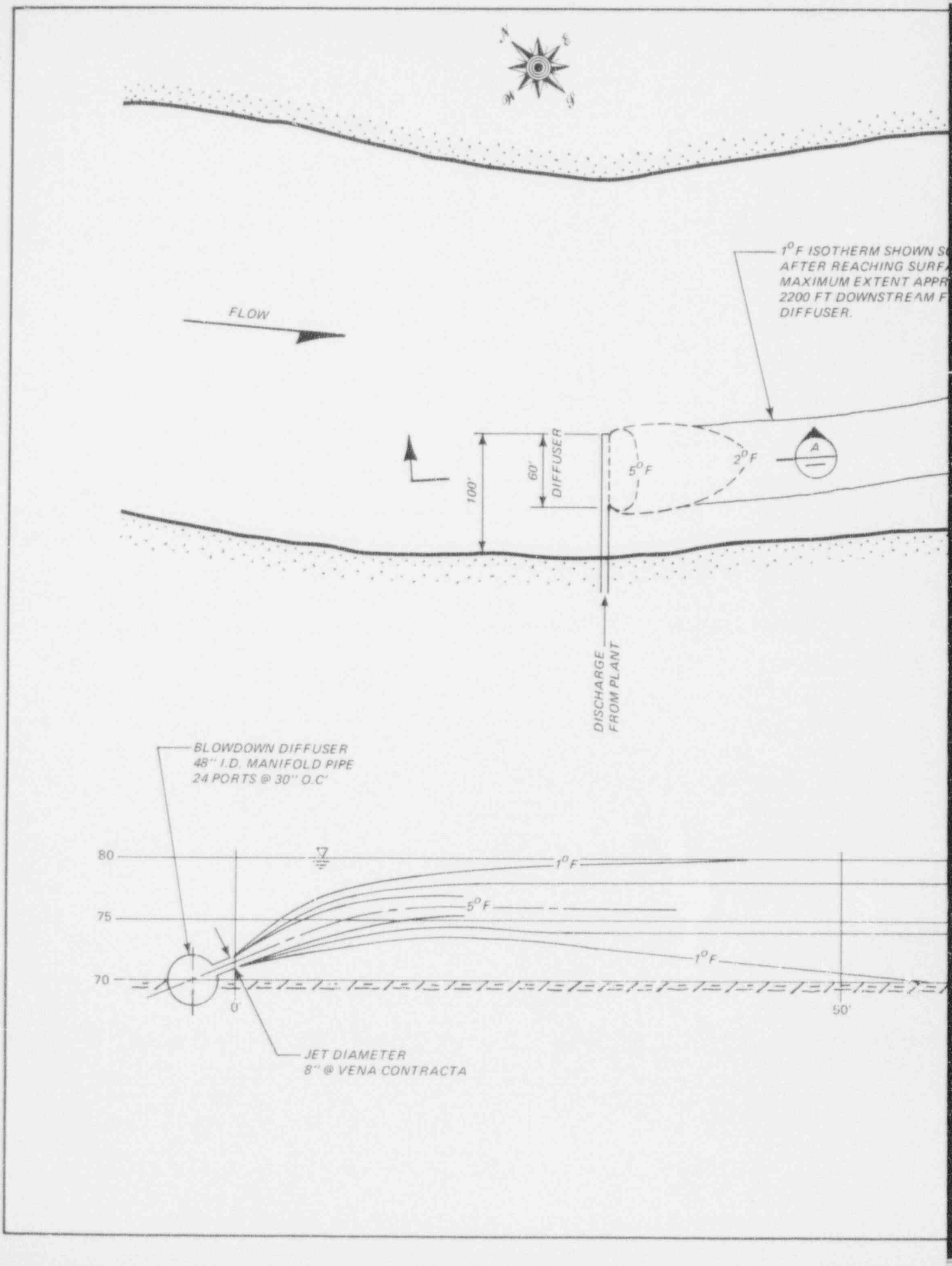
PLANT EFFLUENT THERMAL PLUME
CASE 4: PLAN

FIGURE 3.5-11


N
E
W
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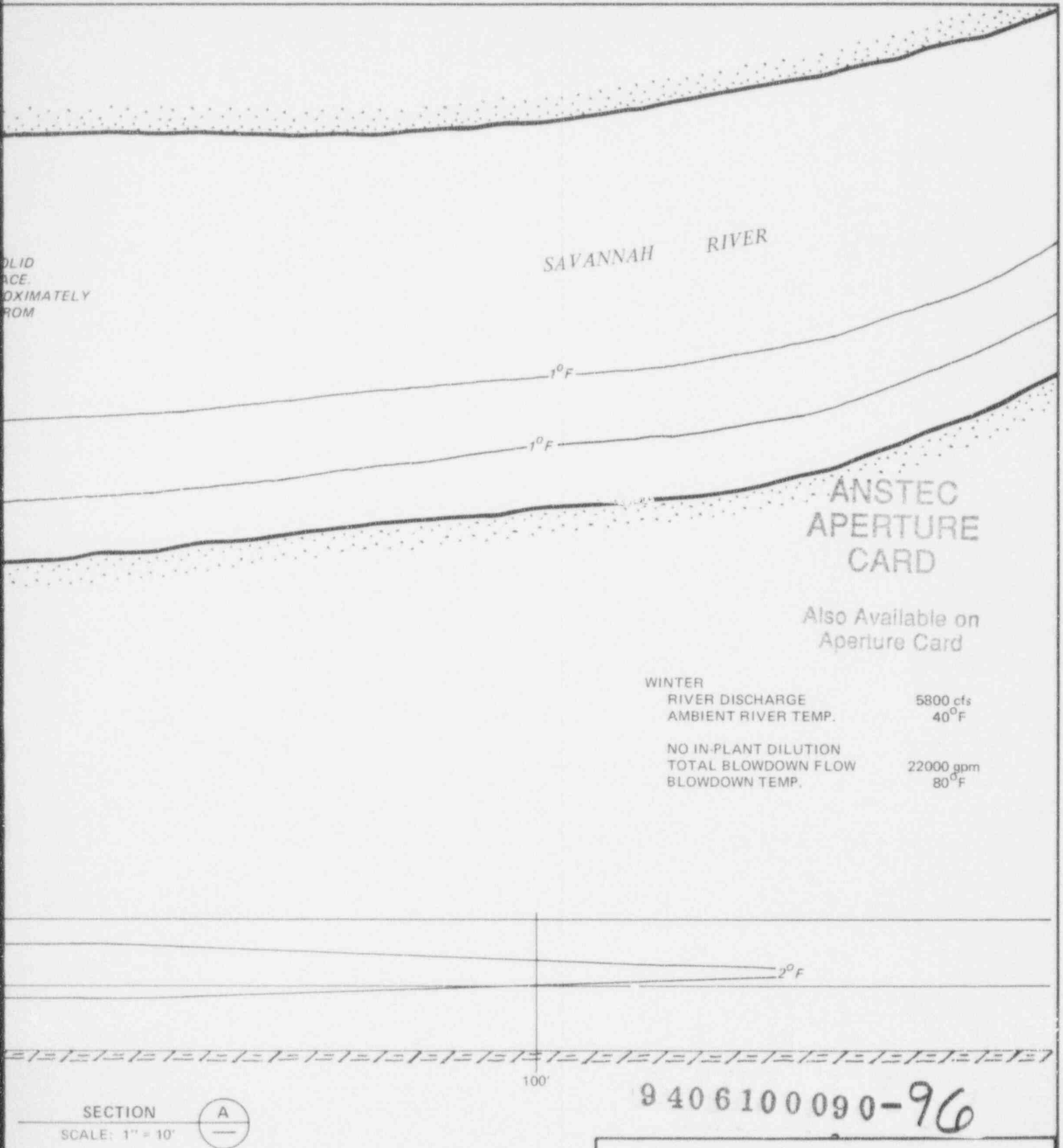
FLOW
1°F ISOTHERM SHOWN S
AFTER REACHING SURF
MAXIMUM EXTENT APPR
2200 FT DOWNSTREAM F
DIFFUSER.
100'
60'
DIFFUSER
5°F
2°F
A
DISCHARGE
FROM PLANT
BLOWDOWN DIFFUSER
48" I.D. MANIFOLD PIPE
24 PORTS @ 30" O.C.
80
75
70
1°F
5°F
1°F
0'
50'
JET DIAMETER
8" @ VENA CONTRACTA



WINTER

RIVER DISCHARGE	5800 cfs
AMBIENT RIVER TEMP.	40°F
NO IN-PLANT DILUTION	
TOTAL BLOWDOWN FLOW	22000 gpm
BLOWDOWN TEMP.	80°F

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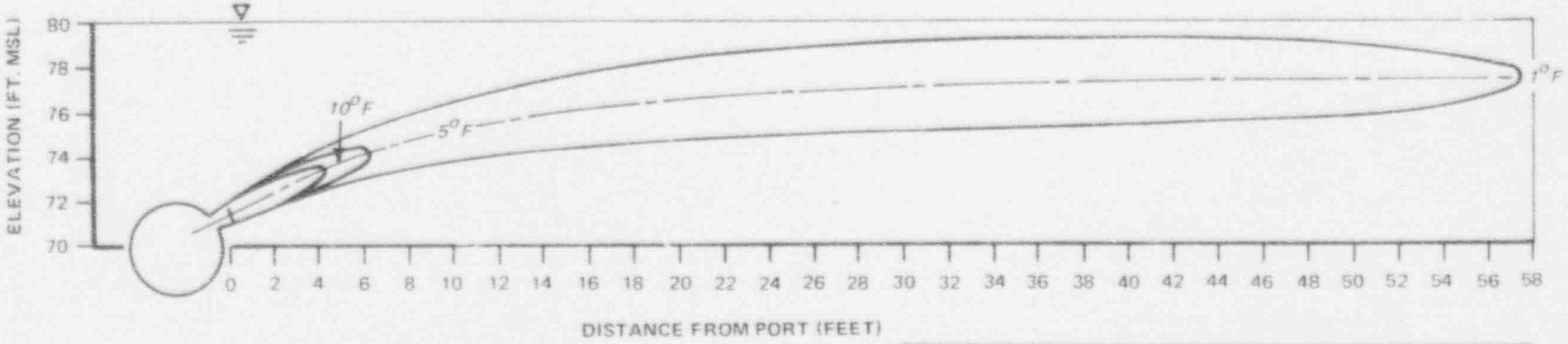
ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM - CASE 1

FIGURE 3.5-12

SUMMER

AMBIENT RIVER TEMP.	79°F
RIVER DISCHARGE	5800 cfs
NO IN-PLANT DILUTION	
TOTAL BLOWDOWN FLOW	22000 gpm
BLOWDOWN TEMPERATURE	93°F



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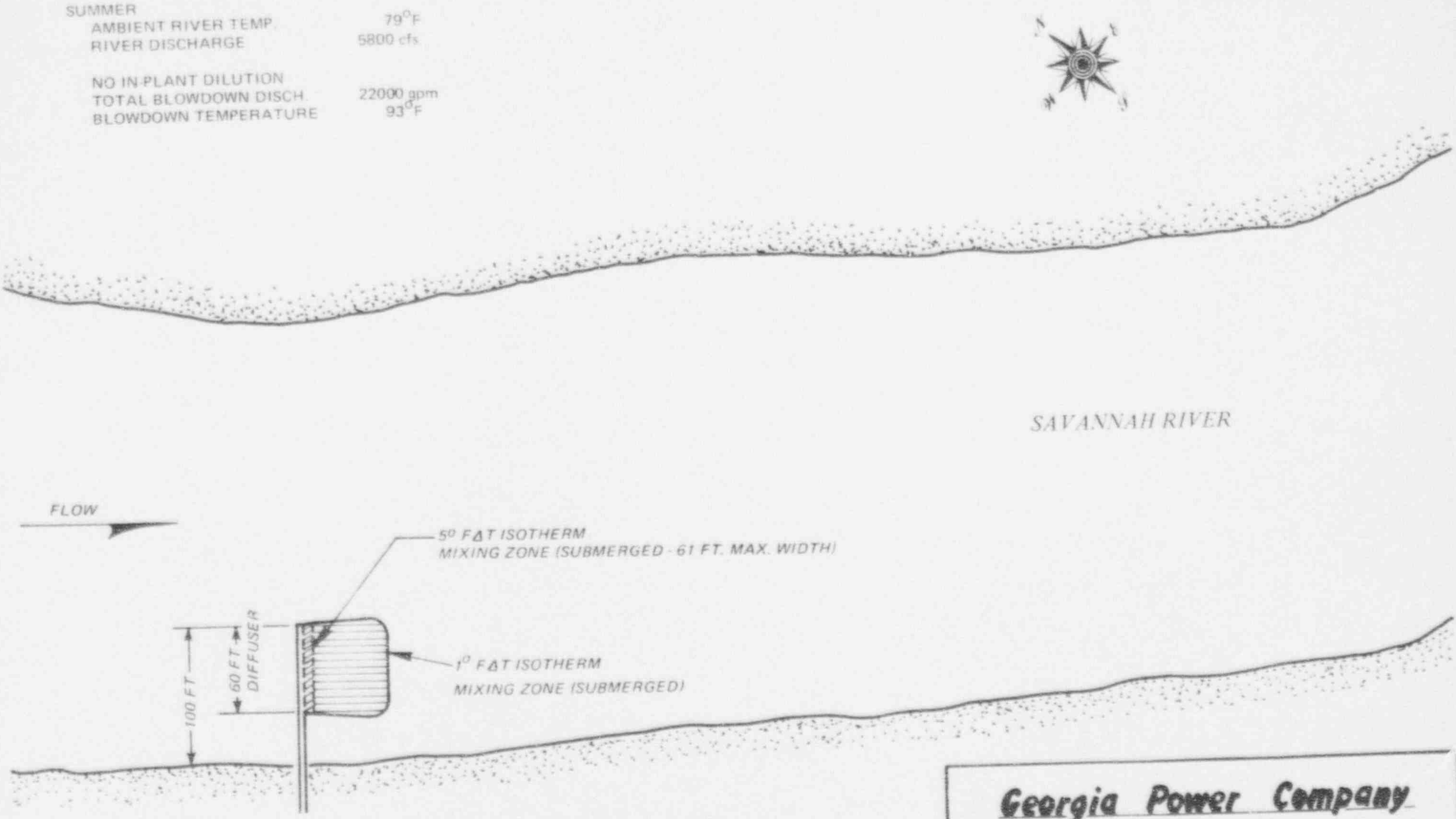
PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM - CASE 2
ELEVATION

FIGURE 3.5-13

Amend. 2 11/26/73



SUMMER
AMBIENT RIVER TEMP. 79°F
RIVER DISCHARGE 5800 cfs

NO IN-PLANT DILUTION
TOTAL BLOWDOWN DISCH. 22000 gpm
BLOWDOWN TEMPERATURE 93°F

PLAN 1 IN. = 100 FT

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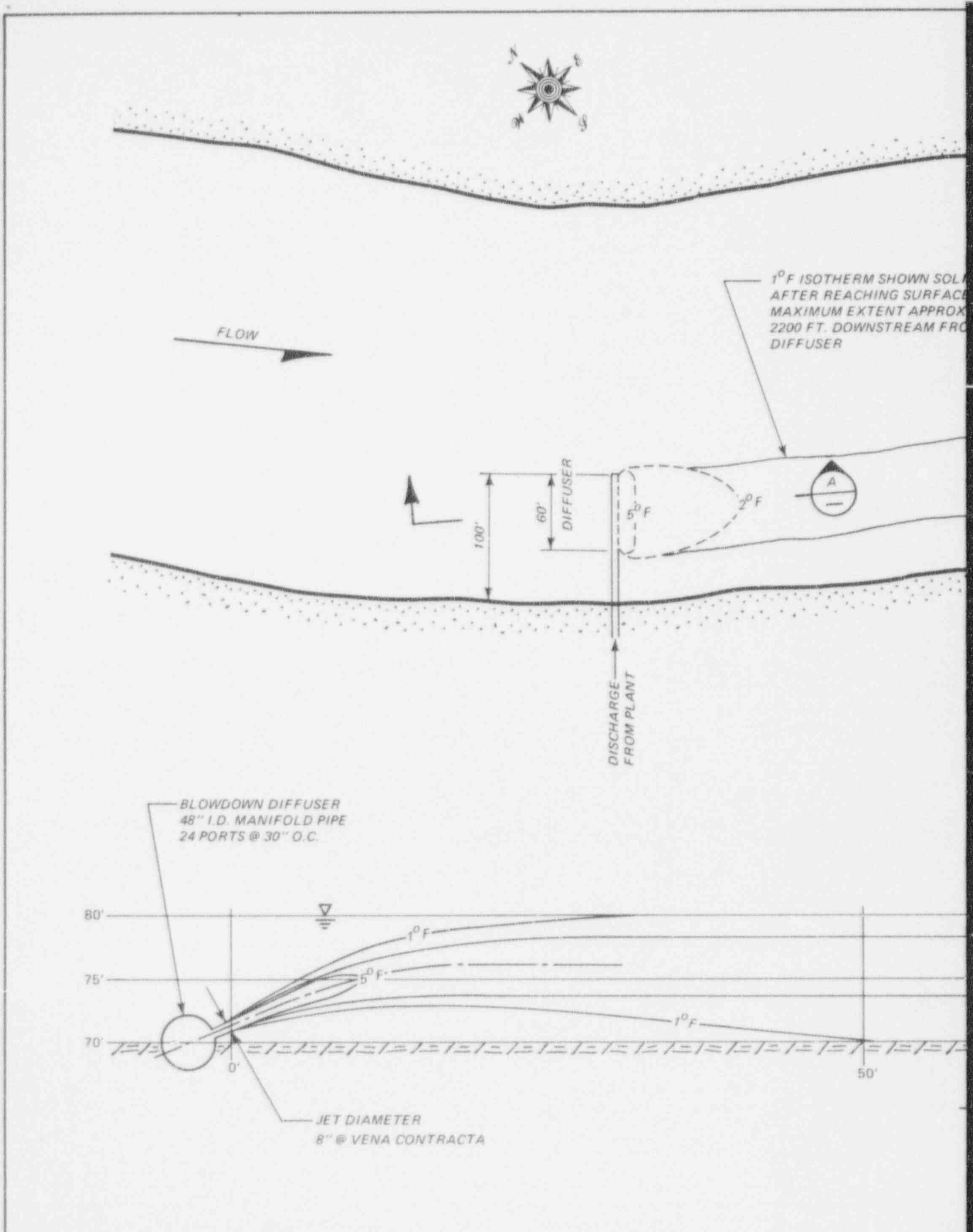
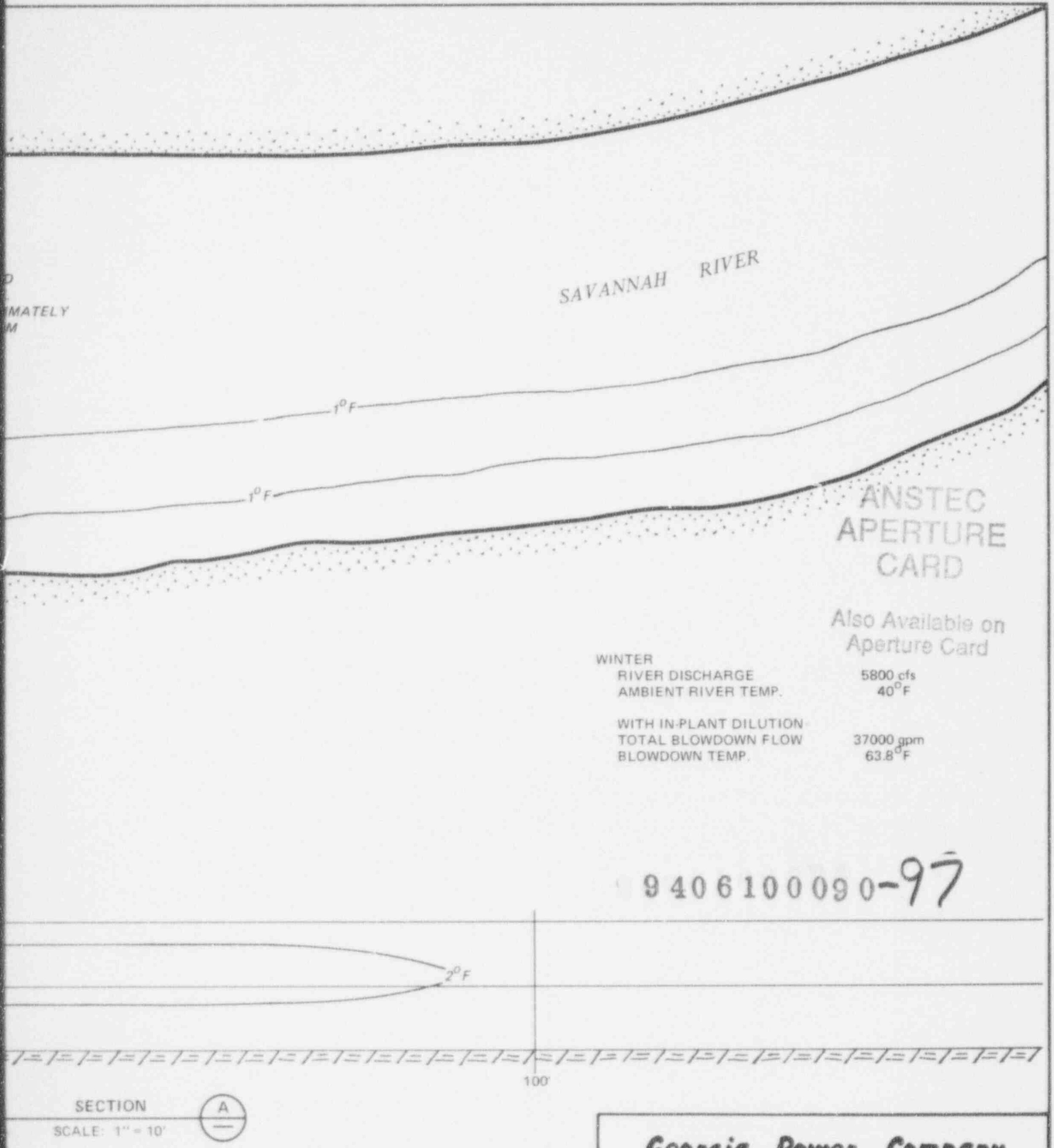
ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM - CASE 2
PLAN FIGURE 3.5-14

Amend. 2 11/26/73


N
E
W
S
FLOW
1°F ISOTHERM SHOWN SOL
AFTER REACHING SURFACE
MAXIMUM EXTENT APPROX
2200 FT. DOWNSTREAM FRO
DIFFUSER
DIFFUSER
60'
100'
5°F
2°F
A
DISCHARGE FROM PLANT
BLOWDOWN DIFFUSER
48" I.D. MANIFOLD PIPE
24 PORTS @ 30" O.C.
80'
75'
70'
1°F
5°F
1°F
0'
50'
JET DIAMETER
8" @ VENA CONTRACTA



WINTER
RIVER DISCHARGE 5800 cfs
AMBIENT RIVER TEMP. 40°F

WITH IN-PLANT DILUTION
TOTAL BLOWDOWN FLOW 37000 gpm
BLOWDOWN TEMP. 63.8°F

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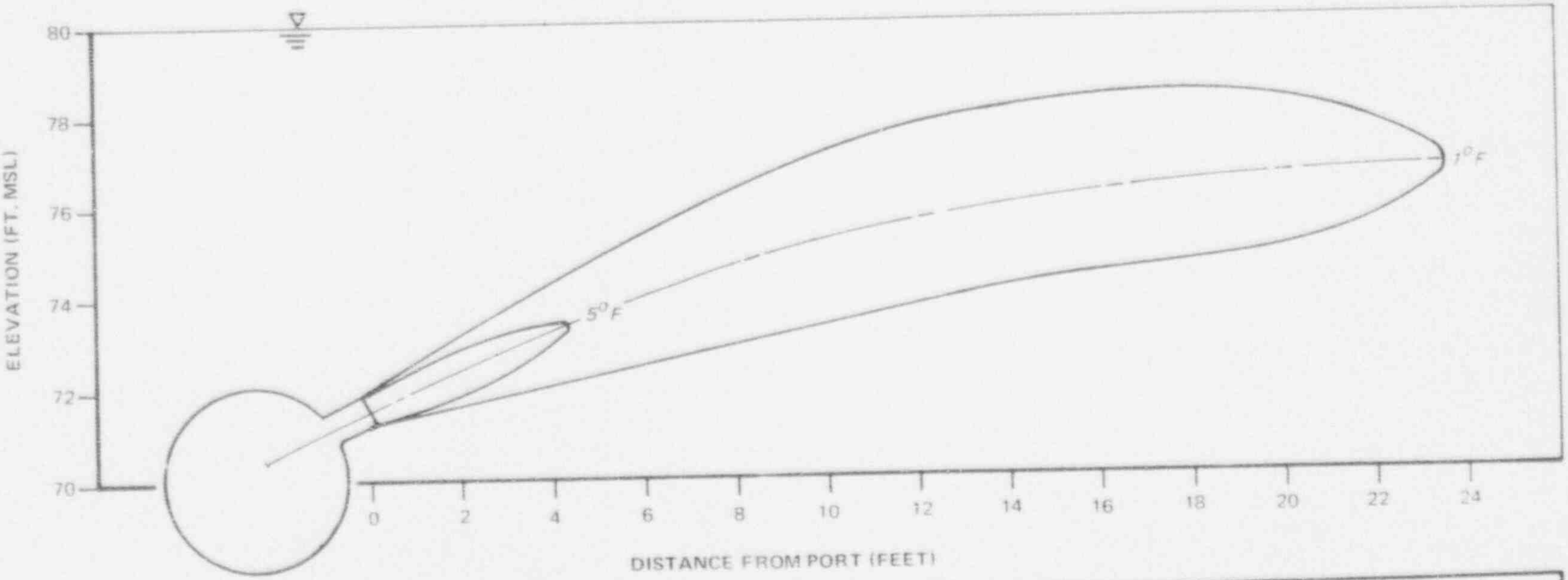
PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM - CASE 3

FIGURE 3.5-15

Amend. 2 11/26/73

SUMMER

AMBIENT RIVER TEMP	79°F
RIVER DISCHARGE	5800 cfs
WITH IN-PLANT DILUTION	
TOTAL BLOWDOWN FLOW	37000 gpm
BLOWDOWN TEMPERATURE	87.3°F



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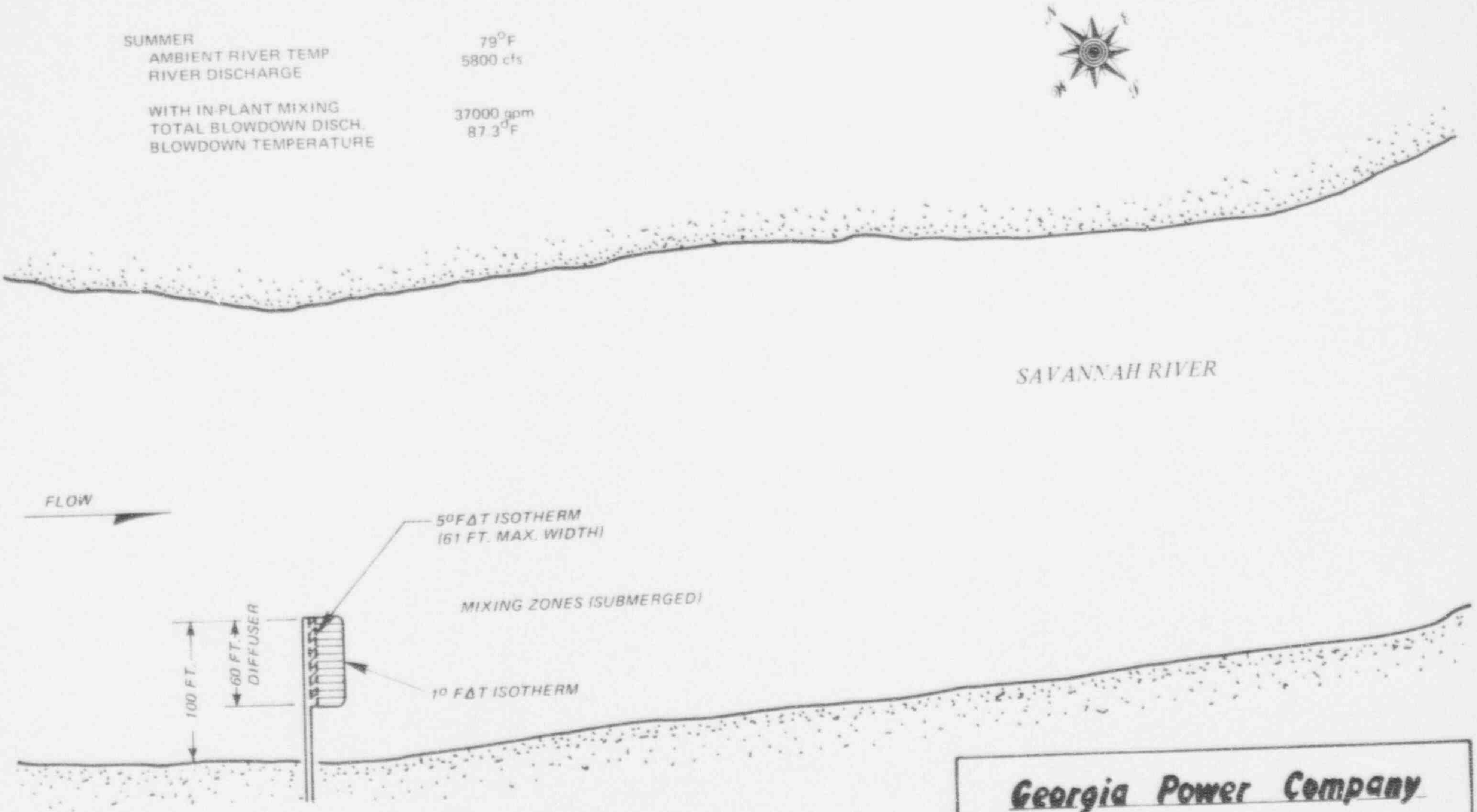
ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM CASE 4
ELEVATION

FIGURE 3.5-16

Amend. 2 11/26/73



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ENVIRONMENTAL REPORT

PLANT EFFLUENT THERMAL
PLUME - 1° ISOTHERM - CASE 4
PLAN

FIGURE 3.5-17

Amend. 2 11/26/73

3.6 RADIOACTIVE DISCHARGE SYSTEMS

3.6.1 DESIGN OF WASTE PROCESSING SYSTEMS

GPC will install the new Environmental Assurance System, designed by Westinghouse, in the VNP units. This system will provide means to limit the radioactive releases from the plant to the environment to levels as low as practicable. Part of this system is the use of silver-indium-cadmium control rods to reduce the production of tritium in the reactor. A summary description of the systems for liquid, gaseous and solids waste processing as well as the expected radioactive release rates with isotopic breakdown is given in this subsection.

3.6.1.1 Liquid Waste Processing System

The liquid waste processing system is designed to segregate the liquid wastes into two separate subsystems. These subsystems utilize different process methods most suitable to the category of liquid waste to be treated. Categories of the liquid wastes are determined by their points of origin, their radioactivity content, and the practicality, as well as suitability, for recycling their processed products. This design feature enables GPC to reduce the radioactive discharges, including tritium, from the plant to the environment to levels as low as practicable.

The liquid recycle subsystem shown in Figure 3.6-1 collects and processes reactor grade water wastes through filters, evaporator, and demineralizer and returns the product liquid to the appropriate tank to be reused in the primary system. Bottoms of the waste evaporator are either drummed or, if radioactivity and chemical content permits, can be returned to boron recycle system for reuse.

The non-recycle subsystem shown in Figure 3.6-2 collects and processes non-reactor grade water wastes which will be discharged to the environment. The largest source of liquid waste collected in this subsystem will originate from laundry and hot shower drains. This very low activity waste will be filtered, monitored and discharged to the environment. The remaining wastes collected in this subsystem consist of various leaks and drains which are either processed through filter, or filter and demineralizer, before being monitored and discharged to the environment.

Provisions are made to process liquid waste from this subsystem in the waste evaporator should this become necessary. Processed liquid from the evaporator would then be returned to this subsystem for ultimate discharge to the environment. The bottoms from the evaporator would be drummed for off-site disposal. This subsystem also collects the chemical waste produced in the laboratory in the chemical waste tank. This waste consists of samples taken from various parts of the plant which are likely to be tritiated or contain high activity, as well as chemicals used for laboratory analysis (see Figure 3.6-3). However, due to the very low volume of these wastes they are drummed directly for off-site shipment.

Under normal operating conditions, steam generator blowdown will be discharged to the environment without treatment. However, fuel cladding defect in combination with steam generator tube leaks can result in significant liquid radioactive releases to the environment. Therefore, a steam generator blowdown treatment system is provided with the objective of reducing the liquid radioactive discharge to the environment to levels as low as practicable. A schematic flow diagram for the system is shown in Figure 3.6-4. This full flow system consists of a blowdown tank, a condenser to condense the steam produced in the blowdown tank, heat exchangers, demineralizer, and radiation monitors. Cation and mixed-bed demineralizers will be used in anion. Radiation monitors are provided to detect and isolate the blowdown in the event the radiation exceeds predetermined levels. Treated blowdown liquid will be diluted by mixing with cooling tower blowdown and cooling tower bypass.

The treatment system design is based on short-term treatment for 1 percent fuel cladding defects with a simultaneous steam generator tube leakage of up to 1 gpm and a blowdown flow rate of 75 gpm for 30 days operation or .4 percent fuel cladding defect with a simulataneous steam generator tube leakage of up to .1 gpm and a blowdown flow rate of 75 gpm for continuous operation.

3.6.1.2 Gaseous Waste Processing System

Another major component of the plant system which serves to protect the environment is the gaseous waste processing system A schematic flow diagram of the system is shown in Figure 3.6-5. The system will be a closed loop, comprised of two waste gas compressors, two catalytic hydrogen recombiners, seven gas decay tanks for service during normal operation, and one gas decay tank for service at shutdown and startup. The system will be designed to remove most of the fission product gases from the reactor coolant system. This is accomplished by continuous purge of hydrogen gas into the volume control tank of the Chemical and Volume Control System (CVCS) and transport of stripped fission product gases from the reactor coolant to the gaseous waste processing system. The hydrogen gas mixed with radioactive gases will mix with the nitrogen carrier gas, continuously circulating around the loop, and will be removed by the recombiners. The resulting gas stream will be transferred to the gas decay tanks where accumulated activity will be contained in seven parts. By the operation of this system, a considerable reduction in the fission product gas inventory in the reactor coolant system will be achieved. This will substantially reduce the fission product release from unavoidable reactor coolant leakage in the plant.

The gaseous waste processing system also collects the residual radioactive gases discharged to the vent header from various equipment in the plant. This includes the gases stripped by the gas stripper and evaporator in the CVCS system. The system will be provided with gas storage capacity to accumulate all the fission product gases released to the reactor coolant with the very conservative assumption that the plant operates with 1 percent failed fuel over a 40 year period. The one shutdown tank will be utilized during plant cooldown after the majority of the gases are stripped from the reactor coolant. This system will carry very small amounts of radioactive gas; however, it is incorporated in the design with the intent to reduce the controlled discharge from the plant to levels as low as practicable.

The bulk of the activity collected in gas decay tanks will be from Xe-133 with a half life of 5.3 days. If all gases are stored for 40 years, the amount of Kr-85 inventory present at the end of this time will be only approximately equal to the Xe-133 activity present during any fuel cycle with 1 percent fuel cladding defects. Since the volumetric quantity of these gases is small, the system pressure is not expected to exceed about 15 to 20 psig during the life of the plant.

Anticipated operation will result in no significant gaseous activity release to the environment from this system. However, should it become necessary to discharge waste gas to the atmosphere, the system will include provisions to sample and control the discharge to assure that releases are made within the permissible limits for the plant.

3.6.1.3 Solid Waste Processing System

Solid wastes, from the VNP, will be shipped in 55 gallon drums to off-site burial facilities. Each shipment will be made in accordance with Atomic Energy Commission and Department of Transportation regulations. However, it is GPC's feeling that estimates of anticipated frequency and mode of shipment at this time would be premature. Solid waste shipment from any Nuclear Power Plant facility depends on the operation of the plant as well as the availability and schedule of the carriers.

VNP will have a solid waste handling facility for each two units. It is conservatively estimated that approximately 2000-55 gallon drums, the majority containing low-level activity, will be shipped from VNP each year. If, in the very unlikely event of operation of the plant with design basis fuel cladding failures (1 percent), it is anticipated that filters shipped from the primary side of the plant will contain high-level activity solid wasts and will amount to approximately 400 shielded 55 gallon drums per year. These 400 drums are included in the 2000 drum estimate given above.

The solid waste handling facilities incorporated in the VNP design have the flexibility and the capability to handle the solid wastes which will be generated within the plant and will allow flexibility in the schedule for off-site shipments from the plant.

3.6.2 RADIOACTIVE DISCHARGE

3.6.2.1 Liqud

Estimates of normal annual liquid volumes through the waste processing system for each unit are given in Table 3.6-1. Processed liquid waste will be diluted with cooling tower blowdown before entry into the river. Interlocks are provided to terminate the discharge if either the radiation level in the liquid exceeds a preset value or cooling tower blowdown flow rate falls below preset value. Estimated annual liquid isotopic releases from normal operation of each unit are listed in Table 3.6-2.

Table 3.6-1

DESIGN ESTIMATES OF NORMAL ANNUAL LIQUID VOLUMES FROM A SINGLE UNIT

Liquid Source	Volume (gallons) per year)	Basis (330 day/year)
Laundry and Hot Showers	120,000	~300 gallons/day with remainder for abnormal and refueling operations
Decontamination Water	15,000	~40,000 ft^2 once per week with 20 gallons of water per 5000 ft^2
Laboratory Equipment	16,000	~60 gallons/day
Non-recycleable Reactor Coolant	7,000	~20 gallons/day
Non-Reactor Grade Leakage	13,000	~40 gallons/day
TOTAL	171,000	

TABLE 3.6-2

ESTIMATED ANNUAL LIQUID ISOTOPIC RELEASES FOR NORMAL OPERATION, PER UNIT

Isotope	Millicuries/year	Isotope	Millicuries/year
Cr-51	0.37	Nb-95	0.45
Mn-54	0.26	Zr-95	0.34
Mn-56	0.09	Mo-99	411.
Fe-55	0.38	I-131	501.
Fe-59	1.46	I-132	2.46
Co-58	12.21	I-133	97.50
Co-60	0.45	I-134	.61
Br-84	0.03	I-135	16.70
Rb-88	1.33	Te-132	23.10
Rb-89	0.03	Te-134	0.03
Sr-89	1.74	Cs-134	147.
Sr-90	0.08	Cs-136	46.50
Sr-91	0.02	cs-137	730.
Sr-92	0.01	Cs-138	0.63
Y-90	0.01	Ba-140	1.19
Y-91	2.88	La-140	0.06
Y-92	0.01	Ce-141	0.28

Total (Excluding H^3 and dissolved gases) = 2,000

3.6.2.2 Gaseous

The estimated annual average activity releases rates during normal plant operation, including contributions from containment purging, unavoidable reactor coolant leakage, and possible leakage from the gaseous waste processing system, is expected to result in the quantities of gaseous effluents given in Table 3.6-3.

Table 3.6-3

Estimate of Gaseous Releases from VNP for 4 Units

Nuclide	Curies Released/Year
Kr-85m	932
Kr-85	1,420
Kr-87	548
Kr-88	1,620
Xe-133m	828
Xe-133	44,000
Xe-135m	77
Xe-135	2,810
Xe-138	289
I-131	1

3.6.3 GASEOUS EFFLUENT RELEASE POINTS

There are 3 exhaust stacks per unit in VNP. The locations of these stacks are shown on Figure 3.6-6. The effluent velocities, flow rates, and temperatures and the stack elevations are given below: 1

1. Containment purge exhaust stack

   effluent velocity - 3,200 fpm

   volume flow rate - 36,200 cfm 1

   temperature - 120° F (max)

   discharge elevation 407 ft

2. Continuous exhaust stack

   effluent velocity - 3,200 fpm

   volume flow rate - 86,000 cfm

   temperature - 110° F (max)

   discharge elevation 407 ft

3. Turbine building exhaust stack 1

   effluent velocity - 3,500 fpm

   volume flow rate - 5,000 cfm

   (includes discharge from

   steam jet air ejector)

   temperature - 100° F (max)

   discharge elevation 330 ft

3.6.4 RADWASTE HANDLING

1

Solid radwaste will be handled at VNP as described in Paragraph 3.6.1.3. The handling procedures for liquid radwaste to be shipped off-site is found in Paragraph 3.6.1.1.

3.6.5 TRANSPORTATION OF FUEL

The transportation of new fuel assemblies to VNP from a fabrication facility and the transportation of spent fuel assemblies from VNP to a reprocessing facility will be in accordance with Department of Transportation regulations and any other applicable regulations in effect at the time.

3.6.5.1 Transportation of New Fuel

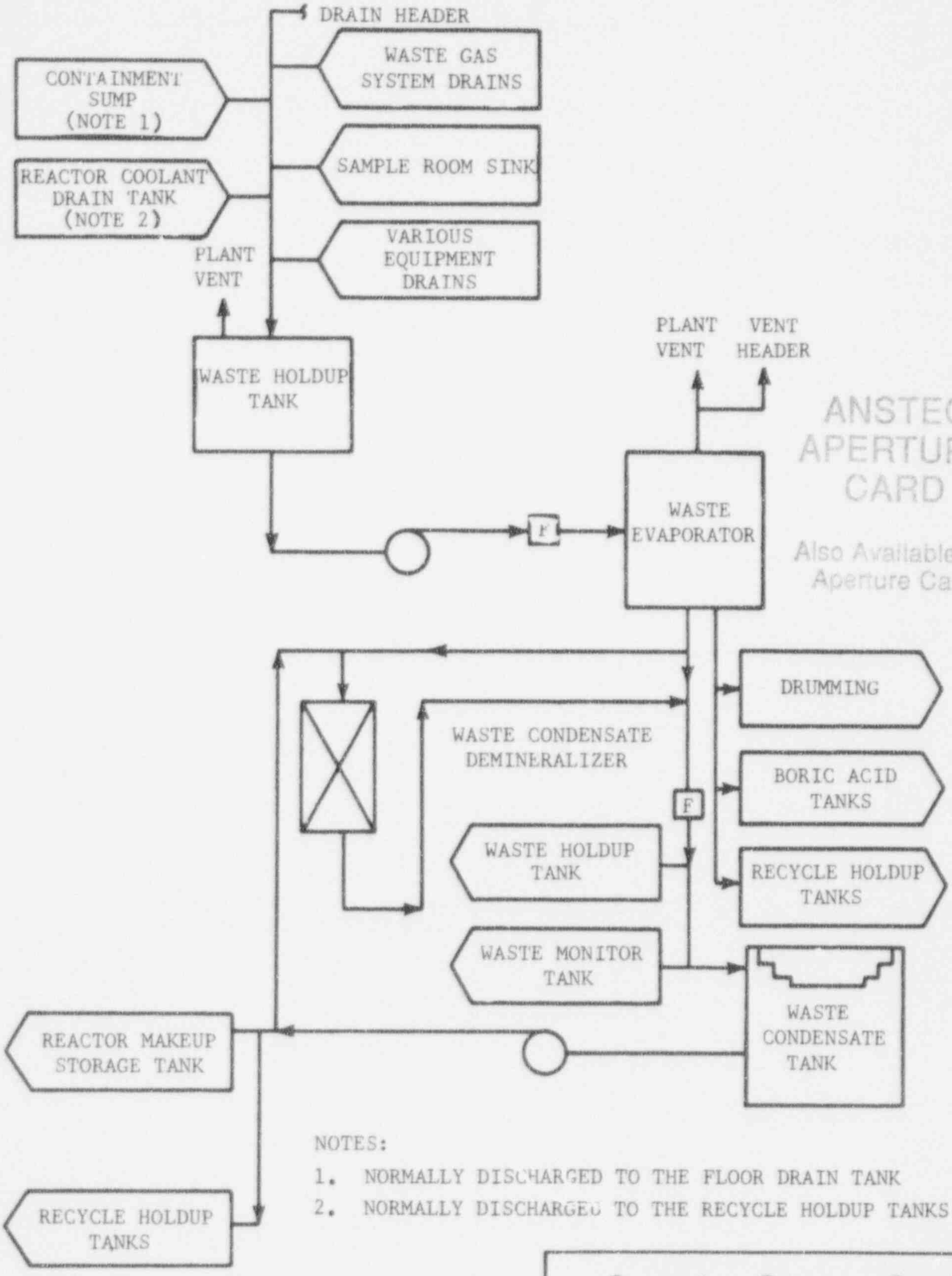
The initial fuel loading for each of the 2 units will consist of 193 fuel assemblies. About 72 new assemblies are expected to be loaded every year into each of the units after they begin commercial operation. These fuel assemblies will have been fabricated at a fuel fabrication plant and shipped to the plant site shortly before they are required. It is anticipated that these shipments will be made by truck in containers similar to those shown in Figure 3.6-7. Each of these containers can accommodate two fuel assemblies and six or seven containers would constitute a truckload. Thus, for each unit about fourteen to seventeen shipments will be required for the initial loading with only about five or six shipments every year thereafter.

3.6.5.2 Transportation of Spent Fuel

Approximately 72 spent fuel assemblies are expected to be discharged for each unit annually and will remain at the plant for at least three months while the short half-life isotopes decay. The fuel will then be transported to a reprocessing plant for the necessary reprocessing services. These shipments will be made in containers approved by the Department of Transportation. Examples of a container used for rail shipment are shown in Figures 3.6-8 and 3.6-9. The railroad car will carry no other cargo. The container is able to accommodate from about 6 to about 16 fuel assemblies, depending upon its size. Thus, for each unit the shipment of from 5 to 12 containers would be required each year.

3.6.5.3 Additional Shipping Information

The exact details of the container designs, shipping procedures, routings, etc., will depend upon the requirements of the suppliers providing the fabrication and reprocessing services. These items will always comply with applicable regulations.



NOTES:

1. NORMALLY DISCHARGED TO THE FLOOR DRAIN TANK
2. NORMALLY DISCHARGED TO THE RECYCLE HOLDUP TANKS

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LIQUID RECYCLE PORTION OF
THE WASTE PROCESSING SYSTEM

Figure 3.6-1

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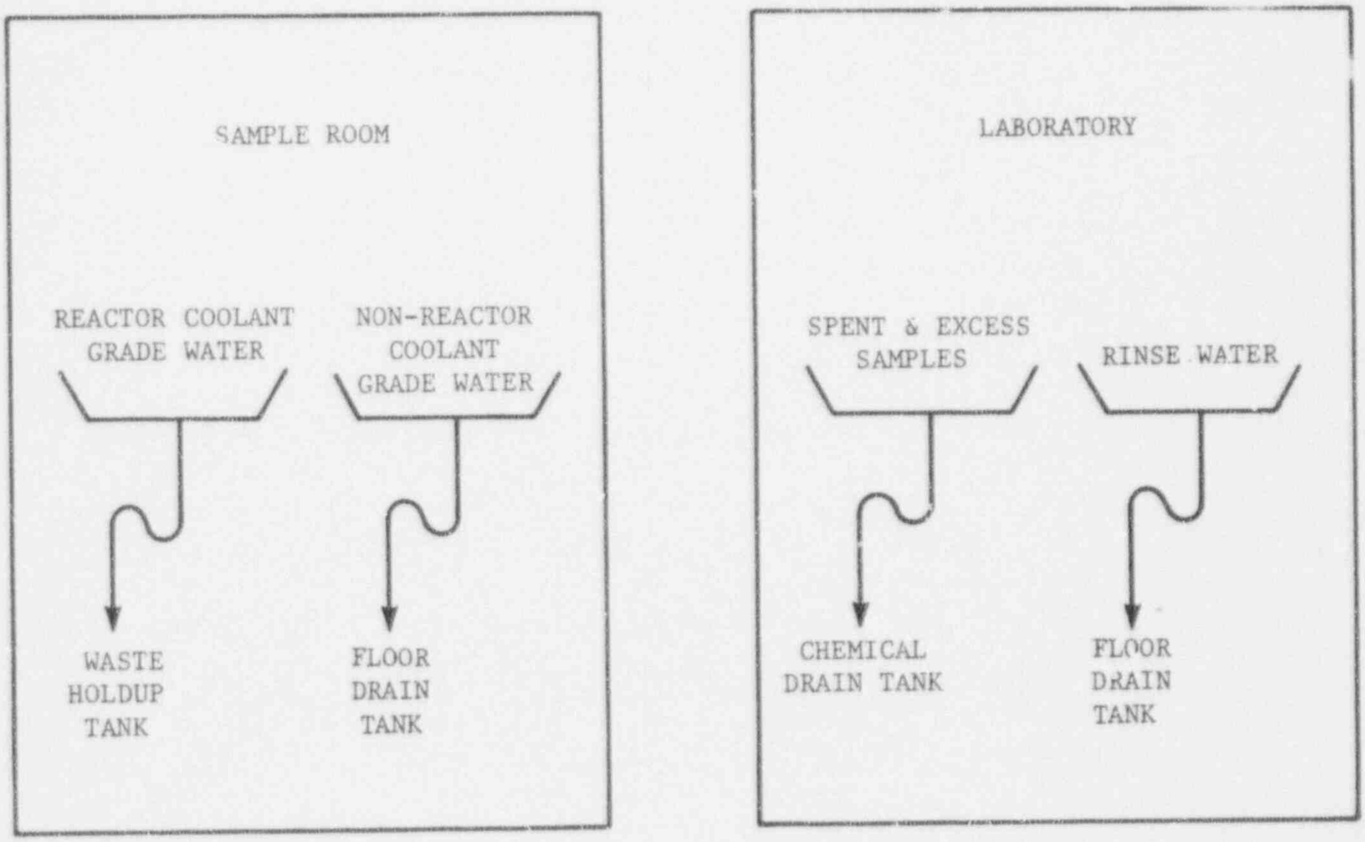

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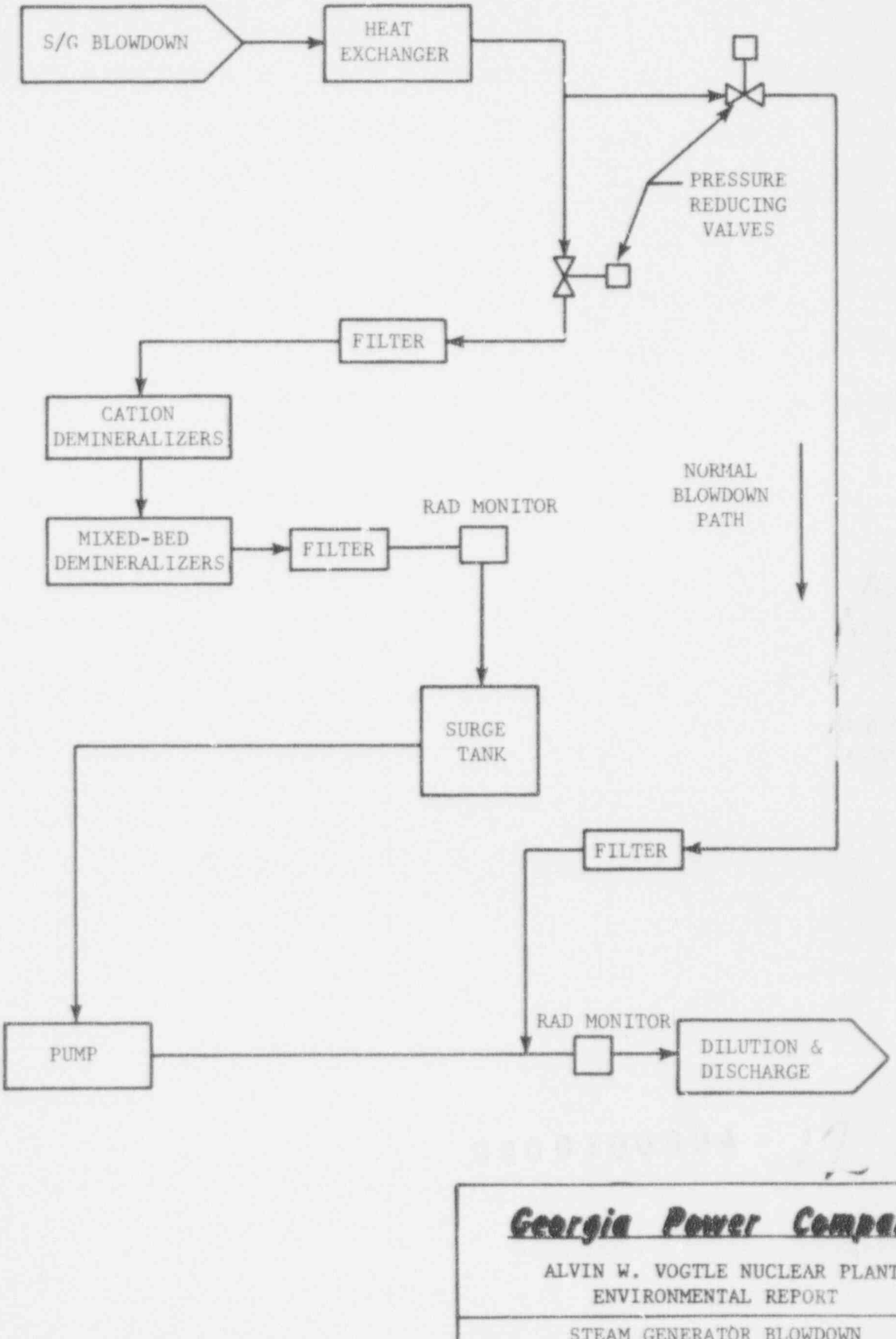
DISPOSITION OF WATER IN THE
SAMPLE ROOM AND LABORATORY

Figure 3.6-3



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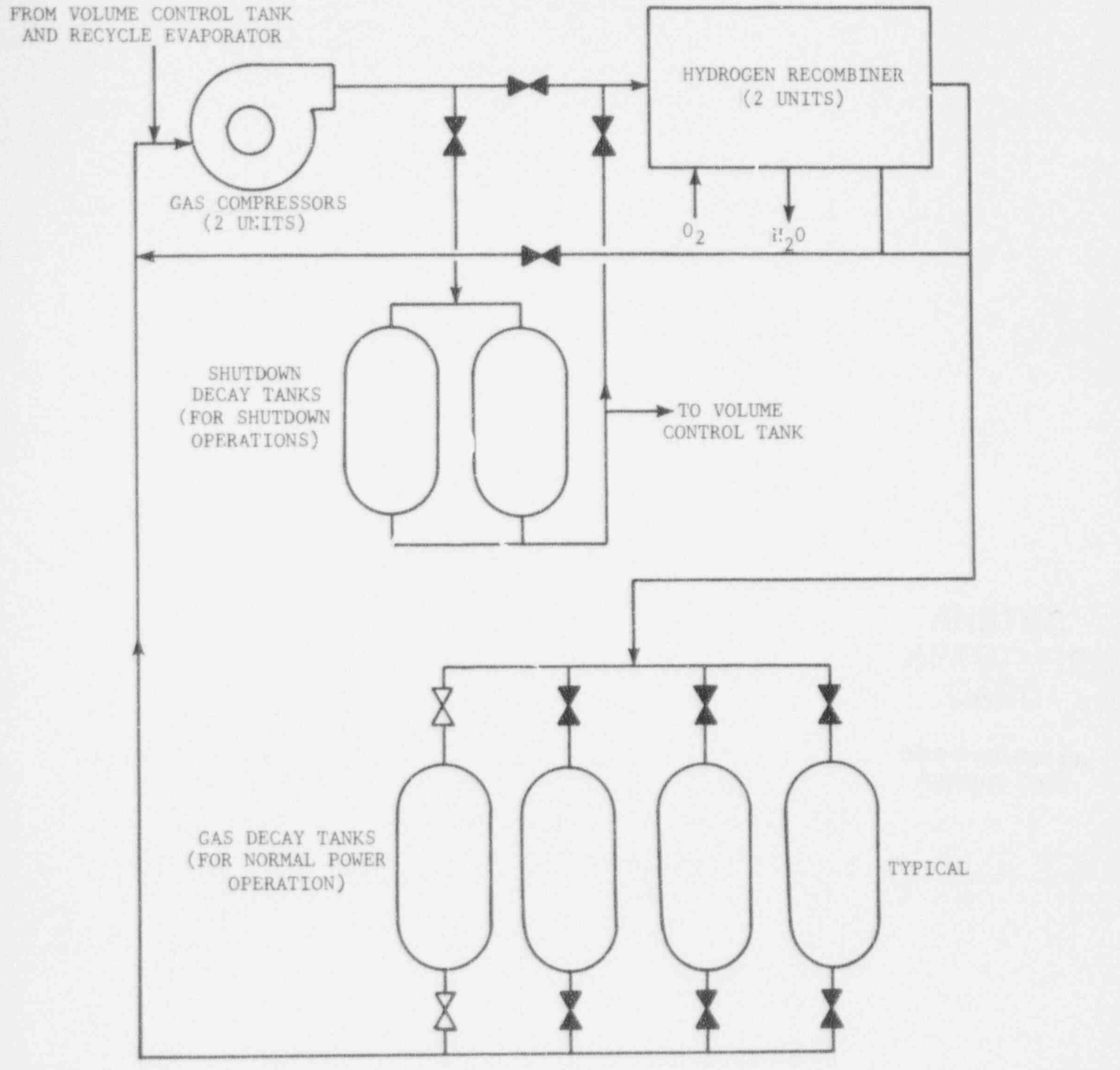
STEAM GENERATOR BLOWDOWN
PROCESSING SYSTEM

FIGURE 3.6-4



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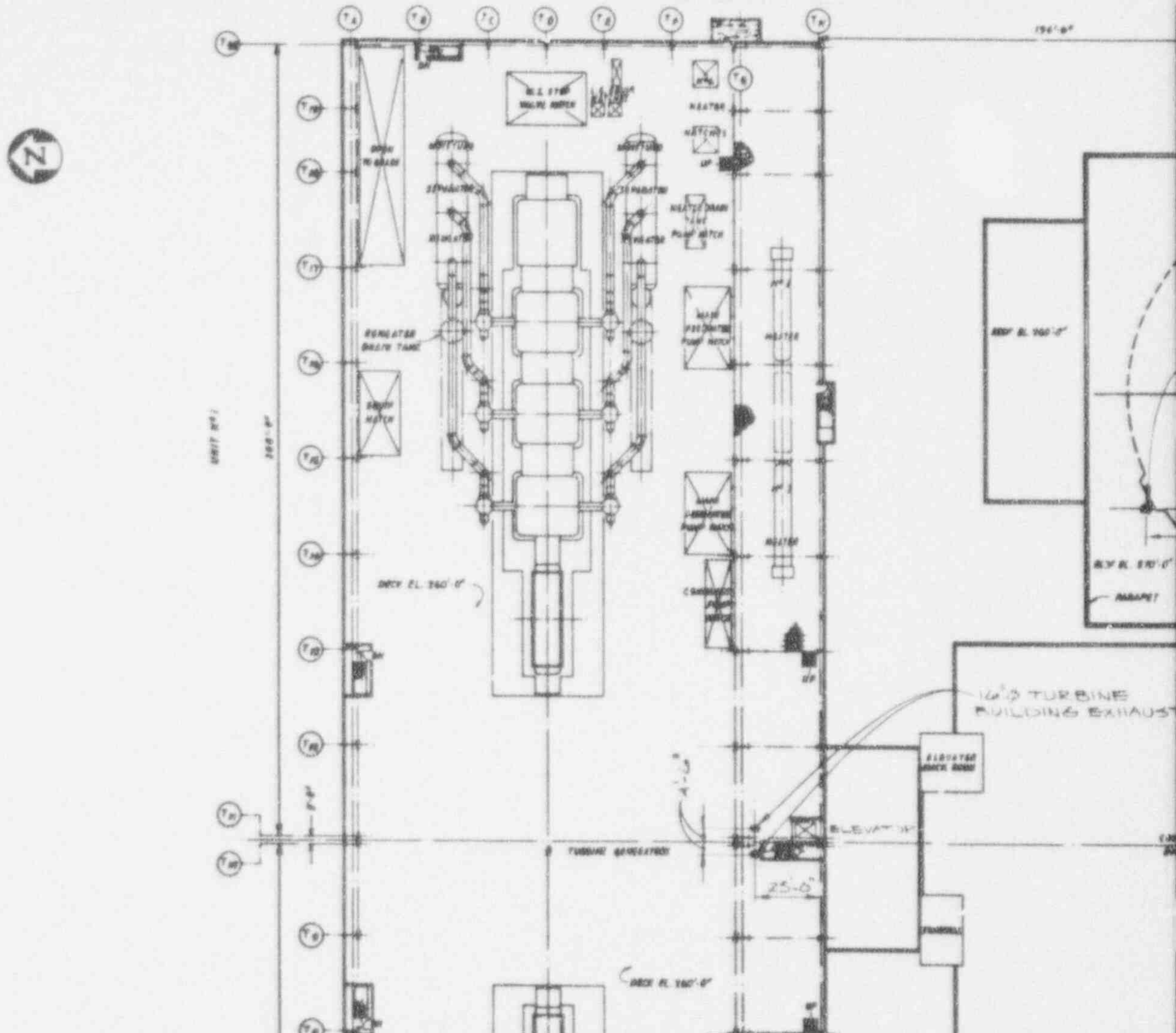
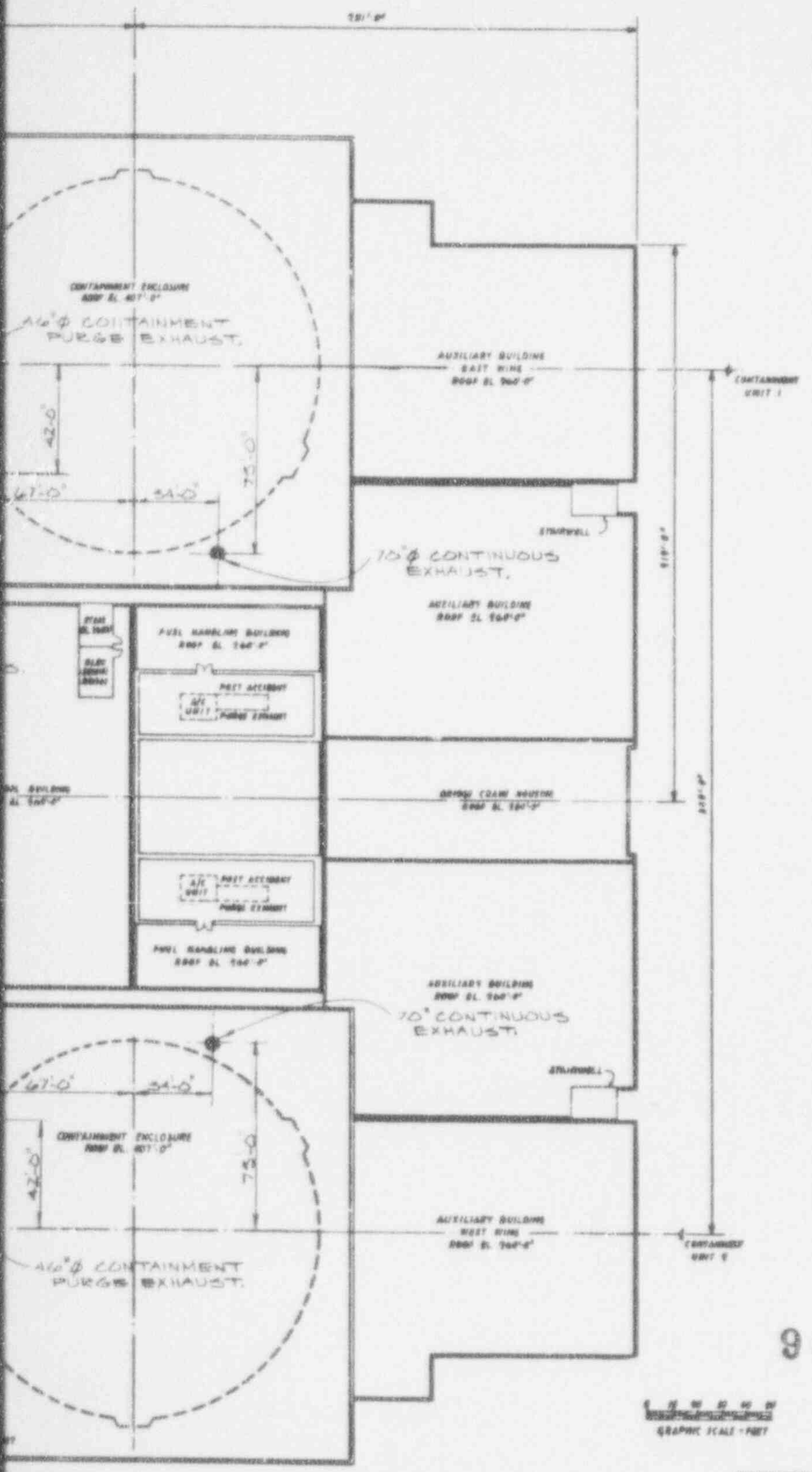
WASTE GAS SYSTEM

FIGURE 3.6-5


N
UNIT Nº 1
UNIT Nº 2
MOISTURE
SEPARATOR
REHEATER
REHEATER DRAIN TANK
HEATER
HEATER DRAIN TANK PUMP HATCH
UP
DECK EL. 360'-0"
TURBINE GENERATOR
ELEVATOR
25'-0"
12"Ø TURBINE BUILDING EXHAUST
ELEVATOR MACH. ROOM
PARAPET



OTE:
UNITS #3 & 4 TYPICAL TO
UNITS #1 & #2.

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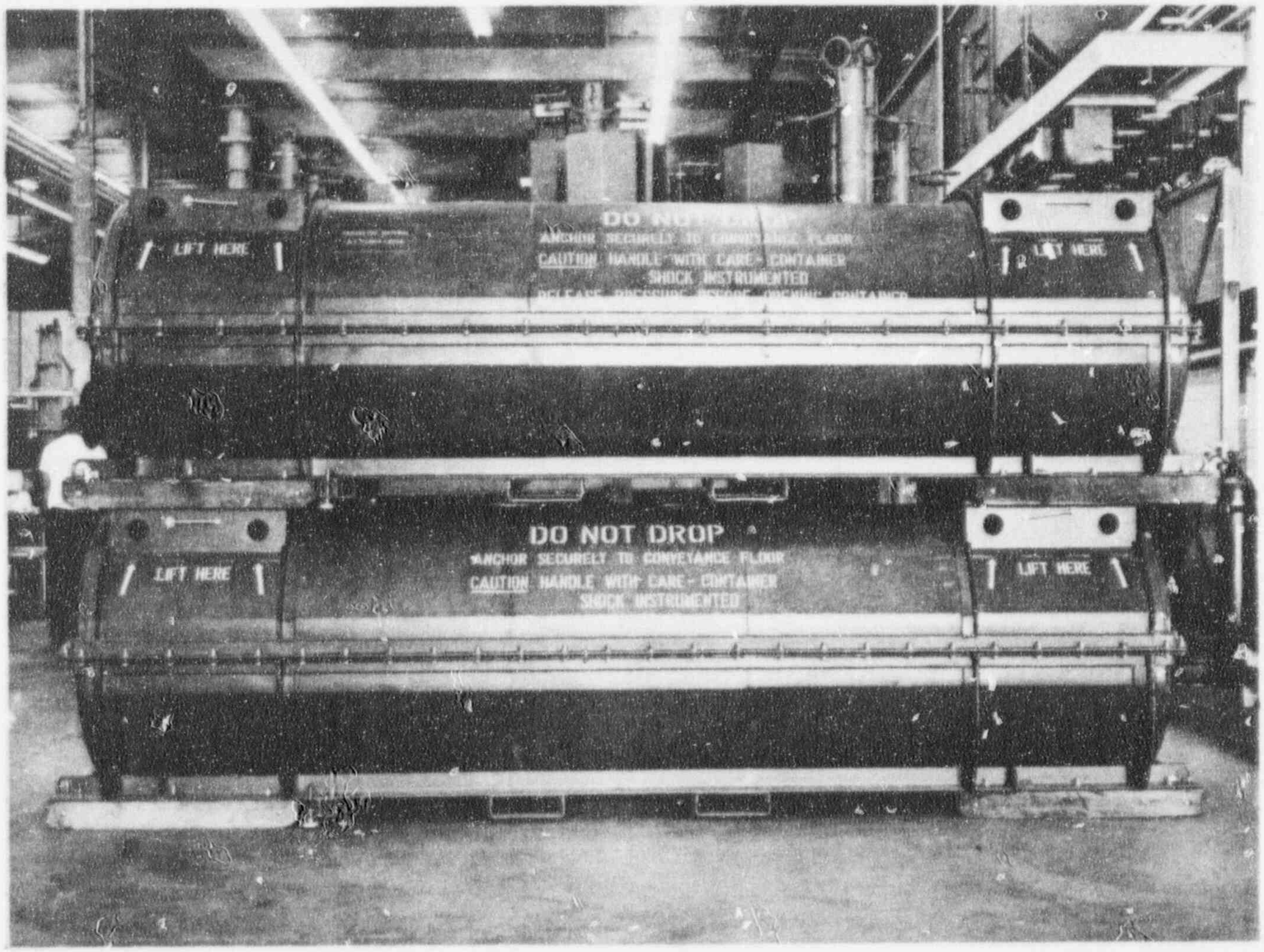
GENERAL ARRANGEMENT PLAN
GAS RELEASE POINTS

FIGURE 3.6-6



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LOADED SHIPPING CONTAINER

FIGURE 3.6-7

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3.7 CHEMICAL AND SANITARY WASTE SYSTEMS

The chemical and sanitary waste from VNP will be accommodated by a diffusion-type disposal utilizing a large discharge line with a mixing chamber which dilutes the wastes to acceptable levels with river water pumped by the dilution pumps. This system accommodates waste from the following:

Hold-up basin used for collecting initial clean-up wastes
Main cooling tower blowdown
NSSS cooling tower blowdown
Steam generator blowdown
Neutralized demineralizer waste
Monitored radwaste system discharge
Plant sanitary waste

The diffusion pipe system is designed to handle 4 units; therefore, the plant will have a single river outfall discharge point which will be monitored. Figure 3.7-1 includes a schematic diagram of the waste system.

3.7.1 MAIN COOLING TOWERS

Cooling tower blowdown is necessary for the control of the solids levels of the main condenser circulating water and plant heat exchanger cooling water. Although it is possible to operate from 3 to 9 cycles of concentration, the towers will normally operate from 5 to 8 cycles so that the tower blowdown will be diluted sufficiently to limit the temperature difference between the river and the plant discharge to 5°F or less. The characteristics of tower blowdown depend on the cycles of concentration, quality of makeup water supply and the chemical feeds to control algae, corrosion, scale, silt, and pH levels.

The tower makeup supply will come from the Savannah River. The dissolved solids levels of the Savannah River are, on the basis of river water analysis, 42 ppm minimum, 60 ppm average and 76 ppm maximum. An analysis of the Savannah River reflecting the average condition is shown in Table 3.7-1. Color characteristics of the river water vary from 30 color units to 60 color units. Cooling tower blowdown will reflect color changes similar to those of the Savannah River. Suspended solids in the river water will vary, and the tower blowdown will have about the same suspended solids level as the river due to the settling of solids in the cooling tower basin. Periodically, the cooling tower basin will have to be drained and cleaned of the mud and deposited materials that have collected on the bottom. This deposited material will be hauled away.

Table 3.7-1

Typical Savannah River Water Quality Analysis

Silica, ppm (SiO_2)	7.5	
Iron, ppm (Fe)	0.3	
Manganese, ppm (Mn)	0.0	
Calcium, ppm (Ca)	6.5	
Magnesium, ppm (Mg)	3.5	
Sodium, ppm (Na)	7.3	
Potassium, ppm (K)	1.9	
Bicarbonate, (HCO_3)	28.8	
Sulfate, ppm (SO_4)	7.3	
Chloride, ppm (Cl)	4.8	
Fluoride, ppm (F)	0.08	
Nitrate, ppm (N)	0.28	
Phosphate, ppm (PO_4)	0.09	
Total Dissolved Solids, ppm	59.9	
Total Hardness as $CaCO_3$, ppm	30.8	
Total Alkalinity as $CaCO_3$, ppm	23.2	
pH, electrometric	6.8	1
Conductivity, micromhos	62.6	
Free Carbon Dioxide, ppm (CO_2)	7.8	
Turbidity, J.T.U.	21.8	
Color, color units	31.4	
Ammonia, ppm	0.21	

The above values are based upon the averaged parameters in Table 2.5-3.

Even though pH control of the system will be maintained by control of tower blowdown, acidic and basic chemical feed provisions will be included in the cooling tower design.

The use of silt control polymers or corrosion inhibitors is not aniticpated in the operation of the main cooling towers. A pH range of 7.4 to 7.8 will be maintained in the tower circuit.

Assuming a normal tower operation at 5 to 8 cycles of concentration, without the addition of chemicals, the following range of total dissolved solids levels can be expected in the cooling tower blowdown:

5 cyles of concentration	210 ppm TDS minimum
	300 ppm TDS average
Blowdown 4,000 gpm/unit	380 ppm TDS maximum
TO	
8 cycles of concentration	336 ppm TDS minimum
	480 ppm TDS average
Blowdown 2,200 gpm/unit	608 ppm TDS maximum

The above values would be increased if chemicals are added for tower treatment.

For control of micro-organisms which cause algae and slime fouling, the cooling towers and condensers will have to be treated with a biocide. Two basic types of materials are available for controlling the water- and air-borne microrganisms in the tower-condenser system. These materials are classified as oxidizing and non-oxidizing.

The oxidizing materials are ozone, chlorine and calcium and sodium hypochlorites. Ozone is oxygen condensed to form O_3 and is obtained by passing a current of air between two electrodes carrying very high electric voltages. Ozone cannot be stored but must be produced on demand; thus, an expensive, large capacity system would be required. While ozone is an excellent agent for sterilizing water and leaves no harmful end product, the equipment and electric energy operating costs would be prohibitively high.

Chlorine is delivered in liquid form of the pure element and is applied as a gas dissolved in water. The hypochlorites are supplied either as a dry powder or in dilute liquid form for liquid application. Liquid chlorine costs about one-fourth as much as bulk delivered hypochlorite on the basis of available chlorine in the product.

The non-oxidizing materials considered are often proprietary products; while they are effective for biocide treatment in tower-condenser water systems, they are usually more expensive than chlorine and frequently produce toxic end products which will not be tolerated in blowdown to a river.

Typical of the non-oxidizing materials are:

Acrolein
Chlorinated Phenolic Compounds
Chromates
Copper Salts
Phenolic Amines
Thiocynates

As alternates to chlorination, the above materials are not practical on a cost and toxicity basis for a large tower system such as the one proposed at the VNP site.

Chlorine was chosen because it is a broad spectrum biocide which is effective, relatively easy to handle (with precautions), and economical.

The chlorine will be delivered to the plant site in 1-ton containers by railrcad cars and provided with suitable storage accommodations. The design basis for the subject tower system is not to use chlorine any more often than absolutely necessary, and, when it is used, there will be strict controls on the feed of chlorine and the levels of chlorine maintained in the water system.

Before chlorine will be introduced into the tower-condenser water system, a chlorine demand "breakpoint" test will be run on water to determine chlorine demand. The results of chlorine demand test run on Savannah River water are shown in Table 3.7-1a. Total residual chlorine can be reduced to a maximum of 2.0 ppm in the water returning to the river by reducing tower blowdown during the period of chlorination and for about 2 hours following chlorination. While the tower blowdown is reduced, the tower water dissolved solids will increase due to tower evaporation.

At 4 to 8 cycles of concentration, with river water total dissolved solids at an average of 60 ppm, the tower water total dissolved solids would be about 240 to 480 ppm. The control range of free residual chlorine during chlorination would be maintained at about 2.0 to 3.0 ppm, when measured in the condenser discharge water line. The chlorine for system chlorination will be introduced with solution diffuser into the circulating water pump discharge before the condenser.

The tower-condenser system chlorination frequency may vary from 2 one-half hour periods per day in the warm summer months to once per week in the cold winter months. Calculations indicate that three 8000-lb. per day rotometers in 8000-lb. modules would be required for a 1000-lb. per hour designed feed rate. Chlorinator capacity is designed for 3 ppm

TABLE 3.7-1a

SAVANNAH RIVER CHLORINE DEMAND

Date	Dosage, ppm	Time After Dosage, Min.	Free Available Chlorine, ppm	Free Chlorine Demand, ppm
02/03/72	3.3	10	2.0	1.3
02/03/72	3.3	30	2.0	1.3
11/16/72	2.0	2	0.2	1.8
11/16/72	2.0	16	0.2	1.8
11/16/72	2.0	32	0.1	1.9
11/16/72	2.0	60	0.1	1.9
11/16/72	3.0	0.5	0.6	2.4
11/16/72	3.0	2.0	0.5	2.5
11/16/72	3.0	16	0.4	2.6
11/16/72	3.0	32	0.3	2.7
11/16/72	3.0	60	0.3	2.7
11/16/72	5.0	0.5	3.0	2.0
11/16/72	5.0	3.5	2.0	3.0
11/16/72	5.0	8	1.6	3.4
11/16/72	5.0	15	1.6	3.4
11/16/72	5.0	32	1.6	3.4

1

Date : 3/27/73
Dosage : 2.0 ppm

Time After Dosage, Min.	Free Available Chlorine, ppm	Combined Available Chlorine, ppm	Total Available Chlorine, ppm	Total Demand, ppm
15	0.1	0.9	1.0	1.0
30	0.1	0.3	0.4	1.6
45	0.1	0.3	0.4	1.6

feed rate.

(a) 100×10^6 lb water in tower-condenser circuit (estimated)

$$100 \times 10^6 \text{ lb water} \times \frac{3 \text{ lb chlorine}}{1 \times 10^6 \text{ lb water}} = 300 \text{ lb to dose system initially}$$

(b) 100×10^6 lb water x 4.5 cycles through tower per hour

$$\times \frac{1.56 \text{ lb chlorine}}{1 \times 10^6 \text{ lb water}} = 700 \text{ lb to maintain concentration through condenser for 1 hour}$$ 1

TOTAL = 1000 lb

Some of the residual chlorine will be removed as the water passes through the tower; therefore, the additional chlorine will be required to maintain a continuous residual over a period of 30 minutes to 1 hour. During periods of chlorination, the blowdown can be reduced, and tower makeup will be cut back to approximately the rate of tower evaporation plus blowdown. The excess makeup water which is normally blowdown will be bypassed as additional dilution water to the river.

Waste systems from 4 units discharge through a common mixing chamber with dilution for a single discharge outfall to the river. This diluted stream will be monitored for either free or total residual chlorine as may be required, using one analyzer capable of measuring either parameter. The analyzer has a range of 0-1 ppm with recording and alarm functions. The alarm will be set 3
at 100 percent of full scale. In addition, pH, conductivity, and temperature will be measured and alarmed. Alarm limits will be as follows: pH, 6.5 minimum and 9.0 maximum; conductivity, 2000 micromhos; temperature, 90°F. 1

Chlorination tests on the Savannah River will be continued in order to gather additional data on the proposed tower makeup water.

3.7.2 STEAM GENERATOR

Disodium phosphate will be used in the steam generators for pH control and scale prevention. An average phosphate concentration of 20 ppm will be maintained. Based on an average blowdown of 12.5 gpm/steam generator (4 steam generators per unit), approximately 27,500 pounds of disodium phosphate would be required for the annual operation of VNP.

Hydrazine will be used in the steam generators for corrosion inhibition. The amount of hydrazine used during plant operations will depend upon the quantity of oxygen entering the feed water system via the condensate and/or make-up water supply system. For conservation, it is estimated an average hydrazine concentration of 50 ppb would have to be maintained in the feedwater for optimum control. Based on a feedwater flow rate of 15 x 10^6 lbs/hr per unit, it is estimated that the hydrazine requirement would be approximately 3,200 gallons per year.

In addition to the normal hydrazine requirements for plant operation, a hydrazine concentration of between 75 and 150 ppm is required for wet layup of a steam generator during extensive plant outages. Based on the maximum hydrazine concentration of 150 ppm, it is estimated that 65 gallons of hydrazine would be required per steam generator. One unit, with 4 steam generators per unit, would require 260 gallons of hydrazine. The annual accumulative total volume of hydrazine allowing 4 cold shutdowns per unit per year would be 7,360 gallons.

In addition to hydrazine, ammonia is also added to the steam generators during wet layup to maintain the pH between 10 and 10.5. Approximately 10 ppm of ammonia is required to yield a pH of 10. Therefore, approximately 1.5 gallons of ammonium hydroxide solution containing 30 ppm ammonia will be required to make the necessary adjustment in 1 steam generator. Assuming 4 cold shutdowns per year per unit 96 gallons per year will be used for VNP.

The steam generator blowdown will have a dissolved solids concentration of approximately 125 ppm, as tabulated below. However, when the steam generator treatment system is in use, most of the solids will be trapped on the resins. The dissolved oxygen concentration in the steam generator blowdown will be virtually zero. However, when this flow of 50 gpm is added to the dilution water, which will be near saturation, its effect will not be noticeable.

Sodium	37 ppm
Phosphates	54 ppm
Boric Acid	17 ppm
Chlorides Carbonates Sulfates Calcium Magnesium	17 ppm
	125 ppm

The maximum recommended feedwater pH for the steam generators is 8.5. The use of pH adjustment chemicals will be required. The 3 chemicals that could possibly be used are morpholine, cyclohexylamine, and ammonia. Morpholine will probably be used, but until additional studies are completed, cyclohexylamine and ammonia cannot be ruled out.

Assuming that the make-up water is neutral, the following approximate concentrations will be required for initial plant start-up.

Morpholine	4.5 ppm
Cyclohexylamine	1.0 ppm
Ammonia	0.05 ppm

The above chemical concentrations would be used for initial start-up only. The actual quantity of any 1 of these 3 chemicals during normal operations would be reduced because of recycling through the steam system. It is estimated that VNP would require between 1600 and 2400 gallons of morpholine, 800 to 1200 gallons of cyclohexylamine, or 800 to 1200 gallons of ammonium hydroxide per year.

3.7.3 MAKE-UP DEMINERALIZER

VNP will have 2 make-up demineralizer plants for the 4-unit plant. Each demineralizer is designed to supply demineralized water for 2 plant units. Each demineralizer consists of two 50 percent flow trains of a filter, a primary cation resin bed, a vacuum degasifier, a working mixed resin bed and a single 100 percent flow polishing mixed resin bed. Each train is rated at 220 gpm capacity, giving a total make-up demineralizer plant capacity of 440 gpm. The influent to the make-up plant will be from deep wells on the site at the rate of 440 gpm. A well water analysis used as a basis of the demineralizer design is shown in Table 3.7-2. The analysis is of a water sample taken April 12, 1972, from an observation point that was constructed for the pumping test of the standby makeup well located at the plant site. The water is from sands of the Tuscaloosa aquifer between depths of 500 and 800 feet beneath plant site. The water quality data were determined by generally recognized standard laboratory methods.

From the attached well water analysis, the expected make-up demineralizer influent will have the following adjusted ionic loading:

Cations	(as $CaCO_3$)
Calcium (Ca)	16 ppm
Magnesium (Mg)	10 ppm
Sodium (Na)	89 ppm
Potassium (K)	3 ppm
	118 ppm

Anions	(as $CaCO_3$)
Sulfate (SO_4)	1.4 ppm
Chloride (Cl)	2.0 ppm
Fluoride (F)	1.3 ppm
Phosphate (PO_4)	1.3 ppm
Bicarbonate (HCO_3)	112.0 ppm
	118.0 ppm
Silica (SiO_2)	10.0 ppm
Carbon Dioxide (CO_2)	3.5 ppm

In the demineralizing process, the bicarbonate is converted to carbon dioxide, and the carbon dioxide is almost completely removed in the degasifier.

In removing this loading by ion exchange, the make-up demineralizer ion exchange resins eventually become exhausted and must be regenerated with acid and caustic. The waste that is produced as a result of the regeneration of the resins will be released to the make-up demineralizer waste neutralizing system. The waste will be neutralized in the neutralizing system before it is released to the diffusion pipe. Each regeneration will take about 5 hours and can occur once every 24 hours.

Table 3.7-2

Well Water Analysis

Silica, ppm (SiO_2)	7.2
Iron, ppm (Fe)	0.16
Manganese, ppm (Mn)	0.0
Calcium, ppm (Ca)	6.4
Magnesium, ppm (Mg)	2.4
Sodium, ppm (Na)	36.4
Potassium, ppm (K)	2.0
Carbonate, ppm (CO_3)	0.0
Bicarbonate, ppm (HCO_3)	136.6
Hydroxide, ppm (OH)	0.8
Sulfate, ppm (SO_4)	1.3
Chloride, ppm (Cl)	1.5
Fluoride, ppm (F)	0.47
Nitrate, ppm (N)	0.00
Phosphate, ppm (PO_2)	0.84
Total Dissolved Solids, ppm	161.6
Total Hardness as ($CaCO_3$)	26.0
Alkalinity as $CaCO_3$, ppm	
Phenolphthalein	0.0
Total	112.0
pH, electrometric	7.8
Conductivity, micromhos	170
Free Carbon Dioxide, ppm (CO_2)	3.5

The regeneration is accomplished by taking one 50 percent train out of service while leaving the other train in service.

The make-up demineralizer waste is composed of the waste from neutralization of acid and caustic used in regeneration resins, sulfate and sodium waste from regenerant acid and caustic, and cations and anions that are removed from the exhausted resins. Based on the ion-exchange resin design data, the regeneration of one 50 percent make-up demineralizer train will require the following quantities of acid and caustic:

Type of Resin Bed	Regenerant
Primary cation	Approx. 544 lbs. 66°Be H_2SO_4
Working mixed bed - cation resin	Approx. 100 lbs. 66°Be H_2SO_4
anion resin	Approx. 313 lbs. 100% NaOH

Of the sulfuric acid required for regeneration, an estimated 306 lbs. H_2SO_4 will be used in exchange for cations by the cation resin in the primary cation bed and the working mixed bed. This leaves an excess of approximately 338 lbs. 66°Be H_2SO_4 to be neutralized by caustic. Of the caustic used for regeneration of the anion resin in the working mixed bed, an estimated 47 lbs. 100 percent NaOH will be exchanged for anions and 276 lbs. of 100 percent NaOH will be available for neutralization of the excess from the cation resin.

Chemically, the neutralization of the acid and caustic is as follows:

49		40		71		18	Equivalent
H_2SO_4	+	$2NaOH$	$\rightarrow$	Na_2SO_4	+	$2H_2O$	Chemical Reaction
6.9		6.9		6.9		6.9	Pound Equivalent
338	+	276	=	490	+	124	Pounds
614			=	614			Balance

The excess acid and caustic will neutralize, yielding 490 lbs. of sodium sulfate.

The waste sulfate and sodium from the total regenerative process amounts to approximately 630 lbs. of sulfate and 181 lbs. of sodium.

The cations and anions removed by ion-exchange from the resins add to approximately 180 lbs. (138 lbs. of cations and 42 lbs. anions).

The total volume of liquid waste is approximately 22,000 gallons per regeneration. This liquid waste is primarily water used in backwashing and rinsing down resin beds during the regeneration cycle.

The waste discharge from one regeneration contains approximately 991 lbs. in 22,000 gallons or approximately 5,560 ppm total dissolved solids. Assuming a discharge time of 1.5 hours, 245 gpm will be discharged to the diffusion pipe. This waste discharge will increase the total dissolved solids level in the diffusion line by approximately 25 ppm.

The filters (1 per train) for the make-up demineralizer are estimated to require approximately 5,600 gpm per filter of backwash water. Since well water will be used for filter backwash, disposal of the water will not add significantly to the solids levels of the waste diffusion pipe. Also, the filters can be backwashed so that the filter backwash water will not have to be released with the make-up demineralizer waste.

During initial plant clean up, there could be a maximum of two 22,000 gallon batches of neutralized demineralizer waste released per 24 hours for each demineralizer system. The 4-unit plant will have 2 demineralizer systems. Therefore, the maximum discharge could be four 22,000 gallon batches per day. Only 2 batches could be produced simultaneously for processing. Under normal operating conditions for the 4-unit plant, it is expected that only one 22,000 gallon batch of waste will be produced and released per day from the demineralizer installation. The release of the demineralizer waste will be controlled to avoid releasing more than 1 batch at a time.

3.7.4 NUCLEAR SERVICE COOLING TOWERS

VNP will have 1 operating and 1 spare nuclear service cooling tower per unit. Each tower will operate with a normal blowdown flow equal to 65 gpm and a shutdown flow equal to 60 gpm.

The nuclear service cooling tower blowdown will have a total dissolved solids concentration equal to 593 ppm, a sulfate concentration equal to 390 ppm and a chloride concentration equal to 6 ppm. The pH of the blowdown will be maintained at 7.0 to 7.5. Sulfuric acid will be added at a rate of 0.78 lb/min. to maintain the above pH.

Chlorine for nuclear service cooling tower chlorination will be delivered to VNP in liquid form of the pure element and applied as a gas dissolved in water. Tower chlorination will vary from 1 hour/day on warm summer days to 1 hour/week during the winter. A chlorine demand will be run on the nuclear service circulating water to determine the amount of chlorine that should be added. The maximum chlorine concentration in the circulating water will be 3 ppm. During a 1-hour chlorination period, 42 lbs. of liquid chlorine will be used. The chlorine concentration will be monitored, but the exact procedure has not yet been decided.

All chemical concentrations in the nuclear service cooling tower blowdown will be substantially diluted in the mixing chamber.

3.7.5 SANITARY WASTE

The VNP sanitary waste will be routed to a package extended-aeration sewage
treatment plant. The plant is prefabricated and contains a submerged
bar screen, an aeration tank and a hypochlorination system. The plant
will process approximately 10,000 gallons/day of raw sewage which will have
a 5-day BOD of 14 pounds. The plant is designed to remove 95 percent of the 1
BOD and suspended solids before the waste is released.

The waste flow through the bar screen into the filtered aeration tank. The 1
aeration tank holds approximately 10,000 gallons and provides a minimum of
24 hours' retention of the designed flow. From the aeration tank, the liquids
flow to the 1500-gallon clarifier, which provides a minimum of 2 hours' retention 1
at design flow. The settled sludge and floating material is returned to
the aeration tank. The clarifier effluent passes over an adjustable height
weir into an effluent trough and into the chlorine contact tank. This
tank provides 90 minutes' retention at the design flow. The chlorinated effluent,
which has a residual chlorine content of less than 1.0 ppm, is discharged into
the diffusion line. Due to the small amount of sanitary waste, the effluent
from the sewage plant will not significantly alter the chemical concentrations
in the diffusion line. Accumulated sludge will be hauled off the site to 1
an acceptable disposal area.

3.7.6 START-UP WASTE

At present, plans for pipe cleaning and start-up operations call for
alkaline cleaning only of the condensate, feedwater and main steam system.
Circulation of the cleaning solution will be from the filled condenser hot
wells, through the condensate and feedwater piping and heaters, by-passing the
steam generators, back through the main steam lines, by-passing the turbines,
through the reheaters, to the condenser hot wells (via temporary piping).
Chemicals for this cleaning are planned to be:trisodium phosphate, 1 percent
by weight, Triton X 101 wetting agent, 0.05 percent by weight; Dow 2A1 deter- 1
gent, 0.05 percent by weight. This alkaline solution will be dumped into the
detention basins after cleaning. Clean water refill will be circulated
through the system to pick up remaining pockets of the solution and dumped into
the detention basins. Another clean water refill may be circulated and dumped
into the river or the detention basins, depending on its contamination.
The total amount of water involved will depend on the number of refills. It
is estimated that the amount of trisodium phosphate to be used would be
on the order of 20,000 pounds and that the amounts of wetting agent and
detergent to be used would be insignificant.

After the start-up wastes are deposited in the detention basins, they will then be pumped and metered to the mixing chamber for dilution with cooling tower blowdown and discharged to the river through the outfall structure. See Figure 3.7-1. The mixture discharged into the river will meet the requirements of the Federal Water Pollution Control Authority dated April 1, 1968.

3.7.7 LABORATORY, LAUNDRY AND HOT SHOWER WASTE

VNP will have a 10,000 gallon laundry and hot shower waste tank. The waste will be held until it can be released into one one the plant drumming stations. From there, the waste will be drummed and disposed of properly, Generally, the laundry service will be provided by contract with an outside firm and will be performed on site in emergencies only. In the event that an emergency occurs, low foam, low phosphate detergent that is commercially available will be used. The maximum number loads that could be washed per day will be 36. Each load will require 0.75 lbs. of detergent; therefore, 27 lbs. of detergent is the maximum amount that could be used per day. Each load will require 133 gallons of water.

VNP will have two 600-gallon chemical drain tanks to hold laboratory wastes until they can be released into one of the plant drumming stations. The chemical concentrations in this waste will be similar to the concentrations of the water and steam samples collected at various points in the plant. The quantity of laboratory waste will be very small and can be considered insignificant when it is discharged into the diffusion line. However, if any significant quantity is released, it will be picked up at the monitoring point at the outfall.

A discussion of drumming is included in Section 3.6.

3.7.8 SUMMARY OF DISCHARGES

VNP will have a normal discharge approximately equal to 22,000 gpm for 4 units. Intermittent waste flows and dilution water flow will increase this flow to approximately 37,000 gpm for 4 units. (See Figure 3.7-1.) The concentrations of various chemicals in the discharge will vary with operating conditions. The concentrations at 4 cycles and 8 cyles of concentration are:

	4 CYCLES		8 CYCLES	
Chemical	Continuous	With Demineralizer Waste	Continuous	With Demineralizer Waste
Sulfate	79.8 ppm	125.2 ppm	215.3 ppm	308.9 ppm
Sodium	29.3	45.7	58.6	97.2
Ammonia	0.096	0.096	0.232	0.232
Phosphate	0.111	0.111	0.270	0.270
Chloride	21.0	21.0	42.9	42.9

The above concentrations do not include any dilution water, and the concentrations with the demineralizer waste included are based on 1 demineralizer train operating at full capacity discharging its waste in 2 hours. The maximum chemical concentrations in the discharge will occur when the cooling towers are operating at 8 cycles of concentrations and the demineralizer waste is being discharged. Therefore, with 2 demineralizer plants discharging waste alternately, the greatest duration for the maximum concentration is 4 hours per day. However, since the cooling towers will rarely operate at 8 cycles of concentration, the maximum concentrations could occur only a few hours per year at most. Most of the chloride in the discharge is due to natural background; less than 5 ppm at 8 cycles of concentration and less than 2ppm at 4 cycles is due to chlorine usage in the plant. When the steam generator blowdown demineralizers are in operation, no ammonia or phosphate is released under normal conditions. 1

The quantities of chemicals used at VNP for 1 year are:

CHEMICAL	4 CYCLES	8 CYCLES
Sulfuric Acid	3,150,000 lbs.	5,350,000 lbs.
Sodium Hydroxide	228,010	228,010
Chlorine	272,952	272,952
Hydrazine	13,030	13,030
Ammonium Hydroxide	308	308
Phosphate	8,220	8,220

Chlorination of the main circulating water systems and the nuclear service cooling towers will be performed sequentially. A free residual chlorine analyzer at the discharge will limit the maximum free residual chlorine concentration in the blowdown from any of the systems to 2.0 ppm.

The blowdown from a unit being chlorinated will be diluted with the blowdown from the other generating unit, the blowdown from the nuclear service cooling tower and all other plant liquid discharges prior to introduction to the river. This dilution effect, as well as the chlorine demand of the diluting waters, will reduce free residual chlorine content prior to discharge.

The curve shown in Figure 3.7-2 represents the method used by GPC for chlorination of the natural draft cooling tower at an existing plant. Chlorine was injected into the circulating water system for the period necessary to achieve a free chlorine residual of 2.0 ppm, and grab samples were taken every 5 minutes from the tower blowdown to determine the free residual chlorine concentration. Table 3.7-3 gives the average 5-minute concentration of free residual chlorine leaving the system. The circulating water system at VNP will be chlorinated at the discharge of the circulating water pumps in the same manner, and it is expected that the free residual chlorine concentrations shown by Figure 3.7-2 and in Table 3.7-3 will not be exceeded.

The plume study in Subsection 3.5.3 shows the end of the 5°F isotherm for the winter condition to be approximately 20 feet downstream from the discharge in 11.4 seconds (20 ft ÷ 1.75 ft/sec = 11.4 sec) with a dilution factor of 8 (40°F ÷ 5°F = 8). It is, therefore, estimated that a 2.0 ppm free residual chlorine concentration in the 12 cfs of blowdown for 1 unit will be diluted to .25 ppm in approximately 11.4 seconds (2 ppm ÷ 8 = .25 ppm). The chlorine demand of the Savannah River is shown in Table 3.7-1a and indicates a 90% reduction in 2 minutes and 95% in 60 minutes for a 2.0 ppm dose. Using these points, a curve plotted and extrapolated on a log-log scale indicates a chlorine demand of 1.7 ppm at 11.4 seconds or a reduction of 85 percent. Therefore, it is estimated that the .25 ppm concentration remaining after dilution will be reduced by the chlorine demand of the river in 11.4 seconds to 0.04 ppm (.25 - (.85 x .25) = .0375). The total residual at 15 minutes is .4 ppm (see Table 3.7-1a), and the dilution factor of 8 at 11.4 seconds will give a diluted concentration of 0.5 ppm in less than 15 minutes.

Chlorine may be injected at the river makeup pump discharge to maintain the conduits to the circulating water system. Chlorination will be sequential and performed in the same manner as described above. Chlorination at the intake is expected to reduce the chlorination required in the cooling towers.

The chlorine residence time throughout the system is expected to be as follows:

1. Minimum contact within the circulating water system prior to blowdown -- 200 seconds.

TABLE 3.7-3

FREE RESIDUAL CHLORINE CONCENTRATION* AT DISCHARGE AND WITH DILUTION

TIME (MIN.)	AVG. CONC. (PPM)
0 - 5	0
5 - 10	.250
10 - 15	.725
15 - 20	1.215
20 - 25	1.740
Peak	2.000
25 - 30	1.750
30 - 35	1.400
35 - 40	1.150
40 - 45	.800
45 - 50	.500
50 - 55	.400
55 - 60	.350
60 - 65	.300
65 - 70	.300
70 - 75	.275
75 - 80	.250
80 - 85	.200
85 - 90	.150
90 - 95	.100
95 - 100	.050
100 - 105	.045
105 - 110	.033
110 - 115	.018
115 - 120	.005

1

*Taken from curve on Figure 3.7-2

2. Minimum contact within the discharge line blowdown from both units -- 400 seconds.

3. Minimum contact time within the mixing chamber -- 36 seconds.

Differentiation of combined and free residual chlorine is not possible until chlorine demand tests can be performed upon the actual circulating water. Varying organic content of the makeup water and the air passing through the tower and material blowing into the circulating water basins will affect this, as will the chlorine demand. Table 3.7-1a gives the free available chlorine, the total residual chlorine, the combined available chlorine and the total chlorine demand of the Savannah River. 1

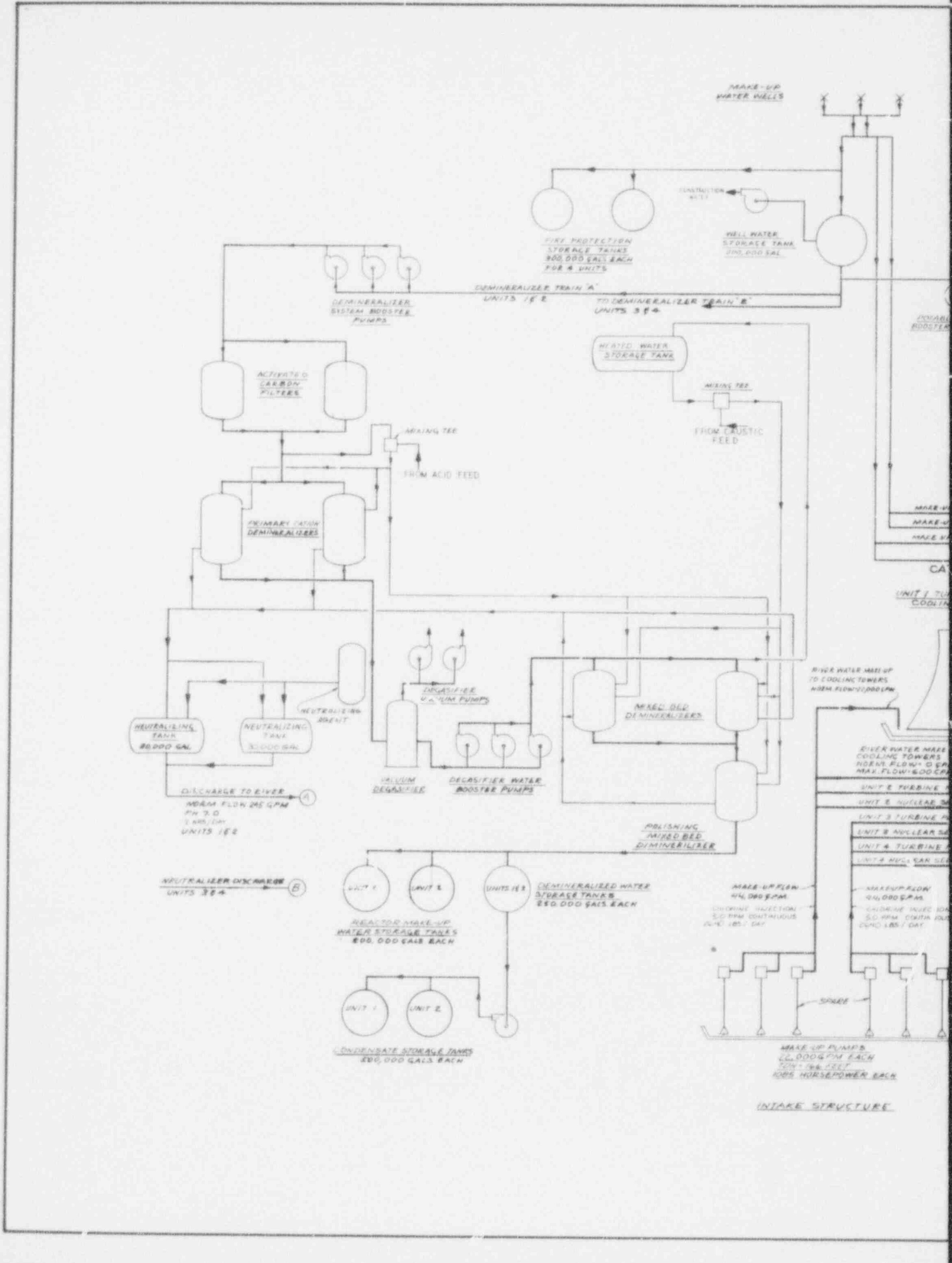
The hydrazine concentration in the VNP discharge will be zero. The amount of hydrazine added will be equal to the amount needed to remove the dissolved oxygen in the steam generator feedwater. It is possible that trace amounts of hydrazine could be released in the steam generator blowdown. If this occurs, the hydrazine will be rapidly dissipated in the mixing chamber.

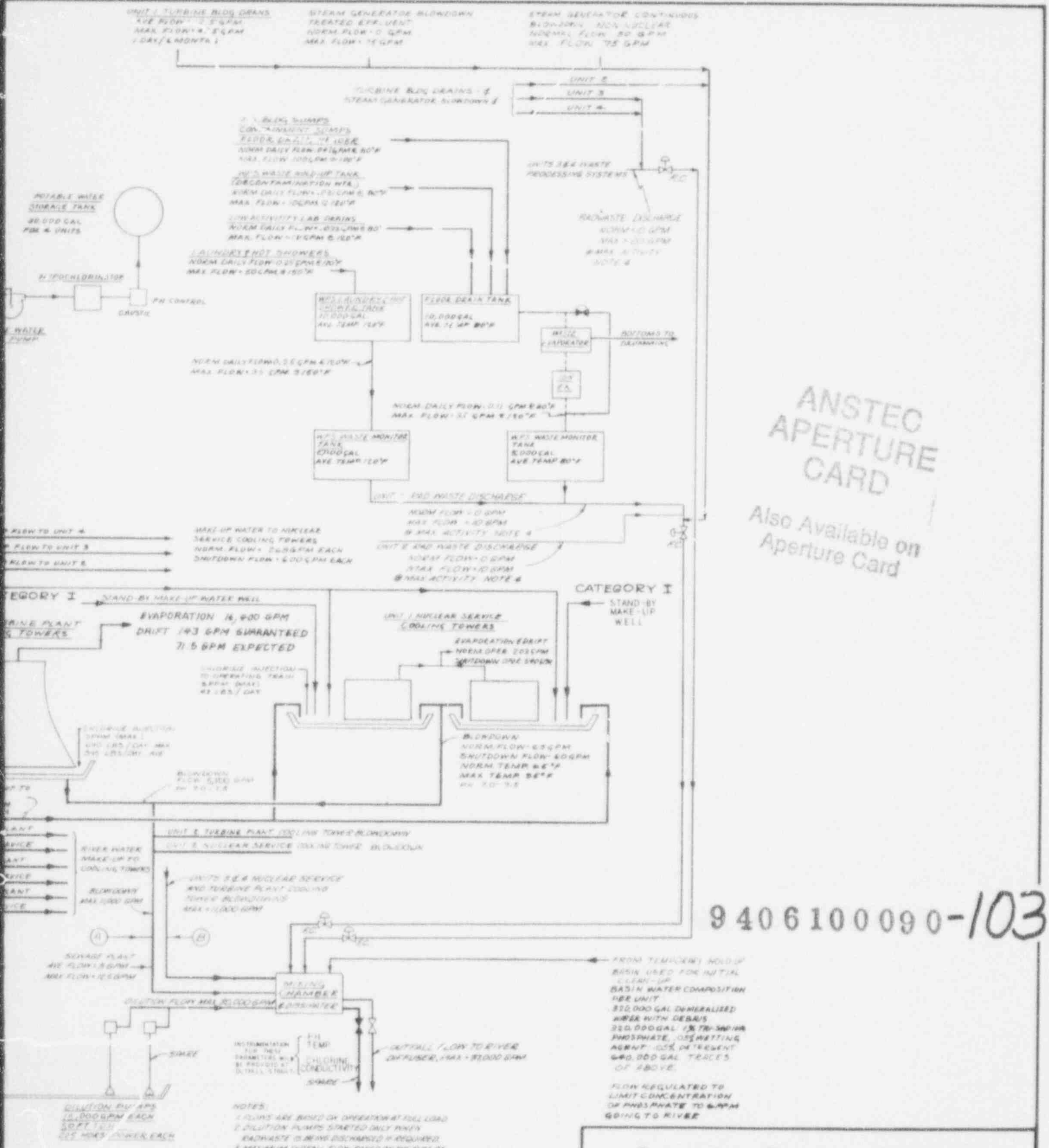
The dissolved oxygen content of the dilution water will be approximately the same as the concentration in the river water. Due to the aerating effect of the cooling towers, the dissolved oxygen content in the cooling tower blowdown will be higher than that of the river. This will compensate for the zero dissolved oxygen level in the steam generator and demineralizer waste. The discharge water leaving the mixing basin will have a dissolved oxygen concentration approximately the same as the river.

3.7.9 COOLING TOWER DRIFT

The cooling tower manufacturer guarantees a drift rate of not more than 0.03 percent of the total circulating water flow but expects a rate of no more than 0.015 percent of the total flow. Using the expected figure, the drift rate for VNP will be 286 gpm (71.5 gpm per unit). 2

The chemical concentrations in the drift will be approximately the same as the concentrations in the main cooling tower circulating water. These concentrations are discussed in Subsection 3.7.1


MAKE-UP WATER WELLS
CONSTRUCTION WATER
FIRE PROTECTION STORAGE TANKS 300,000 GALS EACH FOR 4 UNITS
WELL WATER STORAGE TANK 200,000 GAL
DEMINERALIZER SYSTEM BOOSTER PUMPS
DEMINERALIZER TRAIN 'A' UNITS 1 & 2
TO DEMINERALIZER TRAIN 'B' UNITS 3 & 4
POTABL
BOOSTER
HEATED WATER STORAGE TANK
MIXING TEE
FROM CAUSTIC FEED
ACTIVATED CARBON FILTERS
MIXING TEE
FROM ACID FEED
PRIMARY CATION DEMINERALIZERS
MAKE-U
MAKE-U
MAKE-U
CA
UNIT 1 TU
COOLIN
NEUTRALIZING AGENT
NEUTRALIZING TANK 30,000 GAL
NEUTRALIZING TANK 30,000 GAL
DEGASIFIER VACUUM PUMPS
VACUUM DEGASIFIER
DEGASIFIER WATER BOOSTER PUMPS
MIXED BED DEMINERALIZERS
POLISHING MIXED BED DEMINERILIZER
RIVER WATER MAKE UP TO COOLING TOWERS NORM. FLOW 22,000 GPM
RIVER WATER MAKE
COOLING TOWERS
NORM. FLOW = 0 GP
MAX. FLOW = 600 GP
UNIT 2 TURBINE
UNIT 2 NUCLEAR SE
UNIT 3 TURBINE P
UNIT 3 NUCLEAR SE
UNIT 4 TURBINE
UNIT 4 NUCLEAR SE
DISCHARGE TO RIVER
NORM FLOW 245 GPM
PH 7.0
2 HRS/DAY
UNITS 1 & 2
A
NEUTRALIZER DISCHARGE UNITS 3 & 4
B
UNIT 1
UNIT 2
UNITS 1 & 2
DEMINERALIZED WATER STORAGE TANKS 250,000 GALS EACH
REACTOR MAKE-UP WATER STORAGE TANKS 200,000 GALS EACH
UNIT 1
UNIT 2
CONDENSATE STORAGE TANKS 200,000 GALS EACH
MAKE-UP FLOW 44,000 GPM
CHLORINE INJECTION 5.0 PPM CONTINUOUS 2640 LBS / DAY
MAKEUP FLOW 44,000 GPM
CHLORINE INJECTION 5.0 PPM CONTINUOUS 2640 LBS / DAY
SPARE
MAKE-UP PUMPS 22,000 GPM EACH TDH = 146 FEET 1085 HORSEPOWER EACH
INTAKE STRUCTURE



NOTES:
1. FLOWS ARE BASED ON OPERATION AT FULL LOAD
2. DILUTION PUMPS STARTED ONLY WHEN RADWASTE IS BEING DISCHARGED IF REQUIRED.
3. MAXIMUM OUTFALL FLOW BASED ON THE SUM OF THE MAXIMUM BLOWDOWN FLOW AND THE FLOW FROM ONE DILUTION PUMP.
4. MAXIMUM RADWASTE DISCHARGE FLOW AT NORMAL ACTIVITY IS 150 GPM PER UNIT.

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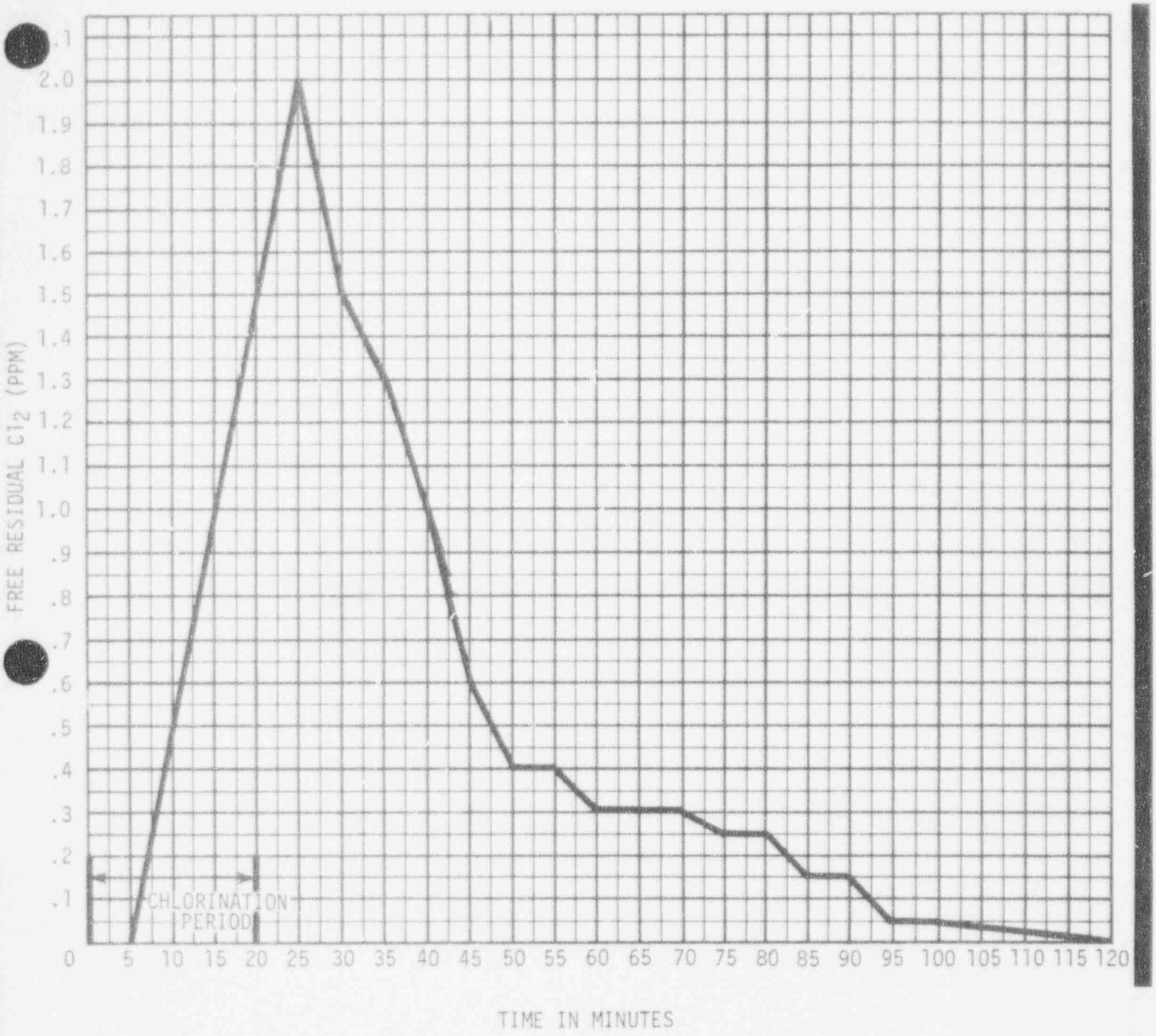
ENVIRONMENTAL REPORT

PLANT MAKE-UP WATER
FLOW DIAGRAM
FIGURE 3.7-1

Amend. 2 11/26/73



1

Amend. 1 4/27/73

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ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

FREE RESIDUAL CHLORINE IN THE BLOWDOWN FROM A GPC NATURAL DRAFT COOLING TOWER DURING CHLORINATION

FIGURE 3.7-2

3.8 OTHER WASTES

3.8.1 EMERGENCY GENERATORS 1

VNP will have a standby power source for each unit consisting of 2 diesel-engined generators. These generators are designed to supply auxiliary onsite power in the event of loss of offsite power. It is expected that the diesels will be run once a month for a minimum of 1 hour for test purposes. The diesel generator emissions will have minimal environmental effects. The expected pollutants from a typical exhaust gas analysis (based on a total exhaust flow of 18,000 cfm per diesel) are:

	Diesel Operation	
Pollutant	Engine Exhaust	Crankcase Exhaust
Oxides of Nitrogen, NO_x-ppm	1,375	59
Nitrogen Dioxide, NO_2 ppm	1,052	7
Aldehydes (as Formaldehyde) ppm	101	4.6
Hydrocarbons (as Methane) ppm	43	840
(as Hexane) ppm	7	140
Organic Acid (Acetic) ppm	13	
Carbon Monoxide, CO ppm	50	35
Particulates - grains/scf	0.0019	--
Visual Rating Ringelmann	0	--
Sulfur Oxides (as SO_2)* ppm	200	

1

*Based on worst case of fuel oil containing maximum of .590 sulfur by ASTM Standard D975. 2

3.8.2 OIL LEAKAGE

Plant equipment is designed so as to minimize oil leakage. Normal oil leakage will be removed by wiping with rags or by mopping. Major possible sources of oil leaks are pump lubrication systems. Pumps will be purchased with drain rim bases which will have sufficient retention volume to contain a major oil loss. Each base will be provided with a normally closed drain valve. If a major oil spill floods the pump base, plant personnel will drain the material into a bucket for disposal offsite. Oily rags, sawdust, etc. used for minor leaks will also be disposed offsite. 1

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4.2 EFFECTS ON HUMAN ACTIVITIES 4.2-1
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4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND PLANT CONSTRUCTION

4.1 PLANS, SCHEDULES, MANPOWER REQUIREMENTS

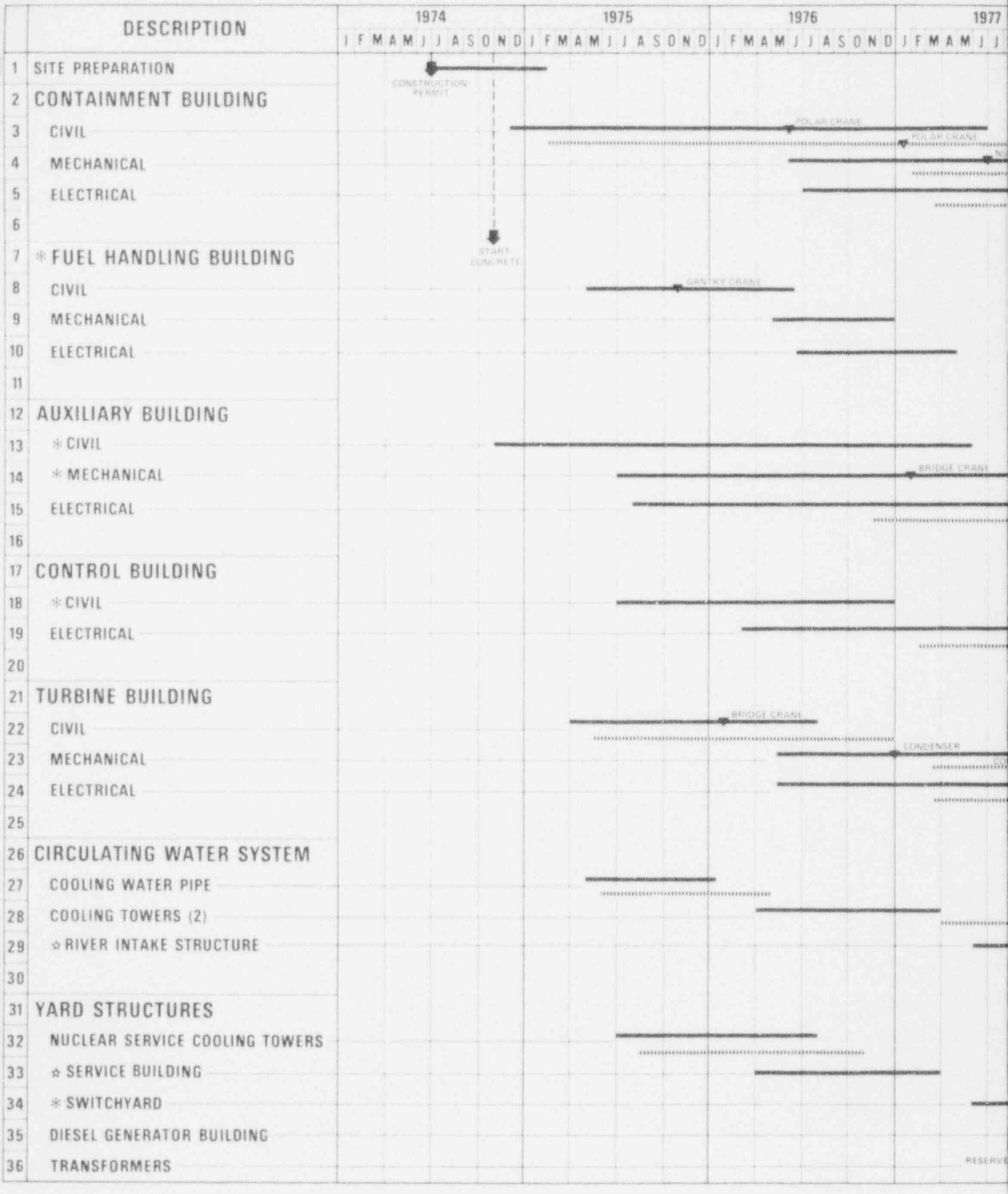
During the construction activities at the VNP site, there will be some disruptions and temporary changes to the environment. However, GPC acts as its own general construction contractor and makes specific efforts to minimize the effects of these activities. Typical of the efforts are:

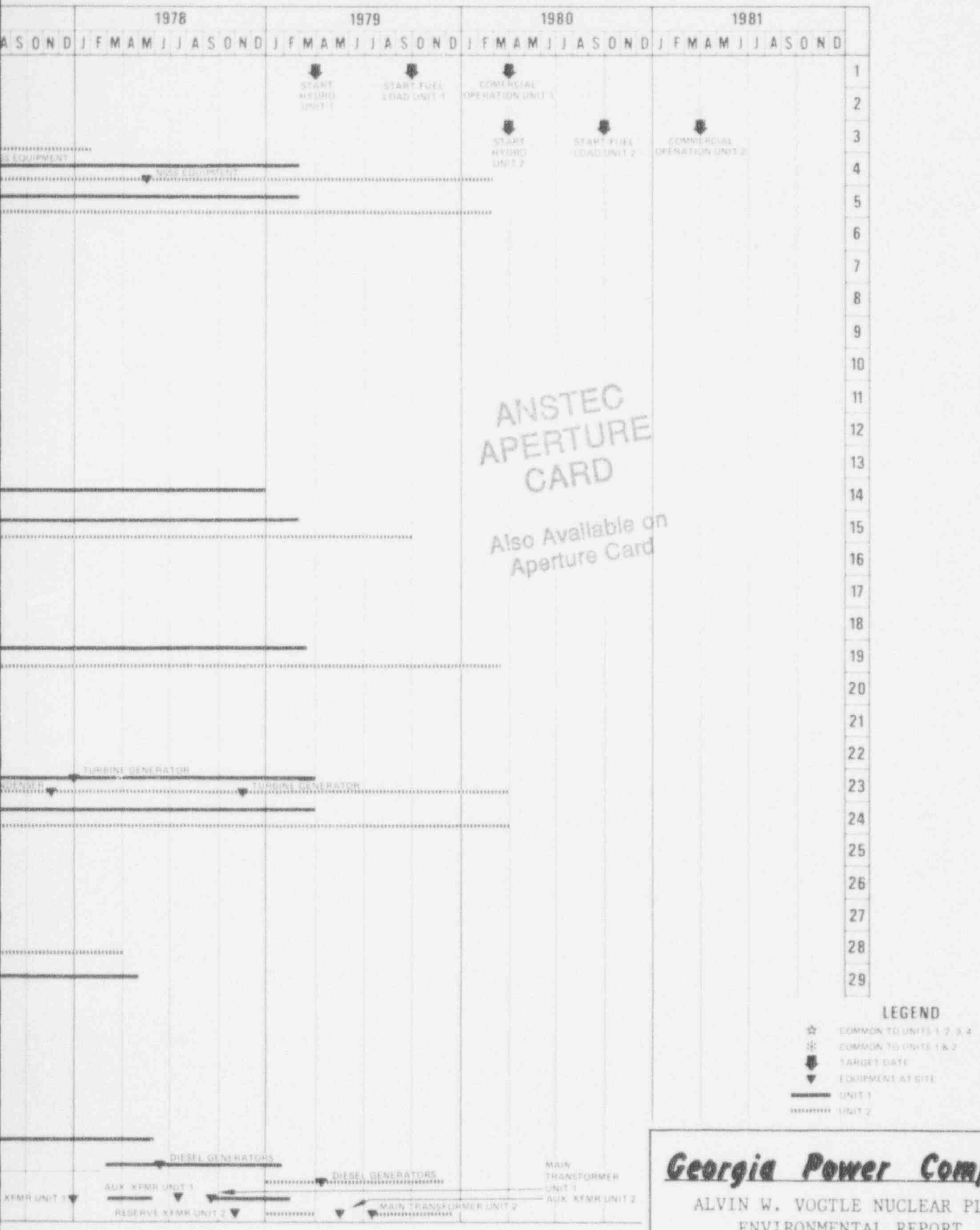
1. Refuse from the clearing of the construction area, access roads, and railroad and transmission line rights-of-way is generally burned or buried; no unnnecessary grading is permitted.
2. Dust from grading is minimized by spraying water on the surfaces being graded. Erosion from graded areas is controlled through contouring and planting.
3. There will be only spot dredging for construction of a barge slip and other river structures.
4. Sediment discharge to the river will be kept as low as possible due to the small number of activities in the river bed and on the river bank. Detention basins will be constructed in the site area in order to keep sediment discharge due to site runoff to a minimum.
5. The final design for the concrete batch plant will not be known until the contract for the concrete structural work has been let. However, a dust control system, such as bag filters or precipitrons, will be incorporated into the batch plant design. 1

A total of 3177 acres of land has been acquired for the VNP site. This land was purchased in late 1971and in the first few months of 1972. Approximately 300 acres of timber was cleared by Kimberly-Clark Corporation immediately prior to purchase by GPC. All other clearing, grading, and construction will be delayed pending issuance of an AEC construction permit. Upon issuance of the construction permit, GPC will begin working under an intensive construction schedule in order to meet the projected commerical operation date of April 1, 1980, for VNP-1 (similar schedules for VNP-2, -3, and -4 will follow in consecutive years).

Approximately 10 percent of the design and engineering effort has been completed, 1 percent of the total anticipated plant cost has already been expended, and 25 percent of the total cost has already been committed.

Major construction activities for VNP are tentatively scheduled as shown in Figure 4.1-1 (Construction Milestone Schedule, Units 1 & 2) and 4.1-2 (Construction Milestone Schedule, Units 3 & 4), assuming appropriate permits are issued. Figures 4.1-3 and 4.1-4 show projected manpower requirements and payroll expenditures for the construction period.


DESCRIPTION
1974
1975
1976
1977
J F M A M J J A S O N D
1 SITE PREPARATION
CONSTRUCTION PERMIT
2 CONTAINMENT BUILDING
3 CIVIL
POLAR CRANE
POLAR CRANE
4 MECHANICAL
5 ELECTRICAL
6
START CONCRETE
7 * FUEL HANDLING BUILDING
8 CIVIL
GANTRY CRANE
9 MECHANICAL
10 ELECTRICAL
11
12 AUXILIARY BUILDING
13 * CIVIL
14 * MECHANICAL
BRIDGE CRANE
15 ELECTRICAL
16
17 CONTROL BUILDING
18 * CIVIL
19 ELECTRICAL
20
21 TURBINE BUILDING
22 CIVIL
BRIDGE CRANE
23 MECHANICAL
CONDENSER
24 ELECTRICAL
25
26 CIRCULATING WATER SYSTEM
27 COOLING WATER PIPE
28 COOLING TOWERS (2)
29 ☆ RIVER INTAKE STRUCTURE
30
31 YARD STRUCTURES
32 NUCLEAR SERVICE COOLING TOWERS
33 ☆ SERVICE BUILDING
34 * SWITCHYARD
35 DIESEL GENERATOR BUILDING
36 TRANSFORMERS



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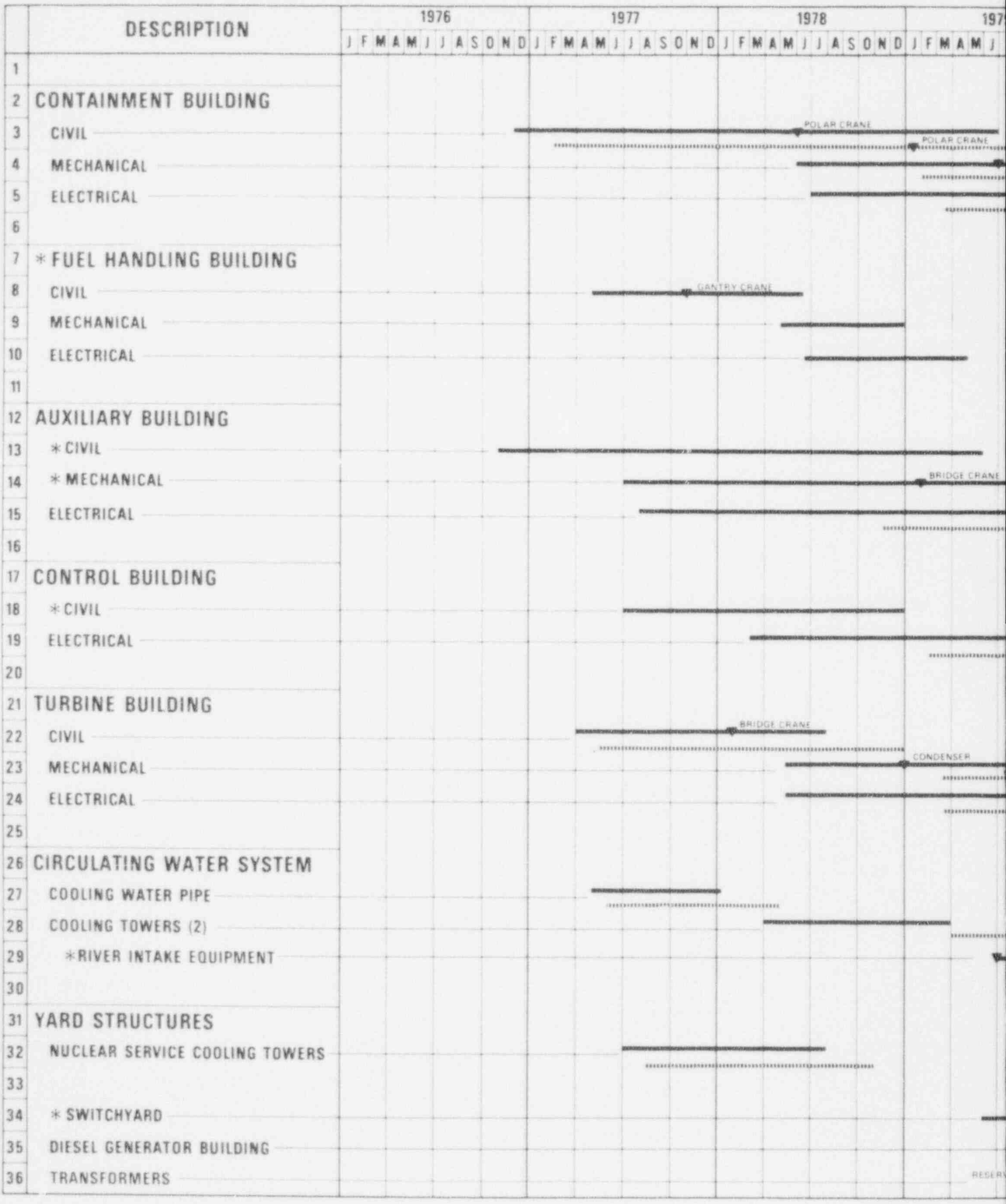
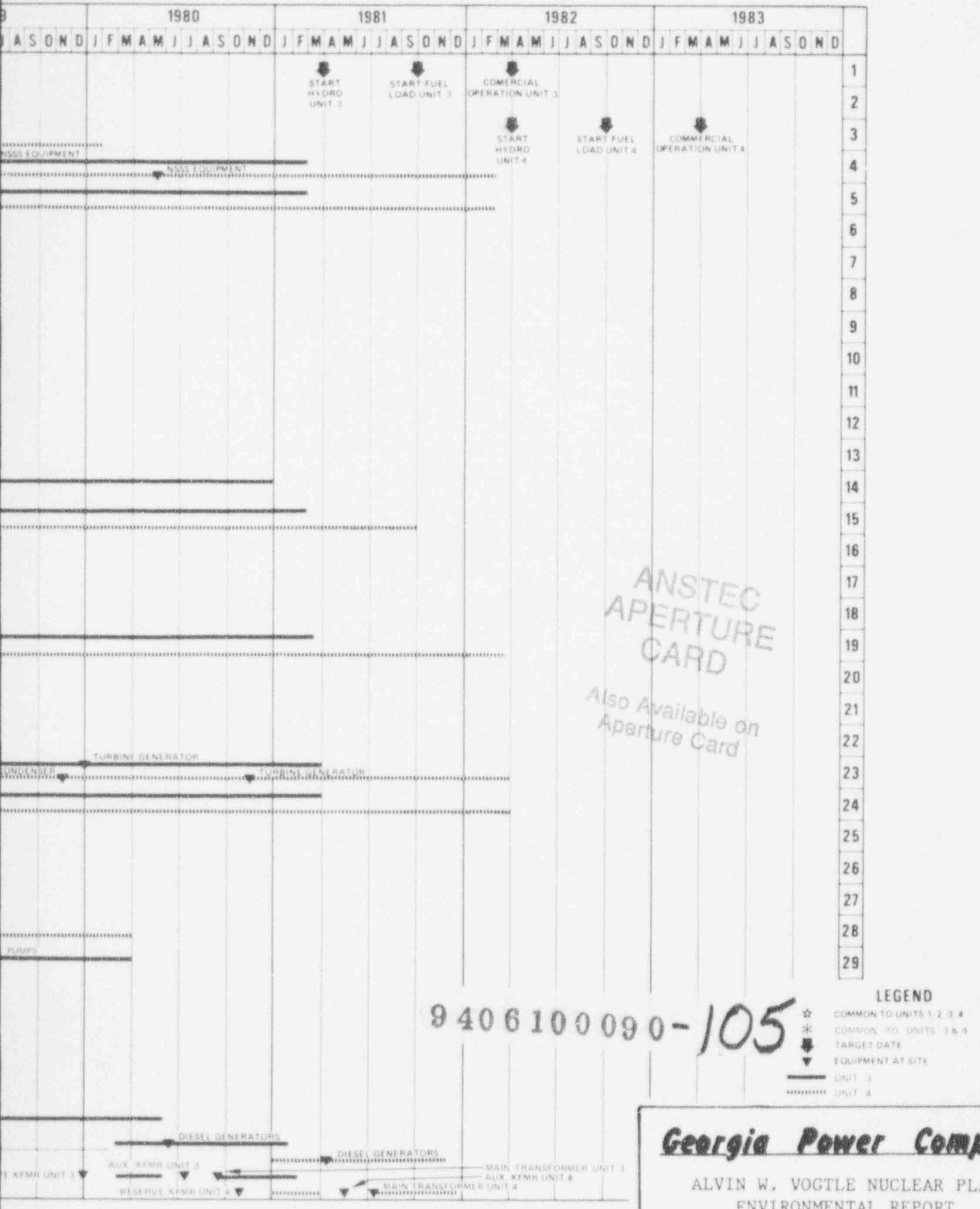
ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

CONSTRUCTION MILESTONE SCHEDULE
UNITS 1 & 2

FIGURE 4.1-1


DESCRIPTION
1976
1977
1978
197
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
1
2 CONTAINMENT BUILDING
3 CIVIL
POLAR CRANE
POLAR CRANE
4 MECHANICAL
5 ELECTRICAL
6
7 * FUEL HANDLING BUILDING
8 CIVIL
GANTRY CRANE
9 MECHANICAL
10 ELECTRICAL
11
12 AUXILIARY BUILDING
13 * CIVIL
14 * MECHANICAL
BRIDGE CRANE
15 ELECTRICAL
16
17 CONTROL BUILDING
18 * CIVIL
19 ELECTRICAL
20
21 TURBINE BUILDING
22 CIVIL
BRIDGE CRANE
23 MECHANICAL
CONDENSER
24 ELECTRICAL
25
26 CIRCULATING WATER SYSTEM
27 COOLING WATER PIPE
28 COOLING TOWERS (2)
29 *RIVER INTAKE EQUIPMENT
30
31 YARD STRUCTURES
32 NUCLEAR SERVICE COOLING TOWERS
33
34 * SWITCHYARD
35 DIESEL GENERATOR BUILDING
36 TRANSFORMERS
RESERV



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ALVIN W. VOGTLE NUCLEAR PLANT
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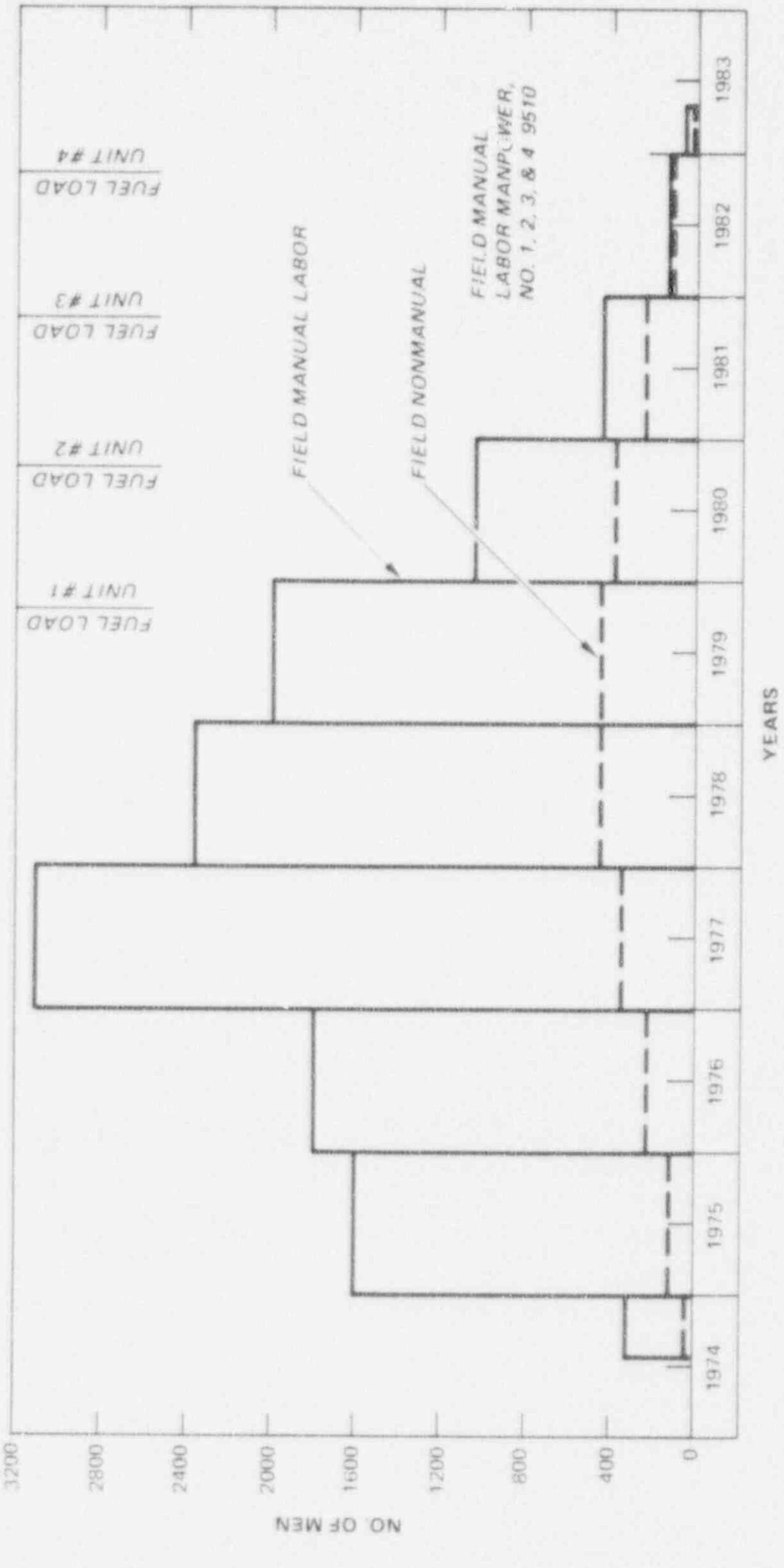
CONSTRUCTION MILESTONE SCHEDULE
UNITS 3 & 4

FIGURE 4.1-2



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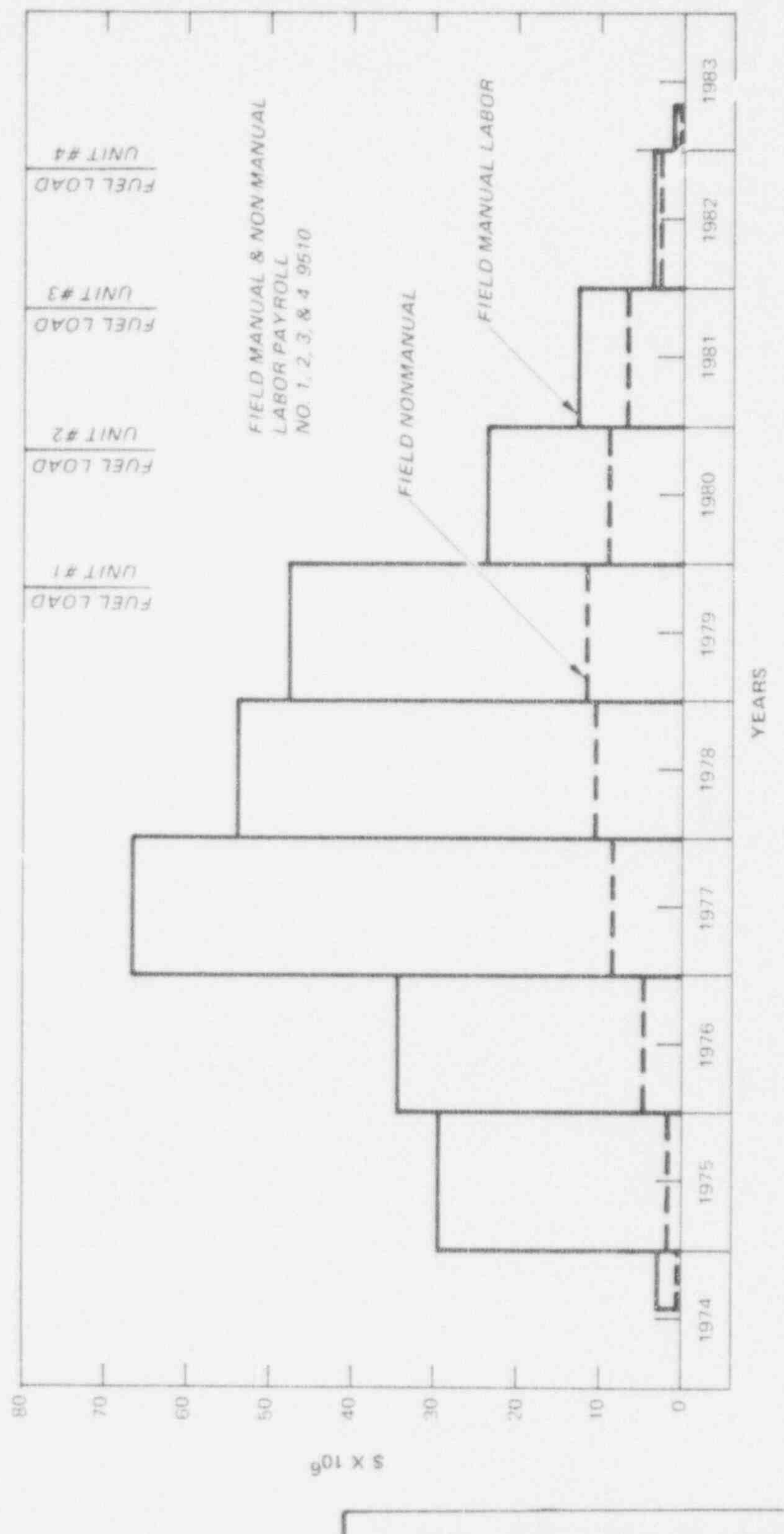
ENVIRONMENTAL REPORT

CONSTRUCTION SITE MANPOWER

FIGURE 4.1-3



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ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

CONSTRUCTION SITE PAYROLL

FIGURE 4.1-4

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4.2 EFFECTS ON HUMAN ACTIVITIES

Most of the information in this section was drawn from a report made for GPC by the City Planning Department of the Georgia Institute of Technology. This report is contained herein as Appendix A, and material drawn from it is denoted by (A)

Site preparation and plant construction of VNP will provide employment for local residents and will draw new workers into the area. During the peak construction year, the anticipated construction work force will be approximately 3,500 workers. Of the new families moving into the area during the peak construction year, it is anticipated that about 220 families will rent/purchase homes in Richmond County, Georgia, while about 60 families are expected to rent/purchase homes in Burke County, Georgia. As of 1970, the average single family house sales prices for Richmond and Burke Counties were $17,200 and $9,200, respectively. (A)

An estimated 2990 of the required 3,500 workers will be available within Burke and its surrounding counties. (A) Thus, labor resources within the region are adequate to provide the majority of the required work force for the construction project. (A) Current unemployment should be significantly eased by the creation of the new construction jobs. (A) Population in the study area, except for Richmond County, has been declining steadily for the past 30 years. (A) A curtailment in the population decline can be anticipated as result of the construction project. (A) Although some influx of workers has been projected, their numbers are not so significant as to prompt extensive construction or development activities solely in support of VNP. (A)

The majority of the incoming work force must be accommodated by existing facilities in Richmond County, as Burke County's housing resources are extremely limited. (A) It is expected that during the peak construction period, about 550 incoming workers (roughly 70 percent) will reside in Richmond County, while the remaining 210 incoming workers (roughly 30 percent) will reside in Burke County. These projections are based on the assumption that the facilities in Burke and Richmond Counties remain much the same. Aggressive actions taken by nearby communities in order to attract more of the workers would, of course, increase the percentage of workers settling in that area. No controls are anticipated to prevent aggressive recruitment of construction workers to reside in the undeveloped areas of Burke County. A county-wide zoning ordinance is scheduled for enactment in January, 1973; this ordinance will restrict population density and land use in certain portions of the undeveloped areas of Burke County. It is anticipated that land use controls will be an asset to such recruitment since they encourage good standards which will make the area more attractive. (1)

The housing and other facilities (water, sewage, health, etc.) of Richmond County are presently sufficient to meet the demand anticipated during the construction period for VNP. (A) The school systems in Richmond County should also be adequate to accommodate the projected increase in enrollment, since there is a 20.4 to 1 student - teacher ratio in the public schools and a 19.1 student - teacher ratio in the private schools. (2)

The construction of VNP in Burke County will have a positive effect on economic development in the area, particularly in Burke and Richmond Counties. (A) The results of in-depth analysis and observation indicate that Richmond County will receive the majority of the short-term economic benefits during the 8 1/2-year construction period (resulting partly from the expenditure of the annual construction payroll which is estimated to be $75,000,000 during the peak construction period). (A) Burke County, however, will receive most of the long-term benefits, since the power plant is located in that county. The most significant impact projected for Burke County is the greatly increased property tax revenues anticipated from GPC. For example, Appling County, in which another GPC nuclear plant is currently under construction, has experienced a 21-fold increase in tax revenues received from GPC during the first 3 years of construction. (A) Listed below are the estimated annual ad valorem taxes on VNP for the period from 1972 through the end of construction activities in 1983. These figures include taxation of the Combustion Turbine Plant and of the 230 kV and 500 kV transmission lines to be built in Burke County. Average construction costs are approximately $55,000 per mile for 230 kV lines and $56,600 per mile for 500 kV lines; average assessed valuations per mile are $38,500 and $39,600 for 230 kV and 500 kV, respectively. 1

Year	Estimated Taxes
1972	$ 10,650.00
1973	159,950.00
1974	209,535.00
1975	356,477.00
1976	662,913.00
1977	1,334,800.00
1978	2,212,076.00
1979	2,723,162.00
1980	3,307,975.00
1981	3,111,276.00
1982	3,142,176.00
1983	3,142,176.00

After construction is completed, the annual taxes will tend to stabilize. The above figures are a significant increase over the $22,924.52 and $27,094.50 in taxes paid by GPC to Burke County in 1970 and 1971, respectively. This projected tax inflow will also have a substantial impact on total Burke County revenues, since the 1971 revenues from the total county tax digest amounted to only $596,000.(A) It would be difficult to make a specific estimate of how much Richmond County will receive through increases in business activity and in taxable income and property; however, it is thought that the increases in county income will outweigh any additional expenses for increased county services.(1)

The following tabulations show the estimated fractions of capital costs of construction that will be spent locally (Central Savannah River Area), within Georgia and within the U.S.A. It should also be noted that no construction spending is expected to take place outside the U.S.A.

	Percentages			
	Materials & Equipment	Labor	Subcontracting	Totals
C.S.R.A.	5	80	2	28
Ga. (excluding C.S.R.A.)	5	0	30	7
U.S.A. (excluding Ga. & C.S.R.A.)	90	20	68	65
Totals	100	100	100	100

1

The present water treatment facilities in Waynesboro, Georgia, are adequate to meet the demands during the period of construction estimated for VNP.(A) Burke County has no public water system.

A recently proposed addition to the sewage disposal plant in Waynesboro will update the system to sufficiently meet all the sewage demands for the period of construction estimated for VNP.(A) Burke County has no public sewage treatment system.(A)

According to the recommended standards of the Georgia Law Enforcement Advisory Board, the police forces of both Waynesboro and Burke County are understaffed.(A) VNP will have an impact on these agencies primarily in the form of increased traffic on the main roads of Burke County.

The existing fire protection facilities should be adequate to serve the needs of the workers that locate within a 3-mile radius from the center of Waynesboro.(A) Trailer parks will be allowed within the outlying areas of Burke County provided they meet the specific standards suggested within the proposed zoning ordinance that will be passed in January, 1973. It is anticipated that the county-wide voluntary fire department will develop sufficiently in the outlying reaches of Burke County so as to provide the protection necessary for these expected trailer parks.(1) County water treatment, county sewage treatment, county fire protection, and more extensive police protection are matters that may need attention due to the impact of at least those construction workers seeking housing in local mobile home parks. These facilities will be even more important if Burke County should try to attract more of the workers to settle within the area. Plans for adequate facilities in these areas have been presented to the county leaders and are under consideration.

The Burke County Hospital and the Burke County Health Department have modern facilities and up-to-date programs which serve the needs of the area residents.(A) The close proximity of the excellent medical facilities in the Augusta area preclude the need for extensive development of hospital and health services in the immediate vicinity of Waynesboro in order to handle the influx of workers. The Burke County Board of Commissioners is currently studying the need for additional facilities due to the construction of VNP. The area-wide solid waste collection and disposal plan has been completed along with physical land use plans for the county. Action is anticipated in January, 1973.(1)

It is felt that the Burke County school system will be able to absorb the increase in pupil load that will come with plant construction.(A) After an examination of the existing capacity of the school facilities within Burke County, it was found that most of the additional students can be absorbed by the schools in the Waynesboro area.(A) Figures show that most of the schools in Burke County are operating well below their capacity.(A) It is calculated that there are facilities presently available for 1223 students in the Burke County school system that are not being used.(A) The one exception to this situation is a private school, Edmund Burke Academy, which is already operating above capacity.(A) The student-teacher ratio in the Burke County public schools is 20.3 to 1 while the student-teacher ratio for Edmund Burke Academy is 28 to 1.(A)

As mentioned above, a county-wide zoning code will take effect in Burke County in January, 1973. This code will affect the areas along existing paved roads.(1) The Central Savannah River Area Planning and Development Commission has worked with Burke County in the past and will continue to do so in order to achieve an effective plan for future development.(A) Construction of VNP should help stimulate these activities.

Air pollution occuring during construction will come from open burning during land clearing and cleaning up. All burning will be in accordance with state and county regulations.(3) It is not expected that any blasting will be required during construction. Noise associated with the construction, such as vehicle operation and material loading and unloading, is considered to be inconsequential, since the construction site is some 3 air miles from the nearest dwelling.

There will be an increase in the local highway traffic due to the shipment of miscellaneous materials and the commuting of the construction workers and plant operating personnel. The present Burke County highway system in the plant area is in need of some updated construction and maintenance in order to support the increased traffic. (A) However, the above mentioned increase in tax revenues should more than offset the cost of these improvements.

Burke County has plans for initiation of a landfill facility and garbage pickup system designed to meet the needs of the expected influx of workers. Expenditures for this project are expected to be from \$100,000 to \$150,000. However, the proposed tax revenues (page 4.2-2) from VNP should be more than adequate to cover these costs.

Recommended actions for Burke County arising from the study detailed in Appendix A include: (1) improvement of existing highway system; (2) enactment of county-wide zoning controls; (3) improvement of the overall quality of both the education and the facilities in the public schools; (4) improvement of first the quality, and then the quantity, of available community services and facilities. Increased tax revenues could feasibly help with all these things. Existing community services to be improved might include those relating to health, recreation, and law enforcement; consideration could also be given to adding county-wide water and sewer systems and fire protection to the list of existing services. As mentioned above, plans have already been made to implement a garbage collection system. In the end result, however, the final decision as to how these increased tax revenues are actually utilized will be made by the Burke County Commission, who may or may not choose to accept such recommendations. 1

A special railroad will be built into the plant site in order to avoid overcrowding the highways when the majority of the construction materials and supplies are delivered. Plans are not definite at this time, but the proposed layout runs approximately 14 miles from the plant site to the nearest commercial railroad line, about 8 railroad miles above Waynesboro. The railroad spur is expected to occupy approximately 245 acres but has not been definitely located.

A barge landing will be constructed at the plant site for receiving shipments of the large reactor components. Once the plant becomes operational, the barge landing may be used for occasional fuel oil shipments for the Combustion Turbine Plant.

Judging from past experience, it is not expected that the construction and operation of the barge landing and the railroad spur will have significant impact on the industrial or economic development of the area.

Hunting is a major recreation in the general area, and there is controlled hunting permitted across the Savannah River in specified areas of the Savannah River Plant Reservation. Hunting will not be permitted on the VNP site.

The VNP site is located in a rural area several miles from any town. A total of 3177 acres of land was acquired for the VNP site. Approximately 379 acres were in cultivation, growing primarily beans, peanuts, and corn. With the exception of a 6-acre pond, the remaining acreage was in timber growth. Approximately 300 acres of the timber consisted of slash pine previously owned and cleared by Kimberly-Clark Corporation.

The property acquired was owned by 15 property owners. Included in the figure is 1 parcel of land owned by 2 property owners. Relocation of 4 families was required. Of the property involved, only 2 owners lived on their property. One of these 2 property owners purchased a new farm in Burke County. The relocation of the other property owner is unknown. The remaining property owners live in Augusta, Georgia; Florida; South Carolina; and Tennessee. Two tenants lived on property acquired, but the place of their relocation is unknown.

The construction of VNP will cause 1011 acres to be taken out of food crop and timber production and used for the production of electricity. However, other land use in the area of the project site should not be materially changed. Also, it is not expected that any satellite industry or services will be established in the region that can be directly related to the plant construction.(A)

REFERENCES

(1) Starnes, R. L., Director of Planning, Central Savannah River Area Planning & Development Commission, letter to Alan Harrelson, Georgia Power Company, Augusta, Georgia, November 8, 1972.

(2) Economic Development Profile for Augusta, Georgia, Department of Industry and Trade, Atlanta, Georgia, 1971.

(3) Rules and Regulations for Air Quality Control, Georgia Department of Public Health, Atlanta, Georgia, March 13, 1972.

4.3 EFFECTS ON TERRAIN, VEGETATION, WILDLIFE

4.3.1 EFFECTS ON TERRAIN

Construction activities are not expected to have any adverse effects on the terrain outside of the construction area. In the construction area, the terrain will be altered by clearing, grubbing, excavating, filling, grading, stock-piling, and building. It is expected that these alterations will not create any permanent adverse effects because proper construction techniques will be used, as described below.

Approximately 300 acres of the VNP site were cleared by the previous owner. About 30 acres were cleared by GPC for construction of a meteorological tower. About 1011 acres (including the 300 acres already cleared) will be cleared for construction of VNP. About 764 acres of land will be covered by buildings, parking lots, roads, power lines, a meteorology tower, detention ponds, and a railroad spur. About 247 acres will be used for stockpiling of building material and for construction facilities. As many of these acres as practical will be cleaned up and landscaped after construction is complete. Landscaping will consist of grading and planting with appropriate grasses, shrubs, or trees. The Soil Conservation Service (SCS) of the U.S. Department of Agriculture has provided GPC with advice on replanting and landscaping. 2

For any short term undesirable effects that can be foreseen, corrective measures will be taken. Corrective measures will include the following proper construction techniques. Proper erosion control techniques will be used. Berms and dikes will be constructed. Interceptor ditches will be built to protect side hill cuts. Other ditches will be constructed. Sheet piling and sandbagging will be used to control erosion. Fugitive dust will be controlled by watering and natural windbreaks. Traffic control procedures will be followed. Heavily traveled site roads will be graveled if necessary. Flooding should not occur in any areas as a result of terrain alterations. Soil slopes from all the cuts, fills, stockpiles and disposal area will be stabilized as soon as the slope is formed. Chemical soil binders such as Aerospray 52 Binder or Curasol AE will be applied to denuded areas or slopes as an immediate temporary protection. These products are nontoxic and physiologically harmless. Slopes that will become permanent or exposed for a long period will be seeded for permanent vegetation after the chemical stabilization. 1

A hydroseeder slurry containing mulch, seeds, fertilizer and a soil chemical binder will be applied to the permanent, stockpile, and disposal slopes to establish the permanent vegetation. For use on stockpile slopes, seed selection will be restricted to a low root and growth ground cover. This will reduce the amount of removal required before reusing the material. If, during germination and early growth, additional protection against erosion is required, special protective blankets will be maintained in place by metal staples.

Permanent excavation slopes, stockpiles slopes, and disposal area slopes, will have benches at 30-foot vertical height. intervals and collector downdrains at 400-foot intervals. Collector downdrains may be constructed of gunite or corrugated metal pipe with dissipators at the base.

The top surface of the stockpile embankments and disposal area will be stabilized with a chemical binder if required. Additional protection can be provided with sandbag check dams. The sandbags are spaced at 50-foot intervals. They are one bag high and allow silt to deposit on the upstream side. Runoff is allowed to sheet over the bags. Periodic maintenance of these dams is required. If silt deposits build up too readily, an additional row of bags will be constructed.

Permanent ditches will be lined with gunite, and temporary ditches will be lined with either gunite or asphaltic concrete. Culverts and ditches will follow the natural drainage patterns as closely as possible.

Two sediment retention basins will be built downstream of the stockpile areas and the disposal area. The disposal and stockpile areas will be located within the drainage area contributing to the retention basins. Additional ditches will be built as required to orientate any runoff to the retention basins. The retention basin located southeast of the power block will have a storage capacity of approximately 140,000 cubic yards, and the one located southwest of the power block will have a storage capacity of 50,000 cubic yards. The capacity of each retention basin will exceed the usually recommended ration of 0.5-inch of storage per acre of drainage area.

A maximum annual sedimentation of 40,000 and 20,000 cu. yd. for the larger and smaller basins, respectively, is anticipated. Based on these values it can be assumed that cleaning the retention basins will be required only once every 2 years during plant construction. The material obtained from cleaning the retention basins will be deposited in the disposal area.

The areas designated for the retention basins will be cleared. Trees, stumps, and brush will be cut off as near the ground surfaces as practical.

The retention basins will be sized to produce a detention time of approximately 9 to 10 minutes for the peak flow during a storm with a recurrency period of 25 years. Study of 79 gradation tests shows that at least 80 percent of the particles in suspension will be retained in the retention basins during the peak flow. When the flow is below peak flow conditions, it is expected that the particle retention will be greater than 80 percent. 1

After construction is completed, the top surface of the disposal area and the retention basins will be seeded for permanent vegetation. Any area cleared for stockpiles will be seeded after the stockpiles are removed.

Figure 4.3-1 is a scale layout of site topography prior to beginning any construction. Figure 4.3-2 is a scale layout of site topography during construction. Figure 2.1-3 shows the relation of the **Combustion Turbine Plant** to VNP. The only existing common facility for construction of VNP and for any addition to the turbine facility is the construction power transformer in the switchyard adjacent to the combustion turbines. 1

4.3.2 EFFECTS ON VEGETATION

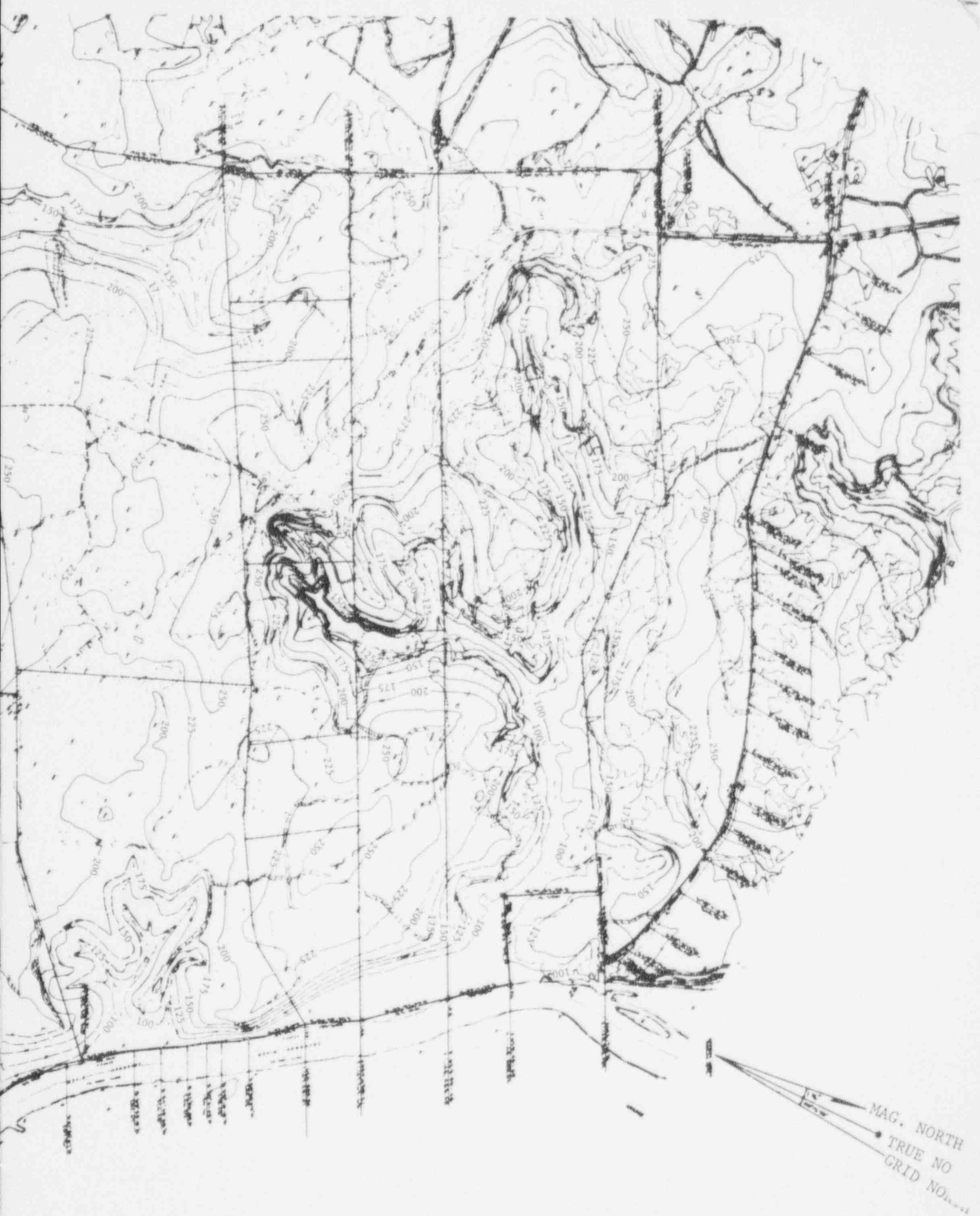
Construction activities are expected to have no adverse effects, or only very minor effects, on vegetation outside the immediate construction areas. As noted in Subsection 4.3.1, about 300 acres had been cleared of standing trees prior to purchase by GPC. About 711 more acres will be cleared as construction proceeds; some of this land is forested, and some was formerly cultivated land. Any cleared material that is salable will be sold. There may be some open burning of brush and trees during land clearing activities. Any burning will be done in accordance with all state and local regulations, and all necessary permits will be acquired. 1 After land clearing activities are completed, there will be no further open burning of debris or rubbish. The remaining material will be buried, windrowed, or carried to a landfill.

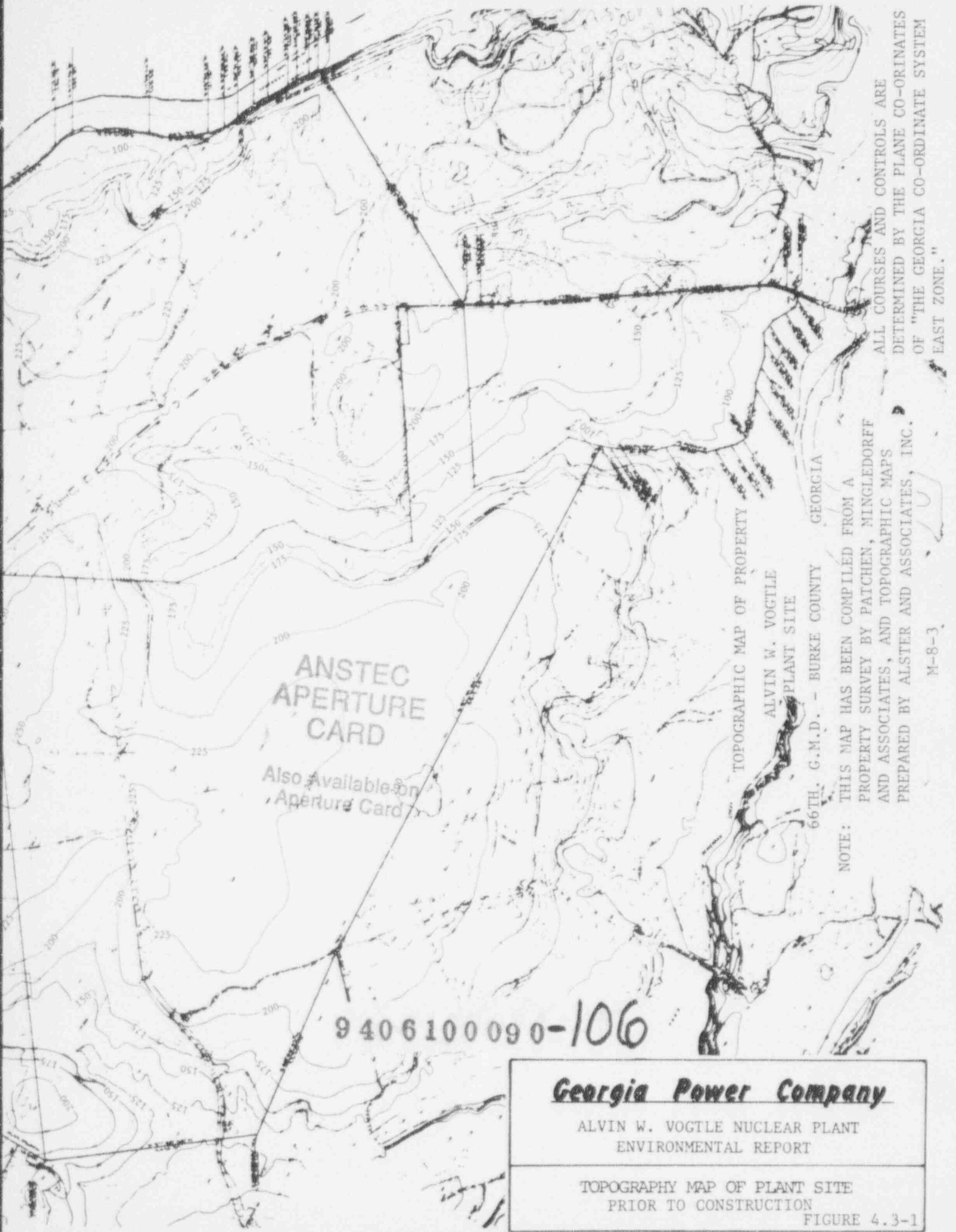
The plant site is predominately covered in sandhill-upland hardwood-pine communities. Most of the clearing will be done on land that was in crops or cleared when GPC acquired the site. Nearer the Savannah River a swamp forest exists. Clearing near the Savannah River will be kept to a minimum. Only 9 acres will be cleared in the floodplain of the river for the construction of intake and discharge structures and barge facilities. The remainder of the floodplain (approximately 46 acres) will be left as a greenbelt. A more complete discussion of vegetation is given in Section 2.7 along with a vegetation map (Figure 2.7-2).

4.3.3 EFFECTS ON WILDLIFE

Construction activities are not expected to have any lasting adverse effects on wildlife at the plant site. Most wildlife will leave the immediate vicinity of construction as man's activities increase, but some are expected to return as construction is completed and man's activity subsides somewhat. The clearing process will result in some loss of animal life, especially small mammals. The construction of temporary roads and railroad spurs, and the other construction activities may also cause some loss of animal life. However, it is unlikely that any significant part of their population on the site will be destroyed. The southeastern states field representative of the National Audubon Society stated in correspondence with GPC that bird life will most likely relocate to surrounding areas where trees will not be cleared. (According to a letter from the National Audubon Society dated March 14, 1973, this should not be construed as an official statement from the Society.) 1 Construction activities will remove about 1011 acres from wildlife habitat; there are no known unusual or rare species which will be endangered due to loss of habitat. See Section 2.7 for a listing of biota.

When construction is completed, areas that are no longer needed for operational activities will be replanted with appropriate grasses, shrubs, or trees and thus made available for use by wildlife as much as possible. About 2142 acres of the site will not be used for construction of VNP or the Combustion Turbine Plant. This acreage will be available to wildlife. As stated previously, the SCS will advise GPC on landscaping and replanting procedures.


MAG. NORTH
TRUE NO
GRID NO...
100
125
150
175
200
225
250
275



TOPOGRAPHIC MAP OF PROPERTY
ALVIN W. VOGTLE
PLANT SITE
66TH. G.M.D. - BURKE COUNTY GEORGIA

NOTE: THIS MAP HAS BEEN COMPILED FROM A PROPERTY SURVEY BY PATCHEN, MINGLEDORFF AND ASSOCIATES, AND TOPOGRAPHIC MAPS PREPARED BY ALSTER AND ASSOCIATES, INC.

ALL COURSES AND CONTROLS ARE DETERMINED BY THE PLANE CO-ORINATES OF "THE GEORGIA CO-ORDINATE SYSTEM EAST ZONE."

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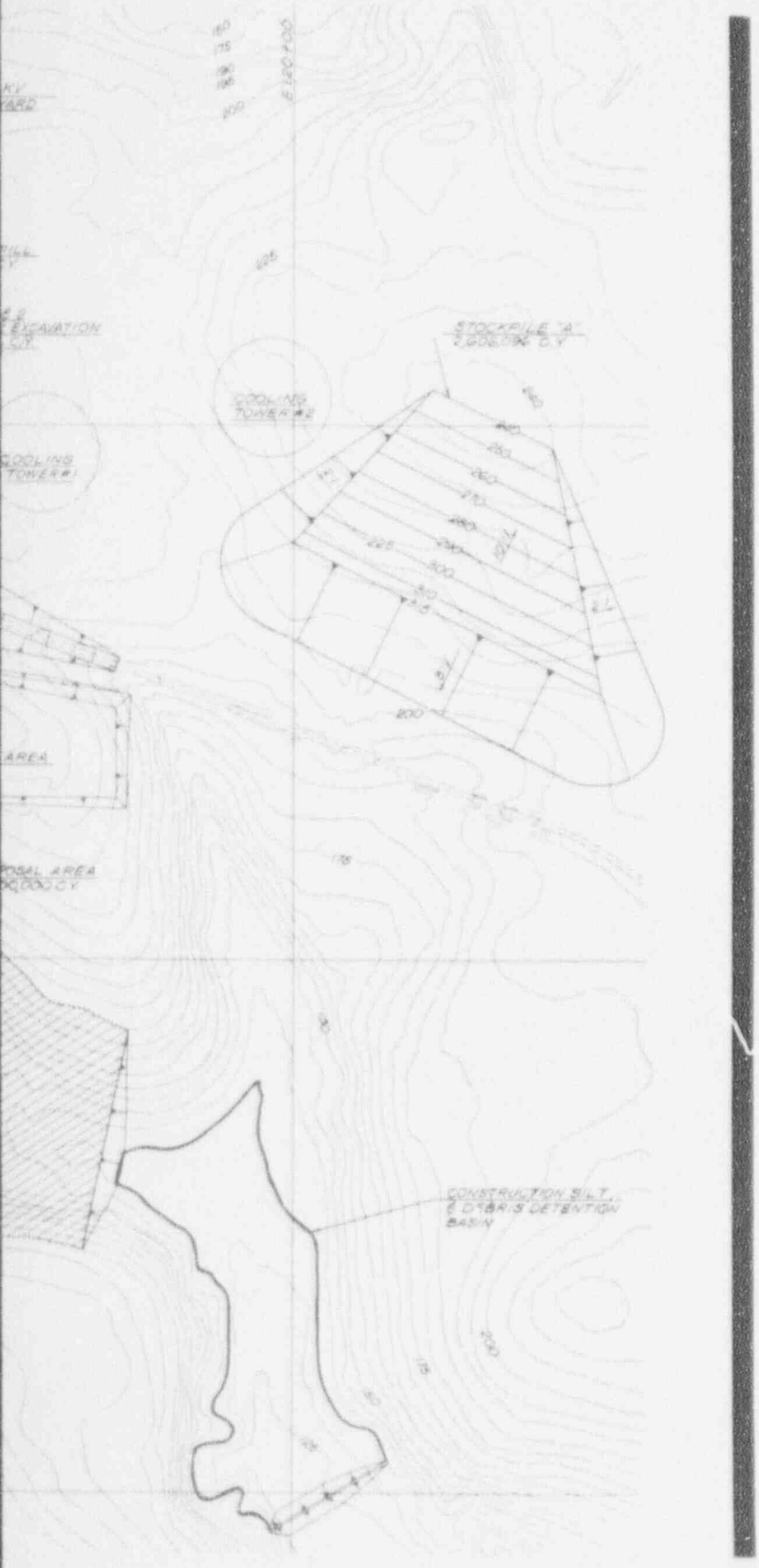
ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

TOPOGRAPHY MAP OF PLANT SITE
PRIOR TO CONSTRUCTION

FIGURE 4.3-1


N
CONSTRUCTION ACCESS ROAD
EXISTING RIVER ROAD
E 85+00
500 KV SWITCHYARD
CONST PARKING
RIVER FACILITY ROAD
500 KV SWITCHYARD
E 100+00
230
SWITCH
INITIAL BACK
123,000
UNIT 3 & 4
POWER BLOCK EXCAVATION
4,708,035 C.Y.
PHASE II
UNIT
POWER BLOC
4,161,09
PHASE
COOLING TOWER #3
N 80+00
COOLING TOWER #4
EL 199
EL 190 BOTTOM OF EXCAV
N 71+40
℄ RAILROAD
BATCH PLANT AREA
CONSTRUCTION FACILITIES & STAGING
EXISTING DIRT ROAD
STOCKPILE "C"
900,000 C.Y.
N 80+00
DIS
EXISTING EBENEZER CHURCH ROAD
MAIN ACCESS ROAD
N 40+00
STOCKPILE "B"
4,000,000 C.Y.
3:1
10:1
300
290
280
270
260
250
240
230
175
200
225
250
260
275



1

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ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

SITE TOPOGRAPHY
CONSTRUCTION PHASE 1 & 2

FIGURE 4.3-2

4.4 EFFECTS ON ADJACENT WATER AND AQUATIC LIFE

4.4.1 EFFECTS ON ADJACENT WATER

The effects of construction activities on the Savannah River will be held to a minimum. The activities that will result in disturbance of the river are construction of a barge slip, river water intake structure, and outfall structure, excavation for which will cause localized temporary increases in sediment loads on the river.

It is assumed conservatively that 250 cubic yards of the excavated material in the river bank might become temporary sediment load on the river during the construction of the intake structure. Similarly, during construction of the barge slip and the outfall structure, 200 cubic yards and 100 cubic yards, respectively, of excavated material might become sediment load on the river. 1

The construction schedule calls for excavation in the river bank at these 3 structures during different years; therefore, the sediment load produced on the river during this construction will not be additive. The intake structure will be built approximately 400 ft. from the edge of the river. The barge slip will be built on the river bank and back from the river's edge; therefore, the portion of the bank exposed to the water is not disturbed during construction of these structures. After the structures are completed, the river bank will be excavated between the structures and the river. It is only during the bank excavation that additional silt and sediment material will be deposited in the river. 2

A study of grain size distribution of the excavated soil and of water velocity in the river shows that most of the soil will settle in a bottom area less than 60 feet wide and 400 feet long along the southerly river bank during construction of each of the 3 structures. A total of less than 100 cubic yards of soil is expected to be carried by the river in permanent suspension. 1

The material excavated from the river bank which is unsuitable for use as backfill will be placed on the disposal site near the power block. The river bank will be affected for a total length of less than 220 feet during construction of the intake structure, barge slip, and outfall structure.

Riprap will be placed as required to prevent erosion of the river bank and to keep the sediment load added to the river as low as possible. Construction activities will not interfere with navigation along the river nor cause any flooding. As construction is completed, the river bank will be restored by planting with appropriate grasses, shrubs, or trees to prevent erosion. The Soil Conservation Service of the U.S.D.A. has provided advice on this matter. 2

Beaverdam Creek, a small stream flowing along the southern boundary of the site, and Daniels Branch, a tributary to Beaverdam Creek, should not be affected by construction activities due to erosion control practices (described in Subsection 4.3.1). Two construction debris and silt basins will be built south of the power block, and there is an existing basin north of the power block. Those basins will catch runoff from the 1 construction area and allow silt and debris to settle out on the site rather than reach Beaverdam Creek, Daniels Branch, or the Savannah River.

During construction of VNP, a large number of workers (about 3800) are expected, and the sanitary waste flow is estimated to be as great as 40,000 gallons per day. Treatment for this waste will be provided by 2 package sewage plants of the extended aeration type. One plant, with capacity of 10,000 gpd, will remain in use during the operation of the power plant; the other plant, with capacity of 30,000 gpd, will be disconnected and removed after construction is completed. Until the package sewage treatment plants become operational(4 months after issuance of construction permit), portable temporary sanitary facilities will be furnished. 1

The effluent from the sewage treatment plants will have 95 percent of the suspended solids and biochemical oxygen demand removed. After the effluent of the sewage plants has been chlorinated, it will be discharged into the Savannah River with an expected chlorine residual of less than 1.0 ppm. These sewage plants and their effluent will meet all the requirements of the Georgia Department of Natural Resources, Environmental Protection Division.

1

4.4.2 EFFECTS ON GROUND WATER

Ground water affected during construction would be primarily in the semi-isolated, near-surface ground water aquifer. This ground water would be allowed to return to its own level upon completion of construction. The proposed use of water from the Tuscaloosa aquifer for construction purposes would be of limited quantity and duration.

The planned facilities would require several excavations of sizeable proportions. This would require dewatering of the sands above the marl in the interfluvial high. It is estimated that such dewatering would probably reduce the spring outflow at the Hancock Landing drainage but would not eliminate it. The excavations should have no effect on the Tuscaloosa Aquifer below the bearing horizon. The dewatering equipment will discharge to the silt and debris basins.

Construction of the plant should not have any lasting effect on the Tuscaloosa aquifer. The shallow ground water table aquifer will be affected during construction, but since it is within the exclusion radius of the plant, no known problem exists.

4.4.3 EFFECTS ON AQUATIC LIFE

There is no way to predict the increase in sediment load in the Savannah River during construction of VNP. Sediment basins described in Subsection 4.4.1 will be used to retard excessive silting of the river and Beaver Dam Creek swamp. Some adverse effects to the benthic fauna are expected in the portion of the river adjacent to the site. The river bottom generally is composed of shifting sand and hard clay. In general, sand is the poorest habitat, and rubble, gravel or mud mixed with sand support increased biomasses. Also, islands of rubble, trees, and debris in sandy areas are concentration points for the fauna. The above conditions were pointed out by Hynes (1) and are descriptive of GPC observations on the Savannah River.

Patrick, et. al. (2) reported that the center of the river bed was composed of loose sand which shifted easily with changing amounts of flow and that this heavy bed load was very deleterious to the development of suitable habitats for aquatic organisms. The Savannah River channel is maintained by intermittent dredging, and this adds to the instability of benthic conditions.

The effects of construction activities on the aquatic life of the Savannah River will be only short-term effects. Any bottom life in the area of excavating or dredging will be destroyed. Any life suspended or floating in the construction area will most likely be destroyed.

Samples were collected in the Savannah River with a modified Petersen dredge (125 cm^2) in April, May and July 1972. Densities of benthic invertebrates in the river were as follows (station locations are described in Subsection 2.7.9):

Station		
1	2600 individuals/m^2	1
3	2320 individuals/m^2	
4	3440 individuals/m^2	
5	13280 individuals/m^2	

These samples were taken in a mud substrate and represent greater densitites than those found in the sandy substrate which comprises most of the river bed.

Although some benthic organisms may be destroyed due to increased silt load, many will probably relocate. Organisms most likely to be affected are the filter feeding species which include mussels and the following insects: Chironomidae, Hydropsychidae and Simuliidae. Aquatic life that is capable of relocating, such as fish, is expected to do so. Wu[3] found that larvae of the blackfly, *Simulium*, move away from parts of sticks and vegetation on which silt is deposited, although current speed and other factors might be suitable for them. Harrison and Elsworth [4] found the nymphs of the mayfly *Pseudocloeon* only on vegetation without a coating of silt. Chutter [5] in a review of the literature reported that even though *Simulium* and *Pseudocloeon* do not tolerate silty surfaces, they are not adversely affected by silty water. Most of the literature concerned with the effects of silt and sand on aquatic fauna has dealt with stoney bottom types which were altered by the deposition of material, and in many instances the fauna of the streambed was considerably reduced.[6] Although the Savannah River bottom is not stoney, material added by construction activities still may alter the bottom in the vicinity of the site.

Results of GPC preoperational drift surveys will help identify spawning areas for American shad and striped bass. Drift form samples will show the relation of spawning activity to temperature, flow and time. A 1
count of sunfish nesting sites will be made in areas expected to be subjected to siltation. The increased sediment load in the river due to excavation and dredging will place stress on aquatic life downstream. However, this increase in sediment load will be only temporary and will 1
be kept to a minimum. The schedule for the excavation at the river bank is as follows: intake structure, June 1977; outfall structure, June 1978; 3
barge slip, November 1976. The schedule is flexible and is expected to be subject to adjustment to accommodate the most favorable spawning periods 1
of anadromous and other fishes. Installation and removal of temporary sheet piling is not expected to cause a permanent effect on aquatic life. Construction activities located in areas other than along the river bank should produce no significant effect on aquatic life due to the 3 debris and silt basins described in Subsection 4.4.1.

Although not abundant in this portion of the Savannah River, aquatic plants may provide some protection for fish fry. Aquatic plants are most likely to occur in sheltered areas, i.e. around spur dikes. Since, at this writing, the river elevation is about 10 feet above normal, and the plants have not regrown from the winter die-off, it is not feasible at this time to estimate the amount of plant material available to shelter small fish. Following are locations where macrophytes are likely to be found. 1

	Miles Approx. Distance Below Intake-Discharge-Bargeslip Area
Spur dike and river bank GA. side	.25
Spur dike S.C. side	.45
Spur dike GA. side	.75
Spur dike S.C. side	.90
Spur dike GA side	1.10
Spur dike S.C. side	1.30
River bank GA side	1.65
Spur dike S.C. side	3.35

Sanitary wastes discharged into the Savannah River should have little effect on aquatic life. Two sewage plants, as described in Subsection 4.4.1, will be used to treat these wastes.

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5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.1 EFFECTS OF RELEASED HEAT

5.1.1 EFFECTS OF HEATED EFFLUENT ON RIVER TEMPERATURES

Heated effluent from VNP will have a limited effect on the Savannah
River. Under normal operating conditions, the main cooling towers will
operate at 4 to 8 cycles of concentration. Table 5.1-1 shows the 1
minimum monthly river temperatures for the 11-year period ending in
1970. The dimensions of the mixing zone have not been determined. 1
Table 5.1-1 also shows calculated river temperatures,
including the discharge temperature, the river temperature assuming
mixing of the VNP discharge with 10 percent of the river, and the
river temperature assuming mixing of the discharge with 100 percent
of the river. The Δt's (i.e., the difference between the river
temperature after mixing with VNP discharge and the ambient river
temperature) associated with 10 percent and 100 percent mixing are
also included in this table. In Table 5.1-1, discharge temperatures
were calculated; river temperatures after mixing were calculated 1
using the following:

For mixing with 100 percent flow:

$$T_R = \frac{F_R T_I + 396\ T_D}{F_R + 396} \qquad \text{(Eq. 1)}$$

T_R = River temperature downstream ($^{\circ}$F)

T_I = Intake (ambient river) temperature ($^{\circ}$F)

T_D = VNP discharge temperature ($^{\circ}$F)

F_R = River flow (cfs)

396 = VNP discharge for 4 units (cfs) @ 3 cycles of concentration

$\Delta t = T_R - T_I$

For mixing with 10 percent flow:

Substitute $0.10F_R$ in place of F_R in equation (1).

Sample calculation (for month of June):

$$\text{(100 percent flow)} \quad T_R = \frac{(9,150)\ (64.0) + (396)\ (69.0)}{9,150 + 396} = 64.0$$

$$\Delta t = 64.0 - 64.0 = 0.0$$

$$\text{(10 percent flow)} \quad T_R = \frac{(915)\ (64.0) + (396)\ (69.0)}{915 + 396} = 65.5$$

$$\Delta t = 65.5 - 64.0 = 1.5$$

5.1.2 APPLICABLE THERMAL STANDARDS AND EFFECTS OF RELEASED HEAT ON AQUATIC ORGANISMS

The current state of Georgia thermal standards state: "Temperature: Not to exceed 90.0°F at any time and not to be increased more than 5°F above intake temperature."(1) Under normal operating conditions, the VNP discharge will meet all state standards. As can be seen in Table 5.1-1, under the worst expected conditions, and at 3 cycles of concentration, the state standards can be met after a short mixing zone.

Provisional maximum permissible temperatures established by the Environmental Protection Agency (EPA)(2) for various species of warm water fish are given in Table 5.1-2 and may be compared to lists of fishes of the Savannah River (Tables 2.7-32 through - 36). The maximum temperature of record in the Savannah River is 86°F, and the highest average monthly temperature for the 1960-1970 period is 76.8°F. Based on the calculated temperature after mixing (Table 5.1-1), average river temperatures will not exceed the provisional maxima recommended for fish growth. The maximum temperature for spawning of threadfin and gizzard shad, catfish, and buffalo is 80°F. During March, April, and May, the months of greater shad spawning,(3) mean river temperatures varied from 53 to 67°F. Assuming an operation of 4 units at 4 cycles of concentration, the average monthly discharge temperature will range from 53.3 to 67.6°F for the same time period. Most bass are spring spawners, and, after only 10 percent mixing, the temperature of the river will be within the temperature range recommended for bass spawning (Tables 5.1-1 and 5.1-2). Based on these data, no thermal barrier or other adverse effects to fish spawning are expected. 2

The very small temperature increases that VNP will cause in the Savannah River are below those that are harmful to aquatic life.(4-6)

RIVER TEMPERATURES (°F) AND D
CALCULATIONS BASED ON THE OPE

Month	River Flow Rate (cfs) F_R	Minimum Expected Intake Temperature T_I	Maximum Expected Cooling Tower Blowdown Temperature T_B
JAN.	12,200	41	84
FEB.	12,750	41	85
MAR.	15,800	43	85.5
APR.	16,450	53	86
MAY	11,350	59	89
JUNE	9,150	64	91
JULY	8,150	69	91
AUG.	7,600	72	92
SEPT.	8,000	69	90
OCT.	7,600	60	89.5
NOV.	7,050	51	89
DEC.	9,550	44	80.5

T_R = River Temperature Downstream fro

$\Delta t = T_R - T_I$

$\Delta t_B = T_B - T_I$

$\Delta t_D = T_D - T_I$

TEMPERATURES ROUNDED TO NEAREST HALF DEGR

Table 5.1-1

ISCHARGE TEMPERATURES, (^{O}F) AT VNP UNDER VARIOUS CONDITIONS.
RATION OF FOUR UNITS AT THREE CYCLES OF CONCENTRATION.

	Amount of Dilution Needed to have $\Delta t_B = 5^{O}$ (cfs)	VNP Discharge Temperature with Bypass Dilution		10% Mixing		100% Mixing	
Δt_B		T_D	Δt_D	T_R	Δt	T_R	Δt
43	550	49.0	8.0	43.0	2.0	41.0	0
44	565	49.5	8.5	43.0	2.0	41.5	0.5
42.5	545	51.0	8.0	44.5	1.5	43.0	0
33	405	59.5	6.5	54.5	1.5	53.0	0
30	435	64.0	5.0	60.5	1.5	59.0	0
27	390	69.0	5.0	65.5	1.5	59.0	0
22	320	73.0	4.0	70.5	1.5	69.0	0
20	290	76.0	4.0	73.5	1.5	72.0	0
21	305	73.0	4.0	70.5	1.5	69.0	0
29.5	430	65.5	5.5	62.0	2.0	60.5	0.5
38	550	58.0	7.0	53.5	2.5	51.5	0.5
36.5	530	52.5	8.5	46.5	2.5	44.5	0.5

m VNP Outfall

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Table 5.1-2

Provisional Maximum Temperatures Recommended as Compatible with the Well-being of Various Species of Fish and Their Associated Biota(2)

93°F: Growth of catfi[illegible], white or yellow bass, spotted bass, buffalo, ca[illegible]ker, threadfin shad, and gizzard shad.

90°F: Growth of largemouth bass, drum, bluegill, and crappie.

84°F: Growth of pike, perch, wall[illegible]allmouth bass, and sauger.

80°F: Spawning and egg development of catfish, buffalo, threadfin shad, and gizzard shad.

75°F: Spawning and egg development of largemouth bass, white, yellow, and spotted bass.

68°F: Growth or migration routes [illegible] salmonids and for egg development of perch and s[illegible]mouth bass.

55°F: Spawning and egg development of salmon and trout (other than lake trout).

48°F: Spawning and egg development of lake trout, walleye, northern pike, sauger, and Atlantic salmon.

5.1.3 EFFECTS OF INTAKE AND OUTFALL STRUCTURES

The VNP make-up water system at the Savannah River consists of an intake structure. At the front of the intake structure is a trash rack. In the intake structure are vertical traveling screens; screen mesh size of the traveling screen is 3/8-inch. Water velocity through the traveling screen is calculated to be less than 1.0 fps at the guaranteed minimum flow of 5800 cfs. 1

During operation of some power plants, fish mortality resulting from impingement on the traveling screen can occur. At VNP, the velocity through the traveling screen is less than 1 fps. Velocities of less than 1 fps greatly reduce the chances of fish mortality.(7-9) Due to the low intake velocity, it is not expected that significant mortality from impingement will occur at VNP. 1

Organisms less than 3/8-inch in size that happen to be in the cooling water intake will probably pass through the heat removal system. All of the organisms that pass through the heat removal system will be killed, due to the use of a closed cycle cooling tower system. The impact of entrainment depends on the proportion of the total river volume diverted through the cooling system.

At VNP, approximately 4.8 percent (490 cfs) of the river is diverted through the plant at an average flow of 10,150 cfs. Approximately 1.7 percent of the river (174 cfs) passes through the condenser. It is certain that organisms passing through the condenser will be harmed or killed, but it is not known what portion of the organisms in the bypass water (approximately 3.1 percent or 315 cfs of the average river flow) will be harmed or killed. The Corps of Engineers guarantees a minimum flow of 5800 cfs from Clark Hill Reservoir, and, under these conditions, approximately 8.4 percent of the flow will pass through the plant. Approximately 3 percent of this is cooling water.

Patrick, et. al., (10,11) sampled 2 stations on the Savannah River near VNP and found an average of 1249 phytoplankton cells/liter. *Melosira* was the most abundant organism. Assuming an average mass of 3.0×10^{-3} ug/cell, there are 13.7×10^{-6} grams of phytoplankton per gallon of river water. Under normal operating conditions (5 cycles of concentration), cooling water make-up is 76,000 gpm (170 cfs). This accounts for 581.4 kg (approximately 1300 lbs.) of phytoplankton killed per year due to thermal effects. No estimate can be made of attrition due to mechanical or chemical effects, but this should be small compared to attrition due to thermal effects. The amount of phytoplankton killed would support roughly 130 pounds of primary consumers (invertebrates and fish), which would, in turn, support roughly 13 pounds of carnivorous fish. A comparison of the relative importance of fish species in the Savannah River can be found in Tables 2.7-33 through -36. The most abundant plankton feeding fish in the Savannah is the gizzard shad, which is considered to be a "nuisance" fish.(12) The longnose gar, which accounts for the largest carnivore biomass, is also a nuisance fish. The channel catfish, an omnivore, accounts for the greatest biomass of any sport fish in the river. The spotted sucker, another omnivore, represents a great amount of biomass; it is also a nuisance fish. Since most primary consumers in flowing water depend primarily on allochthonous material (leaves from stream side trees), rather than autochthonous material (primary production in the water body), for their main food source,(13,14) the impact of VNP on fish production via primary production is considered to be negligible.

Under average and guaranteed low flow conditions, a small percentage of the total drift invertebrates and fish larvae will be affected. The river is at maximum flow in March, April, and May ($\bar{x}$=14, 533 cfs) when most shad eggs are drifting; therefore, only 3.4 percent should pass through the cooling system. Drift invertebrates (aquatic insects) are most abundant in spring when the river is at maximum flow and are least numerous in late summer when flows are lowest. Sportfish eggs are extremely adhesive, and very few are expected to be entrained. No data are presently available which would enable calculation of attrition of drift invertebrates, fish eggs, and fish larvae on a weight basis. Based on the proportion of river water which passes through the plant, and assuming a homogeneous distribution of organisms in the river, less than 4.8 percent of the organisms at average flow and 8.4 percent at low flow will be affected mechanically, chemically, or thermally by the plant due to entrainment.

Through the use of energy dissipators in the outfall canal, the velocity of discharge water will be approximately the average velocity of the river (3 fps). This should prevent scouring. Since energy dissipators will be used, the discharge velocities will be low enough that no adverse conditions should be caused by the outfall structure.

5.1.4 REACTOR SHUTDOWN

Four shutdowns per unit year are scheduled. Water is cooled prior to release during a scheduled shutdown. Approximately 8 unscheduled shutdowns per unit should occur per year. The thermal impact from these should be small. During unscheduled shutdown, heated water from the plant heat exchanger (14,000 gpm/unit) will be discharged if the cooling towers are not operating. After complete mixing, this water will be .09°F above the river ambient temperature at average flow (10,150 cfs) and .16°F above ambient at the low flow guaranteed by the Corps of Engineers from Clark Hill Reservoir (5,800 cfs). These temperature increases are within the 5°F range established by the EPA.(3) During scheduled shutdowns and during unscheduled shutdowns after the cooling towers are drained, there will be a slight drop in river temperature. Since the Δt's (Table 5.1-1) are so small, no "thermal shock" effects are expected from reactor shutdown.

5.1.5 ENVIRONMENTAL EFFECTS OF WET COOLING TOWERS

Mechanical draft wet cooling towers and natural draft wet cooling towers were evaluated in detail as the heat rejection alternatives for VNP. These tower alternatives will release water vapor to the atmosphere at a rate which varies from 2.0 (10^6) gm/sec on a cold winter morning to over 3.7 (10^6) gm/sec on a hot summer day. The potential environmental effects from the towers may include some modification of the local environment by increased frequency of fog formation, increased fog density, reduced visibility and icing on nearby objects when surface temperatures are below freezing. Analyses were performed to estimate these effects for each of the cooling tower alternatives.

With reference to Paragraph 2.6.2.2.5, the Augusta Airport meteorological data indicate that naturally occurring heavy fog (visibility of 1/4 mile or less) may occur 10 percent of the days throughout the year with a minimum frequency of about 1 day a month in the spring. Figure 2.6-18 summarizes the visibility for 5 years at Augusta Airport. Figure 2.6-14 illustrates variations in the monthly average and average daily extremes of relative humidity which may be expected in the region of VNP. The humidity data indicate that for most days of the year the natural moisture condition will exceed, for some portion of the day, a 90 percent relative humidity. Heavy fogs and high humidity conditions are normally associated with a stable atmospheric condition during the late night and early morning hours. A measure of the extent of high fogging potential of the VNP region is illustrated in Paragraph 2.6.2.2.5, where the data indicate a visibility of 4 miles or less for 12 percent of the total hours of the year.

There is today no tested analytical model which will permit precise, quantitative predictions of the fogging effects due to wet cooling towers. A TVA formula was developed from observations of natural draft cooling tower plumes which can be used with local meteorological data to estimate the length and frequency of occurrence of visible plumes. The formula has not been published, but the field program at the TVA Paradise Steam Station from which it was developed is described in (15). 1

The TVA formula for evaluating the potential environmental effects from cooling tower operations is based on field observations from August 1, 1970, to August 31, 1971, at the TVA Paradise Steam Plant in Kentucky. During this period, one or more of the 3 natural draft cooling towers were in operation on 122 days during all seasons in the year. Observations were made by the resident meteorologist, usually between 0730 and 0900 hours local time. These observations were augmented by the Paradise meteorological station and Nashville rawinsonde data.

Since the length of a visible cooling tower plume depends primarily on the moisture content of the ambient air, observed plume lengths at the Paradise Steam Plant cooling towers were correlated with the saturation deficit or the amount of moisture a parcel of air can contain at saturation for a specific dry-bulb temperature, less the actual amount of moisture present. Observed plume lengths and saturation deficits were fitted by the least squares method. A correction factor was applied for tower evaporation rate to allow the formula to be applied to plants whose emission rate differed from the Paradise Steam Plant. The equation is as follows:

$$L = (11{,}197 - [3816 \times D_w]) \times (Q_v/Q_p)^{1.32}$$

Where

L = plume length in feet

D_w = saturation deficit at plume height in grams per cubic meter 1

Q_v = vapor emission from towers of plant whose plume length is being predicted in grams per second

Q_p = vapor emission from Paradise Valley cooling towers (768,558 grams per second)

Two types of mechanical draft cooling towers were considered for possible use at the VNP. Depending upon the supplier, the use of standard crossflow mechanical draft cooling towers would require approximately twelve towers 73 ft. wide, 56 ft. high and 433 ft. long. This would result in 144 fans.

For such a large mechanical draft tower installation, it is felt that the TVA formula is not applicable because it would predict plume lengths of far greater magnitude than those which would actually occur. Major reasons for these unrealistic predictions are the facts that the formula does not allow for the entrainment of ambient air into each of the individual plumes and that use of the formula assumes that the plumes from each individual cooling tower combine into a single plume. In reality, only a portion of the plumes would normally combine for a given wind direction. Also, the TVA formula by itself gives no indication as to how high the mechanical draft tower plumes will initially rise. In the final analysis, it was plume rise, and not plume length, which was of greatest concern when evaluating mechanical draft cooling towers for the VNP, since visible plumes leaving the VNP site would normally be at an altitude of neutral buoyancy. For a plant of this size (four 3425 MW_t units) the concern was whether the plumes would be at sufficient altitude to have minor surface influence.

The physical layout of twelve standard mechanical draft towers is such that it is doubtful that the plumes would combine to give added buoyancy. Also, when the wind is blowing broadside to these box-shaped towers, the plume will be drawn closer to the ground by the downwind wake cavity of the tower. Because of the high natural humidity conditions at the VNP, both of these conditions could significantly increase onsite fogging.

The use of natural draft cooling towers would require four towers approximately 400 ft. in diameter and 500 ft. tall. Five years of 1500-2000 ft. upper air data from the U. S. Weather Bureau station of Athens, Georgia, were used with the TVA formula to calculate plume lengths. The plume length data were separated into sixteen 22-1/2 degree compass point sectors. The cases where visible plumes were masked by naturally occurring restricted visibilities and/or low ceilings were excluded. The results of the analysis were used to construct radial graphs which give the distance and number of hours of occurrence of visible plumes downwind from the plant. The results for natural draft cooling towers at the VNP are presented in Figures 5.1-1 (Annual) and 5.1-2 (January), where the plotted contours represent the number of hours of occurrence of visible plumes equal to, or greater than, the indicated distance for a given direction. It is significant to note in Figures 5.1-1 and 5.1-2 that the elevated plumes will seldom, if ever, be in the region of the Augusta Airport, which is about seventeen miles north-northwest of the VNP.

Based on the observations at the TVA Paradise Steam Plant, no increased density or frequency of ground fog resulting from natural cooling tower plumes is expected. During periods of natural fog, the air will be moderately stable; therefore, no mixing of the plume to ground level will likely occur. On the average, the plume rise is expected to range from 500 to 1000 feet above the 500 ft. towers. Because of the height of the natural draft towers and the moderate climate in the region of the VNP, direct contact icing and light fallout of freezing precipitation should rarely, if ever, occur.

Natural draft cooling towers were selected for the VNP because no increased frequency of ground fog, reduced visibility or icing is expected due to the operation of these towers. Due to the large size of the VNP (four 3425 MW_t units) and because of the high natural fogging potential of the region, it was decided that the moisture added to the lower atmosphere by standard mechanical draft towers would significantly increase the frequency of ground fog formation at the plant site.

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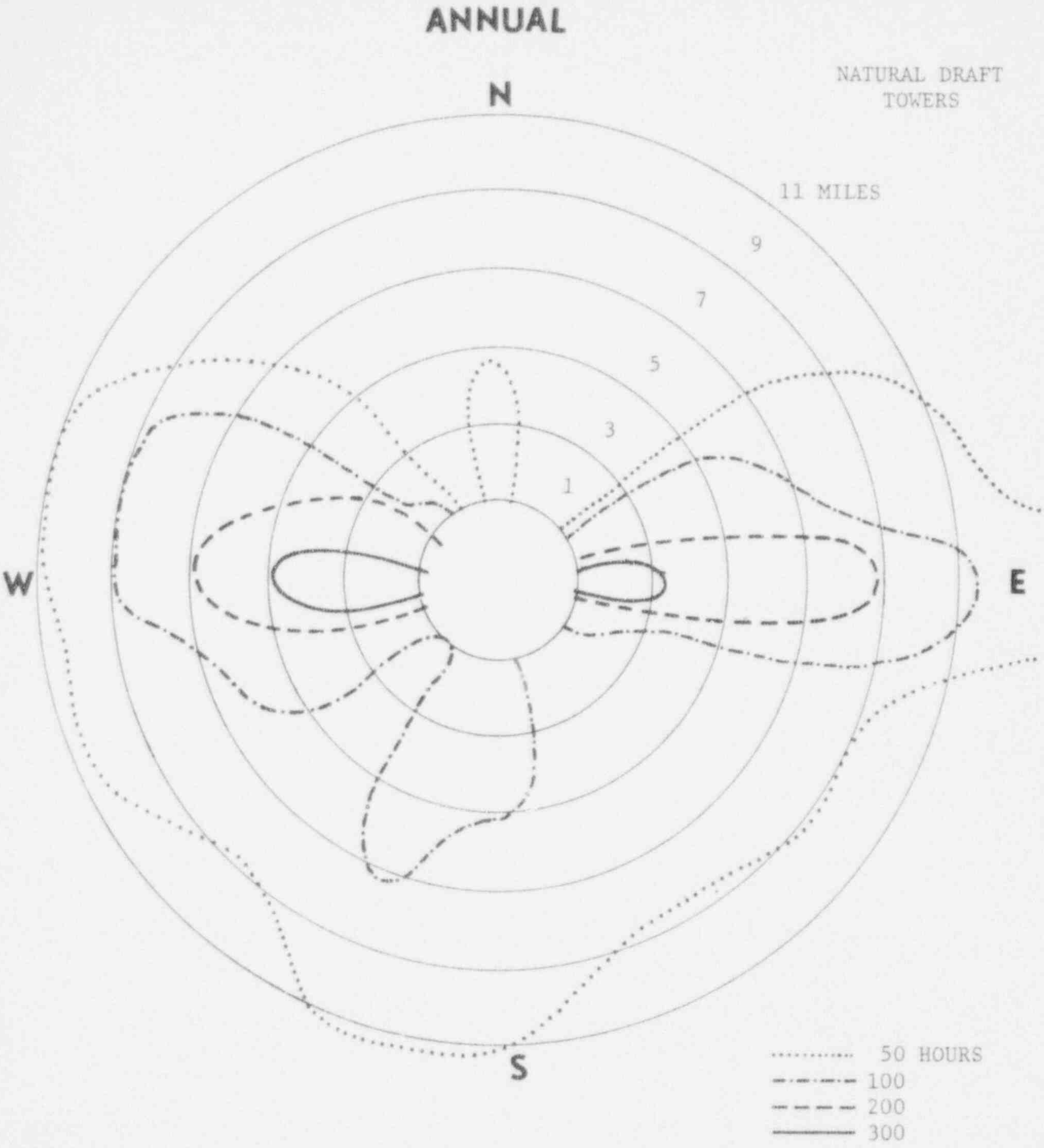


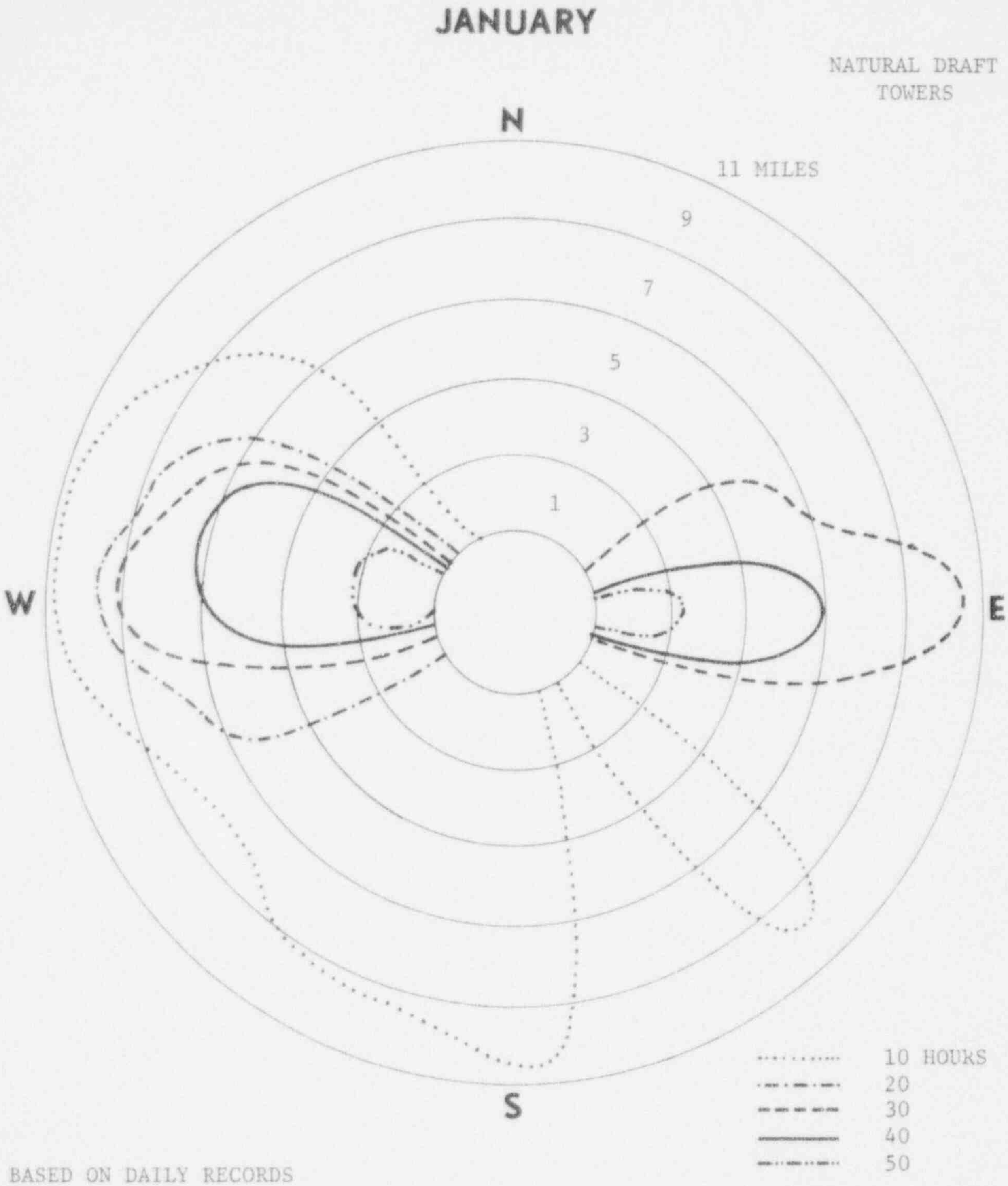
BASED ON DAILY RECORDS
JULY 1967-APRIL 1972

Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

NUMBER OF HOURS OF VISIBLE PLUMES
DOWNWIND FROM THE PLANT ANNUALLY

FIGURE 5.1-1



BASED ON DAILY RECORDS
JULY 1967-1972

Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

NUMBER OF HOURS OF VISIBLE PLUMES
DOWNWIND FROM THE PLANT IN JANUARY

FIGURE 5.1-2

5.2 EFFECTS OF RELEASED RADIOACTIVE MATERIALS

During normal operation of VNP, radioactive gaseous and liquid wastes will be generated. Only a small fraction of these will be released to the environment under controlled conditions in accordance with applicable regulations and the AEC operating license. Using this small fraction, and taking into consideration the measured climatology of the area, the river characteristics and principal modes of exposure, an estimate of the population exposure out to a 50-mile radius is developed. This estimate, the derivation of which is shown below, indicates that population exposure attributable to routine operation will be very small compared to that from natural background radiation.

Estimates of maximum individual exposure are also made and their derivations are shown below. Such exposures are small compared to limits in applicable regulations and compared to natural background (see Subsection 5.2.3).

Doses to organisms other than man are considered in Subsection 5.2.5.

5.2.1 ESTIMATES OF EXPOSURE DUE TO GASEOUS RELEASES

5.2.1.1 Source of Radioactive Gaseous Effluent

The radioactive waste gas processing systems will be designed to maintain gaseous releases to a level as low as practicable. In this report, it is assumed that, on the average, the plant will release the gaseous isotopes shown in Table 5.2-1.

5.2.1.2 Atmospheric Dispersion Estimates

Isopleths, which are lines on a map showing where equal long-term average ground level concentrations of materials released from the plant are expected, have been prepared using two years of weather data measured at the Savannah River Laboratory.

Using these isopleths which extend out to 50 miles, the average ground level concentration for released materials

Table 5.2-1

Estimate of Gaseous Releases from VNP for 4 Units

Nuclide	Curies Released/Year
Kr-85m	932
Kr-85	1,420
Kr-87	548
Kr-88	1,620
Xe-133m	828
Xe-133	44,000
Xe-135m	77
Xe-125	2,810
Xe-138	289
I-131	1

is approximated in each of sixteen 22 1/2° direction sectors at distances of 3/4, 1 1/2, 2 1/2, 3 1/2, 4 1/4, 7 1/2, 15, 25, 35 and 45 miles from the plant which represent the centers of the ten annuli used in making the evaluation of population exposure within a 50-mile radius.

5.2.1.3 Population Estimates

Population estimates were taken from Figures 2.2-2, 2.2-3, and 2.2-4, which give population estimates projected for 1997 in each of sixteen direction sectors. Each sector is separated into 10 rings corresponding to the annuli for which average annual ground concentrations are estimated as discussed in Paragraph 5.2.1.2 above.

5.2.1.4 Computation of Individual Exposure

5.2.1.4.1 Whole Body Gamma Dose

The whole body gamma dose to an individual (including each internal organ) in air is calculated using the semi-infinite cloud model:

$$D_j = (X/Q)(F_{wb})$$

$$F_{wb} = 0.25 \sum_{i=1}^{N} (A)_i (\overline{E})_i$$

D_j = Gamma dose for year (rem)

X/Q = Annual average atmospheric dispersion (sec/m^3)

N = Number of isotopes considered

A_i = Amount of i^{th} isotope released during the year (Ci)

$\overline{E}_i$ = Average gamma energy per disintegration (Mev/dis) of the isotope

$$F_{wb} = \text{Whole body gamma dose factor } \frac{\text{rem}}{\text{yr.}} \times \frac{m^3}{\text{sec.}}$$

(See Table 5.2-2 for work sheet.)

5.2.1.4.2 Surface Body Beta Dose

The beta dose to the surface of the body skin is calculated using the infinite cloud model$^{(2)}$ as follows:

$$D_B = (X/Q)(F_{be})$$

$$F_{be} = 0.23 \sum_{i=1}^{N} (A)_i (\bar{E}b)_i$$

where the symbols are the same as in Paragraph 5.2.1.4.1 except:

D_B = Beta dose for the year (rem)

$\bar{E}b_i$ = Average beta energy per disintegration (Mev/dis) of the i^{th} isotope

F_{be} = Beta dose factor $\frac{\text{rem}}{\text{yr.}} \times \frac{m^3}{\text{sec.}}$

(See Table 5.2-3 for work sheet.)

5.2.1.4.3 Dose Due to Inhalation

For internal exposure due to inhalation, annual doses to all organs may be considered to be much less than the thyroid dose. It is estimated that, as shown in Table 5.2-1, only a small amount of iodine may be released to the atmosphere. The greatest exposure from iodine will be the dose received by the thyroid.

The equation used for determining the thyroid dose due to inhalation of iodine is as follows:

$$D_I = (X/Q)(F_I)$$

$$F_I = (BR)(f_c)(A)$$

where: D_I = Whole body equivalent dose due to inhalation of iodine-131 during the year (rem/yr.)

Table 5.2-2

Work Sheet for Whole Body Gamma Dose Factor

Gaseous Isotope	A_i (Curies/Year)	$\overline{E}_i$ (Mev/dis)	$F_{wb} = 0.25 A_i E_i$ $\frac{\text{rem}}{\text{yr.}} \times \frac{\text{m}^3}{\text{sec.}}$
Kr-85m	932	0.179	41.9
Kr-85	1,420	0.003	1.1
Kr-87	548	1.067	146.2
Kr-88	1,620	2.069	837.9
Xe-133m	828	0.233	48.2
Xe-133	44,000	0.081	891.0
Xe-135m	77	0.530	10.3
Xe-135	2,810	0.264	185.4
Xe-138	289	0.420	30.3
I-131	1	0.389	0.097
			$\sum$ = 2162.1

Table 5.2-3

Work Sheet for Surface Body Beta Dose Factor

Gaseous Isotope	A_i (Curies/Year)	$\overline{Eb}_i$ (Mev/dis)	F_{be} $.23\ A_i\ \overline{Eb}_i$ $\frac{\text{rem}}{\text{yr.}}$ X $\frac{\text{m}^3}{\text{sec.}}$
Kr-85m	932	0.270	57.8
Kr-85	1,420	0.224	73.1
Kr-87	548	1.050	132.3
Kr-88	1,620	0.331	129.9
Xe-133m	828	0.0	0.0
Xe-133	44,000	0.115	1,163.8
Xe-135m	77	0.0	0.0
Xe-135	2,810	0.300	193.9
Xe-138	289	0.800	53.2
I-131	1	0.191	0.044
			$\sum$ = 1,804.0

X/Q = Average annual atmospheric dispersion (sec/m^3)

BR = Average breathing rate (m^3/sec)

f_c = Dose conversion factor for I-131 (rem/Ci)

A = Amount of I-131 released during the year (Ci)

F_I = Inhalation dose factor $\frac{rem}{yr.} \times \frac{m^3}{sec.}$

(See Table 5.2-4 for work sheet.)

5.2.1.4.4 Thyroid Dose Due to Ingestion of Iodine in Milk

For internal exposure due to ingestion of milk, annual doses to all organs may be considered to be negligible compared to the thyroid dose from iodine. Computation of dose due to ingestion of iodine is made considering that the most significant pathway to man would be through possible concentration of iodine in the "cow-milk" pathway. Studies have shown that for a given ground level atmospheric concentration the dose would be about 700 times the inhalation dose for certain population groups. However, the concentration factor would not be this high for the entire population exposed, thus a weighted average factor is computed taking into account differences in thyroid weight, breathing rate and amounts of milk consumed by age groups as follows:

(1) For the 1-10 year old age group the factor of 700 is used. About 20% of the population is estimated to be in this age group.

(2) For ages of 10 years and above a factor of 150 is estimated assuming that:

   (A) on the average about half as much milk is consumed per person;

   (B) the thyroid weight is 7.5 times greater; and

Table 5.2-4

Work Sheet for Inhalation Dose

Isotope	A (Curies/Year)	f_c Dose Conversion (Factor I-131) (rem/Ci)	BR Breathing Rate (m^3/sec)	F_I (A) (BR) (f_c) $\frac{rem}{yr.}$ X $\frac{m^3}{sec.}$
I-131	1.0	$1.46 \times 10^{+6}$	2.32×10^{-4}	343

(C) the breathing rate is 3.3 times higher than for the 1-10 year old group.

(3) The resulting population group weighted average concentration factor is:

$$(0.2 \times 700) + (0.8 \times 150) = 260.$$

The thyroid dose to the average population group from ingestion of iodine-131 is computed by multiplying the inhalation dose by the concentration factor as follows:

$$D_{IG} = (D_I)(f_{cm})$$

where: D_{IG} = Thyroid dose due to ingestion of iodine

D_I = Whole body equivalent dose due to inhalation of I-131 (rem/yr)

f_{cm} = Concentration factor in cow-milk pathway.

5.2.1.5 Computation of Total Population Exposure

The annual population dose (man-rem/yr) due to gaseous effluent was estimated for each annular sector by multiplying the exposure at the center of the sector by the population in the sector for the year 1997. This is done for each of the four types of exposure considered, i.e., whole body gamma, surface body beta, inhalation and ingestion. Then the total annual population dose for each type of exposure out to a radius of 50 miles is calculated by summing such doses for all annular sectors using the following relationship:

$$TD_{i,j} = \sum_{i=1}^{s} \sum_{j=1}^{d} D_{i,j} P_{i,j}$$

where: i = Subscript for direction sector

j = Subscript for annulus (population ring)

$TD_{i,j}$ = Annual total population dose for the particular type of exposure (man-rem/yr)

s = Number of direction sectors (16)

d = Number of annuli (10)

$D_{i,j}$ = = Gamma, beta, inhalation or ingestion dose (rem/yr)

$P_{i,j}$ = Population estimate for the year 1997 for each direction and annular section.

The results of these calculations are summarized in column (1) of Table 5.2-5.

5.2.1.6 Computation of Maximum Off-Site Exposure

The maximum off-site exposures to an individual due to routine gaseous effluent releases are computed using the methods described in Paragraph 5.2.1.4 above and the maximum average ground level concentrations at the site boundary. A value of $X/Q = 2.0 \times 10^{-6}$ sec/m^3 is used which corresponds to the highest estimated average value at any site boundary.

The maximum whole body gamma dose from Table 5.2-2 and equation (a)is computed as follows:

$$D_{\gamma\ max} = (X/Q)_{ave}\ (F_{wb}).$$

The maximum surface body beta dose from Table 5.2-3 and equation (b) is computed as follows:

$$D_{bmax} = (X/Q)_{ave}\ (F_{be}).$$

The maximum inhalation dose from Table 5.2-4 and equation (c) is as follows:

$$D_{Imax} = (X/Q)_{ave}\ (F_I).$$

Type of Exposure
From Gaseous Effluents:
Whole Body Gamma
Surface Body Beta
Inhalation*
Ingestion of Milk*
From Liquid Effluents:
Drinking Water**
Ingestion of Fish from the River
Ingestion of oyster and Clam Meat
Ingestion of Shrimp and Crab

---

* Dose given is fo

** These doses are

Results of Annual Exposure Calculations

(1) Annual Total Population Exposure (Man-rem/yr)	(2) Annual Average Exposure Per Capita (rem/yr)	(3) Annual Maximum Individual Exposure (rem/yr)
16.6	2.2×10^{-5}	4.3×10^{-3}
13.6	1.8×10^{-5}	3.6×10^{-3}
2.6	3.4×10^{-6}	6.8×10^{-4}
673.4	8.9×10^{-4}	1.17×10^{-2}
3.2×10^{1}	4.6×10^{-4}	6.8×10^{-4}
2.8×10^{-1}	3.8×10^{-7}	7.7×10^{-4}
6.7×10^{-1}	8.9×10^{-7}	5.5×10^{-5}
2.6×10^{-1}	3.4×10^{-7}	5.4×10^{-5}

r the thyroid gland.

for a specific population group living outside the 50-mile radius (see Section 5.2.2.3.2).

For an individual to receive these doses, he would have to remain, for the whole year, at the point of highest exposure on the site boundary. The realistic maximum exposure would be much lower.

The maximum exposure due to ingestion of milk is estimated assuming that the milk producing cows are located at the nearest dairy, 6 miles from the VNP site. The annual average X/Q at the site location is about 5×10^{-8} sec/m^3. A factor of 700 for concentration in the cow-milk pathway is used; no account is taken for reduction of dose due to pooling of milk. The maximum dose from above and Paragraph 5.2.1.4.3 is computed:

$$D_{IG\ max} = D_{I\ max} \times 700.$$

Results of these computations are given in column (3) of Table 5.2-5.

5.2.1.7 Computation of Average Population Exposure

Estimates of the average annual population exposure are made by dividing the total population exposure due to the given type exposure from column (1) of Table 5.2-5 by the total population within the 50-mile radius (756,000 people). Results are given in column (2) of Table 5.2-5.

5.2.2 ESTIMATES OF EXPOSURE DUE TO LIQUID RELEASE

5.2.2.1 Source of Radioactive Liquid Effluents

The liquid portion of the rad-waste system will be designed to maintain liquid releases to a level as low as practicable. The annual quantities of radioactive materials which are estimated to be released from all four units under the design basis conditions are listed in column (2) of Table 5.2-6.

5.2.2.2 Dilution in the Savannah River

Average concentrations of each isotope downstream of the plant are estimated for the Savannah River. The average Savannah

(1)	(2)	(3)	(4)	(5)	(6)
				Three Days	
Isotope	Quantity ** Released Annually (µCi)	Concentration in Savannah River and Estuary (µCi/cc)	MPC For Isotope (µCi/cc)	F_{cf} Concentration Factor For Fish Flesh	F_{cm} Concentration Factor For Molluscs
Cr-51	1.48(+3)	1.63(-13)	2.00(-3)	2.00(+2)	1.00(+3)
Mn-54	1.04(+3)	1.15(-13)	1.00(-4)	5.00(+1)	5.00(+4)
Mn-56	3.60(+2)	3.97(-14)	1.00(-4)	-	-
Fe-55	1.52(+3)	1.68(-13)	2.00(-3)	1.00(+1)	2.00(+3)
Fe-59	5.84(+3)	6.44(-13)	6.00(-5)	1.00(+1)	2.00(+4)
Co-58	4.88(+4)	5.38(-12)	1.00(-4)	1.00(+2)	3.00(+2)
Co-60	1.80(+3)	1.99(-13)	3.00(-5)	1.00(+2)	3.00(+2)
Br-84	1.20(+2)	1.32(-14	*	-	-
Rb-88	5.32(+3)	5.87(-13)	3.00(-6)	-	-
Rb-89	1.20(+2)	1.32(-14)	3.00(-6)	-	-
Sr-89	6.96(+3)	7.68(-13)	3.00(-6)	5.00	1.00
Sr-90	3.20(+2)	3.53(-14)	3.00(-7)	5.00	1.00
Sr-91	8.00(+1)	8.83(-15)	5.00(-5)	-	-
Sr-92	4.00(+1)	4.41(-15)	6.00(-5)	-	-
Y-90	4.00(+1)	4.41(-15)	2.00(-5)	-	-
Y-91	1.15(+4)	1.27(-12)	2.00(-5)	1.00(+2)	1.00(+1)
Y-92	4.00(+1)	4.41(-15)	6.00(-5)	-	-
Nb-95	1.80(+3)	1.99(-13)	1.00(-4)	3.00(+2)	2.00(+2)
Zr-95	1.36(+3)	1.50(-13)	6.00(-5)	5.00(+2)	1.00(+2)
Mo-99	1.64(+6)	1.81(-10)	4.00(-5)	-	-
I-131	2.00(+6)	2.21(-10)	3.00(-7)	1.00(+2)	1.00(+2)
I-132	9.84(+3)	1.09(-12)	8.00(-6)	3.00(+1)	-
I-133	3.90(+5)	4.30(-11)	1.00(-6)	-	-
I-134	2.44(+3)	2.69(-13)	2.00(-5)	-	-
I-135	6.68(+4)	7.37(-12)	4.00(-6)	-	-
Te-132	9.24(+4)	1.02(-11)	2.00(-5)	1.00(+1)	1.00(+2)
Te-134	1.20(+2)	1.32(-14)	*	-	-
Cs-134	5.88(+5)	6.49(-11)	9.00(-6)	5.00(+2)	1.00(+1)
Cs-136	1.86(+5)	2.05(-11)	6.00(-5)	5.00(+2)	1.00(+1)
Cs-137	2.92(+6)	3.22(-10)	2.00(-5)	5.00(+2)	1.00(+1)
Cs-138	2.52(+3)	2.78(-13)	3.00(-6)	-	-
Ba-140	4.76(+3)	5.25(-13)	3.00(-5)	5.00	3.00
La-140	2.40(+2)	2.65(-14)	2.00(-5)	-	-
Ce-141	1.12(+3)	1.24(-13)	9.00(-5)	1.00(+2)	1.00(+2)
H-3	2.70(+9)	2.98(-07)	3.00(-3)	1.00	1.00

* No value given in 10CFR20.

** Releases for all four units.

*** Concentrations in the estuary are assumed to be a factor of 3 lower than in the river. (Shown in column 3)

Table 5.2-6

Quantity of Finfish, Molluscs and Oysters Taken From the River System

(7) F ce ncentration actor For rustacea	(8) Individual Dose Due to Drinking 2200 cc of River Water Per Day (rem/yr)	(9) Individual Dose Due to Ingestion of 0.05 gm/day of Fish Flesh From Savannah River (rem/yr)	(10) Individual Dose *** Due to Ingestion of 0.164 gm/day of Oyster & Clam Meat (rem/yr)	(11) Individual Dose *** Due to Ingestion of 0.062 gm/day of Shrimp & Crab (rem/yr)
.00(+3)	4.08(-11)	1.86(-13)	1.0(-12)	3.70(-13)
.00(+4)	5.74(-10)	6.52(-13)	6.90(-10)	5.20(-11)
-	1.99(-10)	-	-	-
.00(+3)	4.19(-11)	9.53(-15)	2.03(-12)	1.52(-12)
.00(+3)	5.37(-09)	1.22(-12)	2.60(-09)	1.95(-10)
.00(+4)	2.69(-08)	6.12(-11)	1.95(-10)	2.44(-09)
.00(+4)	3.31(-09)	7.52(-12)	2.40(-11)	3.01(-10)
-	-	-	-	-
-	9.78(-08)	-	-	-
-	2.21(-09)	-	-	-
.00	1.28(-07)	1.45(-11)	3.10(-12)	1.15(-12)
.00	5.89(-08)	6.69(-12)	1.42(-12)	5.36(-13)
-	8.83(-11)	-	-	-
-	3.68(-11)	-	-	-
-	1.10(-10)	-	-	-
.00(+2)	3.17(-08)	7.21(-11)	7.70(-12)	2.88(-11)
0	3.68(-11)	-	-	-
.00(+2)	9.93(-10)	6.77(-12)	4.80(-12)	1.80(-12)
.00(+2)	1.25(-09)	1.42(-11)	3.03(-12)	1.13(-12)
-	2.26(-06)	-	-	-
.00(+2)	3.58(-04)	2.50(-07)	8.93(-07)	3.33(-07) 1
-	6.79(-08)	-	-	-
-	2.15(-05)	-	-	-
-	6.73(-09)	-	-	-
-	9.21(-07)	-	-	-
.00(+1)	2.55(-07)	5.79(-11)	6.16(-10)	3.32(-11)
-	-		-	-
.00(+1)	3.60(-06)	4.10(-08)	8.73(-10)	1.64(-09)
.00(+1)	1.71(-07)	1.94(-09)	4.13(-11)	7.76(-11)
.00(+1)	8.06(-06)	9.15(-08)	1.95(-09)	3.66(-09)
-	4.63(-08)	-	-	-
.00	8.75(-09)	9.95(-13)	6.36(-13)	2.38(-13)
-	6.62(-10)	-	-	-
.00(+2)	6.87(-10)	1.56(-12)	1.66(-12)	6.23(-13)
.00	4.97(-05)	1.13(-09)	1.20(-09)	4.50(-10)
	4.55 x 10^{-4}	3.84 x 10^{-7}	8.95x10^{-7}	3.40x10^{-7}

River flow is 10,150 cfs near the site. Average concentrations in the river are determined by dividing the annual release of each isotope by the annual river flow. The resulting river concentrations are shown in column (3) of Table 5.2-6. Concentrations in the estuary are assumed to be a factor of three lower than in the river, due to dilution from the ocean.

5.2.2.3 Pathways Considered

Significant pathways whereby radioisotopes released to the river could reach man have been investigated. There is no known use of the Savannah River for human drinking for a distance of about 103 river miles downstream of the plant. At approximately this distance, Jasper and Beaufort counties take about 7.5 mgd of river water for public use. Although this is not within the population group studied in this report, drinking water doses are nevertheless computed for this group, as discussed below. There is essentially no use of river water for irrigation of farm land downstream of the plant. The most significant pathway identified was through ingestion of fish taken from the river and through ingestion of seafood taken from the river estuary as the river enters the Atlantic.

5.2.2.3.1 Population Exposed Due to Drinking River Water

Jasper and Beaufort counties in South Carolina, (which lie outside the 50-mile radius being considered in the report) withdraw water from the Savannah River. The 1997 population of these two counties is estimated to be about 70,000.

5.2.2.3.2 Population Exposed through Eating Fish, Shrimp, Crabs, Oysters and Clams from the River and Estuary

The population group of interest for this study is that within a 50-mile radius of the VNP. There are projected to be about 756,000 people in this area in the year 1997. It is assumed that the amount of fish and seafood consumed in this population group is distributed equally.

5.2.2.4 Compilation of Doses to Individuals

Four significant pathways to man of radionuclides in liquid effluent have been identified in the river system. These include drinking water, the ingestion of fish, the ingestion of oyster and clam meat (molluscs), and the ingestion of shrimp and crab (crustaceans). The average annual amounts of each group estimated to be taken from the river system and estuary are given in Table 5.2-7.

Aquatic organisms concentrate certain elements which exist in the water and in the food they eat (generally living near or in the water). Therefore, the fish or seafood consumed may have a higher concentration of certain radioactive isotopes than is present in the water. To account for this, estimates are made of concentration factors for fish and for each type of seafood as shown in columns (5), (6), and (7) of Table 5.2-6. These are based on preliminary studies made on fresh water fish. For molluscs and crustaceans which live in marine environments, the factors reported by Freke(3) were used.

A survey is now underway for the Savannah River system to determine the extent to which organisms in the river concentrate elements of interest. When these studies are complete, they will provide information specific to the Savannah River system. Isotopes with half-lives less than three days were not considered since it is judged that they would have decayed to insignificant levels by the time they were ingested by humans.

For internal exposure due to ingestion of water and aquatic organisms, reference doses (equivalent to whole body doses) are calculated assuming that consumption of 2.2 liters per day of water containing any one isotope, in a concentration equal to $PMPC_w$(8) would result in an annual reference dose of 0.5 rem.

Values of $PMPC_w$ for iodine isotopes, the only significant contributors to thyroid dose, would result in an annual dose of 1.5 rem to the thyroid of an infant consuming 1.0 liters/day.(9) The annual dose to the thyroid of an adult consuming 1.0 liters per day at a concentration equal to $PMPC_w$ for any one iodine isotope would be 0.15 rem because the adult thyroid is ten times heavier than the infant thyroid. The annual dose to the thyroid of an infant consuming quantities of water and aquatic organisms specified herein may be obtained by multiplying the reference doses listed in Table 5.2-5, p. 5.2-11, by 2.2/1 x 1.5/0.5, or by approximately six. However, it must be realized that the specified consumption rates are certainly not applicable to infants. Infants are

Table 5.2-7

Estimated Annual Quantity of Fish and Shellfish Taken From the River System and Estuary

Category	Quantity*
Fish from Savannah River	200,000 lbs.
Oysters & Clams (Mollusk)	500,000 lbs. (meat)
Shrimp & Crab (Crustacea)	150,000 lbs.

*These estimates are based on creel census reports and commerical catch data from similar areas. At present, taking certain types of fish, oysters and other seafood from the river and estuary is illegal or limited.

not likely to consume any aquatic organisms and water consumption would probably not exceed 1 liter/day. In this case the annual dose to the thyroid of an infant would exceed the reference dose from water ingestion by a factor approximately equal to three. The annual dose to the thyroid of an adult consuming daily quantities of water and organisms specified herein may be obtained by multiplying the reference doses listed in Tables 5.2-5 and 5.2-6 by a factor of $\frac{2.2}{1} \times \frac{0.15}{0.5}$, or approximately 0.6.

Values of $PMPC_w$ for Sr-89 and Sr-90, probably the only significant contributors to bone dose, result in an annual bone dose of 1.5 rem assuming consumption of 2.2 liters/day of water containing either isotope at $PMPC_w$.(9) The annual bone dose may be obtained by multiplying reference doses listed in Tables 5.2-5 and 5.2-6 by a factor of 1.5/0.5, or three.

$PMPC_w$ values for other organs result in annual doses limit of 1.5 rem for other organs. Therefore, annual doses to other organs will exceed the calculated reference doses listed in Table 5.2-5 and 5.2-6 by a factor not exceeding 1.5/0.5=3.

5.2.2.4.1 Dose Due to Drinking Water

It is assumed that each person drinks 2200 cc of river water per day and that no further dilution occurs after leaving the plant area. The annual dose is computed as follows:

$$D_{DW} = \sum_{i=1}^{N} \frac{(C)_i\,(0.5)}{M\,P\,C_i}$$

where: D_{DW} = Dose due to drinking water (rem/yr)

C_i = Average concentration of isotope in water (Ci/cc)

i = Isotope

N = Number of isotopes

0.5 = Dose (rem) due to drinking 2,200 cc/day of water at MPC concentration

MPC_i = Maximum permissible concentration of isotope in water (μCi/cc)

Doses due to drinking water are given in column (8) of Table 5.2-6.

5.2.2.4.2 Dose Due to Ingestion of Fish

From Table 5.2-6, for the purposes of calculation, the amount of fish caught in the river is estimated to be 200,000 lbs. per year. It is assumed that the edible portion of this fish is one-third of the total weight and that one-half this amount is consumed by the population group of interest (756,000 people within the 50-mile radius). Each exposed person would, therefore, consume on the average 0.05 gram of fish flesh per day.

To compute doses through fish ingestion the following relationships are used:

$$D_f = \sum_{i=1}^{N} \frac{(C)_i (F_{cf})_i (W)(0.5)}{(2200)\ (MPC)_i}$$

where: D_f = Dose due to ingestion of fish (rem/yr)

i = Isotope

N = Number of isotopes

C_i = Concentration in water (μCi/cc)

F_{cf_i} = Concentration factor in fish flesh of i^{th} isotope

W = Weight of fish flesh consumed per day (grams)

0.5 = Dose due to drinking 2200 cc/day of water at MPC concentration

2200 = Average amount of water ingested per day (cc/day)

MPC_i = Maximum permissible concentration of isotope in water (μCi/cc)

Doses due to ingestion of fish are given in column (9) of Table 5.2-6.

5.2.2.4.3 Dose Due to Ingestion of Molluscs

At present oyster and clam harvesting is limited in the estuary; however. in the future this could become an important pathway. Therefore, dose estimates are made using the following assumptions.

From Table 5.2-7, the amount of oysters and clams (molluscs) estimated to be taken from the bay is about 5.0×10^5 lbs. (meat) per year. It is assumed that most of this meat would be exported and only 20% consumed by the 756,000 people within the 50-mile radius. Each person would, therefore, consume on the average about 0.164 gm/day of oyster and/or clam meat.

Doses due to ingestion of oysters and clams are computed using the equation of Paragraph 5.2.2.4.2 and are shown in column (10) of Table 5.2-6.

5.2.2.4.4 Dose Due to Ingestion of Crustaceans

From Table 5.2-7, the amount of shrimp and crab (crustaceans) taken from the bay is estimated to be about 150,000 lbs. per year. It is assumed that about 25% of this amount is consumed by the 756,000 people within the 50-mile radius. Each person would. therefore, consume on the average about 0.062 gram of shrimp and crab from the estuary per day.

Doses due to ingestion of shrimp and crab are computed using the equation of Paragraph 5.2.2.4.2. and are shown in column (11) of Table 5.2-6.

5.2.2.5 Computation of Total Population Exposure through Ingestion

The total population dose (man-rem/yr) to groups exposed by ingestion of fish and seafood is obtained by multiplying the individual doses for drinking water and ingestion of each type of food given at the bottom of columns (8), (9), (10) and (11) in Table 5.2-6 by the population so exposed as follows:

$$PD_f = D_f \times P_f$$

where: PD_f = Total population exposure due to eating fish and seafood (man-rem/yr)

D_f = Average individual dose due to eating fish and seafood (rem/yr)

P_f = Population that eats fish and seafood from the river system.

Results of these calculations are shown in column (1) of Table 5.2-5.

5.2.2.6 Computation of Maximum Individual Exposure

The maximum exposed individual due to drinking river water is estimated assuming that he drinks one and one-half the average human consumption of water per day or 3300 cc. Thus, the value in column (8) of Table 5.2-6 is multiplied by a factor of one and one-half.

The maximum exposured individual through ingestion of fish is assumed to be a person who eats 100 grams per day of fish caught from the Savannah River. This is about four times the average per capita consumption of fish in the United States. It is further assumed that the individual eats an additional 10 grams of oysters or clams and 10 grams of shrimp or crab per day taken from the estuaries. The maximum individual exposure due to ingestion of fish flesh is obtained by multiplying the value at the bottom of column (9) of Table 5.2-6 by 100/0.05 or the ratio of assumed maximum to average consumption (grams) of fish per day.

The maximum individual exposure due to mollusc ingestion is computed by multiplying the value at the bottom of column (10) of Table 5.2-6 by (10/0.164) or the maximum to average consumption.

The maximum individual exposure due to ingestion of crustacea is computed using column (11) of Table 5.2-6 in the same manner as for molluscs, using the ratio 10/0.062 to represent the maximum to average consumption.

The results of the above computations are given in column (3) of Table 5.2-5.

5.2.2.7 Computation of Average Population Exposure

The average annual exposure of the population within a 50-mile radius due to ingestion of fish and seafood is estimated by dividing the total population exposure from column (1) of Table 5.2-5 by the total population within this radius (756,000 people). The results are shown in column (2) of Table 5.2-5.

5.2.3 EFFECTS OF OPERATION OF VNP

5.2.3.1 Comparison of Average Exposure with Natural Background

The natural background radiation exposure for the station area is estimated to be about 0.125 rem/yr.(4) If this exposure is compared to the average per-capita exposure due to plant operation from column (2) of Table 5.2-5, it is seen that plant operations would increase the exposure due to natural radiation by only a small fraction.

5.2.3.2 Comparison of Total Population Exposure with Natural Background

The total population exposure due to natural background is obtained by multiplying the average individual exposure due to natural background (0.125 rem/yr) by the total population in the 50-mile radius. The resulting exposure is 94,500 man-rem/yr. Comparison of this exposure with the exposure from operation of the unit given in column (1) of Table 5.2-5 shows that the plant would increase the total population exposure by an insignificant amount.

5.2.3.3 Comparison of Maximum Individual Exposure with Applicable Regulations

The Federal Regulations concerning limits of exposure of individuals are set forth in 10CFR20. The limit for "non-occupational" whole body exposure is presently set at 0.5 rem/yr. The maximum computed exposure to an individual shown in column (3) of Table 5.2-5 is below this limit.

5.2.4 DOSES TO PERSONS ENGAGING IN RIVER ACTIVITIES

Doses were calculated for swimmers, boaters, and persons engaging in river bank activities such as picnicking, fishing, etc. Population doses were not calculated because only a few people are involved in these activities.

5.2.4.1 Skin Dose from Swimming

Column 4 of Table 5.2-8 gives the water immersion skin dose rate for each isotope in liquid effluent after full dilution by the Savannah River. Dose conversion factors were obtained from WASH-1209.(10) The skin dose conversion factor for Na-24 was used for isotopes not listed in WASH-1209. Examination of decay schemes for these isotopes indicates that skin dose conversion factors for these isotopes would not exceed the factor for Na-24. The total water immersion skin dose rate is 1.4×10^{-9} rem/hr. Assuming 1% occupancy (88 hours per year), the annual skin dose would be 1.2×10^{-7} rem/yr. for a swimmer.

5.2.4.2 Whole Body Dose from Swimming

Column 6 of Table 5.2-8 gives the water immersion whole body dose rate for each isotope in liquid effluent after complete dilution in the Savannah River. Dose conversion factors were obtained from WASH-1209.(10) The whole body dose conversion factor for Na-24 was used for isotopes not listed in WASH-1209. Examination of decay schemes for these isotopes indicates that whole body dose conversion factors for these isotopes will

TABLE 5.2-8
(Page 1 of 2)
WATER IMMERSION DOSE RATES

(1) ISOTOPE	(2) Cw RIVER CONC (pci/cc)	(3) WATER IMMERSION SKIN DOSE FACTOR (rem/hr/pci/cc)	(4) WATER IMMERSION SKIN DOSE RATE (rem/hr)	(5) WATER IMMERSION WHOLE BODY DOSE FACTOR (rem/hr/pci/cc)	(6) WATER IMMERSION WHOLE BODY DOSE RATE (rem/hr)
Cr-51	1.6(-13)	6.4(-2)	1.0(-14)	5.2(-2)	8.3(-15)
Mn-54	1.1(-13)	1.8(0)	2.0(-13)	1.5(0)	1.6(-13)
Mn-56	3.9(-14)	9.3(0)*	3.6(-13)	7.9(0)*	3.1(-13)
Fe-55	1.7(-13)	3.6(-4)	6.1(-17)	6.4(-5)	1.1(-17)
Fe-51	6.4(-13)	2.6(0)	1.7(-12)	2.2(0)	1.4(-12)
Co-58	5.4(-12)	2.3(0)	1.2(-11)	1.8(0)	9.9(-12)
Co-60	2.0(-13)	5.4(0)	1.1(-12)	4.6(0)	9.2(-13)
Bi-84	1.3(-14)	9.3(0)*	1.2(-13)	7.9(0)*	1.0(-13)
Rb-88	5.8(-13)	9.3(0)*	5.4(-12)	7.9(0)*	4.6(-12)
Rb-81	1.3(-14)	9.3(0)*	1.2(-13)	7.9(0)*	1.0(-13)
Sr-89	7.7(-13)	5.4(-1)	4.2(-13)	4.6(-3)	3.5(-15)
Sr-90	3.5(-14)	1.5(-1)	5.2(-15)	5.4(-4)	1.9(-17)
Sr-91	8.8(-15)	9.3(0)*	8.3(-14)	7.9(0)*	7.0(-14)
Sr-92	4.4(-15)	9.3(0)*	4.1(-14)	7.9(0)*	3.5(-14)
Y-90	4.4(-15)	9.6(-1)	4.2(-15)	1.3(-2)	5.8(-17)
Y-91	1.3(-12)	9.3(0)*	1.2(-11)	7.9(0)*	1.0(-11)
Y-92	4.4(-15)	9.3(0)*	4.1(-14)	7.9(0)*	3.5(-14)
Nb-95	2.5(-13)	1.6(0)	3.2(-13)	1.4(0)	2.8(-13)
Zr-95	1.5(-13)	1.8(0)	2.7(-13)	1.4(0)	2.1(-13)

TABLE 5.2-8
(Page 2 of 2)
WATER IMMERSION DOSE RATES

(1) ISOTOPE	(2) Cw RIVER CONC (pci/cc)	(3) WATER IMMERSION SKIN DOSE FACTOR (rem/hr/pci/cc)	(4) WATER IMMERSION SKIN DOSE RATE (rem/hr)	(5) WATER IMMERSION WHOLE BODY DOSE FACTOR (rem/hr/pci/cc)	(6) WATER IMMERSION WHOLE BODY DOSE RATE (rem/hr)
Mo-99	1.8(-10)	9.1(-1)	1.6(-10)	4.7(-1)	8.4(-11)
I-131	2.2(-10)	9.5(-1)	2.1(-10)	6.8(-1)	1.5(-10)
I-132	1.1(-12)	5.5(0)	6.0(-12)	4.4(0)	4.8(-12)
I-133	4.3(-11)	1.5(0)	6.4(-11)	9.6(-1)	4.1(-11)
I-134	2.7(-13)	9.6(0)*	2.6(-12)	7.9(0)*	2.1(-12)
I-135	7.4(-12)	4.0(0)	3.0(-11)	3.3(0)	2.4(-11)
Tc-132	1.0(-11)	4.8(-1)	4.8(-12)	4.0(-1)	4.0(-12)
Tc-134	1.3(-14)	9.6(0)*	1.2(-13)	7.9(0)*	1.0(-13)
Cs-134	6.5(-11)	3.5(0)	2.3(-10)	2.9(0)	1.9(-10)
Cs-136	2.1(-11)	9.6(0)*	2.0(-10)	7.9(0)*	1.7(-10)
Cs-137	3.2(-10)	1.4(0)	4.5(-10)	1.0(0)	3.2(-10)
Cs-138	2.8(-13)	9.6(0)*	2.7(-12)	7.9(0)*	2.2(-12)
Ba-140	5.3(-13)	7.6(-1)	4.0(-13)	4.6(-1)	2.5(-13)
La-140	2.7(-14)	5.3(0)	1.4(-13)	4.1(0)	1.1(-13)
Ce-141	1.2(-13)	2.4(-1)	2.9(-14)	1.3(1)	1.6(-14)
H-3	3.0(-07)	0	0	0	0
			$\sum$ = 1.4 (-9)		$\sum$ = 1.0 (-9)

* Isotopes marked with asterisk use dose factor for Na-24

not exceed the value of the factor for Na-24. The total water immersion whole body dose rate is 1.0×10^{-9} rem/hr. Assuming 1% occupancy (88 hours per year), the annual whole body dose would be 8.8×10^{-8} rem/yr. for a swimmer.

5.2.4.3 Whole Body Gamma Dose from Shoreline Activities

Areal sediment deposition (uCi/m^2 of Cs-134 and Cs-137) is calculated in Pagraraph 5.2.6.5. A recent AEC Report$^{(11)}$ gives constants relating areal deposition of a nuclide and whole body dose rate at 1 meter above the deposit. The constants include a correction factor of 0.5 to account for dose rate reduction due to surface roughness. This analysis uses the value for Cs-137 since approximately 83 percent of the total Cs-134 and Cs-137 is Cs-137. The value for Cs-137 is 4.1×10^{-6} rem/hr /u Ci/m^2. For a river bank occupation time of 500 hours per year and an areal deposition of 5.7×10^{-2} uCi/m^2, the whole body dose from river bank activity is

$$\begin{aligned} WBD_{Riverbank} &= 5 \times 10^{2} \times 4.1 \times 10^{-6} \times 5.7 \times 10^{-2} \text{ rem/yr.} \\ &= 1.2 \times 10^{-4} \text{ rem/yr.} \end{aligned}$$

5.2.4.4 Whole Body Gamma Dose from Boating

The annual whole body gamma dose at the surface of the river is expected to be approximately half the dose for the swimmer, or 4.4×10^{-8} rem/yr., assuming 1% occupancy. A person working fulltime (2000 hr/yr) on the river (none are know) would receive 1.0×10^{-6} rem/yr. A person living on the river would receive about 4.4×10^{-6} rem/yr. (none are known). This evaluation assumes no shielding effect from boat hulls or other structural materials.

5.2.5 EXPOSURE TO ORGANISMS OTHER THAN MAN

Releases of low-level radioactive liquid wastes to the Savannah River will result in exposure of aquatic organisms to radiation. These organisms will receive both an external radiation dose from living in the water and an internal radiation dose from radionuclides ingested in their food. Releases of radioactive gaseous wastes similarly will result in exposure of terrestrial organisms to both an internal and external radiation. Estimates of the doses to aquatic and terrestrial organisms at VNP have been made in this subsection.

Annual internal doses were calculated for fish and plants exposed to VNP liquid effluents diluted by the Savannah River. The annual dose to a typical local waterfowl which would feed on plants growing in the river was also calculated. The dose to migratory fowl would be less than that to local waterfowl. The results are:

Organism	Annual Internal Dose	Annual External Dose
Aquatic Plant	$2.2x10^{-2}$rad/yr	$8.8x10^{-6}$rad/yr
River Fish	$2.4x10^{-2}$rad/yr	$8.8x10^{-6}$rad/yr
Local Waterfowl	$7.4x10^{-3}$rad/yr	$4.3x10^{-3}$rad/yr

Annual external doses for plants and fish can be estimated as 100 times the annual whole body dose received by a person swimming 1% of the time. This value, calculated elsewhere, is $8.8x10^{-8}$ rem/yr. The corresponding annual dose to fish and plants would be $8.8x10^{-6}$ rad/yr.

The annual external dose for waterfowl can be estimated as one-half the annual dose for fish and plants plus the annual cloud dose received by a person. The external dose rate for waterfowl would not exceed $4.3x10^{-3}$ rad/yr.

The doses calculated above are below those expected to impair the health of the organisms. Two recently published reviews support this conclusion.(6, 7)

The technique for calculating internal dose rates to the organisms is described below.

5.2.5.1 Calculation of Internal Dose Rates to Organisms Other than Man

General Expression for Dose Rate to an Organism

For one isotope:

$$(R_{dose})_{org} = K\, C_{org} E_{eff}$$

$(R_{dose})_{org}$ = dose rate (rad/yr) from radioactive material distributed homogeneously throughout the mass of the organism

C_{org} = concentration of an isotope in the organism (uCi/g)

E_{eff} = effective energy absorbed in the organism per disintegration (Mev/dis)

K = constant of proportionality translating from $\frac{uCi\ Mev}{g\ dis}$ to rad/yr

$$K = 1x10^{-2} \frac{rad\text{-}g}{erg} x\ 2.2x10^{6} \frac{dis}{min\text{-}uCi} x\ 1.6\ x10^{-6} \frac{erg}{Mev} x5.3x10^{5} \frac{min}{yr}$$

$$K = 1.87\times10^{4} \text{ rad/yr per } \frac{\text{uCi-Mev}}{\text{g-dis}}$$

So,

$$(R_{dose})_{org} = 1.87\times10^{4} \; C_{org} \, E_{eff} \, \frac{\text{rad}}{\text{yr}} \tag{1}$$

5.2.5.2 Dose Rate to Aquatic Organisms from a Single Isotope

For organisms living in water C_{org} is proportional to concentration of isotope in water C_w, at equilibrium. The constant of proportionality is $(F_{conc})_{org}$, the concentration factor. Equation (1) is rewritten:

$$(R_{dose})_{org} = 1.87\times10^{4} \, C_w \, (F_{conc})_{org} \, E_{eff} \tag{2}$$

where C_w = concentration of isotope in water $(\frac{\text{uCi}}{\text{cc}})$

$(F_{conc})_{org}$ = equilibrium ratio of concentration of isotope in organism to concentration of isotope in water (cc/g)

and other terms remain as previously defined. E_{eff} depends upon the size of the organism. These evaluations assume a 1,000 gram organism (either plant or animal) with an effective radius of 10 cm. Values of E_{eff} for the human lung were obtained from ICRP 2(12) to represent E_{eff} in the organisms. For those isotopes not treated in ICRP 2, the decay scheme was examined to estimate a value for E_{eff}. Since these isotopes are usually present in low concentration and have very short half-lives, precise calculations of E_{eff} were not made. A conservative value, such as the value of the maximum beta energy, was selected. It should be noted at this point that doses to organisms smaller than the organism evaluated herein will be smaller than doses calculated above, because E_{eff} will be smaller for smaller organisms. It is unlikely, however, that doses to larger organisms will be significantly greater than doses calculated above.

5.2.5.3 Dose Rate to Waterfowl from a Single Isotope

The equilibrium concentration of an isotope in waterfowl which eats aquatic vegetation is

$$C_{waterfowl} = \frac{C_{plant} \times R_{cons} \times (F_u)_{waterfowl}}{\lambda_{eff} \quad M_{org}} \tag{3}$$

where,

C_{plant} = concentration of an isotope in aquatic vegetation (uCi/g)

R_{cons} = plant consumption rate (taken as 0.1 the body mass of the waterfowl, or 100 g/day in this evaluation) (g/day)

(F_u) waterfowl = fraction of ingested nuclide retained in the body of the waterfowl. Values are obtained from Table 5.2-9

Table 5.2-9

Uptake of Elements by Waterfowl

Element	$(F_u)_{waterfowl}$*
Lanthanides & Actinides Be, Sc, Ti, Cr, Ga, Ge, Y, Zr, Nb, Cd, In, La	0.01
Elements with Z = 1 to Z = 19 (excluding Be, Mg, and Al), and Se, Br, Kr, Rb, Mo, I, Xe, Cs, Hg, At, Fr	1.00
All others	0.50

*F_u =fraction of initial ingested activity retained in animals, body. Values from Reichle, et al.(13)

λ_{eff} = removal constant for the fraction initially retained (d^{-1}).

M_{org} = mass of waterfowl (1000 gm)

$C_{waterfowl}$ = concentration of isotope in waterfowl (uCi/g)

For most isotopes in these evaluations, λ_{eff} is taken as λ_r, the radiological decay constant, or $5.5 \times 10^{-5}\ d^{-1}$ (T_{eff}=50yr), whichever is greater. Better estimates of λ_{eff} are used for Cs-137, Cs-134, and H-3. Reichle, et. al.,(13) give estimates of the biological half-life, T_b, of stable cesium as a function of body weight for several types of organisms. The value of T_b for a one-kilogram vertebrate would be approximately 18 days. The biological decay constant is $\lambda_b = 0.693/T_b$, or $3.8 \times 10^{-2}\ d^{-1}$. For Cs-137 and Cs-134, $\lambda_{eff} = \lambda_b + \lambda_r$. For H-3, the ICRP value of λ_{eff} for the standard man,(12) $5.5 \times 10^{-2} d^{-1}$ (T_{eff}=12 d), is used on the assumption that water metabolism is not likely to differ significantly in other organisms.

$\lambda_{eff} = 0.693/T_{eff}$, where T_{eff} is the effective half-life in days, so equation (3) may be restated:

$$C_{waterfowl} = \frac{1.4\ T_{eff} \times C_{plant} \times R_{cons} \times (F_u)_{waterfowl}}{M_{org}} \qquad (4)$$

Equation (4) may be substituted into equation (1):

$$(R_{dose})_{waterfowl} = \frac{1.4 \times 1.87 \times 10^4}{M_{org}} \left\{ T_{eff}\ R_{cons}\ (F_u)_{waterfowl}\ E_{eff}\ C_{plant} \right\} \qquad (5)$$

The waterfowl mass, M_{org} is 1000 gm, R_{cons} is 100 gm/day, T_{eff} is more conveniently expressed in years, so equation (5) may be simplified:

$$(R_{dose})_{waterfowl} = 9.4 \times 10^5\ T_{eff}\ E_{eff}\ (F_u)_{waterfowl}\ C_{plant} \qquad (6)$$

where units are

R_{dose} : rads/yr
T_{eff} : yr
E_{eff} : Mev/dis
F_u : dimensionless
C_{plant} : uCi/g

5.2.5.4 Doses from an Isotope Mix

For aquatic organisms exposed to n isotopes

$$\underset{(\text{rad/yr})}{(R_{dose})_{org}} = 1.87\text{x}10^4 \sum_{i=1}^{n} (C_{org}) \quad (E_{eff}) \qquad (7)$$

For water fowl,

$$(R_{dose})_{waterfowl} = 9.4\text{x}10^5 \sum_{i=1}^{n} \left\{ (T_{eff}) \quad (E_{eff}) \quad \left[(F_u)_{waterfowl} \right] (C_{plant}) \right\} \qquad (8)$$

Computations relating to the above are shown in Table 5.2-10

5.2.6 DISTRIBUTION OF RADIOACTIVE EFFLUENTS IN THE ENVIRONMENT

5.2.6.1 Distribution of Radioactivity in River Water

The anticipated concentrations of isotopes in Savannah River water are given in Table 5.2-6, column 3 on page 5.2-13. Concentrations are based on instantaneous dilution of VNP liquid effluents by the Savannah River flowing at its mean annual flow rate of 10,150 cfs (VNP ER p. 2.5-3)

5.2.6.2 Uptake of Radioactivity by Aquatic Vegetation

The anticipated concentrations of isotopes in Savannah River aquatic vegetation are listed in Table 5.2-10. These concentrations assume instantaneous dilution of VNP effluents by the Savannah River and values of $(F_{conc})_p$, the concentration factor for plants, listed in UCRL-50564. (14)

5.2.6.3 Deposition of Radioactivity on Vegetation

Deposition of radioactivity on vegetation is calculated as follows:

$$(D_{veg})_{max} = \frac{Q_A \times V_{dep} \times (X/Q)_{max}}{\lambda_{field} - \lambda_r}$$

where,

$(D_{veg})_{max}$ = the equilibrium accumulated radioactivity deposited on vegetation in 1 m^2, assuming 100% deposition on vegetation (uCi/m^2)

Q_A = rate of discharge to atmosphere (uCi/yr)

V_{dep} = deposition velocity = 10^{-2} m/sec (Slade, p.207) (15)

(1) ISOTOPE	(2) C_W River Conc (uCi/cc)	(3) $(F_{conc})_P$ Plant Conc Factor	(4) C_P Plant Conc (uCi/g
Cr-51	1.6(-13)	4(+3)	6.4(-1
Mn-54	1.1(-13)	1(+4)	1.1(-9
Mn-56	3.9(-14)	1(+4)	3.9(-1
Fe-55	1.7(-13)	5(+3)	8.5(-1
Fe-57	6.4(-13)	5(+3)	3.2(-9
Co-58	5.4(-12)	1(+3)	5.4(-9
Co-60	2.0(-13)	1(+3)	2.0(-1
Br-84	1.3(-14)	7(+2)	9.1(-1
Rb-88	5.8(-13)	1(+3)	5.8(-1
Rb-89	1.3(-14)	1(+3)	1.3(-1
Sr-89	7.7(-13)	5(+2)	3.9(-1
Sr-90	3.5(-14)	5(+2)	1.7(-1
Sr-91	8.8(-15)	5(+2)	4.4(-1
Sr-92	4.4(-15)	5(+2)	2.2(-1
Y-90	4.4(-15)	1(+4)	4.4(-1
Y-91	1.3(+12)	1(+4)	1.3(-8
Y-92	4.4(-15)	1(+4)	4.4(-1
Nb-95	2.0(-13)	1(+3)	2.0(-1
Zr-95	1.5(-13)	1(+4)	1.5(-9

Table 5.2-10
(Page 1 of 2)

(5) $(F_{conc})_p$ Fish Conc Factor	(6) E_{eff} (Mev/dis)	(7) $C_{fish} x E_{eff}$	(8) $(Fu)_w$ Waterfowl Uptake Factor	(9) $(T_{eff})_w$ $(T_{1/2})$ Waterfowl (yr)	(10) $T_{eff} x E_{eff} x C_p x F_u$ Waterfowl	(11) $C_{plant} x E_{eff}$
2(+2)	1.4(-2)	4.5(-13)	1(-2)	7.6(-2)	6.8(-15)	8.9(-12)
2(+1)	2.3(-1)	5.1(-13)	5(-1)	8.3(-1)	1.0(-10)	2.5(-10)
2(+1)	1.3(0)	1.0(-12)	5(-1)	2.8(-4)	7.1(-14)	5.1(-10)
3(+2)	6.5(-3)	3.3(-13)	5(-1)	2.6(0)	7.2(-12)	5.5(-12)
3(+2)	4.2(-1)	8.0(-11)	5(-1)	1.2(-1)	7.8(-11)	1.3(-9)
5(+2)	2.9(-1)	7.8(-10)	5(-1)	2.0(-1)	1.6(-10)	1.6(-9)
5(+2)	7.2(-1)	7.2(-11)	5(-1)	5.3(0)	3.7(-10)	1.4(-10)
1(+2)	4.7(0)	6.1(-12)	1(0)	6.0(-5)	2.5(-15)	4.3(-11)
2(+3)	5.3(0)	6.1(-9)	1(0)	3.2(-5)	9.9(-14)	3.1(-9)
2(+3)	3.9(0)	1.0(-10)	1(0)	2.9(-5)	1.5(-15)	5.1(-11)
4(+1)	[illegible](-1)	1.7(-11)	5(-1)	1.4(-1)	1.5(-11)	2.1(-10)
4(+1)	1.1(0)	1.5(-12)	5(-1)	2.8(+1)	2.7(-10)	1.9(-11)
4(+1)	1.2(0)	4.2(-13)	5(-1)	1.1(-3)	3.0(-15)	5.4(-12)
4(+1)	2.0(0)	3.5(-13)	5(-1)	3.1(-4)	6.8(-16)	4.4(-12)
1(+2)	8.9(-1)	3.9(-13)	1(-2)	7.3(-3)	2.9(-15)	3.9(-11)
1(+2)	5.9(-1)	7.7(-10)	1(-2)	1.6(-1)	1.2(-10)	7.7(-8)
1(+2)	1.5(0)	6.6(-13)	1(-2)	3.9(-4)	2.6(-15)	6.6(-11)
3(+4)	2.6(-1)	1.6(-9)	1(-2)	9.6(-2)	5.0(-14)	5.2(-11)
1(+2)	5.2(-1)	7.8(-12)	1(-2)	1.8(-1)	1.4(-12)	7.8(-10)

(1) ISOTOPE	(2) C_W River Conc (uCi/cc)	(3) $(F_{conc})_p$ Plant Conc Factor	(4) C_p Plant Conc (uCi/g)
Mo-99	1.8(-10)	1(+2)	1.8(-8)
I-131	2.2(-10)	1(+2)	2.2(-8)
I-132	1.1(-12)	1(+2)	1.1(-10
I-133	4.3(-11)	1(+2)	4.3(-9)
I-134	2.7(-13)	1(+2)	2.7(-11
I-135	7.4(-12)	1(+2)	7.4(-10
Te-132	1.0(-11)	1(+5)	1.0(-6)
Te-134	1.3(-14)	1(+5)	1.3(-9)
Cs-134	6.5(-11)	2(+2)	1.3(-8)
Cs-136	2.1(-11)	2(+2)	4.2(-9)
Cs-137	3.2(-10)	2(+2)	6.4(-8)
Cs-138	2.8(-13)	2(+2)	5.6(-11
Ba-140	5.3(-13)	5(+2)	2.5(-10
La-140	2.7(-14)	1(+4)	2.7(-10
Ce-141	1.2(-13)	1(+4)	1.2(-9)
H-3	3.0(-07)	9(-1)	2.7(-7)

VNP-ER
Table 5.2-10
(Page 2 of 2)

(5) $(F_{conc})_p$ Fish Conc Factor	(6) E_{eff} (Mev/dis)	(7) $C_{fish} x E_{eff}$	(8) $(Fu)_w$ Waterfowl Uptake Factor	(9) $(T_{eff})_w$ $(T_{1/2})$ Waterfowl (yr)	(10) $T_{eff} x E_{eff} x C_p x F_u$ Waterfowl	(11) $C_{plant} x E_{eff}$
1(+2)	4.9(-1)	8.8(-9)	1(0)	7.6(-3)	6.7(-11)	8.8(-9)
1(0)	3.0(-1)	6.6(-11)	1(0)	2.2(-2)	1.5(-10)	6.6(-9)
1(0)	1.0(0)	1.1(-12)	1(0)	2.6(-4)	2.9(-14)	1.1(-10)
1(0)	6.4(-1)	2.7(-11)	1(0)	2.3(-3)	6.4(-12)	2.8(-9)
1(0)	1.1(0)	3.0(-13)	1(0)	9.9(-5)	3.0(-15)	3.0(-11)
1(0)	7.7(-1)	5.7(-12)	1(0)	7.6(-4)	4.3(-13)	5.7(-10)
1(+5)	1.0(0)	1.1(-6)	5(-1)	8.6(-3)	4.8(-9)	1.1(-6)
1(+5)	3.0(0)	3.9(-9)	5(-1)	8.0(-5)	1.6(-13)	3.9(-9)
1(+3)	5.7(-1)	3.7(-8)	1(0)	4.9(-2)	3.6(-10)	7.4(-9)
1(+3)	3.5(-1)	7.3(-9)	1(0)	3.8(-2)	5.7(-11)	1.5(-9)
1(+3)	4.1(-1)	1.3(-7)	1(0)	5.0(-2)	1.3(-9)	2.6(-8)
1(+3)	3.4(0)	9.5(-10)	1(0)	6.1(-5)	1.2(-14)	1.9(-10)
1(+1)	1.4(0)	7.4(-12)	5(-1)	3.5(-2)	6.1(-12)	3.5(-10)
1(+2)	1.1(0)	3.0(-12)	1(-2)	4.6(-3)	1.4(-14)	3.0(-10)
1(+2)	1.8(-1)	2.2(-12)	5(-1)	8.8(-2)	9.7(-12)	2.2(-10)
9(-1)	1.0(-2)	2.7(-09)	1(0)	3.3(-2)	8.9(-11)	2.7(-9)
		$\sum$ = 1.3(-6)			$\sum$ =7.9(-9)	$\sum$ =1.2(-6)

$(X/Q)_{max}$ = atmospheric dispersion parameter at off-site point with highest long-term air concentration = $2.0 \times 10^{-6} \frac{sec}{m^3}$ (VNP-ER, p. 5.2-10)

λ_{field} = rate constant for removal of deposited element by environmental factors = 18 yr^{-1} (equivalent to T_{field} = 14 d) (Russell, p. 92)(16)

λ_r = radiological decay constant (yr^{-1})

Q_a for I-131 was obtained from this report, p. 5.2-5. The accumulated deposition of I-131 on vegetation is expected to be 4.0×10^{-4} uCi/m^2.

5.2.6.4 Accumulation of Radioactive Material in Soil

Accumulation of radionuclides in soil is given by the following equation:

$$(D_{soil})max = \frac{Q_a \times V_{dep} \times (X/Q)max}{\lambda_r} \left[1 - \exp(-\lambda_r L) \right]$$

where,

$(D_{soil})_{max}$ = the deposition in soil accumulated after a forty-year reactor life at the point of maximum X/Q (uCi/m^2)

L = reactor life (40 yr)

and other terms remain as previously defined. The accumulated deposition of I-131 on soil is expected to be 6.5×10^{-4} uCi/m^2.

5.2.6.5 Accumulation of Radioactive Material in Sediment

The expression commonly used to describe sediment transport is

$$Q_s = K_1 Q_w^{K_2} \qquad (1)$$

where,

Q_s = sediment flow rate (g/yr)

Q_w = water flow rate (cm^3/yr)

K_1 = empirically determined constant

K_2 = empirically determined constant

Sediment data from the Savannah River near the Vogtle Plant Site are sparse. Results of analysis of recent quarterly samples collected a Augusta, Georgia, are reported by the U. S. Geological Survey(17) and are listed below in Table 5.2-10a. Stream flow measurements at the time of sampling permit calculations of Q_s for each quarterly sample.

TABLE 5.2-10a

SAVANNAH RIVER SEDIMENT ANALYSIS RESULTS

Sample Date	River Discharge (cfs)	Solids Retained On Filter (mg/liter)
11/19/70	5,150	2
2/10/71	15,400	62
5/12/71	7,220	10
8/12/71	7,380	10

A log-log plot of Q_s versus Q_w for these data approximates a straight line with a slope of 3.56, the value of K_2. The value of K_1 was calculated to be approximately 3.2×10^{-46}. A value of $Q_w = 8.9 \times 10^{15}$ cm^3 per year (10,000 cfs) is the annual average river flow rate, was used in equation 1 to calculate average annual sediment flow rate:

$$Q_s = 3.2 \times 10^{-46} (8.9 \times 10^{15})^{3.56} \text{ g/yr} \qquad (2)$$

$$Q_s = 1.91 \times 10^{11} \text{ g/yr}$$

The expression for concentration of an isotope in sediment is given by:(11)

$$C_s = \frac{I}{Q_s \quad \frac{Q_w}{K_d}} \qquad (3)$$

where,

I = Radionuclide discharge rate (uCi/yr)

C_s = Concentration of isotope in sediment (cm^3/g)

K_d = Distribution coefficient (cm^3/g)

and other terms as previously defined.

A recent AEC report(11) gives a value for K_d of 241 cm^3/g for Cs-134 and Cs-137.

Approximately 1/2 of the non-tritium liquid radioactivity deposition from the Vogtle site will be Cs-134 or Cs-137. The total discharge rate of Cs-134 and Cs-137 will be 3.5×10^6uCi/yr. Discharge rates of other long lived isotopes will be much lower, so other isotopes will be ignored in this analysis.

Substituting in appropriate values, equation 3 becomes

$$C_s = \frac{3.5 \times 10^6}{1.9 \times 10^{11} + \frac{8.9 \times 10^{15}}{2.4 \times 10^2}} \text{ uCi/g} \qquad (4)$$

$$C_s = 9.5 \times 10^8 \text{ uCi/g}$$

Thickness of river sediment deposits will vary, but this analysis assumes a thickness of 20 centimeters because the dose rate at any point above the deposit ceases to increase with thickness when the thickness reaches approximately 20 centimeters.

This analysis assumes further that activity in a sediment deposit 20 centimeters thick is concentrated in a very thin layer at the surface of the deposit. Assumption of a soil density value of 3 grams per cubic centimeter results in an areal sediment deposition value of 5.7×10^{-2} uCi/m^2.

5.2.7 DOSE AT THE SITE BOUNDARY

The maximum expected whole body direct dose at the site boundary from all radioactive sources located on the four-unit site is 1.10×10^{-3} rem/yr. Sources considered in this evaluation were the containment building, auxiliary building, turbine building, condensate storage tank, refueling water storage tank, and make-up water storage tank.

5.2.8 EXPOSURE FROM RADIOACTIVE SHIPMENTS

The total man-rem exposure resulting from transportation of radioactive materials to and from the 4-unit site was determined assuming 287 truck shipments per year over a 1000-mile route at an average rate of 200 miles per day. A uniformly distributed population density of 330 people per square mile along this route was assumed with no persons, excepting the driver and helper, closer to the truck than 100 feet. The assumed exposure rate due to the radioactive cargo was 10 mrem/hr. at 10 feet from the center of the truck and 0.2 mrem/hr. inside the cab. For shipments of new fuel these values were reduced to 0.1 mrem/hr. and 0.01 mrem/hr. respectively. The man-rem exposures resulting from the transport of radioactive materials appear in Table 5.2-11.

TABLE 5.2-11

MAN-REM EXPOSURE

CARGO	PER SHIPMENT		PER YEAR (4UNITS)	
	Driver & Helper	Population	Driver & Helper	Population
Spent Fuel	2.2×10^{-3}	3.3×10^{-3}	0.58	0.865
Solid Radioactive Waste	9.8×10^{-3}	14.7×10^{-3}	2.68	3.87
New Fuel 24 Shipments	0.6×10^{-3}	0.18×10^{-3}	.014	.004
Total	12.6×10^{-3}	18.2×10^{-3}	3.17	4.74

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5.3 EFFECTS OF RELEASED CHEMICAL AND SANITARY WASTES

5.3.1 EFFECTS OF CHEMICAL RELEASES TO THE SAVANNAH RIVER

The increase in total dissolved solids (TDS) in the Savannah River at the outfall from VNP will vary with operating conditions. The amount of TDS in the discharge from VNP is a function of the TDS concentration in the river water and the number of cycles of concentration of the main cooling towers. Table 5.3-1 shows the increase in TDS at different VNP operating conditions and river flows. The VNP discharge will meet Drinking Water Standards for TDS and sulfates at all expected operating conditions.(1)

Two criteria have been used to aid in determining the tolerable increases in total dissolved solids. (2) One criterion is based on the osmotic concentration of body fluids of fresh water animals If the total dissolved materials are relatively innocuous, this criterion indicates that the concentrations should not be increased to exceed 50 milliosmoles (the equivalent of 1500 ppm sodium chloride). The second criterion states that TDS concentrations should not be increased by more than one-third of the concentration that exists in the river under ambient conditions. As can be seen from Table 5.3-1, the VNP discharge will never exceed 50 milliosmoles. VNP discharge, under certain conditions, could have concentrations greater than one-third the concentration that exists in the river. However, after mixing with the river water at the minimum flow of record (1040 cfs), the concentrations of TDS should not be increased to intolerable levels. (It should be noted that at present a minimum flow of 5800 cfs is guaranteed by the U.S. Army Corps of Engineers). Therefore, based on the above discussion, it is expected that the increase in total dissolved solids will not have a significant effect on the freshwater organisms in the Savannah River.

A small amount of phosphate (0.04-0.57 ppm) will be discharged to Savannah River. After dilution by the river, the naturally occurring ratios and amounts of nitrogen to total phosphorus should not be significantly altered. The above has been set forth as a guideline to prevent nuisance algal growths. (3) Based on this criterion, it is not expected that the small phosphate discharge will have any significant adverse environmental effects.

The discharge from VNP should not increase the turbidity or color levels in the Savannah River. Also, the VNP discharge will not cause any substantial reduction in dissolved oxygen concentration in the Savannah River. See Section 3.7 for more details regarding these three parameters. Since no changes are expected, no adverse environmental effects are expected.

Cycles of Concentration	River Condition	Ambient River
3	Max.	76.3 ppm
	Min.	41.8
	Avg.	60.0
5	Max.	76.3 ppm
	Min.	41.8
	Avg.	60.0
8	Max.	76.3 ppm
	Min.	41.8
	Avg.	60.0

NOTES:

"A" - With intermittent waste
"B" - Without intermittent waste
* - After a mixing zone following

Table 5.3-1

TOTAL DISSOLVED SOLIDS
IN
PLANT DISCHARGE AND SAVANNAH RIVER

		SAVANNAH RIVER DOWNSTREAM FROM DISCHARGE*					
VNP DISCHARGE		River Flow 1040 cfs		River Flow 5,800 cfs		River flow 10,150 cfs	
"A"	"B"	"A"	"B"	"A"	"B"	"A"	"B"
111.7 ppm	105.1 ppm	90.2 ppm	87.6 ppm	78.5 ppm	78.1 ppm	77.6 ppm.	77.3 ppm
64.8	58.0	50.8	48.2	43.2	42.8	42.6	42.4
89.5	82.9	71.6	69.0	61.9	61.4	61.0	60.8
114.9 ppm	107.6 ppm	91.5 ppm	88.6 ppm	78.7 ppm	78.3 ppm	77.7 ppm	77.4 ppm
66.9	59.5	51.7	48.8	43.4	42.9	42.7	42.4
92.2	84.9	72.7	69.8	62.0	61.6	61.1	60.9
115.5 ppm	107.9 ppm	91.7 ppm	88.7 ppm	78.8 ppm	78.3 ppm	77.7 ppm	77.4 ppm
67.4	59.7	51.9	48.8	43.4	42.9	42.7	42.4
92.8	85.1	72.9	69.9	62.1	61.6	61.2	60.9

ischarge to the river

There should be no free chlorine in the VNP discharge, but a combined chlorine residual maximum of 0.50 ppm could occur in the discharge. At a low flow of 5800 cfs, if 100 percent mixing with the Savannah River is assumed, a concentration of 0.029 ppm combined chlorine residual will result. If only 10 percent mixing is assumed at a flow of 5800 cfs, a concentration of 0.190 will result.

In order to interpret the possible effects of the above concentrations, a short review of the effect of combined chlorine from the biological literature is necessary. Fifty percent of a population of rainbow trout were able to tolerate 0.23 ppm of a total residual chlorine for only 96 hours.(4) It should be noted that free chlorine was present in the test. At residual chlorine concentrations of 0.04 to 0.05 ppm, chlorinated sewage effluent was found to be toxic to fathead minnows.(5)

Since residual chlorine levels in the VNP discharge will not be continuous, and since the discharge should be rapidly diluted, the effect on organisms in the Savannah River should be minimal. Exposure time for organisms should not be of long duration. Levels of residual combined chlorine concentration in the river will only be slightly higher than levels that are reported to be toxic. For these reasons, it is concluded that the residual chlorine discharge, while possibly having a slight effect on the organisms in the Savannah River, should not have any significant effect.

The dimensions of the VNP discharge plume have not been determined. However, a mathematical model of the plume is being constructed. Due to the large amount of flow in the Savannah River (5800 cfs minimum guaranteed by Corps of Engineers), the VNP discharge will be mixed with an equal amount of river water immediately after it is discharged.

Since no toxic metals are planned to be used in the plant, there will be no toxic metals in the discharge unless they are present in the Savannah River intake water.

Since the chemical concentrations in the VNP discharge are not significantly higher than ambient river concentration, no adverse environmental effects are expected to be caused in the Savannah River.

5.3.2 EFFECTS OF COOLING TOWER DRIFT

The only significant chemical concentrations transported in the cooling tower drift will be total dissolved solids. The concentrations of total dissolved solids in the drift are discussed in Section 3.7. It is expected that the total dissolved solids in the drift will be continuously deposited in the immediate vicinity of the cooling towers. Much of the material that is deposited will be leached into the soil by rainfall (approximately 39 inches annual rainfall). Assuming the drift were spread over a 1-mile radius around the cooling towers, under normal operating conditions, 0.014 lbs. of solids/ft.^{2} will be deposited per year for 4 units. The concentrations of dissolved solids will meet irrigation and livestock water supply guidelines.(6)

During cooling tower chlorination, a maximum chlorine concentration of 3 ppm could be present in the drift. Since irrigation water containing 50 ppm caused the injury to plants,(7) there should be no adverse effects from the chlorine in the cooling tower drift.

It is not expected that the drift will cause any adverse effect on animals, plants, or soil, since it is within irrigation guidelines, due to low or zero concentrations of harmful chemicals in the Savannah River makeup water.

5.3.3 EFFECTS OF SANITARY WASTE

The sewage treatment plant at VNP will reduce BOD and suspended solids to a level that will not affect the suspended solid or BOD load in the Savannah River (see Section 3.7). The chlorine contact tank in the sewage treatment plant will reduce coliform organisms and other bacteria to levels that meet Drinking Water Standards (1) since the fecal coliforms will be less than 20/100 ml.

The free chlorine in the treated discharge will be reduced to zero in the mixing chamber, due to chlorine demand in the mixing chamber. The coliform concentration will be reduced to less than 1/100 ml. due to dilution by other plant waste discharges.

Therefore, due to the small amount involved, sanitary waste is not expected to have a significant effect on the Savannah River.

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5.4 OTHER EFFECTS

5.4.1 TRANSMISSION LINES

The transmission lines necessary for VNP are described in Section 3.2. The effects on the environment of the construction of these lines between the plant and the system will be limited to right-of-way effects and the visual effects of the transmission structures.

5.4.1.1 Right-of-way Location

The eight (8) 500,000 volt (500 KV) transmission lines necessary for the VNP project will be grouped so that 5 separate right-of-way corridors will be utilized for line exit from the plant. These corridors and the lines they contain are described as follows:

1. North Corridor. This corridor will be a right-of-way 387.5 feet in width, of which 275 feet has already been obtained. This corridor is approximately 20 miles in length. The VNP-Goshen No. 1 and No. 2 500 kV lines and the VNP-Goshen 230 kV line will occupy this corridor. The corridor generally parallels the course of the Savannah River and is relatively flat with a few low hills and valleys where creeks flow into the river. It is a farming and timber growing region with most of the timber being second growth Georgia Pine and Scrub Oaks. The corridor was laid out in the most direct route between stations.

2. Northwest Corridor. This corridor is a right-of-way 275 feet in width for a distance of approximately 70 miles. The Evans No. 1 and No. 2 500 kV lines will occupy this corridor. These lines are tentatively routed to the south and west of the U.S. Army Fort Gordon reservation. Before final route selection, the possibilities of crossing this reservation in order to minimize line length will be investigated. The topography of the line routing is relatively flat with a few low hills and valleys. It is a farming and timber growing region with most of the timber being second growth Georgia Pine.

3. West Corridor. This corridor is a right-of-way 275 feet in width for a distance of approximately 40 miles. For this distance, two 500 kV transmission lines will occupy this corridor. These lines are the VNP-Gainesville line and the VNP-Klondike line. From this point, the VNP-Gainesville line will turn in a northerly direction and continue for a distance of approximately 110 miles in a right-of-way 150 feet in width. The VNP-Klondike line will turn in a northwesterly direction and continue for approximately 105 miles in a right-of-way 150 feet in width, also. The topography of the line routings range from the relatively flat country surrounding the VNP site in the

Savannah River plain, through the rolling hill section of the state, to the foothills of the mountains in the vicinity of Gainesville.

4. Southwest Corridor. This corridor is a right-of-way 150 feet in width for a distance of approximately 120 miles. One line, the VNP-Bonaire 500 kV Line, will occupy this right-of-way. This line will be routed near the town of Wadley to accommodate a possible future 500 kV substation facility. This corridor is generally routed over rolling hills, with some relatively flat country occurring in the vicinity of VNP. Some small amount of wetlands will be crossed. The line will primarily traverse rural areas where farming and timber growing are the primary activities.

5. South Corridor. This corridor is a right-of-way 150 feet in width for a distance of approximately 92 miles. One line, the VNP-Plant Hatch 500 kV line, will occupy this right-of-way. This line will be routed in the most direct feasible route between VNP and the Edwin I. Hatch Nuclear Plant located near Baxley, Georgia. This line will be located in the southeastern quadrant of the state and is generally below the fall line. The topography is all relatively flat. The area is primarily rural, with farming and timber growing being the primary activities.

The three 230,000 volt (230 kV) transmission lines to be utilized as off-site power sources will be located as follows:

1. VNP-Goshen 230 kV Line. This line is already constructed, and it occupies the North Corridor described above.

2. VNP-Waynesboro 230 kV Lines 1 and 2. These lines will occupy a right-of-way 200 feet in width. The length is approximately 23 miles. These lines will be routed in the most direct feasible route.

The general routings of the transmission lines are shown in Figure 5.4-1.

At this time, no definite routes have been selected for any of these lines (with the exception of the North Corridor, which has been partially obtained). GPC will endeavor to minimize transmission line construction where possible by use of the most direct feasible routings. Such routings may, in some cases, utilize existing rights-of-way where portions of the VNP 500 kV lines may parallel existing transmission or sub-transmission lines of the GPC transmission system. Since this technique will be used wherever feasible, its effects on overall costs, system reliability, and land requirements will be taken into account by GPC. It will not be feasible to remove existing lines along the routes and construct the 500 kV lines in place of existing lines. The existing lines of the GPC system serve specific purposes that cannot be fulfilled by the VNP lines. 2 1

One adverse environmental effect from the construction of these lines. results from some inherent restriction on the use of the land involved. These lines will be constructed on land obtained by easements and special permits. The use of easements and special permits enables the property owners to continue to use their land for agricultural or other purposes which would not interfere with the operation and maintenance of the lines. Land along the rights-of-way will be fully available for pasture or crops.

A tabulation of the estimated total acreage requirements and approximate percentage and acreage of the different types of land involved is shown in Table 5.4-1. These estimates are based on the best present estimates of line routings and data obtained from Aerial Photo Indexes of Counties, dated 1968.

5.4.1.2 Right-of-way Treatment

Final routes have not been selected. Routes will be selected with the aid of aerial photography. In general the routes will be laid out in the most direct route between terminations, with consideration being given to location of necessary future substations and plants. However, factors other than most direct route distance may enter into the final location of the transmission lines. These factors generally fall into the areas of the effect of transmission lines on the environment and the effect of the environment on the transmission lines. The former is guided by the Department of Interior/Department of Agriculture publication "Environmental Criteria For Electric Transmission Systems". Factors in the latter category are densely populated areas, airports, terrain unsuitable for the construction and operation of the transmission lines, planned use areas, etc. that would conflict with the construction and operation of the lines. These obstacles would be located by aerial photography; areas determined to be of particular concern are visited by a route selection group representing the System Planning, Operating, Land, and Electrical Engineering Departments of GPC. The criteria for decision are sound engineering and environmental considerations. In the final selection of routes, due consideration will be given to the avoidance of possible conflicts with any natural or man-made areas where adverse effects on the environment will result. It is not expected that any people will have to be relocated due to the construction of these lines. Alternate routings will be considered. 1

Insofar as it is feasible and practical, route selection will conform to the Federal Power Commission Publication "Electric Power Transmission and the Environment" and the Department of Interior/Department of Agruculture publication entitled "Environmental Criteria for Electric Transmission Systems". It is recognized that the latter publication is rather broad in scope, covering many types of terrain. Those guidelines applicable to the terrain encountered will be used. The terrain that these transmission lines cross varies from low and flat to low rolling hills. Guidelines involving highways, scenic areas, joint use of rights-of-way, natural growth, planned land use, open expanses of water and marshlands, parks, monuments, recreation and historic areas, access and construction roads, and natural screens would apply. 1

	Goshen #1	Gos #
Length (Miles)	20	20
R/W Width (Feet)	112.5	No Re
R/W Acres	272.80	
Wooded, % Acres	59% 161.0	59
Fields and Cultivated Areas, % Acres	36% 98.2	36
Wetlands, % Acres	2% 5.4	2
Urban, % Acres	3% 8.2	3

Table 5.4-1
VNP - TRANSMISSION LINES
New Right -of-Way Required

hen 2	Evans #1	Evans #2	Gainesville	Klondike	Hatch	Bonaire	Waynesboro #1 (230)	Waynesboro #2
	70	70	150	145	92	120	23	23
ne uired	137.5	137.5	40 Mi. @137.5 110 Mi. @150	40 Mi. @137.5 105 Mi. @150	150	150	100	100
	1166.90	1166.90	666.80 1999.80 2666.60T	666.80 1908.90 2575.70T	1672.56	2181.60	278.76	278.76
%	58% 676.8	58% 676.8	65% 1733.3	68% 1751.5	71% 1187.5	73% 1592.6	73% 203.5	73% 203.5
%	23% 268.4	23% 268.4	25% 666.6	25% 643.9	27% 451.6	24% 523.6	24% 66.9	24% 66.9
	2% 23.3	2% 23.3	4% 106.7	3% 77.3	2% 33.4	1% 21.8	1% 2.8	1% 2.8
	17% 198.4	17% 198.4	6% 160.0	4% 103.0	0% 0	2% 43.6	2% 5.6	2% 5.6

Other than loss of land as discussed in Paragraph 5.4.1.1, remaining environmental effects caused by transmission line construction are generally limited to effects on scenery and wildlife habitat, along with some minor erosion resulting from the right-of-way clearing operation. Where the right-of-way crosses wooded areas, clearing is involved. It is planned that these rights-of-way will be cleared full-width. Where practical and reasonable, GPC does selectively clear rights-of-way. However, the terrain crossed by the VNP lines varies from low and flat to low rolling hills, with the wooded areas being generally second growth Georgia pine. The combination of flat terrain or low rolling hills and Georgia pines does not readily lend itself to selective clearing. It would leave undesirably shaped trees in many instances. It would also make these rights-of-way less acceptable to many forms of wildlife, such as the quail, dove, and deer who need open areas to feed and browse where annual and perennial weeds and grasses flourish and provide food. The creation of an overstory of low-growing, spreading trees would hinder the growth of annual and perennial weeds and reduce or eliminate a source of food for wildlife in areas such as those generally crossed by the VNP lines. 1

Wooded areas will be initially cleared using K-G blades with D-7 or D-8 Caterpillar tractors. Stumps are sheared off at ground level to eliminate soil disturbance that would be caused by grubbing of stumps. Chain saws will be used to clear trees around all streams, lakes, and steep slopes to further minimize chance of erosion. Debris from the clearing operation will either be removed from the rights-of-way or properly disposed of by burying or other methods.

Considerable research has been done by GPC's line clearing section in the areas of right-of-way clearing and maintenance. This section is made up of a supervisor, a landscape architect, and graduate foresters. All are trained in fields of ecology and agronomy. One graduate forester is located in each of 7 GPC divisions.

One area of research has been that of disposal of debris. Chipping of debris and the scattering of these chips on the right-of-way has been attempted. This proved to be a detriment to right-of-way management in that the large quantity of chips on the right-of-way increases the acidity of the soil to a point where growth of grasses and weeds was prohibited. Presently, the lack of mobility of this type of chipping equipment makes it unsuited for cross-country clearing. Methods of crushing trees and brush into the ground proved to be undesirable in that it hinders landowners who often desire to utilize the cleared right-of-way for pastures or crops. This method of disposing of debris makes the ground very difficult to work, but it virtually eliminates erosion problems. 1

After clearing wooded areas, GPC will fertilize rights-of-way and seed the cleared areas with fast-growing annuals, such as rye or wheat, mixed with a perennial, such as sericia lespedeza, to control erosion and provide wildlife food and cover where it is in keeping with the surrounding environment. Treatment of environments varying from this will be in keeping with the environment of the corridor segment.

The location of lines at highways and navigable river crossings will comply with the requirements of the Georgia Department of Transportation and the U.S. Army Corps of Engineers. In general, lines will not parallel highways for any long runs and will be located with a screen of wooded areas or cultivated fields between the lines and major highways. The VNP transmission lines will cross railroad tracks approximately 33 times. The National Electric Safety Code, Sixth Edition, will be the guideline 1
for establishing required clearances over railroads. It is not anticipated that these transmission lines will closely parallel railroad tracks and thereby possibly produce inductive coupling.

Construction of the transmission lines will involve the use of heavy equipment for tower erection and conductor stringing. This equipment may cause temporary rutting along the rights-of-way. Any such damage will be repaired by GPC and planted with either grass or wildlife food; any damage to structures will be paid for, or repaired by, GPC following construction, and landowners will be reimbursed by GPC for the value of crops damaged by construction activity.

Rights-of-way will be re-cleared every 3 years; in addition, a herbicide will be sprayed in selected areas by helicopters every 6 years. The re-clearing is accomplished with rotary or drum mowers and with some hand clearing using chain saws and hand tools. No permanent access roads will be maintained along the rights-of-way. Any damage to rights-of-way during maintenance will be repaired. The above-mentioned herbicide consists of 1-1/2 gallons of chemical (either 2-4-5 T or 2-4-5 TP in a concentration of 4 pounds per gallon), 1 gallon of diesel fuel, and 6-1/2 gallons of water. It is sprayed at a rate of 9 gallons per acre using a helicopter with a microfoil boom. Spraying is limited to periods when the wind does not exceed 1-1/2 to 2 miles per hour. The 9 gallons per acre application is a low rate but has proven to be adequate for the re-clearing cycle. Only broadleafed plants are killed. This process does not adversely affect pines and other vegetation near the right-of-way or grasses and narrow-leafed plants on the right-of-way. Herbicides are used to control hardwoods which, in the Southeast, are prolific sprouters that send up many sprouts from cut 1
stumps. These clumps of sprouts become thicker and more hardy each time they are cut. The killing of these hardwood sprouts on the rights-of-way liberates the grasses and annual weeds for hardy growth. In sensitive areas, such as along roadsides, around lakes, or areas surrounded by residential housing or crops, no spraying of herbicides is done.

Part of the land management program of GPC is the Right-of-Way Conversion Program in which GPC will pay, at present, up to $75.00 per acre to the landowner to plant the cleared right-of-way in pasture, crops, or game food plots. Planting is limited to grasses, crops, and low-growing shrubs and trees that will not reach a height that will hinder the operation of the transmission lines. The program is actively publicized through advertisement and is administered by GPC foresters. Since the inception of the program, approximately 1600 acres of land have been planted under this program. Each acre planted has an excellent opportunity of being maintained by the property owner in a manner most suitable to him and acceptable to GPC.

5.4.1.3 Transmission Line Structures

Standard GPC transmission line structures will be utilized for the construction of the VNP lines. The 500 kV lines will utilize galvanized on steel, rigid base, lattice-type structures. These structures, depending on topograpy, will range from 80 to 155 feet in height, with the average height being 110 feet. Figure 5.4-2 illustrates a typical 500 kV structure. The 230 kV lines will utilize guyed steel 'H' frame structures. These structures will range from 80 to 100 feet in height, with the average height being 90 feet. Figure 5.4-3 illustrates a typical 230 kV structure.

It is estimated that there will be approximately 4.2 lattice - type towers per mile of 500 kV line. Approximately 5184 square feet per tower will be required for tower construction. After construction, 38.6 square feet of this area will be covered by concrete, leaving approximately 5145.4 square feet of the original 5184 square feet per tower that can be restored. Foundation and tower dimensions for typical 500 kV tower are shown on Figure 5.4-4.

It is estimated that the VNP 230 kV lines will require 4 to 4.5 H-frame structures per mile. Approximately 24,000 square feet of area per structure will be required for construction purposes. After construction, approximately 18 square feet per structure will be covered by concrete and anchor rods, leaving approximately 23,082 square feet per structure that can be restored. Structure and guy dimensions for a typical 230 kV H-frame are shown on Figure 5.4-5. 1

5.4.1.4 Production of Ozone

The possibility of production of ozone by high voltage transmission lines has been examined by GPC. In a study by the American Electric Power Service Corporation (3), ozone formation in the vicinity of 765 kV lines was not detectable with instrumentation sensitive to 2 ppb. On sunny days, the natural ozone level was found to be 40 to 60 ppb. The 765 kV lines associated with the test would have more corona discharges and higher ozone formation than the 500 kV lines associated with VNP. Thus, the 500 kV lines would have no significant environmental impact due to ozone formation.

5.4.2 TRANSPORTATION OF FUEL

5.4.2.1 Spent Fuel

The U. S. Department of Transportation (DOT) regulations specify both normal and accident conditions for which a package designer must evaluate any radioactive material packaging. These conditions are intended to assure that the package has requisite integrity to meet all conditions which may be encountered during transport. The normal shipping conditions require that the package be able to withstand temperatures ranging from -40°F to 130°F and to withstand the normal vibrations, shocks and wetting that would be incident to normal transport. In addition, the packages are required to withstand specified accident conditions with the release of no radioactivity except for slightly contaminated coolant and 1,000 curies of radioactive noble gases. The accident conditions for which the package must be designed include, in sequence, a 30-foot free fall onto an essentially unyielding surface, followed by a 40-inch drop onto a 6-inch diameter pin, followed by 30 minutes in a 1475°F fire, followed by 8 hours immersion in 3 feet of water. The maximum permissible radiation levels and releases under these accident conditions are shown in Table 5.4-2 .

These levels represent limits established by the regulations. In most cases, the containers will exhibit radiation levels and releases less than those permitted by the regulations. This is because the fuels and materials which will be handled will not be at the maximum activity levels for which the containers have been designed.

Under normal shipping conditions, no release of any radioactive materials will occur and under the very severe accident conditions postulated, the only releases expected are slightly contaminated coolant and noble gases. An accident may also result in a minor increase in radiation levels associated with the reduction of shielding.

Prior to shipment, the fuel will be retained at the plant for a minimum of 3 months with the result that essentially all radioactive noble gases, with the exception of Krypton-85, will have decayed and the iodine 131 will have decayed to a very low level. Further, the decay heat will have been reduced to about 0.1 percent of the heat which has been generated by the fuel during reactor irradiation. This, coupled with the high melting point

TABLE 5.4-2

CONTAINER DESIGN REQUIREMENTS

	NORMAL CONDITIONS	ACCIDENT CONDITIONS
EXTERNAL RADIATION LEVELS		
Surface	200 MR/hr	
3 ft. from surface		1000 MR/hr
6 ft. from surface	10 MR/hr	
PERMITTED RELEASES		
Noble Gases	None	1000 Ci
Contaminated Coolant	None	.01 Ci alpha, 0.5 Ci mixed fission products 10 Ci Iodine
Other	None	None
CONTAMINATION LEVELS		
Beta and Gamma	2200 dpm/100 cm^2	
Alpha	220 dpm/100 cm^2	

of the fuel pellets assures that during a shipping cask accident, there is very little potential for any radioactivity other than the noble gases being released into the cask cavity.

There are several features which are typical of all shipping casks, such as heavy steel shells on the inside and outside, separated by dense shielding material, such as depleted uranium. Additionally, the cask has an extended surface area for dissipation of decay heat, and will be equipped with an energy absorbing impact structure such as fins, to absorb the energy in case of a fall, and to limit the forces imposed on the cask and contents. The cask also will contain a basket which will be provided to support the fuel during transport. Additionally, for high exposure fuel, provisions will be made for a moderator material, such as water, to provide for absorption of the fast neutrons generated through spontaneous fission and alpha-n reactions of the transuranium isotopes.

The principal normal environment effect from these shipments will be the direct radiation dose from the shipments as they move from the reactor to the reporcessing plant. For the purpose of this calculation, it has been assumed that the shipments will be made at the maximum permitted level of 10 mrem per hour at a distance of 6 feet from the nearest accessible surface. Based on this assumption, and assuming that the nearest person will be 100 feet from the centerline of the tracks, it is estimated that the dose rate would be 0.2 mrem per hour. This would be reduced to 0.01 mrem per hour at a distance of 300 feet and beyond this distance the radiation exposure received would be negligible.

A principal environmental effect from an accident would be whole body radiation due to the increase radiation levels caused by the release of noble gases. Exposure to personnel could result from direct radiation. Because of the dose attenuation effects with distance, it can be concluded that the direct radiation dose effects to the general population will be negligible. Even if this accident is evaluated in accordance with the Department of Transportation hypothetical accident criteria set forth in 49CFR173, which considers that 1000 Ci of gaseous activity is released to the environment, the population exposure should be negligible. A similar conclusion may be reached regarding thyroid dose from iodine.

5.4.2.2 New Fuel

New fuel is expected to be shipped by truck in containers designed to protect them from physical damage due to the normal handling and vibration of transportation. Because new fuel contains practically no fission products or radioactive gases, the results of an accident, even if the fuel should be damaged, would be only economic loss.

5.4.2.3 Conclusions

It is currently expected that new fuel will be shipped by truck to VNP and that spent fuel will be shipped from the plant by rail. All shipments will be made in accordance with DOT regulations as well as any other applicable regulations in effect at the time.

As the result of having the alternates of barge, railroad and highway transportation from the plant, GPC is in a position to select the mode of shipment for fuel that will have the least risk of accident and minimal environmental impact when shipments are made. Since nuclear fuel shipping technology is still developing, GPC considers it important to have these alternates for fuel shipment.

5.4.3 EFFECTS ON GROUND WATER

5.4.3.1 Raising/Lowering of Ground Water Levels

Design use of ground water by VNP is 5000 gpm and the expected use is 2000 gpm. This is well below the capacity of the Tuscaloosa aquifer,(1,2) and should have no effect on the ground water level. Pumping tests by GPC indicate that lowering of piezometer levels will be negligible beyond a distance of 1000 feet from the pumping site.

5.4.3.2 Chemical and Radiological Contamination

Spills of liquids containing chemical or radioactive contaminants would be restricted to the shallow ground water by the marl aquiclude which is found throughout the VNP site and would not affect the deep Tuscaloosa aquifer. The migration of any spills would be controlled by the permeabilities of the soil in the saturated ground water zone and is estimated to be in the order of 350 years as indicated in the following calculations.

1. Permeabilities:

   Field: 200 to 250 ft/yr

   Laboratory: 10 to 20,000 ft/yr

   Assume permeabilities of 8000 ft/yr and 200 ft/yr

2. Ground Water flow paths and gradients:

   Minimum flow path of 2500 feet

   Gradient over initial 1000 feet: 4.5×10^{-3}

   Gradient over last 1500 feet: 10^{-2}

3. Seepage velocities:

   $v = ki/p$

   v = seepage velocity
   k = Coeff. of permeability
   i = hydraulic gradient
   p = porosity (assume 45%)

When $k = 8000$ ft/yr and $i = 4.5 \times 10^{-3}$

$$v = \frac{8 \times 10^{+3} \times 4.5 \times 10^{-3}}{4.5 \times 10^{-1}} = 80 \text{ ft/yr}$$

When $k = 200$ ft/yr and $i = 10^{-2}$

$$v = \frac{2 \times 10^{+2} \times 10^{-2}}{4.5 \times 10^{-1}} = 4.5 \text{ ft/yr}$$

4. Estimated time to traverse minimum flow path:

   1000/80 = 12.5 years and 1500/4.5 = 333 years

   Total years = 12.5 + 345.5 years, say 350 years

5.4.4 VNP INTERACTION WITH OTHER NUCLEAR FACILITIES

Three nuclear facilities exist in the 50-mile radius surrounding the VNP site. Ther are the Savannah River Plant, the Barnwell Nuclear Fuel Plant, and Chem-Nuclear Services, Inc.

A major mode of interaction between VNP and these nuclear facilities (SRP, BNFP and Chem-Nuclear Services, Inc.) is a comparison of the combined estimated man-rem doses from all 4 plants with the estimated man-rem doses due to natural background.

The Barnwell Nuclear Fuel Plant Environmental Report estimates a dose of 17 man-rem/yr within a 50 mile radius of BNFP. The BNFP Environmental Report also states that "published SRP data suggests potential exposure valves similar to those expected from BNFP;"(3) therefore, a similar valve of 17 man-rem/yr will be estimated for SRP. Chem-Nuclear Services, Inc. has no planned releases of radioactivity (see Subsection 2.8-3). The estimated man-rem dose from VNP (see Section 5.2) is approximately 16.6 man-rem/yr.

The estimated man/rem dose due to natural background radiation is approximately 95,000 man-rem/yr (see Section 6.1 or 5.2).

The combined estimated man-rem/yr dose from all 4 nuclear facilities in the area is approximately 50.6 man-rem/yr, which is 0.05 percent of the population dose due to natural background radioactivity.

REFERENCES:

1. Geological Survey Water Supply Paper 1841, Geology and Ground Water of the Savannah River Plant and Vicinity South Carolina.

2. Geological Survey Water Supply Paper 1669-W, The Yield of Sedimentary Aquifers of the Coastal Plain Southeast River Basins.

3. Frydman, M., A. Levy, and S. E. Miller, "Oxidant Measurements in the Vicinity of Energized 765 KV Lines." IEEE PES Summer Meeting, San Francisco, California, July 9-14, 1972. 1

Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

TRANSMISSION LINE ROUTING

FIGURE 5.4-1

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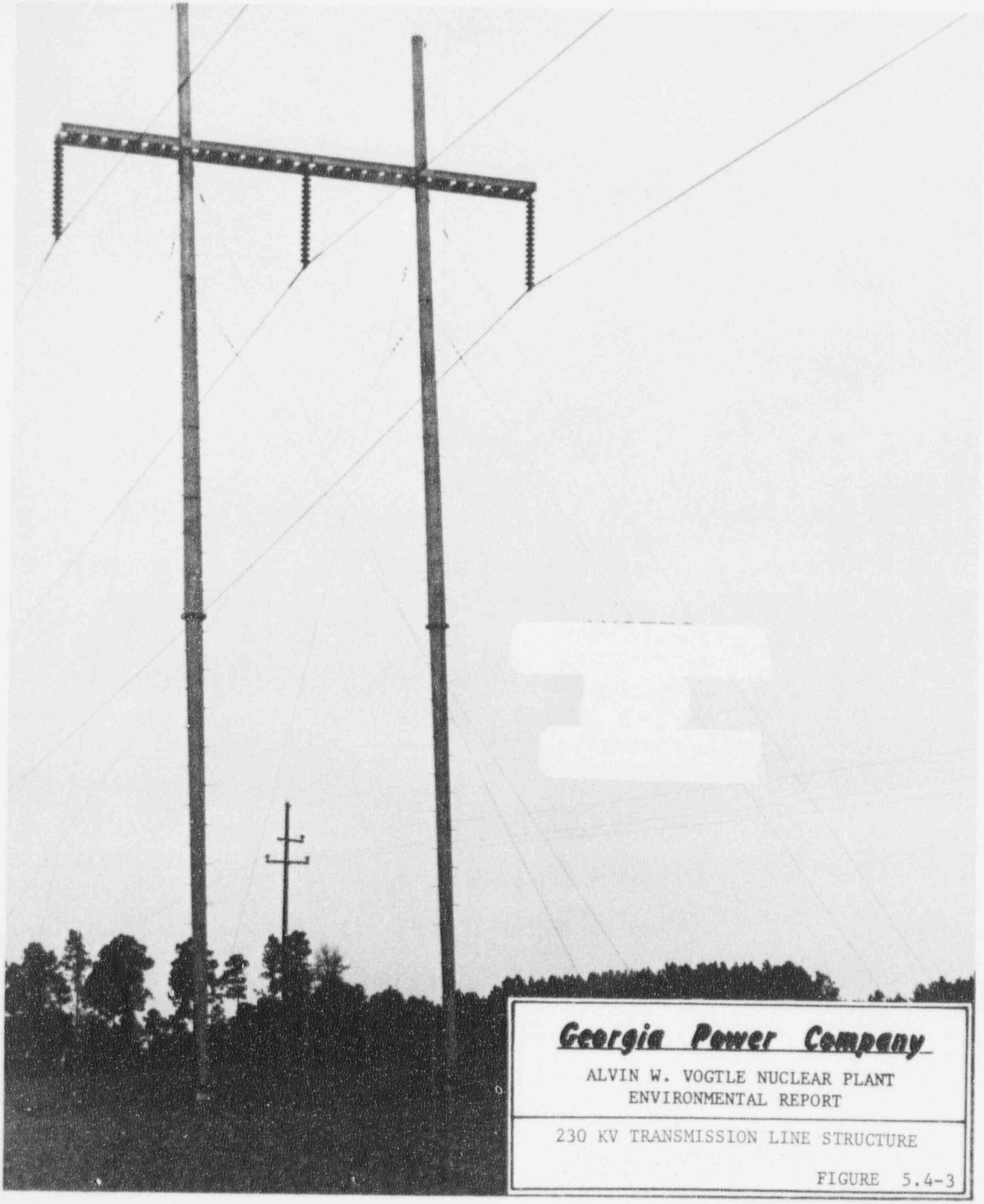
ENVIRONMENTAL REPORT

500 KV TRANSMISSION LINE STRUCTURE

FIGURE 5.4-2



Georgia Power Company

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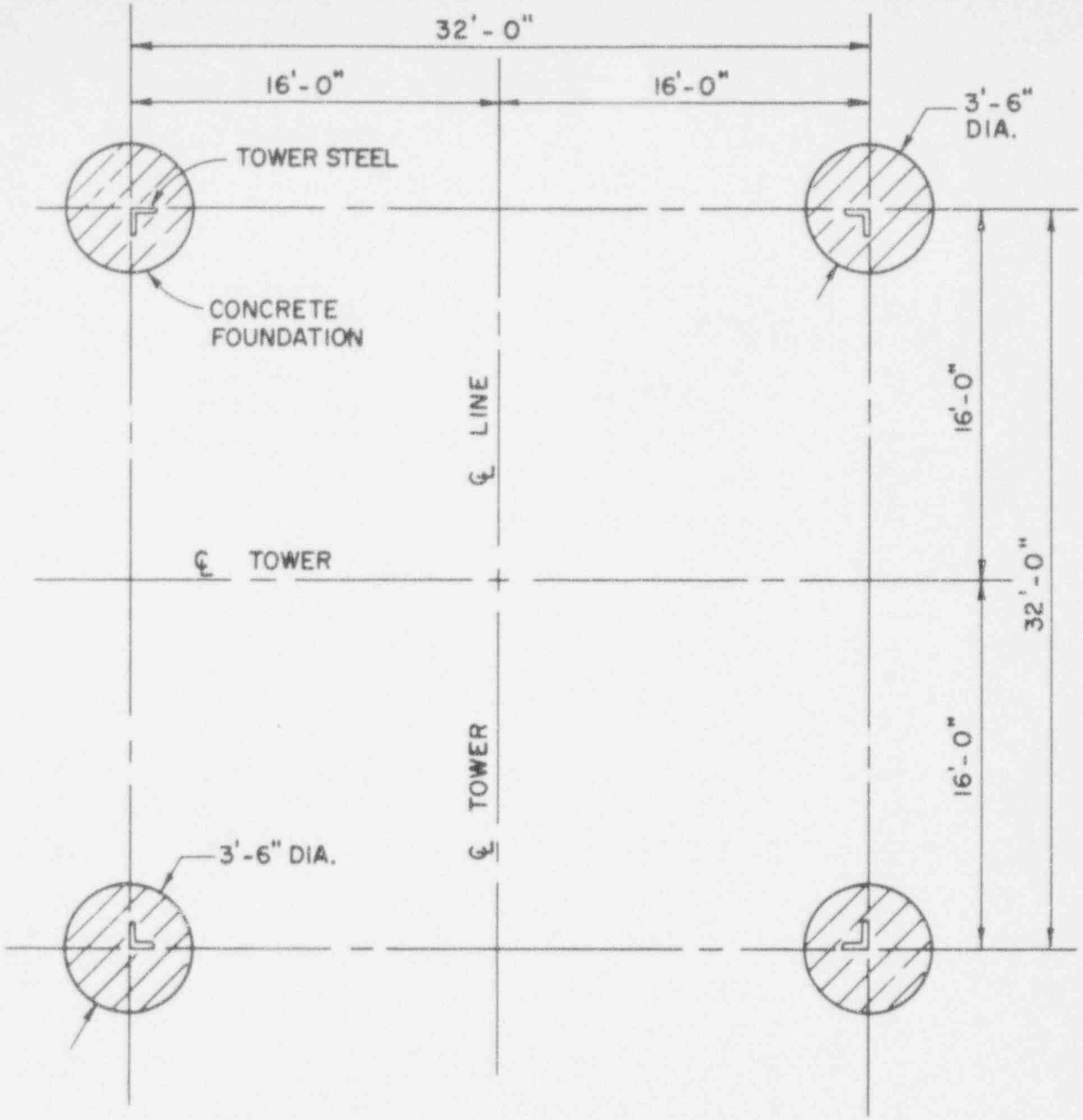
ENVIRONMENTAL REPORT

230 KV TRANSMISSION LINE STRUCTURE

FIGURE 5.4-3



1

FOUNDATION AND TOWER DIMENSIONS
FOR TYPICAL 500KV TOWER

FOUNDATION AREA PER TOWER - 38.6 SQ.FT.
ESTIMATED CONSTRUCTION WORK AREA (72'x72') 5184 SQ.FT.

Georgia Power Company
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ENVIRONMENTAL REPORT

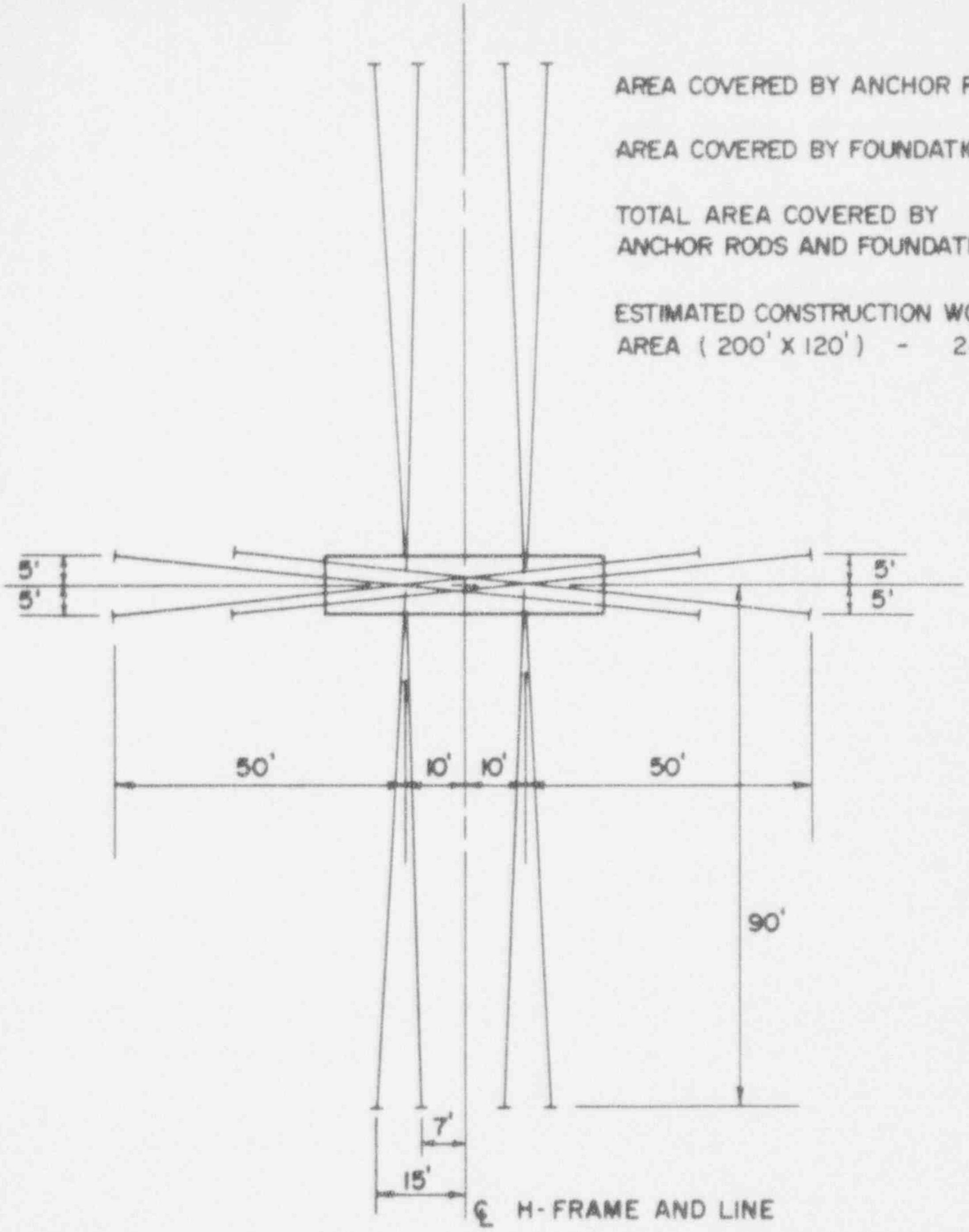
FOUNDATION AND TOWER DIMENSIONS
FOR TYPICAL 500 KV TOWER
Amend. 1 4/27/73 FIGURE 5.4-4

AREA COVERED BY ANCHOR RODS - 16 SQ.FT.

AREA COVERED BY FOUNDATIONS - 2 SQ.FT.

TOTAL AREA COVERED BY
ANCHOR RODS AND FOUNDATIONS - 18 SQ.FT.

ESTIMATED CONSTRUCTION WORK
AREA (200' X 120') - 24,000 SQ.FT.



TYPICAL TANGENT GUYED H-FRAME 230 KV

Georgia Power Company

ALVIN W. VOGTLE NUCLEAR PLANT
ENVIRONMENTAL REPORT

TYPICAL TANGENT GUYED H-FRAME 230 KV
Amend. 1 4/27/73 FIGURE 5.4-5

5.5 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.5.1 EXPECTED BACKGROUND

5.5.1.1 Natural Sources

There is no evidence or reason to suggest that sources of natural radiation in the area are untypical of the southeastern United States. The extensive data obtained in the studies of the Savannah River Plant (SRP)(1) support this belief; the preoperational studies for VNP should provide further evidence in this connection.

5.5.1.2 Man-made Sources

There are at present 3 principal sources of man-made radiation and radioactivity in the area: SRP, Chem-Nuclear Services, Inc., and fallout from nuclear detonations. In a few years the Allied-Gulf Nuclear Services plant at Barnwell, South Carolina, will constitute a fourth source.

The environmental monitoring program of the SRP started in 1951, before the plant went into operation. The program has included measurements of gamma radiation at the plant perimeter and at a distance of 25 miles from the plant, of atmospheric radioactivity collected on filters at the plant perimeter and at 25 and 100 miles from the plant, and of radioactivity in the Savannah River upstream and downstream from the plant discharges. This program has included numerous additional measurements, but these 3 are of particular importance in the present connection. Semi-annual reports of the results of the Savannah River Plant environmental program are available at least as far back as 1962.(1)

The recent gamma radiation measurements available from the Savannah River Plant environmental program are summarized in Table 5.5-1. Several conclusions may be drawn from this table. These conclusions are

1. The operation of the plant has had no significant influence on the gamma dose rates at the perimeter of the plant.

Table 5.5-1

GAMMA RADIATION DOSE RATES IN THE VICINITY OF THE SAVANNAH RIVER PLANT(1)

	mR/24 Hours			mR/24 Hours		
	Plant Perimeter			25-Mile Radius		
Year	Ave.	High	Low	Ave.	High	Low
1966	0.27	0.41	0.18	0.23	0.32	0.12
1967	0.25	0.50	0.12	0.24	0.44	0.13
1968	0.23	0.59	0.06	0.22	0.71	0.03
1969	0.26	0.79	0.07	0.24	0.77	0.02
1970	0.17	0.28	0.11	0.18	0.41	0.10
	0.24	-	-	0.23		
	(88 mR/Yr)			(84 mR/Yr)		
First Half 1971	0.18	0.27	0.08	0.17	0.25	0.08

2. The average dose rate over the area covered by the survey for the 5-year period is 86 mR (milliroentgen) per year. This is not significantly different from the value of 74 mrad per year measured at Sylvania, Georgia, in 1968.(2)

3. Variation about the average is large; the interval of ±50 percent of the average for any one year encompasses only about half of the extreme values in the table.

The measurements of filterable beta radioactivity in air since 1961(1) show variations with a ratio of high reading to low reading of about 400 to 1; the highest values occurred in the spring of 1963, and the lowest values occurred in late summer of 1967. Throughout this 10½ year period, the 3 sets of measurements (plant perimeter, 25-mile radius and 100-mile radius) show no systematic variations from one another. From this it may be concluded that the operation of SRP is having no appreciable influence on airborne filterable beta radioactivity at the perimeter of the plant or beyond.

Measurements of radioactive iodine in air since 1966(3) show only occasional positive values at the perimeter of the Savannah River Plant, and these are matched in almost every instance by similar values at the 100-mile radius. It thus appears that the plant is having no appreciable effect on airborne radioactive iodine at the perimeter.

Table 5.5-2 summarizes the measured concentration of airborne tritium collected on silica gel. It is evident from this table that concentrations of airborne tritium at the plant perimeter have been about 3 times those at a distance of 25 miles from the plant. It is clear, therefore, that the operation of SRP is increasing concentrations of airborne tritium by measurable amounts at the plant perimeter. These concentrations are very small in comparison to the maximum permissible concentrations.

Table 5.5-3 summarizes conditions of radioactivity in the Savannah River during 1970. Clearly, the operation of SRP is contributing measurable increases in the radioactive concentrations of the river. The significance of the last row in the table is not immediately evident. A negative value in this row indicates that less radioactivity appears in the river than is released by the plant. This lost activity possibly has been taken up in the sediments and swamps, or in the case of tritium, has been lost by evaporation.

Table 5.5-2

CONCENTRATIONS OF TRITIUM IN AIR IN THE VICINITY OF THE SAVANNAH RIVER PLANT(3)

	uCi per cc	
Year	Perimeter	25 mile radius
1966	1.9×10^{-10}	0.6×10^{-10}
1967	2.0×10^{-10}	0.7×10^{-10}
1968	2.7×10^{-10}	0.9×10^{-10}
1969	1.7×10^{-10}	0.5×10^{-10}
1970	1.7×10^{-10}	0.5×10^{-10}

RADIOAC

1. Above the SRP, µCi/cc
2. Above the SRP, Ci/year
3. Below the SRP, µCi/cc
4. Below the SRP, Ci/year
5. Apparent plant contrib (row 4-row 2) Ci/yr.

SRP Additions

6. Four Mile Branch Ci/yr
7. Pen Branch, Ci/yr.
8. Steel Creek, Ci/yr.
9. Lower Three Runs, Ci/y
10. Total SRP Addicions, C
11. Balance (row 5-row 10)

Table 5.5-3

TIVE MATERIALS IN THE SAVANNAH RIVER FOR THE YEAR 1970(3)

	H-3	Sr-89	Sr-90	Cs-137	S-35	Non Volatile Beta
	$8x10^{-7}$	-	$7x10^{-10}$	-	-	$2x10^{-9}$
	4,572	-	3.7	-	-	22.
	$5.9x10^{-6}$	$1.4x10^{-9}$	$1.1x10^{-9}$	$1.2x10^{-9}$	$4.1x10^{-9}$	$7x10^{-9}$
	36,345	2.2	6.5	5.3	26.0	38.
ion,	31,773	2.2	2.8	5.3	26.0	16.
	16,539	1.4	2.2	7.9	-	22
	9,262	0.9	0.3	1.4	-	2
	11,455	3.5	1.7	9.2	-	21.
.	57.	0.01	0.01	0.1	-	0.1
/yr.	37,313	5.8	4.2	18.6	0	45.
Ci/yr.	-5,540	-3.6	-1.4	-13.3	+26.	-29.

5.5.1.3 Measurements of Background Radiation for VNP

Ten provisional locations for external radiation monitors (thermoluminescent dosimeters, TLD's) and 2 provisional locations for airborne radioactive material samplers have been selected and are shown in Figure 5.5-1. The external radiation monitors were set out in January 1972. Several months of the data are given in Table 5.5-4. 3

One air sampling unit was put into operation on the north side of the site in 1973. The other was set up at the meteorological tower in February, 1974. These locations are shown on Figure 5.5-1. These stations will be operated until about July 1, 1974 and then discontinued until about two years prior to fuel loading. Other background radiation measurements are described under the preoperational program in Subsection 5.5.3. 3

5.5.2 CRITICAL PATHWAYS

The expected liquid and gaseous releases of radioactive materials from VNP are given in Table 3.6-2 and 3.6-3, respectively. In view of expected rates of releases, half-lives, and concentration factors in the food chain, it is considered that the principal pathways of human exposure will be among those given in Table 5.5-5.

The following studies will provide the information necessary to establish which human food pathways are critical, the degree to which the principal radioactive isotopes may be concentrated in these pathways, and the volume of food which moves along these pathways:

Biological studies (aquatic, terrestrial and agricultural)

Stable element concentrations

5.5.2.1 Biological Studies

The biological studies are intended to supplement, where necessary, the available information on the present state of the environment, to provide a system of observation sensitive and efficient enough to detect changes in any of the 3 biological communities - aquatic, terrestrial, and agricultural - and to provide samples and guidance for the design of the radiological portion of the program.

Table 5.5-4

PRELIMINARY DATA FROM EXTERNAL RADIATION BACKGROUND STUDY

DATA PERIOD
February, 1972

	NET MREM					
Station	1st	2nd	3rd	4th	5th	Average ± 2σ
00 Control	8	8	7	7	8	7.6 ± 1.0
01	10	11	11	11	10	10.6 ± 1.0
02	10	12	11	10	12	11.0 ± 2.0
03	10	9	12	10	11	10.4 ± 2.2
04	10	10	10	10	10	10.0 ± 0.0
05	9	9	10	9	9	9.2 ± 0.8
06	12	12	12	11	12	11.8 ± 0.8
07	10	10	11	11	10	10.4 ± 1.0
08	10	10	12	11	12	11.0 ± 2.0
09	11	11	10	11	11	10.8 ± 0.8
10	11	12	13	12	11	11.8 ± 1.6

NOTES:

1. Station numbers correspond to Figure 5.5-1.
2. Each dosimeter contains 5 individual chips. A dose reading is obtained from each chip.
3. Dose due to beta plus gamma.

Table 5.5-4

PRELIMINARY DATA FROM EXTERNAL RADIATION BACKGROUND STUDY

DATA PERIOD
March, 1972

Station	NET MREM 1st	2nd	3rd	4th	5th	Average ± 2σ
00 Control	6	6	6	6	6	6.0 ± 0.0
01	9	10	8	9	9	9.0 ± 1.4
02	11	9	11	10	10	10.2 ± 1.6
03	9	10	9	11	11	10.0 ± 2.0
04	10	11	11	9	9	10.0 ± 2.0
05	9	8	10	9	9	9.0 ± 1.4
06	11	12	12	13	13	12.2 ± 1.6
07	10	10	11	9	10	10.0 ± 1.4
08	9	9	9	9	10	9.2 ± 0.8
09	9	9	9	9	9	9.0 ± 0.0
10	9	10	9	8	10	9.2 ± 1.6

Table 5.5-4

PRELIMINARY DATA FROM EXTERNAL RADIATION BACKGROUND STUDY

DATA PERIOD
April, 1972

	NET MREM					
Station	1st	2nd	3rd	4th	5th	Average ± 2σ
00 Control	9	7	8	9	8	8.2 ± 1.6
01	14	10	12	11	14	12.2 ± 3.6
02	12	10	10	12	10	10.8 ± 2.2
03	10	8	8	10	9	9.0 ± 2.0
04	12	9	10	10	12	10.6 ± 2.6
05	10	11	11	10	10	10.4 ± 1.0
06	10	13	13	11	10	11.4 ± 3.0
07	10	9	12	10	12	10.6 ± 2.6
08	9	8	8	9	9	8.6 ± 1.0
09	9	8	9	9	9	8.8 ± 0.8
10	9	9	9	9	9	9.0 ± 0.0

Table 5.5-4

PRELIMINARY DATA FROM EXTERNAL RADIATION BACKGROUND STUDY

DATA PERIOD
May, 1972

	NET MREM					
Station	1st	2nd	3rd	4th	5th	Average ± 2σ
00 Control	6	7	6	6	5	6.0 ± 1.4
01	10	11	10	8	11	10.0 ± 2.4
02	10	10	12	11	12	11.0 ± 2.0
03	11	9	10	12	11	10.6 ± 2.2
04	10	10	10	10	9	9.8 ± 0.8
05	11	11	11	9	9	10.2 ± 2.2
06	11	11	11	12	13	11.6 ± 1.8
07	10	11	11	9	11	10.4 ± 1.8
08	10	11	10	12	10	10.6 ± 1.8
09	11	10	11	11	11	10.8 ± 0.8
10	10	10	10	10	11	10.2 ± 0.8

Table 5.5-5

PATHWAYS TO HUMAN EXPOSURE

Radioactive Material	Released to	Pathway to Humans
noble gases	atmosphere	direct exposure
tritium	atmosphere river	drinking water
iodine	atmosphere river	milk fish
cesium cobalt molybdenum rubidium strontium tellurium	river	wild birds fish irrigated crops

These studies were initiated in 1971. With this information it will be possible to relate the discharge rate measured by the plant effluent monitors to the resulting maximum and average dose to individuals in the area. This information will play a large part in the final design of the radiological monitoring program and will permit the limits of detection of this program to be expressed in terms of plant discharge rates.

5.5.2.1.1 Aquatic Studies

Studies of the benthic macroinvertebrate community and the fish community are currently being conducted by GPC and are described in detail in Section 2.7. The principal purpose of these studies is to gather pre-operational data that will allow GPC to detect any ecological changes in the river that might occur in either the construction or operation of VNP. These studies will also serve two secondary purposes - the selection and collection of species for stable element analysis and the selection of suitable species for radiological monitoring. The criteria used for selecting the species for these two secondary purposes are given below in Subsection 5.5.3.

Sampling station locations for the benthic macroinvertebrate community are as follows:

GPC Biol. 1:	River mile 159
GPC Biol. 2:	River mile 153
GPC Biol. 3:	River mile 150.4 (VNP site)
GPC Biol. 4:	River mile 148
GPC Biol. 5:	River mile 145.5

The locations of these stations are shown on Figure 5.5-2.

Sampling station locations for the fish community are as follows:

GPC F.B. 1:	River mile 169.6
GPC F.B. 2:	River mile 153
GPC F.B. 3:	River mile 148.4
GPC F.B. 4:	River mile 128.5

The locations of these stations are shown on Figure 5.5-2.

Benthic macroinvertebrate sampling currently is being conducted on a six-week basis at all five sampling stations. Collecting techniques currently being employed include the use of Modified Dendy-artifical substrates, rock-filled baskets, and dredge samples. Each sample is analyzed for species present and the relative numbers of each. Data are expressed in terms of species diversity indices.

Fish are currently being sampled on a six-week basis at two of the four fish stations. Collecting techniques currently being employed include electrofishing, gill nets, and seining. Species are identified, the number of each species determined, and the length and weight of each individual recorded. Four more stations recently have been selected for collection of a wide variety of aquatic organisms for stable element concentration studies. At present these stations are not fixed as the work has just been started. However, the following ranges for these stations on the Savannah River can be indicated:

S.L. 1: between river mile 158 and 162

S.L. 2: between river mile 151.7 and 153.6

S.L. 3: between river mile 148.4 and 144

S.L. 4: below river mile 128.5

The locations of these stations are shown on Figure 5.5-2. These locations will not be narrowed to a more definite range in distance for several months. The stable element concentration studies are described in Paragraph 5.5.2.2.

All of the above listed stations - benthic macroinvertebrate, fish, and stable element concentrations - are subject to change as more data becomes available. Sampling frequencies may also be changed.

5.5.2.1.2 Terrestrial Studies

The principal stresses VNP will have on the terrestrial environment will be from heat, water vapor and chemicals from the cooling towers and from radioactive effluents. The radiological monitoring program, described in Subsection 5.5.3, will detect radioactivity at levels far less than those which have ever been observed to cause any ecological change. Suitable methods for monitoring ecological changes caused by heat, water vapor, and chemicals are being sought. A program to monitor deposition of chemicals (both rate and amount), deposition of water, and movement of organisms on the plant site is currently under consideration.

Terrestrial studies also will identify the species of wild game important for hunting, estimate the annual harvest of game species in the area, and collect samples for stable element analysis. A survey of terrestrial plant communities was conducted by GPC and is described in detail in Section 2.7.

5.5.2.1.3 Agricultural Studies

A census will be taken of the food and fodder crops and of the domestic animals and domestic birds in the area. Available sources of information (county agents, farm and dairy associations, etc.) will be utilized and supplemented by field studies where necessary. Particular attention will be paid to the use of river water for irrigation and watering stock.

The data obtained from this census will be presented in the form of a series of maps which show the production and distribution of each of the principal agricultural products within 50 miles of the VNP.

5.5.2.2 Stable Element Concentration Studies

The determination of the concentrations of certain stable elements in water and in a variety of biological species enables one to make three estimates important for the radiological program: (1) upper limits on the degree to which radioactive materials discharged from the plant into the river will be reconcentrated in human food derived from the river, (2) the population dose produced by the anticipated liquid radioactive discharges from the plant, and (3) the concentrations of plant-produced radioactive materials in fish from measurements of concentrations of these materials in monitor organisms, such as clams or aquatic plants.

These applications of stable element concentrations are based on two premises: (1) that there is in the environment no physical, chemical, or biological mechanism which can discriminate amoung the isotopes (stable and radioactive) of a chemical element to any significant degree, and (2) that the radioactive isotopes in plant liquid wastes are present in much lower concentrations than are the corresponding stable analogs in the river water.

The chemicals which will be included in the stable element study are derived from consideration of the radioactive isotopes expected to occur in the VNP liquid wastes. Table 3.6-2 gives the isotopes which are expected in the liquid waste from a pressurized water reactor. The thirteen elements selected for study on the basis of expected releases, half-lives, concentration factors, and MPC's in water, as well as lead, mercury, and zinc, because of their importance in non-radioactive pollution, are listed in Table 5.5-6. Concentrations of these 16 elements will be measured in river water, sediment, and biological materials.

Table 5.5-7 lists the kinds of samples, numbers of sampling stations, and sampling frequency being considered for the stable element study. The selection will be guided by information gained from the biological studies, e.g. importance, availability and size.

Locations of sampling stations in the Savannah River for the stable element concentration study are given in Paragraph 5.5.2.1.1

5.5.2.3 Other Studies

The purpose of the studies described below is to provide support data for the biological and stable element concentration studies as well as to assess the effects of construction and plant operation on the environment.

Table 5.5-6

STABLE ELEMENT STUDY

Selected Elements

Barium
Cerium
Cesium
Cobalt
Iodine
Iron
Lead
Manganese
Mercury
Molybdenum
Niobium
Strontium
Tellurium
Yttrium
Zinc
Zirconium

Table 5.5-7

TYPES OF SAMPLES TO BE CONSIDERED FOR THE MEASUREMENT OF CONCENTRATIONS OF STABLE ELEMENTS

	SAMPLING STATIONS		
Sample material	Indicator *	Background *	Sampling periods
Water (filtered)	2-3	1-2	2 (Spring Fall)
Sediment (extractable)	2-3	1-2	2 (Spring Fall)
Bottom organisms (e.g. clams, snails)	2-3	1-2	2 (Spring Fall)
Rooted aquatic plants (e.g. water weed, parrot's feather)	2-3	1-2	2 (Spring Fall)
Game Fish (Plankton-feeder, e.g. gizzard shad; bottom-feeder, e.g. carp or sucker; omnivore, e.g. one of the catfish; carnivore, e.g. pickerel, sunfish)	1-2	1-2	2 (Spring Fall)
Wild game and birds (deer, squirrels, duck, pheasant, quail, etc.)	1	1	1 (hunting season)
Corps	1	1	1 (at harvest)
Domestic animals	1	1	1 (at slaughter)

* Refer to paragraph 5.5.3.1.1 for definition of station types.

5.5.2.3.1. Water Quality Studies

Dissolved oxygen and temperature measurements are taken once weekly at several stations on the Savannah River both above and below the plant site (see Section 2.5). Temperature data are recorded continuously by the USGS at river miles 156.83 and 138.80. This program was begun in October 1971. Daily maximums, minimums, and averages are available in the U.S.G.S. Water Resources Data for South Carolina. 3

A Yellow Springs Instrument Model 54 Oxygen Meter is used to measure D.O. (dissolved oxygen) and temperature. The instrument is calibrated to the nearest 0.1 ppm before and after each survey by the Modified Winkler Method for dissolved oxygen. Measurements are taken at the 1-, 3-, 5-, and 10-foot depths and also at the bottom. The survey was begun in July 1971.

To date, the lowest D.O. recorded in the river has been 3.9 ppm on the bottom with a temperature of 21.2°C at river mile 154 in August 1971. A D.O. of 1.8 ppm was recorded at the mouth of Lower Three Runs Creek (river mile 129.3) with a temperature of 23.6°C in July 1971. The highest temperature recorded in the river was 25.1°C at river mile 129 during September 1971. A temperature of 36.0°C was recorded at the mouth of Four Mile Branch in September 1971. No D.O. or temperature stratification has been noticed. At times the temperature of the river increases about 1.0°C from river mile 158 to river mile 129.

The D.O. and temperature survey will be continued on a weekly basis until June 1974. After June 1974, the survey will be discontinued until approximately one year before the plant begins operation. Figure 5.5-3 shows the locations of the weekly survey points. 3

Once every 3 months, grab samples are taken at 2 locations, and analyses are run. One sample is taken at river mile 150. The other sample is taken in Beaverdam Creek. Samples were first analyzed in June 1971. A typical analysis of a sample taken at river mile 150 is given in Table 5.5-8. An analysis for Beaverdam Creek is given in Table 5.5-9. A more thorough analysis for Beaverdam Creek is not yet available. Samples at these 2 locations will be taken quarterly during construction and into plant operation.

A permanent monitoring station for background water quality will be set up approximately 1 mile upstream of the VNP intake structure, and another permanent indicator water monitoring station will be set up approximately 1 mile downstream from the plant site. 2

TABLE 5.5-8
SAVANNAH RIVER
RIVER MILE 150
WATER QUALITY ANALYSIS
by
GPC
January 20, 1972

Color, color units........................	40
Turbidity, J.T.U..........................	18
Ammonia (N), ppm..........................	0.22
Aluminum (Al), ppm........................	0.00
Barium (Ba), ppm*.........................	0.0
Beryllium (Be)ppm*........................	0.0
Boron (B), ppm*...........................	0.0
Calcium (Ca), ppm.........................	5.6
Chloride (Cl), ppm........................	0.0
Total Chromium (Cr), ppm..................	0.0
Cobalt (Co), ppm**........................	0.0
Copper (Cu), ppm..........................	0.00
Fluoride (F), ppm.........................	0.00
Iodide & Iodine (I), ppm*.................	0.0
Iron (Fe), ppm............................	0.18
Lead (Pb), ppm*...........................	0.0
Magnesium (Mg), ppm.......................	5.8
Manganese (Mn), ppm**.....................	0.0
Molybdenum (Mo), ppm*.....................	0.0
Nickel (Ni), ppm*.........................	0.0
Phosphate (P), ppm........................	0.01
Potassium (K), ppm........................	1.8
Silicon (Si), ppm.........................	4.7
Silver (Ag), ppm..........................	0.0
Sodium (Na), ppm..........................	4.2
Strontium (Sr), ppm*......................	0.0
Sulfate (S), ppm..........................	2.1
Titanium (Ti), ppm*.......................	0.0
Vanadium (V), ppm*........................	0.0
Zinc(Zn), ppm**...........................	0.0
Zirconium (Zr), ppm**.....................	0.0
pH, electrometric.........................	6.4
Total Dissolved Solids, ppm...............	41.8
Nitrates and Nitrites (N), ppm............	0.17
Hardness as $CaCO_3$, ppm....................	38.0
Cyanide (CN), ppm.........................	0.08
Detergent, ppm............................	0.0
Tannin and Lignin, ppm.................	**0.39**
Oil and Grease, ppm....................	**7.2**

NOTE: * Recorded as 0.0 - is less than 0.1 PPM
** Recorded as 0.0 - is less than 0.01 PPM

TABLE 5.5-9
BEAVERDAM CREEK
WATER QUALITY ANALYSIS
by
GPC
December 20, 1971

Silica (SiO_2)	7.4
Iron (Fe)	0.24
Manganese (Mn)	0.0
Calcium (Ca)	5.6
Magnesium (Mg)	3.9
Sodium (Na)	7.6
Potassium (K)	1.9
Carbonate (CO_3)	0.0
Bicarbonate (HCO_3)	29.3
Sulfate (SO_4)	6.5
Chloride (Cl)	6.0
Fluoride (F)	0.0
Nitrate (N)	0.06
Phosphate (PO_4)	0.14
Total Dissolved Solids	61.3
Total Hardness as $CaCO_3$	30.0
Alkalinity as $CaCO_3$:	
Phenolphthalein	0.0
Total	24.0
pH, electrometric	6.9
Conductivity; micromhos	59
Free Carbon Dioxide (CO_2)	6
Turbidity, J.T.U.	6.5
Color, color units	29
Ionic Balance:	
Cations	0.979
Anions	0.780

NOTE: All values are expressed as parts per million, except the pH, conductivity, turbidity, color and balance.

The exact locations for these stations have not been decided upon yet. The water quality parameters to be monitored have not been decided upon yet, although dissolved oxygen, temperature, chlorides, pH, conductivity, and others are being considered.

5.5.2.3.2. Air Quality Studies-Sulfur Dioxide

A background sulfur dioxide study has been initiated to provide ambient air quality data in the vicinity of VNP. The study consists of 12 lead dioxide sulfation plates located at 1-, 5-, and 10-mile radii from the plant site. These sulfation plates are changed on a monthly basis. (See Figure 5.5-4 for approximate locations of sulfation plates.)

The sulfation plates give an estimation of long-term mean concentrations of sulfur dioxide in an area. This technique is best used to identify areas of sulfur dioxide pollution and to aid in locating continuous monitoring instruments in the most strategic locations, if required. Figure 5.5-5 shows a plot of results to date of the sulfation plate network of VNP. About July 1, 1974, this survey will be discontinued until approximately one year prior to plant operation. 3

5.5.2.3.3 Wet Cooling Tower Fogging and Icing Impact

This topic is discussed in Subsection 5.1.5.

5.5.2.3.4 5-Mile Survey

Starting 2 years prior to plant operation, a survey of the area within 5 miles of VNP will be conducted annually to determine the approximate numbers of milk cows, goats, and vegetable gardens and the location of the nearest potential pasture land. Data obtained from the surveys will be used to determine locations for obtaining samples for radiological analysis. The SRP reservation will not be surveyed since access to this area is limited. 2

A preliminary survey of this nature was conducted in July, 1973. Figure 5.5-10 shows the results of this survey.

5.5.2.4. Mathematical Models for Exposure Estimates

Estimates for this and other nuclear power plants indicate that the following pathways of exposure are likely to account for most of the radiation exposure to people within 50 miles of the plant.

1. External exposure to the radiations from airborne noble gases.
2. Internal exposure from the air-food-man pathway, in particular iodine-131 in milk.
3. Internal exposure from the water-fish-man pathway, in particular fresh-water fish and estuarine shell-fish.

There are, of course, many other potential pathways of exposure, but none of them which has been examined contributes appreciably to the exposure from the three pathways enumerated above.

Mathematical models have been developed to estimate the annual dose from measurements made on the effluent streams. Environmental measurements made at points along the exposure pathway serve to confirm, or refine the models for early stages of the pathway and to provide the input for models which describe later stages of the pathway. Figure 5.5-5a illustrates the relations among effluent measurements, environmental measurements and the environmental models.

For purposes of dose estimation, five mathematical models have been developed.

1) External dose model: gives the whole body dose which results from air containing radioactive noble gases.

2) Atmospheric ingestion rate model: gives the rate of ingestion for each isotope in the atmospheric effluent. Note in Figure 5.5-5a that this includes the Atmospheric Dispersion Model, Deposition Model, the Terrestrial Translocation Model, and the Population Ingestion Model.

3) Atmospheric dispersion model: gives the values of X/Q, the dispersion parameter used in the atmospheric ingestion rate model, number 2 above.

4) Aqueous ingestion rate model: gives the rate of ingestion for each principal isotope in the aqueous effluent. Note in Figure 5.5-5a that this includes the Aquatic Dispersion Model and the Population Ingestion Model.

5) Organ dose Model: gives the annual organ doses from all important sources of exposure by ingestion.

5.5.2.4.1 External Dose Model

The basic mathematical model used to calculate the whole body exposures is defined in reference 4 and modified as follows:

$$D_g = \sum_{\substack{\text{stability} \\ J=1}}^{4} \; \sum_{\substack{\text{isotope} \\ I=1}}^{13} \int_y \int_z \int_t C_1 \, C_i \, f_i \, X_J \, G_i \, dy \, dz \, dt \quad (4)$$

Where

D_g = Cloud gamma dose (rem)

C_1 = Conversion factor (3.7×10^4 Dis/sec-μCi)

C_i = Flux to dose conversion factor for the i^{th} isotope (rem/sec-γ/cc)

f_i = Number of photons of the i^{th} isotope emitted per disintegration (γ's/dis)

G_i = Dose attenuation kernel for the i^{th} isotope (dimensionless)

$$X_J = \left[\int_Y \frac{f_j \; Q_i}{2\pi \quad u \sigma_y \sigma_z} \exp\left(-\frac{z^2}{2\sigma_z^2} - \frac{y^2}{2\sigma_y^2} \right) dy \right] \Bigg/ \phi R \quad (5)$$

Where

X_J = Average annual isotopic airborne concentration of of the i^{th} isotope (uCi/cc)

f_j = Accumulative frequency for wind speed, stability and sector (dimensionless)

Q_i = Plant release rate of the i^{th} isotope (uCi/sec)

σ_y, σ_z = Horizontal and vertical diffusion coefficients (cm)

u = Wind speed (cm/sec)

y,z = Horizontal & vertical distances from plume centerline (cm)

ϕ = Sector angle over which plume is averaged(radians)

R = Distance from release point to detector position (cm)

5.5.2.4.2. Atmospheric Ingestion Rate Model

This model starts with the discharge rate of individual isotopes to the atmosphere (Q_{air}) and calculates the rate of ingestion (R_{ing}) for each isotope in terrestrially derived food. There are 15 individual stages to this calculation, which are set forth below.

(a) Rate of deposition: (5)

$$R_{dep} = (Q_{air}) \quad (V_{dep}) \quad (X/Q)$$

note that $C_{air} = (Q_{air}) \quad (X/Q)$

where C_{air} = concentration of isotope in air
If the deposition velocity is taken to be

$$V_{dep} = 10^{-2} \text{ m/sec}$$

$$R_{dep} = (10^{-2}) \quad (Q_{air}) \quad (X/Q), \qquad \frac{\text{u Ci}}{\text{m}^2 - \text{year}}$$

(b) Maximum rate of deposition:

$$(R_{dep})_{max} = (Q_{air}) \quad (V_{dep}) \quad (X/Q)_{max}, \qquad \frac{\text{uCi}}{\text{m}^2 - \text{year}}$$

(c) The maximum accumulated deposition on soil is important only for long-lived isotopes:

$$(D_{soil})_{max}^{(6)} = \frac{(R_{dep})_{max}}{\lambda_{soil}} \left(1-e^{-(L)(\lambda_{soil})} \right)$$

where:

λ_{soil} (6) = elimination constant for soil = 0.04 $year^{-1}$

L = Life of the plant = 40 years

substitution of these values gives

$$(D_{soil})_{max} = 20 \quad (R_{dep})_{max}, \quad \frac{uCi}{m^2}$$

(d) The maximum accumulated deposition on vegetation:

$$(D_{veg})^{(7)}_{max} = \frac{(R_{dep})_{max}}{\lambda field + \lambda r} \qquad \frac{uCi}{m^2}$$

where:

λ field = elimination constant while growing in the field = 18 $year^{-1}$

λr = radioactive decay constant, which is characteristic for the isotope

(e) Concentration in edible vegetation due both to recent deposition and to soil accumulation for the life of the plant; uptake from the soil is important only for strontium - 90 for which:

$$40y^C \text{ potato} = 1 \times 10^3 \; (R_{dep})_{max} \qquad \frac{pCi}{\text{kg wet wt.}}$$

$$40y^C \text{ flour} = 1 \times 10^3 \; (R_{dep})_{max} \qquad \frac{pCi}{\text{kg wet wt.}}$$

$$40y^C \text{ green veg} = 4 \times 10^4 \; (R_{dep})_{max} \qquad \frac{pCi}{\text{kg wet wt.}}$$

At the end of plant life (40 years), these concentrations in vegetation are derived predominatly from the strontium -90 accumulated in the soil, and only to a small extent from that which deposits directly on the growing plant. The factors for these three materials are obtained from data on calcium and strontium -90 concentrations and the general relations given in Russell, Radioactivity and the Human Diet.(7)

(f) Concentration in edible vegetation from direct deposition only (ignores uptake from the soil):

$$_{dep}C_{ev} = \frac{(F_{ev})\quad(D_{veg})_{max}\quad(K_w)\ (10^6)}{\Upsilon_{ev}},\quad \frac{pCi}{\text{kg wet wt.}}$$

where:

F_{ev} = fraction of the accumulated deposition on vegetation which falls on edible vegetation

$D_{veg\ max}$ = accumulated deposition on vegetation where ground-level concentration in air is a maximum

K_w = ratio of wet weight of vegetation to the dry weight

Υ_{ev} = yield of edible vegetation kg dry wt/m^2

10^6 = converts uCi to pCi

Take as representative values $F_{ev} = 0.1$, $\Upsilon_{ev} = 0.1$ kg dry wt./m^2
$K_w = 0.25$ kg (dry) /kg (wet)

$$_{dep}C_{ev} = 2.5 \times 10^5 \quad (D_{veg})_{max}\ ,\quad \frac{pCi}{\text{kg wet wt.}}$$

(g) Deposition rate at the dairy farm which has the highest ground concentration:

$$(R_{dep})_{milk} = \frac{(X/Q)_{milk}}{(X/Q)_{max}}\quad (R_{dep})_{max},\quad \frac{uCi}{m^2 - year}$$

where:

$(X/Q)_{milk}$ = the maximum value of the dispersion parameter at a dairy farm

$(X/Q)_{max}$ = the maximum value of the dispersion parameter

$(R_{dep})_{max}$ = maximum rate of deposition, see (b) above

(h) Accumulated deposition on vegetation at the dairy farm which has the highest ground concentration:

$$(D_{veg})_{milk} = \frac{(X/Q)_{milk}}{(X/Q)_{max}}\quad (D_{veg})_{max}\quad \frac{uCi}{m^2}$$

This relation applies only for strontium -89

(i) Concentration in milk:

$$C_{milk} = 2.7 \times 10^{3} \; ({}_{milk}K_{dep\ rate}) \; ((R_{dep})\ milk), \quad \frac{pCi}{liter}$$

where:

${}_{milk}K_{dep}$ rate = the constant which relates

C_{milk} to (R_{dep}) milk

$(R_{dep})_{milk}$ = Deposition rate at the dairy farm which has the highest ground concentration, see (g), above.

This relation applies for iodine -131, cesium -137 and strontium -90. For strontium -89, see (j), below

(j) Concentration of strontium -89 in milk:

$$C_{milk} = 1 \times 10^{6} \; ({}_{milk}K_{dep}) \; (D_{veg})\ milk$$

where:

$({}_{milk}K_{dep})$ See (i) above

$(D_{veg})_{milk}$ from (h) above

(k) Depostion rate at the beef-producing farm:

$$(R_{dep})_{beef} = \frac{(X/Q)_{beef}}{(X/Q)_{max}} (R_{dep})_{max}$$

where: $(X/Q)_{beef}$ = The value of the dispersion parameter at the beef-producing farm

$(R_{dep})_{max}$ See (b) above

This relation applies only for cesium -137 and strontium -90.

(l) Concentration in beef:

$$C_{beef} = 2.7 \times 10^3 \left({}_{beef}K_{dep\ rate}\right) (R_{dep})_{beef}$$

$$\frac{pCi}{kg\ wet\ wt.}$$

where:

$\left({}_{beef}K_{dep\ rate}\right)$ = the constant relating the concentration in beef to the total deposition rate at the beef-producing farm

$(R_{dep})_{beef}$ See (k) above

This relation applies only for strontium -90 and Cesium -137.

(m) Rate of ingestion by way of milk:

$$(R_{ing})_{milk} = (C_{milk}) (R_{cons})_{milk}$$

where: C_{milk} is given by (i) and (j)

$(R_{cons})_{milk}$ = rate of milk consumption, liter/day

take $(R_{cons})_{milk}$ = 1 liter/day for a child, then

$(R_{ing})_{milk} = C_{milk}$, $\frac{pCi}{day}$

This relation is important only for I-131, Sr-90, Sr-89 and Cs-137.

(n) Rate of ingestion by way of beef:

$$(R_{ing})_{beef} = (C_{beef}) \quad (R_{cons})_{beef}$$

where: C_{beef} is given by (l) (above)

$R_{cons})_{beef}$ = rate of beef consumption, kg wet wt./day.

take $R_{cons})_{beef}$ = 0.1 kg wet wt./day, then
$R_{ing})_{beef} = 0.1\,(C_{beef})\,,\ \frac{pCi}{day}$

This relation is important only for cesium -137 and strontium -90.

(o) Rate of ingestion by way of vegetables:

$$(R_{ing})_{ev} = (C_{ev}) \quad (R_{cons})_{ev}$$

where C_{ev} is given by (e) or (f) (above)

$(R_{cons})_{ev}$ = rate of consumption of edible vegetables, kg wet wt./day

take $(R_{cons})_{ev}$ = 0.1 kg wet wt./day, then
$(R_{ing})_{ev} = 0.1\,(C_{ev})\ \frac{pCi}{day}$

Note: for Sr-90, use $C_{ev} = L^{C}{}_{veg}$ (5c)

5.5.2.4.3. Atmospheric Dispersion Model

This model is used to derive the annual average ground-level value for X/Q. The formula is that given by Slade (ref. D. H. Slade, editor <u>Meteorology and Atomic Energy</u>, TID-24190, 1968, p. 113):

$$\frac{X}{Q_{air}} = \left(\frac{2}{\pi}\right)^{1/2} \sum_{i} \sum_{j} \frac{0.01\, f_i}{\sigma_{zi}\, \bar{u}_j\, (2\pi x/n)} \exp\left[-\frac{h^2}{2\,\sigma_{zi}^{\;2}}\right]$$

where:

X = ground level air concentration at downwind distance x in a given sector (Ci/m^3)

Q_{air} = effluent discharge rate to air (Ci/sec)

i = atmospheric stability class

f_i = frequency of stability class i in the sector

σ_{zi} = standard deviation of the vertical concentration distribution at distance x for stability class i (m)

$\bar{u}_j$ = average wind velocity for wind class j (m/sec)

x = downwind distance (m)

n = number of sectors (16)

h = stack height (m)

The on-site meteorological data should be available by December, 1973 (see Section 2.6).

5.5.2.4.4 Aqueous Ingestion Rate Model

This model gives the rate of human ingestion for each isotope in the aqueous effluent. There are three individual stages to this calculation, which are set forth below.

(1) Aquatic dispersion: Calculate the average annual concentration in river water

$$C_{water} = \frac{Q_{water}}{R_{flow}}$$

where:

C_{water} = average annual liquid effluent discharge rate for each isotope ($uCi/_{cm^3}$)

Q_{water} = average annual liquid effluent discharge rate for each isotope (uCi/year)

R_{flow} = average annual river flow (cm^3/year)

This relation assumes instantaneous and complete dilution of the effluent by river water. This condition will be realized within several miles downstream from the outfall. It is unlikely that many fish spend their entire lives in this mixing zone and even less likely that such fish constitute a significant fraction of any individual's diet of fish.

The relation above also assumes constant, continuous rates of effluent release and river flow. Seasonal variations of river flow and discrete but frequent nuclide discharges are unlikely to influence dose estimates appreciably. Such annual averaging is consistent with the recommendations of 10 CFR 20.

The annual average river flow estimated from 34 years of data is:

$$R_{flow} = 8.9 \times 10^{15}\ \mathrm{cm}^3/\mathrm{year}$$ | 2

(2) Aquatic translocation: Calculate the average concentration in each important aquatic organism.

$$C_{aq\ org} = C_{water}\ (F_{conc})\ org$$

where: $C_{ag\ org}$ = average annual concentration for each isotope in the aquatic organism (uCi/g)

C_{water} = average annual concentration for each isotope in river water, See (1) above (uCi/cm^3)

$(F_{conc})_{org}$ = concentration factor for each isotope in the organism (uCi/g_{ev} uCi/cm^3)

Values for the concentration factor, $(F_{conc})_{org}$, are obtained from Chapman, et al, VCRL-50564, December 1968; Jinks and Eisenbud, Radiation Data and Reports, vol. 13, No. 5, May 1972; Freke, Health Physics 13: 743-758, 1967; and from pre-operational studies at the site.

(3) Population ingestion: Calculate the average annual rate of ingestion of an isotope by eating aquatic organisms.

where:

$(R_{ing})_{lim}$ = limiting rate of ingestion of the isotope (pCi/day)

10^6 converts uCi to pCi

Then for any medium

$$(R_{ing})_{medium} = (R_{cons})_{medium} \times C_{medium}$$

where $(R_{ing})_{medium}$ = rate of ingestion of the isotope by way of the medium (pCi/day)

$(R_{cons})_{medium}$ = rate of consumption of the medium (g/day)

C_{medium} = concentration of the isotope in the medium (pCi/g)

Let $F_{dose\ lim}$ = the ratio of organ dose to organ dose limit for any organ

then

$$F_{dose\ lim} \leq \frac{(R_{ing})\ medium}{(R_{ing})\ lim}$$

(2) The situation with strontium -89, strontium -90 and iodine -131 is different from that with other isotopes because the Federal Radiation Council has recommended specific intake rates which are expected to deliver the maximum permissible population dose to the critical organ.

Isotope	(R_{ing}) lim
I-131	80 pCi/day
Sr-89	6,000 pCi/day
Sr-90	600 pCi/day

With these values for $(R_{ing})_{lim}$ the same expression used for other isotopes applies

$$F_{dose\ lim} \leq \frac{(R_{ing})\ medium}{(R_{ing})\ lim}$$

(3) The organ dose from ingestion can be calculated from

$$R_{\text{organ dose}} \le R_{\text{organ dose limit}} \left(\sum_{\text{media}} \sum_{\text{isotopes}} F_{\text{dose limit}} \right)$$

where the organ dose limits are

Organ	$R_{\text{organ dose limit}}$
Whole body, gonads, bone marrow	0.17 rem/year
Thyroid, skin	0.5 rem/year
Other organs	0.5 rem/year

Note:

The following data are necessary in the formulary of 5.5.2.4. They are given here, with the source.

Symbol	Value	Reference
V_{dep}	10^{-2} m/sec	5, p. 207
L	40 years	SAR
λ soil	0.04 year^{-1}	6
λ field	18 year^{-1}	7, p. 92
λ r	year^{-1}	6
K_w	0.25 kg (dry)/kg (wet)	11, p. 42
F_{ev}	0.1 dimensionless	9, & 7, p. 193
Y_{ev}	0.1 kg (dry) /m^2	9
$_{\text{milk}}K_{\text{dep rate}}$	1.7 uCi/1 per uCi/m^2-day (for I-131	6
	4.9 for Cs-137	6
	0.23 for Sr-90	6

beef^{K}dep rate	23 uCi/kg (wet) per uCi/m^2-day (for Cs-137)	6
	0.94 for Sr-90	6
	0.03 for Sr-89	7
$(R_{cons})_{beef}$	100 g/day wet (1/4 of meat)	7, p. 68
$(R_{cons})_{ev}$	100 g/day wet	12, p. 200
$(R_{cons})_{milk}$	1 liter/day	10

5.5.3 SAMPLING MEDIA, LOCATIONS AND FREQUENCY

5.5.3.1 The pre-Operational Phase

5.5.3.1.1 Basis for the Choice of Sampling Locations

The radiological survey program is designed on the principle that samples and measurements are to be taken at two kinds of locations: indicator stations, where concentrations of plant-produced radioactive materials are expected to have equal long-term or maximum values, and background stations, where concentrations of plant-produced radioactive materials will be insignificant. Indicator samples provide the most sensitive indications of plant emissions, while background samples provide concurrent measures of radiological conditions not associated with the plant operation. The latter type of information enables GPC to distinguish changes brought about by fallout from nuclear detonations, emissions from other nuclear plants, discharges from nuclear medicine clinics, and other sources from those changes produced by plant discharges. Before-and-after comparisons do not permit this distinction to be made.

5.5.3.1.2 Indicator Stations for Atmospheric Radioactivity

Stations for atmospheric radioactivity, both indicator and background, will contain a continuous air sampler, a precipitation collector and one or more devices for measuring external beta and gamma radiation. The continuous air sampler will consist of a pump able to draw at least one cubic foot per minute (300 cubic meters per week) through the filter train consisting of a dust filter and an iodine-trapping cartridge, a pressure gage, and a running-time clock, or a gas-volume meter. The precipitation collector consists of a plastic funnel of known area and a plastic jug. Devices suitable for measuring external beta and gamma radiation are photographic film dosimeters, dessicated and sealed, or TLD's.

Optimum locations for the indicator stations are determined from the data generated by the meteorological program described in Subsection 5.5-7. These data are used to calculate the average annual ground-level concentrations and doses which would occur if radioactive gases were emitted continuously from the plant at a constant rate. The results of such calculations are plotted on a map as isopleths of equal doses. The indicator stations will be placed, as far as practical, along an isopleth of equal concentration which falls inside the site boundary.

5.5.3.1.3 Background Stations for Atmospheric Radioactivity

Background stations will be placed 10 to 15 miles from the site at locations not expected to be significantly influenced by plant operations. The location of neighboring nuclear facilities and the direction from which the prevailing winds come will aid in determining the locations.

5.5.3.1.4 External Radiation Monitors

A monitor for external beta and gamma radiation (film badge or TLD) will be placed at each of the indicator atmospheric monitoring stations. Ten additional monitors will be placed at intervals midway between these stations on the same isopleth. Each of the background atmospheric monitoring stations will contain two external radiation monitors to provide sufficient background data as reference for the indicator readings.

5.5.3.1.5 Surface Water Monitoring Stations

There will probably be 4 stations for monitoring surface water, two background stations upriver from the point of discharge of VNP and two indicator stations below the discharge. Sediment and aquatic organisms will also be collected at three of these stations. The locations for these stations will be established on the basis of the information obtained in the preliminary phase and,consequently, cannot be given at this time. Several species of rooted aquatic plants exist in the river, and the expectation is that at least one of these species can be used as a monitor organism for radiological purposes.

5.5.3.1.6 Ground Water Monitoring Stations

There will be 5 indicator wells drilled to the surface of the ground water (30 to 40 feet below grade). These will be 1500 to 2000 feet from the center of the plant to the east, southeast, south, southwest and west. There will be one background well about 2000 feet north of the plant center.

5.5.3.1.7 Agricultural Samples

When the types and locations of various agricultural activities in the area have been established, the selection of agricultural materials suitable for radiological monitoring will be considered. For each type of indicator sample, a corresponding background sample will be designated.

5.5.3.2 The Operational Phase

Table 5.5-10 summarizes the present plans for the Operational Phase of the radiological program. The other samples which are assayed for radioactivity will be analyzed by appropriate means for those isotopes which occur in the corresponding waste discharge to an appreciable extent.

Table 5.5-10 indicates that three sampling regimes will be used. Regime I involves the analysis of only the radiation dosimeters and the collection of only airborne dust and precipitation. These samples could not be collected soon enough after an unanticipated release to give information about such a release. If no unwanted release occurs during the collection period, the samples of airborne dust and precipitation are discarded without analysis. Regime II will be used when plant discharges are sufficiently large that they may produce measurable levels of radioactivity in the environment. Regime III is an intensive program which will be used when plant discharges are several times larger than those which call for Regime II. For the first 12 months of commercial operation, Regime II will be used regardless of how low the discharges may be.

5.5.3.2.1 Basis for the Choice of Sampling Media

The environmental media to be sampled have been selected because they are the most sensitive, the most reliable, and the most readily interpreted in terms of the environmental parameters (dispersion, dilution, deposition and concentration) which control the population dose resulting from any given rate of discharge.

SAMPLE
External Radiation
Airborne Dust
Precipitation
Milk
Other Agricultural Products
River Water
River Sediment
Aquatic Organisms
Groundwater

Notes:

(1) Milk or other agr
areas where the g
concentration.

(2) The station water

(3) Key: F dessicat
S collecte
C collecte
G a grab s
H-52 a grab s
P survey o

The numbers

Table 5.5-10

Tentative Schedule for the Operational Radiological Program

VOGTLE NUCLEAR PLANT

NUMBER OF STATIONS		SAMPLING FREQUENCY (See Notes Below) REGIME			
INDICATOR	BACKGROUND	I	II	III	TYPE OF ANALYSIS
20	5	F-13	F-13	F-4	Film badges and/or TLD's will be read by outside firms with in plant personnel providing periodic checks.
10	5	S-1	C-1	C-1	Filters will be assayed by gross beta, followed, if necessary by gamma scan.
10	5	S-4	C-4	C-4	Precipitation will be assayed by gamma spectrometer.
(1)	(1)	None	G-4	G-1	Analyzed for Iodine by gamma spectrometer.
(1)	(1)	None	H-52	H-4	Analyzed by gamma spectrometer.
2	2 (2)	None	C-4	C-1	River water will be assayed by gamma spectrometer. At least quarterly a sample will be filtered and assayed and insoluable material will be scanned for gross beta.
2	1	None	P-52	P-13	Sediment will be surveyed by underwater gamma probe.
2	1	None	G-13	G-4	Soft muscle portion and fillets will be assayed by gamma spectrometer.
5	1	None	G-13	G-4	The entire sample will be assayed for tritium.

icultural products will be included in the program only if they are produced in
round concentration of plant effluent is 1/10 or more of the site boundary

intake will provide the second background station for river water.

ed film badge or TLD read at the end of the exposure period
d and discarded without analysis
d continuously and assayed for radioactivity
ample assayed for radioactivity
ample at harvest, H-4 a grab sample at 4-week intervals during the growing season
f sediment with an underwater gamma probe

after the letters give the sampling period in weeks.

For example, organisms which move over an extensive area are not generally suitable as sample media because there is no way to know what location they represent.

5.5.3.2.2 Basis for the Choice of Sampling Frequency

The frequencies of sampling of the 3 monitoring regimes given in Table 5.5-10 are adjusted to correspond to the amount of radioactive material released. When the amounts released are large, the frequency of sampling of the affected media will be high. The converse is also true. At discharge rates where prediction and measurement indicate that no detectable quantities of plant-produced materials occur, the sampling frequency will drop to zero. In some cases the sampling frequency is determined by inherent characteristics of the medium: air filters can be run only for a week before excessive pressure-drop arises; agricultural crops are best sampled at the time of harvest.

5.5.3.2.3 Plans for Implementation of Table 5.5-10

5.5.3.2.3.1 Indicator Stations for Atmospheric Radioactivity.

These stations will contain a film badge and/or a thermoluminescent dosimeter for measuring external beta and gamma radiation, a continuous air sampler for sampling airborne dust, and a precipitation collection jug. There will also be an elapsed running-time clock or a gas-volume meter for use with the continuous air sampler. The air sampling pumps will be Bell and Gossett Motor Vacuum Pumps, Model STC 19-1, equipped with in-line aluminum charcoal cartridge holders coupled to an aluminum filter holder for 47 mm paper.

There will be 10 indicator stations placed approximately 36 degrees apart on the site. These 10 stations will be located on, or as near as practical to, an isopleth of equal long-term ground level concentration. Isopleths will be calculated using data generated by the on-site meteorological tower.

One on-site air sampling station was established in 1973 and another in February, 1974. The locations of these two stations are shown on Figure 5.5-1. These stations will be operated until about July 1, 1974 and then discontinued until about one year prior to fuel loading when all of the indicator air sampling stations will be installed. The locations of the two stations already installed may change based on meteorological data and the isopleths calculated. 3

5.5.3.2.3.2 Background Stations for Atmospheric Radioactivity.

These stations will contain the same instruments and will perform the same functions as the indicator stations. However, these stations will contain 2 external radiation dosimeters to provide adequate background data. Three of these stations will be located in Georgia 10 to 15 miles from the plant, approximately 72 degrees apart. Two stations will be located in South Carolina--one on the SRP reservation and the other at Johnson's Landing, S.C. Four of these five stations were installed in 1973 and the fifth (located at Johnson's Landing, S.C.) will not be installed until about one year prior to fuel loading. The locations of these stations are shown on Figure 5.5-6. These locations are as follows:

> Station 1 is located on Horseshoe Road in Richmond County, Georgia about 0.2 miles from Georgia Highway 56 and about 14 miles northwest of the VNP site.
>
> Station 2 is located at the GPC district office in Waynesboro, Georgia about 14 miles west of the VNP site.
>
> Station 3 is located in downtown Sardis, Georgia on Georgia Highway 24 about 11.5 miles south of the VNP site. 3
>
> Station 4 will be located at Johnson's Landing, South Carolina about 18 miles southeast of the VNP site.
>
> Station 5 is located at the intersection of South Carolina Highway 125 and SRP 1 about 13 miles north of the VNP site.

These stations will be operated until about July 1, 1974 and then discontinued until about one year prior to fuel loading. The locations of these stations may change based on meteorological data and the isopleths calculated.

5.5.3.2.3.3 External Radiation Monitors.

External radiation monitors will be located as far as practical in accordance with Paragraph 5.5.3.1.4.

At the present time there are 10 on-site external radiation monitoring
stations set up to obtain background data (also described in Subsection
5.5.1.3). Each station contains 1 thermoluminescent dosimeter (TLD). 3
The TLD is exchanged quarterly. These stations were located so as to
cover the site adequately and to be out of the way of construction
activities. The station locations are given on Figure 5.5-1. These
stations were established in January 1972 and will be continued until
isopleths have been calculated. Then these stations will be relocated
in accordance with Paragraph 5.5.3.1.4. Some results of this program 3
are given in Table 5.5-4.

5.5.3.2.3.4 Station Locations. The proposed sampling program for the radiological survey is given in Table 5.5-10. All the information necessary to determine the locations for proper sampling is not yet available. However, from preliminary surveys, the following can be given as tentative sampling locations:

1. External Radiation, Airborne Dust, and Precipitation- Sampling stations will be located as stated in Paragraphs 5.5.3.2.3.1, 5.5.3.2.3.2, 5.5.3.2.3.3, and as shown on Figure 5.5-6.

2. Milk and Agricultural Products - If milk or other agricultural products are produced in areas where the ground concentration of plant effluent is 1/10 or more of the site boundary concentration, these areas will be used as indicator stations and background stations will be located at areas not significantly influenced by the plant.

3. River Water - Background stations for monitoring river water will be located about 1 mile upstream and at the river intake structure. Indicator stations for monitoring river water will be located about 1 mile downstream and about 7 miles downstream.

4. River Sediment - A background station for river sediment will be located about 1 mile upstream. Indicator stations will be located about 1 mile downstream and about 7 miles downstream.

5. Aquatic Organisms - A background station for aquatic organisms will be located about 1 mile upstream. Indicator stations will be located about 1 mile downstream and 7 miles downstream.

6. Ground Water - A background well for ground water will be located about 2000 feet north of the plant center. Indicator wells will be located 1500 to 2000 feet to the east, southeast, south, southwest, and west of the plant center.

5.5.4 ANALYTICAL SENSITIVITY

Table 5.5-10 and Figure 5.5-7 give a brief description of tentative plans for and types of analyses to be performed and the measuring equipment to be used. A more detailed description follows.

5.5.4.1 Monitoring Equipment

The Vogtle Nuclear Plant environmental monitoring program will use the following apparatus:

Gross beta --	thin window, wide-area, low-level beta counter
H-3 --	liquid scintillation counter
Gamma Spectrometry -	4" x 4" NaI crystal in a shielded cave. Spectrometry will be performed by a multi-channel analyzer

5.5.4.2 Sample Characteristics

The characteristics of samples will vary depending upon the medium and the analysis:

Gross beta --	2" diameter paper or glass fiber filter
H-3 --	small volume of water distilled from sample
Gamma Spectrometry - Liquid --	large volume of untreated liquid in Marinelli beaker
Organisms --	flesh separated from bones, shells, etc.
Charcoal --	small mass of charcoal granules (~50 gm) in canister or vial.

5.5.4.3 Sample Size

Air samples will be limited in size by collection techniques. Water and milk samples will be limited in size by analytical techniques. Aquatic organism sample sizes will probably be limited by availablility. Anticipated sample sizes are listed in Table 5.5-10a.

5.5.4.4 Lower Detection Limits and Sample Sensitivities

An equation(13) universally used to estimate the 95% confidence level uncertainty is:

$$E = \pm 1.96 \left[\frac{S}{t_s} + \frac{B}{t_b}\right]^{\frac{1}{2}}$$

Table 5.5-10a

VNP RADIOLOGICAL MONITORING PROGRAM SAMPLE SIZES AND SENSITIVITIES

REGIME III

Sample Types	Frequency	Sample Size	Analysis	Lower Detection Limit	Collection Efficiency	Sample Sensitivity
Agricultural Products	Monthly	500 g.	γ-Spec.	80 pCi/sample	100%	15 x 10 pCi/g wet
Airborne Dust	Weekly	400 m^3	B	5 x 10^{-1} pCi/sample	100%	1 x 10^{-3} pCi/m^3
Airborne Iodine	Weekly	400 m^3	I-131	80 pCi/sample	25%	8 x 10^{-1} pCi/m^3
External Radiation	Monthly	1 mo.	Read-out	<10 mrem/period	100%	<10 mrem/mo.
Precipitation	Monthly	3.5 l.	γ-Spec.	80 pCi/sample	100%	20 pCi/l
Precipitation	Monthly	0.005 l.	H-3	2.5 pCi/sample	100%	5 x 10^2 pCi/l
River Water	Weekly	3.5 l	γ-Spec.	80 pCi/sample	100%	20 pCi/l
River Water	Weekly	0.005 l.	H-3	2.5 pCi/sample	100%	5 x 10^2 pCi/l
River Water	Weekly	3.5 l	I-131	80 pCi/sample	100%	20 pCi/l
Milk	Weekly	3.5 l	γ-Spec.	80 pCi/sample	100%	20 pCi/l
Milk	Weekly	3.5 l	I-131	80 pCi/sample	100%	20 pCi/l
River Benthos	Monthly	500 g.	γ-Spec.	80 pCi/sample	100%	1.5 x 10^{-1} pCi/g wet
River Fish	Monthly	500 g.	γ-Spec.	80 pCi/sample	100%	1.5 x 10^{-1} pCi/g wet
Well Water	Monthly	3.5 l	γ-Spec.	80 pCi/sample	100%	20 pCi/l
Well Water	Monthly	0.005 l	H-3	2.5 pCi/sample	100%	5 x 10^2 pCi/l
Well Water	Monthly	3.5 l	I-131	80 pCi/sample	100%	20 pCi/l

For I-131 on charcoal, a one-pint freezer jar geometry is assumed. Assuming 100% collection efficiency, the corresponding sample sensitivity is 5×10^{-2} pCi/m^3. If the sample configuration could be reduced in size, the lower limit of detection would decrease.

The general form for sample sensitivity is

$$\text{Sample Sensitivity} \left(\frac{\text{pCi}}{\text{unit}}\right) = \frac{\text{Lower Limit of Detection} \left(\frac{\text{pCi}}{\text{sample}}\right)}{\text{Sample Size} \left(\frac{\text{units}}{\text{sample}}\right) \times \text{Collection efficiency (\%)} \times 100}$$

5.5.4.5 Collection Efficiency

Collection efficiency for airborne dust is taken as 100% because filters to be used are to be membrane type or glass-fiber type, efficiencies of which are approximately 100% for airborne particles.(14)

There is some disagreement about the efficiency of charcoal and iodine-impregnated charcoal, as illustrated in the results of two experiments.

1. Craig, et al.(15) found that charcoal and its impregnated charcoal had CH_3I efficiencies of ~ 90% at RH = 75%, temperature = 22°C, and concentrations ranging from 2.3×10^{-6} ug/cc to 2.7×10^{-10} ug/cc. ($PMPC_a = 1 \times 10^{-15}$ ug/cc).

   However, they found that absorption of I_2 depended upon upstream concentration below 1×10^{-5} ug/cc. The efficiency fell to about 50 % at 5×10^{-8} ug/cc, the lowest concentration used in the experiment. Efficiency was related to concentration by a power function. In all cases, temperature ranged from 20-25°C, and RH ranged from 60-80%.

   Linear flow rate for the test facility is estimated to have been 250 l fpm (1000 cfm flow through 4 ft.^{2} cross-section).

2. Keller, et al.(16) observed different results at lower incident concentrations. They found efficiency of charcoal and iodine-impregnated charcoal exceeded 99% for elemental iodine. For these tests, linear flow rate ranged from 40 to 200 ft/min, relative humidity ranged from 5% to 75%, and incident I_2 concentration ranged from 10^{-8} to 10^{-12} ug/cc. ($PMPC_a$ = 1×10^{-10} uCi/ml is equivalent to 1×10^{-15} ug/cc).

> Data from Keller, et. al, for CH_3I also contradict the findings of Craig, et al. Efficiencies varied with linear flow rate, ranging from 20-35% at 200 l fpm to 50-70% at 50 l fpm for charcoal and iodine-impregnated charcoal. The authors speculate that efficiencies were also affected by canister design, and provide data from a test of silver zeolite in a commercial canister to support that speculation. The CH_3I tests were conducted with an incident I-131 concentration of 1×10^{-10} ug/cc and 75% relative humidity.

This work bases iodine collection efficiencies on the experiment of Keller, et al., for two reasons. First, the collection devices tested are the devices planned for use as samplers. (Craig, et al. were testing large-scale air cleaning devices.) Second, the incident iodine concentrations used in Keller's work more nearly approach anticipated environmental levels than do Craig's.

The collection device planned for use has a 1.5-inch inside diameter, and a 1.5 cfm flow rate. The corresponding linear velocity is 125 feet per minute. Keller, et al. determined collection efficiency of charcoal to be~100% for molecular iodine and~25% for methyl iodide at this flow rate.

5.5.5 DATA ANALYSIS AND PRESENTATION

If exposure rates or isotope concentrations in background samples do not exceed sample sensitivities (i.e., if these results are "not detectable"), no statistical analysis need be performed. The mean value for indicator stations is translated to dose using models described in 5.5.2.4. It is anticipated that data from all I-131 analyses, all H-3 analyses, and analyses of gamma emitting nuclides in water may be treated this way.

Other measurements will probably require statistical analysis. The technique planned for use is Student's "t" test for the difference between two normal means. A flow chart for applying this test to environmental monitoring data is presented in Figure 5.5-8. Terms are defined as follows:

x_i = measurement at indicator station

N_i = number of indicator stations

x_b = measurement of background station

N_b = number of background stations

$$\bar{x} = \text{mean value} = \frac{1}{N} \sum_{j=1}^{N} x_j$$

$$S = \text{standard deviation} = \left[\frac{\sum_{j=1}^{N} (x_j - \bar{x})^2}{N - 1} \right]^{\frac{1}{2}}$$

Subscripts "i" and "b" are not used in the flow chart because of the requirement that $s_1^2 > s_2^2$. However, the application should be clear. Required values from statistical tables are drawn from Table 5.5-10b and 5.5-10c. Note that in this "t" test values for "both tails" are used for t_{cal}.

If significant differences are discovered, factors derived from models if 5.5.2.4 are used to translate these differences to dose.

If differences are not significant, minimum detectable differences will be calculated, noted, and translated to dose.

The calculation for minimum detectable difference is given by Pelletier(12) as:

$$M = t_{table} \quad S_P \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$$

where

M = minimum detectable difference in same units as sample sensitivity

t_{table} = the one-tailed value of t for DF = $N_1 + N_2 - 2$ obtained from Table 5.5-10c for P = 0.01

Table 5.5-10b

Values of F Table

DF$_1$

DF$_2$	1	2	3	4	5	6	7	8	9	10	20	30	∞
1	4052	5000	5403	5625	5764	5859	5928	5982	6022	6056	6209	6261	6366
2	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.45	99.47	99.50
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	26.69	26.50	26.13
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.02	13.84	13.46
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.55	9.38	9.02
6	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.40	7.23	6.88
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.16	5.99	5.65
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.36	5.20	4.86
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	4.81	4.65	4.31
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.41	4.25	3.91
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.10	3.94	3.60
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	3.86	3.70	3.36
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.66	3.51	3.17
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.51	3.35	3.00
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.37	3.21	2.87
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.26	3.10	2.75
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.16	3.00	2.65
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.08	2.92	2.57
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.00	2.84	2.49
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	2.94	2.78	2.42
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	2.88	2.72	2.36
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	2.83	2.67	2.31
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	2.78	2.62	2.26
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	2.74	2.58	2.21
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.70	2.54	2.17
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.66	2.50	2.13
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.63	2.47	2.10
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.60	2.44	2.06
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.57	2.41	2.03
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.55	2.39	2.01
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.37	2.20	1.80
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.20	2.03	1.60
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.03	1.86	1.38
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	1.88	1.70	1.00

Table 5.5-10c

Values of t Table

DF	$P = 0.05$		$P = 0.01$	
	One Tail	*Both Tails*	*One Tail*	*Both Tails*
1	6.32	12.8	31.9	63.7
2	2.92	4.30	6.96	9.92
3	2.35	3.18	4.54	5.84
4	2.13	2.78	3.75	4.60
5	2.02	2.57	3.36	4.03
6	1.94	2.45	3.14	3.71
7	1.90	2.36	3.00	3.50
8	1.86	2.31	2.90	3.36
9	1.83	2.26	2.82	3.25
10	1.81	2.23	2.76	3.17
11	1.80	2.20	2.72	3.11
12	1.78	2.18	2.68	3.06
13	1.77	2.16	2.65	3.01
14	1.76	2.14	2.62	2.98
15	1.75	2.13	2.60	2.95
16	1.75	2.12	2.58	2.92
17	1.74	2.11	2.57	2.90
18	1.73	2.10	2.55	2.88
19	1.73	2.09	2.54	2.86
20	1.72	2.09	2.53	2.84
21	1.72	2.08	2.52	2.83
22	1.72	2.07	2.51	2.82
23	1.71	2.07	2.50	2.81
24	1.71	2.06	2.49	2.80
25	1.71	2.06	2.48	2.79
26	1.71	2.06	2.48	2.78
27	1.70	2.05	2.47	2.77
28	1.70	2.05	2.47	2.76
29	1.70	2.04	2.46	2.76
30	1.70	2.04	2.46	2.75
∞	1.64	1.96	2.33	2.58

S_p, N_1, N_2 = values used or derived in the "t" test.

A typical form for statistical analysis is given in Figure 5.5-9.

Results of the radiological monitoring program will be reported in a format similar to Table II, Appendix A of the AEC Safety Guide Number 21 on Monitoring and Reporting of Effluents and Environmental Levels, dated June 23, 1971.

5.5.6 PROGRAM STATISTICAL SENSITIVITY

The assay of background samples of a given medium will give a mean and standard deviation on the mean; corresponding statistics will result from the assay of indicator samples. If the indicator mean is significantly greater than the background mean, the difference is a measure of plant-contributed radioactivity and radiation. This difference can be used in the mathmatical models developed in 5.5.2.4 to estimate a population dose.

Recognizing that the important isotope from the standpoint of ingestion is I-131 (in aquatic organisms and in milk) and that the most important exposure pathway is exposure to a noble gas cloud, it is clear that the sensitivity of the program will be limited by sensitivities of these analyses.

Based on statistical analysis of the Edwin I. Hatch Nuclear Plant TLD data found in Section 2.6 of the Hatch FSAR, the program should be sensitive to 20 mrem/yr whole body gamma dose from a noble gas cloud.

Based on sample sensitivities for I-131 in milk and aquatic organisms, and assuming consumption rates of one l/day and 0.1 kg/day respectively the program should be sensitive to rates of intake of 15 pCi/day from aquatic organisms and 20 pCi/day from milk. Using FRC relations between rate of intake and dose, these intakes correspond to 100 mrem/year and 130 mrem/year to the thyroid.

5.5.7 ONSITE METEOROLOGICAL MEASUREMENTS PROGRAM

The onsite meterological measurement program commenced operation in April, 1972. Instruments for measuring pertinent meteorological parameters are installed on a 150-foot tower located in a cleared area south of the plant site (see Figure 2.1-3). The tower is not affected by large plant structures, as it is approximately 3000 feet from the nearest large structure. The base of the tower is at elevation 245 feet, which is approximately that of plant grade (220 feet). Instrument elevations and descriptions are given in Table 5.5-11.

The data are continuously recorded on strip chart recorders, and in addition, are recorded in digital form on magnetic tape at one minute or less. The instruments are monitored 3 times a week, and preventative maintenance is performed by Georgia Power Company personnel in accord with the instrument manuals. The personnel are also available on a "rapid call" basis for emergency repair work to minimize outages and to assure maximum data recovery. Calibrations are performed at approximately 6-month intervals in accord with the instrument manuals. An inventory of spare parts is maintained by the repair personnel, and new parts are ordered as they are used. Presently there are no on-site repair personnel. However, repair personnel should be based on-site in the near future.

Routine processing of the data will be by digital computer using the magnetic tape records from the site. These data will be converted to engineering units and summarized to provide averages representative of each hour of data. These hourly averages will be stored on magnetic tape from which monthly, seasonal, and yearly summaries can be tabulated as required.

Useful data from the tower will be available after at least one complete year of data has been compiled. A year's data should be available by December, 1973. Due to equipment problems the tower did not become operational unitl November, 1972.

Approximate Height Above Tower Base	I
150' (mounted on SE side of tower)	Wind S
35' (mounted on SE side of tower)	Wind S
100' (mounted on SE side of tower	Vertic Angle
150'	Tempe
95'	Tempe
33'	Tempe
33'	Refere ture fo with 1
33'	Dew P
6'	Solar
Ground	Rainfa

* All parameters are reco
signals from a Climet M
to six per minute. Addi
(Esterline Angus Model

** Outputs from sensors ar
which provides input to t

Table 5.5-11

VOGTLE ONSITE WEATHER INSTRUMENTS

Sensed arameter	Recorded* Parameter	Instrument Characteristics**
peed & Direction	Wind Speed (Recorder #1) & Direction (Recorder #2)	Climet-Model WS-001 (speed) 0.6 mph threshold; and model 012-10 (direction). Distance constant is 5 feet, vane has 0.75 mph threshold & damping ratio of 0.4.
peed & Direction	Wind Speed (Recorder #1) & Direction (Recorder #2)	Climet (same as above)
al & Horizontal	Vertical & Horizontal Angle (Recorder #3)	Climet Bivane Model 012-11
rature	-	Thermistor (Climet 15-3) in aspirated solar radiation shield (Climet 016-1). Accuracy ± 0.15°C.
rature	-	(Same as above)
rature	Ambient Temperature (Recorder #5)	(Same as above)
nce Tempera- r Comparison 0' & 95' Levels	$T_{150'} - T_{33'}$ and $T_{95'} - T_{33'}$ (Both Recorder #4)	(Same as above)
oint	Solar Radiation	Dew Point Sensor (Climet 015-12) Shield (Climet 016-2)
adiation	Solar Radiation (Recorder #6)	Pyramometer (Climet 503-1). Responds to wavelengths of .32 to 2.5 microns.
l	Rainfall (Recorder #6)	Climet Model 0501-1

---

rded on Kennedy incremental tape recorder (Model 1600-360). This tape drive receives
odel 100 sequential sampler and analog to digital converter which has sampling rates of up
ionally, each parameter is recorded on one of six dual channel servo strip chart recorders
E1102S). Recorders are numbered 1-6 on the table.

e input to a Climet Model 060 multipurpose, multi-parameter signal conditioner module
he strip chart recorders and to the A-D converter for the tape drive.

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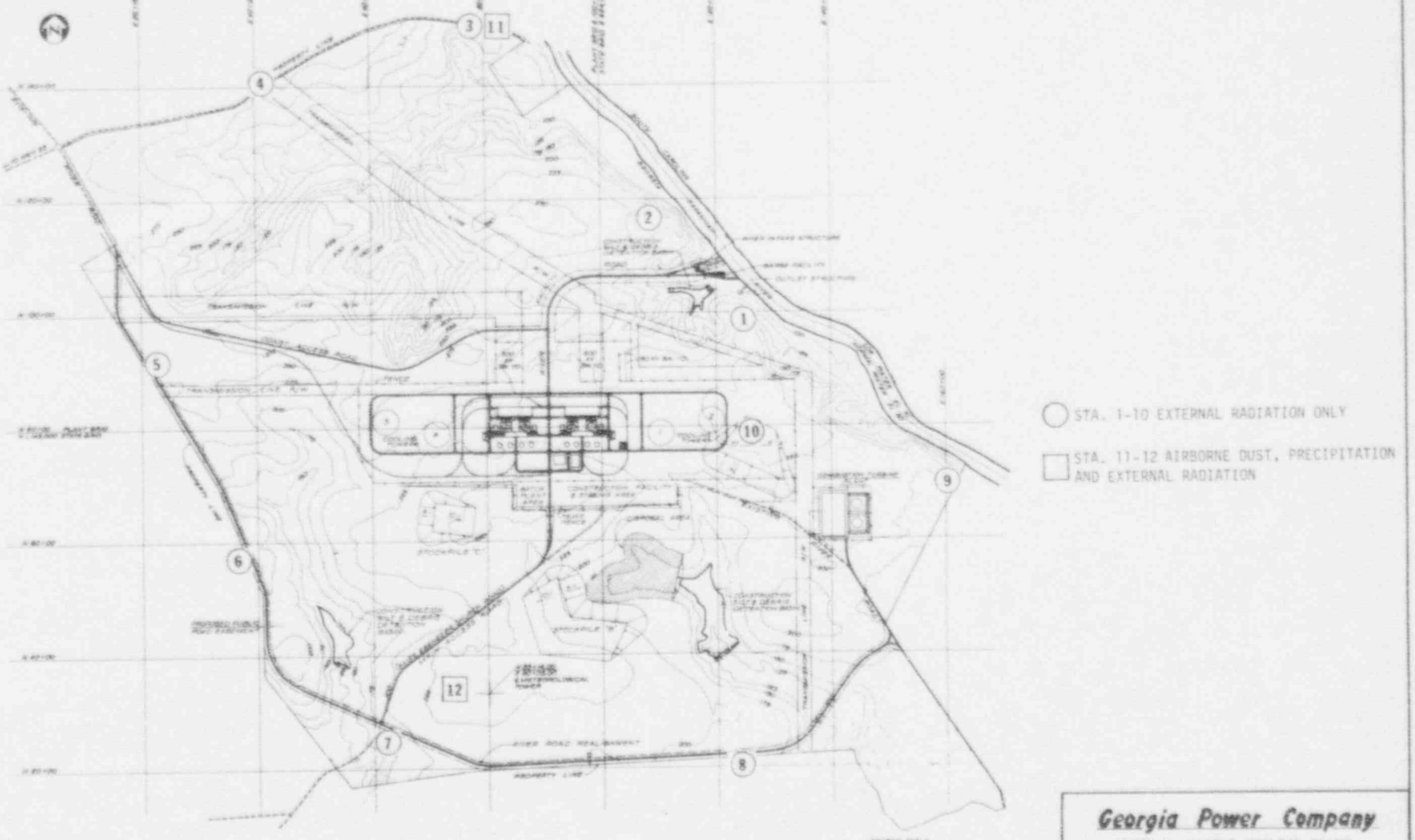

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PROVISIONAL LOCATIONS FOR MONITORING
ATMOSPHERIC RADIOACTIVITY
FIGURE 5.5-1

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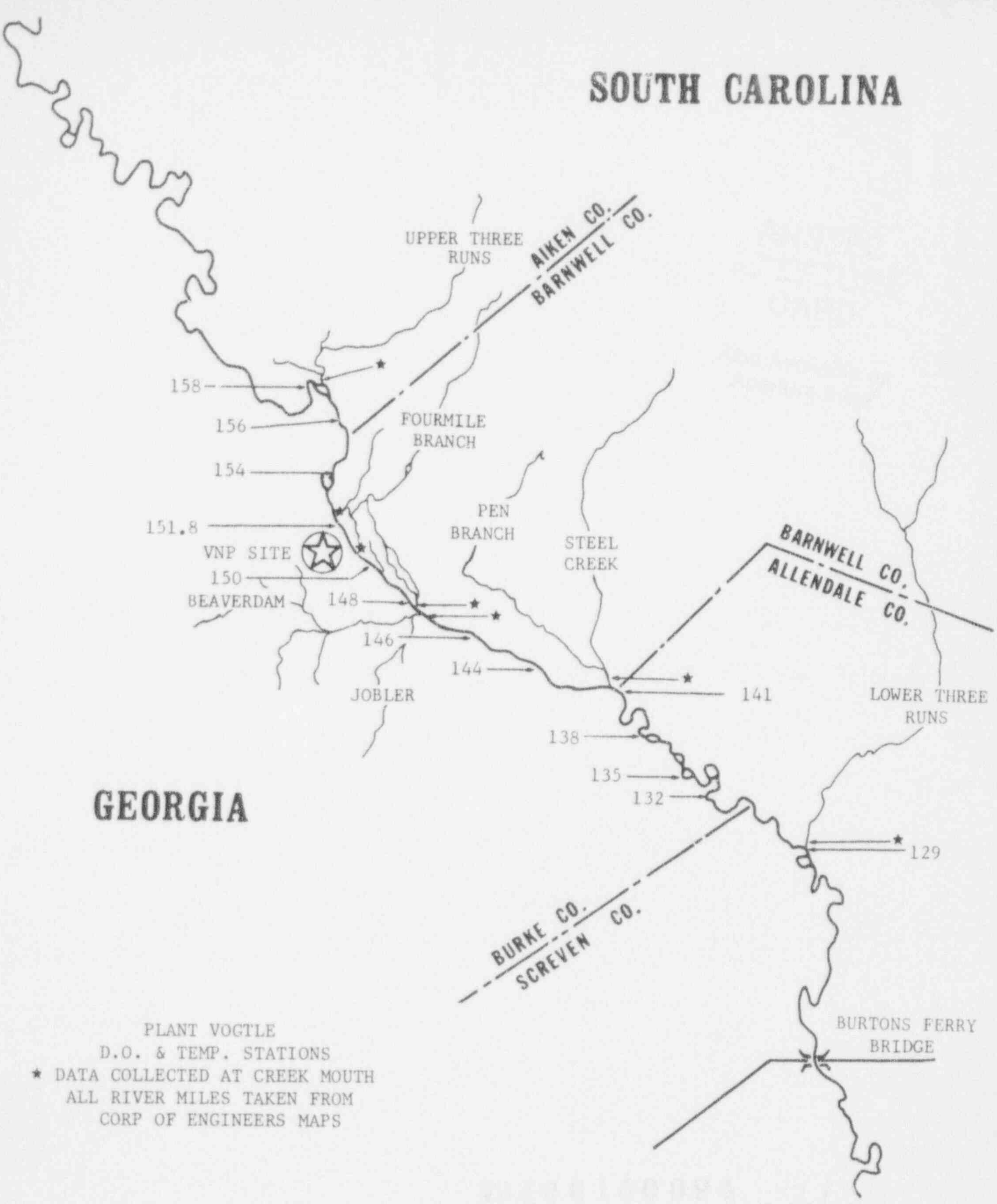

PLANT VOGTLE
D.O. & TEMP. STATIONS
★ DATA COLLECTED AT CREEK MOUTH
ALL RIVER MILES TAKEN FROM
CORP OF ENGINEERS MAPS

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D.O. & TEMPERATURE STATIONS

FIGURE 5.5-3

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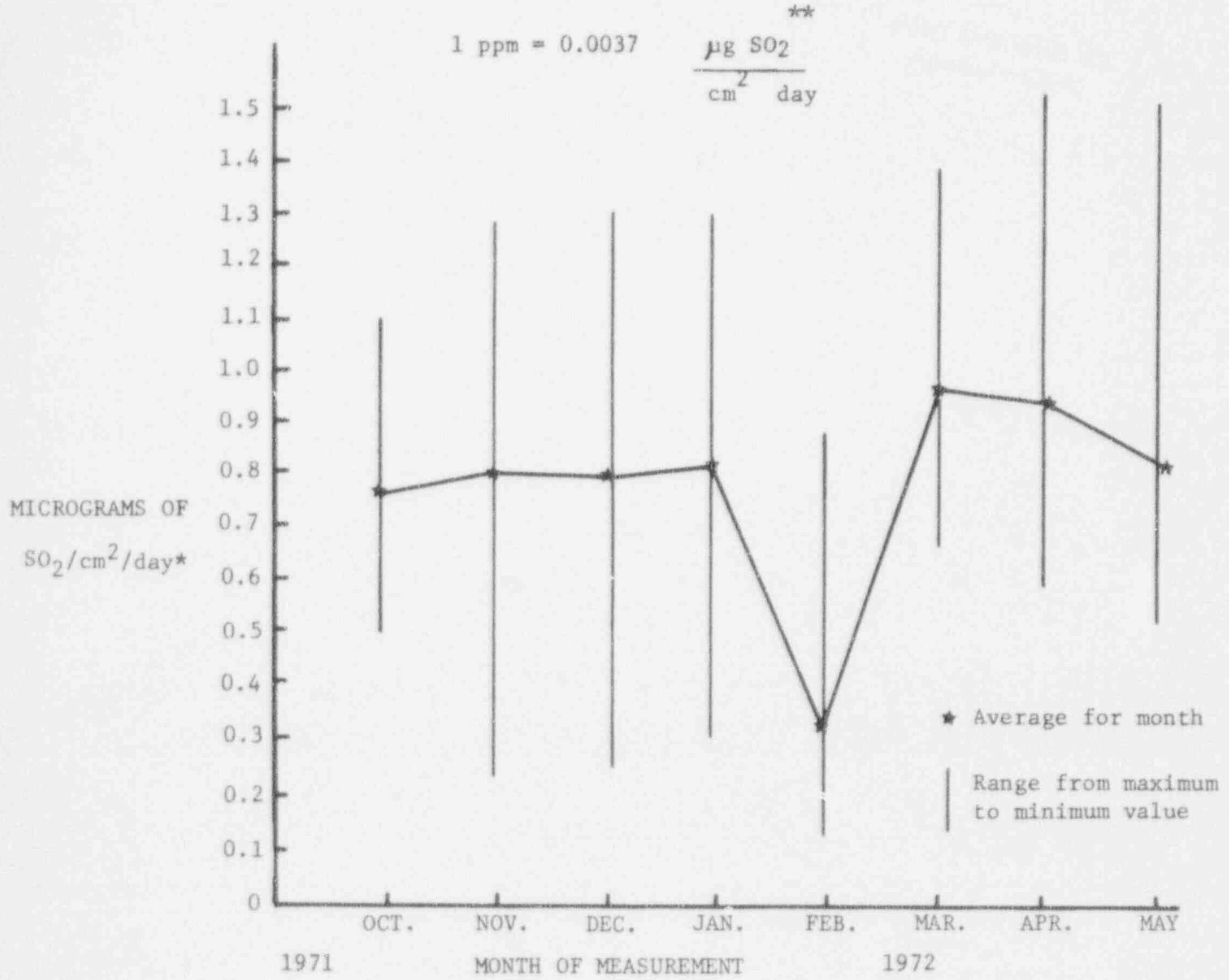

* To convert to an approximation of ppm SO_2 use the conversion factor 0.0037.

** Written correspondence between C. M. Dixon, Ga. Power Co., and Robert Corning, Corning Laboratories, Inc., Nov. 2, 1971.

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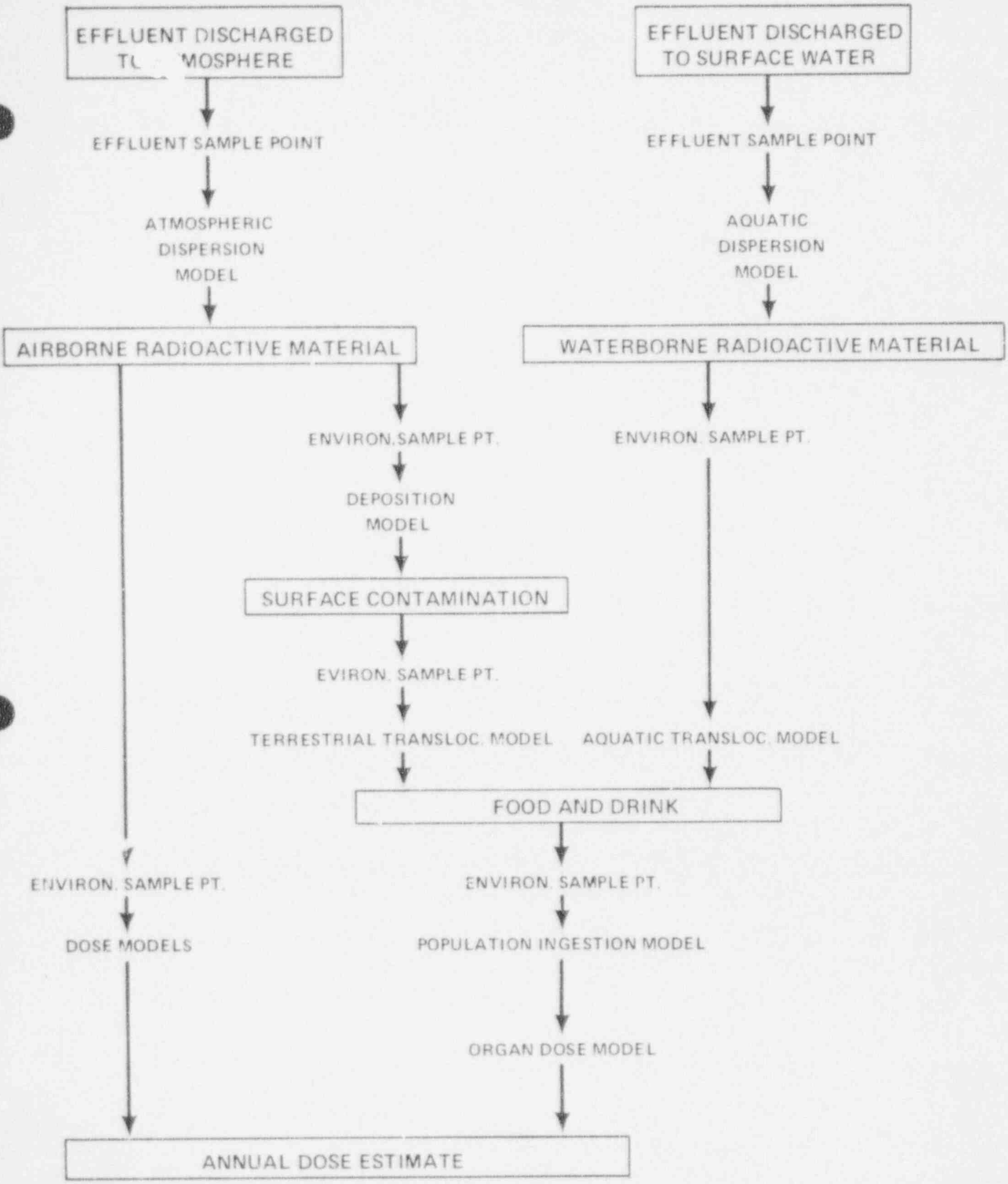
SULFATION PLATE RESULTS
PLANT VOGTLE

FIGURE 5.5-5



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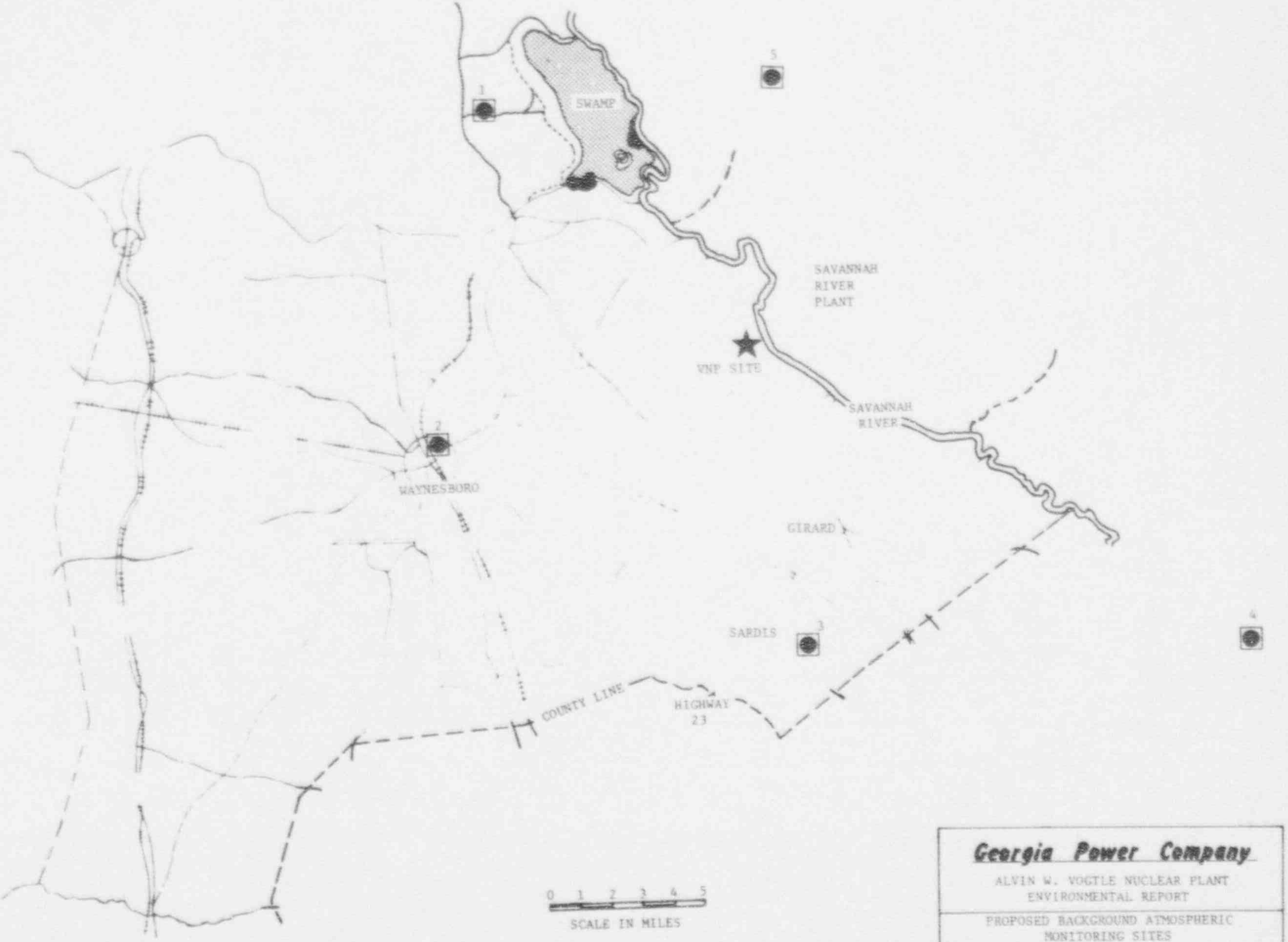
RELATIONS AMONG EFFLUENT MEASUREMENTS, ENVIRONMENTAL MEASUREMENTS, MATHEMATICAL MODELS AND DOSE ESTIMATES.

FIGURE 5.5-5a



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PROPOSED BACKGROUND ATMOSPHERIC
MONITORING SITES

FIGURES 5.5-6

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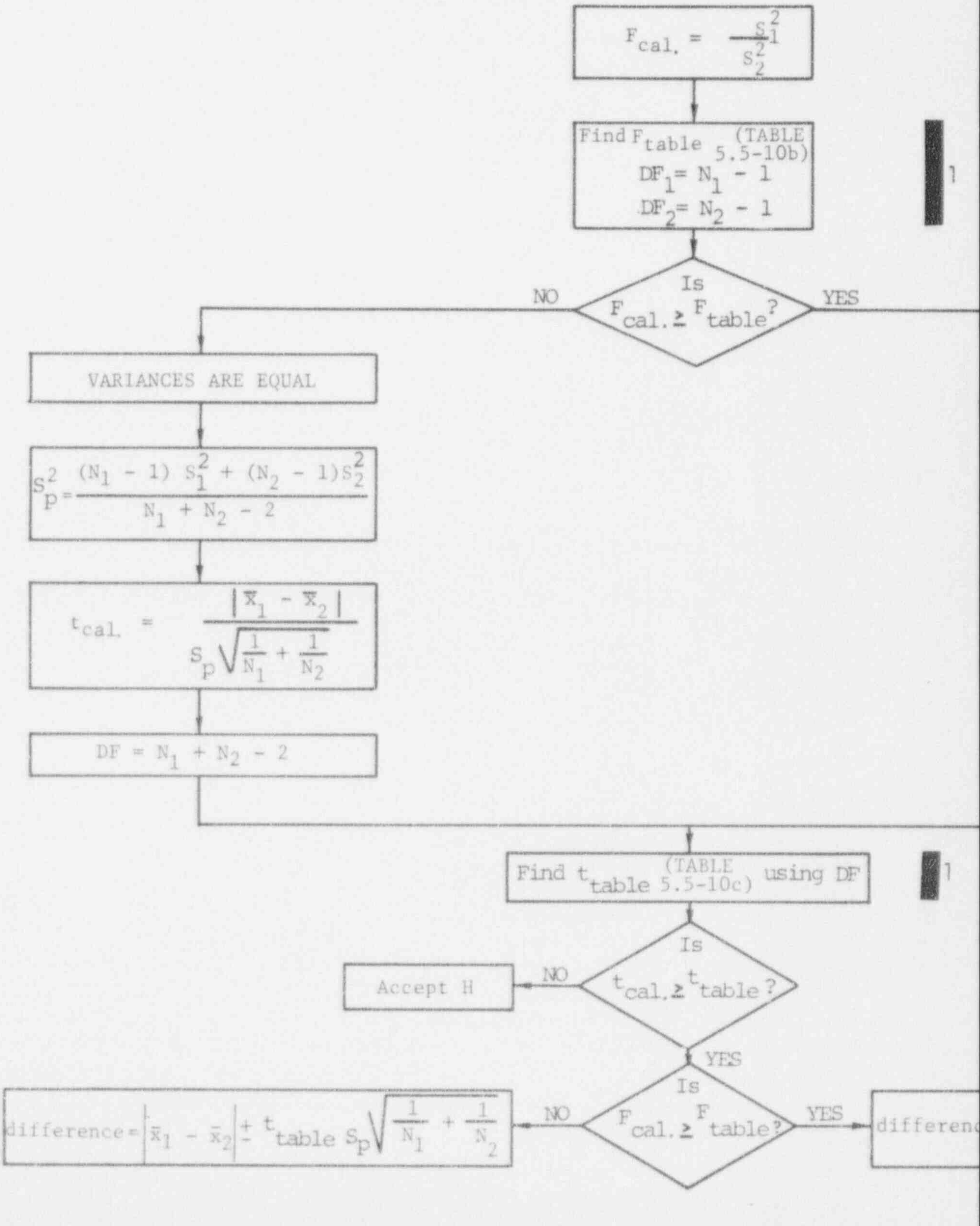
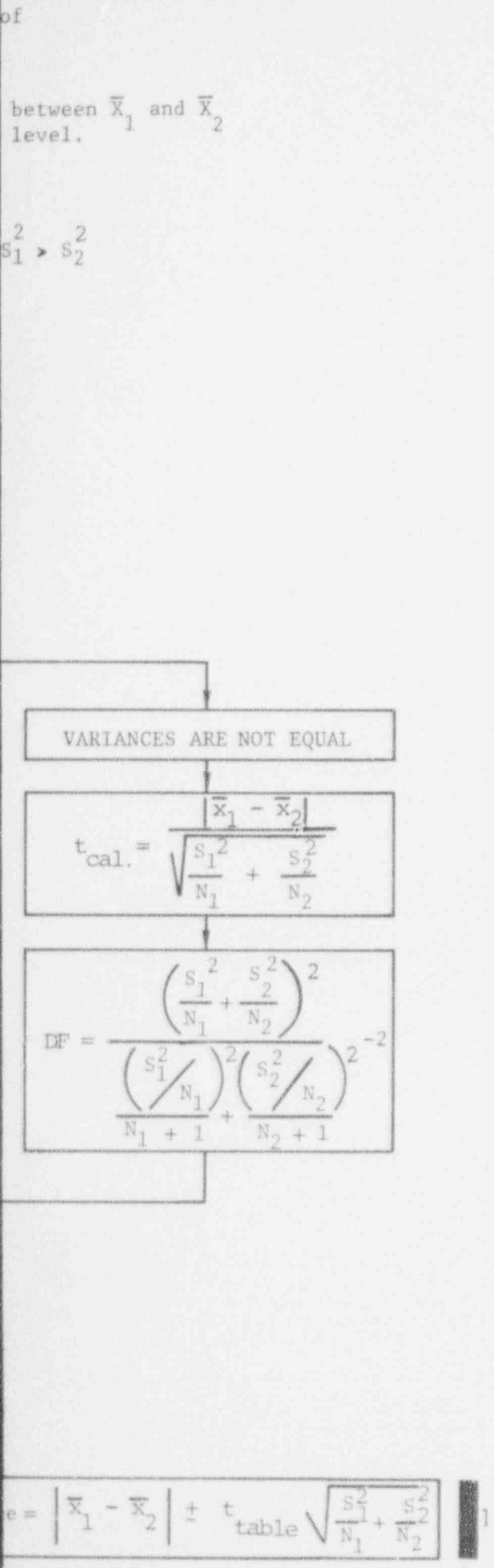
Flow Chart of the F-test (analysis
variance) and the t-test.

Test the Hypothesis (H): There is no differenc
at the 99% confidenc

Given: N_1: $\overline{X}_1 \pm s_1$ where
N_2: $\overline{X}_2 \pm s_2$





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STATISTICAL ANALYSIS FLOW CHART
FOR RADIOLOGICAL SAMPLES

Amend. 1 4/27/73 FIGURE 5.5-8

RADIOLOGICAL DATA ANALYSIS

Media =

Analysis =

Period =

	Indicator	Background
$\bar{X}$		
s		
N		
F_{cal}		
F_{table}		
t_{cal}		
t_{table}		

If $t_{cal} > t_{table}$, calculate difference 1

If $t_{cal} < t_{table}$, calculate minimum detectable difference

Using factors developed from dose models, translate difference or MDL to dose.

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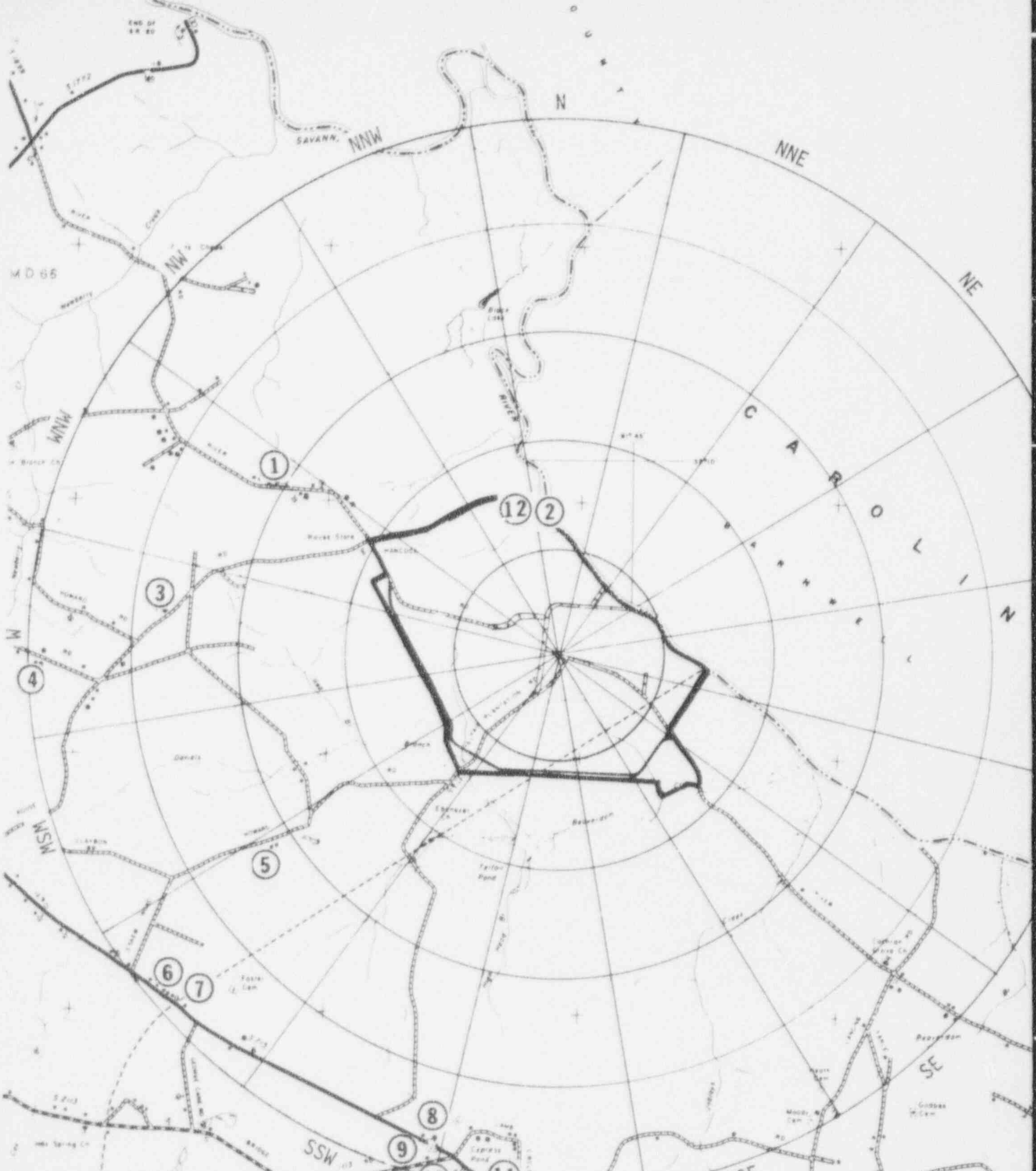
EXAMPLE FORM -
RADIOLOGICAL DATA ANALYSIS

Amend. 1 4/27/73 FIGURE 5.5-9



N
NNE
NE
NNW
NW
WNW
W
WSW
SSW
S
SSE
SE
CAROLINA
SAVANN
MD 65
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
House Store
Foster Cem
Cypress Pond

NOTES:

①	3 Dairy cows
②	Nearest vegetable garden
③	2 Dairy cows
④	4 Goats
⑤	3 Dairy cows
⑥	2 Dairy cows
⑦	1 Dairy cow
⑧	1 Dairy cow
⑨	1 Dairy cow
⑩	20 Goats
⑪	2 Goats
⑫	Nearest potential pasture land

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JULY 1973 5 MILE SURVEY

Amend. 2 11/26/73 FIGURE 5.5-10

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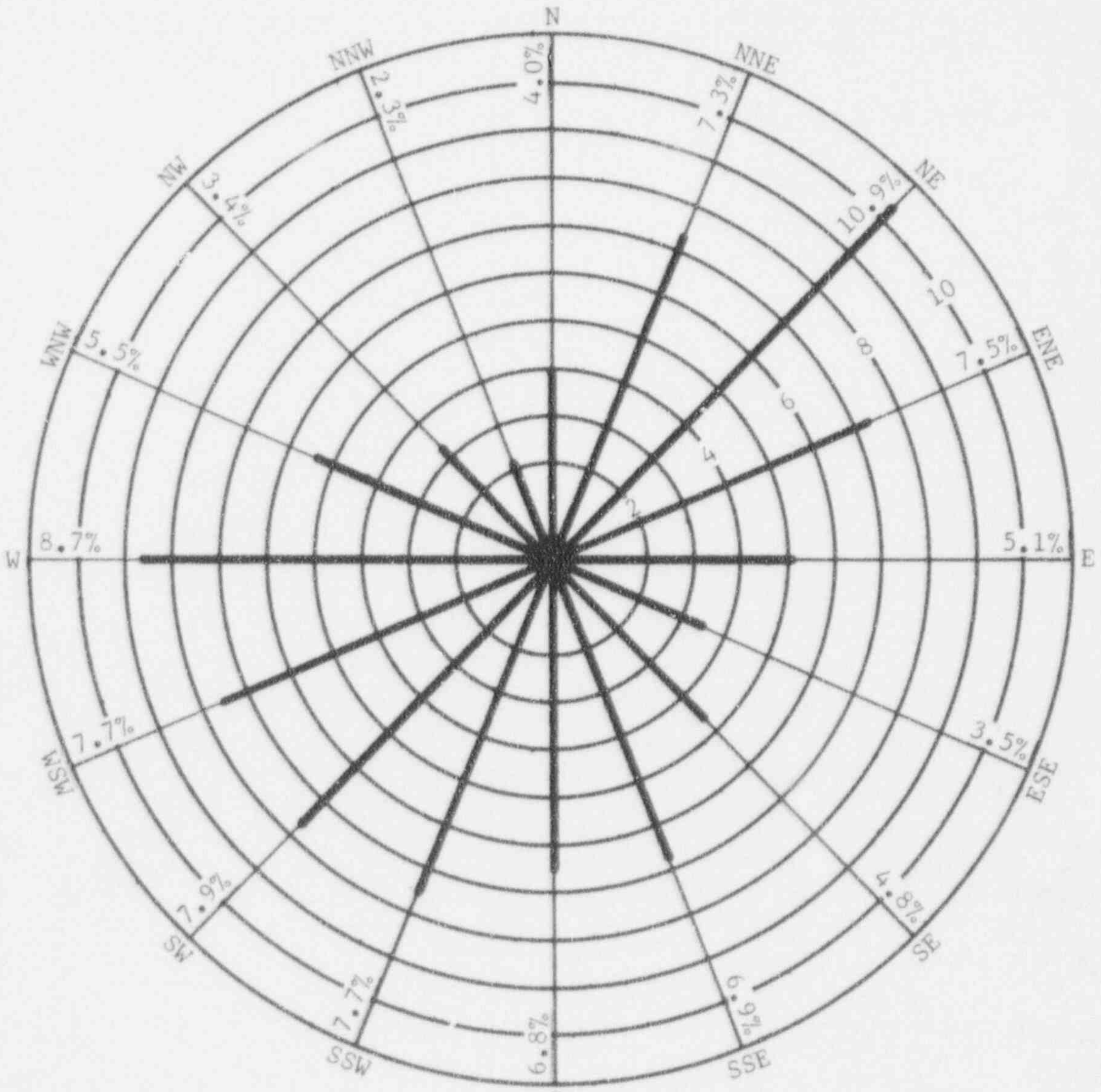

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WIND ROSE
SAVANNAH RIVER TOWER (3/66-2/68)
Figure 6.1-1

6. ENVIRONMENTAL EFFECTS OF ACCIDENTS

6.1 GENERAL BASIS FOR ANALYSIS OF POSTULATED ACCIDENTS

This section evaluates the environmental impact of postulated accidents and occurrences which may occur, however remote the possibility, during the operating life of the Alvin W. Vogtle Nuclear Plant. The evaluation follows the guidelines given in the AEC document "Consideration of Accidents in Implementation of the National Environmental Policy Act of 1969", published in the Federal Register December 1, 1971, hereafter referred to as the AEC guide.(1) The results of this evaluation reveal that the consequences of the postulated accidents and occurrences have no significant adverse environmental effects.

The average natural background radiation exposure in Georgia is about 125 mrem/yr. The largest computed total body dose at the site boundary is 2.4 mrem for the large pipe break loss of coolant. The annual integrated exposure from natural background to the population within 50 miles of the plant is 95,000 man-rem. The largest computed incremental exposure to the same population from any postulated accident is 1.7 man-rem for the large pipe break loss of coolant. Thus, the exposure resulting from any accident is well within the increment of exposure to the general public from natural background.

The postulated accidents and occurrences are divided into the nine accident classes identified in the AEC guide of December 1, 1971 and shown in Table 6.1-1. The environmental impact of the postulated incidents is evaluated using the assumptions contained in the AEC guide, as opposed to the conservative assumptions used in the Preliminary Safety Analysis Report (PSAR). The radiological consequences of an accident are evaluated on the basis that average meteorological conditions and the population distribution at the midpoint of plant life exist at the time of an accident. This is considered realistic for random events.

6.1.1 EVENT CLASSIFICATION

In the following pages, typical accidents for each class are described and their consequences evaluated. Consideration of the 9 classes reveal that these classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

Table 6.1-1

Classification of Postulated Accidents and Occurrences

Class	Description	Accidents
1	Trivial Incidents	Small spills and leaks inside containment
2	Small Releases Outside Containment	Small spills and leaks of radioactive materials outside containment
3	Radwaste System Failures	1. Equipment leakage or malfunction 2. Release of waste gas storage tank contents 3. Release of liquid waste storage tank contents
4	Fission Products to Primary System (BWR)	Not applicable to Vogtle Nuclear Plant
5	Fission Products to Primary and Secondary Systems (PWR)	1. Fuel cladding defects and steam generator leakage - considered under normal operation for expected range of variables 2. Off-design transients that induce fuel failure above those expected and steam generator leak 3. Steam generator tube rupture
6	Refueling Accidents	1. Fuel assembly drop in containment 2. Heavy object drop onto fuel in core
7	Spent Fuel Handling Accident	1. Fuel assembly drop in fuel storage pool 2. Heavy object drop onto fuel rack 3. Fuel cask drop
8	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report	1. Loss of coolant accident - small break 2. Loss of coolant accident - large break 3. Break in instrument line from primary system that penetrates the containment 4. Rod ejection accident 5. Steamline break - small break 6. Steamline break - large break
9	Design Basis Accidents Assuming Multiple Failures	Discussion not required for this report, per the AEC guide.

Class 1 through Class 5

This group deals with events which are likely to occur at one time or another during the life of the plant. The compilation of a complete list of postulated events which fall in this group, with their corresponding frequencies, is neither practical nor necessary. The environmental impact of each event, as will be shown later, is very small. Throughout plant operating life a record of the magnitude and consequences of each event is maintained and the cumulative effect of subsequent occurrences is evaluated. This procedure gives timely identification of any possible cumulative effects or trends leading to unacceptable environmental effects. This also allows corrective actions (such as equipment repair, changes in procedure, frequent inspection, or temporary plant shutdown) to be taken before a significant adverse impact on the environment can occur.

Postulated occurrences for Classes 2 through 5 are considered in the following pages. Class 1 events, which are considered to consist of small spills or small leaks inside the containment, are a part of normal operation and are not considered in this accident evaluation.

Classes 6 and 7

This group deals with refueling and fuel handling accidents inside and outside the containment. Detailed procedures are provided to insure proper handling of irradiated fuel. However, considering the large number of fuel assembling handled during the life of the plant, an incident falling in this category could conceivably occur. The consequences of such an accident, as shown in the subsequent pages, have no significant adverse environmental impact.

Class 8

This class includes those accidents that are not expected to occur during the life of this plant and whose initiation events are considered in the PSAR. Accidents falling in this class have no significant adverse environmental effects because:

i) hypothetical PSAR types of accident initiation events are not expected to occur during the life of this plant because of the numerous steps taken in design, manufacture, construction, operation, and maintenance to prevent them,

ii) and, the expected environmental consequences if any one of the accidents were to occur are even below the limits considered safe for normal operation (10 CFR 20).

Class 9

This accident class involves hypothetical sequences of failure more severe than Class 8, i.e., successive failures of multiple barriers normally provided and maintained.

Considering as an example the rupture of a Reactor Coolant System pipe, Class 8 covers the case of this initiation event and expected performance of plant safeguards. Class 9, on the other hand, would consider the initiation event, rupture of a Reactor Coolant System pipe, occurring simultaneously with hypothetically deteriorated performance of plant safeguards; i.e. failure of outside power supply, and/or failure of a containment spray pump, and/or failure of a containment spray valve, etc. This chain of failures can, theoretically, be carried as far as an individual's imagination can go.

The PSAR contains studies on the consequences of many successive failures. The likelihood of the combination of the initiation event and these successive failures is extremely remote. The consequences, as presented in the PSAR, are within the allowable limits for remote probability accidents (10 CFR 100 limits). The product of the occurrence frequency and the consequences of successive failures as presented in the PSAR or beyond is so minimal that the environmental risk is extremely low. Hence, it is not necessary to discuss these multiple barrier failures in this report.

6.1.2 EVENT ANALYSIS

Each accident is treated separately in the following pages. The treatment consists of a brief description of the accident, a summary of the steps taken in the design, manufacture, installation and operation to essentially eliminate the possibility of its occurrence, a list of the significant assumptions used in the analyses and the results of the dose calculations. The accident consequences are evaluated by using the analytical models described in the PSAR. The basic difference between the PSAR evaluations and those presented in this section is represented by the values of the parameters used as input in the analytical models. The PSAR analyses performed in this report are based on assessments of the performance of the nuclear plant safeguards. The values suggested by the AEC guide are used throughout. Where an additional assumption has been made, it has been clearly identified by an asterisk.

The radionuclide concentrations in the primary and secondary coolants are required to compute the activity releases associated with coolant releases. Only the noble gases and iodine concentrations are given, since there are only gaseous releases associated with the accidents considered in this section. The filters provided in the plant are very effective in removing airborne particulates from the gaseous effluents.

The primary and secondary concentrations are based on the assumptions of the AEC guide, i.e. a fuel defect level of 0.5%, a steam generator leak rate of 20 gpd, and a steam generator blowdown rate of 10 gpm/generator. The assumptions on fuel defects and blowdown rate are not the same as those used in Section 3.6 Radwaste System. It is the intent to follow the AEC guide as closely as possible in this accident evaluation to facilitate regulatory review. This does not imply that the applicant considers the guide assumptions applicable to this plant.

The primary concentrations are given in Table 6.1-2, and the secondary concentrations in Table 6.1-3.

6.1.3 RADIOLOGICAL DOSE MODELS

Three radiological doses are calculated for each accident, the average thyroid dose at the side boundary, the average total body dise at the site boundary, and a total dose to the population within a 50 mile radius of the site. The average site boundary total body dose includes beta and gamma contributions. However, the population dose, which is a measure of the genetically significant and long-term somatic effects, is derived from the gamma contributions only.

The demographic data is given in Section 2.2. It is assumed that the average off-site population that will be potentially affected by operation of the Vogtle Nuclear Plant can be approximated by the estimated population distribution that would exist at the midpoint of the plant's 40-year useful life. The data for 1997 from Figure 2.2-2, 2.2-3 and 2.2-4 were used.

TABLE 6.1-2

AVERAGE PRIMARY COOLANT RADIOACTIVITY LEVELS**

Isotope	Concentration (μc/gm)
I-131	1.23
I-132	0.44
I-133	1.92
I-134	0.27
I-135	1.03
Kr-85	0.068
Kr-85m	1.03
Kr-87	0.62
Kr-88	1.85
Xe-133	41.8
Xe-133m	0.82
Xe-135	2.95
Xe-135m	0.089
Xe-138	0.33

**Calculated for 0.5% fuel defects and 3565 MWt steady power operation.

TABLE 6.1-3

AVERAGE SECONDARY COOLANT RADIOACTIVITY LEVELS

Isotope	Concentration (µc/gm)**
I-131	4.0×10^{-4}
I-132	2.2×10^{-5}
I-133	4.1×10^{-4}
I-134	5.7×10^{-6}
I-135	1.2×10^{-4}

Isotope	Primary to Secondary Release Rate (µc/sec)
Kr-85	0.06
Kr-85m	0.90
Kr-87	0.54
Kr-88	1.62
Xe-133	36.7
Xe-133m	0.72
Xe-135	2.58
Xe-135m	0.08
Xe-138	0.29

**Calculated for 20 gpd primary-secondary leak rate.
10 gpm blowdown/steam generator.
Total steam generator water mass of 385,680 lbs.
0.5% fuel defects and 3565 MWt steady power operation.

The estimates of atmospheric diffusion used in the dose analyses are based on one tenth of Safety Guide 4(2), as recommended by the AEC guide. The specific model utilized is one tenth of Pasquill Type F with a wind speed of 1 meter/second. The population doses are calculated by weighing the effects in different directions by the frequency the wind blows in each direction, as given in Figure 6.1-1. The integral of the weighted X/Q times the population is 1.42×10^{-2} man-sec/m^3. The X/Q at the site boundary, used for the thyroid and total body doses, is 3.6×10^{-6}, which is the X/Q at the site boundary distance weighted by the maximum wind frequency in any sector, 10.9 percent for the NE sector. The radioactivity is assumed to be released at ground level and natural radioactive decay is not considered after the activity is released to the environment.

The models used to compute the thyroid, total body and population doses are presented below:

(a) Thyroid Dose

The average thyroid dose at the site boundary is computed using the equation:

$$\text{Thyroid Dose} = \overline{(X/Q)}_{S.B.} \times \bar{B} \times \sum_i (A_i \times DCF_i)$$

where:

A_i = activity released to the environment of isotope i (curies)

DCF_i = dose conversion factor of isotope i (rem/curie)

$\bar{B}$ = breathing rate of the average man (20 m /day)

$\overline{(X/Q)}_{S.B.}$ = weighted X/Q at the site boundary (sec/m)

(b) Total Body Dose

The average total body dose, including the beta contribution, at the site boundary is computed using the equation for a semi-infinite spherical cloud as given by:

$$\text{Total Body Dose} = D \times \overline{(X/Q)}_{S.B.} \times \sum_i A_i \times (\bar{E}_{\gamma_i} + \bar{E}_{\beta_i})$$

where:

A_i = activity released to the environment of isotope i (curies)

$\overline{E}_{\gamma_i}$ = gamma energy of isotope i (MEV/dis)

$\overline{E}_{\beta_i}$ = beta energy of isotope I (MEV/dis

$(\overline{X/Q})_{S.B.}$ = weighted X/Q at the site boundary (sec/m^3)

D = conversion factor = 0.246 m^3rem/MEV

The assumption of a semi-infinite spherical cloud is conservative.

(c) Population Dose

The population dose is computed using the equation:

$$\text{Population Dose} = D \times \sum_i A_i \times \overline{E}_{\gamma_i} \sum_r \sum_\phi \frac{X}{Q}_{r,\phi} \; P_{r,\phi}$$

where:

A_i , D , and $\overline{E}_{\gamma_i}$ = are the same as given for the total body dose model, and

$X/Q_{r,\phi}$ = the annual average X/Q for a given sector (ϕ) and distance (r) (sec/m^3)

$P_{r,\phi}$ = the population estimate for a given sector (ϕ) and distance (r) (men).

The values for the various parameters in the dose equations are given in Section 5.2.

6.1 REFERENCES

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6.2 CLASS 2 - SMALL RELEASES OUTSIDE CONTAINMENT

6.2.1 DISCUSSION

Class 2 events include spills and leaks from equipment outside the containment. Small valve leaks and pipe leaks may be expected during the lifetime of the plant. Also, a low level of continuous leakage may be expected from components such as valve packing and stems, pump seals, flanges, etc. Infrequent increases in leakage from specific components might occur; however, these would be detected by operators and/or inplant monitoring and appropriately repaired to minimize any potential offsite effect. Liquid releases would not be released to the environment since they would be contained by the drain systems and processed by the Liquid Waste System. Gaseous releases, however, would be released to the building ventilation system and ultimately to the plant vent stack and the environment.

6.2.2 VOLUME CONTROL TANK RELEASE

6.2.2.1 Event Description

A significant valve and/or pipe leak in the reactor coolant letdown line may occur during the lifetime of the plant. A representative example of such an occurrence is a leak in the volume control tank sampling line which would allow a fraction of the contents of the volume control tank to be released. Were such a leak to occur, the Radiation Monitoring System would detect the activity and with appropriate operator action the release could be limited to 10 percent of the gaseous contents in the tank. The event used to evaluate the environmental effect is defined as the release to the outside atmosphere of 10 percent of the gaseous activity in the volume control tank.

6.2.2.2 Discussion of Remoteness of Possibility

The volume control tank is designed to 75 psig internal pressure at 250°F with a normal internal operating pressure of approximately 15 psig at 127°F. The volume control tank design philosophy provides for level alarms, pressure relief valves and automatic tank isolation and valve control to assure that a safe condition is maintained during system operation. Quality control in the design, manufacture, and installation introduces a high degree of reliability and confidence to further assure that no failure in this system will occur. The volume control tank is designed to ASME III, Class 2. Since the volume control tank is not subject to high pressure or stress a rupture of the tank is considered very remote.

A release of ten percent of the gaseous inventory is considered to represent the accidents or occurrences falling in this class.

6.2.2.3 Assumptions

The tank volume is 400 ft^3. Based on experience, it is normally about 1/3 full. The following assumptions are used in the evaluation of the release of the volume control tank activity.

a) The activity in the tank, as presented in Table 6.2-1, is based on 0.5 percent equivalent fuel defects.

TABLE 6.2-1

VOLUME CONTROL TANK AVERAGE ACTIVITY

Isotope	Gaseous Activity (curies)
I-131	4.2×10^{-6}
I-132	1.5×10^{-6}
I-133	6.6×10^{-6}
I-134	9.0×10^{-7}
I-135	3.5×10^{-6}
Kr-85	0.34
Kr-85m	2.05
Kr-87	0.95
Kr-88	3.9
Xe-131m	1.35
Xe-133	187.
Xe-133m	3.4
Xe-135	8.35
Xe-135m	0.05
Xe-138	0.25

*b) The coolant has passed through a mixed bed demineralizer with a decontamination factor of 10 for halogens.

*c) The halogen partition factor between the liquid and vapor space is 200 (μc/cc liquid)/(μc/cc vapor).

*d) Ten percent of the gaseous inventory is released.

*e) Immediately after the gaseous activity escapes from the volume control tank, it is released from the auxiliary building at ground level to the outside atmosphere. Holdup in the auxiliary building is expected, thus reducing even further the environmental effect of this occurrence. However, no credit for holdup is taken in the analysis.

f) The halogens are exhausted to the atmosphere through filters with a 99% efficiency.

6.2.2.4 Doses at the Site Boundary and Population Dose

The thyroid inhalation dose and the total body dose at the site boundary are 7.9×10^{-6} mrem and 0.045 mrem, respectively. The population dose is 0.059 man-rem. The site boundary doses may be compared with the proposed 10CFR50, Appendix I guidelines of 5 mr/yr thyroid and 10 mr/yr noble gas.

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*Not specifically an assumption from the AEC guide since none are given for Class 2 events.

6.3 CLASS 3 - RADWASTE SYSTEM FAILURES

6.3.1 DISCUSSION

Class 3 events cover equipment malfunction and human error which may result in the release of activity from the Waste Disposal System. A leaking valve or the inadvertent opening of a valve by an operator may cause such a release. This type of event is expected to occur infrequently during the operation of the plant.

6.3.2 EQUIPMENT LEAKAGE OR MALFUNCTION

This incident is defined as the release of 25 percent of the liquid and gaseous contents of the largest storage tank in the radwaste system. The waste gas storage tanks and the liquid waste storage tank are considered separately below.

The only other tanks in the waste processing system that contain significant radioactivity are the spent resin storage tanks. However, these tanks contain liquid waste only, no gaseous activity. All tanks in the radwaste system and all tanks in the Chemical and Volume Control System (CVCS) that contain significant liquid radioactivity are below grade level in the support systems building. Therefore all liquid release from these two systems would be contained in the building with no escape to ground water or the Savannah River.

The only tank in either the radwaste or CVCS systems that contains significant gaseous radioactivity, other than the waste gas storage tanks which are considered separately below, is the volume control tank. A release of 10 percent of its contents was evaluated in Section 6.2. Therefore, the doses resulting from a 25 percent release of the contents of this tank would be simply 2-1/2 times the results in Section 6.2, or 2.0×10^{-5} mrem thyroid and 0.11 mrem total body at the site boundary with a population dose of 0.15 man-rem.

6.3.3 GAS DECAY TANKS

6.3.3.1 Event Description

The major collection point for gaseous activity outside the containment is the Gaseous Waste Processing System (GWPS). The gas decay tanks contain the gases vented from the reactor coolant system and the volume control tank. Sufficient volume is provided to store the gases tripped during a reactor shutdown. The incident evaluated is a malfunction or operator error which would allow initiation of an activity release from the tanks. This activity would be exhausted to the plant vent stack by the ventilation fans. The radiation monitors would detect this release and transmit an alarm signal to the control room.

6.3.3.2 Discussion of Remoteness of Possibility

The gas decay tanks are carbon steel, designed to ASME III, Class 3. The design pressure is 150 psig at 180°F. At the beginning of life the tanks will operate under a pressure of 3 to 5 psig, with the maximum anticipated pressure at any time not exceeding 50 psig.

Most of the gas received by the GWPS during normal operation is cover gas displaced from the chemical and volume control system and consists mostly of hydrogen and nitrogen. This mixture is pumped to a catalytic hydrogen recombiner where enough oxygen is added to reduce the hydrogen to a low residual level.

The release of the entire contents of one of the gas decay tanks is considered highly improbable.

6.3.3.3 Assumptions

*a) Tank volume = 600 ft^3

b) Inventory (Table 6.3-1) based on 0.5 percent defective fuel

*c) Activity is divided evenly between the 7 tanks

d) Release of total contents of one tank

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*Not specifically an assumption from the AEC guide.

TABLE 6.3-1

AVERAGE GAS DECAY TANK ACTIVITY

Isotope	Activity (Curies tank)
Kr-85	305
Xe-133	2470

6.3.3.4 Doses at Site Boundary and Population Dose

The total body dose at the site boundary is 0.44 mrem. The calculated population dose is 0.26 man-rem.

6.3.4 LIQUID WASTE STORAGE TANK

The waste holdup tank stores all contaminated liquids from the plant that are to be processed by the waste evaporator before discharge. The tank has a volume of 10,000 gallons and is normally filled to about 25% before processing. The postulated incident is the release of the entire tank contents. The tank inventory is given in Table 6.3-2.

TABLE 6.3-2

WASTE HOLDUP TANK AVERAGE INVENTORY

Isotope	Activity (Curies)*
I-131	4.7
I-133	7.3
I-135	3.9

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*Based on operation with 0.5% fuel defects

The waste holdup tank is located in the auxiliary building below ground level. The top of the tank is more than 40 feet below grade. Therefore any liquid leakage will be contained within the building (the building is assumed to remain intact during the incident) and cannot contaminate the ground water or the Savannah River. The piping and valving of the liquid waste processing system is such that inadvertent activation of the waste evaporator feed pump cannot result in direct discharge to the dilution line. The waste holdup tank is maintained at atmospheric pressure. There is an inconsequential gaseous radioactive inventory in this tank and it is continuously vented through charcoal filters to the auxiliary building exhaust system. Therefore, any gases released would be considered as a part of the plant's routine operations. Therefore, no radiation doses are presented for this incident.

6.4 CLASS 4 - FISSION PRODUCTS TO PRIMARY SYSTEM (BWR)

This class of incidents is not applicable to VNP, which utilizes pressurized water reactors.

6.5 CLASS 5 - FISSION PRODUCTS TO PRIMARY AND SECONDARY SYSTEMS (PWR)

6.5.1 DISCUSSION

The Class 5 events are defined as those events that transfer radioactivity from the reactor coolant into the secondary system through steam generator tube leakage, with a fraction of the transferred radioactivity in turn being released to the environment through the condenser air ejectors. Radioactivity releases to the environment resulting from the events in this class require a concurrent occurrence of the two independent events of fuel defects and steam generator tube leakage. This has occurred in some operating plants.

6.5.2 FUEL CLADDING DEFECTS AND STEAM GENERATOR LEAK

6.5.2.1 Event Description

Over the forty year life of the VNP, it is possible that concomitant fuel defects and steam generator tube leaks will occur. The values that would be considered in the normal range are 0.5 percent fuel defects with a steam generator leak rate of 20 gpd and a blowdown of 10 gpm/steam generator.

If the plant is operated with fuel defects and concurrent steam generator tube leakage, the secondary system would contain fission products and radioactive corrosion products. The degree of fission product transport into the secondary side is a function of the amount of defective fuel in the core and the primary-to-secondary leak rate. The radioactivity releases from the secondary system are proportional to the secondary system coolant activity. Since the condenser air ejector effluent is monitored with a radiation monitor, it would indicate the steam generator tube leakage and the resultant radioactivity releases. In addition, the steam generator blowdown liquid sampler monitor provides backup information to indicate primary-to-secondary leakage.

The operator must evaluate secondary system activity in terms of the plant technical specifications. If the primary-to-secondary leak rate and the resultant releases were insignificant, the operator could continue to operate the plant until a convenient time is available to shut down and repair the leaking steam generator. If the releases became significant, the steam generator blowdown would be terminated and preparations made for shutdown of the leaking unit.

Plant operation with 0.5 percent equivalent fuel defects and a 20 gpd steam generator leakage is considered routine and is not separately considered in this section on the environmental effects of accidents.

6.5.2.2 Discussion of Remoteness of Possibility

Steam generators have leaked to the extent they have had to be repaired. The leaks have been of two types, one attributed to a tube sheet-clad separation and the other to defects in the tubes. The first cause of leakage has been eliminated through a design change. Leakage through tube defects has occurred in 2 of 5 domestic Westinghouse plants with Inconel steam generators. The possibility of leakage of this type thus cannot be considered negligible.

6.5.2.3 Doses at Site Boundary and Population Dose

No doses from this routine operation are presented in this accident evaluation section of the report. (See Section 5.2)

6.5.3 OFF-DESIGN TRANSIENTS THAT INDUCE FUEL FAILURE

6.5.3.1 Event Description

VNP is designed so that all anticipated transients may be met with no damage to the fuel or to the plant.

However, a transient is postulated which results in the release of 0.02 percent of the reactor core inventory of fission products (equivalent to 2 percent fuel defects) to the reactor coolant. A specific mechanism for this transient cannot be identified.

6.5.3.2 Discussion of Remoteness of Possibility

As discussed in Chapter 15 of the PSAR, VNP is designed to survive all Condition I and II transients with no fuel damage or loss of capability to return to full power. By definition, these transients do not propagate to a more serious fault and thus will not lead to the postulated fault. Condition III transients are faults which may occur infrequently during the life of the plant with at most the failure of a small fraction of the fuel rods.

Several of these transients are analyzed in the PSAR, including minor primary and secondary pipe breaks, inadvertent loading of a fuel assembly into an improper position, and a complete loss of forced reactor coolant flow.

A specific transient leading to the postulated fault cannot be identified, therefore a discussion of possibilities is not possible.

6.5.3.3 Assumptions

a) Primary system equilibrium activity based on 0.5% fuel (Table 6.1-2).

b) Secondary system equilibrium activity based on 20 gpd leak rate and 10 gpm blowdown/steam generator (Table 6.1-3).

c) Additional fuel damage resulting in the release of 0.02% of the reactor core inventory of noble gases and halogens to the primary coolant.

*d) Blowdown terminated upon initiation of the transient

*e) Duration of transient in one day

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*Not specifically an assumption from the AEC guide.

f) Steam generator halogen partition factor of 0.1 $\frac{\mu c/gm\ steam}{\mu c/gm\ water}$ (Reference - Item 8.3.a.b. of the AEC guide)

g) Condenser halogen partition factor of 100 $\frac{\mu c/gm\ steam}{\mu c/cc\ air}$

*h) Air ejector flow rate of 26 scfm

Doses at Site Boundary and Population Dose

The additional activity released by this incident is given in Table 6.5-1. Based on these data, the thyroid inhalation dose and the total body dose at the site boundary are 2.5×10^{-3} mrem and 5.9×10^{-2} mrem, respectively. The population dose is 0.17 man-rem.

6.5.4 STEAM GENERATOR TUBE RUPTURE

6.5.4.1 Event Description

This accident consists of a complete single tube break in a steam generator. Since the reactor coolant pressure is greater than the steam generator shell side pressure, contaminated primary coolant is transferred into the secondary system. A portion of this radioactivity would be vented to the atmosphere through the condenser air ejector. A general sequence of events following a tube rupture is as follows:

> The operator would be made aware of a radioactivity release within seconds by the condenser air ejector vent monitor.
>
> Pressurizer water level would decrease for one to four minutes before an automatic low pressure trip occurs. Seconds later, low pressurizer level will automatically complete the safety injection actuation signal.

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*Not specifically an assumption from the AEC guide

TABLE 6.5-1

ACTIVITY RELEASE FOR INCREASED FUEL DEFECT LEVEL

Isotope	Activity (Curies)*
I-131	1.4×10^{-3}
I-132	8.7×10^{-5}
I-133	2.0×10^{-3}
I-134	2.1×10^{-5}
I-135	7.0×10^{-4}
Kr-85	0.058
Kr-85m	2.23
Kr-87	4.19
Kr-88	6.04
Xe-133	14.3
Xe-133m	0.34
Xe-135	2.98
Xe-135m	2.95
Xe-138	10.3

---

*0.02% of core inventory in primary coolant

The unit trip would shut off steam flow through the turbine, open steam bypass valves and bypass steam to the condenser.

Automatic actions and cooldown procedures are as follows:

Boration by high head safety injection pumps.

Operator-controlled reduction of safety injection flow to permit the RCS pressure to decrease below the setting of the lowest affected steam generator safety valve.

Operator-controlled steam dumping to the condenser in order to: reduce the reactor coolant temperature; maintain primary coolant subcooling equivalent to a suitable over-pressure; minimize steam discharge from the affected steam generator.

Isolation of the affected steam generator would be achieved by:

Identifying the affected steam generator by observation of rising level and use of the blowdown liquid sample activity monitor.

Closing the steamline isolation valves connected to the affected steam generator.

Terminating the feedwater flow to the generator.

6.5.4.2 Discussion of Remoteness of Possibility

The potential for catastrophic failure of a steam generator tube is considered minimal. The steam generator tubes are made of Inconel 600, a highly ductile material. The primary side design pressure is 2485 psig, and the secondary (shell) side design pressure is 1285 psig, resulting in a nominal design pressure differential across the tubes of ~1200 psi. However, the tubes have been designed to the requirements of the ASME Nuclear Power Plant Components Code assuming 2485 psig as the normal operating pressure differential. Further, based on ultimate strength at design temperature, the calculated bursting pressure of a steam generator tube is ~7000 psi.

The steam generator is hydrotested at 3107 psig on the primary side and zero psig on the secondary side. The normal operating pressures are 2250 psia on the primary side and ~990 psia on the secondary, or a differential of ~1260 psi. Hence there is a large margin between nominal operating conditions and pressures which would lead to a tube rupture.

It is expected that rupture would be preceded by cracking, which failure would be induced by fretting, corrosion, erosion or fatigue. This type of failure is of such a nature as to produce detectable leakage. The activity in the secondary system is continuously monitored via the condenser air ejectors discharge and periodic sampling, and continued unit operation is not permitted if the leakage exceeds technical specification limits. As a result, any failure of this nature would be detected before the large safety margin in pressure strength is lost and a rupture developed.

Finally, in over 400,000 tube years for Westinghouse built steam generators, there have been no gross tube ruptures. This experience, combined with stringent quality control requirements in the construction of the generator tubes and constant monitoring of the secondary system renders the likelihood of a steam generator tube rupture highly remote.

This accident is one of the Condition IV events considered in the PSAR and should be included in this report as a Class 8 event. It is discussed here in Class 5 in conformance with the AEC guide.

6.5.4.3 Assumptions

a) Activity in primary coolant based on 0.5% equivalent fuel defects. The accident would cause no additional fuel damage. (Table 6.1-2)

b) The equilibrium secondary system activity is based on steam generator leakage of 20 gpd and a blowdown of 10 gpm/generator. (Table 6.1-3)

c) 15% of the primary coolant is carried over to the secondary side.

d) Steam generator halogen partition factor of $0.1 \frac{\mu c/gm \text{ steam}}{\mu c/gm \text{ water}}$ (Reference: Item 8.3.a.b of AEC guide).

e) Condenser halogen partition factor of $1000 \frac{\mu c/gm \text{ steam}}{\mu c/cc \text{ air}}$

*f) Blowdown terminated at the initiation of the incident.

*g) Faulty steam generator isolated in 30 minutes.

6.5.4.4 Doses at Site Boundary and Population Dose

The activity released to the atmosphere by this incident is given in Table 6.5-2. Based on these data, the thyroid inhalation and total body doses at the site boundary are 4.8×10^{-3} mrem and 0.6 mrem, respectively. The population dose is 1.05 man-rem.

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*Not specifically an assumption from the AEC guide

TABLE 6.5-2

STEAM GENERATOR TUBE RUPTURE ACTIVITY RELEASE

Isotope	Activity (Curies)
I-131	2.6×10^{-3}
I-132	9.1×10^{-4}
I-133	4.0×10^{-3}
I-134	5.6×10^{-4}
I-135	2.1×10^{-3}
Kr-85	2.87
Kr-85m	42.7
Kr-87	25.8
Kr-88	77.4
Xe-133	1749.
Xe-133m	34.5
Xe-135	123.
Xe-135m	3.78
Xe-138	13.8

6.6 CLASS 6 - REFUELING ACCIDENTS

6.6.1 DISCUSSION

Accidents which fall into accident Class 6 are: a fuel assembly dropped inside the containment and the dropping of a heavy object onto the fuel in the core.

The only events in the accident class which could possibly result in a release of radioactive gases from a fuel assembly are the mishandling of a fuel element or the dropping of a heavy object onto the fuel in the core. The fuel handling procedures are such that no objects can be moved over any fuel elements being transferred from the core through the refueling canal to the transfer tube. A loss of cooling in the transfer tube will not cause the cladding of a fuel assembly to be damaged since the residual heat generated by the assembly would be removed by natural convection.

6.6.2 FUEL BUNDLE DROP

6.6.2.1 Event Description

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in damage to the equivalent of one row of fuel rods (15 fuel rods) in the assembly. The radioactivity subsequently released from the damaged fuel elements will bubble through the water covering the assembly, where most of the radioactive iodine will be entrained. The remainder will be released to the containment atmosphere. For the first 5 minutes following the accident, activity is drawn through the containment purge line to the environment. After 5 minutes the purge line is isolated and the only means of escape of any radioactive gases airborne in the containment is by means of leakage through the containment, which is negligible since this accident does not generate a positive pressure in the containment.

6.6.2.2 Discussion of Remoteness of Possibility

The possibility of the postulated fuel handling incident is remote due to the administrative controls and physical limitations imposed on fuel handling operations. All refueling operations are conducted in accordance with prescribed procedures under the direct surveillance of personnel technically trained in nuclear safety. In addition, before any refueling operations begin, verification of complete rod cluster control assembly insertion is obtained by tripping each rod individually to obtain indication of rod drop and disengagement from the control rod drive mechanisms. As the vessel head is raised, a visual check is made to verify that the drive shafts are free in the mechanism housing. After the vessel head is removed, the rod cluster control drive shafts are removed from their respective assemblies. A spring scale is used to verify that the drive shaft is free of the control cluster as the lifting force is applied.

The fuel handling manipulators and hoists are designed so that fuel cannot be raised above a position which provides adequate shield water depth for the safety of all operating personnel. This safety feature applies to handling facilities in both the containment and in the spent fuel pit area outside the containment.

Adequate cooling of fuel during underwater handling is provided by convective heat transfer to the surrounding water. The fuel assembly is immersed continuously while in the refueling cavity or refueling canal. Even if a spent fuel assembly becomes stuck in the transfer tube, natural convection will maintain adequate cooling.

6.6.2.2.1 Criticality

Boron concentration in the coolant is raised to the refueling concentration and verified by sampling. The refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subcritical by at least 10 percent $\Delta\rho$ with all rod cluster control assemblies inserted. At this boron concentration the core would also be more than 2 percent $\Delta\rho$ subcritical with all control rods withdrawn. The refueling cavity is filled with water meeting the same boric acid specifications.

Two Nuclear Instrumentation System source range channels are continuously in operation and provide warning of any approach to criticality during refueling operations. This instrumentation provides a continuous audible signal in the containment and would annunciate a local horn and a horn and light in the plant control room in the unlikely event that the count rate increased above a preset low level.

Only one fuel assembly is transferred at a time, effectively precluding any possibility of inadvertent criticality in the refueling canal.

6.6.2.2.2 Mechanical Damage

Special precautions are taken in all fuel handling operations to minimize the possibility of damage to fuel assemblies during transport to and from the transfer tube and during installation in the reactor. All handling operations on irradiated fuel are conducted under water. The handling tools used in the fuel handling operations are conservatively designed and the associated devices are of a fail-safe design. In addition the motions of the cranes which move the fuel assemblies are limited to a low maximum speed.

The design of the fuel assembly is such that the fuel rods are supported laterally along their length by Inconel 718 grid clip assemblies which provide a total axial restraining force of 60 pounds on each fuel rod. If the fuel rods are in contact with the bottom plate of the fuel assembly, any force transmitted to the fuel rods is limited by the restraining force of the grid clips. The force transmitted to the fuel rods during fuel handling is not sufficient to breech the fuel rod cladding. If the fuel rods are not in contact with the bottom plate of the assembly, the rods would have to slide against the 60 pound friction force. This would absorb the shock and thus limit the force on the individual fuel rods.

After the reactor is shutdown, the fuel rods contract during the subsequent cooldown and would not be in contact with the bottom plate of the assembly. Analyses have been made assuming the extremely remote situations of a fuel assembly dropping 14 feet and striking a flat surface and of one assembly being dropped on another. The analysis of a fuel assembly assumed dropped and striking a flat surface considered the stresses the fuel cladding would be subjected to and any possible buckling of the fuel rods between the grid clip supports. The results show that the axial load at the bottom section of the fuel rods, which would receive the highest loading (approximately 100 lb.) would be below the critical buckling load (250 lb.) and the stresses would be relatively low and below the yield stress. For the case of one assembly assumed dropped on top of another fuel assembly, the loads would be transmitted through the end plates and the RCC guide tubes of the struck assembly before any of the loads would reach the fuel rods. The end plates and guide thimbles would absorb a large portion of the kinetic energy as a result of bending in the lower plate of the falling assembly. Also, energy would be absorbed in the struck assembly top end plate before any load would be transmitted to the fuel rods. The results of this analysis indicate that the buckling load on the fuel rods would be below the critical buckling loads and the stresses in the cladding would be relatively low and below yield.

Based on the above, it is unlikely that any damage would occur to the individual fuel rods during handling, and the assumption of a failure of an entire row of rods is a conservative upper limit.

No fuel cladding integrity failures resulting in measureable radioactivity releases have occured during any fuel handling operations involving over 50 reactor years of Westinghouse PWR operating experience in which more than 2200 fuel assemblies have been loaded or unloaded.

6.6.2.3 Assumptions

a) The accident occurs one week following reactor shutdown.

b) The accident results in the rupture of the cladding of 15 fuel rods, the equivalent of one row.

*c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the 15 rods with ruptured cladding is released to the refueling canal at the time of the accident.

e) The refueling canal water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed from the refueling canal water directly to the upper half of the containment.

*g) The purge line flow rate is 25,000 cfm.

*h) The purge is terminated by a high radioactivity level within the containment, a safety injection signal, or a containment isolation signal. For this analysis it is assumed to be terminated within 5 minutes of accident initiation.

i) Containment purge system halogen filter efficiency is 99%.

j) After isolation of the containment, the leak rate through the containment is minimal since the pressure differential across the

*Not specifically an assumption from the AEC guide since none are given for class two events.

containment is negligible. The amount of activity leaked from the containment is assumed negligible compared to that escaping through the purge line during the first 5 minutes prior to isolation.

6.6.2.4 Doses at Site Boundary and Population Dose

The activity released to the environment with the above assumptions is given in Table 6.6-1. Based on these data, the doses at the site boundary are 4.4×10^{-4} mrem thyroid inhalation and 4.3×10^{-3} total body. The population dose is 0.003 man-rem.

6.6.3 HEAVY OBJECT DROP

6.6.3.1 Event Description

This accident is defined as the dropping of a heavy object onto the fuel in the core during refueling. The accident is assumed to result in damage to the equivalent of all the rods in one fuel assembly. The radioactivity released from the damaged fuel assembly will bubble through the water covering the reactor cavity, where most of the radioactive iodine will be entrained, the remainder being released to the containment atmosphere.

6.6.3.2 Discussion of Remoteness of Possibility

Operating procedures prohibit the carrying of heavy objects over the core. However, of necessity the vessel head and the internals must be handled over the core during installation and removal. Special lifting fixtures are provided to safely handle these components. In addition, the cranes and rigging are adequately sized for the expected loads.

All equipment is completely checked out prior to use. All refueling operations are performed under the direct surveillance of personnel technically trained in nuclear safety. Thus the possibility of dropping a heavy object onto the reactor core is considered very remote.

TABLE 6.6-1

ACTIVITY RELEASED TO THE ENVIRONMENT FROM A FUEL BUNDLE DROP INSIDE CONTAINMENT

Isotope	Activity (Curies)
I-131	3.6×10^{-4}
I-133	3.8×10^{-6}
Kr-85	0.32
Xe-133	27.0
Xe-133m	0.21

6.6.3.3 Assumptions

a) The accident occurs 100 hours following reactor shutdown.

b) The accident results in the damaging of one fuel assembly.

c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the damaged assembly is released to the refueling water covering the reactor vessel at the time of the accident.

e) The refueling water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed from the refueling water directly to the upper half of the containment.

*g) The purge line on the containment is isolated within 5 minutes after the accident. The flow rate through this purge line is 25,000 cfm.

h) The halogen removal efficiency of the containment purge system filter is 99%.

i) After isolation of the containment, the leak rate through the containment is minimal since the pressure differential across the containment is negligible. The amount of activity leaked from the containment is assumed negligible compared to that escaping through the purge line during the first 5 minutes prior to isolation.

6.6.3.4 Doses at Site Boundary and Population Dose

The activity released to the environment with the above assumptions is given in Table 6.6-2. Based on this table, the doses at the site boundary from a heavy object drop onto the fuel in the core are 0.08 mrem thyroid and 0.97 mrem total body. The population dose from this accident is 0.65 man-rem.

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*Not specifically an assumption from the AEC guide since none are given for class two events.

TABLE 6.6-2

ACTIVITY RELEASED TO ENVIRONMENT FROM DROP OF A HEAVY OBJECT ONTO FUEL IN THE CORE

Isotope	Activity (Curies)
I-131	6.4×10^{-2}
I-133	7.3×10^{-3}
Kr-85	50.2
Xe-133	6080.
Xe-133m	74.6
Xe-135	1.4

6.7 CLASS 7 - SPENT FUEL HANDLING ACCIDENTS

6.7.1 DISCUSSION

Accidents which fall into Class 7 are: dropping of a fuel assembly in the fuel storage pool, the dropping of a heavy object onto fuel outside the containment, or dropping of a loaded shielding cask.

The only event in this accident class which could possibly result in a release of radioactive gases from a fuel assembly is the mishandling of a fuel assembly. The fuel handling procedures are such that no objects can be moved over any fuel elements being transferred or stored. The shielding and shipping casks are designed so that if dropped there would be no subsequent damage to the cask or the assembly.

6.7.2 FUEL ASSEMBLY DROP IN FUEL STORAGE POOL

6.7.2.1 Event Description

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in damage to 15 fuel rods, the equivalent of one row in the assembly. The subsequent release of radioactive gases from the damaged fuel rods will bubble through the water covering the assembly, where most of the iodine will be entrained, the remainder being released to the fuel handling building atmosphere. The gases would then be exhausted through charcoal filters to the environment via the plant vent.

6.7.2.2 Discussion of Remoteness of Possibility

A fuel handling incident outside the containment is considered to be equally as remote as that inside the containment. The administrative controls and physical limitations imposed on fuel handling operation are essentially the same as those described for the Class 6 events. As described earlier, the fuel handling manipulators and hoists are designed so that the fuel assembly is continuously immersed while in the spent fuel pit. In addition, the design of storage racks and manipulation facilities in the spent fuel pit is such that:

Fuel at rest is positioned by positive restraints in an eversafe, always subcritical, geometrical array, with no credit for boric acid in the water.

Fuel can be manipulated only one assembly at a time.

Violation of procedures by placing one fuel assembly in any position with a group of racked assemblies will not result in criticality.

In summary, those factors which are discussed under Section 6.6.2.2 "Mechanical Damage" regarding remoteness of possibility of fuel handling accidents within the containment also apply here.

6.7.2.3 Assumptions

a) The accident occurs one week following reactor shutdown.

b) The accident results in the rupture of the cladding of 15 fuel rods, the equivalent of one row.

*c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the 15 rods with ruptured cladding will be released to the spent fuel pit water at the time of the accident.

e) The spent fuel pit water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed into the air above the spent fuel pit and exhausted through charcoal filters with a halogen efficiency of 99%.

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*Not specifically an assumption from the AEC guide since none are given for class two events.

6.7.2.4 Doses at Site Boundary and Population Dose

The activity released to the atmosphere, based on the above assumptions, is given in Table 6.7-1. The doses at the site boundary from a refueling accident outside the containment are 4.6 x 10^{-3} mrem thyroid and 0.05 mrem total body. The population dose from this accident is 0.03 man-rem.

6.7.3 HEAVY OBJECT DROP ONTO FUEL RACK

6.7.3.1 Event Description

The accident postulated is a drop of a heavy object over the spent fuel racks such that all of the fuel rods in one assembly are damaged. The subsequent releases of radioactive gases from the damaged fuel elements will bubble through the water covering the assembly, where most of the iodine will be entrained, and be released to the fuel handling building atmosphere. The activity would then be exhausted through charcoal filters to the environment via the plant vent.

6.7.3.2 Discussion of the Remoteness of Possibility

The design of the spent fuel storage area and equipment is such that it is not possible to carry heavy objects, such as a spent fuel transfer cask, over the fuel assemblies in the storage racks. The possibility of occurrence of this accident is remote.

6.7.3.3 Assumptions

a) The accident occurs 30 days following reactor shutdown.

b) The accident results in the rupture of the cladding of all the fuel rods in one assembly.

c) The damaged assembly is the one that had operated at the average power level.

d) One percent of the inventory of fission products in the assembly will be released to the spent fuel pit water at the time of the accident.

TABLE 6.7-1

ACTIVITY RELEASED TO THE ENVIRONMENT FROM A FUEL ASSEMBLY DROP IN THE FUEL STORAGE POOL

Isotope	Activity (Curies)
I-131	3.7×10^{-3}
I-133	5.8×10^{-5}
Kr-85	3.7
Xe-133	308.
Xe-133m	2.3
Xe-135	6.2×10^{-4}

e) The spent fuel pit water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed into the air above the spent fuel storage pool and exhausted through charcoal filters with a halogen efficiency of 99%.

6.7.3.4 Doses at the Site Boundary and Population Dose

With the above assumptions, the activity released to the atmosphere is given in Table 6.7-2. The thyroid inhalation dose and the total body dose at the site boundary are 8.5×10^{-3} mrem and 0.04 mrem, respectively. The population dose is 0.03 man-rem.

6.7.4 FUEL CASK DROP

6.7.4.1 Event Description

This accident is a drop of a fully loaded (assumed to hold 6 assemblies) fuel cask as it is being transferred out of the auxiliary building. The fall is of such a distance that the cask is breached and all of the fuel rods in all of the assemblies are ruptured. All of the noble gases contained in the pellet-clad gaps are released directly to the atmosphere.

6.7.4.2 Discussion of the Remoteness of Possibility

Loaded fuel casks are handled under carefully detailed procedures with adequately designed equipment. The probability of dropping a cask is low. However, the cask is designed to satisfy a 30 foot drop test onto an unyielding surface without rupture, as required by DOT regulations. Since the cask will survive this drop without rupture and the fuel assemblies are protected by restraints within the cask, a release of radioactivity is considered only remotely possible.

TABLE 6.7-2

ACTIVITY RELEASED TO THE ENVIRONMENT BY A HEAVY OBJECT DROP ONTO SPENT FUEL RACK

Isotope	Activity (Curies)
I-131	6.9×10^{-3}
Kr-85	50.
Xe-133	203.
Xe-133m	0.03

6.7.4.3 Assumptions

*a) The cask is loaded with 6 fuel assemblies.

b) One percent of the total noble gas inventory in all 6 assemblies is released to the atmosphere.

c) The fuel cask drop occurs 120 days after reactor shutdown.

6.7.4.4 Doses at the Site Boundary and Population Dose

With the above assumptions, the activity released to the atmosphere is given in Table 6.7-3. The total body dose at the site boundary is 0.06 mrem. The population dose is 0.002 man-rem.

TABLE 6.7-3

ACTIVITY RELEASED TO THE ENVIRONMENT
IN A FUEL CASK DROP

Isotope	Activity (Curies)*
Kr-85	296.
Xe-133	0.09

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*Not specifically an assumption from the AEC guide since none are given for class two events.

6.8 CLASS 8 - ACCIDENT INITIATION EVENTS CONSIDERED IN DESIGN BASIS EVALUATION IN THE PRELIMINARY SAFETY ANALYSIS REPORT

6.8.1 DISCUSSION

Accidents considered in this class are loss of coolant, steam line break, and control rod ejection. These extremely unlikely accidents are used, with highly conservative assumptions, as the design basis events to establish the performance requirements of safety features. For purposes of this report, the accidents are evaluated on the realistic basis that these engineered safeguards will be available and will either prevent the progression of the accident or mitigate the consequences.

6.8.2 LOSS OF COOLANT ACCIDENT (LOCA) - SMALL PIPE BREAK

6.8.2.1 Event Description

A LOCA is defined as the loss of primary system coolant due to a rupture of a Reactor Coolant System (RCS) pipe or any line connected to that system up to the first closed valve. Leaks or ruptures of a small cross section would cause expulsion of the coolant at a rate that can be accommodated by the charging pumps. The pumps would maintain an operational water level in the pressurizer permitting the operator to execute an orderly shutdown. A small quantity of the coolant containing fission products normally present in the coolant would be released to the containment.

Should a break occur beyond the capacity of the charging pumps, depressurization of the RCS causes fluid to flow from the pressurizer to the break resulting in a pressure decrease in the pressurizer. Reactor trip occurs when the pressurizer low pressure set point is reached. The Emergency Core Cooling System (ECCS) is actuated when the pressurizer low pressure and low level set points are reached. ECCS actuation and reactor trip are also provided by a high containment pressure signal. The ECCS is comprised of high pressure passive accumulators which discharge water into the cold leg of each coolant loop, and high head safety injection and charging pumps and low head residual heat removal pumps that deliver through the cold legs. These countermeasures limit the consequences of the accident in two ways:

a. Reactor trip and borated water injection supplement void formation by causing rapid reduction of the core thermal power to a residual level corresponding to the delayed fissions and fission product decay.

b. Injection of borated water ensures sufficient flooding of the core to limit the peak fuel cladding temperature such that clad damage does not result.

The fission products present in the primary coolant discharged to the containment are partially removed from the containment atmosphere by the spray system and plateout on the containment structures. Some of the remaining fission products in the containment atmosphere will be slowly released through minute leaks to the enclosure building. These minute leaks could be expected to be choked by water and water vapor, although credit for this was not taken in evaluating releases. Activity in the enclosure building is further reduced by recirculation filters. A small fraction of the activity is released to the environment through the filters of the purge system used to maintain a negative pressure in the enclosure building.

6.8.2.2 Discussion of Remoteness of Possibility

The rupture of a reactor coolant pipe or a pipe connected to it is not expected to occur because of very careful selection of design, construction, operation and quality control requirements. A very strict and detailed "Quality Assurance Program" is followed to make sure that the specific requirements are met during the various stages of design, construction, erection and fabrication.

The reactor coolant system is designed to withstand a Safe Shutdown Earthquake (for the VNP site defined as a maximum horizontal ground acceleration of 0.2g) and assure capability to shutdown and maintain the nuclear facility in a safe condition. Pressure-containing components of the reactor coolant system are designed, fabricated, inspected and tested in conformance with ASME III, Class 2 or USAS 16.5, as applicable. The design loads for normal operational fatigue and faulted conditions were selected by conservatively predicting the type and number of cycles that the plant is expected to experience, as described in the PSAR. Also, essential equipment is placed in a structure which is capable of withstanding extraordinary natural phenomena, such as floods, tornadoes, and high wind.

The materials and components of the reactor coolant system are subjected to thorough non-destructive inspection prior to operation and a pre-operational hydro test is performed at 1.25 times the design pressure.

The plant is operated under very closely controlled conditions to ensure that the operating parameters are kept within the limits assumed in the design. For example, the concentrations of oxygen and chlorides are kept to low levels below 0.10 and 0.15 ppm, respectively, to minimize corrosion of the reactor coolant system surface. The reactor pressure vessel is paid particular attention because of the shift in nil ductility transition temperature (NDTT) with irradiation. Therefore, technical specification limits are imposed on the maximum heatup and cooldown rates to make sure that the vessel wall temperature is above the NDTT to prevent brittle fractures whenever the stresses become significant. Materials of construction are selected for the expected environment and service conditions in accordance with the appropriate code requirements.

It is expected that for pipes of the size, thickness, and material used in the RCS significant leakage will occur before catastrophic failure. The plant is provided with various means of detecting leakage from the reactor coolant system, i.e. containment sump level, containment humidity and air particulate measurement, maintenance of water volume inventories, routine surveillance of charging header flow, and radiation monitoring. Leak rates less than one gpm can be detected within a matter of hours. The sensitivity of these leak detection systems gives reasonable assurance that a small crack will be detected and repaired before it reaches the size that will cause failure.

Furthermore, provisions are made for periodically inspecting all the areas of relatively high stress in order to discover potential problems before significant flaws develop. The inspection processes vary from component to component and include such inspection techniques as visual, ultrasonic, and radiographic examinations. The in-service inspection program (as described in the PSAR) provides additional assurance of the continuing integrity of the Reactor Coolant System.

To further demonstrate the adequacy of the reactor coolant system, certain abnormal conditions are analyzed in detail in the PSAR. Those credible transients which could cause pressure surges are analyzed and protection demonstrated by actuation of the following:

a. Reactor protection system trips

b. Pressurizer relief and safety valves

c. Steam side safety and relief valves

These safeguards insure that the system pressures and temperatures attained under unexpected modes of plant operation or anticipated system interactions will be within the design limits, giving further assurance that a rupture of the Reactor Coolant System is very remote.

6.8.2.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects. This data is given in Table 6.1-2.

b) All the primary coolant released to the containment.

c) A halogen reduction factor of 20 inside the containment due to plateout and the containment spray system.

*d) Vogtle Nuclear Plant has a double containment. The inner containment free volume is 2,750,000 ft^3.

*e) There is complete mixing in the enclosure building.

*f) The enclosure building recirculation system charcoal filters (external to the containment) have a halogen filter efficiency of 99% and a flow of 25,000 cfm.

g) The leak rate to the enclosure building is 0.15%/day for the first 24 hours and 0.075%/day for the next 29 days.

*h) The uncontrolled leak rate from the enclosure building is zero.

*i) The enclosure building purge system charcoal filters have a halogen efficiency of 99% and a flow of 250 cfm.

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* Not specifically an assumption from the AEC guide since none are given for class two events.

6.8.2.4 Doses at Site Boundary and Population Dose

With the above assumptions, the activity released from the containment is given in Table 6.8.1. The thyroid inhalation and total body dose at the site boundary are 2.8×10^{-5} mrem and 0.008 mrem, respectively. The population dose is 0.005 man-rem.

6.8.3 LOSS OF COOLANT - LARGE PIPE BREAK

6.8.3.1 Event Description

This incident is the rupture of a large pipe (greater than 6" diameter) with a resulting loss of coolant. The operation of the ECCS is as described in Section 6.8.2 - Small Pike Break, except the injection of borated water is insufficient to prevent clad damage, although it is sufficient to prevent clad melting.

Although the ECCS prevents fuel clad melting, as a result of the increase in cladding temperature and the rapid depressurization cladding failures may occur in the hotter regions of the core. Some of the volatile fission products contained in the pellet-cladding gap may be released to the containment. These fission products, plus those present in that portion of the primary coolant discharged to the containment, are partially removed from the containment atmosphere by the spray system, and plateout on the containment structures. Some of the remain- slowly released to the enclosure building through minute leaks in the containment. These minute leaks could be expected to be choked by water and water vapor although credit for this was not taken in evaluating releases. The activity in the enclosure building is partially removed by the enclosure building recirculation and purge filters before a small fraction is released to the external environment.

6.8.3.2 Discussion of Remoteness of Possibility

The discussion in Section 6.8.2 - Small Break, is applicable to the large break, also. However, the possibility that a large break would occur is much less than the possibility of a small break. The critical crack length* increases as the pipe diameter and wall thickness increase. Since leakage

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* Critical crack length is that crack which will propagate to pipe rupture during the life of the plant.

TABLE 6.8-1

LOSS OF COOLANT RELEASE FROM CONTAINMENT - SMALL BREAK

Isotope	Activity (Curies)
I-131	2.1×10^{-5}
I-132	1.1×10^{-7}
I-133	5.0×10^{-6}
I-134	1.5×10^{-8}
I-135	9.5×10^{-7}
Xe-133	$5.0 \times 10^{+1}$
Xe-133m	3.1×10^{-1}
Xe-135	5.5×10^{-2}
Xe-135m	1.2×10^{-6}
Xe-138	5.7×10^{-6}
Kr-85	4.6×10^{-2}
Kr-85m	4.9×10^{-3}
Kr-87	2.4×10^{-4}
Kr-88	3.5×10^{-3}

from the pipe is proportional to the size of the crack, leakage will be greater for a larger pipe than a smaller pipe. A greater amount of leakage before pipe rupture reduces the possibility of pipe rupture in that a) it is easier to detect, and b) more time is available for corrective action once leakeage is detected, since the detection threshold is a constant independent of leak rate. In addition, service experience indicates that circumferential rupture of a small branch line at the connection point to a pipe run is much more common than a failure in that pipe run.

6.8.3.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects (Table 6.1-2)

b) 100% fuel cladding failure, releasing 2% of the core inventory of noble gases and halogens to the containment. (2% of Table 3.6-3)

c) All of the primary coolant is released to the containment

d) 0.5% of the halogens in the containment are in organic form

e) A halogen reduction factor of 20 inside the containment due to plateout and the containment spray system

*f) Vogtle Nuclear Plant has a double containment. The free volume of the inner containment is 2,750,000 ft^3

*g) There is complete mixing in the enclosure building

*h) The enclosure building recirculation system charcoal filters (external to the containment) have a halogen filter efficiency of 99% and a flow of 25,000 cfm

*i) The leak rate to the enclosure building is 0.15%/day for the first 24 hours and 0.075%/day for the next 29 days

*j) The uncontrolled leak rate from the enclosure building is zero

*k) The enclosure building purge system charcoal filters have a halogen efficiency of 99% and a flow of 250 cfm.

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*Not specifically an assumption from the AEC guide since none are given for class two events.

6.8.3.4 Doses at the Site Boundary and Population Dose

With the above assumptions, the activity released from the containment is given in Table 6.8-2. The thyroid inhalation and the total body dose at the site boundary are 0.16 mrem and 2.4 mrem, respectively. The population dose is 1.7 man-rem.

6.8.4 BREAK IN INSTRUMENT LINE FROM PRIMARY SYSTEM THAT PENETRATES THE CONTAINMENT

This incident is not applicable to the Vogtle Nuclear Plant since this plant does not have any instrument lines connected to the primary system that are not provided with isolation capability inside the containment.

6.8.5 ROD EJECTION ACCIDENT(PWR)

6.8.5.1 Event Description

A highly unlikely rupture of the control rod mechanism housing, creating a full system pressure differential acting on the drive shaft, must be postulated for this accident to occur. The operation of a plant with chemical shim control is such that the severity of an ejection accident is inherently limited. Since control rod clusters are used to control load variations only, and the core depletion is followed with boron dilution, there are only a few partially inserted control rods in the reactor at full power.

The design of the control system utilizes the flexibility in the selection of control rod cluster groupings (both radial locations and axial positions may be adjusted as a function of load) to minimize the peak fuel and clad temperatures for the worst* ejected rod. Analyses of the possible reactivity transients at beginning and end of life at full and zero power, indicate that the resultant power transients do not result in melting of either the fuel pellet or cladding. The reactor core thermal power excursion is limited by the Doppler reactivity effects of the increased fuel temperature and terminated by a reactor trip actuated by a high neutron flux signal.

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*Rod with maximum reactivity effect.

TABLE 6.8-2

LOSS OF COOLANT RELEASE FROM CONTAINMENT - LARGE BREAK

Isotope	Activity (Curies)
I-131	1.2×10^{-1}
I-132	2.6×10^{-3}
I-133	4.2×10^{-2}
I-134	1.0×10^{-3}
I-135	1.3×10^{-2}
Kr-85	4.7×10^{2}
Kr-85m	1.4×10^{1}
Kr-87	2.2×10^{0}
Kr-88	1.5×10^{1}
Xe-133	1.2×10^{4}
Xe-133m	1.4×10^{2}
Xe-135	1.2×10^{2}
Xe-135m	1.2×10^{-1}
Xe-138	1.4×10^{-1}

Minor cladding perforation occurs as a result of this accident. Activity in the primary coolant is released to the containment, where sprays and plateout partially reduce the airborne fission product concentration. Fission products escaping to the external environment do so through minute leaks in the inner containment structure and the enclosure building purge filters.

6.8.5.2 Discussion of Remoteness of Possibility

A failure of a control rod mechanism housing sufficient to allow a control rod to be rapidly ejected from the core is considered very remote. Each control rod drive mechanism housing is completely assembled and shop tested at 4100 psi. On-site, the mechanism housings were individually hydrotested as they are installed, and checked again during the hydrotest at 3107 psig of the complete Reactor Coolant System. These pressures are considerably higher than the normal operating pressure of 2250 psia.

Design of the mechanism considered the stresses due to anticipated system transients at power and the thermal movement of the coolant loops. Moments induced by the dafe shutdown earthquake can be accepted within the allowable primary working stress range specified by ASME III for Class I Components. The latch mechanism housing and rod travel housings are each a single length of forged type-304 stainless steel. This material exhibits excellent notch toughness at all temperatures that will be encountered. The joint between the latch mechanism housing and the vessel head adapter, and between the latch mechanism housing and the rod travel housing, are threaded joints, reinforced with canopy type seal welds.

The significant margin of strength in the elastic range together with the large energy absorption capability in the plastic range gives additional assurance that gross failure of the housing will not occur. Finally, periodic inspections of the housings are made during the plant lifetime to insure against defects.

Because of the conservative design, the number of pre-operational tests, the material of construction and the periodic inspection program, the potential of rod ejection accident is considered minimal.

6.8.5.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects (Table 6.1-3).

b) 0.2% of the core inventory (10% fuel defects) released to the coolant.

c) All of the primary coolant released to the containment.

d) A halogen reduction factor of 20 inside the containment due to plateout and the containment spray system.

*e) Vogtle Nuclear Plant has a double containment. The free volume of the inner containment is 2,750,000 ft^3.

*f) There is complete mixing in the enclosure building

*g) The enclosure building recirculation system charcoal filters (external to the containment) have a halogen filter efficiency of 99% and a flow of 25,000 cfm.

*h) The leak rate to the enclosure building is 0.15%/day for the first 24 hours and 0.075%/day for the next 29 days.

*i) The uncontrolled leak rate from the enclosure building is zero.

*j) The enclosure building purge system charcoal filters have a halogen efficiency of 99% and a flow of 250 cfm.

6.8.5.4 Doses at Site Boundary and Population Dose

With the above assumptions, the activity released from the containment is given in Table 6.8-3. The thyroid inhalation and total body doses at the site boundary are 0.015 mrem and 0.32 mrem, respectively. The population dose is 0.29 man-rem.

6.8.6 STEAM LINE BREAK - LARGE BREAK

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*Not specifically an assumption from the AEC guide since none are given for Class two events.

TABLE 6.8-3

ROD EJECTION ACCIDENT RELEASE FROM CONTAINMENT

Isotope	Activity (Curies)
I-131	1.1×10^{-2}
I-132	2.3×10^{-4}
I-133	3.8×10^{-3}
I-134	9.0×10^{-5}
I-135	1.2×10^{-3}
Kr-85	4.8×10^{0}
Kr-85m	1.3×10^{0}
Kr-87	2.2×10^{-1}
Kr-88	$1.5 \times 10^{+1}$
Xe-133	1.8×10^{3}
Xe-133m	1.4×10^{1}
Xe-135	7.0×10^{0}
Xe-135m	5.5×10^{-3}
Xe-138	2.4×10^{-2}

6.8.6.1 Event Description

A rupture of a steam line is assumed to include any accident which results in an uncontrolled steam release from a steam generator. The release can occur due to a break in a pipe line or due to a valve malfunction. The steam release results in an initial increase in steam flow which decreases during the accident as the steam pressure falls.

The following systems limit the potential consequences of a steam line break:

1. Safety injection system actuation from any of the following:
    a) Coincident low pressurizer pressure and level signals.
    b) High differential pressure signals between steam lines.
    c) High steam line flow in two main steam lines in coincidence with either low-low reactor coolant system average temperature or low main steam line pressure in any two lines.
    d) High containment pressure.
2. The overpower reactor trips (neutron flux and T), and the reactor trip occurring upon actuation of the Safety Injection System.
3. Redundant isolation of the main feedwater lines. In addition to the normal control action which will close the main feedwater valves, a safety injection signal will close all feedwater control valves, trip the main feedwater pumps, and close the feedwater pump discharge valves.
4. Trip of the fast acting steam line stop valves (designed to close in less than 5 seconds) on:
    a) High steam flow in two main steam lines in coincidence with either low-low reactor coolant system average temperature or low steam line pressure in any two lines.
    b) High-high containment pressure.

Each steam line has a fast closing stop valve with a downstream check valve. These valves prevent blowdown of more than one steam generator for any break location even if one valve fails to close. For example, for a break upstream of the stop valve in one line, closure of either the check valve in that line or the valves in the other lines will prevent blowdown of the other steam generators. In particular, the arrangement precludes blowdown of more than one steam generator inside the containment, thus preventing structural damage to the containment.

If there were no steam generator tube leaks (Class 5), there would be no fission product release to the atmosphere from this accident. With tube leaks, a portion of the equilibrium fission product activity in the secondary system will be released. In addition, some primary coolant with its entrained fission products will be transferred to the secondary system as the reactor is cooled down. The steam is dumped to the condenser, and the noble gases transferred from the primary system would be released through the condenser air ejectors.

6.8.6.2 Discussion of Remoteness of Possibility

A steam line break is considerably highly unlikely. The steam system valves, fittings and piping are conservatively designed. The piping is a ductile material completely inspected prior to installation. The steam and feedwater lines with their supports and structures from the steam generators to their respective isolation valves are designed to seismic Class I specifications. After installation, the entire system undergoes hot functional testing prior to fuel loading. This pre-operational hydrotesting is conducted at 1.25 the design pressure. This test is designed to uncover any flaws that may exist in the piping, fittings or valves.

In addition to pre-operational tests to insure the steam system integrity, during operation the water in the sceondary side of the steam generators is held within chemistry specifications. A chemical treatment is used to prevent the formation of free caustic. These measures control deposits and corrosion inside the steam generators and steam lines. The phenomena of stress-corrosion cracking and corrosion fatigue are not generally encountered unless a specific combination or conditions (i.e., combination of susceptible allow, aggressive environment, stress and time) is present. The steam system is designed to avoid any critical combination of these conditions.

6.8.6.3 Assumptions

a) An equilibrium radioactivity in the secondary system of 0.5% equivalent fuel defects with 20 gpd steam generator leakage and 10 gpm blowdown/generator. (Table 6.1-3).

b) No additional fuel defects or additional releases from fuel occur due to the accident.

c) Volume of one steam generator released to atmosphere.

d) Halogen partition factor of $0.1 \frac{\mu c/gm\ steam}{\mu c/gm\ water}$ for the activity present in the steam generator before the incident.

e) Primary to secondary leakage of 20 gpd occurs for 8 hours after the accident, the length of time required to cool the plant down.

f) Halogen partition factor of $0.5 \frac{\mu c/steam}{\mu c/water}$ for the activity leaked from the primary side to the secondary during the course of the accident.

g) The break occurs outside the containment.

*h) The condenser is available for steam dump after the faulted line is isolated.

6.8.6.4 Doses at the Site Boundary and the Population Dose

With the above assumptions, the activity released to the environment is given in Table 6.8-4. The thyroid inhalation and total body doses at the site boundary are 7.8×10^{-3}mrem and 3.4×10^{-4} mrem, respectively. The population dose is 0.001 man-rem.

6.8.7 STEAM LINE BREAK - SMALL BREAK

This incident has not been separately analyzed. The ohly different assumption for this incident as compared to the large steam line break (Section 6.8.6) is that a halogen partition factor of 0.1 (μc/gm steam)/(μc/gm water), instead of 0.5, is used for the steam generator when the tubes are covered by feedwater. An analysis of the length of time required to boil a steam generator dry versus line break size has not been performed. It is considered that the time would be fairly short compared to the time required to cool the plant down, and thus would be only a minor reduction in the doses presented for the large steam line break.

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*Not specifically an assumption from the AEC guide since none are given for Class two events.

TABLE 6.8-4

STEAM LINE BREAK ACTIVITY RELEASE

Isotope	Activity (Curies)
I-131	4.4×10^{-3}
I-132	1.1×10^{-3}
I-133	6.0×10^{-3}
I-134	6.2×10^{-4}
I-135	2.8×10^{-3}
Kr-85	1.7×10^{-3}
Kr-85m	2.6×10^{-2}
Kr-87	1.6×10^{-2}
K4-88	4.7×10^{-2}
Xe-133	1.0×10^{0}
Xe-133m	2.1×10^{-2}
Xe-135	7.4×10^{-2}
Xe-135m	2.2×10^{-3}
Xe-138	8.3×10^{-3}

6.9 SUMMARY OF DOSES FROM EACH CLASS

For each of the accident classes considered in this report an average site boundary thyroid and total body dose were computed. The total body includes both beta and gamma contributions. The integrated dose to the population within a 50 mile radius of the plant has been computed, based on gamma contributors only. These have been compiled into Table 6.9-1.

TABLE 6.9-1

SUMMARY OF DOSES AND ENVIRONMENTAL EFFECTS

		Site Boundary Dose (mrem)		Environmental
Class	Representative Event	Tyroid	Total Body	Effect (man-rem)
2	Volume Control Tank Release	7.9×10^{-6}	4.5×10^{-2}	0.059
3	Volume Control Tank Release	2.0×10^{-5}	1.1×10^{-1}	0.147
3	Waste Gas Decay Tank	- -	4.4×10^{-1}	0.260
3	Liquid Waste Storage Tank		No release to environment	
4	Fission Products to Primary System		Not applicable to this plant	
5	Fuel Cladding defects and Steam Generator Leak		Considered under routine effects	
5	Off-Design Transients that Induce Fuel Failure	2.5×10^{-3}	5.9×10^{-2}	0.170
5	Steam Generator Tube Rupture	4.8×10^{-3}	6.0×10^{-1}	1.05
6	Fuel Bundle Drop	4.4×10^{-4}	4.3×10^{-3}	0.003
6	Heavy Object Drop Onto Fuel in Core	8.1×10^{-2}	9.7×10^{-1}	0.647
7	Fuel Assembly Drop in Storage Pool	4.6×10^{-3}	4.9×10^{-2}	0.033
7	Heavy Object Drop onto Fuel Rack	8.5×10^{-3}	4.5×10^{-2}	0.027
7	Fuel Cask Drop	- -	5.9×10^{-2}	0.002
8	Loss of Coolant - Small Pipe Break	2.8×10^{-5}	7.9×10^{-3}	0.005
8	Loss of Coolant - Large Pipe Break	1.6×10^{-1}	2.4×10^{0}	1.66
8	Instrument Line Break		Not applicable to this Plant	
8	Rod Ejection Accident	1.5×10^{-2}	3.2×10^{-1}	0.289
8	Steam Line Break - Large Break	7.8×10^{-3}	3.4×10^{-4}	0.001
8	Steam Line Break - Small Break	Not separately analyzed - doses only slightly smaller than for large steam line break.		

6.10 CONCLUSIONS

Based on the evaluations of the various postulated accidents and occurrences in Section 6.2 through 6.8 and the resultant radiological results as tabulated in Section 6.9, it is concluded that the environmental impact from these accidents and occurrences are insignificant and inconsequential.

The average natural background radiation exposure in the United States is about 130 mrem. This varies from a low of 100 mrem/yr. in coastal Texas and Louisiana to a high of 250 mrem/yr. in the mountains of Colorado and Wyoming, or a variation of 150 mrem/yr. In the vicinity of the Vogtle Nuclear Plant it is about 125 mrem/yr. Building construction, whether frame, brick, or stone can result in variations in the radiation exposure inside the structure of greater than 50 mrem/yr. Even the variation in the radiation exposure between a transcontinental round trip by plane as compared to train is 4 mrem. The largest computed total body dose at the site boundary from a postulated accident is 2.4 mrem for the large pipe break loss of coolant.

The annual integrated exposure from natural background to the population within 50 miles of the VNP is 94,613 man-rem (736,902 people times 125 mrem/yr.). By comparison, the largest computed incremental population exposure from any postulated accident is 1.7 man-rem for the large pipe break loss of coolant.

Thus, the exposure resulting from any accident is well within the increment of exposure to the general public corresponding to variations in natural background.

7. UNAVOIDABLE "ADVERSE" EFFECTS OF PLANT CONSTRUCTION AND OPERATION

7.1 UNAVOIDABLE CONSTRUCTION EFFECTS

Unavoidable effects from the construction of VNP are those of noise, slight erosion, dust and congestion, in addition to the destruction of approximately 1011 acres of forested and farming areas which existed prior to the construction of VNP.

Some of the above effects are of a local and temporary nature and at the end of the construction period will not exist. Approximately 247 acres of land used for construction facilities will be landscaped to prevent erosion and dust effects and to lessen the adverse visual effects created by construction activities. Of the 3177 acres, approximately 2142 acres will be left in their present state to provide a wildlife habitat.

The clearing of new transmission line routes is an adverse, but necessary, effect of power generation. The impact of clearing rights-of-way will be minimized wherever possible by routing through agricultural areas where the land can continue to be used for farming or pasturage beneath the transmission lines. Where the lines must be through forested land, GPC will either leave the area in natural species of low shrub cover or plant the areas to provide wildlife habitats and to prevent erosion. The approximate acreage required for new transmission lines is 12,000 as outlined in Sections 2
3.2 and 5.4

The clearing and grading required for the access railroad to VNP will be an adverse impact. Every effect will be made to minimize the impact from the clearing and grading by utilizing good construction methods such as ditching and grading to reduce runoff and erosion and planting the grade areas to prevent erosion after construction and to provide, to the extent possible, new wildlife habitat. The off site area required for the railroad consists of approximately 245 acres as described in Section 4.2.

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CHAPTER 7 UNAVOIDABLE "ADVERSE" EFFECTS OF PLANT CONSTRUCTION AND OPERATION

7.1 UNAVOIDABLE CONSTRUCTION EFFECTS 7.7-1
7.2 UNAVOIDABLE OPERATIONS EFFECTS 7.2-1

7.2 UNAVOIDABLE OPERATIONS EFFECTS

One of the possible effects from the operation of VNP will be occasional fog due to the operation of the cooling towers. As indicated in Subsection 5.1.5, it is expected that the increase in frequency of fogging at a given off-site location will be no more than 5 percent of the hours in a day. Since climatic conditions are mild, icing conditions will not be expected to be increased significantly.

The presence of the plant facilities in a rural environment will cause a visual impact which might be objectionable to some; however, the site is remote from large populated areas and is not adjacent to heavily traveled highways. Screening by natural vegetation and the low plant profile will make the plant almost invisible from the local highways and the river. Moisture plumes from the cooling towers may be conspicuous from the highway and the river and will tend to give an industrial image to the area if visible. 2

The release of radioactive materials to the atmosphere and to the Savannah River will add an increment of dose to the environment which is small compared to the existing background radioactivity in the vicinity. Releases from VNP will meet the AEC requirements that exposures be as low as practicable. Section 5.2 gives the expected dose to the population in the area as approximately 95,000 man-rems.

Chemicals which would be toxic in high concentrations will be released from VNP. However, the amounts and concentrations expected to be released to the environment will be below applicable standards and are not expected to significantly affect the environment. Section 3.7 discusses the chemicals which will be released and gives the concentrations and amounts which will be released by the cooling tower blowdown, the demineralizer waste system and other systems. Section 5.3 discusses the expected effects of these chemicals.

The intake structure has been designed to reduce entrainment of aquatic biota in the cooling water system by the use of the velocities of less than 1.0 foot per second through the intake screens. However, nonmobile aquatic organisms, such as fish larva, eggs, and plankton, will be entrained, and, due to the use of cooling towers, will be destroyed. The nutrient available from this biomass will be returned to the environment via the cooling tower blowdown. 2

It is estimated that approximately 1.2 percent of the drifting (nonmobile) organisms will be entrained through the main cooling water system at minimum flow. An additional 5.0 percent will be entrained through the bypass water but will not be subject to heat effects. At normal flows, approximately 0.7 percent will be entrained through the cooling system and an additional 2.8 percent will be entrained in the bypass water. Studies will be made to identify and quantify the biomass of the organisms entrained. Section 5.1 discusses the percent of entrainment expected.

The use of cooling towers at VNP will eliminate adverse thermal effects since the cooling tower blowdown, when mixed with the river will increase the river temperature by less than 1°F. Section 5.1 discusses the thermal effects of cooling towers.

The visual impact from the transmission lines and the railroad spur will be minimized wherever possible by screening with existing or replanted vegetation; and by the use of low profile-type towers to reduce the visual impact. Section 5.4 and 3.1 discuss these aspects in detail.

The impact from a transportation accident during shipment of spent fuel and solid radwaste material is problematic at best and is dependent to some extent on the common carrier used to ship these materials. Section 3.6 discusses the measures taken to prevent or minimize the impact from the transportation of spent fuel and solid radwaste.

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8. ALTERNATIVES TO CONSTRUCTION AND OPERATION OF PLANT

8.1 NOT PROVIDING THE POWER

Georgia Code Ann. Section 93-307 authorizes the Georgia Public Service Commission to require all public service companies under its supervision to establish and maintain such public service facilities as may be reasonable and just, either by general rule or by specific order in particular cases. The Commission's General Rule 14 states that a public utility may not discontinue or curtail any privileges or services which are presently being rendered to the public unless the Public Service Commission consents. Moreover, in Georgia Public Service Commission v. Georgia Power Company, 182 Ga. 706, the court applied Section 93-307 and upheld an order of the Public Service Commission which required GPC to furnish new electric service to the inhabitants of Andersonville, Georgia. Therefore, it is clear that the law in the state of Georgia, under which GPC operates as a public utility, mandates that GPC make adequate provision for supply of electricity to its customers, who comprise the bulk of Georgia's residential, commercial and industrial population. 1

Because of the long lead times involved in the planning and construction of major power facilities, electric utilities have no option but to base their plant expansion programs on demand forecasts. In recent years, actual demand growth in many areas has exceeded forecast figures. GPC's current projection of power demand on its system indicates that its load will reach 16,728 megawatts in the summer of 1980 and 22,728 megawatts in the summer of 1983. This is discussed in detail in Section 1.2. 1

GPC is also obligated to maintain reserve capacity in excess of peak load. Thus, in order to meet the projected summer peak load and maintain a minimum reserve margin, GPC must be able to provide a very large block of new generating capacity by the early summer of each year. GPC presently has about 6,500 megawatts of existing generating capacity, including gas turbine capacity, and an additional 11,500 megawatts of capacity (apart from VNP) are either under construction or have been authorized for construction. GPC has no option but to make firm provision for at least this much additional power supply. Section 1.2 lists GPC's generating capacity, including capacity under construction or authorized for construction. 1

8.2 PURCHASING POWER FROM OTHER UTILITIES

Purchasing power from other utilities in the amounts necessary to satisfy, or even partially satisfy, the power requirements indicated in Sections 1.2 and 8.1 is not a practical alternative. The applicant presently has transmission interconnections for exchanging power with its neighboring utilities included within The Southern Company group. These interconnections exist for reliability purposes, including exchange of power in the event of a major unscheduled outage of generating capacity on one of the systems and helping to meet unexpected non-coincident peaks in demand.

Through the "Pooling Agreement" among the companies of The Southern Company System (Alabama, Georgia, Gulf, and Mississippi power companies), the system companies buy and sell temporary deficits and surpluses of power through the Pool. Such amounts of capacity bought and sold are on a year-to-year basis to equalize reserves among companies and take advantage of economy of scale in staggering the installation of generating units. Any surplus existing on the system of one company in excess of its own load and other firm commitments is only temporary (one to three years, normally) and is relatively small in magnitude (possibly up to 300 to 400 megawatts in any one year). This type of capacity purchase and sale could not be counted upon to replace a large generating unit otherwise needed on the system requiring substantial added capacity.

Neighboring systems of The Southern Company System (T.V.A., Middle South System, Florida Power Corporation, South Carolina Electric and Gas Company, and Duke Power Company) have all made load and capacity projections through 1981. These estimates of loads and capacity additions are all set forth or included as parts of the reports made April 1, 1972, in response to Appendix A of FPC Order No. 383-2. Based upon these data, none of the neighboring systems are planning on having capacity in excess of its own needs for forecast loads and reserve requirements. Should any surplus exist because of variations in load forecasts from actual loads or previous forecasts, these surpluses would not be known but a short time previous to such occurrence.

Additionally, the interconnections now existing and planned between the Southern System companies and neighboring systems are primarily for increased service reliability through mutual emergency assistance and short-term power exchanges. If capacity in the quantity required were available from neighboring

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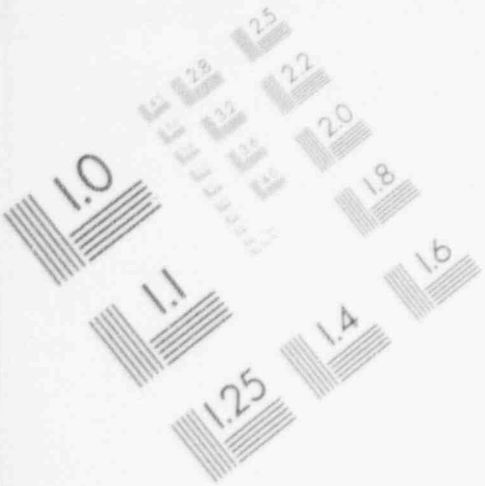

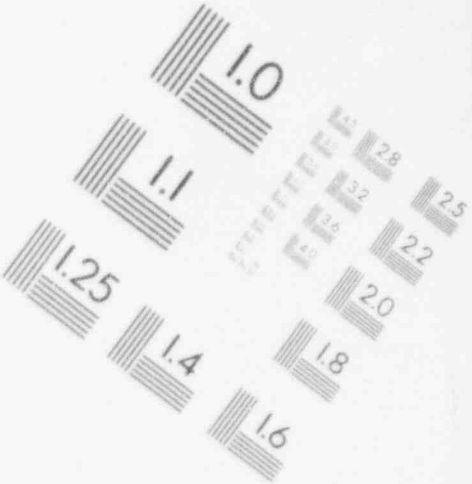

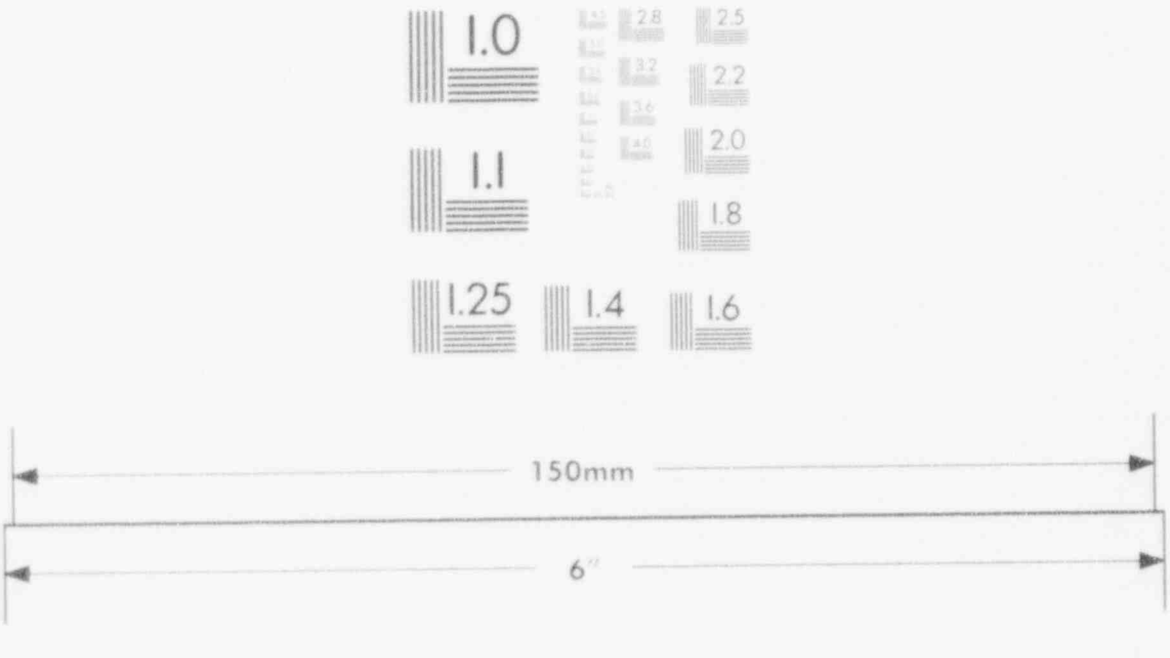

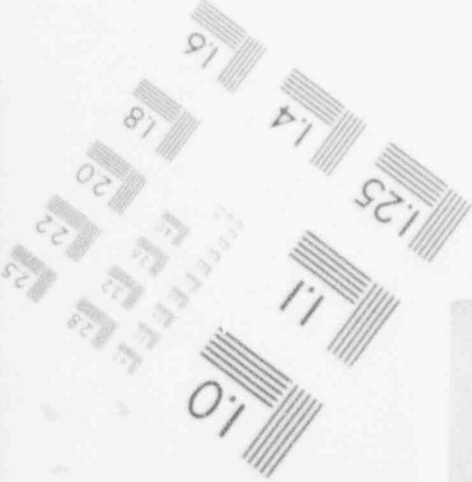

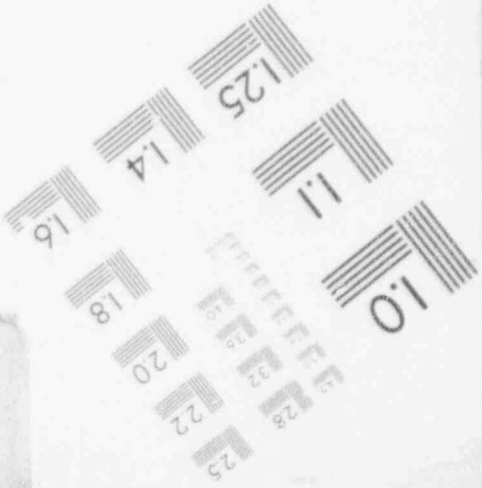

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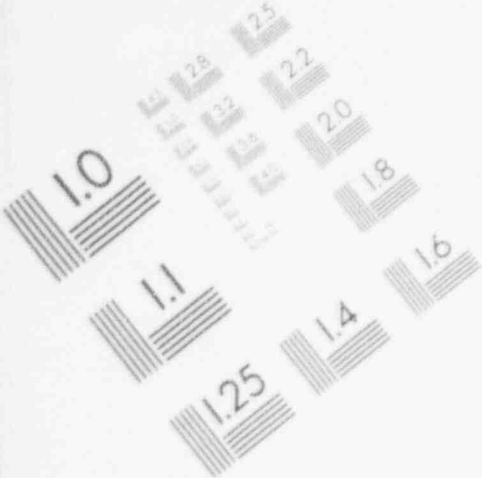

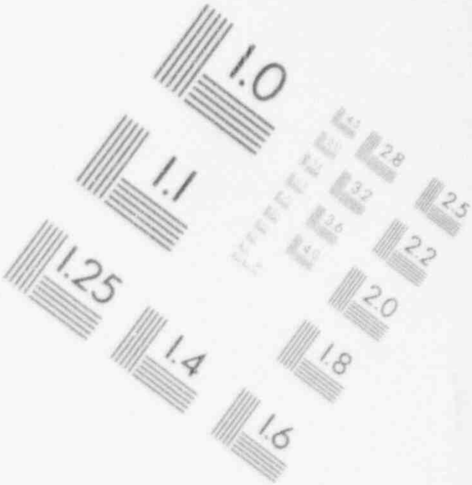

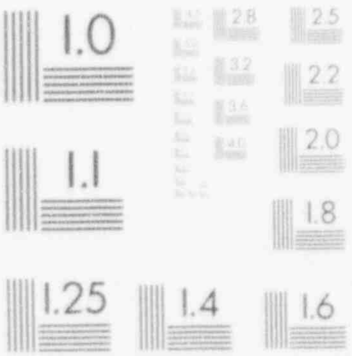

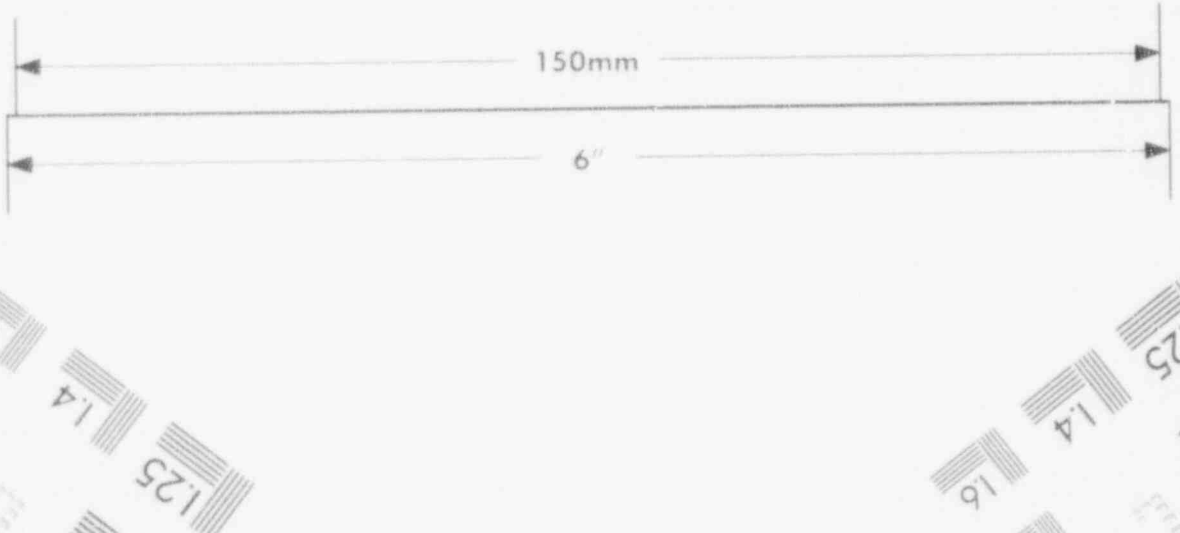

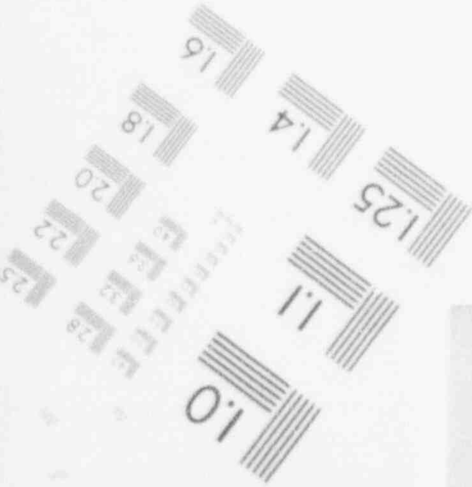

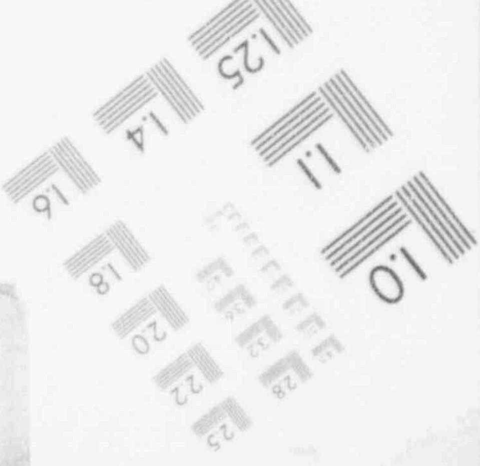

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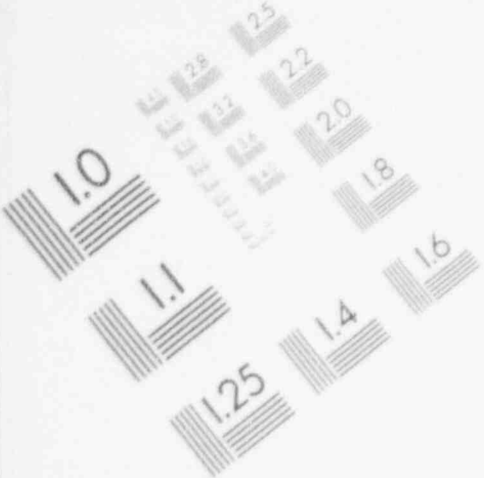
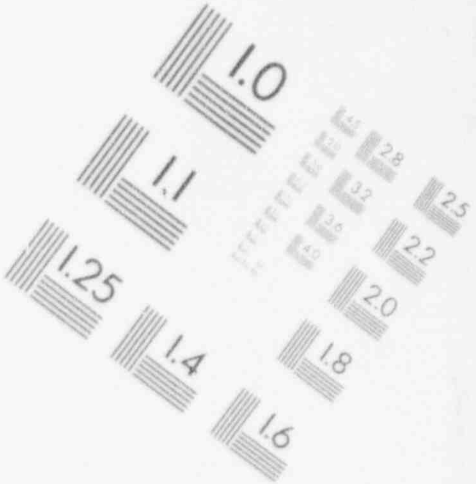
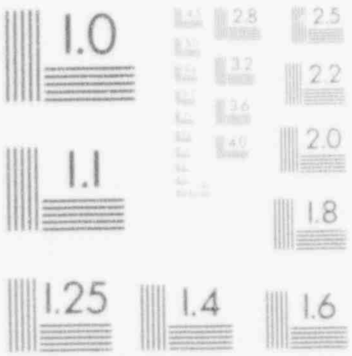
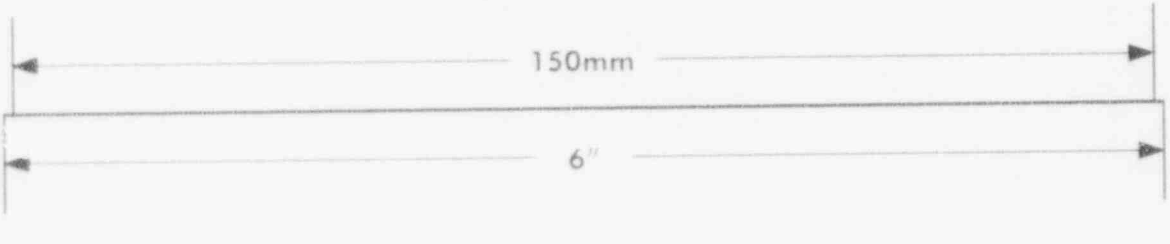

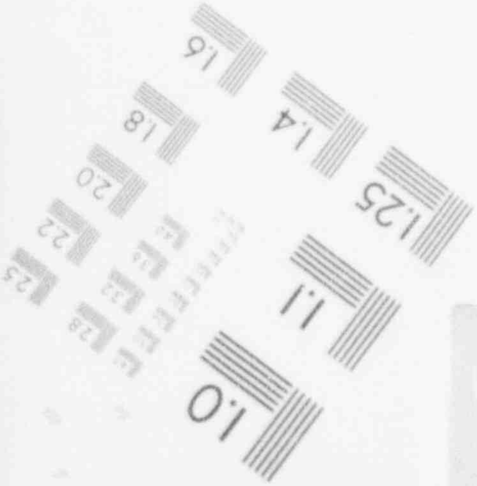


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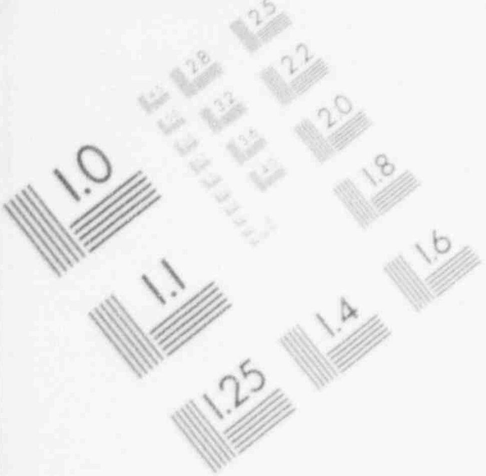

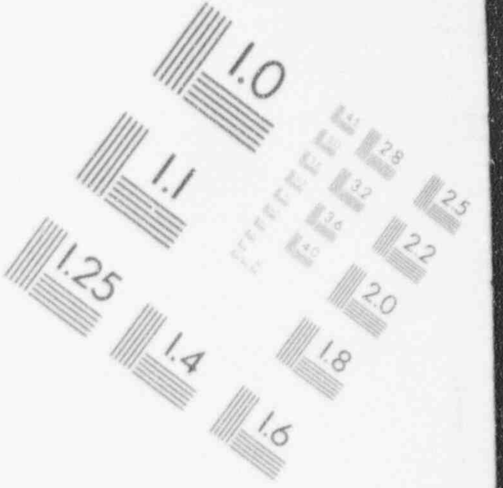

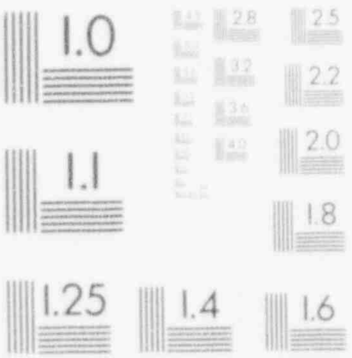

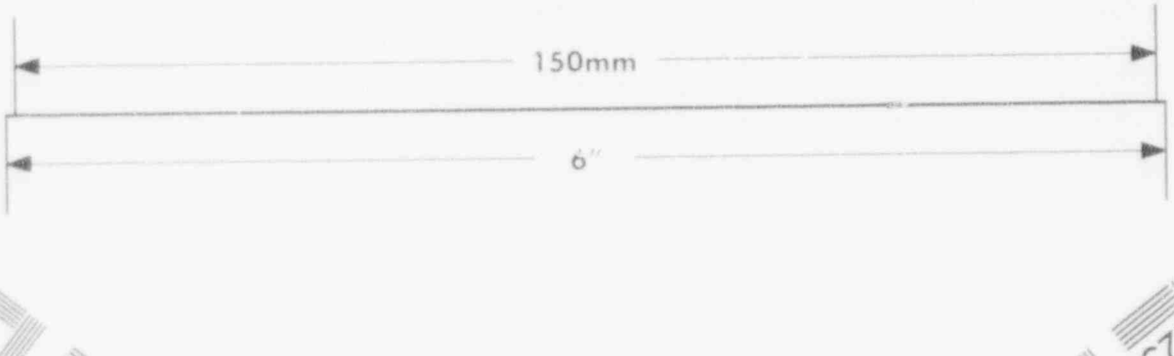

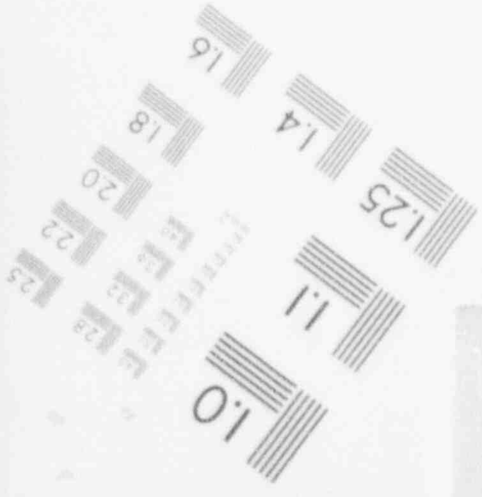

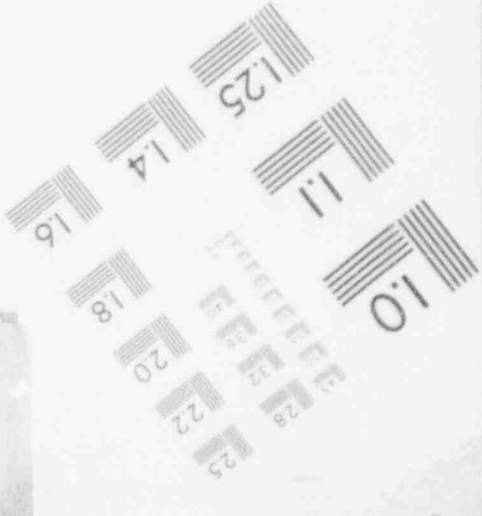

systems, the regular scheduling of use of such capacity on interconnections could seriously affect reliability of power supply on The Southern System during emergency conditions experienced therein or during emergency conditions on neighboring systems where transfer of power from a third party through the system to the affected party could otherwise have been achieved. Because of the demands upon construction schedules and fuel requirements associated with new plants in meeting air and water quality regulations, it is highly unlikely that any electric utility is going to undertake the planning and construction of surplus generating and transmission facilities to export such surplus to another area for any extended time period. All future surpluses appear to be too small in magnitude and too short in duration to be of significant assistance in supplying a substantial deficit of another area.

8.3 ALTERNATIVE METHODS OF GENERATING POWER

8.3.1 COAL-FIRED GENERATING PLANT

Prior to entering a contract for the supply of the reactors for VNP, the applicant analyzed the competitive economics of a nuclear vs. a coal-fired plant. In this analysis, costs were developed for the plant capital investment, fuel cost, and maintenance and operating costs to assess the total energy cost for each type of plant. The nuclear plant had higher capital costs, but lower fuel costs than the coal-fired plant for the area under study. The net result showed nuclear fuel to have a competitive economic edge over coal-fired plants at the site required to service the load efficiently. The cost of power is compared for coal and nuclear units at the Vogtle site in Table 8.3-1. In addition, the environmental effects of a nuclear plant versus a coal-fired plant are essentially equal when consideration is given to the amount of land required. A coal-fired plant, in addition to the radioactivity(1) released, as compared to a nuclear plant, releases considerable amounts of SO_2, NO_x, particulate matter, and other combustion products, even when the latest technology is used to reduce these products. A nuclear plant, on the other hand, releases only radioactivity in small amounts which generally are not detectable in the environment. At this particular site a tall chimney required to meet Air Quality Standards for the State of Georgia could create a hazard for aircraft due to the location of the Augusta Airport approximately 17 miles north of the site.

8.3.2 OIL-FIRED GENERATING PLANT

Oil-fired plants were also considered in lieu of other types of plants. However, the cost of fuel and the fact that oil must be imported in huge quantities from foreign sources to meet the fuel requirements could, in the opinion of GPC, in time of national emergency, seriously affect the national security by creating a severe national power shortage at the time of greatest need. The cost of power is compared for oil and nuclear units at the Vogtle site in Table 8.3-1. The above, when considered with the environmental effects of oil-fired plants, such as SO_2, and NO_x emissions, land use for storage tanks, and the potential hazard of oil spills, would in essence have the same environmental effects as a coal-fired plant. This makes the alternative not acceptable for the plant size at this site.

TABLE 8.3-1

COMPARISON OF COST OF POWER

		Nuclear	(1) Coal	(2) Oil	(3) Combustion Turbine
Net Capacity, MWe		4648	4767	4964	4640
Capital Cost:	$million	2196	1267	1018	780
	$/Kw	472	266	205	168

30-Year Levelized Energy Cost (Mills/KWh)
(78.1% Plant Factor)

	Nuclear	Coal	Oil	Combustion Turbine
Fixed Charges (6)	10.82	6.07	4.68	3.93
Fuel Cost @ 17.8% (7)	(8) 3.16	(4) 11.34	(5) 9.67	(5) 13.73
O&M and Nuclear Insurance	(8) 0.82	0.60	0.46	0.47
Total	14.80	18.01	14.81	18.13

(1) Coal fired units with SO_2 removal equipment. Net plant heat rate after adjustment for power and steam required to operate the SO_2 removal equipment = 9875 Btu/KWh. 90-day reserve supply of coal. Includes 5% capacity credit for overpressure.

(2) Oil fired units without SO_2 removal equipment. Net plant heat rate = 9020 Btu/KWh. No storage facilities for reserve oil supply. Includes 5% capacity credit for overpressure.

(3) Combustion turbine units to be operated on oil. No SO_2 removal equipment. Net plant heat rate = 12,800 Btu/KWh. No storage facilities for reserve oil supply.

(4) Delivered cost of coal at Vogtle Site - 58.3¢/MBtu in 1972. Simple escalation applied @ 7.7% through 1976 and @ 2.65% thereafter. Coal from Illinois Basin with 3.0-3.5% sulfur content. Fuel cost shown includes additional expenses associated with operating SO_2 removal equipment.

(5) Delivered cost of oil at VNP site for a single unit in 1980 = 92.7¢/MBtu; for 2 units in 1981 = 90.4¢/MBtu; for 3 units in 1982 = 92.1¢/MBtu; for 4 units in 1983 = 91.2¢/MBtu. Simple escalation applied @ 2.5¢/MBtu per year thereafter. Oil processed from foreign crude at Savannah and delivered by pipeline. Low sulfur content (0.7%).

(6) Fixed charge rate = 15.70% for nuclear units, 15.62% for coal and oil units, and 16.03% for combustion turbines. These fixed charges include return on investment, depreciation, income taxes, ad valorem taxes, and insurance.

(7) The 17.8% factor is the carrying charge rate applicable to non-depreciable investments such as fuel and includes return on investment, income taxes and ad valorem taxes. 1

(8) The estimated fuel, O&M, and nuclear insurance costs shown were obtained by averaging together the 30-year levelized costs for all 4 units. The annual costs for each unit were estimated including the projected effects of cost escalation during the entire 30-year period. These annual costs were then levelized for each unit using a 10.4 percent annual discount rate.

8.3.3 NATURAL GAS-FIRED GENERATING PLANT

The use of a natural gas-fired generating plant was not seriously considered as an alternative source of power due to inadequate gas reserves to insure fuel supply for the plant. GPC presently purchases natural gas from Atlanta Gas Light Company on an interruptible basis for use as boiler fuel at Plants Atkinson, McDonough, Arkwright and Yates. Atlanta Gas Light Company purchases the gas it markets from Southern Natural Gas Company, a pipeline supplier. During previous years, when gas supplies were more plentiful, GPC was permitted to purchase substantial quantities of gas, particularly during the summer months. However, as supplies of natural gas allegedly dwindled, Southern Natural Gas Company filed with the Federal Power Commission a curtailment plan, pursuant to which gas sold for the generation of electricity is curtailed prior to gas sold for other purposes. This plan was implemented by the Federal Power Commission on December 26, 1971, in FPC Docket No. RP72-74. The effect of this curtailment plan has been to render Atlanta Gas Light Company unable to deliver significant quantities of natural gas to GPC. For example, GPC was able to purchase only 29,729,971 mcf of natural gas during the first 11 months of 1972, as compared with 48,285,114 mcf during the first 11 months of 1971.

This severe cutback of supplies of natural gas must be viewed in light of the facts that Atlanta Gas Light Company is the only distributor of adequate size within GPC's territory to serve its requirements, that Southern Natural Gas Company is the only supplier of Atlanta Gas Light Company of adequate size to provide gas for GPC's requirements, and that Southern Natural Gas Company has testified before the Federal Power Commission that it anticipates its curtailment plan to be of long duration. Accordingly, GPC has concluded that it cannot expect to continue receiving substantial quantities of natural gas for generating purposes at those 4 plants which now utilize natural gas as boiler fuel. Furthermore, GPC has concluded that it cannot acquire significant new deliveries of natural gas for use in plants to be built in the future.

8.3.4 COMBUSTION TURBINES

Combustion turbines are not economical for base-load service despite their low capital costs. The principal reason is their high fuel costs, which more than cancel out their capital cost advantage. The cost of power is compared for combustion turbines and nuclear units at the VNP site in Table 8.3-1. GPC has significant combustion turbine capacity in peaking service today and plans increased use of such peaking units. However, feasibility of such installations depends on maintaining a proper balance of economic base-load capacity.

8.3.5 HYDRO GENERATION

Table 8.3-2 shows 1166 MW of planned hydro generation additions by GPC. Of this amount, 891 MW is pumped hydro and, as such, serves only as energy storage and not for energy production. Also included in GPC reserve considerations are Southeastern Power Administration (SEPA) hydro installations of 573 MW, of which 250 MW is pumped hydro. This totals 1739 MW of hydro in Georgia, of which 1141 MW is pumped hydro and 598 MW is conventional hydro. Not included in GPC reserve 1

TABLE 8.3-2

PLANNED HYDRO ADDITIONS IN GEORGIA

Year	Name	Capacity MW	GPC or SEPA	Type	Location
1975	Carters Dam	250	SEPA	Conv.	Northwest Georgia
1976	Carters Dam	250	SEPA	Pumped	Northwest Georgia
	West Point	73	SEPA	Conv.	Georgia-Alabama State Line
1977	Wallace Dam	216	GPC	Pumped	Central Georgia
	Wallace Dam	108	GPC	Conv.	Central Georgia
1979	Rocky Mountain	675	GPC	Pumped	Northwest Georgia
	Bartletts Ferry	100	GPC	Conv.	Georgia-Alabama State Line
1981	Goat Rock	67	GPC	Conv.	Georgia-Alabama State Line
1982	Trotters Shoals	169	SEPA	Conv.	Georgia-So. Carolina State Line
	Spewrell Bluff	50	SEPA	Conv.	West Central Georgia
1983	Trotters Shoals	169	SEPA	Conv.	Georgia-So. Carolina State Line
	Spewrell Bluff	100	SEPA	Conv.	West Central Georgia
	TOTAL	2227			
	Conventional	1086			
	Pumped	1141			

considerations but listed by SEPA as planned installations are 488 MW of hydro in 1982 and 1983. The total of all these hydro power sources is 2227 MW, of which 1141 MW is pumped storage and 1086 MW is conventional hydro. The power sources represented by conventional hydro from 1975-1983 are approximately equal to only 1 VNP unit and cannot be considered as an alternative base load power source. The locations of GPC and SEPA planned and proposed hydro installations are shown on Table 8.3-2. 1

8.3.6 OTHER GENERATING SOURCES 1

Eight alternate generating methods are considered in this subsection. Evaluation is made on the basis of technical and economic feasibility within the time and scale requirements of the power demands. The first 6 methods involve various processes of steam generation, while tidal power involves an alternate prime mover, and MHD involves a new approach to electrical generation.

8.3.6.1 Coal Gasification 1

Coal gasification (2) may provide the means of balancing the demands upon the fossil fuel reserves. The demand for the clean burning natural gas is beginning to exceed the supplies, while the demand for coal, which represents 75 percent of the fossil fuel reserves, is decreasing rapidly. While gasification can produce gas of natural gas quality from coal, the costs are not presently competitive with other energy sources.

From the point of view of overall energy consumption and fuel resource utilization, coal gasification coupled with gas-fired steam power plants will result in a lower overall efficiency in terms of the useful energy per ton of coal. In terms of energy efficiency, conventional coal power plants combined with pollution control methods are far superior.

8.3.6.2 Coal Liquefaction 1

Coal liquefaction, like gasification, may provide the means to balance the demands on the fossil fuel reserves.

Coal liquefaction is a fuel treatment process that removes impurities from the fuels prior to combustion. The products are char, volatiles and vapors that can be condensed to a high-quality fuel oil. This synthetic crude oil is free of the oxides of sulfur and much of the particulates which ordinarily accompanies coal burning.

Currently, a plant to liquefy 36 tons per day of high quality coal is in operation in Princeton, New Jersey.(3) The scale of production at this plant is only 0.1 percent of the size required for large utility operation. To be economically feasible, the fuel oil derived from liquefaction process must cost about 60¢ per million Btu, but this fuel is made from coal costing 20¢ per million Btu. Hence, the process triples the original cost of the fuel.(4)

The fuel produced is free of SO_2 and low in particulates, thus reducing the air emissions that accompany coal burning.

For a utility with a readily available coal fuel supply, liquefaction results in an elimination of SO_2 emissions; but at a price of more than three times the coal fuel costs. This is significant since fuel costs average 80 percent of the total production costs. Technologically, it appears that it will be at least 10 years before liquefaction becomes technically feasible for implementation into power plant plans. Even then, it does not appear to be an economically viable alternative. Nevertheless, the power demand to be satisfied by VNP is such that coal liquefaction would not be developed on a timely basis.

8.3.6.3 Fluidized Bed Boilers 1

In areas where only high sulfur coal is available, fluidized bed boilers can reduce the SO_2 and particulate emissions produced by coal burning. NO_x emissions are not effected.

This process is not available in the time frame of power demands. Fluidized bed boilers have considerable potential for replacing the conventional, pulverized coal fired boilers. However, the advantages in terms of lower costs, lower emissions, smaller boiler sizer, higher efficiencies are not expected to be available for implementation into power plant plans until 1980.(5) When perfected, fluidized bed boilers may prove economically, technically and environmentally attractive for utilities burning high sulfur coal.

8.3.6.4 Geothermal Steam 1

Steam with sufficient temperature, pressure and reliability to do useful work in generating electricity through a steam turbine has been known to exist over most of the world. The process of utilizing the steam requires tremendous amounts of exploration, investigation and land area. Several shafts over a wide area may be required to run a steam generator. Highly corrosive gases are present in most steam, and scale formation are constant maintainance problems.

Geothermal steam, when it is available, is a commercially feasible alternative to the consumption of fossil fuels. However, it is basically an immobile resource that can be utilized only at its source, and then only in units of limited size.

Potential for geothermal power exists largely in the Western United States with the largest potential estimated to be in the Imperial Valley area of California. There is no known source of geothermal power available to meet the power demands for the southeast.

8.3.6.5 Nuclear Fusion 1

Nuclear fusion basically involves the forced combining of two nuclei. The resultant combination results in a slight mass decrease. The mass difference is transformed to energy by Einstein's theory ($E=mc^2$). This energy is in the form of heat. The source of difficulties is in forcing two nuclei is used in fusion reactions. More often than not, the amount of energy required to force two hydrogen nuclei together is greater than the release of energy upon combination.

The first operational fusion reactor will most likely not occur until the 1980's or 1990's. This process is therefore not available on the time scale requirements of the power needs in this area.

8.3.6.6 Solar Energy(6) 1

Many proposals have been forwarded for using solar energy for power generation. The most recently published system would use geostationary satellites positioned so that at least one would be illuminated by the sun at all times. Several methods of energy transmission to earth have been proposed. Energy generation in these schemes, as well as others, involve either steam generation of electricity or direct energy conversion.

This method of electrical generation is not available in the quantities needed or the time required.

8.3.6.7 Tidal Energy 1

The basic scheme involves the capturing of water available at high tide in huge retention basins, such as a natural bay with a man made dam. The basin is held at a maximum level until power is needed or the sea is sufficiently below the level of the pool, at which time it is released through hydraulic turbine-generators to the sea, creating electricity.

The technological feasibility of tide harnessing has been demonstrated. The Rance River Plant in France, with a difference of from 9 to 14 meters between high and low tide, produces over 544 megawatts.(7) Using a reversible turbine, power is tapped from the waters as they rush upstream at high tide and as the waters recede towards the sea. The Soviet Union has also built an experimental plant on the Kislogubskaia River to investigate the use of tidal power. The Pasamaquoddy Bay on the United States-Canada border is considered to have a potential for a huge tidal power plant.(8)

This method of power generation is not available on the magnitude and reliability requirements of the power needs in this area.

1

8.3.6.8 Magnetohydrodynamic Generation

Magnetohydrodynamic (MHD) generation of power is based on the same principle as conventional generation. However, instead of a solid conductor (turbine rotor) moving across a magnetic field, a jet of ionized fluid is forced through it. By placing electrodes in this fluid stream, direct current electricity at relatively high potential, e.g., 2,000 volts or more, can be obtained.(9)

Since high temperatures are required to make most fluids, and especially gases, sufficiently conductive, MHD is generally thought of as a topping cycle for conventional steam cycles, resulting in an overall plant efficiency of 50 to 60 percent, and can therefore significantly reduce the amount of thermal discharge from a power plant.

U.S.S.R. currently has the world's largest open cycle MHD power station. The plant, which operates on natural gas, develops 75 MW. However, only 25 MW is produced by the MHD generator; the remainder resulting from a conventional bottoming steam cycle.(10,11) The largest MHD installation in the U.S. provides 20 MW power bursts of 3 minutes duration to drive an electric wind tunnel.(12)

Numerous problems must be overcome before MHD can become a viable alternative for central station generation. These problems include metals corrosion associated with the high temperatures used in MHD and, so far, inability to achieve economical operation.

MHD generation is not now at the point of utilization, but its potential for fulfilling utility system needs during the decade of the seventies and beyond is highly speculative.

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8.4 ALTERNATE SITES

8.4.1 SYSTEM PLANNING

System planning studies are made for future years taking into account the total new generating requirements for The Southern Company system as well as the requirements of each of its four operating companies (including Georgia Power Company). The Southern Company system serves 120,000 square miles and is planned and operated as a power pool. The Southern system has a Planning Committee and an Operating Committee each of which has a member from each of the four operating companies and Southern Services, Inc. These committees review generation and transmission alternatives for future years and make recommendations of selected expansion plans to the Southern System Executive Group for approval.

For the very large area to be served and the substantial future new generation requirements, many considerations must be taken into account in arriving at specific plans. First, the Southern system peak loads for each year are estimated using peak loads of the operating companies and diversity among these peak loads. These peak loads for 1973 through 1985 are discussed in Section 1.2 of this report and are summarized in this section for the year 1980 through 1983. The Southern system load shape throughout each year is also estimated. Computer studies are made to determine the Loss of Load Probability (LOLP) for each year using estimated loads throughout the year, estimated forced outage rates and scheduled maintenance for all generating units assumed to be installed through that year, along with any firm purchase or sales or seasonal interchange arrangements with utilities not in the Southern system.

The relative mix of base load and peaking thermal generation, hydroelectric and pumped storage capacity also must be considered. The relative economics of capital and operating costs for various generation mixes are determined. Since new hydroelectric and pumped storage capacity additions are relatively limited, the principal consideration for generation mix determination is the relative proportion of base load and peaking capacity. From these studies it has been determined that power supply economics is relatively insensitive to the fraction of peaking capacity in the range of 15 to 25 percent of total generation. Thus, there is relatively loose coupling between generation mix studies and generation expansion plans. This permits flexibility for the system planners to schedule peaking capacity when an additional base load full-size unit would not be needed to meet LOLP criteria, to provide "black start" capability at thermal generating sites, or to provide voltage or transmission loading relief in particular locations.

With the above factors, the system planners take into account the relative locations and sizes of generating plants in existence prior to the years being studied. Consideration is also given to the availability, costs of fuels and the reliability and quality of transmission service to various areas of the system, and environmental factors.

With the above as an explanation of actual system planning considerations for the Southern system, including the Georgia Power Company system, the bases for selection of the Vogtle units are discussed below. Southern system and Georgia Power Company estimated peak hour loads in MWe for the 1980 through 1983 period are:

	Peak Loads - MW	
	Southern System	Georgia Power
1980	30,362	16,728
1981	33,434	18,528
1982	36,824	20,528
1983	40,545	22,728

The corresponding total and incremental generating capacity needed to meet LOLP considerations (approximately 0.1 day/year loss of load) for the Southern system are:

	Total Generation (MW)	Addition During Year (MW)
1980	35,808	3,280
1981	39,685	3,877
1982	44,045	4,360
1983	48,295	4,250

Based on the above new generation needs, the following distributions and types of generation were selected which would provide a balanced plan for reliable and economic service to Southern system customers:

Year	Unit	Rating MW	Type	Location
1980	Vogtle #1	1100	Nuclear	East Central Georgia
	Wansley #4	880	Coal	West Central Georgia
	West Jefferson #3	650	Coal	North Central Alabama
	Unlocated (CT)	650	Combustion Turbine	
1981	Vogtle #2	1100	Nuclear	East Central Georgia
	Central Ala. #1	1100	Nuclear	Central Alabama
	Goat Rock Hydro	67	Hydro-Electric	West Central Georgia
	Unlocated (CT)	700	Combustion Turbine	
	Unlocated	880	Coal	
1982	Vogtle #3	1100	Nuclear	East Central Georgia
	Central Ala. #2	1100	Nuclear	Central Alabama
	Unlocated	1100	Nuclear	
	Unlocated	880	Coal	
	Unlocated (CT)	150	Combustion Turbine	
1983	Vogtle #4	1100	Nuclear	East Central Georgia
	Unlocated	1100	Nuclear	
	Unlocated	1100	Nuclear	
	Unlocated (CT)	950	Combustion Turbine	

Since system planning considerations identified the need for base load generating units in sizes of about 1100 Mwe in each of the years 1980 thru 1983 in East Central Georgia, attention needed to be given to selection of a site and the fuel which would optimize economics and environmental benefits over costs in that geographical area of the Georgia Power Company system.

In considering site locations, it was known from past studies that evaporative cooling towers would be needed to meet water quality standards with regard to allowable temperature rises for a total plant capacity of almost 5,000 Mwe. Thus, a primary consideration was to select a water body where the water consumption of up to about 350 cfs would be environmentally and socially acceptable. The only locations in Eastern Central Georgia where this consumption would have a small effect on minimum and average water flows is the Savannah River system which includes the possibility of Clark Hill reservoir and the river below the reservoir.

Transmission connections to the existing transmission system for a thermal plant at Clark Hill reservoir (north of Augusta, Georgia) would be comparable to those from a site south of Augusta on the Savannah River. Thus, the principal considerations are economics and environmental impact for alternative fuels and for the site alternatives, and it is necessary to have site characteristics which will meet licensing requirements for public health and safety and the environment.

8.4.2 EVALUATION OF ALTERNATE SITES ON THE SAVANNAH RIVER

Approximately a 60-mile reach of the Savannah River (from about 30 miles northwest of Augusta, Georgia, to about 30 miles southeast of Augusta) was selected as the primary area for investigation. The site area chosen for study upstream from Augusta, Georgia, was about 22 air miles from Augusta on the west side of Clark Hill Reservoir.

This potential site is located in the lower portion of the Piedmont Province of East Central Georgia. It is underlain by igneous and metamorphic rocks of Pre-cambrian through Paleozoic Age.

The Piedmont Province is characterized by gently rolling hills and occasional granite outcrops which produce riffle areas (rapids) where they intersect the bed of a river or stream. Until recently the area was largely dominated by rowcrop agriculture,and this, in addition to severe natural erosion, placed high sediment loads on stream. The soil is composed of sandy loam, reddish and yellowish clays, and decomposed granite and gneiss. The soils exhibit a natural lack of fertility which has been further depleted by the above mentioned erosion and agricultural practices. Forests are generally of the pine-hardwood type. In coves the major tree species are White Ash, Tuliptree, Beech, Redbud, and Magnolia. Bottomlands are dominated by Beech, Sweetgum, Oak, Elm, River Birch, and Red Maple.

The climate is characterized by long summers, mild winters, and abundant, evenly distributed rainfall. Streamflow is greatest in February and March and lowest in September and October.

Based on regional geology and general soil data,it was concluded that a suitable foundation probably could be found in this area. Also, an adequate supply of water for closed cycle condenser cooling could be obtained from Clark Hill Reservoir. However, as discussed below, this potential site has a number of features which are not as favorable as the Vogtle site.

A field inspection of the potential site revealed that a new residential housing development had been started in the area. Indications were that the housing development could extend into the area needed for the potential site. Although the local population density was low at that time, indications were that the population probably would increase considerably during the life of the plant. There is a considerable amount of recreational use made of Clark Hill Reservoir such as fishing, boating, swimming, and other water sports. Thus it is expected that significant housing developments will occur around the reservoir.

An important consideration for thermal plants is the availability of the transportation for alternative fuels as well as large plant equipment and building materials during construction.

A coal-fired plant at the Clark Hill site would be supplied by railroad. This would require that a railroad spur be built to the nearest connection which is about 25 miles away. For an oil-fired plant, a pipeline would be constructed from a terminal near Savannah, Georgia, which would be the delivery point for foreign oil. Building materials and equipment for the oil-fired plant would need to be transported by road. The nearest road for such loadings is about ten miles away. Natural gas could not be considered because of its unavailability as discussed in Subsection 8.3.3 For a nuclear plant it would be necessary to bring the large plant components to the site by overland route from a barge unloading point below Clark Hill Dam,and building materials and other components would be brought by truck.

For a nuclear plant there would be a significant advantage to having a site south of Augusta with access by barge for delivery of the large components. Three such site locations were considered along that stretch of the Savannah River. These were the Shell Bluff site,which is approximately 11 miles upstream of the Vogtle site, the Boggy Gut Creek site,which is approximately 11 miles upstream of the Vogtle site, and the Vogtle site. Foundation conditions at the Shell Bluff and Boggy Gut Creek sites are sands and clayey calcareous sands. Solution of the calcareous materials raised questions concerning the karst-type topography with numerous "sinks" in these areas. Thus, there was a serious question as to adequacy of the foundation materials from the standpoint of licensing of a nuclear plant. The Vogtle site does not have the "sinks" and has an underlying thick, dense, and continuous marl which is adequate for any of the thermal plants, including nuclear.

The Vogtle site has access to the river, is about 10 miles from the nearest railroad for coal and materials shipments, is closer to Savannah, Georgia, for pipeline oil delivery, has sufficient elevation for flood protection, has adequate foundation materials, and is environmentally acceptable (as is more fully discussed in this report). Thus the Vogtle site was selected as the candidate site on the Savannah River.

Table 8.4-1 shows an economic comparison of four coal-fired, oil-fired, and nuclear units at the Clark Hill and Vogtle sites. It is clear that coal-fired units are not economical at either Clark Hill or Vogtle and that oil-fired units are more economical at the Vogtle site than at Clark Hill. The oil-fired units at Vogtle are approximately competitive with nuclear units at Clark Hill or Vogtle.

Emissions for coal-fired and oil-fired units are shown in Attachment E of Chapter 11. Total emissions are greater from the coal-fired units. Thus oil would be more economical and would have less impact on the environment at the Vogtle site. Consequently oil-fired units at Vogtle were compared with nuclear units at Vogtle or Clark Hill.

Oil-fired units would have much greater impact on the air and land environment than the nuclear units, due to the emissions of nitrogen

TABLE 8.4-1

VOGTLE-CLARK HILL BUSBAR ECONOMIC COMPARISONS

Nuclear Plant vs. Fossil Plant

	Vogtle Site			Clark Hill Site	
	Nuclear	Coal(1)	Oil(2)	Coal(1)	Oil(2)
Net Capacity, MWe	4648	4767	4964	4767	4964
Capital Cost: $million	2196	1267	1018	1267	1018
$/Kw	472	266	205	266	205
				30-Year Levelized Energy Cost (Mills/KWh) (78.1% Plant Factor)	
Fixed Charges(7)	10.82	6.07	4.68	6.07	4.68
Fuel Cost @ 17.8%	3.16	11.34(3)	9.67(4)	11.63(5)	9.94(6)
O&M and Nuclear Insurance	0.82	0.60	0.46	0.60	0.46
Total	14.80	18.01	14.81	18.30	15.08

NOTES FOR VOGTLE-CLARK HILL BUSBAR ECONOMIC COMPARISONS

(1) Coal-fired units with SO_2 removal equipment. Net plant heat rate after adjustment for power and steam required to operate the SO_2 removal equipment = 9875 Btu/KWh. 90-day reserve supply of coal. Includes 5% capacity credit for overpressure.

(2) Oil fired units without SO_2 removal equipment. Net plant heat rate = 9020 Btu/KWh. No storage facilities for reserve oil supply. Includes 5% capacity credit for overpressure.

(3) Delivered cost of coal at Vogtle Site - 58.3¢/MBtu in 1972. Simple escalation applied @ 7.7% through 1976 and @ 2.75% thereafter. Coal from Illinois Basin with 3.0-3.5% sulfur content. Fuel cost shown includes additional expenses associated with operating SO_2 removal equipment.

(4) Delivered cost of oil at Vogtle Site for a single unit in 1980 = 92.7¢/MBtu; for two units in 1981 = 92.4¢/MBtu; for three units in 1982 = 92.1¢/MBtu; for four units in 1983 = 91.2¢/MBtu. Simple escalation applied @ 2.5¢/MBtu per year thereafter. Oil processed from foreign crude at Savannah and delivered by pipeline. Low sulfur content (0.7%).

(5) Delivered cost of coal at Clark Hill Site = 60.0¢/MBtu in 1972. Simple escalation applied @7.7% through 1976 and @ 2.75% thereafter. Coal from Illinois Basin with 3.0-3.5% sulfur content. Fuel cost shown includes expenses associated with operating SO_2 removal equipment.

(6) Delivered cost of oil at Clark Hill Site for a single unit in 1980 = 97.0¢/MBtu; for two units in 1981 = 94.1¢/MBtu; for three units in 1982 = 95.2¢/MBtu; for four units in 1983 = 96.2¢/MBtu. Simple escalation applied @ 2.5¢/MBtu per year thereafter. Oil processed from foreign crude at Savannah and delivered by pipeline. Low sulfur content (0.7%).

(7) Fixed charge rate = 15.70% for nuclear units, 15.62% for coal and oil units, and 16.03% for combustion turbines.

oxides, sulfur dioxide, and particulates. Very importantly, use of foreign oil in such huge quantities and for a substantial percentage of generating capacity causes great concern for national security as well as risks concerning future costs, delivery reliability, and environmental effects due to oil spills. Because of these factors of risks, national security, and environmental impact, the nuclear units were selected over the oil-fired units of approximately the same apparent economics.

The choice of preferred alternatives became a nuclear plant at Clark Hill or at the Vogtle site. There are a number of advantages to the Vogtle site which caused it to be selected. As mentioned previously, the Vogtle site is not in a future growth area for recreational uses. It is accessible by barge for delivery of large nuclear components. A railroad can be built economically to deliver building materials and equipment, and this will prevent a large impact on highway usage in the site vicinity. The nearest good road is about 5 miles away instead of 10 miles for the Clark Hill site. Thus, there would be 5 miles less road to build for use of the Vogtle site. It is expected that other environmental impacts on aquatic life, terrestial life, and humans would be small and comparable.

8.4.3 BUILDING VNP-3 AND VNP-4 AT ANOTHER SITE

GPC plans to bring into operation 1 or 2 1100-MW nuclear units per year during the period when VNP-3 and -4 are scheduled for start-up (see Table 1.2-8). If these 2 units were moved to another location, e.g. a north Georgia site, it would still be necessary to return to the VNP site for subsequent units. The same number of transmission lines would be required at either site. At best, perhaps a short portion of 1 line could be delayed 1 year; this would have to be determined through extensive stability studies. In the long run, however, the same number of lines and the same amount of right-of-way would be required. Therefore, there would be no advantage to such a relocation. 1

8.5 ALTERNATE HEAT DISSIPATION METHODS

Ultimately all waste heat generated by the VNP must be discharged to the atmosphere. The alternatives available to the designers are once-through cooling, cooling ponds, dry cooling towers, wet cooling towers, and combinations of each of these methods. Analyses were performed using the following factors as a basis: feasibility, environmental considerations, and economic considerations. The analyses were carried out to the extent required to determine the acceptability of each alternative when considering these factors. This resulted in a complete analysis of only the wet cooling tower alternatives.

8.5.1 ONCE-THROUGH COOLING

Once-through cooling, economically, is the least expensive of the cooling methods available. Environmentally, however, it is considered by some to be the most expensive in terms of thermal effects and damage to aquatic organisms. At VNP, once-through cooling was not seriously considered since a study of the recorded flow of the Savannah River showed the flows could not support a plant the size of VNP without major thermal influence in the river. The circulating water flow requirement per unit is approximately 1930 cfs or approximately 7720 cfs for four units. This exceeds the flow of the Savannah River.

8.5.2 COOLING PONDS

The original plant studies included the use of a large (approximately 8000 acres) cooling lake in a closed system; however, after investigation this was discarded due to serious questions raised as to the amount of seepage loss from the lake. Since the lake would have been formed by the use of dikes across Beaverdam Creek, the question of the lake having to meet water quality standards was a major concern. Preliminary questions concerning the standards to the Georgia Water Quality Control Board indicated that the lake would have to meet water quality standards. Due to the time required to settle these issues, the studies for a cooling lake were dropped and no cost estimates were made.

8.5.3 DRY COOLING TOWERS

Dry cooling towers are considered, at present, impractical for reasons of loss of energy as compared to wet towers and reduction of generating capability of the plant during hot weather.

Dry cooling towers have only been built in small sizes. There are physical and economic problems of extrapolating the units to large sizes that would accommodate VNP. In addition, the maintenance costs (e.g., prevention of corrosion) of dry cooling towers are high. In order for the dry cooling tower to be operated economically, the allowable condenser back pressure must be greater than 5" Hg. Abs. Steam turbines in the 1100 MW range which will exhaust at this pressure are not available.

8.5.4 WET COOLING TOWERS

8.5.4.1 Economics

A detailed economic study was undertaken comparing wet type mechanical draft towers to wet type natural draft towers. Some 4300 condenser-cooling tower combinations were studied, concluding that the most economical mechanical draft cooling tower condenser system was the economic choice over natural draft towers for the VNP site by some $1,400,000 per 1100 MW unit. This was a present worth evaluation which included capital cost of all equipment and material (condensers, towers, pumps and motors, piping, etc.), power requirements for pumps and fans, impact on turbine performance, plus maintenance and insurance costs. Because of environmental considerations, however, natural draft towers were selected. Capital cost of natural draft towers at the VNP site is approximately $9,500,000 per 1100 MW unit. Annual operating cost is expected to be approximately $90,000 per unit per year. Plant net output will be approximately 55 MW less using natural draft towers versus once through cooling.

8.5.4.2 Feasibility

Both the wet type mechanical draft and natural draft towers have been used successfully in the United States and in The Southern Company system.

8.5.4.3 Environmental Impact

This topic is discussed in Subsection 5.1.5.

8.5.5 CONCLUSION

Natural draft wet cooling towers were selected for the VNP because no increased frequency of ground fog, reduced visibility or icing is expected ot occur due to operation of these towers.

8.6 CHEMICAL WASTE SYSTEMS

Chemical wastes from VNP include the makeup water demineralizer neutralized wastes, possible algae and corrosion inhibitors in the cooling tower blowdown, and filtered wastes from laboratories.

The methods of disposing of such waste are by (1) dilution, (2) neutralization and (3) drumming and off-site shipment.

Chemical waste from VNP will be disposed of by each of these methods, and all discharges to the river will be within applicable water quality standards. In any event, the nature of the chemical waste system is such that alternative designs could be adopted later if applicable.

8.6.1 LIQUID WASTES

Natural draft-type cooling towers require treatment with a biocide to control microorganisms which cause algae and slime fouling. Two basic types of material are available for the requirements of controlling the aquatic and airborne microorganisms in the cooling tower-condensing system. These materials are either oxidizing or non-oxidizing. 1

The oxidizing materials are ozone, chlorine and calcium and sodium hypochlorites. Ozone cannot be stored but must be produced on demand; thus an expensive, large capacity system would be required. Therefore, the equipment and electric energy operating cost would be prohibitively high.

The use of hypochlorites, as alternative oxidizing chemicals, was rejected because they provided no advantages over chlorine to justify their higher cost (liquid chlorine costs about one fifth as much as the hypochlorite on the basis of available chlorine in the product).

The use of chlorine has been selected as the most desirable alternative for treating the cooling tower aquatic and airborne microorganisms. Chlorine is a broad spectrum biocide which is economical, effective, and relatively easy to handle with precautions.

Chlorine is delivered as a liquid in the pure elemental form and applied as a gas dissolved in water. The latter materials are supplied either as a dry powder or in dilute liquid form.

The non-oxidizing materials considered are often proprietary products, and while effective for biocide treatment in tower-condenser water systems, are usually more expensive than chlorine and frequently produce toxic end products which would not be tolerated in blowdown to a river.

Typical of the non-oxidizing materials are:

Acrolein
Chlorinated Phenolic Compounds
Chromates
Copper Salts
Phenolic Amines
Thiocynates

As alternates to chlorination the above materials are not practical on a cost and toxicity basis for a large tower system such as that proposed at the VNP site.

8.6.2 SOLID WASTES

Solid wastes from VNP will be boxed or drummed for burial off site. Such wastes would include filters, spent demineralizer resins, rags, contaminated materials and equipment. No other practical methods are available for disposal of solid wastes.

8.6.3 SEWAGE

Domestic sewage from the plant will be processed through standard packaged secondary treatment plants. These plants will be adequately sized for VNP and provide an adequate hold-up time to achieve at least 85% of BOD reduction.

An alternative to this type of waste treatment to further reduce the BOD of the effluent would be a tertiary treatment plant. Such a plant could be added to the presently planned equipment if it becomes necessary.

8.7 RADWASTE SYSTEMS ALTERNATIVES

The VNP radioactive waste treatment systems for liquids and gases incorporates the Westinghouse Environmental Assurance System which incorporates the latest available technology for maintaining radioactive releases to the lowest practicable levels.

The liquid radwaste system for the VNP uses the latest available technology to hold releases to levels as low as practicable and meets the proposed Appendix I of 10 CFR 50. Thus, in accordance with the January 4, 1972, proposed AEC guide on benefit-cost analyses(1), "No further consideration needs to be given to the reduction of radiological impacts in formulating alternative plant designs for Alternatives 2,3, and 4."

Likewise, the VNP gaseous radwaste system incorporates the latest available technology to reduce gaseous radioactive releases to the lowest practicable level and should be substantially below releases from currently operating nuclear plants. Since there will be no planned routine releases from the VNP gaseous radwaste system, such releases are well within Appendix I limits. Thus, in accordance with AEC's guide on benefit-cost analyses alternatives need not be considered for such system.

As described in Section 3.6, the liquid radwaste system uses separated drains and treatment systems which will permit recycling of reactor grade water and treatment of non-reactor grade water prior to discharge so as to reduce effluents to very low levels.

Releases of tritium are minimized by the use of zirconium fuel clad, silver indium-cadmium control rods, boric acid evaporator, and radwaste system which will recycle as much as practicable of reactor grade water.

The estimated annual doses to humans from liquid effluents are presented in Section 5.2 and Table 5.2-5. These doses are less than 2×10^{-3}rem to the maximum exposed individual and less than 4 man-rem to the total population in a 50-mile radius. Furthermore, the total liquid releases are less than 20 curies (excluding tritium) as set forth in Table 5.2-6. The above doses and curie releases are within proposed Appendix I limits.

The gaseous radwaste hold-up system uses a recirculating type of system with continuous holdup. The system will scavenge fission product gases from the primary coolant so that gaseous releases from buildings due to water leaks will be decreased. The gaseous radwaste system incorporates the latest available technology to reduce gaseous radioactive releases to the lowest practicable level and should be substantially below releases from currently operating nuclear plants which do not have gaseous radwaste systems conparable to those of the VNP.

The estimated annual doses to humans from gaseous effluents are presented in Section 5.2 and Table 5.2-5. These doses are less than 8 x 10^{-3}rem (whole body) to the maximum exposed individual and less than 17 man-rem (whole body) to the total population in a 50-mile radius. The above doses are within proposed 10CFR50 Appendix I limits.

The VNP liquid and gaseous radwaste systems utilize the latest available technology to hold releases to level and, therefore, in accordance with the May 1972 proposed AEC guide on benefit-cost analyses, "no further consideration needs to be given to the radiation of radiological impacts in formulating alternative plant designs for Alternatives 2, 3, and 4."

The possibility of adversely effecting the ground water resources or existing wells in the area as a result of the operation of a nuclear plant is remote.

REFERENCES

1. *Proposed AEC Guide to the Preparation of Benefit-Cost Analyses to be Included in Applicants' Environmental Reports (For Defined Classes of Completed and Partially Completed Nuclear Facilities)*, May, 1972, page 4.

8.8 MAKE-UP DEMINERALIZER AND POTABLE WATER SYSTEM ALTERNATIVES

8.8.1 SOURCES OF WATER FOR VNP SITE

The possible sources of water for influent to the potable water system and make-up demineralizer of VNP are deep wells and the Savannah River. Piping or transporting water for plant use from any suitable off-site source of supply would be prohibitively expensive and impractical due to the quantities of water necessary for plant operation.

8.8.2 SAVANNAH RIVER AS WATER SOURCE

The use of Savannah River water as demineralizer influent would require a pretreatment facility consisting of a clarifier, caustic, alum and coagulant aid feeders, pumps, filters, piping, valves, and associated controls. The raw Savannah River water has a lower level of total dissolved solids than does the well water intially, but the addition of chlorine, alum, caustic, and coagulant aid in the clarifier should raise the level of total dissolved solids such that the make-up demineralizer influent would contain approximately the same amount as the deep well water supply. Therefore, the performance and operational procedures of the make-up demineralizer equipment would not be changed by the use of Savannah River water as influent.

According to water analysis of the Savannah River at the VNP site, the fecal coliform levels exceed or approach the maximum levels considered acceptable by the Georgia State Board of Health and U.S. Public Health Service for potable water system supply. The condition of the river in this respect would create problems in obtaining a permit from the State Board of Health for operation of a potable water system.

8.8.3 CLARIFIER INSTALLATION

A clarifier and associated equipment suitable for clarifying the Savannah River water at VNP (500 to 1,000 gpm capacity) is estimated to cost between $225,000 and $275,000 installed, based on current bid information from water treatment equipment vendors. The annual operating cost of labor and chemicals would be higher for a system using a clarifier than for a well water supply. The clarifier would not offer any operating advantage over deep wells. In addition, a sludge blowdown (2-3 percent of flow) would have to be diluted by the waste diffusion system. This sludge blowdown would be composed of aluminum hydroxide and suspended solids from the raw river water.

8.8.4 WELL INSTALLATION

Wells were selected as the source of supply for potable service and demineralizer influent because of suitable quality, economics, operational convenience and a lesser quantity of wastes produced than alternate systems of water treatment.

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CHAPTER 9 LONG TERM EFFECTS OF PLANT CONSTRUCTION AND OPERATION

9. LONG TERM EFFECTS OF PLANT CONSTRUCTION AND OPERATION

The construction of VNP involves 3177 acres of land for the site in Burke County, Georgia, plus approximately 12,000 additional acres for transmission lines off the site and approximately 245 acres for the railroad spur line to the site. Approximately 379 acres of the site were being cultivated, and the remaining 2798 acres were covered by timber and pulp wood. Construction of the plant facilities will require approximately 1011 acres of the site as indicated below:

Main Power Block and Cooling Tower	310 Acres
Construction Facilities and Stockpiles	247 Acres
River Intake, Discharge & Barge Facility	9 Acres
Construction Debris Basin	88 Acres
Transmission R/W	250 Acres
Roadway	80 Acres
Meteorology Tower and Access Road	27 Acres
TOTAL	1011 Acres

It is estimated that, for this land, the average loss of income from agricultural and timber crops amounts to $33 per acre annually (see Appendix B). After construction of the plant is completed, the 247 acres used for construction activities will be landscaped to lessen the visual impact of the plant, to prevent erosion, and to restore some of the habitat for terrestrial wildlife. The use of 764 acres for plant facilities, 245 acres for the offsite railroad spur, and 24 acres for the Combustion Turbine Plant will continue throughout the life of VNP, and this land will not be available for other productive purposes during this period. The remaining 2142 acres of the site will be left in their present state, except for the periodic cutting of timber and pulpwood. The approximately 12,000 offsite acres for transmission line right-of-way can be used by their owners for agriculture or for production of livestock. Sections 3.2 and 5.4 discuss these possible uses.

As noted above, there will be a certain loss of habitat for terrestrial wildlife during construction of VNP, but the portion of the site modified for construction activities will eventually be landscaped. This landscaping may, however, actually enhance existing habitat through increased edge effect. Aquatic habitat should receive no significant impact, since cooling towers will eliminate thermal effects, and chemical releases will meet existing standards.

There will be no long term effect on the Savannah River as a water source resulting from the use of river water as the cooling media for VNP. At present, there are no large municipal, agricultural, or industrial uses of the river below the plant. The consumptive use of water by the plant is approximately 2 percent of the minimum river flow and approximately 1 percent of the average flow. This small withdrawal and use would cease whenever the plant ceases to operate or is decommissioned.

The deposition of radioactivity and chemical elements in the environment will occur during the lifetime of VNP. These discharges will be closely regulated and limited to assure compliance with all existing state, federal, and local regulations.

When it comes time to decommission such a plant, there are two alternatives: (1) returning the site to pre-plant conditions; (2) maintaining the plant in a permanently shut down state. The following is a brief discussion of those steps necessary to decommission VNP and to maintain it in a safe and secured status. The steps presented and the scope described are based on current costs and technology. While numerous alternatives are available for plant decommissioning, the following discussion is limited to those steps required for the removal of any accessible radioactive materials. Removal of major pieces of equipments such as NSSS components or turbine building equipment is not considered.

1. Removal of Spent Fuel From the Site:

   This step represents the removal of the major source of radioactivity from the site. The technology of fuel transport has been proven, and this step will be simply an extension of the methods employed during the previous years of plant operation.

2. Decontamination of Auxiliary Systems:

   The following systems, outside the containment would be chemically cleaned and flushed:
   a) Residual Heat Removal System
   b) Chemical and Volume Control System
   c) Safety Injection System
   d) Radioactive Liquid Waste System
   e) Radioactive Gaseous Waste System
   f) Boron Recovery System
   g) Spent Fuel Pool Cooling System

   It is anticipated that the water stored in the Condensate Storage Tank, Refueling Water Storage Tank, and Reactor Makeup Water Storage Tank will be used for the cleaning and flushing of the above systems.

3. Disposal of Chemical Cleaning and Flushing Water and Other Radioactive Waste Water:

The estimated total volume of potentially radioactive or chemically contaminated water per unit to be disposed of is as follows:

a)	Refueling Water Storage Tank	500,000 gal.
b)	Reactor Makeup Water Storage Tank	200,000 gal.
c)	Condensate Storage Tank	500,000 gal.
d)	Spent Fuel Pool	500,000 gal.
e)	Reactor Coolant System	100,000 gal.
f)	Component Cooling Water System	80,000 gal.

These water sources could all contain radioactive or chemical contaminates to various degrees, and, if they are used in the chemical cleaning and flushing of the systems, they are assumed not to be of acceptable quality for dumping to the river. It is anticipated that through the use of the river water dilution pumps, the contents of the cooling tower basins and liquid waste system could be diluted as necessary and released to the river.

4. Disposal of Resins, Filters and Miscellaneous Radioactive Material:

Existing radwaste system demineralizers may be utilized to clean the decontamination flush water. The disposal method for ion exchange resins and filters would be to transport them from the site using the same techniques employed during the operation of the plant. Approximately 800 ft^3 of resins and 16 filter elements per unit will have to be disposed. In addition, any special or additional resins used as part of the system cleanup would be packaged and disposed.

5. Sealing the Containment:

The systems inside the containment buildings will not be decontaminated, since the containment will be sealed. All piping to the containment will be cut off close to the containment and capped. The equipment hatch would be welded shut, and personnel access locks would be locked closed.

6. Radiation Survey:

Following chemical cleaning of the reactor auxiliary system, radiation surveys will be performed in the auxiliary and fuel handling building to determine the levels of decontamination achieved.

7. Security Force:

   Following the decommissioning, a security force would be provided for surveillance of the site.

The total decommissioning cost, consisting of steps 1 through 6 above, is estimated to be approximately $7,700,000/unit. The annual cost of maintaining a security guard at the facility is estimated to be approximately $200,000.

9.2 LONG TERM PRODUCTIVITY

The long term effect on productivity will be the loss of the agricultural productivity for the land used during the life of VNP.

There will be no long term effect from the commitment of the water source for the use as the cooling water media at the plant. At the present time, there are no large municipal, agricultural, or industrial uses of the river below the plant. The consumptive use of water by the plant from the river is approximately 2 percent of the minimum flow and approximately 1 percent of the average flow of the river. This small withdrawal and use would cease whenever the plant ceases to operate or is decommissioned.

The deposition of radioactivity and chemical elements in the environment will occur during the lifetime of VNP. These discharges will be closely regulated and limited to assure compliance with all existing State, Federal, and local regulations.

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CHAPTER 10 RESOURCES COMMITTED IN PLANT CONSTRUCTION AND OPERATION

10. RESOURCES COMMITTED IN PLANT CONSTRUCTION AND OPERATION

The construction and operation of VNP will involve the commitment and use of certain natural resources and will result in some irretrievable and irreversible commitments of natural resources. Air, water and land commitments are temporary in nature and are retrievable upon cessation of plant operation. At the end of the useful life of this plant, the buildings could be razed, and the grounds returned to essentially their original condition; however, it is most likely that the concrete structures would remain.

It is possible that at the end of the useful life of the plant, some parts of the site area would remain contaminated with radioactive material for a long time. At VNP this is a rather remote possibility. Solid radioactive waste will not be buried or otherwise disposed of on the site. All the radioactive solid waste will be packaged in accordance with AEC requirements and shipped offsite to an authorized regional burial ground.

The resources committed at VNP which are irretrievable would be the uranium used in the form of nuclear fuel and the materials used for construction of the plant. Of these resources committed, only the nuclear fuel is unique, since the commitment and use of air, water, land and construction materials would be essentially the same for a fossil plant.

The following resources are committed for the construction and operation of VNP:

1. Land:

   a. Site: The VNP site consists of 3177 acres of land. The plant facilities will occupy approximately 764 acres of the site, thus changing their use from agricultural and timber production to electrical generation. Of the remainder of the site, 2142 acres will either be allowed to remain in its present state or be landscaped after construction is completed. At the end of the useful life of the plant, the land can be returned to agricultural or other uses with the necessary expenditures of money and human effort.

   b. Transmission Lines: The off-site transmission line rights-of-way will consist of approximately 12,000 acres which will be removed from the growing of timber and agricultural products; however, this land can be returned to its former state if desired.

c. Access Railroad: The off-site access railroad spur will consist of approximately 245 acres which will be removed from the growing of timber and agricultural products; however, this land can be returned to its former state if desired.

d. The total area of the plant site, transmission line rights-of- way and the access railroad spur is approximately 15,422 acres, which is about 0.31 percent of the land within a 50-mile radius of the site.

2. Water:

Water consumed by operation of the VNP cooling towers is a minor local loss to the Savannah River (approximately 2.3 percent of 5,800 cfs at low flow and 1.3 percent of 10,150 cfs at average flow). This water will be returned to the land in the form of precipitation due to natural phenomena.

3. Uranium:

Uranium in the form of nuclear fuel is consumed and converted into waste radioactive materials. Spent fuel will be shipped to a fuel reprocessing plant for recovery of some of the uranium and plutonium. VNP, after equilibrum, is expected to require an annual commitment of approximately 400,000 pounds (net) of natural uranium for processing into fuel.

4. Construction Material:

Construction materials in the form of steel, concrete, timber products, etc. cannot be practically retrieved and are thus consumed.

5. Wildlife Habitats:

There will be minor loss of terrestrial habitat during the construction phase of VNP due to clearing and grading operations. This will not create any irreversible or irretrievable loss of terrestrial habitat since construction activities will be centered in areas of old-fields, previously cleared land and sparse upland hardwood-pine communities. Existing habitat may be enhanced due to increased edge effect created by planting and landscaping following the construction phase. There should be no significant impact to the aquatic habitat, since cooling towers will be used to eliminate thermal effects, and chemical releases will meet existing standards.

The construction and operation of VNP will affect the environment in terms of the irretrievable and irreversible commitment of natural resources to the extent indicated above. However, the extent to which the use of the environment is curtailed is not considered serious and is warranted due to the benefits of the electric power produced. Essentially the commitment of resources would be the same (except for uranium) if a fossil plant, in lieu of a nuclear plant, were built.

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11. COSTS AND BENEFITS OF PLANT AND ALTERNATIVES

This chapter uses as a guideline the AEC Guide for Submission of Information on Costs and Benefits of Environmentally Related Alternative Designs for Defined Classes of Completed and Partially Completed Nuclear Facilities of May, 1972, to evaluate the costs and benefits of VNP.

The section and subsection numbers in this chapter are keyed to the guidelines for environmental cost for easy reference. Attachments, using letters, are used to describe the benefits derived from the construction and operation of VNP.

11.1 NATURAL SURFACE WATER BODY

VNP will draw water from, and release water to, the Savannah River.

11.1.1 COOLING WATER INTAKE STRUCTURE

Water velocities at the intake structure will be less than 0.9 fps under any flow condition. Velocities less than 1 fps greatly reduce the chances of impingement of large numbers of fish.(1-3) No adult and few juvenile fish will be impinged due to the low intake velocity and the 3/8" mesh traveling screens installed in the intake structure. This topic is discussed in Subsection 3.5.4. 1

11.1.2 PASSAGE THROUGH CONDENSER AND RETENTION IN CLOSED CYCLE COOLING SYSTEMS

At average flow (10,150 cfs), approximately 4.8 percent (490 cfs) of the river is diverted through the plant. Approximately 1.7 percent of the river is used as makeup for the circulating water system, and 3.1 percent is bypass water. It is certain that organisms in the cooling water will be killed, but the effect on organisms in the bypass water is not known. At the guaranteed low flow of 5800 cfs, approximately 8.4 percent of the river will pass through the plant, and approximately 3 percent of this is cooling water.

An estimated 1300 pounds of phytoplankton per year will be killed due to retention in the cooling system. This would support approximately 130 pounds of primary consumers and 13 pounds of carnivorous fish. The most abundant plankton feeding fish is the gizzard shad, which is considered a nuisance fish. The longnose gar, also considered to be a nuisance fish, represents the greatest carnivore biomass. Channel catfish and spotted suckers, important omnivores, probably derive most of their nutrition directly or indirectly from allochthonous sources. Suckers also are considered to be nuisance fish.

Drift invertebrates and floating fish eggs are most abundant in spring when the river is at maximum flow (Subsection 5.1.3). At this time, approximately 3.4 percent of the river passes through the plant, and approximately 1.2 percent is diverted through the cooling system. No data are presently available which would enable calculation of attrition of drift invertebrates, fish eggs and fish larvae on a weight basis.

11.1.3 OUTFALL AREA AND THERMAL PLUME

The rate of dissipation of excess heat to the circulating water system will be 7942 x 10^6 Btu per hour. In the river, the Δt is less than 1°F after the effluent mixes with only 10 percent of river water. The small 1
Δt is not expected to produce a thermal plume with any demonstrable effect on the fauna (see Subsection 3.5.3). The data presented in Subsection 3.7.8 indicate that the dissolved oxygen will be essentially the same in the water at the intake and outfall structures. As stated in Section 5.1, no measurable effect from the thermal plume is expected on aquatic biota, amphibious wildlife, or fish migration.

11.1.4 CHEMICAL EFFLUENTS

VNP will have a maximum discharge of approximately 37,000 gpm to the 1
Savannah River. Virtually all of this will be river water that has been used for cooling and dilution. The remainder will be well water (See Section 3.4).

As discussed in Section 5.3, the chemical concentration will not violate Public Health Service Drinking Water Standards(4) or FWPCA Water Quality Criteria guidelines.(5) Therefore, there should be no adverse effects to water quality, aquatic biota, wildlife or people.

11.1.5 RADIONUCLIDES DISCHARGED TO WATER BODY

Four significant pathways to man of radionuclides in liquid effluents have been identified in the Savannah River system. These include drinking water, the ingestion of fish, the ingestion of oysters and clam meat (molluscs) and the ingestion of shrimp and crab (crustaceans). The average annual amounts of each group estimated to be taken from the river system and estuary are given in Table 5.2-7. The annual average exposure to an individual by ingestion through the above pathways is 4.6 x 10^{-4} rem/yr. (See Table 5.2-7). The annual total population exposure through these pathways is approximately 33.4 man-rem/yr (See Table 5.2-5).

Subsection 5.2.5 describes exposures to organisms other than man from low-level radioactive liquid wastes to the Savannah River. Estimates of the doses to aquatic organisms at VNP have been made. The maximum total dose rate for aquatic organisms is 24 millirads/yr. Reference literature, cited in Subsection 5.2.5, indicated that no measurable effects of radiation would be detected at this dose rate.

11.1.6 CONSUMPTIVE USE

VNP will consume 3.15×10^{10} gallons of Savannah River water per year. This volume will be lost from the main cooling towers as evaporation and drift. The nearest known drinking water intake downstream from VNP is located approximately 103 river miles from the site. The amount of water consumed by VNP will be insignificant when compared to the total Savannah River flow.

There are no known agricultural uses of Savannah River water downstream from the site. However, as discussed in Section 5.3, the VNP discharge will meet agricultural water quality standards.

VNP will also use 2.1×10^{9} gallons of well water per year. This amount will not significantly affect the ground water reserve near the site.

11.1.7 OTHER IMPACTS

None

11.1.8 COMBINED OR INTERACTIVE EFFECTS

Three nuclear facilities exist in the 50-mile radius surrounding the VNP site. They are the Savannah River Plant, the Barnwell Nuclear Fuel Plant, and Chem-Nuclear Services, Inc.

As described in Subsection 5.4.4, SRP has an estimated dose to the population in a 50-mile radius of 17 man-rem/yr. BNFP has an estimated dose to the population of 17 man-rem/yr. Chem-Nuclear Services, Inc. has no planned releases of radioactivity. VNP estimates an annual man-rem dose to the population in a 50-mile radius to be 16.6 man-rem/yr.

The combined estimated man-rem/yr dose from all 4 nuclear facilities in the area is approximately 50.6 man-rem/yr, which is 0.05 percent of the population dose due to natural background radioactivity (95,000 man-rem/yr) in the same area.

REFERENCES

1. "Fish Protection at Indian Point," Environmental Report Supplement for Indian Point Unit No. 2, Appendix S, 1970.

2. E. C. Raney, "Discussion," p. 371-374 in P. A. Krenkel and F. L. Parker (eds.), Biological Aspects of Thermal Pollution, Vanderbilt University Press, Nashville, Tennessee, 1969.

3. National Academy of Engineering, Engineering for Resolution of the Energy-Environment Dilemma, Washington, D. C., 1972.

4. U. S. Department of Health, Education, and Welfare, Public Health Service Drinking Water Standards, Pfls Pub. 956, 1962, Washington, D. C.

5. U. S. Department of the Interior, Water Quality Criteria, 1968, Washington, D. C.

11.2 GROUND WATER

11.2.1 RAISING/LOWERING OF GROUND WATER LEVELS

The nominal maximum amount of ground water extracted at the plant site is 4000 gpm. This is well below the capacity of the Tuscaloosa aquifer (1, 2) and should have no effect on the ground water level. It is doubtful that any significant amount of drawdown would extend beyond the influence of the Savannah River, or 2500 feet distant. All of the wells will be located on the VNP site, and there will be no loss of water to local off-site wells. Deep rooted vegetation will not be affected by the use of water from the Tuscaloosa aquifer. Subsection 2.5.4 discusses ground water at the site.

11.2.2 CHEMICAL CONTAMINATION

Spills of liquids containing chemicals would be restricted to the shallow ground water zone by the marl aquiclude found throughout the VNP site and would not affect the deep Tuscaloosa aquifer. The time of migration of any spill would be controlled by the soil permeabilities in the saturated ground water zone and is estimated to be on the order of 350 years as discussed in Subsection 5.4.3.

Subsection 2.5.2 discusses movement of the shallow ground water at the VNP site. No nearby communities use water from the shallow ground water aquifer at the site, and there is no known irrigation use in the area.

11.2.3 RADIONUCLIDE CONTAMINATION OF GROUND WATER

Subsections 2.5.2 and 11.2.2 discuss the ground water use at VNP. There are no nearby communities which use water from the shallow aquifer at the VNP site, and there is no known irrigation use in the area.

11.3 AIR

11.3.1 COOLING TOWER FOGGING

Natural draft cooling towers will be used at VNP because the operation of these towers is not expected to cause any increased frequency of ground fog, reduced visibility, or icing. Subsection 5.1.5 discusses the effects of these towers in detail.

11.3.2 CHEMICAL DISCHARGES TO AMBIENT AIR

VNP will have a start-up boiler to be used for furnishing steam for miscellaneous plant systems and turbine start-up. There will also be a standby power source for each unit consisting of 2 diesel engine generators. The diesels will be run periodically for test purposes.

Emissions from both of these units may include slight amounts of particulates, SO_2, and NO_x. As no specifications have been decided for either the boiler or the generators, more detailed emission figures are not presently available.

11.3.3 RADIONUCLIDES DISCHARGED TO AMBIENT AIR

The maximum off-site exposures to an individual due to routine gaseous effluent releases and the maximum average ground level concentrations at the site boundary were computed using the methods described in Paragraph 5.2.1.4. The estimated external whole body gamma dose to an individual is 2.2×10^{-5} rem/yr (See Table 5.2-5). The estimated external whole body dose to the total population is 16.6 man-rem/yr (See Table 5.2-5).

It is estimated that, as shown in Table 5.2-1, only a small amount of iodine may be released to the atmosphere. The greatest exposure from iodine will be the dose received by the thyroid. The 2 sources of exposure contributing to this dose are ingestion of milk through the "cow-milk" pathway and direct inhalation. Calculations for these 2 factors are given in Paragraphs 5.2.1.4.3 and 5.2.1.4.4, respectively. The estimated dose from this source to an individual is approximately 8.9×10^{-4} rem/yr (See Table 5.2-5). The estimated dose to the total population is approximately 676 man-rem/yr (See Table 5.2-5).

Subsection 5.2.5 describes exposure to organisms other than man from low-level radioactive gaseous wastes. Estimates of the doses to terrestrial organisms at VNP have been made. The maximum total dose rate for terrestrial organisms is 11.7 mrad/yr. Reference literature cited in Subsection 5.2.5 indicates that no measurable effects of radiation would be detected at this dose rate.

11.4 LAND

11.4.1 PRE-EMPTION OF LAND

The pre-emption of land by VNP is the use of 1,011 acres on the site, plus approximately 245 acres for offsite railroad right-of-way, for a total of 1,256 acres of land for industrial facilities, thereby resulting in the loss of agricultural and forest production on this land. In addition, approximately 12,000 acres of land offsite will be used for transmission line rights-of-way. This land can be used for agriculture or production of livestock. This use does restrict timber production and industrial and residential use. The impact of land use is discussed in Chapter 9.

11.4.2 PLANT CONSTRUCTION AND OPERATION

11.4.2.1 People (amenities)

Noise beyond the VNP site boundaries from construction and operation will not exceed 65 dBA more than 8 hours in 24 hours and, therefore, fall within the "Discretionary - normally acceptable" range as detailed in the U. S. Department of Housing and Urban Development Circular 1390.2. The unit "dBA" denotes sound level as measured on the A-weighted network (established by the U.S.A. Standards Institute); this network most closely approximates the responses of the human ear to sound. Calculations were based on estimated sound levels at each source, with consideration given to the combined effects of multiple sources and attenuation from coverings, buildings, trees, distance, etc. Sound levels at the nearest existing occupied house, about 3 air miles southeast of the center of the VNP-1 containment, should not be objectionable.

11.4.2.2 People (aesthetics)

External design for VNP relates directly to the site and surrounding area and is based on an analysis of existing environmental characteristics.

Colors and materials are indigenous to the area and will blend harmoniously with the vegetation and earth color. Viewed from a distance, the plant has a simple profile that blends with the environment. Visual impact is minimized by topography, design, and by distance from public thoroughfare and towns. Simple forms, materials, textures, color, and landscaping will enhance the visual quality of the plant and minimize the environmental effect.

The design philosophy is to integrate the various site components into a clean, functional, and attractive complex. This is reflected in the artist's rendering, which is the frontispiece of this report. A more detailed description of the external aesthetic considerations of the plant site is found in Section 3.1.

11.4.2.3 Wildlife

Construction activities are not expected to have any lasting adverse effects on wildlife at the plant site. Most wildlife will leave the immediate vicinity of construction as man's activities increase, but some are expected to return as construction is completed and man's activity subsides somewhat. The clearing process will result in some loss of animal life, especially small mammals. However, it is unlikely that any significant part of their population on the site will be destroyed. There are no known unusual or rare species which will be endangered.

A complete listing of the biota is found in Section 2.7. A more detailed description of the effects on wildlife is found in Subsection 4.3.3.

11.4.2.4 Land, Flood Control

The flow in the Savannah River is regulated by Clark Hill Dam which is located 87 river miles upstream from the plant site. The Savannah River complies with flood control regulations, and a flow greater than, or equal to, 6300 cfs from the Clark Hill Dam can be relied on 70 percent of the time.(1)

11.4.3 SALTS DISCHARGED FROM COOLING TOWERS

The VNP main cooling towers will normally operate at **4 to 8 cycles of** concentration. The main cooling tower drift will contain from **240 to** 480 ppm total dissolved solids under average ambient river conditions (See Section 2.5). The total dissolved solids in this drift will vary from 150 to 300 tons per year. Assuming the drift were spread over an area within a 1-mile radius around the cooling towers, the concentration of solids will vary from 0.003427 to 0.06855 lbs/ft^2/yr. Assuming the drift were spread over an area within a 5-mile radius around the cooling towers, the concentration of solids will vary from 0.000135 to 0.00027 lbs/ft^2/yr.

The above concentrations were calculated as follows (using an expected drift rate of 71.5 gpm per unit): 2

lbs. solids/year = gal./min x liters/gal. x mg/liter
x min/yr x lbs/mg

lbs. solids/yr. = 3.0×10^5 at 4 cycles
6.0×10^5 at 8 cycles 2

tons solids/yr. = 150 at 4 cycles
300 at 8 cycles 2

solids concentration = lbs/yr. ÷ ft.^2

solids concentration (1-mile radius) = 0.003427 $\text{lbs./ft.}^2\text{/yr.}$
at 4 cycles
0.06855 $\text{lbs./ft.}^2\text{/yr.}$
at 8 cycles 2

solids concentration (5-mile radius) = 0.000135 $\text{lbs./ft}^2\text{/yr.}$
at 4 cycles
0.00027 $\text{lbs./ft}^2\text{/yr.}$
at 8 cycles 2

The above concentrations of dissolved solids are within the water quality guidelines for irrigation water.(2) Since VNP is located in an area of moderately heavy, high-intensity rainfall, there is little likelihood of significant accumulation of chemicals on land areas. Intrusion of salts from the cooling towers into groundwater should not cause significant effects for the above reasons.

The salts discharged from the cooling towers should not significantly affect people, plants, or animals since they are within irrigation guidelines.

REFERENCES

1. Reservior Regulation Manual, Savannah River Basin, U. S. Army Corps of Engineers, Savannah District, 1968.

2. Water Information Center, The Water Encyclopedia, 1970, p. 333.

ATTACHMENT A - PLANT DESIGN SUMMARY

GENERATING COST	Present Worth Attachment D	$4,199,000,000
	Annualized Attachment D	$460,000,000

1

INCREMENTAL ENVIRONMENTAL EFFECTS		Units
Primary Impact	Population or Resource Affected	
1. Natural Surface Water Body		
1.1 Cooling Water Intake Structure	1.1.1 Fish	Negligible (11.1.1)
1.2 Passage Through the Condenser and Retention in Closed Cycle Cooling Systems	1.2.1 Primary Producers and Consumers	1.7% of total at average flow (11.1.2)
	1.2.2 Fish	1.7% of total at average flow
1.3 Discharge Area and Thermal Plume	1.3.1 Water Quality Physical	Δt <1°F (11.1.3)
	1.3.2 Oxygen Availability	No effect (11.1.3)

	1.3.3 Aquatic Biota	No effect (11.1.3)
	1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	No effect (11.1.3)
	1.3.5 Fish, Migration	No effect (11.1.3)
1.4 Chemical Effluents	1.4.1 Water Quality, Chemical	No effect (11.1.4)
	1.4.2 Aquatic Biota	No effect (11.1.4)
	1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	No effect (11.1.4)
	1.4.4 People	No effect (11.1.4)
1.5 Radionuclides Discharged to Water Body	1.5.1 Aquatic Organisms	No effect (11.1.5)
	1.5.2 People, External	No effect (11.1.5)
	1.5.3 People, Ingestion	4.6 x 10^{-4} rem/yr - individual (11.1.5.3) 33.4 man-rem/yr - population
1.6 Consumptive Use (evaporative losses)	1.6.1 People	Insignificant (11.1.6)
	1.6.2 Property	No effect (11.1.6)
1.7 Other Impacts		None (11.1.7)
.8 Combined or Interactive Effects		Negligible (11.1.8)

2. Groundwater		
2.1 Raising/Lowering of Groundwater Levels	2.1.1 People	No effect (11.2.1)
	2.1.2 Plants	No effect (11.2.1)
2.2 Chemical Contamination of Groundwater	2.2.1 People	N.A.
	2.2.2 Plants	No effect (11.2.2)
2.3 Radionuclide Contamination of Groundwater	2.3.1 People	No effect (11.2.3)
	2.3.2 Plants and Animals	No effect (11.2.3)
2.4 Other Impacts on Groundwater		None
3. Air		
3.1 Fogging and Icing (caused by evaporation and drift)	3.1.1 Ground Transportation	No effect (11.3.1)
	3.1.2 Air Transportation	No effect (11.3.1)
	3.1.3 Water Transportation	No effect (11.3.1)
	3.1.4 Plants	Insignificant (11.3.1)
3.2 Chemical Discharge to Ambient Air	3.2.1 Air Quality, Chemical	Insignificant (11.3.2)
	3.2.2 Air Quality, Odor	Insignificant (11.3.2)
3.3 Radionuclides Discharged to Ambient Air	3.3.1 People, External	16.6 man rem/yr. (11.3.3)
	3.3.2 People, Ingestion	676 man rem/yr. (11.3.3)
	3.3.3 Plants and Animals	Negligible (11.3.3)
3.4 Other Impacts on Air		None

4. Land

4.1 Pre-emption of Land	**4.1.1** Land, Amount	1256 acres (11.4.1)
4.2 Plant Construction and Operation	**4.2.1** People (amenities)	Negligible (11.4.2)
	4.2.2 People (aesthetics)	No effect (11.4.2)
	4.2.3 Wildlife	Negligible (11.4.2)
	4.2.4 Land, Flood Control	N.A.
4.3 Salts Discharged from Cooling Towers	**4.3.1** People	No effect (11.4.3)
	4.3.2 Plants and Animals	No effect (11.4.3)
	4.3.3 Property Resources	No effect (11.4.3)
4.4 Other Land Impacts		None
4.5 Combined or Interactive Effects		None

ATTACHMENT A - BENEFITS FROM THE PROPOSED FACILITY

Direct Benefits (Attachment B)

Expected Average Annual Generation in Kilowatt Hours	31,744,000,000
Capacity in Kilowatts	4,640,000
Proportional Distribution of Electrical Energy–Expected Annual Delivery in Kilowatt Hours:	
Industrial	30.90%-9,809,000,000
Commercial	23.38%-7,422,000,000
Residential	24.12%-7,657,000,000
Other	21.60%-6,856,000,000
Expected Average Annual Btu (in millions) of Steam Sold from the Facility	
Expected Average Annual Delivery of Other Beneficial Products (appropriate physical units)	None

Revenues from Delivered Benefits (Annual)

Electrical Energy Generated	$444,416,000
Steam Sold	None
Other Products	None

Indirect Benefits (as appropriate)

Taxes (Local, State, Federal) (Attachment C)	$ 82,693,996
Research (Attachment G)	
Regional Product (Attachment F)	
Environmental Enhancement (Attachment E)	
Recreation	None
Navigation	None
Air Quality:	
SO_2	342,835,000 lbs
NO_x	199,987,000 lbs
Particulates	28,569,000 lbs
Others	None
Employment (Attachment F)	100 people
Education	None
Others	None

ATTACHMENT B - BENEFITS OF POWER

It is impractical to determine the future monetary benefits of power to be generated by Vogtle 1, 2, 3, & 4 based on the present value of what users will pay for this power. This power will flow through the interconnected transmission network and distribution systems of the company to its industrial, commercial, residential, municipal, rural electric cooperatives, and other customers. This system is, of course, supplied by power from all of the company's generating plants - old and new - and the selling price of power to customers is dependent on the composite capital investment, fuel and operating costs of all of the generating plants, transmission and distribution systems and other operating and maintenance costs. Georgia Power Company's electric power rates are subject to regulation by the Georgia Public Service Commission and the Federal Power Commission. The future power rates of the company will depend on so many variable and unpredictable factors that it is impractical at this time to predict, with any reasonable assurance, what the selling price of power will be during the life of VNP.

In the draft, Guide to the Preparation of Benefit-Cost Analyses for Nuclear Power Plants, an alternative to supplying the estimated monetary benefits of the power to be generated is suggested. This information was developed as follows:

ESTIMATED ANNUAL ENERGY GENERATION FROM VNP

FROM EACH OF 4 UNITS IN MILLIONS OF KILOWATT-HOURS

		Plant Factor
1st Year of Operation:	Approx. 6996-M Kwh	72.6%
2nd Year of Operation:	Approx. 8109-M Kwh	79.8%
3rd Year of Operation:	Approx. 8465-M Kwh	83.3%

NOTE: These production figures are based on the plant being available for base load operation at all times except during an estimated 5 weeks per year refueling and maintenance period and during the following estimated forced outage periods.

$$\% \text{ Forced Outage Hours} = \frac{\text{Forced Outage Hours}}{\text{Service Hours} + \text{Forced Outage Hours}} \times 100$$

1st Year	17.8%
2nd Year	10.6%
Mature Rate	7.1%

After the second year, it is expected to operate each of these units at or near 7936-M Kwh per year until such time in the future that the plant is no longer base loaded to its full capability. It has been estimated that the annual production from this plant over its estimated 30 year useful life will be at a levelized plant factor of 78.1 percent. This amounts to an annual production from each unit of 7936 million kilowatt hours or a total levelized annual production for the four units of 31744 million kilowatt hours.

The following tabulation shows the estimated levelized annual generation in millions of kilowatt hours by classes of customers served.

Class of Customers	% of Total (1)	Levelized Annual Generation (m Kwh)
Industrial	30.90	9809
Commercial	.23.38	7422
Residential	24.12	7657
Other Uses(2)	21.60	6856
Total	100.00	31744

(1) Based on expected percentages in 1977.

(2) Includes sales to municipal systems, REA Co-op Systems, street lighting systems, company uses, system losses, and preference customers.

For reasons mentioned previously, it is impractical to estimate the future selling price of power over the life of this plant. Due to the rising costs of providing facilities to generate, transmit and distribute electric power, and increases in fuel and cost of operating a power system, the future selling price of power will undoubtedly be considerably higher than today's price.

The very minimum monetary benefit to be expected from the power generated by VNP during its life could be based on the present average selling price of power by Georgia Power Company. During the past 12 months this average price amounted to approximately 1.40 cents per kilowatt hour.

The present worth of future power, based on today's selling price would amount to the levelized annual production in KWH times 1.40 cents per KWH times the present worth factor for a uniform annual series at the appropriate rate of interest (10.4%) for 30 years (9.121). This amounts to a present worth value of $4,054,000,000.

ATTACHMENT C - LOCAL TAXES

Estimated present worth of county and state ad valorem taxes over an estimated 30 year life of the plant:

Total estimated capital cost of Units #1 - #4	\$2,196,000,000
Estimated cost of Units 1 - 4, excluding pollution control equipment which is not subject to ad valorem tax	\$2,025,000,000

Equivalent annual depreciated plant:

$$= \frac{\text{Capital Recovery Factor - Straight Line Depreciation Rate}}{\text{Required Rate of Return}}$$

Capital Recovery Factor = Sinking Fund Depreciation Factor plus Rate of Return 1

For 30 year life type R_5 Retirement Dispersion

Sinking Fund Depreciation Factor = 0.69%
Straight Line Depreciation Rate = 3.33%
Required Rate of Return = 10.4 %

$$\text{Equivalent Annual Depreciation Plant} = \frac{10.4\% + 0.69\% - 3.33\%}{10.4\%} = .7462$$

Estimated Ad Valorem Taxes:

Combined tax rate for State of Georgia and Burke County:

\$1.50 per year per \$100 as assessed value (or .015)

Assessment Ratio: 40%

Estimated annual levelized ad valorem taxes:

\$2,025,000,000 x .7462 x .015 x .40 = \$9,066,330

Present worth of estimated ad valorem taxes over 30 year plant life:

P.W. Factor for a uniform annual series at 10.4% return on investment: 9.121

9.121 x \$9,066,330 = \$82,693,996* - The present worth of ad valorem taxes

---

* Costs of cooling towers are exempted from ad valorem taxes in the state of Georgia.

Estimated Generating Costs

$C_o = \$2,060,000,000$

$C_i = 0$

$P_t = 0$

$T_1 = 30$

$\sum_{t=1}^{T_1} v^t(O_t+F_t)$ = the present worth of operating costs and fuel costs over the life of the plant.

The estimated levelized fuel and operating costs for Units No. 1, No. 2, No. 3, and No. 4 are 3.62, 3.25, 3.73, and 3.39 mills per KWH respectively, based on a levelized plant factor of 78.1 percent over an estimated 30 year service life including expected escalation. The expected system peak hour capability of the plant after the initial year of operation is 1160 MW for each unit or 4640 MW for the 4 units. The present worth factor for a uniform annual series for 30 years at 10.4 percent (the annual cost of capital) is 9.121.

The levelized annual fuel and operating cost is equal to the levelized cost of fuel and operation per KWH times the levelized plant factor times 8760 hours per year, times the capability of the plant in kilowatts, as follows:

$$\begin{array}{r} 3.62 \\ \$.3.25 \\ 3.73 \\ 3.39 \end{array} \times .781 \times 8760 \times 1{,}160{,}000 = \begin{array}{r} 287{,}290{,}788 \\ \$257{,}926{,}812 \\ 296{,}020{,}618 \\ 269{,}037{,}505 \end{array}$$

The present worth of the levelized annual cost for 30 years is:

$9.121 \times \$1,110,275,723 = \$10,126,824,869$

The estimated total generating cost for VNP is the capital cost of the plant plus the present worth of the levelized annual fuel and operating costs during the life of the plant, as follows:

$TC_g = \$2,060,000,000 + \$10,126,824,869 = \$12,186,824,869$

ATTACHMENT D - GENERATING COSTS

The following estimated generating costs were based on the formula in Table 2 Monetized Bases for Plant Costs of the Atomic Energy Commission's draft Guide to the preparation of Benefit-Cost Analyses for Nuclear Power Plants, dated 1/7/72, as reproduced below:

MONETIZED BASES FOR PLANT COSTS

ITEM	SYMBOL	UNITS	METHOD OF COMPUTATION
Total Capital outlay at time when plant is put into operation.	C_o	$	To include total value of capital invested in a presently constructed plant. Applicant may use present worth of all capital costs annualized over life of the plant using the utility's annual carrying charges.
Additional Capital Required by an alternative i= 1,2.	C_i	$	To include all additional costs to the power utility of modifying present installation to alternative installation. The sum should be expressed on a present value basis for disbursements over a number of years, as for C_o above.
Deficient Power Purchased or Supplied in Year t.	P_t	$	Power purchased or supplied internally in year t to make up deficiency of power in dollars, including environmental costs.
The expected life of this plant.	T_1	years	This should conform to period of amortization of the plant investment.
Annual Operating Cost	O_t	$	This is the total operation and maintenance cost of plant operation in year t.
Annual Fuel Cost of Plant.	F_t	$	This is the total fuel cost in year t.
Discount factor	v		$v = (1 + i)^{-1}$ where i is the cost of capital used in Table 1 over the life of this plant.
Total Generating Cost	TC_g	$	$TC_g = C_o + C_i + \sum^{T_1} v^t (O_t + F_t) + \sum^{T_1} v^t P_t$

Estimated Generating Costs

C_o =	Unit 1 (1980) =	$ 575,000,000
	Unit 2 (1981)	505,000,000
	Unit 3 (1982)	574,000,000 1
	Unit 4 (1983)	542,000,000
	Total	$2,196,000,000

$C_i = 0$

$P_t = 0$

$T_1 = 30$

$$\sum_{t=1}^{T_1} v^t (O_t + F_t)$$ = the present worth of operating costs and fuel costs over the life of the plant.

Calculation of the total present worth of generating costs is most conveniently done by first obtaining the levelized annual generating costs (as shown below) and then converting to a present worth figure. The levelized annual generating costs for VNP are determined by adding the following components:

1. Capital Recovery Requirements - Capital recovery requirements are determined by applying a capital recovery factor to the estimated plant cost. This factor equals the sum of the cost of capital (currently 10.4 percent) plus a sinking fund depreciation factor (0.69 percent). Capital recovery requirements are: $2,196,000,000 x 0.1109 = $243,500,000 per year.

2. Fuel Costs - The levelized annual fuel costs for VNP when all 4 units are in operation will be 3.16 mills/kWh. The annual fuel costs will be: $0.00316/kWh x (4 x 1,160,000) kW x 8760 hrs./year x 0.781 levelized plant factor = $100,300,000 per year. 1

3. Other Costs- Other costs of generation include income taxes, ad valorem taxes, insurance (both nuclear and non-nuclear), labor, and supplies. The estimated annual costs associated with these items amounts to $116,600,000.

The total levelized annual generating costs are:

$243,500,000 + $100,300,000 + $116,600,000 = $460,400,000

The total present worth of generating costs for VNP is determined by applying the present worth factor for a 30-year uniform series at the current 10.4 percent cost of capital rate (factor = 9.121): 1

$460,400 x 9.121 = $4,199,300,000 present worth

ATTACHMENT E - ENVIRONMENTAL ENHANCEMENT FROM REDUCTIONS IN AIR POLLUTION IF GENERATING CAPABILITY IS NOT PROVIDED THROUGH FOSSIL FUEL

A coal fueled plant of similar capacity to VNP will produce the following quantities of emissions annually based upon certain assumptions:

(1) Assume 31,744,000,000 KWH/year - 4 units

(2) Assume heat rate = 9000 BTU/KWH

(3) Assume particulate emission = 0.1 lbs/M BTU (EPA Standards)

(4) Assume SO_2 emission = 1.2 lbs/M BTU (EPA Standards)

(5) Assume NO_x emission = 0.7 lbs/M BTU (EPA Standards)

Then annual heat input equals:

$$31{,}744 \times 10^6 \text{ KWH} \times 9 \times 10^3 \text{ BTU/KWH} = 285{,}696{,}000 \times 10^6 \text{ BTU}$$

Then annual particulate emission:

$$285{,}696{,}000 \times 10^6 \text{ BTU} \times 0.1 \text{ lbs}/10^6 \text{ BTU} = 28{,}569{,}000 \text{ lbs.}$$

Then annual SO_2 emission:

$$285{,}696{,}000 \times 10^6 \text{ BTU} \times 1.2 \text{ lbs}/10^6 = 342{,}835{,}000 \text{ lbs.}$$

Then annual NO_x emission:

$$285{,}696{,}000 \times 10^6 \text{ BTU} \times 0.7 \text{ lbs}/10^6 \text{ BTU} = 199{,}987{,}000 \text{ lbs.}$$

An oil fueled (# 6 oil) plant of similar capacity to VNP will produce the following quantities of emissions annually based upon certain assumptions:

(1) Assume 31,744,000,000 KWH/year - 4 units

(2) Assume heat rate = 9000 BTU/KWH

(3) Assume particulate emission = 0.1 lbs/M BTU (EPA Standards)

(4) Assume SO_2 emission = 0.8 lbs/ M BTU (EPA Standards)

(5) Assume NO_x emission = 0.3 lbs/M BTU (EPA Standards)

ATTACHMENT E - ENVIRONMENTAL ENHANCEMENT FROM REDUCTIONS IN AIR POLLUTION IF GENERATING CAPABILITY IS NOT PROVIDED THROUGH FOSSIL FUEL

A coal fueled plant of similar capacity to VNP will produce the following quantities of emissions annually based upon certain assumptions:

(1) Assume 31,744,000,000 KWH/year - 4 units

(2) Assume heat rate = 9000 BTU/KWH

(3) Assume particulate emission = 0.1 lbs/M BTU (EPA Standards)

(4) Assume SO_2 emission = 1.2 lbs/M BTU (EPA Standards)

(5) Assume NO_x emission = 0.7 lbs/M BTU (EPA Standards)

Then annual heat input equals:

$31,744 \times 10^6$ KWH $\times 9 \times 10^3$ BTU/KWH = $285,696,000 \times 10^6$ BTU

Then annual particulate emission:

$285,696,000 \times 10^6$ BTU $\times$ 0.1 lbs/10^6 BTU = 28,569,000 lbs.

Then annual SO_2 emission:

$285,696,000 \times 10^6$ BTU $\times$ 1.2 lbs/10^6 = 342,835,000 lbs.

Then annual NO_x emission:

$285,696,000 \times 10^6$ BTU $\times$ 0.7 lbs/10^6 BTU = 199,987,000 lbs.

An oil fueled (# 6 oil) plant of similar capacity to VNP will produce the following quantities of emissions annually based upon certain assumptions:

(1) Assume 31,744,000,000 KWH/year - 4 units

(2) Assume heat rate = 9000 BTU/KWH

(3) Assume particulate emission = 0.1 lbs/M BTU (EPA Standards)

(4) Assume SO_2 emission = 0.8 lbs/ M BTU (EPA Standards)

(5) Assume NO_x emission = 0.3 lbs/M BTU (EPA Standards)

Then annual heat input equals:

$31{,}744 \times 10^6$ KWH $\times 9 \times 10^3$ BTU/KWH $= 285{,}696{,}000 \times 10^6$ BTU

Then annual particulate emission:

$285{,}696{,}000 \times 10^6$ BTU $\times 0.1$ lbs/10^6 BTU $= 28{,}569{,}000$ lbs.

Then annual SO_2 emission:

$285{,}696{,}000 \times 10^6$ BTU $\times 0.8$ lbs/10^6 BTU $= 228{,}556{,}800$ lbs.

Then annual NO_x emissions;

$285{,}696{,}000 \times 10^6$ BTU $\times 0.3$ lbs/10^6 BTU $= 85{,}708{,}800$ lbs.

ATTACHMENT F - REGIONAL PRODUCT

Regional benefits due to the construction and operation of VNP are discussed in Section 4.2. In general, these are the short term economic benefits due to wages paid to construction crews and the long term impact on the economy of Burke County due to the ad valorem taxes paid by GPC.

In 1981, GPC will maintain approximately 100 operating employees at the plant for 2 units. By 1983, there should be approximately 150 operating employees for all 4 units. 1

ATTACHMENT G - RESEARCH

Intangible research benefits will be derived from monitoring programs implemented by GPC and discussed in Sections 2.6, 2.7, and 5.5. These programs, designed to detect changes in the environment, will provide data in the fields of biology, meteorology, water quality and radiation.

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CHAPTER 12 ENVIRONMENTAL APPROVALS AND CONSULTATIONS
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12. ENVIRONMENTAL APPROVALS AND CONSULTATIONS

12.1 PERMITS AND LICENSES

At this time no applications for permits or licenses, except as noted, have been made for VNP. The following permits and licenses will be required from Federal, State and local authorities, as indicated, for the protection of the environment and for the construction and operation of VNP.

12.1.1 FEDERAL AGENCIES

AGENCY AND AUTHORITY FOR THE REQUIREMENT	LICENSE OR PERMIT REQUIRED	STATUS OF
U.S.A.E.C. 10 CFR 50	Construction Permit and Operating License	Filed August 1, 1972
U.S.C. of E.	Intake Structure	No Action
(33 USC 403)	Discharge Structure	No Action
(33 USC 407)	Barge Slip	No Action
	Waste Discharges	No Action
FAA (14 CFR 77)	Cooling Towers	No Action

12.1.2 STATE OF GEORGIA

AGENCY AND AUTHORITY FOR THE REQUIREMENT	LICENSE OR PERMIT REQUIRED	STATUS OF
Georgia Environmental Protection Division	Intake Structure	No Action
	Discharge Structure	No Action
(Ga. Code Chapter 88-9, 17-5, and 88-26)	Barge Slip	No Action
	Waste Dischargers	No Action
	Sewage Treatment Plant	No Action
	Potable Water Supply	No Action
	Start-up Boiler	No Action
Georgia Fire Marshal (Ga. Code Chapter 92A 710, 711)	Building Fire Safety	No Action

12.2 CONSULTATIONS AND NOTIFICATIONS

GPC has consulted with the following groups concerning the location of VNP.

1. U.S.A.E.C. Savannah River Plant
2. Barnwell Nuclear Fuel Plant
3. Central Savannah River Area Planning and Development Commission
4. Georgia Historical Commission
5. Georgia Water Quality Control Board
6. Georgia Air Quality Control Section
7. Georgia Radiological Health Service

In addition to the above consultations, GPC notified the State of Georgia Agencies concerned with air, water and radiation that GPC was investigating a site on the Savannah River in the early summer of 1971. This notification was to give the concerned agencies an opportunity to comment on the proposed location as early as possible. In addition to these early notifications of intent, GPC formally notified by letter Federal, State and local agencies, including other interested groups, prior to the announcement in the press, during the week of September 1 and 6, 1971, of the proposed plant. The following pages list the Georgia and South Carolina Environmental Agencies contacted, plus partial lists of local and regional representatives contacted.

GEORGIA AND SOUTH CAROLINA ENVIRONMENTAL AGENCIES CONTACTED

Mr. Jack Crockford, Director
Game and Fish Division
Room 713
Trinity-Washington Building
270 Washington Street
Atlanta, Georgia 30334

Mr. Charles H. Badger
Office of Planning & Budget
A-95 Clearinghouse
270 Washington Street
Room 615-C
Atlanta, Georgia 30334

Mr. R. S. Howard, Jr., Director
Environmental Protection Division
Department of Natural Resources
47 Trinity Avenue, S.W.
Atlanta, Georgia 30334

Mr. Robert Collum, Chief
Air Quality Control Section
Department of Natural Resources
47 Trinity Avenue, S.W.
Atlanta, Georgia 30334

Mr. Richard Fetz, Director
Radiological Health Service
535 Milam Avenue
Atlanta, Georgia 30315

Mr. Clair Guess
Executive Director
South Carolina Water Resources Commission
2414 Bull Street
Columbia, South Carolina 29201

Dr. Hubert Webb
Executive Director
South Carolina Pollution Control Authority
J. Marion Simms Building
Columbia, South Carolina 29201

Dr. E. K. Aycock
State Health Officer
S. C. Board of Health
J. Marion Simms Building
Columbia, South Carolina 29201

Mr. H. G. Schealy
Director
Division of Radiological Health
S. C. Board of Health
2600 Bull Street
Columbia, South Carolina 29201

Mr. W. G. Crosby, Director
Division of Air Pollution Control
S. C. Board of Health
P. O. Box 11628
Columbia, South Carolina 29211

Mr. Bonner Manley, Director
S. C. State Development Board
P. O. Box 927
Columbia, South Carolina 29202

Mr. James W. Webb
Executive Director
S. C. Wildlife Resources
P. O. Box 167
Columbia, South Carolina 29202

Mr. A. Louis Abbott
Forrest Drive
Waynesboro, Georgia 30830

Mr. Laurie K. Abbott
507 American Building
Savannah, Georgia 31402

The Honorable George Aiken
Joint Committee on Atomic Energy
Washington, D. C.

The Honorable Clinton Anderson
Joint Committee on Atomic Energy
Washington, D. C.

The Honorable John Anderson
Joint Committee on Atomic Energy
Washington, D. C.

Mr. W. A. Anderson, Sheriff
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VOLUME III

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GEORGIA POWER COMPANY
ALVIN W. VOGTLE NUCLEAR PLANTS UNITS 1-4
ENVIRONMENTAL REPORT
AMENDMENT NO. 3
DOCKET NOS. 50-424, 50-425, 50-426, 50-427

INSTRUCTIONS FOR FILING AMENDMENT NO. 3

There is no tab for Amendment No. 3. The transmittal letter for Amendment No. 3 and this instruction sheet should be placed in Volume III immediately behind the instruction sheets for Amendment No. 2.

Remove and/or insert the ER material listed below:

VOLUME I

Remove	Insert
Page 2.3-1, -2	Pages 2.3-1, -1a, -2

VOLUME II

Remove	Insert
Page 3.7-5	Page 3.7-5
Page 4.4-3	Page 4.4-3
Pages 5.5-6, -18, -21, -26, -27	Pages 5.5-6, -18, -21, -26, -27
Figures 5.5-1, -6	Figures 5.5-1, -6

GEORGIA POWER COMPANY
ALVIN W. VOGTLE NUCLEAR PLANT UNITS 1 - 4
ENVIRONMENTAL REPORT
AMENDMENT NO. 2
DOCKET NOS. 50-424, 50-425, 50-426, 50-427

INSTRUCTIONS FOR FILING AMENDMENT NO. 2

Along with this amendment, you are being sent a Volume III binder and an Amendment No. 1 tab if you have not already received them. Volume III should contain in the following order: a title page sheet (transmitted with Amendment No. 2); Appendices A and B with their respective tabs; the tab, transmittal letter, and instruction sheets for Amendment No. 1; the 66 pages of "Responses to AEC Questions on the Vogtle Nuclear Plant Environmental Report (Dated April 11, 1973)"; the tab, transmittal letter, and instructions for Amendment No. 2. If you are missing any of this material, you should notify Mr. J. H. Motz, Jr., Environmental Division, Georgia Power Company.

Remove and/or insert the ER material listed below:

VOLUME I

REMOVE	INSERT
Page iv	Page iv
Figure 2.1-3	Figure 2.1-3
Page 2.3-1	Page 2.3-1

VOLUME II

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Page iv	Page iv
Figure 3.1-1	Figure 3.1-1
Pages 3.5-2, -2a	Pages 3.5-2, -2a, -2b
Pages 3.5-5, -5a, -6, -7	Pages 3.5-5, -5a, -6, -7, -7a
	Figures 3.5-2a, -12 through -17
Page 3.7-12c	Page 3.7-12c
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Page 5.1-2	Page 5.1-2
Page 5.4-2	Page 5.4-2
Page 5.5-18	Page 5.5-18
Page 5.5-21	Page 5.5-21

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Page 5.5-21j	Page 5.5-21j
Page 5.5-30	Page 5.5-30
Figure 5.5-1	Figure 5.5-1
	Figure 5.5-10
Page 7.1-1	Page 7.1-1
Page 7.2-1	Page 7.2-1
Pages 11.4-2, -3	Pages 11.4-2, -3

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AMENDMENT NO. 1
DOCKET NOS. 50-424, 50-425, 50-426, 50-427

INSTRUCTIONS FOR FILING AMENDMENT NO. 1

Volume III and an Amendment No. 1 tab will be issued at a later date. At that time, Appendices A and B, the Amendment No. 1 tab, the transmittal letter, this instruction sheet, and the 66 pages of "Responses to AEC Questions on the Vogtle Nuclear Plant Environmental Report (Dated April 11, 1973)" should be inserted in Volume III.

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VOLUME I

These changes made 5/22/73 (ss)

REMOVE	INSERT
	Black-and-white illustration of site (behind color illustration of plant)
Pages iii, vi	Pages iii, vi
Pages 1.2-1, -2, -3, -4	Pages 1.2-1, -2, -2a, -3, -4
	Pages 1.2-5a, b, -6a, b
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APPENDIX A

IMPACT OF THE GEORGIA POWER COMPANY
VOGTLE NUCLEAR POWER PLANT
ON THE
CENTRAL SAVANNAH RIVER AREA

Prepared for

Central Savannah River Area Planning and Development Commission

By

Graduate Students of City Planning

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CHAPTER I

INTRODUCTION

The purpose of this study is to identify and to evaluate the major areas of impact anticipated from the construction of the Georgia Power Company nuclear power plant on the west bank of the Savannah River, approximately 26 miles south of Augusta, Georgia.

This study is confined to a five-county area within the Central Savannah River Area (CSRA) Planning and Development Commission composed of Burke, Jefferson, Jenkins, Screven and Richmond Counties. Analysis has been made of labor resources, transportation networks, existing commercial and industrial development, housing availability, community services and facilities, and population. These factors, combined with an on-site evaluation of the area, suggested that the study concentrate on Burke and Richmond Counties.

Georgia Power Company Nuclear Power Plant

Georgia Power Company is about to construct the Alvin W. Vogtle nuclear plant on the west bank of the Savannah River approximately 26 miles south of Augusta, Georgia. The site is located in the eastern sector of Burke County, Georgia, across the river from Barnwell County, South Carolina (Figure 1).

The site, owned by the Georgia Power Company, consists of approximately 3,000 acres. Vogtle Nuclear Plant will include a 300 megawatt combustion turbine installation, oil storage facilities, a barge slip, substation area, and four nuclear reactor units. Initially two reactor units will be constructed; after several

Figure 1

years a decision will be made regarding additional units. Each reactor unit consists of a large multi-story domed facility housing one nuclear reactor. When completed, each reactor unit will generate 1,172 megawatts of electricity. Total projected cost of the construction project is in excess of $1,300,000,000. When completed, the plant is expected to bring the study area an annual payroll of approximately $1 million.

The power plant construction program provides for the consecutive construction of four reactor units beginning in early 1974. Construction is expected to continue over an eight-year period with employment gradually rising to a peak of 3,800 employees in the fourth year (1977). Generally, this peak will be maintained over a four-year period (until 1980) when a sharp decline in employment is anticipated.

General Observations

Burke and Richmond Counties are representative of extremes in urban development.

Richmond County, containing a majority of the population and economic development of the Augusta Standard Metropolitan Statistical Area (Aiken County, South Carolina containing the remainder) is a highly developed metropolitan region. Industrial development has been controlled so as to provide minimum impact upon residential and commercial activities. Clark Hill Reservoir provides excellent recreational facilities for the region. Fort Gordon, located to the west of Augusta, stimulates the commercial and residential development of the area. Residential areas in south and southwest Augusta are abundant, attractively designed and generally void of conflicting or objectionable land uses. Large areas of southern Richmond County are available for planned development projects.

Burke County's greatest attraction is its rural atmosphere. The County's topography is one of gently rolling hills interspersed with streams and large tracts of forests. Rural homes are generally attractive and widely dispersed. Rural commercial activity is almost nonexistent. The limited amount of industry is located close to Waynesboro, Midville, Sardis, and Girard. Despite a lack of land use controls in the unincorporated areas of the county, the potential for controlled development is excellent. The county is a logical expansion of the industrial development of Augusta along the Savannah River.

Method of Analysis

The impact of the nuclear plant on the area was analyzed as follows:

STEP 1 -- Available plans and data concerning the scheduled construction of the nuclear power plant, together with the number of workers required during the phased construction program were assembled. These data, combined with analyses of existing population projections and the 1970 decennial census statistics, provided the basis for population projections.

STEP 2 -- Available plans, studies and reports of the study area, covering transportation, economic development, community facilities and other areas which might affect the impact of the construction project were reviewed and analyzed. These data served as the basis for an indepth analysis of labor resources, population, housing, transportation, and community facilities.

STEP 3 -- Other power plant construction projects, either completed or currently in progress, were studied to provide a basis for comparison with the Vogtle Nuclear Plant.

STEP 4 -- An on-site survey was made of all facilities and services. Interviews were conducted with knowledgeable city and county leaders in the several functional areas addressed. Surveys of existing resources were conducted. These activities were used to refine projections.

STEP 5 -- Based upon collected data, the impact of the Vogtle Nuclear Plant on the several functional areas was estimated.

STEP 6 -- Courses of action by which the affected areas might take advantage of potential opportunities and solve problems arising from the construction of the Vogtle Nuclear Plant are recommended.

CHAPTER II

LABOR, EMPLOYMENT, AND WAGES

Power plant construction operations are expected to have a major impact on labor, employment, and wages within the study area. The greatest impact on labor forces should occur in Burke and Richmond Counties. Impact on labor forces in the remaining three counties of the study area will probably be insignificant. Industries expected to undergo changes because of power plant construction include all the construction industry as well as industries paying relatively low wages.

Existing Labor Characteristics

The total work force for the five county region in 1970 was 91,690. Of this number, 86,200 were employed and 5,490 (5.9 percent) were unemployed (Table 1).

Table 1: 1970 WORK FORCE DATA

County	Civilian Work Force	Employed Total	Employed Agri.	Employed Non-Agri.	Unemployed Total	Unemployed Rate
Burke	6,140	5,670	1,380	4,290	470	7.7
Jefferson	5,730	5,460	840	4,620	270	4.7
Jenkins	3,060	2,880	540	2,340	180	5.9
Richmond	72,400	68,060	830	67,230	4,340	5.9
Screven	4,360	4,130	950	3,180	230	5.3
Total	91,690	86,200	4,540	81,660	5,490	

Source: Georgia Department of Labor, Employment Security Agency.

Existing labor resources are engaged in a variety of agricultural and non-agricultural activities. Except for Richmond County, agriculture, manufacturing, government, domestic services, and self-employment account for a large percentage of employment. Richmond/Aiken County's work force is primarily engaged in manufacturing, trade and governmental services. Table 2 gives a breakdown of employment by industry category for each of these counties.

Construction employment accounts for only a small percentage of the total non-agricultural employment in each of the five counties. Construction employment in Richmond and Aiken Counties in 1970 was 4,500 persons. These persons account for approximately five percent of Augusta's total non-agricultural employment. Construction employment in the remaining four counties is less than two percent of non-agricultural employment.

Generally speaking, except for agriculture, all employment categories in the study area were stable or showed an increase between 1960 and 1970, resulting in an overall increase in total employment during this period. However, Richmond County, despite minor agricultural activities, showed a relatively small increase in total employment.

Table 2: 1970 EMPLOYMENT BY INDUSTRY CATEGORY

Industry Category	Burke	Jefferson	Jenkins	Richmond/ Aiken*	Screven	Total
Agriculture	1,380	840	540	830	950	4,540
Construction	59	90	30	4,500	59	4,738
Manufacturing	1,440	1,842	839	29,800	793	34,704
Transportation & Communication	69	159	151	3,800	59	4,238
Wholesale & Retail Trade	568	527	312	15,200	470	17,077
Finance, Insurance & Real Estate	108	80	30	3,100	49	3,367
Services	254	219	161	10,500	186	11,320
Government	842	657	312	20,100	597	22,508
Self Employed, Domestic & Others	950	1,046	505	--	967	3,468

*Data are for Augusta SMSA which includes Richmond County, Georgia, and Aiken County, South Carolina.

Source: Georgia Department of Labor, Employment Security Agency.

Unemployment within the five-county area was relatively high in 1970 (Table 3).

Table 3: 1970 UNEMPLOYMENT

County	Male	Female	Total	Rate	White Male	Non-White Male
Burke	230	240	470	7.7	60	170
Jefferson	110	160	270	4.7	50	60
Jenkins	70	110	180	5.9	40	30
Richmond	2,040	2,300	4,340	5.9	1,420	620
Screven	100	130	230	5.3	50	50
Total	2,550	2,940	5,490		1,620	930

Source: Georgia Department of Labor, Employment Security Agency.

Similar conditions existed in the State of Georgia and the nation as a whole in the same year. Because a breakout of unemployment by industry category was unavailable for the five-county region, and the region is not unique in the State of Georgia, unemployment statistics for the state were used to analyze unemployment within the region. Manufacturing, trade, and construction account for a large majority of Georgia's unemployment insurance payments in 1970. Manufacturing accounted for 60 percent of these payments followed by wholesale and retail trade (15 percent) and construction (10 percent). Manufacturing's high rate of unemployment occurred in textiles, apparel, and transportation equipment. Unemployment was approximately equally divided between males and females. Unemployment among white males was almost twice that of non-white males.

Because unemployment is still high, a sizable number of workers are available for employment. Many of these unemployed persons are unqualified for skilled construction work, but can be trained for skilled jobs.

Employment agencies and labor leaders in the Augusta area believe a large number of highly skilled construction workers are now available in the area. Many of the workers have experience in constructing nuclear facilities. This experience was gained while working in construction at the Atomic Energy Commission's Savannah River Plant, located across the Savannah River from the Vogtle site. In addition to those now working in the area, a considerable number of former AEC construction workers working outside the area have homes and families in the area. Most of them want to return to the Augusta area when suitable employment becomes available.

Analysis of existing wage rates within the region showed that many industries pay low wages compared to estimated wage rates of power plant construction workers. Table 4 shows those industries now paying low wages. Table 5 shows anticipated minimum wage rates for Vogtle Nuclear Plant construction workers. Actual wage rates for construction workers will be determined during contract negotiations.

Construction Project Workforce

The Georgia Power Company currently plans to construct a four-unit power plant over a period of eight years. Based upon past experience with similar projects, construction employment was estimated (Table 6). However, Georgia Power Company

Table 4: 1970 AVERAGE WEEKLY WAGES FOR SELECTED INDUSTRY

Industry Category	Burke	Jefferson	Jenkins	Richmond	Screven
Agricultural Services					
All Components	$23	$83	*	$93	*
Construction					
All Components	65	78	$77	110	$81
Manufacturing					
Logging	--	55	--	--	52
Sawmills	--	--	--	--	73
Retail Trade			60**		
Gen. Merchandising	--	26	--	--	--
Eating & Drinking Establ.	--	38	--	48	36
Food Stores	48	52	--	74	41
Gasoline Service Stations	--	59	--	71	49
Misc. Retail Stores	--	58	--	77	--
Liquor Stores	--	--	--	55	--
Services		56**	73**		
Hotel & Lodging Places	--	--	--	54	35
Tourist Courts	--	--	--	57	--
Laundry & Dry Clean. Plants	--	--	--	62	--
Personal Services	50	--	--	--	--

*Data Unavailable
**Breakdown by Components Unavailable

Source: U.S. Bureau of Census, County Business Patterns, 1970.

Table 5: ESTIMATED MINIMUM WAGES FOR CONSTRUCTION WORKERS (*)

Craft	Journeyman		Apprentice	
	Hourly	Weekly **	Hourly	Weekly**
Carpenters	$6.35	$254	$3.65	$147
Millwrights	6.65	266	3.82	153
Pipefitters	6.85	274	2.82	113
Ironworkers	6.96	278	***	***
Boilermakers	7.06	282	***	***
Operating Engineers	6.95	278	***	***
Electricians	6.10	236	2.85	114
Painter	5.20	208	***	***
Laborer	2.90	116	***	***
Asbestos workers	6.40	256	3.62	145
Brickmason	5.60	244	***	***
Cement mason	5.20	208	***	***
Teamsters	***	***	***	***

*Includes only wages paid to workers--does not include benefits, travel and board allowances, etc.

**Based on 40 hours regular time per week

***Information unavailable

Source: Augusta Building and Trades Council and Georgia Power Company.

Table 6: CONSTRUCTION EMPLOYMENT FOR 4-UNIT POWER PLANT*

Year Ending	Total Employment	Change from Previous Year
1974	600	+600
1975	1,200	+600
1976	2,900	+1700
1977	3,800	+900
1978	3,800	0
1979	3,800	0
1980	3,800	0
1981	2,000	-1800
1982	100	-1900

*Figures are for consecutive construction of four power units.

Source: Georgia Power Company

warns that construction at the proposed site may be terminated after completing two units. Accordingly, projected construction employment for two units is shown in Table 7.

Table 7: CONSTRUCTION EMPLOYMENT FOR 2-UNIT POWER PLANT*

Year Ending	Total Employment	Change from Previous Year
1974	600	+ 600
1975	1,200	+600
1976	3,200	+2,000
1977	3,800	+600
1978	2,000	-1,800
1979	100	-1,900

*Figures are for consecutive construction of two power units

Source: Georgia Power Company

Workforce Sources

Based upon comparative analysis with similar Georgia Power Company construction projects and discussions with representatives of the Augusta Regional Office of the State Employment Bureau and the Augusta Building and Trade Council, the following assumptions are made regarding origin of the construction workforce. All employment levels cited are for peak construction periods.

a. The five-county study area plus Aiken County, South Carolina, can provide a majority of the skilled workforce required. These workers represent approximately one-half of the total construction workforce.

b. Approximately one-third of the workforce, composed of laborers and apprentices, will be recruited from within the study area.

c. Approximately 20 percent of the workforce will come from outside the study area. Approximately one-half of these workers are based in Savannah, Georgia--400 skilled iron workers, boiler makers, operating engineers, and sheet metal workers. Teamster workers representing approximately one percent of the workforce are based in Atlanta, Georgia.

d. Of 600 workers coming from outside the study area, approximately 40 percent will commute daily to the construction site. The remaining workers from outside the study area will move into the area.

e. Approximately 200 Georgia Power Company employees are to be transferred to the project site from other Georgia Power plant locations. These persons are expected to move into the study area during the construction period.

Impact on Labor Force, Employment, and Wages

The following impacts on tne labor force, employment, and wages within the five-county area are expected: 1) The labor force will increase; 2) Unemployment will decrease; 3) Total construction employment will increase; 4) Some shifts in employment probably will occur; 5) Wage rates in construction employment are likely to increase.

An increase in the labor force is anticipated because a large number of construction workers will be required to complete the project. Although a sizable construction force is already available in the Augusta area, certain crafts, such as boiler makers, operating engineers, iron workers, and sheet metal workers are located in Savannah, Georgia. Consequently, most of these workers will come from the Savannah area. Other shortages in skills will be met by former residents returning to join their families, as well as other workers moving into the area. An estimate of the number of workers required for each construction craft is shown in Table 8.

Table 8: CONSTRUCTION CRAFTS REQUIREMENTS

Craft	Number Required
Carpenters	504
Ironworkers	288
Pipefitters and Plumbers	720
Millwrights	96
Electricians	420
Boilermakers	96
Painters	120
Operating Engineers	264
Laborers	612
Brickmasons	96
Cement Masons	96
Sheet Metal Workers	96
Asbestos Workers	96
Teamsters	96
	3,600

Source: Georgia Power Company

Unemployment within the five-county region should be reduced as a result of power plant construction. Unemployed skilled construction workers now living in the region will seek employment on the project. Unemployed persons having no previous construction experience but who are qualified for apprentice training probably will seek construction employment. Also, some unemployed persons not qualified for apprentice training, but willing to work in unskilled jobs are likely to be employed on the project.

Because the project will pay relatively high wages, some persons now working in other industries are expected to shift to construction work. Such shifts are likely to be from industries now paying low wages (Table 5). Primarily among these industries are the following:

a. Agricultural Services - All agricultural workers except self-employed persons.

b. Manufacturing - Logging workers and sawmill operators.

c. Retail Trade - Employees of general merchandising establishments, eating and drinking establishments, food stores, and gasoline service stations.

d. Services - Employees of hotels, tourist courts, lodging places, laundries and dry cleaning plants.

When persons shift to construction jobs, vacancies will require replacements in most instances. These replacements may come from unemployment rolls, vocational and trade schools, or from areas outside the five-county region. Although such shifts may be a problem for affected industries, the overall effect on the region should be beneficial for the following reasons: 1) Many residents will receive higher wages;

2) Unemployed persons will obtain employment; and 3) New labor resources will be brought into the region.

A major impact on wages is likely to occur in both construction and non-construction activities. Non-construction employers will increase wage rates in order to retain existing employees or to obtain replacement employment for those shifting to construction work. Non-union construction workers now working at rates lower than union scales will be drawn to the power plant project because it offers better wages. Employers in such instances will have to compete with the power plant for replacement workers. Consequently, wage rates for most construction activities within the region probably will increase.

Analysis

The availability of construction workers in the area was determined from U. S. Bureau of Census Data and by interviewing local officials of the Georgia Department of Labor and Augusta Building and Trades Council. From these sources, it was determined that a large number of construction workers are already available in the area or are willing to return to Augusta when suitable construction employment becomes available. About 1,500 skilled and 1,300 unskilled workers are available for construction work.

Industries affected by shifts in employment were determined from U. S. Bureau of Census Data on payroll and employment. These census data by county showed the total number of employers and total payroll for each industry category and each component group within these categories. Using these two figures, the average amount an individual receives each week in his present job was computed. This average figure (Table 4) was compared with estimated average weekly wages to be paid construction workers (Table 5). Those employees paid considerably lower wages than those for a construction project craft are likely to be attracted to construction jobs for which they qualify or can be trained. For instance, a Burke County food store employee now receiving an average of $48 per week may be attracted to a laborer's job paying $116 per week or an apprentice job paying $113 per week.

CHAPTER III

POPULATION

Construction of the Georgia Power Company's nuclear power plant in Burke County will increase the population of the five-county area. Following construction of the power plant, a decline in population is anticipated. The extent and duration of the decline will depend upon the development of new industrial and commercial activity within the area. This development can be influenced by carefully planning programs, reaching sound decisions, and taking appropriate action.

Population Projection

Several population projections for the five-county area were studied and found to be somewhat optimistic. These projections did not adequately reflect the current magnitude and direction of population movement from rural to urban areas.

A population projection was made by re-analyzing population trends and characteristics (Table 9). Data projected in Table 9 do not indicate the impact of the nuclear power plant construction project. The method used to project population is shown in Appendix I.

Impact of Construction Project on Population

In Chapter II, the construction workforce was projected for the eight year construction period. Analysis of the study area suggests several factors that will influence the residential selection of in-migrating employees, and hence the projected population of specific counties.

a. The workforce available in the study area, in terms of skills required by the construction project, and unemployment levels in the counties of the study area (See Chapter II);

FIVE COUNTY AREA POPULATION PROJECTION WITHOUT IMPACT OF VOGTLE PLANT

RATIO METHOD

County/City	1950[1]	1960[1]	1970[1]	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Burke County[4]	23,458	20,596	18,255	17,540	17,180	16,810	16,440	16,050	15,670	15,270	14,700	14,455	14,035
Jefferson County	18,855	17,468	17,174	17,351	17,660	17,760	17,870	17,970	18,280	18,190	18,310	18,420	18,540
Jenkins County	10,264	9,148	8,332	8,050	7,810	7,760	7,610	7,465	7,310	7,150	6,995	6,830	6,670
Richmond County[2]	108,876	135,601	162,437	167,130	169,550	172,030	174,560	177,140	179,780	182,470	185,215	188,010	190,830
Screven County	18,000	14,919	12,591	11,930	11,610	11,270	10,920	10,560	10,200	9,830	9,450	9,060	8,670
Five-County Area	179,453	197,732	218,789	221,600	223,070	224,070	226,130	227,710	229,330	230,980	232,665	234,370	236,100
Waynesboro[3]	4,461	5,329	5,530	5,510	5,500	5,500	5,500	5,495	5,490	5,490	5,490	5,490	5,475
Augusta[2, 3]	71,508	70,626	59,864	59,300	59,020	58,740	58,450	58,160	58,080	57,780	57,480	57,170	56,840

[1] Data for 1950, 1960, and 1970 obtained from U.S. Bureau of Census.

[2] Relative increase in Richmond County and decrease in Augusta during the years 1960 to 1970 (19.8% and -15.2% respectively) attributed to "flight to the suburbs" movement. Although a true population decline occurred in Augusta, impacting adversely on its revenue resources, it can be assumed that the County growth is reflective of Augusta's metropolitan industrial and commercial development.

[3] Population is included in County projections.

[4] The C.S.R.A. Planning and Development Commission is more optimistic in its estimate of Burke County population projections. Its considerations include such developments as three new industrial plants in Waynesboro, new plants in Midville and aggressive efforts in Sardis to attract industry as likely to allow Burke County to stop its declining population trend. Some out-migration in the black population is expected to continue for the next two decades. In-migration is anticipated by the white population. Farm population is expected to continue its decline, but not at the rate previously experienced. As marginal farms are eliminated, the farm population is expected to level out and maintain reasonable stability.

b. Road networks to the construction site (See Chapter V);

c. Proximity of major retail trade centers (See Chapter VII);

d. Availability of conventional housing and mobile home sites (See Chapter IV); and

e. The quality of public schools and the white-non-white student ratios (See Chapter VI).

Consideration of the above factors resulted in the conclusion that power plant employees moving into the study area will be strongly attracted to the Richmond County-Augusta area. It is estimated that approximately 75 percent of the in-migrating workforce (about 590 employees during peak construction periods) will locate in Richmond County. This figure includes a majority of the Georgia Power Company professional employees. Most of the remaining 25 percent (about 225 employees) will reside in Burke County, primarily in mobile homes. An aggressive community improvement program in the Burke County area is a prime factor in attracting some of the workers from Richmond County.

Comparative analysis of previous Georgia Power Company construction projects suggests that about 70 percent of the non-professional in-migrating workforce will reside in mobile homes, with the balance renting or buying existing structures. An estimate of the workers now living in the study area and the numbers of commuters and workers moving into the area are shown in Table 10.

Table 10

Workforce By Location

Year	Total Employment	Residents of Study Area*	Commuting from Outside Study Area	Total New Residents	New Residents in Mobile Homes	New Residents in Permanent Homes**
1974	630	360	30	240	30	210
1975	1,215	840	70	305	75	230
1976	2,925	2,260	185	480	195	285
1977	3,800	2,990	240	570	255	315
1978	3,800	2,990	240	570	255	315
1979	3,800	2,990	240	570	255	315
1980	3,800	2,990	240	570	255	315
1981	2,000	1,495	120	385	130	255
1982	100	0	0	100	0	100

*Includes five-county study area and Aiken County, South Carolina

**Includes 200 Georgia Power Company employees resident throughout the construction period (1974-1981). During subsequent years, Georgia Power will maintain about 100 operating personnel at the plant.

Workforce Population Impact

Georgia Power Company estimates the size of the average construction worker family to be 3.75 persons. According to the 1970 U.S. Census of Population, the average family size for the five-county area (less Richmond County) is 3.14 persons. A study conducted by the Tennessee Valley Authority at their Paradise Power Plant construction site found the average size of a TVA construction worker's family to be 2.75 persons.

Although it seems large, the Georgia Power Company's estimate of family size was considered the most nearly accurate estimate available at this time and was used throughout the study. The projected new resident population is shown at Table 11.

Table 11

PROJECTED NEW RESIDENT POPULATION

Year Ending	New Resident Employees	Georgia Power Company Factor (3.75)	Burke County	Richmond County*
1974	245	915	205	710
1975	305	1,140	265	875
1976	480	1,795	465	1,330
1977	570	2,125	565	1,560
1978	570	2,125	565	1,560
1979	570	2,125	565	1,560
1980	570	2,125	565	1,560
1981	385	1,440	360	1,080
1982	100	375	75	300

*70 percent of construction workers and 80 percent of Georgia Power Company employees will reside in Richmond County (See Table 13).

As discussed earlier and shown in Table 9, trends in population in the rural counties of the study area have been downward for the past thirty years. The construction project can be expected to slow down, but not stop this population trend.

Because only Burke and Richmond Counties will receive a significant number of new residents, population increases associated with the plant have been estimated only for these two counties (See Table 11). Population increases anticipated during the construction phase of the power plant project have been incorporated into new projections and are shown at Table 12. This new projection is not to suggest that portions of the in-migrating workforce will not reside in Jefferson, Jenkins, or Screven Counties, but that their numbers will be relatively insignificant.

When considering population projections, it should be noted that a rescheduling of work periods, construction delays due to production problems, on-site or off-site labor difficulties, and poor weather are a few of the difficulties which could alter these projections.

Analysis

Current population projections (Table 9) suggest only a modest increase in total population for the five-county area. Two factors--the national decline in rural population and the selection of Burke County as the power plant site--are important to an evaluation of the impact of the plant on rural areas.

First, the decline in population experienced during the period 1940 to 1970, for the four rural counties of the study area, can be attributed to the movement of the rural population to metropolitan areas in search of employment opportunities. The decline in population of the rural counties should be temporarily slowed down by the power plant construction project. At some future date, a "lowest plateau", or that

Table 12

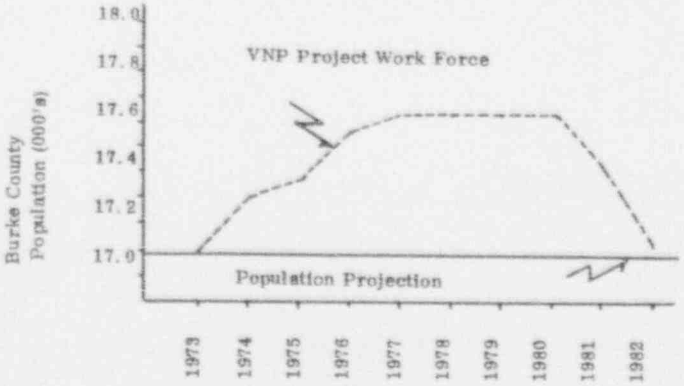
Burke County and Richmond County
Population Projection
Including Impact of Vogtle Plant[1]

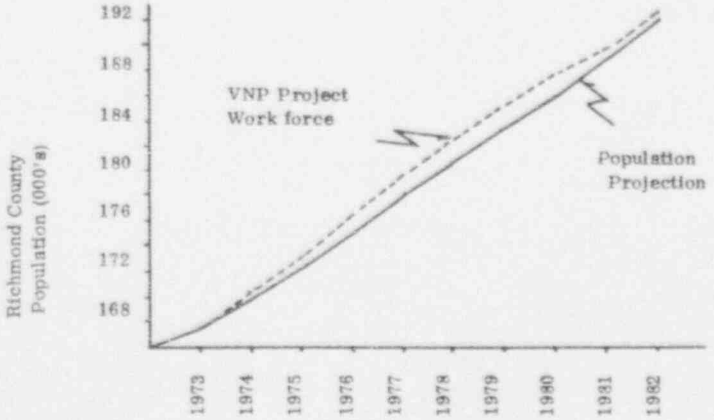
County	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Burke County	17,180[2]	17,180[2]	17,180[2]	17,180[2]	17,180[3]	17,180[3]	17,180[3]	17,180[3]	17,180[3]	17,180[3]
Power plant personnel and their families[3]		205	265	465	565	565	565	565	360	75
Total Burke County	17,180	17,385	17,445	17,645	17,745	17,745	17,745	17,745	17,540	17,255
Richmond County	169,550	172,030	174,560	177,140	179,780	182,470	185,215	188,010	190,830	193,710
Power plant personnel and their families[3]		710	875	1,330	1,560	1,560	1,560	1,560	1,080	300
Total Richmond County	169,550	172,740	175,435	178,470	181,340	184,030	186,775	189,570	191,910	194,010

[1] Data derived from projection at Table 1. Analysis of impact on study area supported conclusion that population increases in Jefferson, Jenkins, and Screven Counties will be nominal. These three counties can, therefore, anticipate some retardation of their current downward population trend as a result of the power plant construction project.

[2] The power plant construction project is expected to stop the existing downward trend in Burke Counties population projection. This tendency will cease when the construction project is completed in 1982, unless other unforeseen development activity is initiated in that county.

[3] Derived from data in Table 6.





point at which desiring rural occupants will have moved to urban areas, will be reached. Stability with modest increases in population can be expected.

Current Congressional interest in rural development, sponsored by Senators Herman Talmadge, Jr. (D-Ga) and Hubert H. Humphrey (D-Minn) may improve the living standards of the population in rural areas, but will not stop the exodus. The program cannot be expected to cause a rush to rural life from urban areas, and, therefore, at best, should provide only a degree of stability to the existing population.

Second, construction of the nuclear power plant in Burke County will result in a modest increase in population. For this population change to be permanent and economically beneficial, efforts to attract new industries and related commercial activity should continue. If not, a population loss can be anticipated following the construction period.

The population projections used in this study reflect no increase in population, with the exception of Richmond County and the small temporary increase in Burke County, during the power plant construction period (1974 to 1982). Unless new factors are introduced, the "lowest plateau" discussed earlier is expected to be reached sometime following the construction period.

The population projections included herein portray only the probable direction and magnitude of the population impact under present conditions and those reasonably anticipated. From these projections, it is obvious that the population impact resulting from construction of the Vogtle Nuclear Plant is expected to occur in Richmond and Burke Counties.

Chapter IV

HOUSING

This section includes an inventory of the housing available in the study area. Housing characteristics considered were the number of available rental units, the median rental price, the number of houses for sale, the median sales price, and a survey of mobile home parks, their locations and services both in Richmond and Burke Counties.

Identical criteria were applied to the counties in order to determine substandard housing structures. Plumbing facilities was the primary standard used to classify available permanent housing. If a dwelling unit contained inadequate plumbing facilities, it was considered to be substandard for incoming construction workers.

Because of restrictions in location, community facilities, housing quality and housing availability, this analysis has excluded consideration of Jefferson, Jenkins, and Screven Counties.

Permanent Housing

Burke County

Medium to high quality housing is scarce in the unincorporated areas of Burke County. About 206 housing units are available for sale or rent in Burke County; however, about 133, or two-thirds of these units, are substandard. Presently, 1,678 out of 2,568 total rental units, or 65 percent, are substandard and have a median rent of below $30 per month. A total of 24 dwelling units are listed for sale, of which only 19 have plumbing. There are about 6 standard units available to incoming construction workers. The median price for housing was not available.

One-third of all housing units in Burke County are located in Waynesboro, where there is also a scarcity of quality housing. Recent estimates indicate that 44 percent of the housing units in Waynesboro are substandard. Available data also shows 60 rental units available at a median rent of $43 per month. In 1970, 11 single family homes were listed for sale at an average sales price of $9,200.

Richmond County

Adequate opportunities for housing, both in terms of quantity and quality, appear to be present in Richmond County. Numerous single-family subdivisions are located in the southern portion of the county. These residential subdivisions are located primarily along Windsor Spring Road, Rozier Road, and Meadowbrook Road. New housing starts are particularly in evidence along Meadowbrook Road. Apartment complexes are also found in this area. Most are located on Windsor Spring Road. All of the residential subdivisions and apartment complexes have excellent access to major highways, particularly Georgia 25 and Georgia 56. Both of these routes give adequate access to the construction site.

As of 1970, 2,480 units were listed for sale or for rent in Richmond County. Housing units available for rent total about 1,800. Only 10 percent of the renter-occupied units were considered to be substandard. Median rental cost for Richmond County was $64 to $75 per month. As many as 630 single-family houses were listed for sale. The average single-family house sales price was $17,200.

Evaluation of Permanent Housing

If the housing picture remains static, estimates are that 70 percent of the new resident construction workers with families will locate in Richmond County (see Table 13). Assuming that 30 percent of the new resident construction workers choose to rent or to purchase housing, the initial construction year will bring 170 families into the Richmond County housing market. Considering the new housing and apartment starts in Richmond County, the initial impact of the project can be easily absorbed. A continued influx on this section of the housing market can be expected until 1977. At that time, the peak housing demand in Richmond County (about 240) will be reached and will taper to 200 by 1981. In 1982, this figure is expected to decrease to 80 families, which represents Richmond County's share of the permanent employees of the power plant facility.

Although rental costs are higher in the Richmond County area, the range of housing types and choices is much greater. With relatively high wages, most construction workers can afford the better housing offered in Richmond County. In addition, available services and community facilities are superior.

Burke County can expect to receive 30 percent of the rental and purchase housing market. In 1974, about 45 new families will seek residences. The peak demand will be reached in 1977. At this time, as many as 70 new families will have located in Burke County, if housing is made available. This figure is expected to remain stationary until 1981. The demand for residences will then drop slightly to about 55 families. Completion of the project in 1982 will further decrease the number of families to about 20. The present supply of available

Table 13

New Residents
Permanent Housing

	BURKE COUNTY			RICHMOND COUNTY		
	New Residents	Ga. Power Residents*	Total	New Residents	Ga. Power Residents*	Total
1974	5	40	45	10	160	170
1975	10	40	50	20	160	180
1976	25	40	65	60	160	220
1977	30	40	70	80	160	240
1978	30	40	70	80	160	240
1979	30	40	70	80	160	240
1980	30	40	70	80	160	240
1981	15	40	55	40	160	200
1982**	--	20	20	--	80	80

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*The 200 employees from Georgia Power Company have been added to only the designated columns. 80 percent of these employees are expected to reside in Richmond County while the remaining 20 percent will rent/purchase in Burke County.

**Of the 100 permanent employees, most are expected to either rent or purchase housing.

quality housing cannot meet the projected demand for residences in Burke County and, in particular, Waynesboro. However, new housing starts should not be initiated solely to support incoming resident construction workers, but should be closely related to long-range economic development.

Building Trade Capability

The influx of new resident construction workers seeking housing over a 9 year period will place an increasing demand on the local housing market and the local construction capability.

Construction trends in the area appear to have followed the national pattern. Nationwide housing starts decidedly increased in the early 1960's. Since that time, climbing interest rates have contributed to the decreased number of housing starts. The decrease in housing construction was more evident in the rural counties as their populations continued to decline. However, with a less rapid increase in interest rates, housing starts have increased, especially in the southern portion of Richmond County.

Most large scale building contractors are located in Richmond County. A few small building contractors are located in the rural communities. Many of the small construction firms purchase building licenses on a project-by-project basis. The work force of many of these companies varies with the time of the year and the fluctuation of bank interest rates.

Some of the rural building contractors may experience difficulty in obtaining both skilled and unskilled labor during the peak construction periods of the nuclear plant facility. The attractiveness of high wages offered by the nuclear power plant project will tend to divert the locally available trade skills. In this case, those incoming workers desiring to build homes will be forced to seek contractors in Augusta or Savannah, where contractors adequate to meet the housing demand are available.

Mortgage and Construction Financing

For the most part, banking officials in Richmond and Burke Counties appear reluctant to finance any large-scale residential construction in Burke County. The relatively short-term period of construction employment in this area was the dominant reason behind this policy. However, most bank representatives were willing to finance residential construction in Richmond County where any housing vacuum would be filled from the increasing population of the Augusta SMSA.

Mobile Homes

Existing mobile home parks, general overall capabilities of the parks, controls, tax impact, and availability of mortgage and construction financing for mobile home park development should be examined in order to determine the impact of about 260 mobile homes moving into the construction site vicinity. (See Table 14). Because mobile homes of new resident construction workers in both the Baxley and Cartersville power plant construction sites located within 50 miles of the project, the survey was limited to this radius.

Existing Mobile Home Parks

The choice of mobile home parks is more extensive in Richmond County than in all of the other rural counties. According to a 1970 Richmond County mobile

Table 14

New Residents in Mobile Homes

Year	Burke County	Richmond Co.	Totals
1974	10	20	30
1975	20	50	70
1976	60	135	195
1977	80	180	260
1978	80	180	260
1979	80	180	260
1980	80	180	260
1981	40	90	130
1982	--	--	--

home park survey, 24 parks were in operation. Monthly charges for rental spaces varied from $15 to $40, depending upon location and available park facilities. In 1970, an additional 30 proposed mobile home park developments were being reviewed by the zoning commission of Richmond County. If all 30 proposed parks are constructed, a total of 5,306 new mobile home spaces will be available for occupancy. Many of the proposed park developments are located in the southern portion of Richmond County. Some of the larger parks are located on Tobacco Road and on Morgan Road. Morgan Road connects to Tobacco Road, which joins with both Georgia 25 and Georgia 56. These state highways provide convenient access to the construction site.

A portion of new mobile home residents will locate in Burke County. During the peak construction period, 30 percent, or about 80 of the expected mobile home residents, will locate here. Few mobile home parks exist in Burke County. Those that are available do not offer services and amenities comparable to those in southern Richmond County. However, the close proximity of mobile home parks to the construction site can be expected to somewhat offset these differences.

Facilities of Mobile Home Parks

Standards established by the Federal Housing Administration and the Mobile Homes Manufacturers Association were used to evaluate the overall facilities of mobile home parks in both Richmond and Burke Counties. These standards cover water supply, sewerage, refuse pick-up, laundry facilities, storage areas, off-street parking, fire protection, and recreation facilities, and are described briefly in Appendix III.

Mobile home parks in both Richmond and Burke Counties vary in their compliance with the recommended FHA and MHMA standards. A small sampling of mobile home parks in southern Richmond County revealed that most of the newer parks, constructed within the last five years, provided services beyond water, electricity and sewage disposal. Some parks offered recreational facilities such as swimming pools and community clubhouses. The more modern mobile home parks often contained paved streets, street lights, and underground utilities. Newly proposed and constructed parks in southern Richmond County, for the most part, consisted of more than 50 rental spaces. The MHMA strongly recommends that mobile home parks be developed with not less than 50 spaces.

For the most part, mobile home parks in Burke County lacked the amenities and services offered by those parks in southern Richmond County. A sampling of available facilities revealed few services beyond water, electricity, and sewage disposal. All parks surveyed lacked laundry facilities, storage areas, off-street parking, recreational facilities, paved streets, and street lighting. If Burke County expects to attract new resident construction workers occupying mobile homes, mobile home parks will have to offer additional services.

Controls

At present, mobile home controls vary throughout the study area. Table 15 presents a general summary of the regulations imposed on mobile homes.

When addressing the potential for additional mobile home parks, it should be remembered that public services can best be provided to these sites if mobile homes are concentrated in a few selected areas, are regulated, and are

Table 15

Local Controls for Mobile Homes

	No Ordinance	Regulatory	Prohibitive	Allowed on Individual Lots
Burke County		x		x
Waynesboro		x		x
Jefferson County	x			
Wrens	x			
Louisville	x			
Wadley	x			
Jenkins County	x			
Millen	x			
Richmond County		x		x
Screven County	x			
Sylvania				

Note: Regulatory refers to ordinances that regulate mobile homes.
Prohibitive refers to ordinances that specifically prohibit mobile homes.

controlled. Table 16 gives a comparison of various selected requirements found within adopted mobile home park ordinances of Burke and Richmond Counties.

The State of Georgia requires a State Health Department permit for a mobile home park and for mobile homes located on individual lots. Permits are available at the local county health departments. These health permits are designed to insure the very minimum of basic sanitation standards; however, they are useless with inconsistent and irregular enforcement procedures.

Tax Problems

Residents of mobile homes often require more in government expenditures than they generate in tax revenues. The lack of financing for additional mobile home park development in Burke County will cause the major tax impact of new mobile home parks to be in southern Richmond County. Both Richmond and Burke Counties should take necessary action to assure that all mobile homes are placed on their tax digests.

Recommendations

Large scale capital investments, both public and private, in housing programs intended to attract new resident construction workers into Burke County should be discouraged. The availability of adequate standard housing units in southern Richmond County will attract the majority of incoming resident construction employees.

Large scale single-family residential subdivisions or mobile home parks in Burke County, initiated in anticipation of incoming resident construction employees, also should not be attempted. Instead, Waynesboro should encourage

Table 16

Comparison of
Selected Proposed Mobile Home Park Standards

Standard	Burke County	Richmond County
Minimum Site Size (Acres)	6	5
Minimum No. Spaces	25	--
Minimum Size Spaces (sq. ft.)	4,500	3,200
Side Yard Setbacks (ft.)	25	20
Required Recreation Area (percent)	8	10
Approved Water & Sewer	yes	yes
Street Lighting	--	yes
Refuse Collection	yes	yes
Service Building	yes	yes
Fire Protection	--	yes
Off-Drive Parking Spaces	yes	yes
Street Standards	yes	yes
License or Permit	yes	yes
Zoning	yes	yes

further development of vacant residential lots located within the municipal limits and presently served by streets and adequate utilities. New residential construction plans to accommodate additional residents beyond the few permanent employees' families should be carefully evaluated. Additional single-family housing construction in Burke County must closely parallel future employment opportunities before long-range speculative housing construction can be successful. However, if residential subdivisions are developed, they should be located in the northern area of the city of Waynesboro. Vacant land with access to Georgia 25 is available in this area. Both municipal water and sewer lines serve the adjacent residential area. Extension of water and sewer services into the vacant incorporated area would be relatively inexpensive as compared to service extensions to other areas beyond the city's corporate limits.

Mortgage and Construction Financing

Financing is available for mobile home parks in southern Richmond County sufficient to accommodate the construction employees locating in this area. However, many banks were reluctant to consider financing park development in Burke County because of the relative short duration of the construction project.

In recent years, the federal government has increased mortgage and construction loans for mobile home park development. These loans are administered through the Federal Housing Administration. Although the Farmer's Home Administration has been active in financing housing in the study area, mobile home park development currently does not qualify for this support.

Interviews were conducted with mobile home park owners of both southern Richmond County and Burke County. Owners in Richmond County, for the most part, were not willing to expand existing facilities. However, owners interviewed in Burke County expressed an interest in expansion in order to accommodate incoming construction workers.

Mobile homes should be encouraged to locate in parks having a minimum of 50 spaces to reduce the cost of extending community services. This requirement will help to insure better facilities for park residents and better profits for park owners.

Taxes on Mobile Homes

A decal system should be initiated to assure the collection of taxes from mobile homes. Each mobile home owner would be required to display a decal which can be obtained at no cost, if a current tax receipt can be produced indicating that the personal property taxes have been paid.

In Burke County, mobile home parks should be subdivided so that spaces can be used for houses at a future date. By so doing, municipal services can serve both types of housing needs at a significant reduction in cost. Vacant tracts of land are available for such parks both within and adjacent to the city of Waynesboro. One area is located immediately east of the city limits on Georgia 56.

Chapter V

TRANSPORTATION

The five-county area is served by excellent transportation systems offering various transportation services to the region. Existing railroads, airports, pipelines and waterways are adequate to accommodate anticipated needs of Georgia Power Company. Georgia Power Company plans to construct a rail spur to connect the power plant site with a Central of Georgia Railroad line that runs between Augusta and Savannah. However, this location is tentative and subject to change after locational studies now underway are completed. Also, Georgia Power Company's construction plans include new dock facilities along the Savannah River. The dock facilities will be used for fuel oil and nuclear reactors transported to the site by barge. The fuel oil is to be used to power combustion turbine generators that will be operated as peaking generators. Except for their location, these generators are not related to the nuclear reactors. Barge transportation is being considered to remove spent fuel casks.

Highways and Roads

The power plant's impact will be primarily on highway and road networks. Construction workers will use their private automobiles to travel to and from work. Because most of the workers will reside in Augusta and Waynesboro, roads from these areas to the site are expected to have significant increases in traffic volumes.

Although most construction materials will be transported to the site by rail, some materials will be moved by truck. For instance, 8,000 tons of structural steel per reactor unit (32,000 tons for 4 units) will be transported to the site by truck. Also, much of the construction equipment will be moved to the site under its own power or by truck. Initially, fuel oil will be transported to the site by truck from terminals located in Augusta.

Existing and Proposed Facilities

Highways and roads within the region are predominantly two-lane primary and secondary facilities (Figure 2). Although several new freeways have been recommended for the region by previous studies, only two--Interstate Route 20 and the Bobby Jones Expressway--are under construction. Interstate Route 20, an east-west freeway located approximately 30 miles north of the power plant site, is open to traffic between Augusta, Georgia, and Columbia, South Carolina. Travel time is approximately one hour. This route provides excellent access for commuters traveling to the site from Columbia, North Augusta and other municipalities located east of Augusta in South Carolina.

Interstate Route 20 from Augusta to Atlanta is open to traffic except for a fifty-mile section between Greensboro and Thomson, Georgia. This uncompleted section is under construction and scheduled to be completed in the fall of 1972. With the completion of I-20, construction workers living west of Augusta will have excellent access to the power plant site.

Bobby Jones Expressway, an important connector, (Figure 3) is completed and in use from I-20 west to Wrightsboro Road. The section from Wrightsboro Road to Deans Bridge Road (U.S. Route 1) is under construction and is scheduled to be completed in the fall of 1973. When this extension is completed, construction

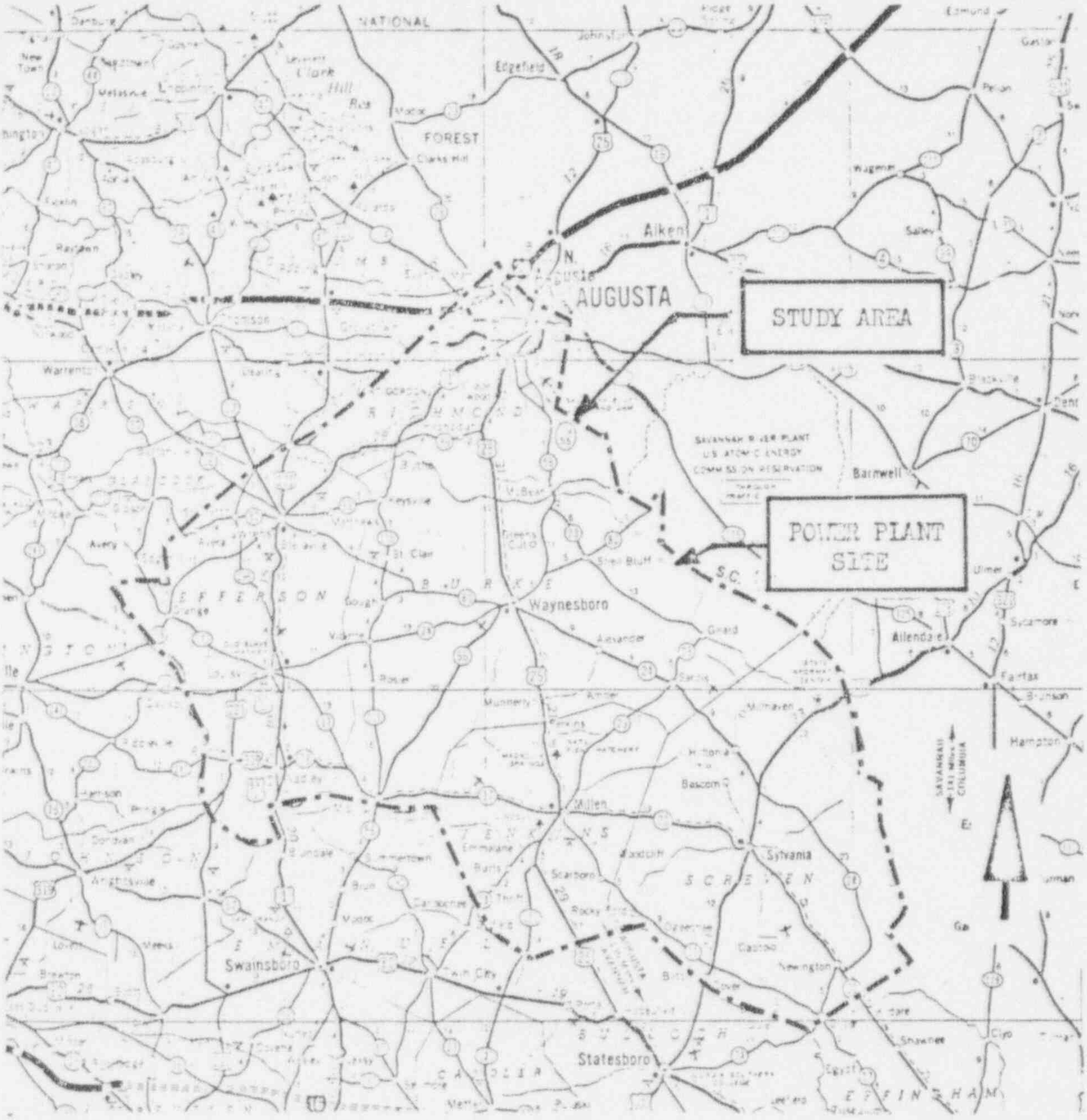


Figure 2 - EXISTING ROAD NETWORK

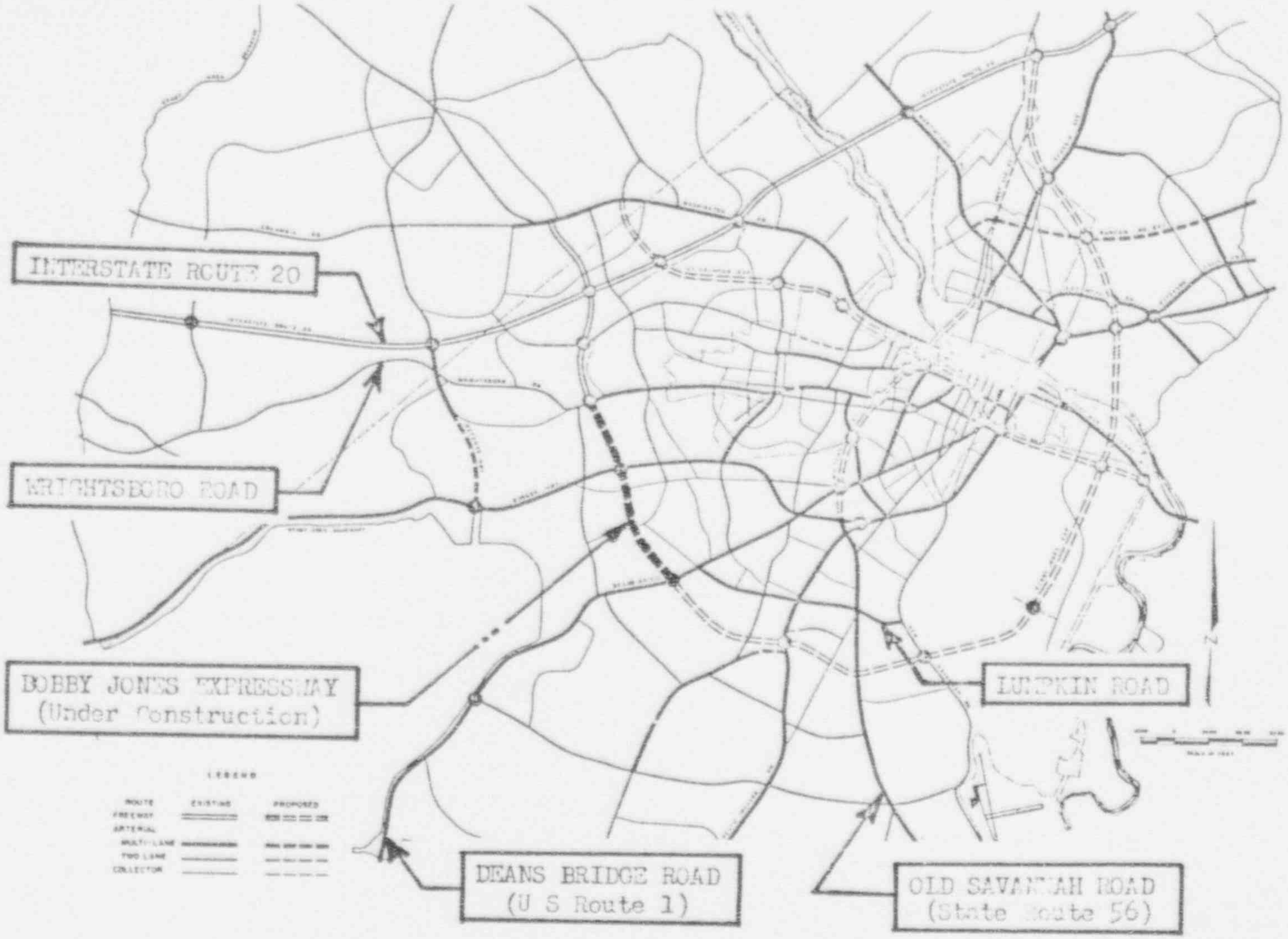


Figure 3 - AUGUSTA's PLANNED HIGHWAY AND STREET NETWORK

workers living east, west and north of Augusta can commute to the power plant site without having to travel through Augusta. After leaving Bobby Jones Expressway, workers can travel east along Lumpkin Road to Old Savannah Road (State Route 56) and then south into Burke County via State Route 56. Between 1975 and 1980, Bobby Jones Expressway is scheduled to be extended from Deans Bridge Road to New Savannah Road. Upon its completion, commuters using Bobby Jones Expressway can travel to State Route 56 (Old Savannah Road) via New Savannah Road in lieu of Lumpkin Road.

Existing paved roads within Burke County are two-lane facilities. State Routes 23, 56 and 80 are nearest the power plant site and, consequently, are expected to be used by commuters traveling to and from work. Two by-pass routes are proposed for Waynesboro but neither is programmed for construction at the present time. Also, certain street widening projects and traffic engineering improvements are proposed. These proposed improvements would appear justified because of anticipated increases in traffic volumes.

Four unpaved roads provide access to the project. Three of these roads have inadequate one-way bridges with capacities of less than six tons. The unpaved road having no bridge is now being improved to State Highway Department standards. However, paving of this road is to be delayed until power plant construction is substantially underway.

Commuters living in Jefferson County must travel through Waynesboro enroute to the power plant site. Persons living in Jenkins and Screven Counties as well as Savannah can travel to the project site via State Route 23.

Recommendations

Previous experience in the vicinity of other Georgia Power Company construction sites emphasizes the fact that good access roads should be provided to the project site before construction work begins. Such improvements should be constructed to State Highway Department standards. Failure to provide good access roads has resulted in large public expenditures for continuous maintenance and repairs on unpaved roads. Therefore, the following recommendations are made:

a. Traffic movements within Burke and Richmond Counties should be studied to determine what existing facilities need improvements to accommodate anticipated increased traffic volumes.

b. A minimum of two paved access routes should be provided between State Route 23 and the power plant site. Recommended route locations are shown in Figure 4. These routes should be constructed to State Highway Department standards including final paving. Initially, one road will be adequate to serve the project site. However, both roads should be completed prior to the time construction employment reaches its peak in 1977.

c. Street widening and traffic engineering improvements recommended in the 1970 Waynesboro Transportation Study should be carried out.

d. At least one of the proposed by-pass routes around Waynesboro should be constructed.

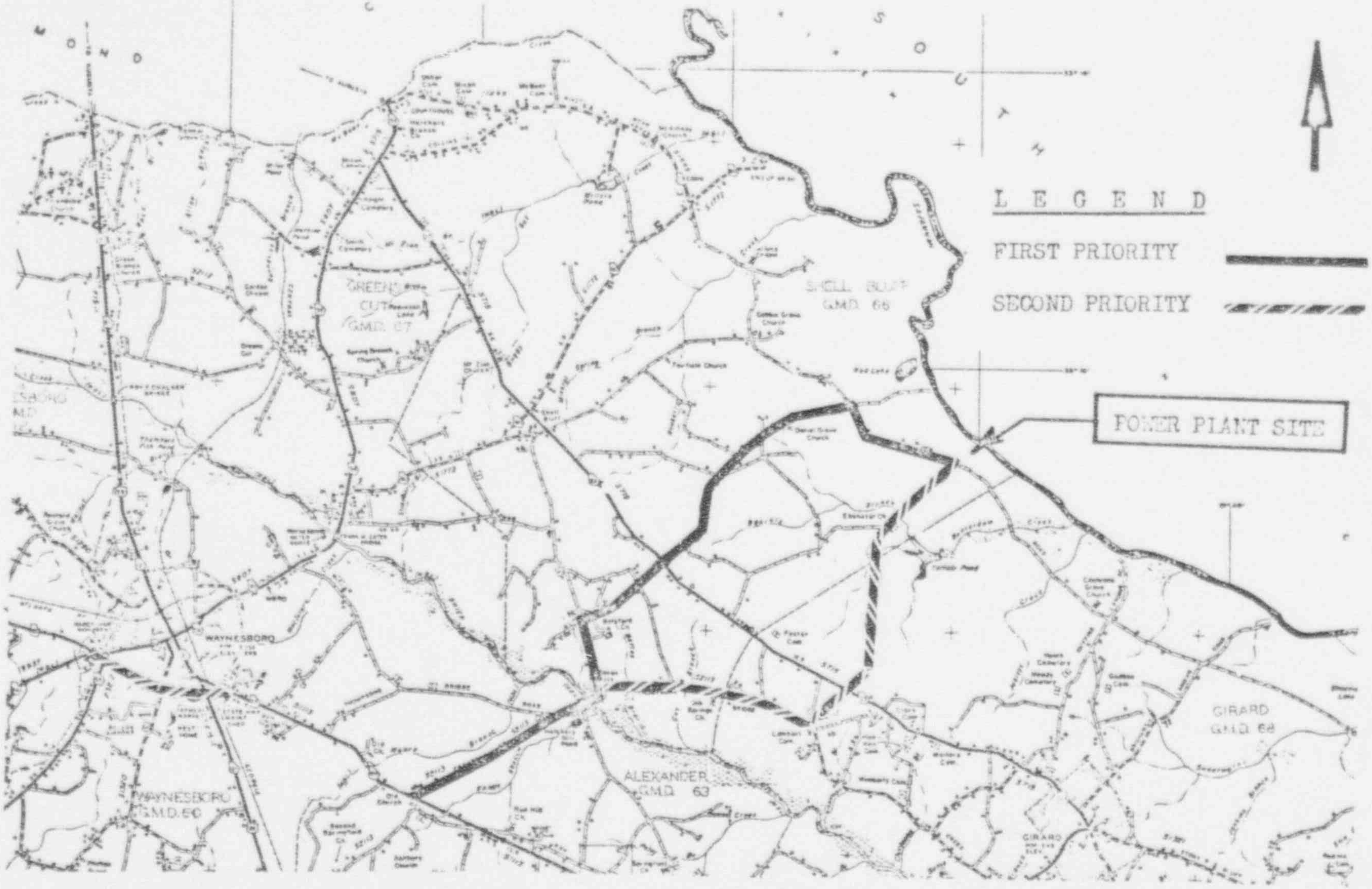


Figure 4 - RECOMMENDED HIGHWAY IMPROVEMENTS IN BURKE COUNTY

Chapter VI

COMMUNITY FACILITIES

This portion of the impact study is concerned with evaluation and development of community facilities. The purpose of this chapter is to provide a basis [illegible] developing policies for the improvement of public services and facilities. Existing community facilities are analyzed and evaluated in light of anticipated future growth patterns.

Educational Facilities

This section of the report addresses the estimated number of additional students expected to attend schools within the Burke County areas as a result of the Vogtle Nuclear Plant construction project.

Figure 5 shows the location of existing educational facilities in Waynesboro. Additional public education facilities are located at Sardis and Girard.

Estimated Additional Students

The influx of new students into the Burke County area will generally correspond with the influx of workers to the nuclear power plant. An examination of the projected employment figures (Table 10) shows a steady increase from 1971 to 1977. Peak employment levels will be maintained for approximately four years. Thereafter, there will be a rapid decrease in the workforce until 1981, when the operating level of employment is reached. The influx of students into Burke County will follow a similar pattern, with a peak of approximately 200 students being reached in 1977.

Figure 5

SCHOOLS:

1. Waynesboro Elementary
2. Blakeney Elementary
3. Blakeney High School
4. Waynesboro High School
5. Edmund Burke Academy (Private)

WAYNESBORO, GA.

NO SCALE

N

Existing Facilities

The Burke County Board of Education operates all public schools in the Burke County area. These schools are: Waynesboro Elementary School; Blakeney Elementary School; Blakeney Junior High School; Waynesboro High School; Cousins Elementary School; Gough Elementary School; Guard Elementary School; Palmer Elementary School; S. R. Dinkins Elementary School; and S. G. A. High School. The public school system has a total enrollment of approximately 4,500 students. Currently 82 percent of the students are Negroes. This relatively high percentage is attributed to the transfer of white students to Edmund Burke Academy in Waynesboro, and to a general decline in white population throughout the county.

Edmund Burke Academy is a racially unrestricted, private facility having an estimated enrollment of about 628 students. At present, it is not accredited by the State. Annual tuition is $450.00 for the first child, $350.00 for the second, and $250.00 for each remaining child in the family. A rate increase is scheduled for the next school year. Substantial improvements both in its program and its physical plant are needed.

Table 17 identifies each school, the grades taught, and its estimated capacity.

Evaluations

Table 17 compares the existing capacity of school facilities within Burke County to the projected influx of new students. Most of the additional new students can be absorbed by the schools in the Waynesboro area. If this occurs, no major

Table 17

School Capacity Data: Burke County
1971-1972

School	Grades	Present Attendance	Estimated Capacity	Estimated Space for Accommodating Student Influx
Waynesboro Area Schools				
Waynesboro Elem.	1-3	690	898	208
Blakeney Elem.	4-6	625	1,250	625
Blakeney Jr. High	7-9	695	1,085	390
Waynesboro High	10-12	625	440	0
[1] Edmund Burke Academy	1-12	628	*	*
Other Schools in County				
Cousins Elem.	1-6	320	350	30
Gough Elem.	1-7	295	400	105
Girard Elem.	1-8	311	300	0
Palmer Elem.	1-8	232	225	0
S.R. Dinkins Elem.	1-8	286	400	114
S.G.A. High School	7-12	365	525	160
Total		5,072	5,873	1,632

[1] Private School

*Information not available

Source: Georgia Education Department, Statistics of Research Division and C.P. 612 Interviews, Winter 1972.

problems are anticipated. Proper planning and efficient use of existing classroom space will minimize any difficulties experienced.

Recommendations

The current educational problem areas of Burke County and Waynesboro will have a significant impact upon the selection of residences by in-migrating workers. Burke County should encourage workers to live near Waynesboro as schools in this area can most easily accommodate new students. Any overcrowding of a facility can be remedied by using portable classrooms.

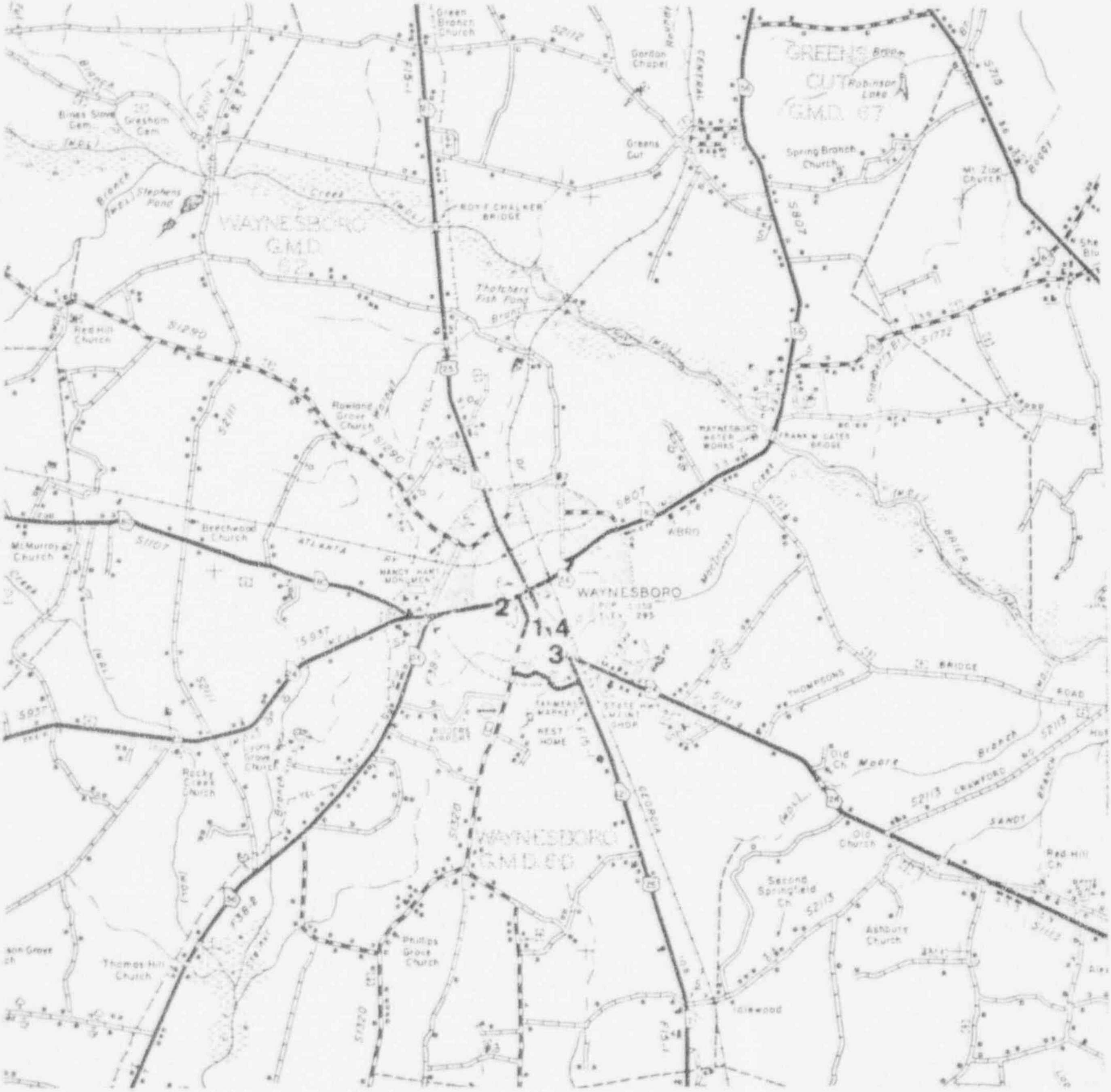
Burke County should improve the quality of its school system by: increasing teacher salaries; reducing student/teacher ratios; improving programs; and rehabilitating older facilities. With improvements such as these, the public schools should attract white students back into the system and thus reduce the non-white/white ratio of enrollment.

Parks and Recreation

The provision of recreation programs and facilities in Burke County is the responsibility of the Waynesboro-Burke County Recreation Commission, with a Director of Recreation appointed to administer the program. This program is funded jointly by the City and County, with the City of Waynesboro providing the bulk of the $32,000 annual budget.

Existing Facilities

Figure 6 shows the location of existing recreational facilities in Burke County. Recreation Commission and city-owned recreation sites include the



PARKS:

1. Liberty Street Park
2. Sixth Street Park
3. Jones Lake
4. Exchange Club Park

WAYNESBORO, GA.

NO SCALE

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Figure 6

Liberty Street Park (2 acres) and the Sixth Street Park (1.5 acres). Liberty Street Park is an attractive area south of U.S. 25 with some playground equipment and the only paved, lighted tennis court available in Burke County. The Recreation Commission is now developing a new recreation facility on a 6.8 acre tract owned by the Waynesboro Housing Authority. It is located north of East Eighth Street and west of Davis Road and includes lighted, multiple-use, hard surface courts, swimming pool, community center, playground facilities for young children, a lighted softball-little league field, full-sized football field, a sandlot baseball field, and off-street parking facilities.

Other recreation facilities operated by the Recreation Commission include the Exchange Club Park, the National Guard Armory, and a 15-acre site owned by Mr. Henry Hopkins. The Exchange Club Park has two lighted ballfields on a 3 acre site plus portable bleachers. Most of the existing little league and men's softball league programs are played on this field. Lighting is for football and is improperly located for baseball and softball programs. The Georgia National Guard Armory has a gym facility available for recreation league basketball games. The 15 acre site owned by Mr. Hopkins is used for summer day-camp, outdoor basketball, and baseball programs. Because this site is owned privately, it must be considered as only a temporary facility.

Other recreational facilities include a swimming pool on Jones Road, a nine-hole golf course and country club, one 412 seat indoor theater, and a 300 car drive-in theater.

Evaluation

Presently, the Recreation Commission owns or controls approximately 28.3 acres of recreation areas, which meet the demands of the present population. The programs appear to serve the community adequately, but may need some modification in the future.

Recommendations

The immediate impact of the Vogtle Nuclear Plant on the recreation program in the Waynesboro area will not be significant. With an eye to the future, the Recreation Commission should begin updating existing programs and modernizing facilities. Emphasis should be placed on improvement of recreational programs. Additional recreational sites and facilities should then be obtained, with the eventual establishment of a county-wide recreational program. Consideration should be given to the use of portable equipment to meet temporary recreational needs in selected areas.

Public Utilities

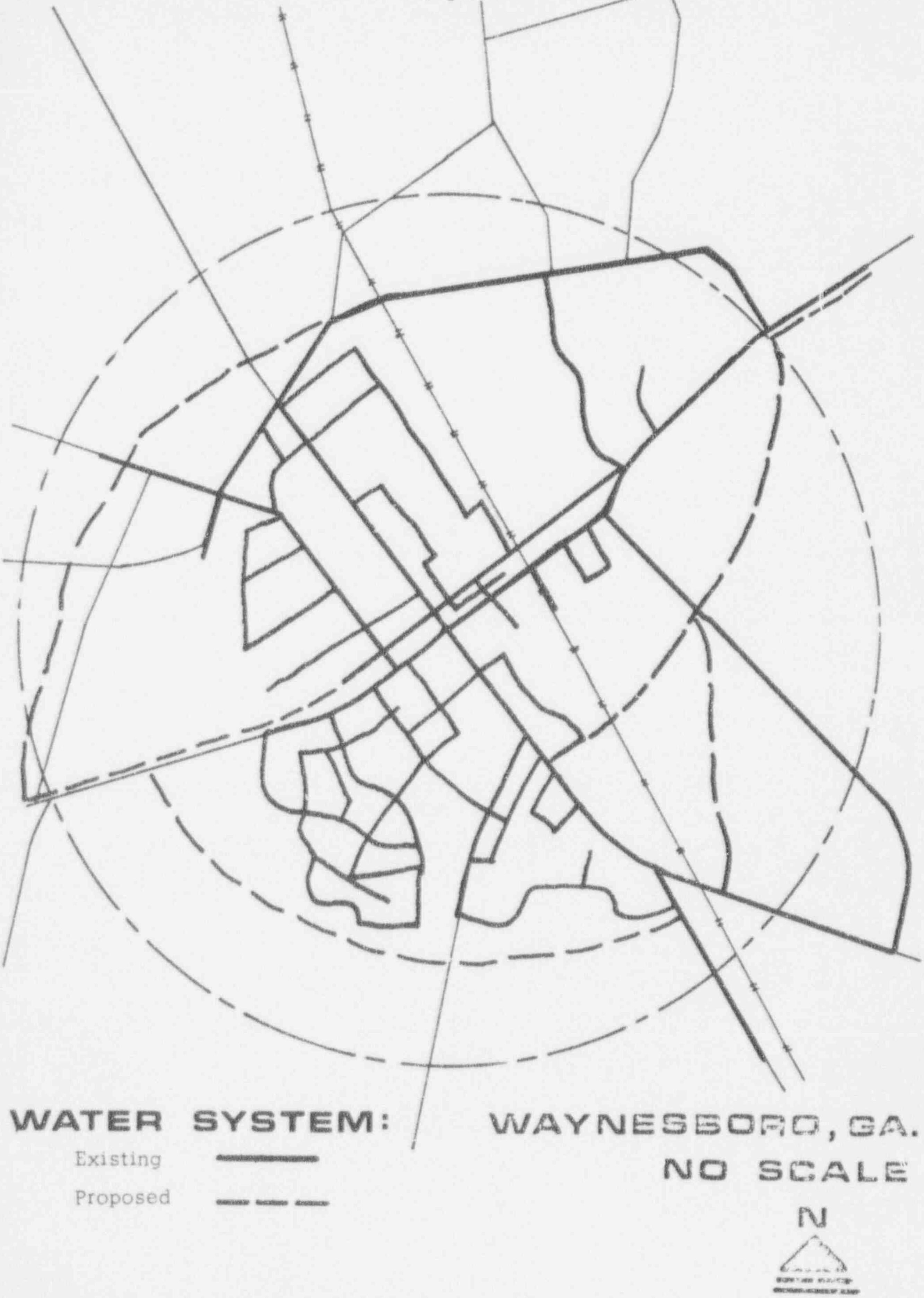
Public utilities include electrical power distribution, natural gas distribution, public water supply and distribution, and the collection and disposal of sewage effluents. With proper planning, the extension of these services can become a useful tool in the control of development in the immediate vicinity of Waynesboro.

Figures 7 and 8 show the location of the water and sewer plants in Waynesboro and give an indication of primary service lines in the immediate area.

Existing Facilities

Electric power is distributed in Waynesboro by the privately owned and

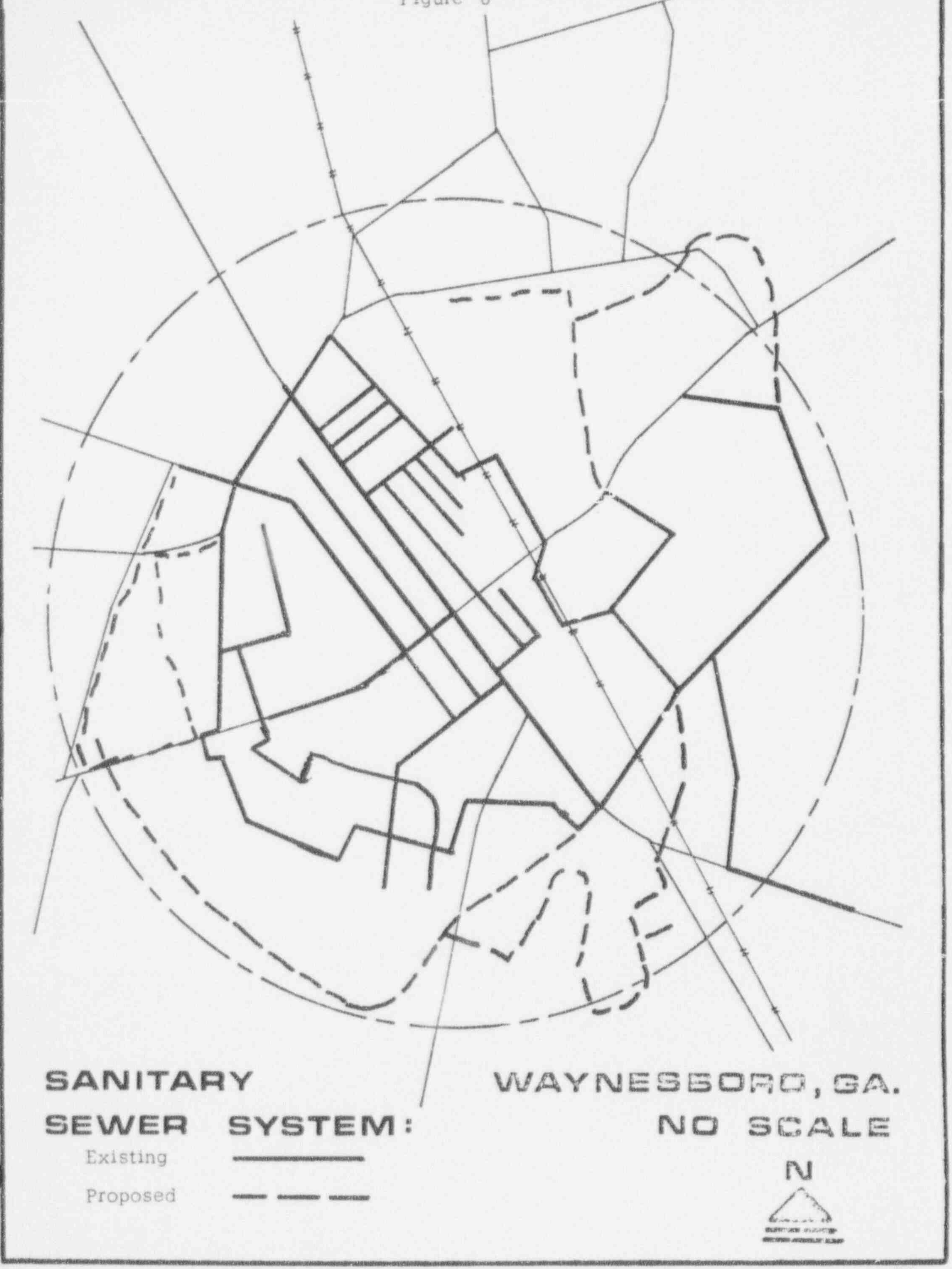
Figure 7



WATER SYSTEM: WAYNESBORO, GA.

NO SCALE

Figure 8



SANITARY SEWER SYSTEM: WAYNESBORO, GA.

NO SCALE

operated Georgia Power Company. It serves the city with four 46-KV and two 115-KV transmission lines. The primary substation transformer bank is rated at 20,000 KVA and has a recorded peak demand of 6,000 KVA.

Natural gas lines are located throughout the area and appear capable of meeting any needs generated by new residents moving into the region. However, natural gas is not available for new industrial users requiring large quantities. Liquified petroleum, commonly called propane, serves household and commercial users not located on natural gas lines and those requiring standby capacity. Propane gas distributors serving the region should be able to meet all demands by new residents in the area.

The Waynesboro water supply is obtained from Brier Creek, located 3.8 miles northeast of town and having a recorded minimum flow of 70 million gallons per day. The water filtration and treatment plant has recently been updated to an operating capacity of 2 million gallons per day. The present average consumption in Waynesboro is 700,000 gallons per day. Ninety-five percent of all buildings in Waynesboro are served by the water system. The County has no water system.

Sewage disposal for the Waynesboro sanitary sewerage system is accomplished by an oxidation-filter-type disposal plant located in the southeast portion of the city adjacent to McIntosh Creek. This facility can treat 1.25 million gallons of sewage per day, but handles 1.5 million gallons per day during wet weather. Because of the high infiltration rate in certain older portions of the collection system, the sewage treatment plant is by-passed and the effluent goes directly into McIntosh Creek. Approximately 90 percent of the city's residents are served by this system.

The County has no sewage system.

Evaluation

The new improvements at the Water Treatment Plant and the Sewage Disposal Plant and the proposed relaying of certain lines will update them sufficiently to meet all sewerage and water demands for the period of construction estimated for the nuclear power project. Electrical service in Waynesboro is adequate for the construction period.

Recommendations

The city should continue its program of improving facilities inside the city limits to attract new residents. Careful planning will determine where and when new facilities are needed. The extension of public utilities should be used as a planning tool to attract new residents to areas that are ready to be developed, while controlling development in fringe areas.

Police Protection

The construction of the Vogtle Nuclear Plant will create several law enforcement problems for Burke County and Waynesboro. The large influx of community workers, limited law enforcement personnel, and the physical location of the plant present special problems that must be faced by law enforcement agencies if adequate police protection is to be provided.

Existing Facilities

The Waynesboro Police Department and the Burke County Sheriff's Department are responsible for the protection of life and property, the prevention and detection of crime, and general regulation of public conduct in Waynesboro and

Burke County.

The Waynesboro Police Department is located in the rear of the City Hall structure. It includes several offices and locker facilities plus a jail facility with a capacity adequate for ten prisoners. The facilities were constructed in 1968, and include sufficient space to expand to a capacity of 20 prisoners. A personnel strength of nine is maintained, including the Police Chief. Continuous 24-hour patrol operations exist, utilizing four mobile patrol units, and one vehicle for the Chief's use. A base station radio provides unbroken communications with the police cruisers. The local communications net monitors the Georgia State Patrol frequency.

The Burke County Sheriff's Department is located on Liberty Street in Waynesboro, in a 36 year old building. The Department is responsible for police protection in the county. They employ 5 officers, including the Sheriff and have 4 duty automobiles. A radio base station is operated from 12-16 hours per day, with a capability to monitor the net of supporting law enforcement agencies.

The Georgia State Patrol regularly patrols State Highways 25 and 80 and sporadically covers approximately 95% of all public roads in the county area.

Evaluation

On the basis of the police force standards recommended by the Georgia Law Enforcement Advisory Board, Waynesboro and Burke County are presently understaffed.

The area is served by three distinct law enforcement agencies--Burke County Sheriff's Department, Waynesboro Police Department, and the Georgia

State Patrol. Some cooperation exists between these bodies, but generally their jurisdictions are restricted by municipal and county boundaries.

Recommendations

The impact of the Vogtle Nuclear Plant will generally be felt in increased traffic on major roads in Burke County from commuting workers. The Georgia State Patrol should be consulted on the feasibility of increasing patrols on heavily used roads to deal with the expected increase of vehicular movement due to the construction project. The Burke County Sheriff's Department should consider the feasibility of directing traffic at key intersections during peak traffic hours.

Methods of coordinating city, county, and state police forces to better serve the anticipated increase should be evaluated by city and county officials according to service needs and availability of funds.

Waynesboro and Burke County should use funds to first strengthen the law enforcement programs and then to update physical facilities. More men, better training, and new equipment are areas of concern that should be addressed early.

Fire Protection

Included under fire protection are the programs of fire fighting and fire prevention. An effective prevention fire program is an essential service for any developing area, in that it protects human life and property and reduces insurance rates.

The Waynesboro Fire Department employs four full-time firemen, including the Fire Chief, and has 18 volunteers that are available to respond and support the department during alarms. Local firemen actively engage in the following activities during bi-monthly drills: fire hydrant testing and maintenance, vehicle maintenance, and life saving first aid techniques. The Fire Department operates from the public safety-city hall structure. Two fire engines, living quarters, and office facilities are located there. Currently, the Department is limited to serving an area within a three-mile radius from the center of Waynesboro. Under special circumstances, such as endangered human life, the department can go farther into the county. The American Insurance Association (AIA) rating for Waynesboro is Class 6.

The county currently has no fire fighting equipment or facilities. Limited protection is available from the State Forestry Department.

The existing facilities should be adequate to serve the needs of the workers that locate within the three-mile radius of the city. However, if large parks of mobile homes should develop outside of this area, some problems are anticipated.

The updating of equipment and facilities should continue under the program outlined in CSRA's Community Facilities Plan for Waynesboro. Special emphasis should be placed on the development of a fire prevention program centering on building codes and fire prevention standards for all buildings.

In the future, with increased development in rural areas, serious consideration should be given by the county to fire protection for these residents. This could be in the form of a contract with the city, or development of the county's own facilities.

Public Health

Health facilities include preventive medicine programs, hospitals, and other medically related functions. Figure 9 shows the location of these facilities.

Burke County Hospital, located in Waynesboro on an eight-acre site, is a public hospital with accommodations for 52 bed patients. In addition to general hospital facilities, special equipment available includes x-ray, electrocardiogram, diathermy equipment, metabolic testing equipment, a laboratory, and a chapel. The staff includes five physicians, including a surgeon, three dentists, and seven registered nurses. Nine physicians and two dentists maintain practices in the Waynesboro area.

The Burke County Health Department is staffed by two registered nurses, six part-time doctors, a secretary, and a sanitarian. It is located in a one-story building directly behind the County Hospital. The department holds maternal, well-baby, child health, family planning, dental, immunization, and T.B. clinics.

The city-county now has in operation a county-wide ambulance program, consisting of two ambulances that serve the entire county on a 24-hour call basis.

The Burke County Hospital and the Burke County Health Department have modern facilities and up-to-date programs which serve the needs of the area residents. The excellent medical facilities in the Augusta area preclude the need

Figure 9

PUBLIC FACILITIES:

1. Public Library
2. Public Health Building

WAYNESBORO, GA.

NO SCALE

N

for extensive development of hospital and health services in the immediate vicinity of Waynesboro.

The recommendations by CSRA in its Community Facilities Plan for Waynesboro should be followed. In addition, some arrangement should be made for the treatment of emergency cases that may arise at the construction site, and a disaster plan for large scale accidents should be formulated.

The regulation of mobile home developments should be closely exercised to assure strict adherence to high standards of environmental sanitation. This enforcement is the responsibility of the County Sanitarian, a position that will require much effort to stay in step with the development that is expected in the future.

Library Facilities

The Burke County Library will find that the influx of the new families associated with the construction of the nuclear power plant will create new demands on the present facility and programs.

Figure 9 shows the location of the Library in Burke County.

The Burke County Library is housed in an attractive, air-conditioned building located in Waynesboro on West Fourth Street, behind the Burke County Hospital. It contains approximately 10,000 volumes on 2,100 lineal feet of shelving in 3,603 square feet of floor space. The service area of the Library has an estimated population of 20,000. Parking space is limited at the Library. Use of the Library facilities has been increasing rapidly in recent years, primarily because of an increased awareness by the public.

Table 18 presents the suggested guidelines for minimum library space requirements of the American Library Association. According to these standards the Burke County Library in inadequate.

Generally, the suggestions made in the 1970 CSRA Community Facilities Plan for Waynesboro should be implemented. In addition, some thought should be given to subscribing to various trade journals that may be of particular interest to the incoming workforce.

Table 18

Guidelines for Minimum Library Space Requirements

Burke County Library 1970

Waynesboro, Georgia

Served	Size of Book Collection	Shelving Space Linear Feet of Shelving	Reader Space	Staff Work Space	Total Floor Space
(1970) 20,000 Pop. excluding Midville Area	20,000 vol. plus 2 bks. per Capita for pop. over 10,000	2,500 linear ft. Add 1 ft. of shelving for every 8 bks. over 20,000	Min. 1,200 sq. ft. for 40 seats Add 4 seats per M over 10,000	1,000 sq. ft. Add 150 sq. ft. for each full time staff member over 7	7,000 sq. ft. or 0.7 sq. ft. per Capita, whichever is greater
Requirement	20,000 vol.	2,500 lin. ft.	2,160 squ. ft.	1,000 sq. ft.	12,700 sq. ft.
Existing	10,000 vol.	2,100 lin. ft.	840 sq. ft.	210 sq. ft.	3,603 sq. ft.
Deficit	10,000 vol.	400 lin. ft.	1,320 sq. ft.	790 sq. ft.	9,097 sq. ft.

Source: American Library Association

Chapter VII

ECONOMY

The construction of the Vogtle Nuclear Power Plant in Burke County will have a positive effect on economic development in the five-county study area, particularly in Burke and Richmond Counties. The results of in-depth analysis and observation indicate that Richmond County will receive the majority of the short-term economic benefits during the eight-year construction period of the project. Burke County, however, will receive most of the long-term benefits, since the power plant is located in that county.

Plant Construction

Two potential areas for economic impact are associated with the construction of the plant: first, the use of locally supplied and available construction materials; and second, the employment of local labor resources. The impact of the real income derived from the payroll of the construction workforce and plant operating personnel will be discussed in a separate section.

Construction Materials

Analysis of other Georgia Power Company construction projects indicates that construction contractors procure little of their construction materials locally. Contractors acquire materials at competitive prices; for instance, lumber probably will be acquired from sources on the west coast of the United States and cement from southwest Georgia.

Georgia Power Company has furnished an estimate of the types and amounts of construction materials required (Table 19). It is doubtful that local businesses will be able to supply this construction project with volume deliveries at competitive prices. However, miscellaneous building materials and supplies currently available at commercial outlets will be purchased locally. Such purchases will not overtax existing commercial activities and do not justify expansion of existing commercial activities, or creation of new activities in the near future.

The potential for economic development of the area's natural resources was studied in detail. Construction of the Vogtle Nuclear Plant will have no significant impact on these resources. Indications are that the demand for construction materials will not significantly encourage development of the natural resources of the study area. The potential for development of many of the resources (especially timber and kaolin) exists, but the power plant construction project is expected to have no direct impact upon them. Aggregate (sand and gravel) exists in sufficient quantities and qualities for construction purposes. Whether or not these resources are utilized will be determined solely by the project contractors.

Plant Operation

The operation of the Vogtle Nuclear Plant will neither consume nor produce any materials that will substantially affect economic development of the counties in the study area. Materials consumed or produced have unique characteristics that require procurement, handling and disposal techniques not associated

Table 19

Major Materials Required for Construction of Two Reactor Units*

Concrete	230, 000 cubic yards
Aggregate	1. 5 tons/cubic yard of concrete
Steel, reinforcing	25, 000 tons
Steel, structural	8, 000 tons
Piping, small (2. 5" dia.)	230, 000 linear feet
Piping, large	200, 000 linear feet
Lumber and plyboard	(unable to give estimate since not a a major part of materials used in construction--used primarily in formwork)

*Estimates are furnished by Georgia Power based on experiences in previous projects.

with any existing or potential economic activity within the area.

Diesel fuel will be required for the operation of the combustion turbines when peak load demands are made on the plant. No economic impact is anticipated from utilization of diesel fuels, since the fuel will be obtained from pipeline terminals in Augusta. Georgia Power Company is considering barging fuel from Savannah after 1975. Barge slip facilities at the power plant site are expected to be completed sometime in 1975, in time for arrival of the first reactor unit by water transportation.

The Vogtle Power Plant will utilize pressurized, light-water reactors. Nuclear fuel is required for operation of the reactors. Since the manufacture of radioactive materials is controlled by the Atomic Energy Commission, the materials required will come from sources outside of the study area. Residual fuels from the fission process have some potential for economic development. However, the reclaiming facilities (Allied-Gulf) at Barnwell, South Carolina, developed in conjunction with the Savannah River Atomic Energy Plant, will provide this function for the Vogtle Nuclear Plant.

Discussions with Georgia Power Company officials indicate that some quantities of chemicals for the operation of waste treatment facilities will be needed. It is doubtful that these chemicals will be obtained locally.

Increased Payroll Impact

The payroll of the construction workforce and the permanent power plant operating personnel will increase the amount of personal income circulated in the economies of the study area.

Figure 10

Breakdown of Payroll Distribution Patterns

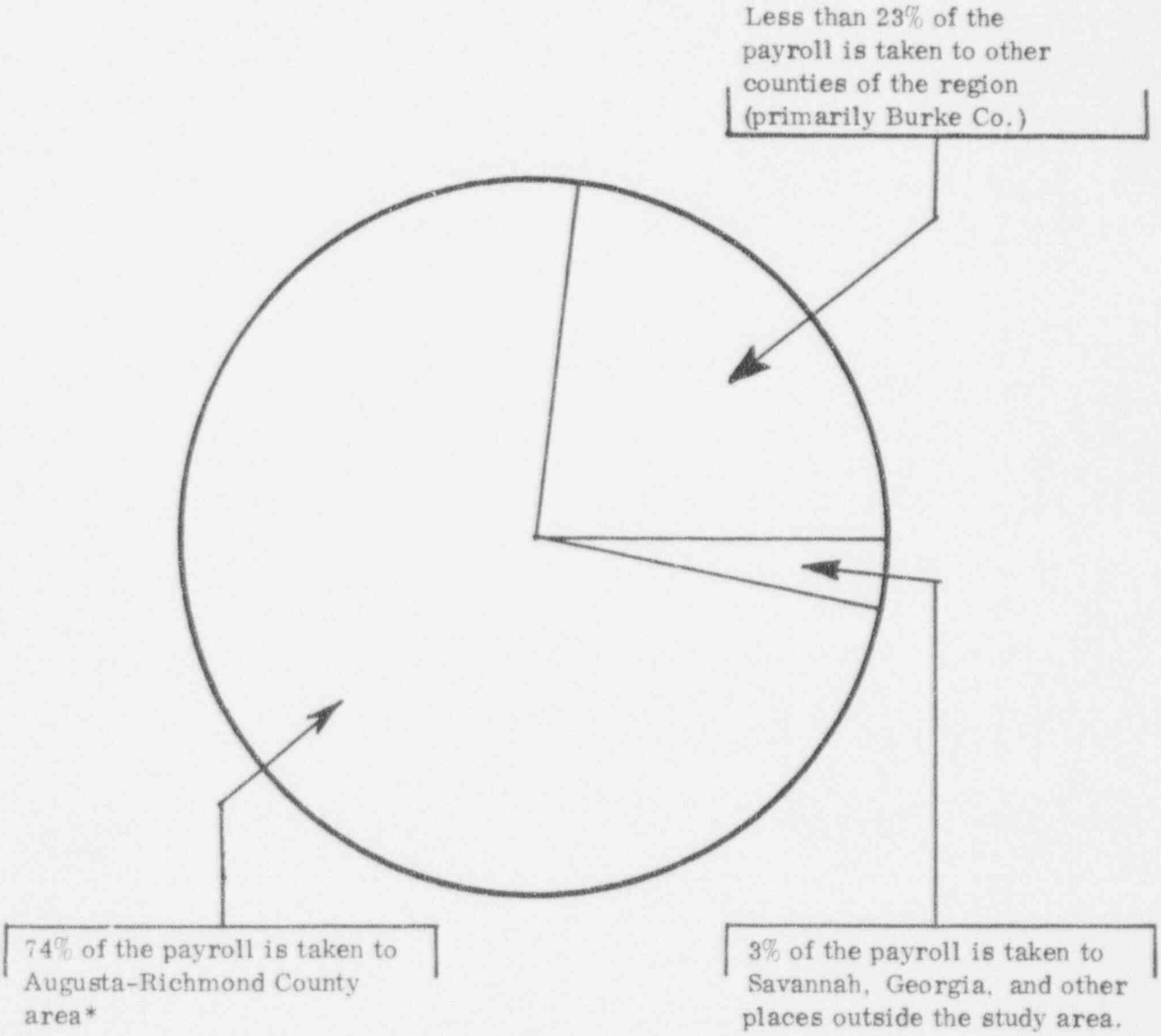


*Table 13 indicates that about 70% of the construction workers and 80% of the professionals will reside in Richmond County.

Estimates of the annual income during the construction phase are given in Table 20. The annual income of the approximately 100 permanent operating personnel is estimated at $1,000,000. (This figure is based on an average salary of $10,000 per year for Georgia Power personnel.)

Not all of the projected income will be spent in the counties of the study area. Table 20 gives a breakdown of the total expected income based on anticipated spending and residential patterns. About three-fourths of the total payroll is expected to be spent in Richmond County. There are several reasons for this conclusion. As discussed in Chapter II, Population, most of the construction and operating workforce is expected to reside in the Richmond County area. This factor, coupled with the fact that almost all of the developed retail shopping centers are located in Richmond County, will significantly influence spending patterns. Central Savannah River Area Planning and Development Commission statistics indicate that local businesses and shopping areas of the rural towns in the remainder of the study area are utilized generally for minor day-to-day needs (minor auto repairs, gasoline, and other spur-of-the-moment purchases).

Because of the variety and quality of the goods and services available in Richmond County, and the lack of a sufficient population and market in the smaller towns of the surrounding counties, most of the payroll monies will be spent in the Richmond County-Augusta area. Expenditures in Burke County are estimated as being insufficient for the stimulation of expansion of the

Table 20

Projected Annual Wages for Vogtle Plant During Construction Phase***

	Number	% of Total Workforce	Annual Wage Based on Minimum Wages*	Annual Wage Based on Georgia Power's Estimate**
Carpenters	504	13.3	6,620,000	
Ironworkers	288	7.4	4,155,000	
Pipefitters	720	19.1	10,230,000	
Millwrights	96	2.5	1,326,000	
Electricians	420	11.1	5,140,000	
Boilermakers	96	2.5	1,458,000	
Painters	120	3.2	1,292,000	
Operating Engineers	264	7	3,820,000	
Laborers	612	16.1	3,695,000	
Brickmasons	96	2.5	1,218,000	
Cement Masons	96	2.5	1,038,000	
Sheet Metal Workers	96	2.5	---	
Asbestos Workers	96	2.5	1,278,000	
Teamsters	96	2.5	---	
Georgia Power Personnel	200	5.3	(2,000,000)**	60,000,000 2,000,000
Total	3,800	100.0%	43,270,000	62,000,000

*Minimum wages based on a 40-hour work week given in Table 5.

**Based on $8/hour average per worker estimated by Georgia Power. Also give an estimate of an average $10,000/year for the 200 Georgia Power personnel involved.

***Estimates are for peak employment periods. Estimates for each year during construction phase can be computed utilizing employment levels given in Table 6, along with percentage ratios given on this page to calculate the corresponding portion of yearly wages.

existing commercial facilities, or the construction of any new ones.

Appendix V illustrates the affects that increased spending by new employment might have in an area. These figures provide an indication of the relative impact an increased payroll might have on economic activity.

Revenues

Under current Georgia State laws, the potential revenues projected for Burke County as a direct result of the Vogtle Power Plant are the single most significant impact that the power plant will create.

Analysis of real property tax revenues received by other Georgia counties having major power plant construction projects has been made. The following applies:

a. The Tax Division of the State Revenue Department annually establishes the market value of utility properties within the State. This value is determined by two primary considerations: income derived by the utility company, and investment by the utility company in the particular installation.

b. Having assessed the property at its current market value, the State Revenue Department provides these data to the resident county. The utility property is taxed in accordance with the current rate of that county.

c. A county in which a nuclear power plant is currently under construction has experienced a twenty-one-fold increase in tax revenues received from the Georgia Power Company during the first three years of construction. Property taxes paid suggest revenues of approximately one percent of the total property value (See Table 21).

d. A fossil-fuel power plant currently under construction in another county has provided a similar increase in property tax revenues (See Table 22).

e. Georgia Power Company paid $27,094 ad valorem taxes to Burke County in 1971.

Table 23 shows projected Georgia Power Company investment in the Vogtle Power Plant. These data suggest the conclusion that revenues accruing to Burke County will significantly overshadow the current revenues ($596,000) received from the total county tax digest.

Reference has been made to prudence in planning, decisions, and judgment. Debts should be controlled with extreme care, if they must be incurred. The best possible objective planning should be secured and reviewed with great care to assure that the interests of all citizens is considered. Goals and objectives to meet these criteria should be defined, exposed to public review and debate, and acted upon when decisions of public officials have been made. The long-term economic future of Burke County may well hinge upon these considerations.

A combination of forces arise; first, the relatively slight adverse impact on Burke County caused by the Vogtle Plant construction project, and second, the receipt by Burke County of significant financial resources from the construction project. Evolving from these forces should be a major effort to invest in quality development programs. It logically follows that tax rates within the county could be reduced--lower tax rates with quality facilities are a great

Table 21

Tax Revenue Experience - Appling County

Construction Year	Georgia Power Company Assessed Value	Property Taxes Paid
Year Prior to Construction	Unknown	$ 19,800
First Year	Unknown	20,650
Second Year	$ 4,000,000	40,800
Third Year	21,000,000	215,100
Fourth Year	43,000,000	437,500

Source: Georgia Power Company and State Revenue Department.

Table 22

Tax Revenue Experience - Bartow County

Construction Year	Georgia Power Company Assessed Value
Year Prior to Construction	$ 51,400
First Year	69,700
Second Year	74,450
Third Year	355,300
Fourth Year	970,140

Source: Georgia Power Company

Table 23

Projected Georgia Power Company Investment - Vogtle Power Plant

Year	Combustion Turbines ($Millions)	Reactor Unit #1 ($Millions)	Reactor Unit #2 ($Millions)	Reactor Unit #3 ($Millions)	Reactor Unit #4 ($Millions)	Annual Investment ($Millions)	Cumulative Investment ($Millions)
First	$ 0.1	$ 1.9	$ ---	$ ---	$ ---	$ 2.0	$ 2.0
Second	27.9	7.6	---	---	---	35.5	37.5
Third	5.0	7.0	3.2	---	---	15.2	52.7
Fourth	--	42.0	6.4	3.5	---	51.9	104.6
Fifth	--	55.7	41.5	7.0	3.4	107.6	212.2
Sixth	--	151.0	54.5	45.5	6.8	257.8	470.0
Seventh	--	61.2	144.0	59.5	44.2	308.9	778.9
Eighth	--	13.6	57.6	157.5	57.8	286.5	1,065.4
Ninth	--	---	12.8	63.0	153.0	228.8	1,294.2
Tenth	--	---	---	14.0	61.2	75.2	1,369.4
Eleventh	--	---	---	---	13.6	13.6	1,383.0
Twelfth	--	---	---	---	---	---	1,383.0
Totals	$33.0	$340.0	$320.0	$350.0	$340.0	$1,383.0	$1,383.0

Source: Georgia Power Company

magnet for attracting industrial, commercial, cultural and social investment.

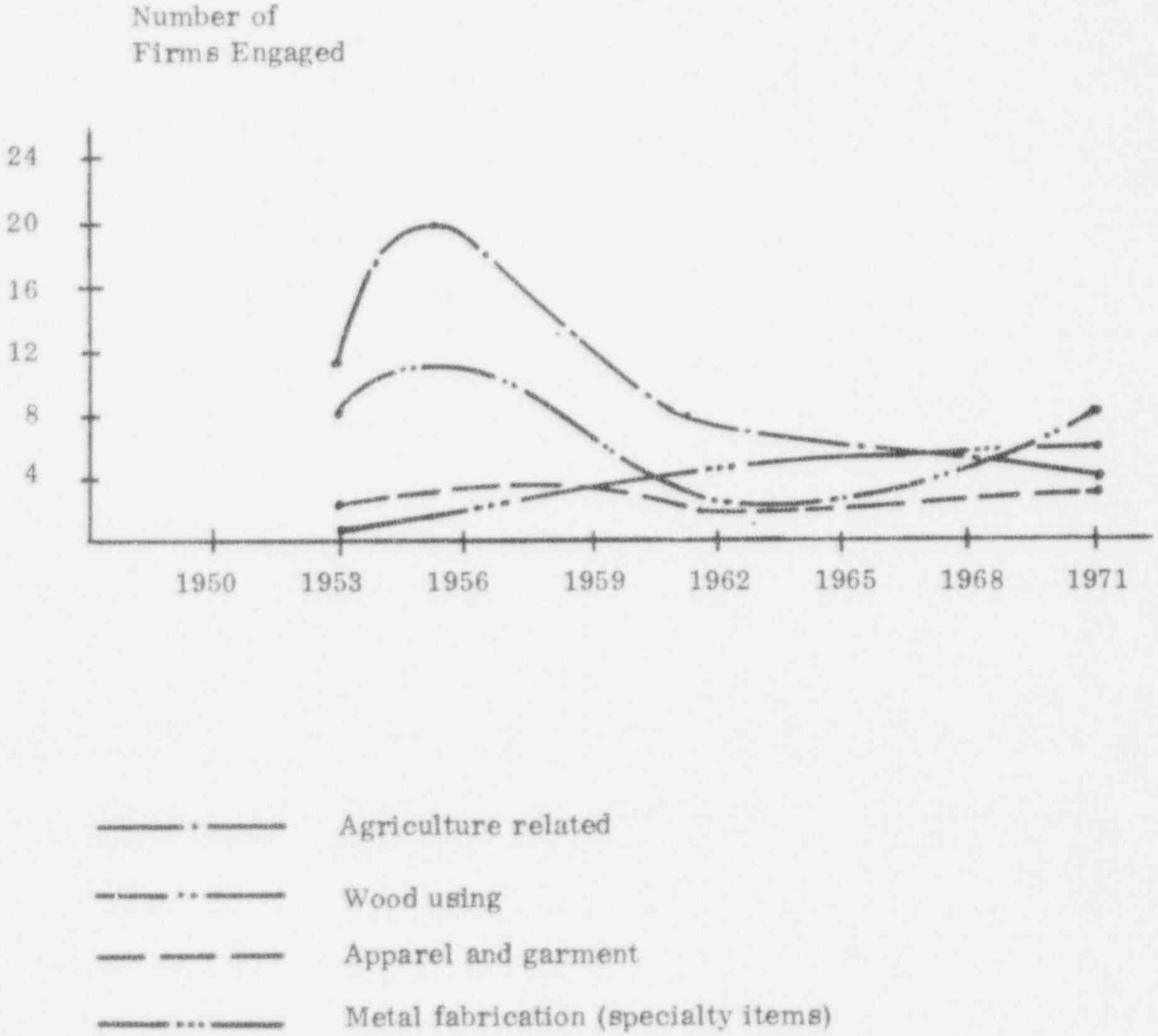
The significance of this revenue impact should not be overlooked. Few counties will have the opportunity to move from a rural environment to a more desirable and stable economy while maintaining a sound financial posture.

With the "Miracle Mile" industrial district in southern Richmond County near capacity, further industrial activity into Burke County appears to be imminent. The fact that the industrial park in Waynesboro is considered to be one of the best in the region should also make Burke County more attractive for early development. Industrial trends for Burke County indicate recent increases in industrial activity (See Table 24). Some categories of industrial activity have experienced greater increases than others. The increased revenue is not expected to have any significant affect upon these trends. However, Burke County and Waynesboro's potential for industrial development has been made more attractive with the expected increase in tax revenues.

The increased tax digest and relatively low bonded indebtedness will create a significant potential for economic development of both Waynesboro and Burke County. (See Appendix IV)

Table 24

Industrial Trends* in Burke County



*Based on the number of firms given in the Directory of Manufacturers Published by Department of Industry and Trade.

Chapter VIII

CONCLUSIONS

This analysis of the impact of Vogtle Nuclear Plant on the five-county study area has identified no significant problem areas that cannot be solved by local governmental agencies.

Labor resources within the region are adequate to provide the majority of the required workforce for the construction project. Current unemployment should be significantly eased by the creation of new construction jobs.

Although some in-migration of workers has been projected, their numbers are not so significant as to prompt extensive construction or development activities solely in support of VNP. The majority of the in-migrating workforce will be accommodated by existing facilities in Richmond County, as Burke County's housing resources are extremely limited. Construction programs initiated by private entrepreneurs to provide housing accommodations nearer the construction site than Richmond County will be hazardous.

Population in the study area, less Richmond County, has been declining steadily for the past thirty years. A curtailment in the population decline can be anticipated as a result of the construction project. Assuming that economic opportunities remain constant throughout the construction period, the current decline in population will be renewed after construction has been completed. The renewed rate of decline in population will probably continue for another decade.

The most urgent problem facing the study area, and particularly Burke County, is the construction and maintenance of a road system that will support the greatly increased vehicular traffic anticipated in the near future. As discussed in Chapter V, high standards must be attained and maintained throughout the construction period. This action will reduce the cost of road repairs during this period.

The most significant beneficial impact projected for Burke County is the greatly increased property tax revenues anticipated from the Georgia Power Company. It is from these revenues that a new, aggressive and future-looking county might develop. Burke County is an open, clean, generally unobstructed geographical area. Its location suggests an early beneficial impact from the expanding industrial development to the south of Augusta.

Currently, no landuse controls exist in the unincorporated areas of Burke County. There has been little historic reason for establishment of landuse controls. This situation will be radically changed as economic development from Augusta moves south. Economic development, if controlled, will provide major benefits to the citizens of Burke County, as well as to those of neighboring counties.

Community facilities within the study area have existing deficiencies discussed in studies by the Central Savannah River Area Planning and Development Commission (CSRA). These deficiencies relate to current conditions and should be corrected at the earliest possible date.

The school situation in both Burke and Richmond Counties is in some turmoil as a result of the February 16, 1970, ultimatum for integration by the nation's highest court. Currently, the white-non-white student ratio in Burke County public school system is estimated at 18 to 82. Popular attitudes point toward expanding the private school system.

The solution to the problem of school integration is to be found in improving the quality of education provided by the public school system, combined with an effort to increase the white population of the county. These actions are well within the realm of possibility for Burke County. The County has developed a five-year plan for revitalizing its public school system, and all indications are that revenues for this plan will be forthcoming.

Early action should be initiated by Burke County officials to develop and approve effective plans for its future development. The efforts of the CSRA have already been directed toward this goal. It is the responsibility of city and county officials to take the initiative in attaining approved goals. Roads, recreation, school improvement, expanded community facilities, controlled use of land, and community attitudes are all potential programs of action.

There is no substitute for good planning. Means to implement such planning should be placed high on the community and county priority lists. Subdivision controls should be established, zoning ordinances and mobile home ordinances should be passed, building and housing codes should be published and enforced, master plans should be developed and adhered to, and land use plans should be prepared and approved.

It is recognized that many of the measures needed to control and guide future development can be put into effect only by the local governments. However, the state government can give technical assistance and pass proper enabling laws.

The wise application of the anticipated increased tax revenues can serve to make Burke County a model of progress to its citizens and to the State of Georgia.

Besides initiating effective planning programs, Burke County should undertake immediately certain actions if it desires to attract resident population from the Vogtle Nuclear Plant construction project. These actions include:

a. Aggressively implement the existing highway improvement program;

b. Implement an effective mobile home ordinance to provide the amenities of a reasonable life for transient citizens;

c. Continue efforts to improve the quality of education provided by public schools so as to entice its white citizens back to these institutions;

d. Deny any tendency to reduce public funds currently available or projected for public school improvement programs;

e. Selectively invest available revenues in improving first the quality and then the quantity of community services and facilities; and

f. Arrange with Georgia Power Company to conduct discussions with civic organizations and other public groups on the impact and construction progress of the Vogtle Nuclear Plant. Topics should include the impact on the environment and local economy, and other current and topical subject matter relative to the power plant construction and operation.

APPENDIX I

RATIO METHOD OF POPULATION PROJECTION

The ratio method of population projection was used in this study. It considered the population of the five-county area as being directly related to the population of the United States as a whole. Ratios were established showing the proportional share represented by the five-county area as a percent of total U.S. population in 1960 and 1970 (using figures derived from the U.S. censuses of those years). An assumption was made that the five-county area would continue to receive its share of the U.S. population in an averaged amount of the 1960 to 1970 period.

Population projections for the United States have been prepared by the Census Bureau, taking into account varying assumptions as to future fertility and mortality rates. Current public attitudes regarding family size prompted use of the lowest of the four series of Census projections as being most appropriate. A series of yearly ratios was calculated for the five-county area which corresponded to the projections of the Nation's population. For each year, the projected United States population was multiplied by the corresponding ratio representing the five-county area's share. The result was the projected five-county area population.

Specifically, the procedure began with the calculation of the ratio of the population in the five-county area to the population of the United States in 1960 (.0010943 per cent) and in 1970 (.0010668 per cent), using the figures in the U. S. Census of Population. The difference was then obtained between the 1960 and 1970 ratios (-.0000275 per cent), representing the 10 year change in the five-county area's share of the nation's population. The 10-year difference was divided by 10 to obtain the annual increase or decrease for the study area. Assuming that the study area's share would change by this same amount each year, the annual increments were applied to the 1970 ratio to provide a 1971 ratio. The process was repeated for each year up through the final year projected. Thus a series of ratios was obtained representing the relationship between the future population in the five-county area and the nation for each year under consideration. For each year the national projection of the Census Bureau for that year was multiplied by the corresponding ratio to give the five-county projection for that year.

Population Projection Methodology

STEP 1: $\frac{\text{1960 target population}}{\text{1960 U. S. Population}} = \text{1960 target ratio}$

$\frac{\text{1970 target population}}{\text{1970 U. S. population}} = \text{1970 target ratio}$

STEP 2: 1960 target ratio less 1970 target ratio = 10 year ratio increment

STEP 3: $\frac{\text{10 year ratio increment}}{10} = \text{average annual ratio increment}$

STEP 4: 1970 target ratio   average annual ratio increment = 1971 target ratio

STEP 5: 1971 target ratio x U.S. population projection for 1971 = 1971 target population

STEP 6: 1971 target ratio   average annual ratio increment = 1972 target ratio

STEP 7: 1972 target ratio x 1972 U.S. population projection = 1972 target population

Repeat STEPS 6 and 7 using subsequent year data for duration of projection

Ratios Applied In Population Projection

County/Community	1960 Ratio	1970 Ratio
Burke County	.0001139	.0000890
Jefferson County	.0000966	.0000837
Jenkins County	.0000509	.0000406
Richmond County	.0007505	.0007921
Screven County	.0000826	.0000613
Five-County Area	.0010943	.0010668
Waynesboro	.0000295	.0000269
Augusta	.0003313	.0002919

U. S. Population Projection*

(000's)

1972 - 208, 799

1973 - 210, 733

1974 - 212, 733

1975 - 214, 735

1976 - 216, 805

1977 - 218, 919

1978 - 221, 077

1979 - 223, 276

1980 - 225, 510

1981 - 225, 510

*Series E Projection, Bureau of Census

APPENDIX II

NEW RESIDENT WORKFORCE
COMPUTATION METHODOLOGY

Step 1

Projected year-end employment level
- 200 Georgia Power Company professional employees*
Projected construction worker strength

Step 2

Projected construction worker strength
x 83 percent (Chapter II)
Construction workers available from five-county area plus Aiken County, South Carolina

Step 3

Total year end employment
- Construction workers locally available and 200 Georgia Power Company professional employees
Construction workers obtained from distant population centers

Step 4

Construction workers from distant population centers
x 40 percent*
Number construction workers expected to commute to work

Step 5

Construction workers from distant population centers
- Commuters
New resident construction workers

Step 6

New resident construction workers
x 70 percent*
New resident mobile home occupants

Step 7

New resident construction workers
- New resident mobile home occupants
New resident construction workers that will rent or buy homes

*Source: Georgia Power Company

APPENDIX III

FEDERAL HOUSING ADMINISTRATION STANDARDS FOR MOBILE HOMES

Water Supply

The standard for adequate water supply is 150 gallons per day per mobile home. All wells and water lines must be constructed so as to preclude any underground or surface contamination. Treatment of a private water supply must adhere to the laws and regulations of the state.

Sewerage

Recommended standards require a public sewage system or one designed for a minimum flow of 150 gallons per day per mobile home lot. If the sewer lines are not connected to a public sewer, all proposed sewage disposal facilities must be approved by health authorities prior to construction. Emergency sanitary facilities should be a part of every mobile home park development. The Mobile Homes Manufacturers Association (MHMA) recommends that one emergency flush toilet and one lavatory for each 100 mobile home lots be accessible to all mobile homes.

Refuse Pick-Up

Garbage and other refuse should be collected at least twice weekly. The MHMA recommends the storage of all refuse in flytight, watertight, rodent-proof containers located not more than 150 feet from any mobile home lot.

Laundry Facilities

The FHA recommends that laundry facilities be located in centralized common facilities, if possible. In order to adequately serve residents, the FHA recommends outdoor drying yards of 2,500 square feet per 100 mobile home units.

Storage Areas

Storage facilities should be constructed of suitable weather resistant materials. The FHA recommends placing storage areas of at least 90 cubic feet per unit not more than 100 feet from each mobile home.

Off-Street Parking

FHA recommends at least one additional car space for each four lots to provide for guest parking, for two-car tenants, and for delivery and service vehicles. Off-street parking spaces should be 9 feet wide and at least 20 feet long.

Fire Protection

The MHMA recommends hydrants be located within 500 feet of any mobile home. Hydrants should deliver at least 75 gallons of water per minute at a pressure of at least 20 pounds per square inch.

Recreation Facilities

Both the FHA and the MHMA recommend that 8 percent of the gross site area be devoted to recreational facilities. The equipment should be appropriate for the intended use and location. Recreation areas may include indoor facilities, swimming pools, hobby and repair shops, and service buildings. Recreation areas should not be less than 5,000 square feet in area.

APPENDIX IV

BONDED INDEBTEDNESS FOR WAYNESBORO AND BURKE COUNTY

Year 1971	Waynesboro	Burke County
Total Tax Digest	$13,556,079	$46,990,000
Bonding Capacity at 7% of Digest	948,926	3,380,000
Bonded Indebtedness	156,000	00
Reserve Bonding Capacity	792,926	3,380,000

Debts Outstanding for Waynesboro (Estimates)

	Amount	No. of Issues	Date of Maturity
General Obligation Bond	$130,000	1	1977
Revenue Bonds			
1) Water & Sewer	670,000	4	--
2) Gas	200,000	1	--

Debts Outstanding for Burke County - Waynesboro (Estimates)

	Amount	No. of Issues	Date of Maturity
Hospital Bond	$125,000	1	1978

2/3 of the monthly payment is by Burke County

APPENDIX IV

COMPARISON OF TAX REVENUES FROM MOBILE HOMES AND SINGLE-FAMILY HOUSES

Mobile Homes

	Fair Market Value of Mobile Home	County Assessment Rate	Assessed Value	Homestead Exemption	Total Assessed Value	County Tax Rate/$1,000	Annual Property Tax
Burke	$6,000	40%	$2,400	$-2,000	$400	$20.25	$8.10
Jefferson	$6,000	40%	$2,400	$-2,000	$400	$22.75	$8.90
Jenkins	$6,000	40%	$2,400	$-2,000	$400	$28.00	$11.20
Richmond	$6,000	40%	$2,400	$-2,000	$400	$39.75	$15.90
Screven	$6,000	40%	$2,400	$-2,000	$400	$24.75	$9.90

Single-Family Houses

	Fair Market Value of Single-Family Home	County Assessment Rate	Assessed Value	Homestead Exemption	Total Assessed Value	County Tax Rate	Annual Property Tax
Burke	$20,000	40%	$8,000	$-2,000	$6,000	$20.25	$121.50
Jefferson	$20,000	40%	$8,000	$-2,000	$6,000	$22.25	$133.50
Jenkins	$20,000	40%	$8,000	$-2,000	$6,000	$28.00	$168.00
Richmond	$20,000	40%	$8,000	$-2,000	$6,000	$39.75	$238.00
Screven	$20,000	40%	$8,000	$-2,000	$6,000	$24.75	$148.50

APPENDIX V

EMPLOYMENT IMPACT

The Vogtle Nuclear Plant construction project is expected to employ an average of 2,452 persons over an eight year period (See Table 6). A study conducted by the U. S. Chamber of Commerce, based on analysis of ten communities, illustrates the impact of 100 new factory workers on each community in the following manner:

100 New Factory Workers Means

296 more people added to the community,

112 more households,

51 more school children

$590,000 more personal income per year,

$270,000 more bank deposits,

107 more passenger cars registered,

174 more factory workers employed,

4 more retail establishments,

$360,000 more retail sales per year.

A similar study, conducted by the Missouri Division of Resources and Development, estimated the development of a new manufacturing plant employing 150 male employees in basic industry as having the following impact:

Plant investment of $390,000,

Annual payroll of $539,000,

The creation of 1,200 secondary jobs.

The sale and service of 431 automobiles.

Need for nine new school rooms.

Property subject to taxation with assessed value of $1, 972, 686.

Need for 48 additional professional men.

Rail freight revenues of $110, 000 annually.

Food sales of $469, 637 annually.

The results of the above studies are no warrant that specific economic advantages will accrue to a community receiving new employment, but they provide sufficient evidence to assure an expanded economic impact.

Source: Robert Kevin Brown, Real Estate Economics, (Boston: Houghton Mifflin Co., 1965), pp. 201-2.

APPENDIX B

Project A-1396

A SURVEY OF THE NATURE AND EXTENT OF LAND USE IN THE VICINITY OF THE ALVIN W. VOGTLE NUCLEAR POWER GENERATING PLANT

by

Ben E. James, Jr.

and

H. Wayne Hodges

Conducted for the
Georgia Power Company

Industrial Development Division
ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
Atlanta, Georgia

May 1972

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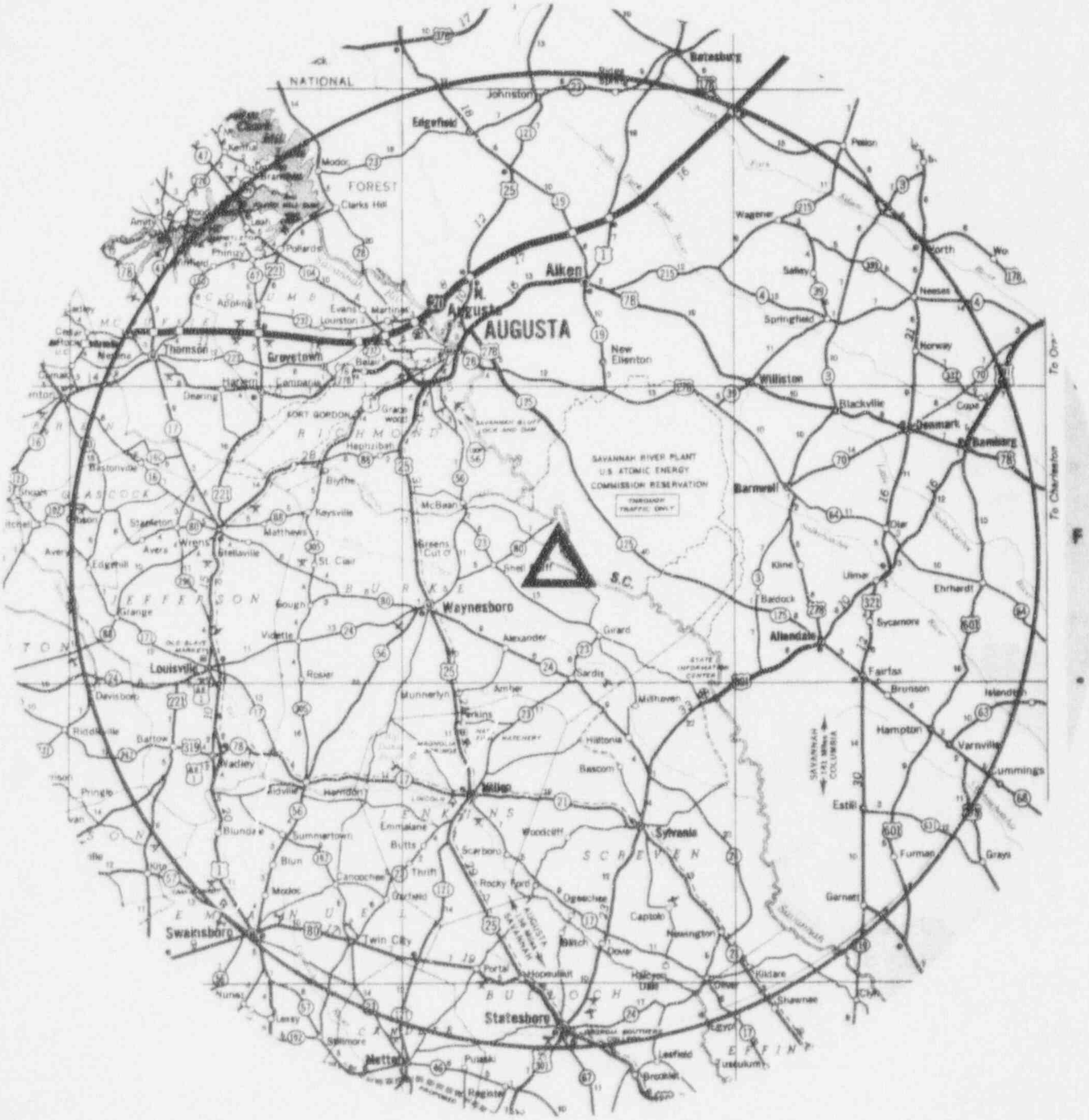

NATIONAL
FOREST
Batesburg
Johnston
Edgefield
Modoc
Clarks Hill
Aiken
N. Augusta
AUGUSTA
New Ellenton
Thomson
Grovetown
Appling
Martinez
Evans
Harlem
Dearing
FORT GORDON
RICHMOND
Hephzibah
Blythe
Keysville
McBean
Greens Cut
Shell Bluff
Waynesboro
Alexander
Girard
Sardis
Millhaven
Louisville
Wrens
Stapleton
Avera
Matthews
St. Clair
Gough
Vidette
Rosier
Munnerlyn
Perkins
Millen
Hiltonia
Bascom
Sylvania
Rocky Ford
Oliver
Swainsboro
Twin City
Portal
Statesboro
Metter
Pulaski
Garfield
Wadley
Bartow
Davisboro
Midville
Summertown
Blundale
Canoochee
Stillmore
BULLOCH
SCREVEN
JENKINS
EMANUEL
BURKE
JEFFERSON
GLASCOCK
SAVANNAH RIVER PLANT
U.S. ATOMIC ENERGY
COMMISSION RESERVATION
THROUGH TRAFFIC ONLY
S.C.
Williston
Blackville
Barnwell
Springfield
Wagener
Salley
Denmark
Bamberg
Allendale
Fairfax
Brunson
Hampton
Varnville
Estill
Furman
Garnett
Ulmer
Sycamore
Ehrhardt
Olar
Kline
Baldock
Norway
Neeses
North
Perry
Cope
Kildare
Newington
Dover
Shawnee
Clyo
Egypt
Brooklet
Leefield
EFFINGHAM
STATE INFORMATION CENTER
SAVANNAH
COLUMBIA
AUGUSTA
SAVANNAH
To Charleston
Cummings
Islandton
Gray
Capitola

Background

The Georgia Power Company, in order to fulfill the reporting requirements of the United States Atomic Energy Commission, required information on the nature and extent of land use within fifty miles of its Edwin I. Hatch nuclear power generating facility near Baxley, Georgia, and its Alvin W. Vogtle nuclear power generating facility near Augusta, Georgia.

The requirements included a description of land used for agriculture, including crops, animals and animal products, and forest products. Also required was information on land used for housing, recreation, industry, and transportation. It was specified that the area within five miles of each of the two nuclear facilities should be described in greater detail than the more remote portions of the fifty-mile study areas.

The Georgia Power Company, in January 1972, commissioned the Industrial Development Division of the Engineering Experiment Station to make such a land-use study on their behalf.

Approach

In order to avoid unnecessary acquisition of primary data, a search was made for pertinent published information on counties and communities within the study areas. In general, it was found that adequate data were available for the fifty-mile regions. However, since the five-mile regions were unique, it was decided that primary data must be developed for these regions. This was done by extensive field work and by the use of aerial photographs acquired from the United States Department of Agriculture, Agricultural Stabilization and Conservation Service.

In some cases, where no explicit information was available, assumptions based on experience of knowledgeable persons were made. Extensive assistance was obtained from the various local offices of the University of Georgia Cooperative Extension Service.

Presentation of specific conclusions was not planned for this study. It was felt that the data could be presented in such a way that the conclusions would be evident. Also, much of the information was to provide a reference base for comparison with possible future changes; as such, no conclusions were required.

Study Areas. The study areas cover all counties in which any portion is within 50 miles of the two nuclear facilities. This approach added accuracy to the study in that data already collected on entire counties could be used rather than estimating various data as a function of partial county areas. This approach indicated study areas of 7,594,000 acres and 8,655,400 acres as opposed to an area of 5,026,600 acres exactly within a 100-mile-diameter circle.

Results

The Plant Alvin W. Vogtle fifty-mile study area encompasses 25 counties. Within this area, the following information was acquired:

Population and Housing. The Plant Alvin W. Vogtle study area has a population of approximately 724,896 persons, 49% of whom are male and 51% female. The age distribution profile of this population is noted on Table 1-V. Population concentrations are noted on Map 1-V. This map indicates population concentrations of 1,000 or more as well as average population density of each county within the area.

There are approximately 226,448 housing units within the area, generally exhibiting the same geographic concentrations as the population. Over the entire area, the value of the owner-occupied housing units is distributed as follows: 12% of the housing units are valued at less than $5,000; 47% of the units are valued between $5,000 and $15,000; 29% of the housing units are valued between $15,000 and $25,000; and 12% of the units are valued at greater than $25,000. These value distributions and number of housing units for each county in the study area are noted on Table 4-V. It is estimated that 18,210 acres are devoted to urban housing and 140,484 acres to rural housing within the area.

Agriculture. Generally, agriculture accounts for a large portion of the economy of this area. However, as is true in most farming areas, the actual number of farms is decreasing and the average farm size is increasing.

Within a 50-mile radius of the Alvin W. Vogtle plant site, there are 18,592 farms. They encompass 4,413,617 acres or 51% of the total land area. These farms produce row crops, forest products, and animal products.

The average value of the land and buildings ranges from a low of $16,737 per farm in Warren County, Georgia, to a high average value of $53,622 per farm in Allendale County, South Carolina.

Approximately 56% of the farms within a 50-mile radius of Plant Alvin W. Vogtle earn an annual income below $2,500, 26% of the farms earn $2,500-$10,000, and only 18% annually earn $10,000 or over.

Some 1,249,137 acres are in harvested cropland and another 927,600 acres are in pasture of one form or another. A great portion of the total land area is in woodland which is documented in the Forests section of this report.

Field-crop, general, and miscellaneous types of farms dominate this area. Livestock farms are the leading type of specialty farm, although they comprise only a small portion of the total.

A total of 215,415,960 pounds of whole milk was produced in the area for sale during 1964. During this same period, 11,426,434 broilers and other types of chickens were raised and sold, along with 34,886,360 dozen chicken eggs. Also during 1964, 128,299 cattle and calves and 390,650 hogs and pigs were sold from this region.

The value of agricultural products sold from the Plant Vogtle study area during 1964 totaled $145,777,673. This included $88,785,578 for field crops, $22,151,134 for poultry and poultry products, $13,056,247 for dairy products, and $21,784,714 for livestock and livestock products.

Forests. Within a 50-mile radius of the Alvin W. Vogtle plant site there are 5,590,200 acres of forest land. This represents 64.5% of the total land area. The majority of the forest land, owned by farmers and the forest industry, is classed as commercial forest land currently producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. The remaining forest land, controlled by public and private interests, is unproductive or is set aside as reserved growth areas.

Growing stock trees are live trees of commercial species qualifying as desirable or acceptable trees. Some 5,261,500,000 cubic feet of timber representing this type of tree is found within this area. The most predominant species is pine, which accounts for 47% of the growing stock volume within the 25-county area.

Growing stock removals are for two primary uses -- sawtimber and pulpwood. In 1970, removals of all species included 108,100,000 cubic feet of sawtimber and 1,013,150 cords of pulpwood. The value of these removals was $28,862,700 and $19,249,850, respectively.

Recreation. In the Alvin W. Vogtle study area, there are 409,887 land acres and 46,571 water acres devoted to public outdoor recreation. This acreage is utilized by facilities which range from simple roadside parks to a major U. S. Corps of Engineers Reservoir.

Industry. According to the Census of Manufactures, 1,081 manufacturing plants were operating in the Plant Vogtle area in 1967. Based on an estimate of five acres as an average plant site size, manufacturing operations would encompass 5,405 acres or .05% of the total land area.

Because of the predominance of woodland throughout the area, most manufacturers are concentrated in the lumber and wood products category, which accounts for 594 plants in the area or 55% of the total. Food and kindred products and textile and apparel plants are the next largest groups; combined, they account for only 23% of the total.

The manufacturing in the area is concentrated in Richmond and Washington counties, Georgia; and Aiken, Lexington, and Orange counties, South Carolina. These five counties contain 48% of the total number of manufacturing plants. Richmond County, with 145 plants, and Lexington County, with 134 plants, are the two most industrialized counties in the area.

Transportation. In the Alvin W. Vogtle study area, there are approximately 14,575 miles of county roads and 3,255 miles of state and federal roads. Based on information received from the State Highway Department, there are 145,750 acres devoted to county road right-of-way and 4,882 acres devoted to state and federal road right-of-way. Railroad right-of-way is estimated at less than 5,000 acres.

The Alvin W. Vogtle five-mile study area covers 50,240 acres. Of this area, approximately 19,200 acres are utilized by the Savannah River Plant of the United States Atomic Energy Commission. This area is entirely in South Carolina. The remaining 31,040 acres is sparsely populated, with only an estimated 220 permanent residents. This indicates an average population density of only 4.6 persons per square mile. Housing density is correspondingly low, with an average of only 1.4 dwellings per square mile. This housing accounts for approximately 100 acres of land use within the non-government area.

The approximately 47 miles of roads and highways within the area account for around 500 acres of land use. The 11-mile stretch of the Savannah River which passes through the area is navigable for barge traffic between Augusta and the Atlantic Ocean. This portion of the river has an area of approximately 500 acres. There are only two or three small country stores and no industry within this area.

No public recreational land is contained in the area. At the present time, no fish are allowed to be taken from this portion of the Savannah River, due to mercury pollutants emanating from industrial sources near Augusta. There are two or three private lakes within the area in which fishing is allowed by permission of the owners. This lake area accounts for only around 150 acres, however.

Agricultural activity within this area is devoted primarily to row crops. Most of the farms in the area raise cattle and hogs to round out their farming activity. At present, there are no farms which raise cattle or hogs in appreciable numbers. One small dairy herd was noted. The size of the herd was estimated at less than 50 cows. No major egg-producing operations were noted. In this area, approximately 4,000 acres of farmland are devoted to row crops and around 700 acres are in pasture. These figures will not remain constant, since farmers traditionally divert farmland from one use to another.

The remaining land in the five-mile study area is essentially forest land. Not all of it, however, has the accessibility or suitability for commercial use.

The distribution of land use within five miles of Plant Alvin W. Vogtle is as follows:

Housing	0.2%
Roads, Highways, and River	2.0
Recreation	0.3
Agriculture	9.3
Government	38.2
Forests and Other	50.0
	100.0%

CHART 1–V

ALVIN W. VOGTLE PLANT SITE STUDY AREA
LAND USE DISTRIBUTION

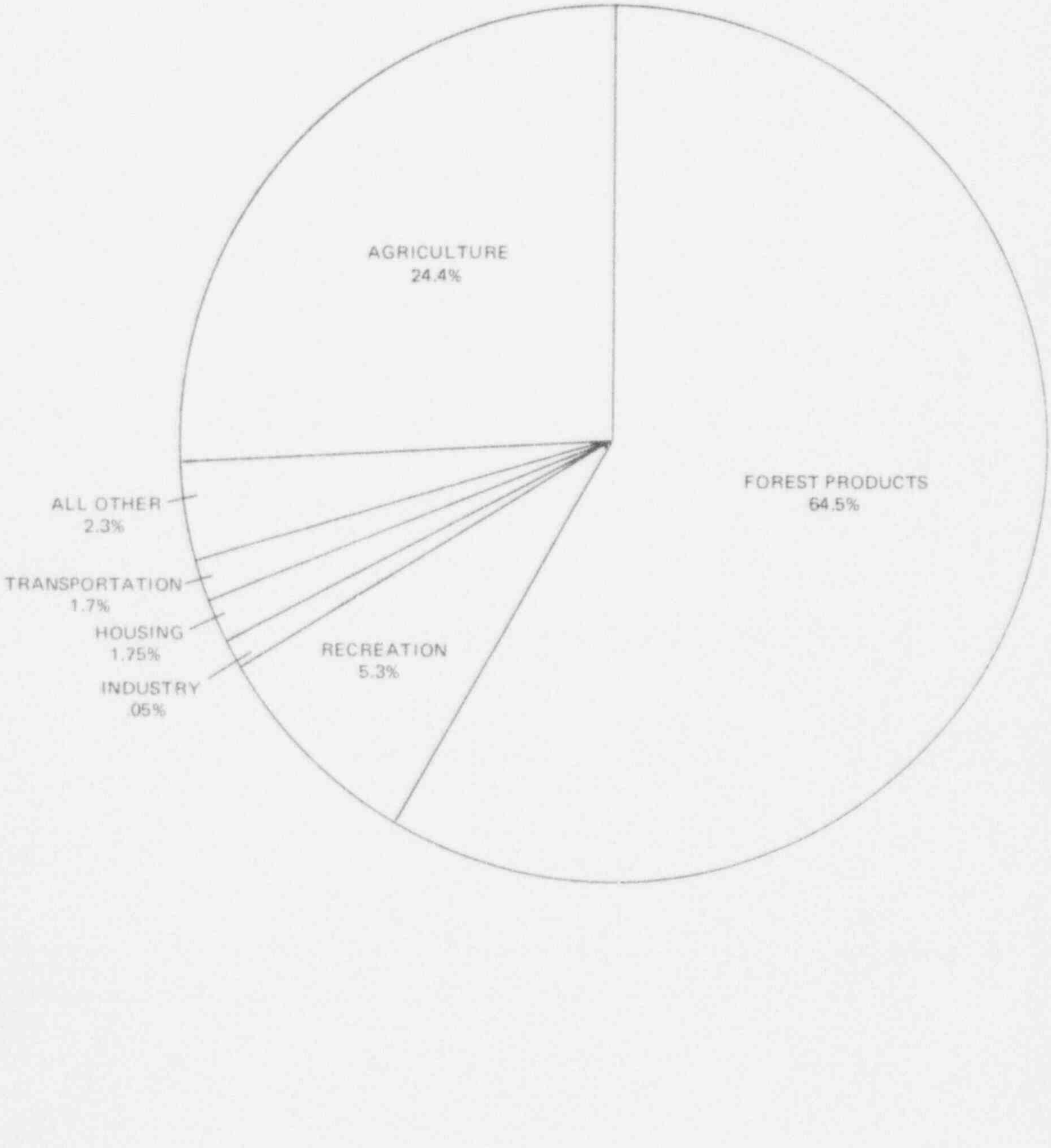


Table 1-V

POPULATION DISTRIBUTION BY SEX

County	Total Population	Male No.	Male %	Female No.	Female %
Georgia					
Bulloch	31,585	15,491	49.0	16,094	51.0
Burke	18,255	8,582	47.0	9,673	53.0
Candler	6,412	3,076	47.9	3,336	62.1
Columbia	22,327	11,009	49.3	11,318	50.7
Effingham	13,632	6,713	49.1	6,919	50.9
Emanuel	18,189	8,738	48.0	9,451	52.0
Glascock	2,280	1,057	46.4	1,223	53.6
Jefferson	17,174	8,146	47.4	9,028	52.6
Jenkins	8,332	4,027	48.3	4,305	51.7
Lincoln	5,895	2,896	49.1	2,999	50.9
McDuffie	15,276	7,175	47.0	8,101	53.0
Richmond	162,437	84,938	52.3	77,499	47.7
Screven	12,591	6,041	48.0	6,550	52.0
Warren	6,669	3,118	46.8	3,551	53.2
Washington	17,480	8,250	47.2	9,230	52.8
South Carolina					
Aiken	91,023	44,267	48.6	46,756	51.4
Allendale	9,692	4,564	47.1	5,128	52.9
Bamberg	15,950	7,719	48.4	8,231	51.6
Barnwell	17,176	8,258	48.1	8,918	51.9
Colleton	27,622	13,331	48.3	14,291	51.7
Edgefield	15,692	7,618	48.5	8,074	51.5
Hampton	15,878	7,621	48.0	8,257	52.0
Lexington	89,012	43,663	49.1	45,349	50.9
Orangeburg	69,789	33,297	48.0	36,492	52.0
Saluda	14,528	7,106	49.0	7,422	51.0
Totals	724,896	356,701		368,195	

Source: U. S. Bureau of the Census, *Census of Population, 1970*.

Table 2-V

POPULATION DISTRIBUTION BY AGE

	All	Under 20 Years		20-44 Years		45-64 Years		65 and Over	
County	Ages	No.	%	No.	%	No.	%	No.	%
Georgia									
Bulloch	31,585	12,592	39.9	9,943	31.5	6,009	19.0	3,041	9.6
Burke	18,255	8,363	45.8	4,502	24.7	3,415	18.7	1,975	10.8
Candler	6,412	2,479	38.7	1,615	25.2	1,528	23.8	790	12.3
Columbia	22,327	9,831	44.0	8,165	36.6	3,277	14.7	1,054	4.7
Effingham	13,632	5,976	43.8	4,185	30.7	2,398	17.6	1,073	7.9
Emanuel	18,189	7,285	40.1	5,041	27.7	4,061	22.3	1,802	9.9
Glascock	2,280	841	36.9	590	25.9	534	23.4	315	13.8
Jefferson	17,174	7,508	43.7	4,486	26.1	3,369	19.6	1,811	10.6
Jenkins	8,332	3,471	41.7	2,226	26.7	1,773	21.3	862	10.3
Lincoln	5,895	2,487	42.2	1,604	27.2	1,196	20.3	608	10.3
McDuffie	15,276	6,363	41.7	4,829	31.6	2,959	19.3	1,125	7.4
Richmond	162,437	63,400	39.0	61,119	37.6	27,137	16.7	10,781	6.7
Screven	12,591	5,163	41.0	3,232	25.7	2,750	21.8	1,446	11.5
Warren	6,669	2,921	43.8	1,610	24.1	1,378	20.7	760	11.4
Washington	17,480	7,383	42.2	4,627	26.5	3,520	20.1	1,950	11.2
South Carolina									
Aiken	91,023	37,720	41.4	29,306	32.3	17,679	19.4	6,318	6.9
Allendale	9,692	4,081	42.2	2,648	27.3	2,026	20.9	937	9.6
Bamberg	15,950	7,021	44.0	4,448	27.8	3,011	18.9	1,470	9.3
Barnwell	17,176	7,363	42.9	4,914	28.6	3,297	19.2	1,602	9.3
Colleton	27,622	11,902	43.1	7,565	27.4	5,573	20.2	2,582	9.3
Edgefield	15,692	6,942	44.2	4,446	28.3	2,958	18.9	1,346	8.6
Hampton	15,878	6,817	43.0	4,418	27.8	3,190	20.1	1,453	9.1
Lexington	89,012	36,091	40.5	31,656	35.6	15,883	17.8	5,382	6.1
Orangeburg	69,789	30,816	44.2	20,001	28.7	13,151	18.8	5,771	8.3
Saluda	14,528	5,966	41.0	4,068	28.0	2,991	20.6	1,503	10.4
Totals	724,896	300,782	41.5	231,244	31.9	135,063	18.6	57,757	8.0

Source: Based on information extracted from Census of Population, 1970.

Table 3-V

POPULATION CONCENTRATIONS

County	Concentrated Population in Communities of 1,000 Persons or More 1/ (persons)	Population Concentration in Remainder of Area (persons per square mile)
Georgia		
Bulloch	14,616	24.8
Burke	5,530	15.3
Candler	-	14.0
Columbia	4,709	60.8
Effingham	2,855	22.5
Emanuel	8,444	14.2
Glascock	-	15.9
Jefferson	6,884	19.4
Jenkins	3,713	13.2
Lincoln	1,422	23.1
McDuffie	6,506	34.7
Richmond	59,864	317.6
Screven	3,119	14.6
Warren	2,073	16.2
Washington	7,299	15.1
South Carolina		
Aiken	28,247	57.8
Allendale	5,563	9.9
Bamberg	6,977	22.7
Barnwell	10,948	11.3
Colleton	-	20.4
Edgefield	5,302	23.6
Hampton	6,354	16.9
Lexington	-	85.9
Orangeburg	1,706	47.2
Saluda	-	26.4

1/ Counties in which no concentrated population is shown either have none or the communities lie outside the 50-mile radius.

Source: Based on information extracted from Census of Population, 1970.

Table 4-V

DISTRIBUTION OF OWNER-OCCUPIED HOUSING BY VALUE
(number of units)

County	Total	Under $5,000	$5,000-$14,999	$15,000-$24,999	$25,000 and Over
Georgia					
Bulloch	3,387	361	1,607	994	425
Burke	1,710	331	866	395	118
Candler	564	93	310	123	38
Columbia	3,013	205	1,087	1,441	280
Effingham	1,740	365	902	399	74
Emanuel	2,175	487	1,212	378	98
Glascock	208	80	110	15	3
Jefferson	1,955	510	1,025	346	74
Jenkins	837	184	475	145	33
Lincoln	594	104	352	120	18
McDuffie	1,799	251	965	453	130
Richmond	23,472	1,176	11,093	7,870	3,333
Screven	1,123	341	511	192	79
Warren	677	172	398	82	25
Washington	1,918	525	969	317	107
South Carolina					
Aiken	16,536	1,951	7,992	4,755	1,838
Allendale	1,206	217	672	221	96
Bamberg	1,807	318	922	399	168
Barnwell	2,245	365	1,185	509	186
Colleton	3,680	841	1,878	676	285
Edgefield	1,643	249	885	371	138
Hampton	2,121	501	1,035	382	203
Lexington	15,563	906	5,343	5,874	3,440
Orangeburg	8,612	1,572	3,943	2,045	1,052
Saluda	1,511	249	792	383	87
Totals	100,096	12,354	46,529	28,885	12,328

Source: U. S. Bureau of the Census, Census of Housing, 1970.

Table 5-V

HOUSING LAND USE

County	Total Housing Units[1]	Persons per Housing Unit[1]	Acres of Urban Land Used for Housing (est.)[2]	Acres of Rural Land Used for Housing (est.)[2]
Georgia				
Bulloch	10,544	3.2	1,142	5,303
Burke	5,551	3.5	395	3,633
Candler	2,143	3.3	221	1,061
Columbia	6,742	3.6	327	4,894
Effingham	3,987	3.6	198	2,994
Emanuel	6,301	3.3	639	2,953
Glascock	875	3.1	-	735
Jefferson	5,254	3.5	492	2,940
Jenkins	2,810	3.4	207	1,358
Lincoln	2,023	3.6	100	1,237
McDuffie	4,871	3.4	478	2,580
Richmond	47,626	3.2	4,677	32,054
Screven	4,203	3.3	236	2,870
Warren	1,977	3.6	144	1,277
Washington	5,488	3.4	537	2,994
South Carolina				
Aiken	29,400	3.4	2,077	18,463
Allendale	3,022	3.5	397	1,181
Bamberg	4,852	3.6	485	2,493
Barnwell	5,384	3.5	782	1,779
Colleton	8,581	3.5	447	6,104
Edgefield	4,552	3.7	358	2,808
Hampton	5,080	3.5	454	2,721
Lexington	29,678	3.4	2,019	18,106
Orangeburg	20,857	3.6	1,223	14,494
Saluda	4,656	3.5	175	3,452
Totals	226,448		18,210	140,484

Sources: 1/ U. S. Bureau of the Census, Census of Housing, 1970, Advance Report.
2/ Based on information extracted from 1970 Census of Housing and 1970 Census of Population.

Table 6-V

FARM ACREAGE AND VALUE

County	Number of Farms*	Acreage of Farms*	Average Value of Land and Buildings per Farm*
Georgia			
Bulloch	1,276	300,428	$55,213
Burke	553	284,010	86,002
Candler	441	97,665	48,462
Columbia	283	74,349	72,098
Effingham	405	126,975	52,264
Emanuel	776	196,491	48,422
Glascock	127	32,199	30,555
Jefferson	521	182,191	56,062
Jenkins	337	132,579	70,202
Lincoln	235	45,970	31,616
McDuffie	243	63,305	52,553
Richmond	184	39,647	62,397
Screven	600	219,783	57,326
Warren	256	87,808	48,351
Washington	544	199,052	56,316
South Carolina			
Aiken	1,229**	233,075**	24,712**
Allendale	338**	149,125**	53,622**
Bamberg	548	133,721	49,907
Barnwell	467	128,926	47,852
Colleton	1,036	258,715	49,822
Edgefield	387	114,539	70,935
Hampton	525	163,895	61,486
Lexington	1,057	152,913	46,105
Orangeburg	2,300	419,501	44,806
Saluda	822	144,788	38,599
Totals	15,480	3,981,650	$1,315,685

* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.

** U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 7-V

DISTRIBUTION OF INCOME FROM FARM PRODUCTS SOLD
(number of farms)

County	Under $2,500*	$2,500 - $9,999*	10,000 and Over*
Georgia			
Bulloch	334	506	436
Burke	209	162	182
Candler	121	159	161
Columbia	205	54	25
Effingham	208	129	68
Emanuel	316	268	182
Glascock	71	36	20
Jefferson	234	163	124
Jenkins	116	97	124
Lincoln	158	25	52
McDuffie	159	61	23
Richmond	121	41	22
Screven	212	190	198
Warren	138	64	54
Washington	227	175	142
South Carolina			
Aiken	660**	269**	170**
Allendale	166**	79**	93**
Bamberg	278	144	126
Barnwell	254	114	99
Colleton	675	236	125
Edgefield	250	57	80
Hampton	263	135	127
Lexington	626	264	167
Orangeburg	1,353	545	402
Saluda	523	152	147
Totals	7,877	4,125	3,349

* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.

** U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 8-V

LAND USE - AGRICULTURAL
(acres)

County	Cropland Harvested*	Cropland Pastured*	Cropland Not Harvested or Pastured*	Woodland Pastured 1/
Georgia				
Bulloch	104,836	18,258	30,784	22,720
Burke	103,196	19,394	31,345	15,543
Candler	29,142	6,005	12,212	11,433
Columbia	4,085	12,785	2,501	26,497
Effingham	21,609	4,948	9,348	12,143
Emanuel	49,190	15,811	24,354	23,887
Glascock	6,582	2,376	3,934	8,246
Jefferson	61,315	12,472	20,202	9,151
Jenkins	43,719	9,562	15,851	11,075
Lincoln	2,436	9,490	2,182	22,415
McDuffie	7,165	10,066	3,536	15,582
Richmond	10,140	4,463	4,038	22,025
Screven	73,075	13,883	23,753	22,089
Warren	15,310	13,000	6,731	18,097
Washington	51,292	17,283	16,573	21,411
South Carolina				
Aiken	59,774**	10,081**	29,895**	11,668
Allendale	63,954**	5,176**	19,080**	4,309
Bamberg	60,618	9,565	14,513	6,015
Barnwell	49,680	6,765	20,889	4,202
Colleton	45,954	14,987	22,230	65,416
Edgefield	23,845	11,986	6,756	16,087
Hampton	58,974	4,813	17,770	23,635
Lexington	45,476	10,443	15,646	10,674
Orangeburg	176,766	25,569	49,677	19,349
Saluda	27,361	33,260	7,630	23,112
Totals	1,195,494	302,441	411,430	446,781

1/ Reflected in Forests section of this report.
* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.
** U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 9-V

LAND USE - AGRICULTURAL (continued)
(acres)

County	Woodland Not Pastured[1]	Other Pasture
Georgia		
Bulloch	130,999	19,270
Burke	105,890	13,474
Candler	40,412	4,309
Columbia	19,167	10,717
Effingham	87,315	5,653
Emanuel	97,237	12,009
Glascock	19,690	2,742
Jefferson	80,667	8,981
Jenkins	51,271	6,122
Lincoln	18,446	18,024
McDuffie	31,511	10,195
Richmond	12,381	4,768
Screven	100,159	18,535
Warren	23,600	15,892
Washington	103,999	17,455
South Carolina		
Aiken	103,324	12,343
Allendale	51,012	3,044
Bamberg	43,717	4,753
Barnwell	39,806	1,325
Colleton	150,664	6,266
Edgefield	68,868	8,191
Hampton	109,138	3,937
Lexington	75,108	5,947
Orangeburg	147,045	13,840
Saluda	50,490	20,106
Totals	1,761,916	247,898

[1] Reflected in Forests section of this report.

Source: U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 10-V

TYPES OF FARMS

County	Field Crop	Vegetable	Fruit & Nut	Poultry	Dairy	Livestock	General	Misc.
Georgia								
Bulloch	264	3	5	10	4	219	656	347
Burke	388	-	1	7	14	32	76	184
Candler	236	2	1	19	-	40	170	111
Columbia	25	1	1	9	20	33	21	228
Effingham	49	2	-	14	3	60	63	281
Emanuel	271	3	2	24	4	99	265	325
Glascock	81	-	-	-	-	25	12	73
Jefferson	299	3	-	11	19	43	50	255
Jenkins	157	2	9	12	37	36	86	147
Lincoln	28	-	-	34	3	38	9	230
McDuffie	95	4	-	9	7	29	15	198
Richmond	28	1	-	9	4	25	11	136
Screven	222	4	3	9	9	102	155	210
Warren	150	-	-	6	8	40	17	128
Washington	242	18	1	18	18	54	86	294
South Carolina								
Aiken	283	20	2	59	17	62	69	517
Allendale	131	9	2	15	1	9	61	110
Bamberg	217	12	-	5	29	41	80	236
Barnwell	167	24	1	2	3	29	73	148
Colleton	331	8	1	15	7	150	109	803
Edgefield	216	4	19	14	29	22	33	327
Hampton	182	16	1	8	3	59	69	269
Lexington	239	46	20	122	13	91	83	768
Orangeburg	1,143	30	4	22	82	125	236	1,048
Saluda	150	2	9	58	75	108	49	570
Totals	5,594	214	82	511	409	1,571	2,645	7,943

Source: U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 11-V

SELECTED AGRICULTURAL UNITS SOLD: DAIRY AND POULTRY

	Dairy Products	Poultry and Poultry Products	
County	Whole Milk (lbs.)**	Broilers and Other Meat Type Chicken*	Chicken Eggs (doz.) **
Georgia			
Bulloch	4,113,278	N/A	742,324
Burke	8,447,589	-	1,013,682
Candler	N/A	D	2,095,279
Columbia	7,583,369	N/A	560,825
Effingham	2,552,140	N/A	542,747
Emanuel	1,154,165	214,000	3,706,348
Glascock	N/A	-	11,119
Jefferson	6,776,371	-	1,101,312
Jenkins	20,695,298	-	2,078,868
Lincoln	1,280,900	N/A	1,708,748
McDuffie	2,684,091	N/A	577,402
Richmond	2,726,440	-	765,394
Screven	7,464,126	N/A	710,008
Warren	3,305,233	-	250,126
Washington	8,678,695	-	4,142,318
South Carolina			
Aiken	4,315,207	3,527,176**	1,816,855
Allendale	-	- **	817,333
Bamberg	17,577,675	-	318,452
Barnwell	-	-	58,615
Colleton	6,320,381	-	683,355
Edgefield	10,039,486	-	1,016,337
Hampton	1,162,667	-	1,497,408
Lexington	2,437,857	6,039,809	3,721,452
Orangeburg	70,137,857	631,503	1,219,060
Saluda	25,963,135	1,796,518	3,730,963
Totals	215,415,960	12,209,006	34,886,360

* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.

** U. S. Bureau of the Census, Census of Agriculture, 1964

Table 12-V

SELECTED AGRICULTURAL UNITS SOLD: LIVESTOCK

County	Cattle and Calves*	Hogs and Pigs*	Sheep and Lambs*
Georgia			
Bulloch	11,946	110,736	166
Burke	10,565	15,113	-
Candler	3,965	31,698	-
Columbia	3,497	1,165	-
Effingham	3,137	20,716	-
Emanuel	8,002	40,312	50
Glascock	1,081	3,806	20
Jefferson	10,737	15,439	-
Jenkins	7,965	12,509	-
Lincoln	2,765	613	-
McDuffie	3,637	2,048	39
Richmond	1,462	4,906	-
Screven	9,601	39,506	128
Warren	4,376	12,402	56
Washington	12,139	17,779	30
South Carolina			
Aiken	4,907**	14,998**	- **
Allendale	3,142**	8,065**	6**
Bamberg	5,224	20,055	31
Barnwell	2,945	6,597	13
Colleton	8,355	30,921	-
Edgefield	4,655	3,854	52
Hampton	3,784	18,469	-
Lexington	5,135	11,980	66
Orangeburg	17,354	54,492	79
Saluda	10,945	3,578	-
Totals	150,421	501,757	730

* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.

** U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 13-V

VALUE OF AGRICULTURAL PRODUCTS SOLD

County	Crops (including field crops, vegetables, fruits and nuts)*	Poultry and Poultry Products*	Dairy Products*	Livestock and Livestock Products*
Georgia				
Bulloch	$8,124,371	$824,808	$570,256	$7,265,358
Burke	5,923,946	180,716	850,219	3,892,226
Candler	2,420,933	1,031,563	61,467	1,965,210
Columbia	75,346	781,644	307,302	673,125
Effingham	860,162	217,220	156,920	1,394,119
Emanuel	2,906,253	1,506,604	156,428	2,821,750
Glascock	307,663	-	18,595	273,952
Jefferson	3,528,772	206,513	538,390	3,160,139
Jenkins	2,100,921	1,866,914	2,245,257	4,305,734
Lincoln	31,381	1,692,257	91,000	326,671
McDuffie	216,285	392,097	367,644	815,781
Richmond	634,647	581,490	149,584	435,516
Screven	4,355,122	428,943	400,197	3,638,269
Warren	662,324	94,058	377,077	1,333,229
Washington	3,123,160	1,279,325	697,505	2,873,579
South Carolina				
Aiken	4,781,875**	2,468,714**	278,892**	864,928**
Allendale	4,813,477**	355,360**	51,277**	552,998**
Bamberg	2,555,735	278,968	1,522,049	3,013,844
Barnwell	3,097,414	570,892	214,371	746,196
Colleton	2,169,014	1,422,608	511,592	2,656,115
Edgefield	3,494,495	1,257,152	819,440	1,535,951
Hampton	3,507,838	2,265,636	115,836	1,641,861
Lexington	2,556,847	5,838,295	240,313	1,174,378
Orangeburg	8,362,837	1,537,141	6,415,476	10,988,675
Saluda	1,773,451	2,771,281	2,161,963	3,310,411
Totals	$64,384,269	$29,850,199	$33,534,050	$61,660,015

* U. S. Bureau of the Census, Census of Agriculture 1969, data booklets.

** U. S. Bureau of the Census, Census of Agriculture, 1964.

Table 14-V

FOREST LAND
(thousands of acres)

County	Total Area[2/]	Forest Area		
		Commercial	Non-Commercial	Total
Georgia[1/]				
Bulloch	438.4	242.3	-	242.3
Burke	532.5	309.3	-	309.3
Candler	160.7	88.9	-	88.9
Columbia	197.1	152.8	-	152.8
Effingham	307.2	247.8	-	247.8
Emanuel	439.0	311.9	-	311.9
Glascock	91.5	62.2	-	62.2
Jefferson	340.5	194.0	-	194.0
Jenkins	224.6	137.1	0.9	138.0
Lincoln	163.2	111.0	-	111.0
McDuffie	168.3	121.3	-	121.3
Richmond	208.6	140.2	1.0	141.2
Screven	416.3	244.7	-	244.7
Warren	181.8	111.9	-	111.9
Washington	431.4	306.9	.1	307.0
South Carolina[3/]				
Aiken	701.7	512.1	.3	512.4
Allendale	267.5	160.6	-	160.6
Bamberg	252.8	152.1	.4	152.5
Barnwell	350.9	240.7	2.5	243.2
Colleton	670.7	484.5	-	484.5
Edgefield[4/]	307.8	230.0	.2	230.2
Hampton	359.7	243.8	-	243.8
Lexington	453.1	264.6	-	264.6
Orangeburg	707.2	347.2	.6	347.8
Saluda[4/]	282.9	166.3	-	166.3
Totals	8,655.4	5,584.2	6.0	5,590.2

Sources: 1/ U. S. Forest Service, Forest Statistics for Georgia, Southeastern Forest Experiment Station, Asheville, North Carolina, 1961.

2/ U. S. Bureau of the Census, Land and Water Areas of the United States, 1960.

3/ U. S. Forest Service, Forest Statistics for the Southern Coastal Plain of South Carolina, Southeastern Forest Experiment Station, Asheville, North Carolina, 1968.

4/ U. S. Forest Service, Forest Statistics for the Piedmont of South Carolina, Asheville, North Carolina, 1967.

Table 15-V

FOREST LAND BY OWNERSHIPS
(thousands of acres)

County	National Forest	Other Public	Forest Industry	Farmer Owned	Misc. Private
Georgia[1]					
Bulloch	-	.3	26.8	153.1	62.1
Burke	-	-	52.0	238.4	18.9
Candler	-	-	10.0	63.1	15.8
Columbia	-	13.7	17.6	96.6	24.9
Effingham	-	.2	55.4	58.5	133.7
Emanuel	-	.1	61.9	124.9	125.0
Glascock	-	-	9.3	43.9	9.0
Jefferson	-	4.0	23.7	166.3	-
Jenkins	-	.1	39.4	81.4	16.2
Lincoln	-	30.6	5.5	70.9	4.0
McDuffie	-	14.9	6.1	90.6	9.7
Richmond	-	42.1	14.2	38.1	45.8
Screven	-	1.2	53.5	114.8	75.2
Warren	-	.1	16.8	81.7	13.3
Washington	-	.6	22.6	216.0	67.7
South Carolina[2]					
Aiken	-	69.5	26.6	236.5	179.5
Allendale	-	3.9	47.6	90.1	19.0
Bamberg	-	-	16.8	110.5	24.8
Barnwell	-	112.3	7.4	72.6	48.4
Colleton	-	2.4	89.7	279.0	113.4
Edgefield[3]	27.7	.2	42.1	34.6	125.4
Hampton	-	4.8	60.2	73.8	105.0
Lexington	-	.9	5.1	178.1	80.5
Orangeburg	-	6.4	28.7	247.4	64.7
Saluda[3]	4.1	.2	25.4	62.4	74.2
Totals	31.8	308.5	764.4	3,023.3	1,456.2

Sources:
[1] U. S. Forest Service, Forest Statistics for Georgia, Southeastern Forest Experiment Station, Asheville, North Carolina, 1961.
[2] U. S. Forest Service, Forest Statistics for the Southern Coastal Plain of South Carolina, Southeastern Forest Experiment Station, Asheville, North Carolina, 1968.
[3] U. S. Forest Service, Forest Statistics for the Piedmont of South Carolina, Asheville, North Carolina, 1967.

Table 16-V

GROWING STOCK VOLUME
(millions of cubic feet)

County[1]	All Species	Pine	Other Softwood	Soft Hardwood	Hard Hardwood
Georgia					
Bulloch	295.1	170.0	4.9	99.7	20.5
Burke	219.3	63.4	6.9	100.4	48.6
Candler	84.3	48.8	2.6	27.6	5.3
Columbia	121.0	78.8	-	26.1	16.1
Effingham	280.2	146.4	4.6	70.3	58.9
Emanuel	283.5	191.5	1.1	70.9	20.0
Glascock	56.7	18.5	-	22.7	15.5
Jefferson	156.5	35.0	8.0	76.3	37.2
Jenkins	160.1	53.4	7.8	47.3	51.6
Lincoln	93.8	74.1	-	5.6	14.1
McDuffie	93.7	59.6	-	22.6	11.5
Richmond	89.6	38.6	2.6	34.5	13.9
Screven	298.8	121.6	17.6	103.1	56.5
Warren	93.2	42.4	-	21.2	29.6
Washington	237.3	98.7	.5	63.5	74.6
South Carolina[2]					
Aiken	313.4	174.3	5.0	93.5	40.6
Allendale	153.4	64.0	10.9	43.5	35.0
Bamberg	149.5	43.7	23.8	56.9	25.1
Barnwell	169.0	69.7	10.1	61.2	28.0
Colleton	577.9	228.6	23.8	192.4	133.1
Edgefield[3]	253.2	194.4	1.0	34.2	23.6
Hampton	345.0	94.7	29.1	123.0	98.2
Lexington	161.2	112.6	.7	24.4	23.5
Orangeburg	398.5	122.9	32.9	157.2	85.5
Saluda[3]	177.3	121.9	-	17.5	37.9
Totals	5,261.5	2,467.6	193.9	1,595.6	1,004.4

Sources: [1] U. S. Forest Service, Forest Statistics for Georgia, Southeastern Forest Experiment Station, Asheville, North Carolina, 1961.

[2] U. S. Forest Service, Forest Statistics for the Southern Coastal Plain of South Carolina, Southeastern Forest Experiment Station, Asheville, North Carolina, 1968.

[3] U. S. Forest Service, Forest Statistics for the Piedmont of South Carolina, Asheville, North Carolina, 1967.

Table 17-V

ANNUAL FOREST GROWING STOCK REMOVALS[1]

County	Volume Sawtimber[2] (millions of cu. ft.)	Volume Pulpwood[3] (standard cords)	Value (delivered-to-mill price) Sawtimber[4]	Value (delivered-to-mill price) Pulpwood[4]
Georgia				
Bulloch	5.9	51,040	$ 1,575,300	$ 969,760
Burke	3.9	56,683	1,041,300	1,076,977
Candler	1.9	24,639	507,300	468,141
Columbia	2.3	40,898	614,100	777,062
Effingham	5.9	45,595	1,575,300	866,305
Emanuel	2.7	86,728	720,900	1,647,832
Glascock	.3	5,214	80,100	99,066
Jefferson	4.8	35,128	1,281,600	667,432
Jenkins	.6	29,592	160,200	562,248
Lincoln	.6	29,119	160,200	553,261
McDuffie	3.1	22,297	827,700	423,643
Richmond	.6	13,757	160,200	261,383
Screven	4.5	45,133	1,201,500	857,527
Warren	1.1	23,996	293,700	455,924
Washington	6.9	58,488	1,842,300	1,111,272
South Carolina				
Aiken	4.0	51,193	1,068,000	972,667
Allendale	4.0	25,336	1,068,000	481,384
Bamberg	*	29,155	*	553,945
Barnwell	3.3	24,625	881,100	467,875
Colleton	28.1	68,858	7,502,700	1,308,302
Edgefield	2.1	73,542	560,700	1,397,298
Hampton	5.0	39,980	1,335,000	759,620
Lexington	4.2	34,655	1,121,400	658,445
Orangeburg	9.2	45,805	2,456,400	870,295
Saluda	3.1	51,694	827,700	982,186
Totals	108.1	1,013,150	$28,862,700	$19,249,850

* Because of the sampling errors in some of the publications, it was impossible to estimate sawtimber removals for each county.

(continued)

Table 17-V (continued)

Sources: 1/ U. S. Department of Agriculture, Forest Service Resource Bulletins.

2/ Sawtimber removals were found in each county by subtracting pulpwood removals (shown in column 2) from the total growing stock removals (Table 9, U. S. Department of Agriculture Forest Service Resource Bulletins).

3/ U. S. Department of Agriculture, Southern Pulpwood Production, 1970.

4/ Estimated delivered to the market averages suggested by personnel at the U. S. Department of Agriculture's Southeastern Forest Experiment Station in Asheville, North Carolina (sawtimber - $267.00 per thousand cubic feet, pulpwood - $19.00 per cord) were used in arriving at the dollar values shown in columns 3 and 4.

Table 18-V

PUBLIC OUTDOOR RECREATION AREA

(acres)

County	Land	Water
Georgia[1]		
Bulloch	32	23
Burke	36	-
Candler	10	-
Columbia	9,224	9,967
Effingham	14	-
Emanuel	6,434	-
Glascock	1	-
Jefferson	4	-
Jenkins	1,154	73
Lincoln	23,160	29,335
McDuffie	10,663	4,041
Richmond	375	1,334
Screven	25	-
Warren	129	-
Washington	1	-
South Carolina[2]		
Aiken	1,050	20
Allendale	-	-
Bamberg	390	-
Barnwell	305	30
Colleton	347,887	1,200
Edgefield	-	-
Hampton	5,700	300
Lexington	95	10
Orangeburg	3,200	238
Saluda	-	-
Totals	409,887	46,571

Sources: 1/ Georgia State Planning Bureau, Inventory of Public Outdoor Recreation Areas, April 1967.
2/ Bureau of Outdoor Recreation, Department of the Interior, Public Outdoor Recreation Area Inventory for South Carolina, 1965.

Table 19-V

INDUSTRY

County	Total Establishments	Food & Kindred Products	Textile & Apparel Products	Lumber & Wood Products (Including Paper, Printing & Publishing)	Chemicals & Allied Products	Stone, Clay & Glass Products	Fabricated Metal Products	Other
Georgia								
Bulloch	39	7	3	18	1	4	2	4
Burke	26	2	3	14	3	2	1	1
Candler	8	1	1	6	-	-	-	-
Columbia	23	-	1	14	-	2	1	5
Effingham	35	1	1	32	1	-	-	-
Emanuel	45	11	4	27	-	-	-	3
Glascock	5	1	1	3	-	-	-	-
Jefferson	41	6	4	23	1	-	-	7
Jenkins	13	1	11	-	-	-	1	-
Lincoln	30	1	1	28	-	-	-	-
McDuffie	26	4	2	15	1	1	1	2
Richmond	145	24	13	52	11	10	8	27
Screven	38	5	2	27	2	2	-	-
Warren	7	1	1	5	-	-	-	-
Washington	65	6	3	51	-	3	-	2
South Carolina								
Aiken	73	10	16	28	4	4	3	8
Allendale	19	3	2	11	1	1	-	1
Bamberg	26	3	5	15	-	1	-	2
Barnwell	15	1	3	7	1	1	-	2
Colleton	44	4	6	32	-	1	-	1
Edgefield	54	1	6	42	-	1	-	4
Hampton	42	5	2	31	3	-	-	1
Lexington	134	20	13	56	5	11	10	19
Orangeburg	99	15	11	55	6	4	3	5
Saluda	29	4	6	16	1	1	-	1
Totals	1,081	137	121	594	41	49	30	95

Source: U. S. Bureau of the Census, Census of Manufactures, 1967.

Table 20-V

LAND USE FOR ROAD AND HIGHWAY RIGHT-OF-WAY

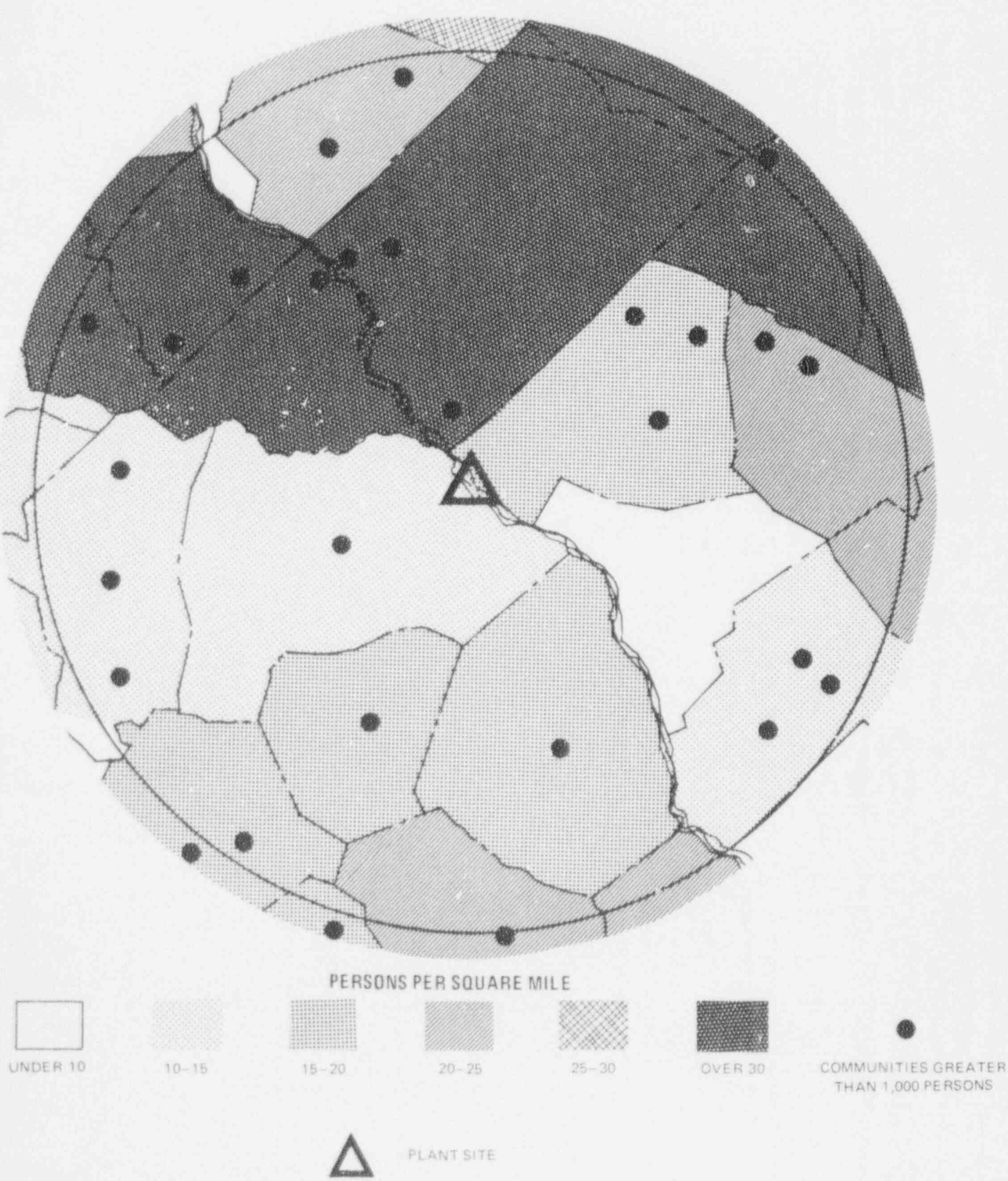
County	County Roads (80' right-of-way)		State and Federal Roads (130' right-of-way)	
	Miles	Acres	Miles	Acres
Georgia[1/]				
Bulloch	1,083	10,830	160	240
Burke	896	8,960	202	303
Candler	374	3,740	70	105
Columbia	300	3,000	149	224
Effingham	476	4,760	91	137
Emanuel	824	8,240	240	360
Glascock	180	1,800	49	74
Jefferson	597	5,970	166	249
Jenkins	402	4,020	101	151
Lincoln	247	2,470	65	97
McDuffie	298	2,980	94	141
Richmond	302	2,020	362	543
Screven	656	6,560	100	150
Warren	315	3,150	92	138
Washington	781	7,810	146	219
South Carolina[2/]				
Aiken	1,022	10,220	259	388
Allendale	411	4,110	49	74
Bamberg	474	4,740	49	74
Barnwell	554	5,540	12	18
Colleton	796	7,960	125	188
Edgefield	480	4,800	60	90
Hampton	423	4,230	71	106
Lexington	928	9,280	287	430
Orangeburg	1,205	12,050	212	318
Saluda	551	5,510	50	75
Totals		145,750		4,882

Sources: 1/ State Highway Department of Georgia, Mileage of Public Roads in Georgia, July 1, 1970.

2/ State Highway Department of South Carolina, Mileage Summary Record by Counties as of February 29, 1972.

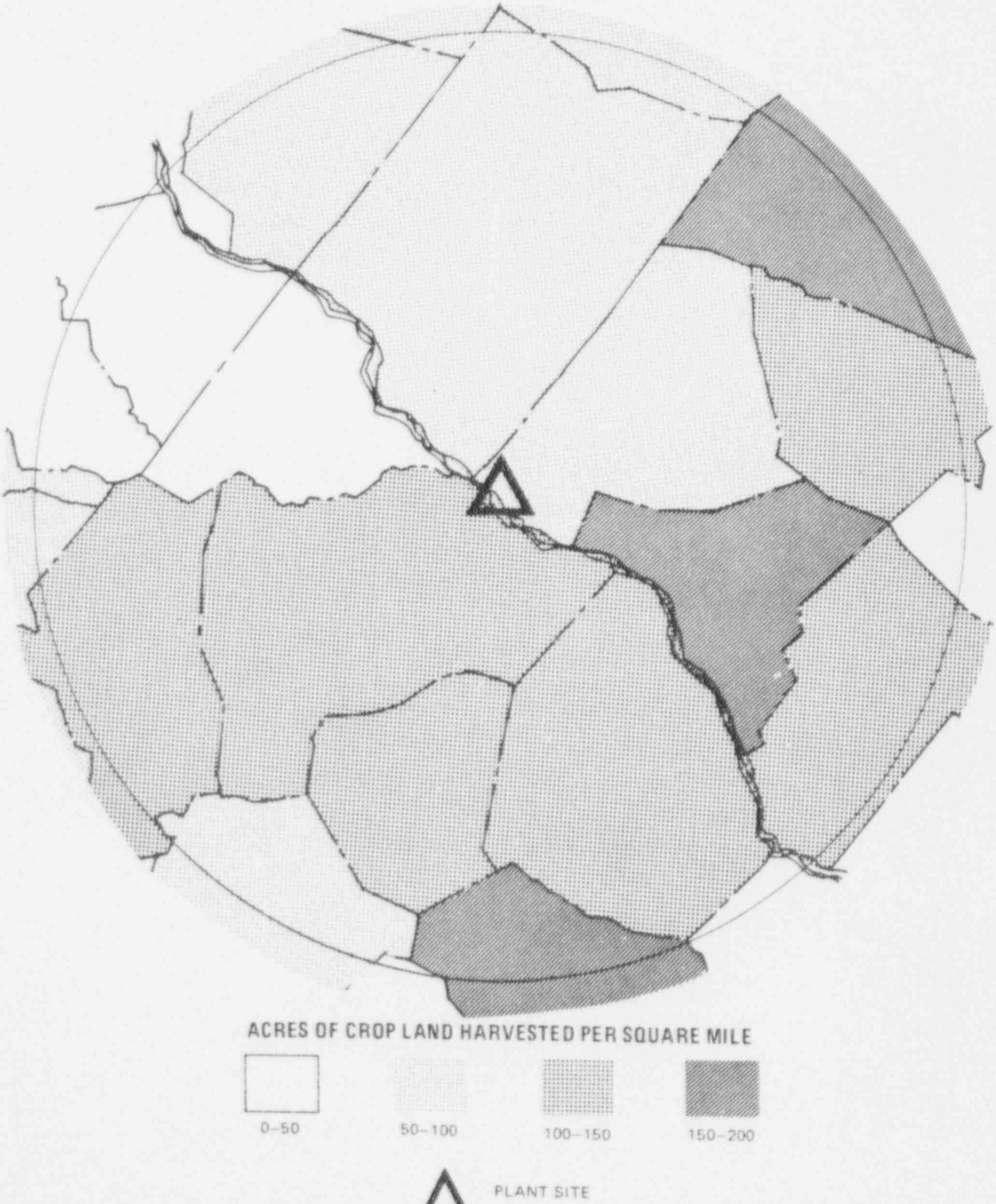
MAP 1–V

ALVIN W. VOGTLE PLANT SITE STUDY AREA
POPULATION DENSITIES



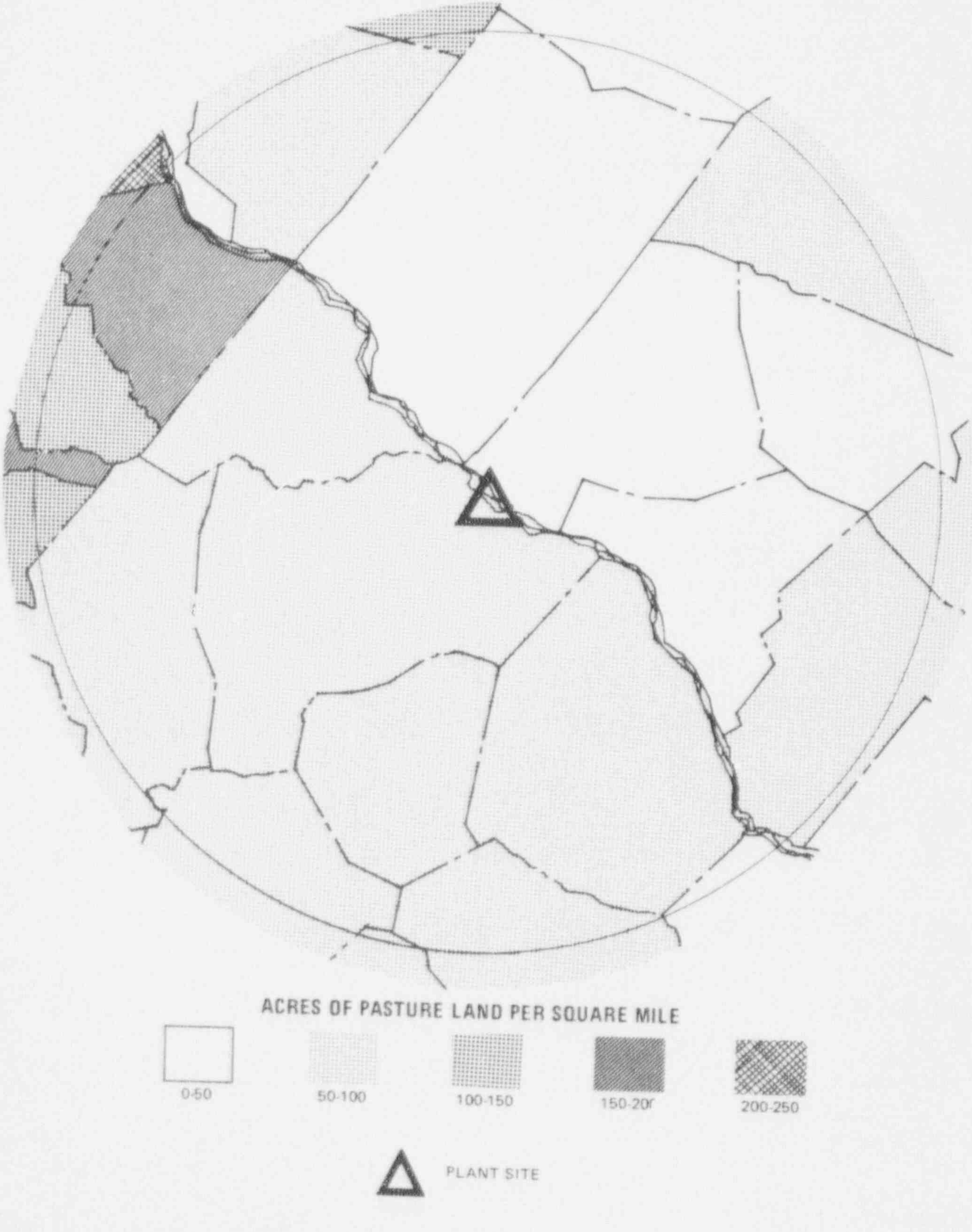
MAP 2-V

ALVIN W. VOGTLE PLANT SITE STUDY AREA
CROP LAND DENSITY



MAP 3–V

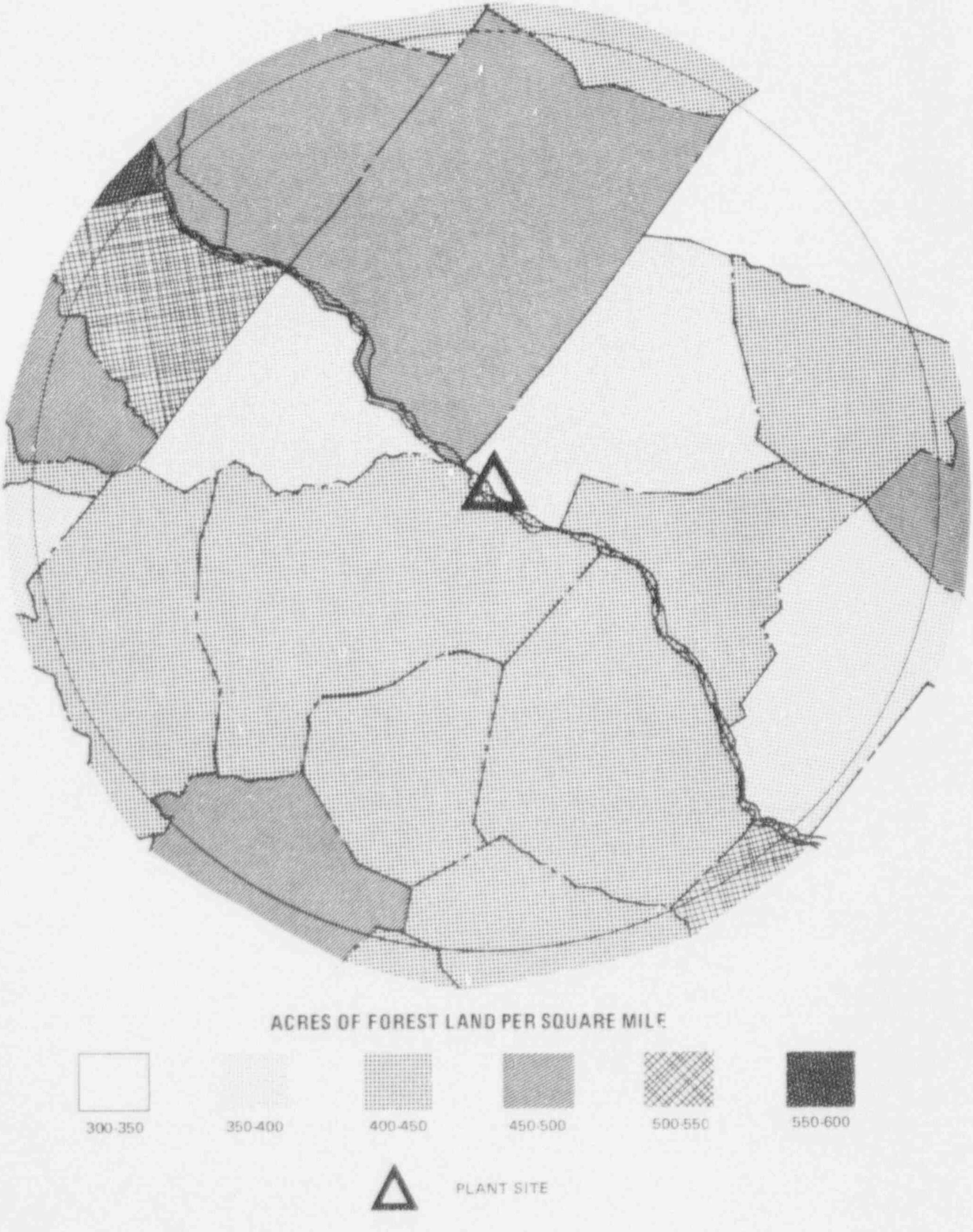
ALVIN W. VOGTLE PLANT SITE STUDY AREA
PASTURE LAND DENSITY



MAP 4–V

ALVIN W. VOGTLE PLANT SITE STUDY AREA

FOREST LAND DENSITY



RESPONSES TO AEC QUESTIONS ON THE VOGTLE NUCLEAR PLANT ENVIRONMENTAL REPORT (DATED APRIL 11, 1973)

1. Site and Environs

1a. Question

Paragraphs 2.5.4 of the ER and 2.4.13 of the PSAR present an extensive discussion and survey of local wells. Identify in Table 2.5-8 (ER), Table 2.4-4 (PSAR) or on Figure 2.4.13-1 (PSAR) which of the local, offsite wells is closest to the plant and state the distance from the plant.

Response

A discussion of the nearest well to the plant site and its distance from the plant have been added to Section 2.5.

1b. Question

Discuss what information is available on the Indian Village located between the town of Shell Bluff and Boggy Gut Creek, when it was occupied and state how far it is in air miles from Unit 1.

Response

The information available on the Indian Village located between Shell Bluff and Boggy Gut Creek is discussed in Section 2.3. It is not known precisely when this town was occupied; however, an arrowhead estimated to be 4,000 years old has been found at the site.

1c. Question

During the site visit, arrowheads and pieces of pottery were found in the outcropping of the bluff where the intake and discharge facilities are proposed to be located. Discuss arrangements that have been made with state agencies for archaeological surveys of the site during construction. Discuss plans for archaeological excavations at the site if the surveys should indicate that the site is of potential archaeological significance.

Response

GPC's plans for archaeological surveys and potential excavations of the site are discussed in Section 2.3.

1d. Question

Discuss the general housekeeping procedures that will be followed to minimize dust from operation of the concrete batch plant.

Response

The steps to be taken to minimize dust from operation of the concrete batch plant are given in Section 4.1.

1e. Question

Clarify the variation on Pages 4.2-4 and 4.3-2 on open burning of debris during land clearing and construction activities.

Response

The variation in GPC's policy on open burning has been eliminated by correcting Page 4.3-2.

1f. Question

Include the number of beds and occupancy rates for the Burke County Hospital, the Andress Nursing Home, the Keysville Nursing Home, the Pine Intermediate Care Home, and the Thompson Hospital.

Response

Information about the number of beds and occupancy rates for the Burke County Hospital, the Andress Nursing Home, the Keysville Nursing Home, the Pine Intermediate Care Home and the Thompson Hospital are given in Subsection 2.2.5.

2a. Question

There appear to be arithmetical errors and internal inconsistencies in the water quality data given in the Environmental Report (ER). The cations and anions of some analyses are out-of-balance by a significant percentage (10-50%). In a number of the tables the TDS value given is significantly lower (up to 50%) than the sum of mineral constituents. Other derived values such as TH, PA and TA should be rechecked. Ammonia concentration should be specified.

Response

Arithmetical errors have been corrected in Table 2.5-4. TDS values being lower than the sum of mineral constituents is consistent with standard analytical methods used as discussed in Subsection 2.5.3. The ammonia concentration has been added to Table 2.5-3.

2b. Question

Explain how Table 3.7-1, "Typical Savannah River Water Quality Analyses", and Table 3.7-2, "Well Water Analyses", were constituted, and any relationships with Table 2.5-3, "Savannah River Water Quality Analysis by GPC", Table 2.5-4, "Savannah River Water Quality Analysis by USGS", and Table 2.5-6, "Water Quality Analyses Observation Holes".

Response

An explanation of how Table 3.7-1 was constituted was added as a footnote to that Table. An explanation of how Table 3.7-2 was constituted was added to Section 3.7.

The relationship between Tables 3.7-1 and 3.7-2 and Tables 2.5-3, 2.5-4, and 2.5-6 is given below:

1st Table	2nd Table	Relation of 1st Table to 2nd Table
3.7-1	2.5-3	Table 3.7-1 is based on the average parameters of Table 2.5-3
3.7-1	2.5-4	No relation (Table 2.5-4 was provided as information as requested in the ER guide)
3.7-1	2.5-6	No relation (see Subsection 2.5.4; Table 3.7-1 is river water and Table 2.5-6 is observation hole water)
3.7-2	2.5-3	No relation (Table 3.7-2 is well water and Table 2.5-3 is river water)
3.7-2	2.5-4	No relation (Table 3.7-2 is well water and Table 2.5-4 is river water)
3.7-2	2.5-6	No relation (see Subsection 2.5.4)

In addition, Table 2.5-3 (rather than Table 2.5-4) was chosen as the reference water quality analysis for river water for use in Chapter 3 (see Table 3.7-1) as stated in Subsection 2.5.3.

2c. Question

Give a breakdown of the composition of the 125 ppm TDS expected in the Steam Generator Blowdown (ER, Page 3.7-2, paragraph 4 and amendment Page 3.7-6, paragraph 4).

Response

The composition of 125 ppm TDS expected in the Steam Generator Blowdown is given in Section 3.7.

2d. Question

Update Figure 3.4-1, "Schematic Diagram, Water Cycle for Units 1 and 2", to reflect the flow changes due to the changeover from Mechanical Draft to Natural Draft Cooling Towers.

Response

Figure 3.4-1 has been deleted. The information it contained can be found on Figure 3.7-1, which shows the correct cooling towers. Figure 3.7-1 is now referenced in Section 3.4 (see page 3.4-1). Figure 3.4-2 was also eliminated since duplicate information is contained in Figure 3.7-1.

2e. Question

Indicate the kinds and amounts of waste chemicals generated during pipe-cleaning and startup operations and how they will be disposed.

Response

The kinds and amounts of waste chemicals generated during pipe-cleaning and startup operations are given in Subsection 3.7.6.

2f. Question

With regard to chlorination, please clarify the design information in Figures 3.4-1 and 3.7-1 by including the exact location of all chlorine injection points in the circulating water systems relative to tower basins, blowdown pipes and circulating water pumps. Explain calculation "b", ER, Page 3.7-5. In addition to chlorination of the Condenser and the Nuclear Service Cooling Tower Systems, the ER mentions chlorination at the discharge of the Makeup Water Pumps at the River Intake Structure. Describe the level and frequency of chlorine injection at the Intake Structure, and indicate how the chlorination schedule of all the individual systems will result in a level of total residual chlorine in the liquid effluent released to the river which is as low as practicable. Include the expected residual chlorine level (free and combined) at the outfall. Describe calculations used to estimate this value, including estimates of chlorine residence time from each of its injection points to the mixing chamber of the discharge structure.

Response

Chlorine injection points have been shown on Figure 3.7-1. (Note that Figure 3.4-1 has been eliminated as discussed in the response to question 2d.)

A modification has been made to calculation "b" on page 3.6-5 which clarifies this calculation.

The philosophy of the chlorine injection operation is discussed in Section 3.7. At the Intake Structure, chlorine injection will be sufficient to achieve a peak free chlorine residual of 2.0 ppm, and the frequency of injection will be sufficient to maintain the conduits. The overall schedule for chlorination will maximize dilution available from other generating units, the blowdown from the nuclear service cooling tower and all other plant liquid discharges in order to achieve a level of total residual chlorine as low as practicable.

The peak free chlorine residual at the outfall structure is expected to be 2 ppm and is expected to be reduced to .04 ppm at the end of the mixing zone. The amount of combined chlorine cannot be given at this time because of the uncertainties in the chlorine demand of the circulating water. Estimates of the residence time from the injection point to the mixing chamber can be made from residence times presented for the circulating water system, the discharge line blowdown and the mixing chamber.

2g. Question

Give details of the measurements of chlorine demand of the Savannah River water. Two values are mentioned -- 1.3 ppm, for 30 minutes contact time (ER, Page 3.7-4), and 2.4 ppm for a 30 second contact time (ER, Page 3.7-12).

Response

The details of measurements of the chlorine demand of the Savannah River are given in Section 3.7 in Table 3.7-1a.

2h. Question

Discuss how chlorine concentrations in the plant effluent will be monitored.

Response

The chlorine monitoring system is discussed in Section 3.7.

2i. Question

Provide design information for the temporary sanitary waste system and the installation schedules for both the temporary and permanent sanitary systems relative to the number of persons and services anticipated during the construction and operation periods. Explain the large difference between the capacities of the sanitary water supply (432,000 gpd, Figure 3.4-2) and waste system (40,000 gpd, Figure 3.7-11).

Response

The design information for the sanitary waste system is discussed in Subsection 3.5.5. Both the temporary and permanent package sanitary waste systems will be operational 4 months after date of issuance of the construction permit.

The 432,000 gpd was derived from the value of 300 gpm given in Figure 3.4-2. The 300 gpm value is a maximum flow which will not occur continuously, whereas the 40,000 gpd is in excess of the expected maximum daily flow during construction (note that Figure 3.4-2 has been eliminated; see response to question 2d).

2j. Question

Discuss the general approach to minimize oil leakages from operating equipment in the station.

Response

Minimization of oil leakages is discussed in Section 3.8.

2k. Question

Identify and list the maximum expected annual amounts of all chemicals, including detergents and corrosion inhibitors (except reagent chemicals), expected to be used and discharged annually at VNP. Indicate their maximum discharge concentrations and the estimated duration (i.e., hours per day, hours per week, etc.) of these maximum releases.

Response

The maximum expected annual amounts of chemicals to be used is given in Section 3.7 along with the concentrations and flow rates of the discharge for the minimum and maximum operating conditions expected (4 cycles and 8 cycles).

3. Detention Basins and Erosion Control

3a. Question

Provide information on the design and operation of the three construction silt and debris detention basins and the temporary detention basin shown in Figure 1.2-2.

Response

There are 2 silt and debris detention basins to be constructed. Information on the design and operation of these 2 basins is given in Section 4.3. An additional detention basin already exists on the site north of the power block as discussed in Section 4.4 and will serve a similar purpose. These basins are shown on Figure 2.1-3. Figures 4.3-3 and 4.3-4 have been deleted. The information they contained is now included in Figure 4.3-2.

3b. Question

The ER states that no effects of siltation from construction activities are expected on Beaver Dam Creek and Daniels Branch. Indicate the maximum runoff rate for which these basins will be designed and the retention time under this condition. Discuss disposition of collected silt and what will be done with the basins after construction.

Response

The information requested on protecting Beaver Dam Creek from siltation is provided in Section 4.3. The maximum runoff rate that can be handled is equivalent to that associated with a storm with a recurrency period of 25 years.

3c. Question

Elaborate on the techniques to be used for the prevention of erosion losses during construction. Describe the extent to which temporary ground cover will be planted during construction to minimize erosion losses. Include information on proposed management of spoil deposition areas.

Response

Additional information on erosion control during construction and management of spoil deposition areas has been added to Sections 4.3 and 4.4.

4. Transmission Line Construction and Maintenance

4a. Question

Define more precisely what is meant by "insofar as it is feasible and practical, route selection will conform to..."
The guidelines in the Department of Interior/Department of Agriculture publication "Environmental Criteria for Electric Transmission System" are rather broad in scope.

Response

An explanation of how the guidelines in the Department of Interior/Department of Agriculture publication "Environmental Criteria for Electric Transmission System" will be applied is contained in Section 5.4.

4b. Question

Discuss Georgia Power's general policies, procedures and criteria for selecting transmission line routes, including considerations given to avoiding possible conflicts with areas where adverse effects on the existing environment will result. Discuss general policies and practices for clearing and restoring cover plants in transmission corridors, right-of-way maintenance procedures (including usage of herbicides) and the land management program offered to property owners.

Response

GPC's general policies, procedures and criteria for selecting transmission line routes are given in Section 5.4. Policies and practices for clearing and maintaining rights-of-way are discussed in Section 5.4.

4c. Question

Provide an estimate of the land area required for construction of lattice type and 'H' frame tower structures and the approximate percentage of this land which cannot be restored (i.e., covered with concrete).

Response

The land area required for construction of lattice type and 'H' frame tower structures and the approximate percentage of this land which cannot be restored is given in Section 5.4. Diagrams containing information on the land used by the towers are found on Figures 5.4-4 and 5.4-5.

4d. Question

Provide an estimate of the number of times new transmission lines associated with the Vogtle Plant will cross railroad tracks and explain briefly the guidelines used to prevent direct faulting or flashover at these crossing points. If the transmission lines will closely parallel railroad tracks, explain how the possibility of inductive coupling will be minimized.

Response

No interaction is expected between transmission lines and railroad tracks as stated in Section 5.4. The number of times new transmission lines cross railroad tracks and the requested guidelines are given in Section 5.4.

4e. Question

For the corridors identified in Section 5.4.1.1, discuss the feasibility of utilizing existing right-of-way for sections of the lines, including the effects on overall costs, system reliability and land requirements.

Response

As discussed in Section 5.4, GPC will use existing transmission line rights-of-way where feasible and the effects on overall costs, system reliability and land requirements will be taken into account. Because final routes have not been selected at this time, neither the extent of using existing transmission line rights-of-way nor the details on cost, system reliability and land requirements are known.

4f. Question

Discuss the effects of ozone formation from high voltage transmission lines on surrounding vegetation and wildlife.

Response

Ozone formation from high voltage transmission lines is discussed in Section 5.4.

4g. Question

Discuss an alternate arrangement of putting Units 1 and 2 at the proposed Vogtle site and Units 3 and 4 in north Georgia from the standpoint of the effect of transmission line acreages, transmission distances and power losses.

Response

The alternate arrangement of putting Units 1 and 2 at the proposed Vogtle site and Units 3 and 4 in north Georgia is discussed in Subsection 8.4.3.

5. Effects of Siltation on Aquatic Biota

5a. Question

For intake and discharge structures and the barge slip, discuss the following:

(1) The procedure to be followed during excavation and construction to minimize siltation in the river.

(2) The general design criteria for the intake and discharge structures (i.e. installation on river bank vs use of inlet and discharge canals).

(3) Methods of disposing of dredged and excavated material.

(4) Estimated timing of construction with respect to spawning season.

(5) Length of river bank and area of river bottom that will be excavated.

Response

(1) The procedure to be followed during excavation and construction to minimize siltation in the river is discussed in Section 4.4.

(2) The design of the intake and discharge structures is given in Section 3.5.

(3) The method of disposing of dredged and excavated material is discussed in Subsection 4.4.1.

(4) The schedule for construction with respect to spawning is discussed in Section 4.4.

(5) The length of river bank and area of river bottom that will be excavated is given in Section 4.4.

5b. Question

Provide an estimate of invertebrate populations from the areas of the river which are likely to be subjected to siltation. Based on observations to date, indicate whether the area subject to siltation is an important spawning ground for resident and anadromous fishes.

Response

The estimated invertebrate populations in areas of the river which are subject to siltation are given in Section 4.4. The program to determine the amount of spawning in the area is given in Section 4.4.

5c. Question

The relative abundance of 5 species of aquatic macrophytes is provided in the Environmental Report. Provide data on the density and effectiveness of these areas as shelters for fish fry in the areas expected to be subjected to siltation.

Response

Data on aquatic macrophytes with respect to shelters for fish fry is given in Section 4.4.

6. Main Heat Dissipation Systems

6a. Question

Provide an estimate of the amount and composition of corrosion products that will be introduced into the plant effluent from corrosion of the condenser tubes.

Response

The estimated amounts of corrosion products from the condenser tubes that will be introduced into the plant effluent are given in Section 3.5.

6b. Question

State how silt which collects in the cooler tower basins will be removed and the method that will be used to dispose of the silt.

Response

Removal and disposal of silt from the cooling tower basins is discussed in Section 3.5.

6c. Question

Furnish the lengths and diameters of pipe to and from the natural draft cooling towers to the condenser.

Response

The lengths and diameters of pipe to and from the cooling towers to the condenser is given in Section 3.5.

6d. Question

Give a reference for the "TVA formula" given on Page 5.1-5 and used to evaluate the potential environmental effects from cooling tower operation.

Response

The "TVA formula" is provided in Section 5.1, and the reference is given at end of that section.

6e. Question

Makeup and blowdown are expected to vary seasonally. Discuss the operation of the towers, including expected number of cycles of concentration as a function of month of year and the river water flow rate.

Response

The operation of the cooling towers is discussed as a function of season in Section 3.5. The makeup and blowdown are not functions of river flow.

6f. Question

Describe the fill material to be used in the cooling water tower and what impurities the fill material will introduce into the blowdown water.

Response

The fill material to be used in the cooling towers and the impurities introduced into the blowdown are given in Section 3.5.

6g. Question

What is the estimated total volume of water in the cooling circuit for each unit?

Response

The total volume of water in the cooling circuit for each unit is given in Section 3.5.

6h. Question

What are the air flows (volumes), temperatures, and exit air velocities from the natural draft cooling towers?

Response

The air flows, temperatures and exit air velocities from the cooling towers are given in Section 3.5.

6i. Question

How many hours per year will the wet bulb temperature be above 78°F and what extremes will be reached?

Response

The hours per year when the wet bulb temperature will be above 78°F and the extreme reached are given in Section 3.5

7. Intake Structure

7a. Question

Describe the design criteria that will be followed to minimize impingement and entrapment of fish in the trash racks and traveling screens.

Response

The design criteria that will be followed to minimize impingement and entrapment of fish in the trash racks and traveling screens are given in Section 3.5.

8. Discharge Structure

8a. Question

Describe the design criteria that will be followed to promote mixing and dilution of the plant effluent with the river water.

Response

The design used to promote mixing and dilution of the plant effluent with the river is discussed in Section 3.5.

9. Thermal Effects

9a. Question

Estimate the size of the mixing zone in which the river water temperature will be increased more than 5°F above the ambient river water temperature.

Response

The size of the mixing zone in which the river water will be increased more than 5°F above ambient river water temperature is given in Section 3.5.

9b. Question

Provide estimates of expected plume dimensions showing areas affected (by 1°F isotherms down to 1°F above intake water temperature) at representative seasonal temperatures and at average minimum river flow conditions.

Response

Estimates of the plume dimensions showing the areas bounded the 5°F isotherm at representative seasonal temperatures and minimum river flow conditions are given in Section 3.5. Plume dimensions by 1°F isotherms are not available at this time.

10. Need for Power, Alternative Plants and Sites, and Benefit/Cost Analysis

10a. Question

Discuss role of hydroelectric power in Georgia Power Company (i.e., peaking vs base loads) and whether hydroelectric plants could be a substitute for steam generating plants.

Response

The role of hydroelectric power in GPC and its possibility as a substitute for steam power are discussed in Section 8.3.

10b. Question

List the monthly peak power demands for the GPC and Southern Company during each of the years from 1960 to date.

Response

Monthly peak power demands for GPC and the Southern Company during the years 1960 to date are given in Tables 1.2-4a and 1.2-5a.

10c. Question

List the total annual (KWH) sales of each Division of the GPC during each year from 1960 to date.

Response

The annual (KWH) sales of each division of GPC during each year from 1960 to date are given in Table 1.2-2.

10d. Question

Provide the sources of purchased power listed in Tables 1.2-11 and 1.2-13 for GPC and in Tables 1.2-12 and 1.2-14 for the Southern Company. State whether these purchases have firm reserves associated with them.

Response

The sources and reserves associated with GPC and the Southern Company purchased power are given in Tables 1.2-15a and 1.2-16a, respectively.

10e. Question

Provide a reference to Georgia law under which GPC operates as a public utility and which mandates that GPC make adequate provision for the supply of electricity to its customers (ER, Page 8.1-1).

Response

Reference to the Georgia law under which GPC operates as a public utility has been added in Section 8.1.

10f. Question

Elaborate on the consequences of GPC being unable to meet its load obligations (ER, Page 1.4-1). Discuss plans for load shedding if demand exceeds load.

Response

The description of GPC's load shedding plans has been expanded and is discussed in Section 1.4.

10g. Question

Based on the experience at Hatch and Farley, provide the approximate percentages of the capital costs of construction that are likely to be spent in the Central Savannah River area and within the State of Georgia.

Response

As estimate of percentages of capital costs of construction to be spent in the Central Savannah River area and within Georgia are given in Section 4.2. These estimates are based on Bechtel Power Corporation (Norwalk, California) experience. Information based on experience at Hatch and Farley is not available.

10h. Question

Provide an estimate of the average per mile construction costs for 230 and 500 kV transmission facilities and the average assessed valuation per mile of GPC's 230 and 500 kV transmission lines.

Response

Construction costs and assessed valuations per mile for 230 kV and 500 kV lines are given in Section 4.2.

10i. Question

Since the combustion turbine plant is now operational, Burke County's tax revenue has been increased significantly with only a minimal requirement for increased governmental services attributable to the plant. The increased tax revenue will be available for several years prior to the arrival of non-area workers for the Vogtle project. Discuss the projected estimates of tax revenue from the combustion turbine plant and associated transmission facilities and how this increased revenue could be used by the County to plan and prepare for the 510 to 760 non-area workers (Page 4.2-1) that you estimate will be utilized during the peak construction period.

Response

Estimates of tax revenues from the combustion turbine plant are located in Section 4.2. Suggested uses of these revenues by the County are found in Section 4.2.

10j. Question

Discuss the reason why costs were levelized on an annual basis before computing present worth (Page 11-D-2).

Response

The calculation of total present worth of generating costs is most conveniently done by first obtaining the levelized annual generating costs and then converting to a present worth figure. These calculation in Attachment D to Chapter 11 have been revised to more accurately reflect the total cost of generation.

10k. Question

State whether the annualized generating cost shown in Table 11-A-1 is in accord with your present discount rate.

Response

The generating costs shown on Page 11-A-1 were in error and have been corrected.

101. Question

In Table 8.3-1, explain the 17.8% factor associated with fuel cycle costs and whether a cost escalation component is included in the 4 mils/kW hr. estimated for fuel, O & M and nuclear insurance.

Response

Footnote (7) to Table 8.3-1 has been added to indicate the components of the 17.8%. Escalation was included in the fuel, O & M and nuclear insurance as is now indicated in footnote (8) to Table 8.3-1.

10m. Question

Identify possible or probable location of:

(1) new fuel supplier

(2) spent fuel reprocessor

(3) radioactive waste disposal site

Response

(1) The initial fuel supply for each of the VNP units will be fabricated by Westinghouse. At present, the Westinghouse fabrication facilities are located in Columbia, South Carolina. Subsequent fuel for VNP could be supplied either by Westinghouse or by other qualified fabricators at other locations.

(2) Spent fuel shipping and reprocessing services are presently being offered by suppliers with facilities either planned, under construction or operating in the states of New York, Illinois, and South Carolina. Reprocessing of VNP fuel could be performed at these locations or at other locations in facilities to be planned, built and operated in the future.

(3) The 2 nearest potential sites being considered by GPC are in Barnwell, South Carolina (Chem-Nuclear Services, Inc.), and in Morehead, Kentucky (Nuclear Engineering Company, Inc.).

11. Miscellaneous

11a. Question

At river flow rates of 5800, 6300 and 10,150 cfs, provide data on the river elevation, width and average velocity in the vicinity of the intake and discharge structures.

Response

River flow and velocity are plotted vs. elevation in a continuous function on figure 2.5-3a. A diagram showing river width vs. elevation is given in Figure 2.5-3b.

11b. Question

Provide information on the size, air flow, exit air velocity, fan power and estimated noise level for the nuclear service cooling towers.

Response

The requested information has been added to Subsection 3.5.6.

11c. Question

Furnish a revised Table 2.6-3 (Page 2.6-11).

Response

Table 2.6-3 has been revised.

11d. Question

Furnish additional information to substantiate the statement in the ER (Page 2.2-5) that barge traffic on the Savannah River has decreased markedly in recent years.

Response

Information on the decrease in barge traffic on the Savannah River is given in Section 2.2.

11e. Question

Describe the environmental effects of the auxiliary power generation units (auxiliary boiler and diesel generator) to be used at Vogtle.

Response

The auxiliary boiler has been eliminated. The environmental effects of the diesel generators are discussed in Section 3.8.

11f. Question

Identify location and elevation of gaseous release point(s) together with relation to centers of containment for each unit.

Response

The locations of the gaseous release points are shown in Figure 3.6-6 and the elevations are given in Section 3.6.

11g. Question

In Table 5.2-6 (ER, Page 5.2-13), indicate whether the summation figure at the bottom of column 9 is as given or should be changed to 1.2×10^{-6}.

Response

The summation figure at the bottom of column 9 in Table 5.2-6 is correct. Two of the items in the column were in error and have been corrected.

11h. Question

The average annual flow of the Savannah River cited in several references (e.g., Page 5.2-14, ER) is 10,150 cfs (9×10^{15} cm^3/yr.). Explain why a flow rate of 1.1×10^{15} cm^3/yr. was used in Volume VII, Page 11.6-28 (PSAR) for the aqueous ingestion rate model. Indicate which flow rate was used in liquid effluent dose calculations.

Response

The aqueous ingestion rate method in the PSAR is being updated to incorporate a flow rate of 10,150 cfs.

11i. Question

In Table 11.6-11 (Volume VII, PSAR, Page 11.6-41), the sensitivity for I^{131} in milk samples is given as 20 p Ci/liter, corresponding to a calculated annual dose to an infant thyroid of 125 mrem (well in excess of the proposed design objective of 5 mrem per year).

Response

This question will be answered at a later date.

11j. Question

A tentative schedule for the operational monitoring program was given in Table 11.6-10 (PSAR, Page 11.6-35). Outline the preoperational monitoring programs for soil, green leafy vegetables (if obtainable within reasonable distance) and pasture grass. Indicate whether the soil analyses will include determination of plutonium.

Response

This question will be answered at a later date.