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CLINCH RIVER
BREEDER REACTOR PLANT
ENVIRONMENTAL REPORT

VOLUME V

PROJECT MANAGEMENT CORPORATION

AMENDMENT I

Additional Information for Detailed
Environmental Assessment of the Clinch
River Breeder Reactor Plant (CRBRP) Site

INTRODUCTION - PART I, Responses to NRC letter, November 19, 1974

Amendment I, Part I, to the Clinch River Breeder Reactor Plant Environmental Report contains copies of questions and/or statements requiring resolution or additional information. These questions and statements were submitted to the Project as Enclosures 1, 2, 3 and 4 in a letter dated November 19, 1974 from A. Giambusso, Deputy Director for Reactor Projects, Directorate of Licensing, Nuclear Regulatory Commission. Since Enclosures 2 and 4 dealt with the PSAR, those questions have been answered in that document and therefore, are not included in this amendment to the ER.

Responses contained in Part I have been previously transmitted to NRC by the Project. It should be noted that the response to some of the items (questions and/or statements) in Enclosures 1 and 3 necessitated a revision of an ER section or the addition of an appendix before docketing. For these items, the pertinent pages or sections of the ER that were revised are given under the "response" to the particular item.

Questions 000.16 through 350.9 were in Enclosure 1 and Questions 000.1 through 350.21 were in Enclosure 3 of the NRC letter. Questions 000.1 through 000.15 will be included in Amendment II.

ITEM 000.16 (Section 7.1)

The analysis of plant accidents does not include consideration of core disruptive accidents (CDA). During pre-application discussions of the CRBRP, the Regulatory Staff has found itself in disagreement with the Project Management Corporation (PMC) with respect to definition of the most serious of the design basis accidents. PMC has argued that reliable shutdown systems will make the probability of CDA's so low that they need not be considered design basis accidents. The staff does not currently agree with PMC's argument, but we have left the matter open for resolution during our formal review of the application. We understand that the PSAR will be submitted with two parallel design basis options, one without CDA and one with CDA, and we have agreed to review both of these options. Until the issue is resolved, however, we must consider the worse case in conducting the environmental review. Therefore, Section 7.1 should be revised to include an environmental impact assessment of CDA's and supporting analysis of the CDA's, including the rationale used to select the assessed case(s) from the spectrum of CDA's. This material should be furnished in sufficient detail to enable our making an independent appraisal of the accident analysis. This will require more detail than is normally furnished with regard to Class 8 accidents for environmental review of light water reactors because general agreement on methods and assumptions has already been established for the latter case. Hence, there is a precedent for Class 8 accident analyses for light water reactors; there is no such precedent for the liquid metal fast breeder reactor.

RESPONSE

In response to NRC Question 000.16 regarding consideration of hypothetical core disrupture accidents, Appendix B to the ER was provided by the CRBRP Project. At the time the issue was raised, the CRBRP Project was submitting a PSAR consisting of a reference design and parallel design options. Parallel design features included core disruptive accidents as part of the design basis. Using the rationale of having to "consider the worse case" in conducting its environmental review, the NRC Staff required an environmental impact assessment of CDA's in the ER.

Consistent with the subsequently developed NRC position that core disruptive accidents need not be considered in the design base, the Project has withdrawn the discussion in the PSAR of the parallel design options (Amendment 24). Accordingly, Appendix B has been removed in ER Amendment VIII. 8

Discussion of CDA analyses and phenomenology is provided in the PSAR in appendix form.

ITEM 010.1 (Section 3.5)

Provide preliminary piping and instrumentation diagrams (P&ID's) for the liquid, gaseous and solid radwaste systems indicating all bypasses through which waste could circumvent process equipment and be released to the environment.

RESPONSE

Preliminary piping and instrumentation presently available are provided in Figures 11.2-2, 11.2-4, 11,3-10, 11.3-11, 11.3-12 and 11.3-13 of the PSAR.

The additional oversized engineering drawings which have been requested will be forwarded in the near future.

ITEM 010.2 (Section 3.5)

List the capacities and volumes for the components in the radwaste systems.

RESPONSE

TABLE 1--ITEM 010.2

DESIGN PARAMETERS OF RAPS AND CAPS PROCESS VESSELS

Item	Number Required	Volume (ft^3)	Capacity at Operating Pressure and Temperature (scf)
Storage Vessel, Recycle Argon	1	300	875
RAPS Charcoal Bed Vessel	4	32	DNA*
RAPS Cryogenic Distillation Vessel	1	25	192
RAPS Vacuum Vessel	1	254	141 to 233
RAPS Surge Vessel	1	1,000	3,200 to 10,000
RAPS Storage Vessel Noble Gas	1	254	2,900 max.
RAPS Transport Cask Noble Gas	1	2	(200 Ci, max)
CAPS Charcoal Bed Vessel	2	32	DNA*
CAPS Vacuum Vessel	1	340	166 to 273
CAPS Surge Vessel	1	775	1,500 to 7,300

8

*DNA = Does not apply because of adsorption variable.

TABLE 2--ITEM 010.2

EQUIPMENT DESCRIPTION OF LIQUID RADWASTE SYSTEM

Description	Inter-mediate Distillate	Low Level Distillate	Intermediate Collection Tanks	Low Level Collection Tanks	Evaporator	Concentrated Waste Collection Tanks	Acid and Caustic Storage Tanks
Capacity (gal)*	20K	2.5K	20K	2.5K	2.5K	2.5K	150
Number of Components	2	2	2	2	2	1	2
Through Put Rates (gpm)	10-125	1/2-10	10-20	10-20	10	2-5	1-10

*20K = 20,000

ITEM 010.3 (Section 3.5)

Provide the following information on the charcoal delay beds:

a. Amount of charcoal in each bed.
b. Temperature and pressure of the charcoal beds.
c. Dynamic adsorption coefficient assumed to determine the charcoal bed capacity.

RESPONSE

Current design of the delay beds has each bed containing 625 pounds of charcoal.

Current design of the CAPS charcoal beds includes an operating pressure of 35 psig and an operating temperature of about -140 degrees F. Design of the RAPS charcoal beds includes an operating pressure of 30 psig and an operating temperature range of from -70 degrees F to -210 degrees F.

Figures 1 and 2 (Item 010.3) provide the dynamic adsorption coefficients used for the cell atmosphere processing system (CAPS) delay bed calculations. Figure 3 (Item 010.3) provides the adsorption coefficients utilized in the radioactive argon processing system (RAPS) delay bed calculations.

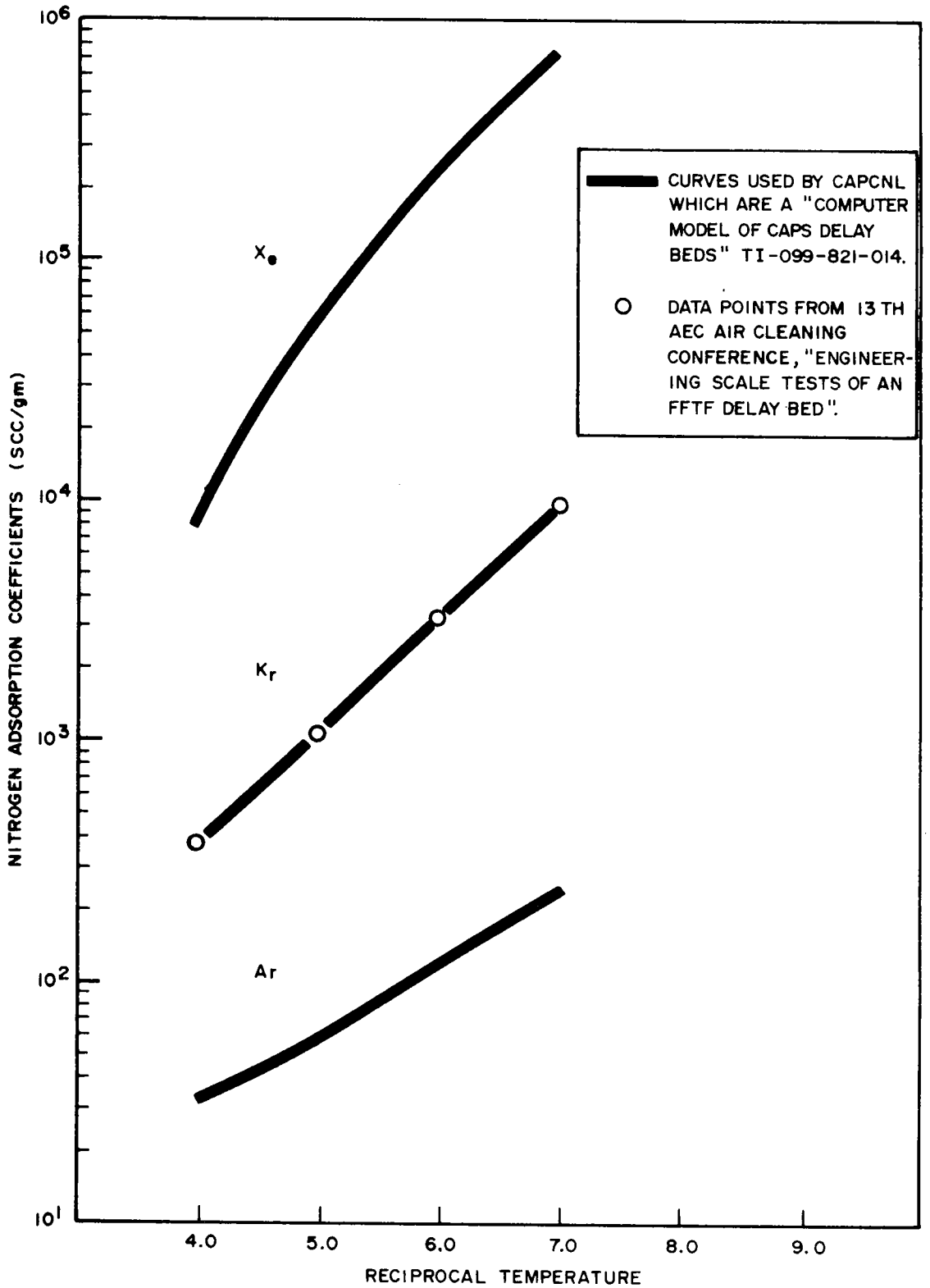

Figure 1 (Item 010.3) DYNAMIC ADSORPTION COEFFICIENTS USED FOR CAPS DELAY BED CALCULATIONS

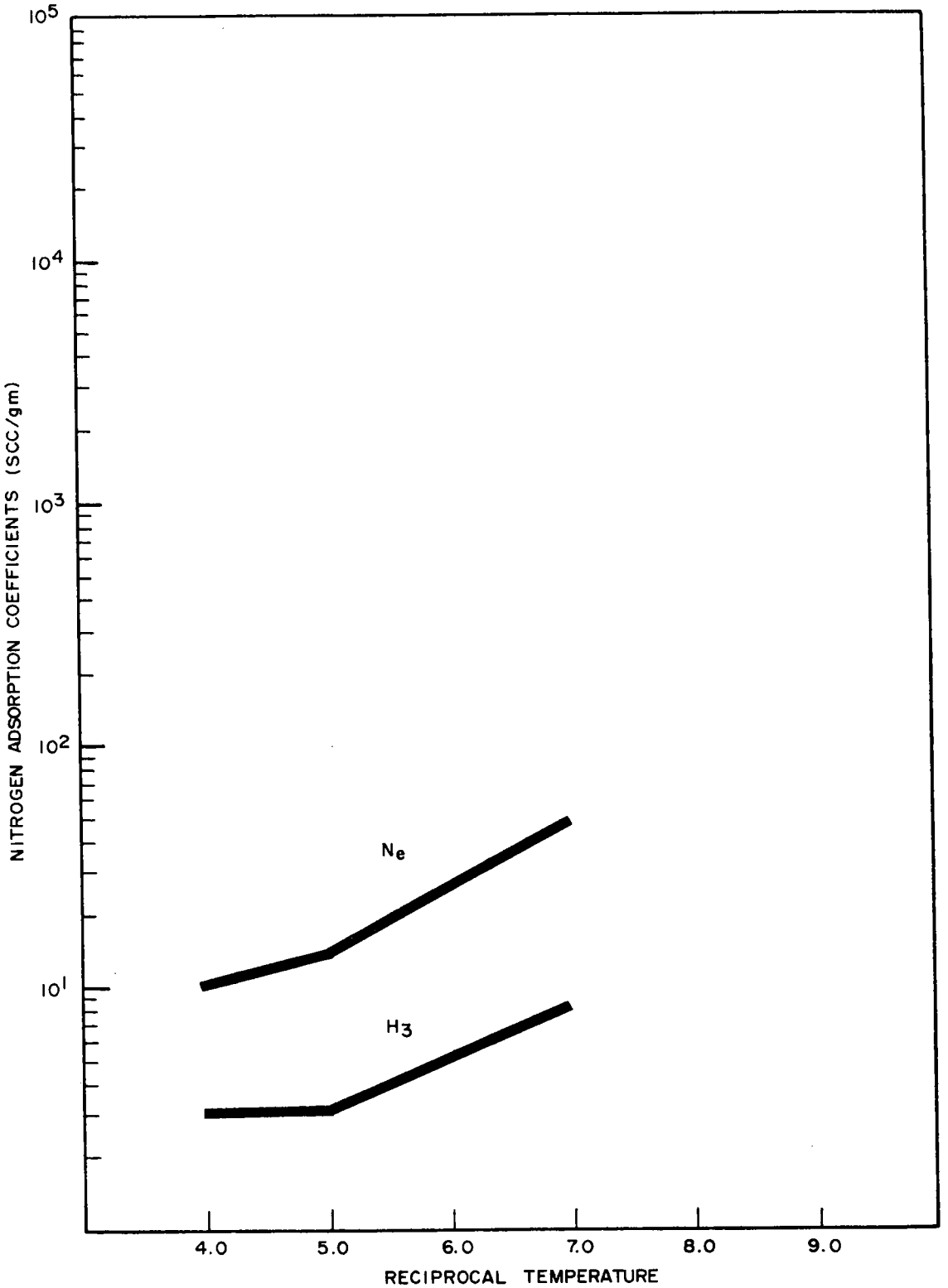

Figure 2 (Item 010.3) DYNAMIC ADSORPTION COEFFICIENTS USED FOR CAPS DELAY BED CALCULATIONS

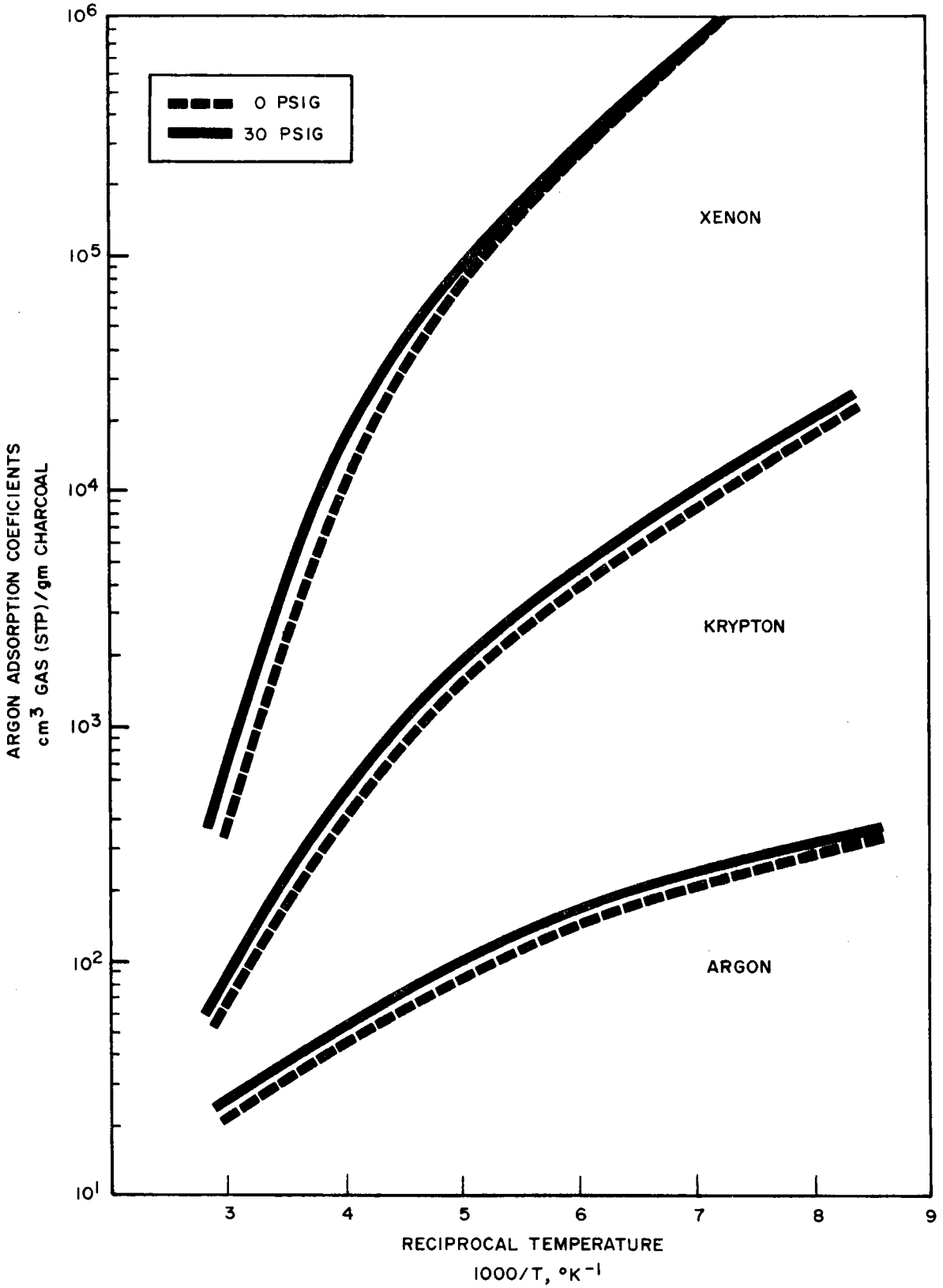

Figure 3 ADSORPTION COEFFICIENTS USED IN RAPS DELAY BED CALCULATIONS (Item 010.3)

ITEM 010.4 (Section 3.5)

Describe the mathematical model and computer codes used to determine the source terms.

RESPONSE

Design values for the fission product isotopic radioactivity in the Heat Transport System sodium are developed using a two-step model procedure. The first step establishes the isotopic equilibrium or total activity released from that fraction of fuel containing small clad defects. The second step establishes the distribution of this activity between the sodium coolant and the "wetted" surfaces (including cold traps) of the Heat Transport System (HTS).

STEP 1

The fission product inventory released is calculated using the following equation:

$$I = K \cdot FF \cdot P \cdot EF \cdot YLD \cdot (1-e^{-\lambda t})/3.7 \times 10^{+10}$$

where

I = Inventory released (Ci)

P = Design or rated thermal power (975 MWt)

K = Fissioning rate (3.1×10^{16} fissions/MW-sec)

EF = Isotopic escape fraction from fuel containing small clad defects (Small holes or fine cracks)

FF = Fraction of design or rated core thermal power generated in the fuel rods containing clad defects (0.01 - design valve)

YLD = Isotopic cumulative yield fraction PU-239 (atoms/fission)

λ = Isotopic decay constant (seconds^{-1})

t = Reactor Operating Time (seconds)

The fission products considered in the CRBRP analysis are those having yield fractions greater than 0.001 and half-lives greater than 1.0 hour including all inert gas fission products with half lives in excess of 10 minutes. The analysis was performed using hand calculation techniques.

STEP 2

The distribution of the fission product inventory released from the core between the sodium and the HTS surface is established on the basis of the chemical nature of the individual element. The inert fission product gases Kr and Xe are assumed to be entirely released to the reactor cover gas.

Regarding non-gaseous fission products, cesium, iodine and antimony isotopes are known to be highly soluble in liquid sodium. All three of these elements can be effectively cold trapped. The degree of cold trapping is dependent on a wide range of variables. The soluble long half life isotopes (Cs-137, Cs-134 and Sb-125) are effectively cold trapped. The soluble shorter half lived isotopes including the iodines, remain in solution because of the relatively small proportion the plant volume processed through the cold trap prior to their decay.

The "best estimate" cold trap removal of Cs-137 is 91 percent while this estimate for Cs-134 is 60 percent. The fraction of Cs-137 and Cs-134 removed per cold trap pass is the same for both isotopes. The differences in cold trap efficiencies are due to their variation in half life (30 years and 2 years, respectively). The proportion of Cs-137 estimated in the coolant was increased to 20 percent to allow for processing uncertainty. Evaluation of cold trap performance for removing long half life isotopes as a function of hydride and oxide content of the primary system is continuing.

Tellurium, strontium and all other fission product isotopes are known to concentrate on reactor and primary heat transfer surfaces together with the activation products released from stainless steel. Therefore, 100 percent of these isotopes have been assumed deposited on the wetted surfaces. In addition, 10 percent of the fission product releases from these isotopes have been assumed in both the cold trap and primary sodium sources.

Table 1 (Item 010.4) contains a listing of the calculated fission product buildup in the CRBRP primary coolant sodium (7.1×10^8 gms) for operating times up to 30 years.

The plant system design basis for plutonium concentration in the reactor coolant is to be based on a maximum plutonium limit of 100 ppb in the reactor coolant during the 30-year operating life of the plant.

Using an escape rate coefficient of 9.71×10^{14} atoms/cm^2-sec, this limit corresponds to continuous operation for 30 years with approximately 43 fuel pins having defects in the fueled region in which plutonium is assumed to escape. This escape coefficient is based on data reported in Reference 1 and obtained from an irradiation test of a purposely defected (0.030 inch hole) fuel rod in a forced convection sodium GETR capsule.

The design parameters for the release of plutonium to the primary coolant are shown in Table 1A (Item 010.4).

The corrosion product activities in the primary coolant sodium are based on the calculation of activation, release and distribution of stainless

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1. Capsule B9D Irradiation and Past Irradiation Examination, GEAP-13925, December 1972.

steel materials located in the core or in high neutron flux regions. The analysis divided the core and surrounding region into 10 radial and 8 axial zones to account for variations in the neutron flux distribution. The radial and axial neutron flux distribution is calculated using the DOT-III code, a two dimension multi-group transport code.[2]

The assumed isotopic steel composition and related activation cross sections are included in Tables 2 and 3 (Item 010.4), respectively. The average corrosion rates in each of the zones were calculated using the following Westinghouse developed corrosion rate correlation (CR):

$$CR = 2.5 \times 10^{-3} \left(v^{0.294}\right) \left(O_\gamma^{1.186}\right) \left(e^{-(13.69-0.008T)}\right) \text{ cm/yr}$$

where

CR = Corrosion rate (cm/yr)

v = Coolant velocity in respective zone (ft/sec)

O_γ = Oxygen concentration in the sodium (ppm)

T = Temperature of sodium in respective zone (°F)

This correlation was applied to the temperature, sodium velocity and surface areas of each of 80 zones considered in the analysis. The activation of the base metal is a function of the residence time in the neutron flux. To account for this buildup in the calculation of released activity, annual refueling was assumed. Table 4 (Item 010.4) presents the radial zone parameters of sodium, temperature, sodium velocity, fraction of material replaced and maximum assembly residence times.

Table 5 (Item 010.4) contains the calculated inventory of corrosion product activity released to primary sodium as a function of reactor

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2. Rhoades, W. A., and Mynatt, F. R., The DOT III Two-Dimensional Discrete Ordinates Transport Code, ORNL-TM-4280.

operating time. For purposes of establishing shielding and process requirements for the waste processing system, the corrosion products are assumed to deposit uniformly on all sodium wetted heat transport system surfaces.

Regarding the questions of radioactive corrosion products in the secondary (steam) system, radioactive corrosion products are not expected in the steam system of the CRBRP since: (1) the steam system is separated from the heat transport system by a non-radioactive sodium loop, (2) system leakage will be into rather than out of radioactive systems, (3) the design level of neutron fluxes impinging on the secondary sodium (HX) is $<5 \times 10^3$ n/cm^2/sec, which eliminates any significant activation of materials in the IHX.

TABLE 1--ITEM 010.4

CRBRP - FISSION PRODUCT ACTIVITY IN THE PRIMARY SODIUM
AT SHUTDOWN μCi/gm

Reactor Operation Time	1 Yr.	5 Yr.	10 Yr.	30 Yr.	Released Inventory Fraction Remaining in Na
Cs-136	16.62	16.62	16.62	16.62	0.95
Cs-137	3.13	14.94	28.19	68.7	0.20
Cs-134	0.55	1.53	1.82	1.88	0.4
Sb-125	0.09	0.29	0.37	0.401	0.1
Te-129m	0.597	0.597	0.597	0.597	0.1
I-131	43.7	43.7	43.7	43.7	0.95
SR-89	0.090	0.090	0.090	0.090	0.1
SR-90	0.003	0.013	0.024	0.056	0.1
Y-91	0.026	0.026	0.026	0.026	0.1
Nb-95	0.048	0.048	0.048	0.048	0.1
ZR-95	0.048	0.048	0.048	0.048	0.1
Ru-103	0.071	0.071	0.071	0.071	0.1
Ru-106	0.024	0.046	0.048	0.048	0.1
Ba-140	0.054	0.054	0.054	0.054	0.0
Ce-141	0.064	0.064	0.064	0.064	0.1
Ce-144	0.038	0.038	0.038	0.038	0.1
PR-143	0.045	0.045	0.045	0.045	0.1
Nd-147	0.021	0.021	0.021	0.021	0.1
PM-147	0.005	0.015	0.020	0.021	0.1

TABLE 1A--ITEM 010.4

PARAMETERS ASSUMED FOR PLUTONIUM RELEASE TO PRIMARY COOLANT*

Parameter	Data	
1. Equilibrium core (MOL)** Pu inventories	Isotope	Weight (kgm)
	Pu^{239}	1.026×10^3
	Pu^{240}	3.65×10^2
	Pu^{241}	1.31×10^2
	Pu^{242}	4.66×10^1
	Pu^{238}	1.4×10^1
2. Total number of fuel rods	42,966	
3. Failed fuel rods containing a postulated 0.03 in. dia. hole in the fuel zone	43	
4. Plutonium escape rate coefficient	9.71×10^{14} $\frac{\text{atoms}}{\text{cm}^2\text{-sec}}$	

*For conservatism, 95% deposition in primary Na, 5% on wetted surfaces and 100% in cold traps is assumed in analyses.

**MOL = Middle of Life

TABLE 2--ITEM 010.4

ISOTOPIC ATOM DENSITIES FOR STAINLESS STEEL-316

(Stainless Steel-316 = 7.98 gm/cc)

Isotope	Material Weight-%	Density gm/cc	(NA) Natural Abundance (%)	(AW) Atomic Weight	Atoms / Cm^3 Atom Density*
$Cr^{50}(n,\gamma)Cr^{51}$	18.00 (Cr)	1.436 (Cr)	4.31 (Cr^{50})	52.0569 (Cr)	7.162E20 (Cr^{50})
$Fe^{54}(n,p)Mn^{54}$	65.17 (Fe)	5.201 (Fe)	5.82 (Fe^{54})	55.9121 (Fe)	3.261E21 (Fe^{54})
$Fe^{58}(n,\gamma)Fe^{59}$	65.17 (Fe)	5.201 (Fe)	0.33 (Fe^{58})	55.9121 (Fe)	1.849E20 (Fe^{58})
$Ni^{58}(n,p)Co^{58}$	14.00 (Ni)	1.117 (Ni)	67.88 (Ni^{58})	58.7947 (Ni)	7.769E21 (Ni^{58})
$Co^{59}(n,\gamma)Co^{60}$	0.05 (Co)	0.004 (Co)	100.00 (Co^{59})	59.0000 (Co)	4.08E19 (Co^{59})
$Ta^{181}(n,\gamma)Ta^{182}$	0.02 (Ta)**	0.0016 (Ta)	99.99 (Ta^{181})	181.0000 (Ta)	5.32E19 (Ta^{181})

*Atom density of target isotope

**The nominal tantalum - columbium material weight of 0.02 is assumed to be 100% tantalum - the more significant component.

TABLE 3--ITEM 010.4

ACTIVATION CROSS-SECTION (BARNS/ATOM)

Group	Energy Max/Group	Cr-50 (n,γ)	Fe-54 (n,p)	Fe-58 (n,γ)	Ni-58 (n,p)	Co-59 (n,γ)	Ta-181 (n,γ)
1	10.5 Mev	0	0.54	0	0.433	0.002	0.01
2	6.5		0.43		0.356	0.002	0.03
3	4.0		0.20		0.162	0.002	0.04
4	2.5		0.04		0.03	0.0031	0.10
5	1.4		0	0.001897	0.0017	0.0046	0.14
6	0.8			0.00237	0	0.0051	0.20
7	0.4			0.00285		0.008	0.27
8	0.2			0.00285		0.008	0.32
9	0.1	0.01		0.00332		0.056	0.45
10	46.5 kev	0.03		0.00806		0.038	0.80
11	21.1	0.065		0.00237		0.46	1.5
12	10.0	0.025		0.001897		1.2	2.9
13	4.65	0.14		0.00522		4.83	5.3
14	2.15	0.09		0.0503		2.81	9.6
15	1.0	0.11		0.00711		0.4	16.7
16	465 ev	0.15		0.0133		3.5	22.0
17	125	0.23		0.0175		24.8	32.0
18	100	0.33		0.025		49.1	32.0
19	46.5	0.48		0.034		1.15	104
20	21.5	0.70		0.049		1.56	111
21	10.0	1.00		0.073		2.19	16
22	4.65	1.50		0.104		3.5	483
23	2.15	2.20		0.156		4.63	4.2
24	1.0	3.20		0.232		6.75	4.9
25	0.465	4.70		0.342		10.2	6.4
26	0.0252	17.0		1.2		37.2	21.0

TABLE 4--ITEM 010.4

RADIAL ZONE PARAMETERS

Radial Zone	Description	ΔT* Effective Temperature Rise (°F)	Velocity (ft/sec)	Fraction Replaced/yr,f	Max. Assem. Residence Years (m)
1	1 Control Assemblies	110	8.0	1	1
2	24 Fuel Assemblies	318	24.6	1/3	3
3	6 Control Assemblies	110	8.0	1	1
4	52 Fuel Assemblies	327	22.9	1/3	3
5	6 Control Assemblies	110	8.0	1	1
6	24 Fuel Assemblies	312	19.3	1/3	3
7	6 Control Assemblies	110	8.0	1	1
8	90 Fuel Assemblies	309	20.0	1/3	3
9	150 Blanket Assemblies	271	5.19	1/5	5
10	72 Reflector Assemblies	260	1.0	1/7	7

*T_{inlet} = 740°F for all zones

TABLE 5--ITEM 010.4

TOTAL ACTIVATED CORROSION PRODUCTS RELEASED TO THE PRIMARY SODIUM - CURIES

	Reactor Operating Time - Years			
Isotope	5	10	20	30
Co-60	525	795	1,004	1,060
Co-58	729	729	729	729
Mn-54	1,080	1,100	1,100	1,100
Fe-59	6.2	6.2	6.2	6.2
Cr-51	195	195	195	195
Ta-182	141	141	141	141

ITEM 010.5 (Section 3.5)

Provide the Kayser model which you used to determine the fission product inventory in the primary coolant.

RESPONSE

The model currently being used in the CRBRP analysis for determining the release of fission product activity from fuel rods containing small clad defects does not employ the "escape rate coefficient" model used by light water reactor designers. Instead, the model currently used by ARD employs a "fission product escape fraction" model.

The fission product escape fractions were developed from a model similar to that used for the Phenix[1] and FFTF. Fission product nuclide escape fractions of the model are presented in Table 1 (Item 010.5). These escape fractions for individual fission product isotopes were compared to escape fractions observed in an irradiated capsule and reported in GEAP-13925[2]. The results of this comparison indicate the conservatism of the model being utilized for the CRBRP as shown in Table 2 (Item 010.5).

The fission products are grouped into five escape classes:

Class 1 - Noble gases (Kr, Xe) & Cs-136
Class 2 - Cesium (134 & 137)
Class 3 - Iodines, Antimony, Tellurium
Class 4 - Strontium
Class 5 - All other fission products

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1. Kayser, G., Problems Due to Fission Products in Circuits of Sodium Cooled Fast Reactors in Event of Can Fractures, EURFMR-593, December 1968.

2. Capsule B9D Irradiation and Past Irradiation Examination, GEAP-13925, December 1972.

The release of noble gases from failed fuel during actual operation will be a function of half life. The escape fraction model used accounts for only the decay during release from the oxide fuel and conservatively assumes no subsequent delay in transit from the fuel to clad gap, fission gas plenums or sodium mass.

The cesium release fraction assumed is 1.0 for both Cs-137 and Cs-134 because of the known high mobility of these isotopes. The noble gas release fraction equation was conservatively used to estimate the release of Cs-136 because of its relatively short half life (13 days). The high release factor to account for cesium isotopes is demonstrated by data in Reference 2 and Table 2 (Item 010.5).

The halogen, antimony and tellurium isotopic releases were treated as one class and modeled after the release fraction euqation used in Phenix for halogen isotopes. Other isotopes such as palladium behave in a similar fashion but have been neglected because of their relatively short half life and low yields. Antimony and tellurium were treated as the same class of halogens because of their similar release behavior as documented in Reference 1 and Table 2 (Item 010.5).

All other isotopes, except for strontium, were treated as a single class (5). The release of these isotopes is due to fission recoil and fuel erosion. Strontium is released at a slightly increased rate. It has been postulated that this is due to the mobile nature of its Kr and Rb parents and its relatively high solubility in sodium. The relative release factors of 0.001 and 0.005 for other fission products and strontium is based on the release data shown in Reference 2.

The constants used for escape classes 1 and 3 are the same as those established for the Phenix design. The key parameters which establish these constants - diameter of fuel rods, centerline fuel temperature and fraction of the fuel cross section undergoing grain growth - are similar for CRBRP and Phenix.

The fission product release model is based on the assumption that small cladding defects exists in fuel rods generating one percent of the total core power.

Although the "escape fraction" model does not specifically address variation in fuel power density, the nature of the correlations made in Reference 1 were based on a long-term follow program which inherently accounts for changes in core power density.

TABLE 1--ITEM 010.5

FISSION PRODUCT ESCAPE FRACTIONS

Class	Element	Escape Fractions
1	Kr*, Xe*, Cs^{136}	$EF = \frac{1}{(1.5E5)\lambda}(1-e^{-(1.5E5)\lambda})$**
2	$Cs^{134, 137}$	EF = 1.0
3	Sb, Te, I	$EF = \frac{0.2}{(1.5E6)\lambda}(1-e^{-(1.5E6)\lambda})$**
4	Sr	EF = 0.005
5	All other Fission Products	EF = 0.001

*Assumed released to cover gas

**λ in (sec^{-1}) decay constant of ith isotope

TABLE 2--ITEM 010.5

COMPARISON OF ASSUMED ESCAPE FRACTION FROM FAILED FUEL RODS WITH MEASURED ESCAPE FRACTIONS IN B9D

Fission Product	Design Escape Fraction	Escape Fraction Observed in B9D Capsule*
Cs-137	1.0	0.27
Sb-125	0.20	0.046
Te-129m	0.168	0.013
I-131	0.1039	0.052
Sr-89	0.005	0.00045
Sr-90	0.005	0.0012
Y-91	0.001	0.00049
Zr-95	0.001	0.00021
Nb-95	0.001	0.00051
Ru-103	0.001	0.00013
Ru-106	0.001	0.00035
Ce-141	0.001	0.00025
Ce-144	0.001	0.00013
Pm-147	0.001	0.00077

*From: Capsule B9D Irradiation and Past Irradiation Examination; GEAP-13925, December 1972

ITEM 010.6 (Section 3.5)

Justify the assumed leakage rates from the reactor coolant system and other systems containing radioactivity for both liquids and gases.

RESPONSE

Gases - Radioactive gases generated in the CRBRP consist of tritium and noble gas isotopes. The latter and some of the tritium migrate to the reactor and to the Primary Heat Transfer System (PHTS) cover gas space. The Radioactive Argon Processing System (RAPS) is a closed, internal system that continuously processes the cover gas to reduce its activity and then returns the recycle cover gas to the seals and cover gas spaces. Radioactive gas leakages into the inerted cells of the Reactor Containment Building (RCB) and the Reactor Services Building (RSB) are collected and processed through the Cell Atmosphere Processing System (CAPS).

Assessment of radioactive flow paths has been conducted using the following:

1. Reactor cover gas is conservatively estimated to diffuse through the reactor head seals at the rate of 0.012 scc per minute. This leakage diffuses into the head access area and is discharged to the atmosphere through the RCB heating and ventilation exhaust.
2. The buffered head seals are expected to leak a maximum of 7 scc per minute of recycle argon cover gas to the head access area.
3. Although the cover gas lines connected to the reactor and other components in the PHTS are not expected to leak, a leakage of 1 scc per minute is the design basis. Also, tritium dissolved in the sodium in this system will diffuse through the hot pipe walls.

4. Although the RAPS and CAPS piping and components are also not expected to leak, a leakage of 1 scc per minute of unprocessed gas is the design basis.

5. Tritium dissolved in the sodium of the PHTS will transfer to the Intermediate Heat System by diffusing through the intermediate heat exchanger (IHX) tube walls. A very small but finite amount will then diffuse through the hot leg piping in the Intermediate Bay Cells of the Steam Generator Building and mix with the exhaust. Diffusion of tritium is calculated via evaluation of both tritium and hydrogen fluxes in the Primary and Intermediate Sodium Systems and using appropriate assumptions of cold trapping efficiency and the hydrogen-tritium permeability in stainless steel.

6. As discussed below, a small amount of tritium is assumed to diffuse to the steam-water system in the form of tritiated water. A condenser off-gas system will remove non-condensable gases from the condensing steam. Tritiated water vapor will be present in the off-gas flow. A condenser off-gas removal of 7 SCFM is assumed for the steam-water system.

Tritium Production and Diffusion - Production of tritium in the CRBRP will be from the following reactions:

1. The interaction of neutrons with boron in B_4C control rod assemblies

2. H^3 from ternary fission in the fuel

3. Interaction of neutrons with Lithium impurity in the sodium.

The average value of tritium production from all sources during a fuel cycle is estimated to be 89 Ci/day.[1]

Most (98.4%) of the tritium generated forms a hydride in the sodium and is then partially removed from solution in the sodium by cold trapping. Using system parameters listed in Table 1 (Item 010.6), the tritium flux to the steam systems is 1.04 Ci per day. Additional data on hydrogen tritium transport in the CRBRP is provided in Table 2 (Item 010.6).

The approach to estimating the movement of tritium through the reactor system involves solving two sets of simultaneous equations. One of these sets describes the behavior of hydrogen in the system. The other set describes the behavior of tritium, whose movement in the system is dependent upon the presence of hydrogen. In principle, these two sets of equations should be solved simultaneously because tritium and hydrogen behave similarly. However, in this particular case the concentration of hydrogen in the system is several orders of magnitude greater than that of tritium. Therefore the effect of the presence of tritium on hydrogen behavior can be neglected, and the hydrogen equations can be solved separately. The tritium equations are then solved using the hydrogen data.

The major sinks for tritium and hydrogen in the system are the cold traps. The key to cold trap performance is the efficiency factor. In these calculations the efficiency is defined as

$$\varepsilon = \frac{(\text{Conc in inlet Na}) - (\text{Conc in outlet Na})}{(\text{Conc in inlet Na}) - (\text{Sat'n Conc'n at C. T. Temp.})}$$

In the equations, the product of the cold trap flow rate and the cold trap efficiency appear essentially as a single variable. Table 3 (Item 010.6) shows selected results of these calculations.

---

1. CRBRP: Tritium Release from the B_4C Control Rods in CRBRP, WA40052, March 14, 1974.

Examination of Table 3 (Item 010.6) shows that there is relatively little difference in the total amounts of tritium that will be captured in the two cold traps as one varies the flows in the cold traps. However, the balance between the primary and the intermediate cold traps is quite sensitive to the respective ($Q\varepsilon$) values. [Q is the flow rate (gpm) and ε is efficiency as defined above]. Therefore, it appears possible to select a suitable combination of ($Q_p\varepsilon_p$) and ($Q_i\varepsilon_i$) for which, say, the intermediate system hydrogen concentration is 0.1 ppm - such as ($Q_p\varepsilon_p$) = 60 GPM and ($Q_i\varepsilon_i$) = 120 GPM.

For this operating condition, the estimated tritium flux through the steam generator is nominally (7.1E-4) μg atom/sec. This amounts to (7.1E-4)/(4.76E-2) or 0.0149 of the tritium produced per day. This is equivalent to (0.0149)(117) = 1.75 Ci/day, which passes into the water/steam in the steam generator. The 117 Ci/day is a maximum daily value of tritium production during a fuel cycle.

Examination of Table 3 (Item 010.6) also shows that the value of $Q_i\varepsilon_i$ controls the concentration of hydrogen in the intermediate system, and that a $Q_i\varepsilon_i$ value 120 GPM corresponds to a hydrogen concentration (H, C, i) of 0.1 wppm in the intermediate sodium.

In addition, at $Q_i\varepsilon_i$ = 120 GPM, the range of estimated tritium fluxes into the steam generator (J_{SG}) is from 2.11 Ci/day at $Q_p\varepsilon_p$ = 20 GPM to 1.55 Ci/day at $Q_p\varepsilon_p$ = 400 GPM. Further, the total amount of tritium captured in cold traps reaches a practical asymptote of 98.3% at $Q_p\varepsilon p$ = 60 GPM.

<u>Liquids</u> - The Reactor and Heat Transport System of the CRBRP includes a Primary Heat Transport System and an Intermediate Heat Transport System (IHTS). The intermediate coolant loops contain non-radioactive sodium and serve to transport heat from the radioactive primary sodium to the steam generator modules. The IHTS is maintained at a higher pressure

than the PHTS to prevent leakage from the radioactive PHTS to the non-radioactive IHTS. Zero leakage of sodium is expected from the PHTS to the IHTS.

No leakage to the environment during normal operation is expected from the PHTS and the IHTS. Assumed leakage of sodium from primary and intermediate systems due to accidents is described in Section 15.6 of the PSAR.

TABLE 1--ITEM 010.6

PARAMETERS USED IN THE CALCULATION OF HYDROGEN-TRITIUM TRANSPORT IN CRBRP

Primary Circuit System Parameters		
Total Weight of Sodium in Primary Circuit	1.7E + 6 lbs	3.35E + 7g mole Na
Temperature of Piping	950°F	783°K
Area of Primary Piping (Excluding IHX)	6,190 ft^2	5.75E + 6 cm^2
Thickness of Primary Piping	0.625 in.	1.59 cm
Total Cold Trap Flow Rate (based on 250°F)	60 gpm	151.7 g moles Na/sec
Minimum Cold Trap Temperature	250°F	394°K
Cold Trap Efficiency for Hydrogen Removal	70%	0.70
Hydrogen Flux to Primary Circuit (not including IHX)	0	0
Tritium Flux to Primary Circuit	89 Ci/day	0.0362 μgm at T/sec
Total Volume of Nitrogen in Primary Cells	698,000 ft^3	7.74E + 5g mole N_2
Exchange Rate of Nitrogen in Primary Cells	10%/day	0.896 g mole N_2/sec
IHX Parameters		
Log Mean Total Diffusional Area of IHX	43,270 ft^2	4.02E + 7 cm^2
Wall Thickness of IHX Tubing	0.047 in.	0.119 cm

(Continued)

TABLE 1--ITEM 010.6 (Continued)

IHX Parameters		
Hydrogen and Tritium Diffusion Coefficient for IHX	---	1.083E - 6 cm^2/sec
Intermediate System Parameters		
Total Weight of Sodium in Intermediate Circuit	7.92E + 5 lbs	1.56E + 7 g mole Na
Temperature of Piping	900°F	756°K
Area of Intermediate Piping (Excluding IHX)	8,130 ft	7.55E + 6 cm^2
Thickness of Intermediate Piping	0.5 in.	1.27 cm
Total Cold Trap Flow Rate (based on 250°F)	180 gpm	455.1 g mole Na/sec
Minimum Cold Trap Temperature	250°F	394°K
Cold Trap Efficiency for Hydrogen Removal	70%	0.70
Total Volume of Air in Intermediate Cells	386,000 ft^3	4.28E + 5 g mole air
Hydrogen Content in Intermediate Cell Air	0.5 vppm	---
Exchange Rate of Air in Intermediate Cell	1%/day	0.049 g mole N_2/sec
Steam Generator Parameters		
Total Inside Area	40,630 ft^2	3.78E + 7 cm^2
Total Outside Area	61,740 ft^2	5.74E + 7 cm^2

(Continued)

TABLE 1--ITEM 010.6 (Continued)

Steam Generator Parameters

Wall Thickness of Tube	0.109 in.	0.277 cm
Hydrogen Flux	1.92E - 11 lb H/sec-ft^2 inside tube area	354.6 μgm at H/sec
Tritium-Diffusion Coefficient	---	1.384E - 6 cm^2/sec

TABLE 2--ITEM 010.6

HYDROGEN-TRITIUM TRANSPORT

Concentration Vector	Hydrogen		Tritium	
	μgm at H/mole*	wppm	μgm at T/mole*	μCi T/gm Na*
Sodium Side of Primary Piping (SS)	0.261	--	4.00E-4	--
Sodium Side of Intermediate Piping (SS)	0.483	--	2.60E-5	--
Nitrogen Side of Primary Piping (SS)	0.181	--	3.28E-4	--
Primary Sodium (Na)	0.979	0.043	1.50E-3	1.86
Sodium Side of Steam Generator Piping (SS)	0	--	1.30E-5	--
Air Side of Intermediate Piping (SS)	0.455	--	2.53E-5	--
Intermediate Sodium (Na)	1.952	0.085	1.05E-4	0.13
Primary Cell Atmosphere (N_2)	7.87E-3	--	1.22E-4	--
Intermediate Cell Atmosphere (Air)	4.23E-2**	--	2.81E-5	--

(Continued)

TABLE 2--ITEM 010.6 (Continued)

Flux Vector	Hydrogen	Tritium	
	μgm at H/sec	μgm at T/sec	Ci/day
Through IHX	11.25	0.0189	46.5
To Primary Cold Trap	11.19	0.0171	42.1
To Primary Cell	6.09E-2	5.48E-5	0.13
By R/A Decay in Primary	--	8.73E-5	0.21
To (or From) Steam Generator	354.6	4.24E-4	1.04
To Intermediate Cold Trap	343.3	0.0185	45.5
To Intermediate Cell	0.0248	6.98E-7	0.0017
By R/A Decay in Intermediate	--	2.86E-6	0.0070

*Mole sodium, stainless steel, nitrogen or air, as applicable

**Including the 0.5 ppm nominal content

TABLE 3--ITEM 010.6

SUMMARY OF TRITIUM DISTRIBUTION CALCULATION

Pri.	Inter.	Tritium					Hydrogen					Tritium	
$Q_p \varepsilon_p$ GPM	$Q_i \varepsilon_i$ GPM	$CT,_p$ *	$CT,_i$ *	J_{SG} *	$T,_{c,p}$ **	$T,_{c,i}$ **	$CT,_p$ *	$CT,_i$ *	J_{IHX} *	$H,_{c,p}$ ***	$H,_{c,i}$ ***	Σ CT *	Σ % CT
20	90	2.4E-2	2.3E-2	9.1E-4	196	19	20.5	411	20.6	0.056	0.116	4.7E-2	97.7
20	150	1.9E-2	2.8E-2	8.0E-4	229	17	12.2	419	12.3	0.049	0.086	4.7E-2	97.9
20	300	1.2E-2	3.4E-2	7.1E-4	278	15	5.8	425	5.9	0.043	0.062	4.7E-2	98.1
60	90	2.9E-2	1.8E-2	7.3E-4	157	16	24.6	406	24.6	0.045	0.115	4.7E-2	98.1
60	150	2.3E-2	2.4E-2	6.9E-4	198	15	14.7	416	14.8	0.042	0.086	4.7E-2	98.3
60	300	1.5E-2	3.2E-2	6.6E-4	258	14	7.0	424	7.1	0.042	0.062	4.7E-2	98.3
100	90	3.0E-2	1.7E-2	6.9E-4	148	15	25.6	405	25.7	0.043	0.115	4.7E-2	98.3
100	150	2.4E-2	2.3E-2	6.7E-4	191	14	15.3	416	15.4	0.041	0.086	4.7E-2	98.3
100	300	1.6E-2	3.1E-2	6.5E-4	252	14	7.3	424	7.4	0.039	0.063	4.7E-2	98.3
200	90	3.1E-2	1.6E-2	6.5E-4	140	14	26.4	405	26.5	0.040	0.115	4.7E-2	98.3
200	150	2.5E-2	2.2E-2	6.4E-4	184	14	15.8	415	15.9	0.039	0.085	4.7E-2	98.3
200	300	1.6E-2	3.1E-2	6.4E-4	248	14	7.6	424	7.6	0.039	0.062	4.7E-2	98.3
400	90	3.1E-2	1.6E-2	6.3E-4	136	13	26.8	404	26.9	0.039	0.115	4.7E-2	98.5
400	150	2.5E-2	2.2E-2	6.3E-4	181	13	16.1	415	16.2	0.039	0.085	4.7E-2	98.3
400	300	1.6E-2	3.0E-2	6.3E-4	246	13	7.7	423	7.7	0.038	0.062	4.7E-2	98.3

*Flux in units of μgm atom/sec

**Concentration in units of parts per million million, ppmm

***Concentration in units of parts per million, ppm

ITEM 010.7 (Section 3.5)

Provide preliminary layout drawings indicating all discharge points to the environment and proposed radiation monitoring instrumentation. Show how General Design Criteria 52 and 56 will be met (AEC-REG Interim General Design Criteria for LMFBR).

RESPONSE

The CRBRP design systems for treating the radioactive liquid and gaseous wastes were selected on the basis of equipment performance data at operating light water reactors as well as from FFTF design information. Equipment sizes, arrangements and process requirements are based on conservative estimates of system leakage, decontamination requirements and activity concentrations.

Liquid radwaste and gaseous radwaste characteristics include:

1. Margins in the processing capabilities
2. Cross connections between subsystems
3. Recycle capabilities

In addition, radiation monitoring of process systems provides early warning of equipment malfunction and potential radiological hazards to enable corrective action to be taken to prevent release of activity to the environment in excess of 10 CFR 20 limits. Alarms associated with the monitoring system will alert operating personnel to channel malfunctions and excessive radionuclide concentration corrective action will then be manually or automatically performed. 6

All design release points which could conceivably undergo rapid changes in radioactivity levels will be continuously monitored. All other release points with the potential for radiological release will be sampled 6

periodically. The design shall include alarms when indicated levels exceed preset concentration limits. The determination of the alarm limits shall be based on resulting doses well below 10 CFR 20 limits for unrestricted areas.

More specifically, in the liquid radwaste system discharge valves will automatically close upon detection of high radiation levels. A flow rate meter and radiation detector will monitor and record the flow rate and gross radioactivity of the discharge stream. Before release, distillate monitoring tanks will be sampled to determine specific isotopic concentrations.

The monitoring of airborne activity will include provisions for fixed airborne radioactivity area monitors in selected locations within the buildings. In addition, effluent monitors will be located for continuous monitoring of gaseous effluent at those release points which could conceivably undergo rapid changes in radioactivity level during abnormal conditions. The radionuclide concentrations in the effluent from design release points will be continuously detected, measured and recorded. In addition, other exhaust points with the potential for radiological release, but having a maximum activity release under accident conditions of well below 10 CFR 20 limits, will be sampled continuously or periodically as appropriate. Fixed airborne radioactivity area monitors and effluent monitors will be provided to continuously detect, measure, indicate, record and initiate alarms and/or control actions when radiations levels or radionuclide concentrations within or released from the facility exceed pre-determined levels. 6

The environmental monitoring program has as one of its objectives the establishment of a baseline of data on the background radiation in the environment near the plant site. The monitoring program will provide the capability of detecting any significant buildup of radioactive material in the environment above and beyond that which is already present. In those cases where a statistically significant increase in the

radioactivity level is seen in a particular sampling sector but not in a control station, meteorology and a specific nuclide analysis will be used to identify the source of the increase. From data obtained from the radioanalytical and radiochemical analyses of vector samples, dose estimates can be made for either an individual or a population living near the plant site.

Figures 1 and 2 (Item 010.7) provide locations of CRBRP design release points to the atmosphere and Clinch River, respectively. Table 1 (Item 010.7) provides information on CRBRP process and effluent monitoring.

It should be noted that in Figure 1, continuous monitoring will be provided for exhaust Points 1, 5, 5a, and 6; continuous sampling at exhaust Points 2, 3, 4 and 7; and periodic sampling at exhaust Points 8, 9, 10, 11 and 12. Monitoring will be provided at exhaust Point 13 only in the event this exhaust point is used which would be for a very low probability accident, beyond the design basis. 6 8

TABLE 1--ITEM 010.7

PROCESS AND EFFLUENT SAMPLING AND MONITORING

Description	Bldg.	Elev.	Continuous Monitoring or Sample	Detector Type	μCi/cc Sensitivity	Quantity Measured	Remarks
Plant Service Building Hot Laboratory and Counting Room Ventilation Particulate Sampler	PSB	830'	Sample	--	--	Gross Conc./ Isotropic Conc.	Sample analyzed in counting room using proportional counter and γ-α spectroscopy sys.
Plant Service Building Decontamination Area Ventilation Particulate Sampler	PSB	830'	Sample	--	--	Gross Conc./ Isotropic Conc.	Sample analyzed in counting room using proportional counter. and γ-α spectroscopy system
Condenser Vacuum Pump Exhaust Tritium	TGB	905'6"	Sample	--	--	Isotropic Concentration	Silica - gel column used to collect sample, analyzed in counting room by liquid scintillation techniques
Control Room Air Intake Monitor Gaseous	CRB	877'	Continuous	β-Scintillation	10^{-6} Kr-85	Gross Conc.	
Control Room Air Intake Monitor Gaseous	SGB/AB	886'	Continuous	β-Scintillation	10^{-6} Kr-85	Gross Conc.	
Control Room Air Intake Duct Downstream of Filter Units	CRB	816'	Continuous				
Particulate				β-Scintillation	10^{-10} Cs-137	Gross Conc.	
Radioiodine				γ-Scintillation	10^{-10} I-131	Gross Conc.	
Gaseous				β-Scintillation	10^{-6} Kr-85	Gross Conc.	
Turbine Generator Building Ventilation (3) Tritium	TGB	921' and 905'6"	Sample			Isotropic Conc.	Silica gel column used to collect sample, analyzed in counting room by liquid scintillation techniques
RCB H&Y and Annulus Pressure Maintenance and Filtration System Exhaust Monitors							
Particulate	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Radioiodine	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Gaseous	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Containment Cleanup System and Annulus Cooling System Exhaust Monitor (s)							
Particulate	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Radioiodine	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Gaseous	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	
Plutonium	TBD	TBD	Continuous	TBD	TBD	Gross Conc.	

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TABLE 1--ITEM 010.7 (Continued)

Description	Bldg.	Elev.	Continuous Monitoring or Sample	Detector Type	μCi/cc Sensitivity	Quantity Measured	Remarks
Reactor Containment Ventilation System Monitors							
(1) Containment Exhaust (3)	RCB	Upstream of Isolation Valve	Continuous	TBD	10^{-6} Kr-85	Gross Conc.	
(2) Head Access Area (3) (Direct Gamma)	RCB	802'	Continuous	TBD	$0.1\text{-}10^{-7}$ $\frac{mRem}{Hr}$	Direct γ	
Intermediate Bay Ventilation	SGB	857'					
Particulate			Continuous	β-Scintillation	10^{-10} Cs-137	Gross Conc.	
Radioiodine			Continuous	γ-Scintillation	10^{-10} I-131		
Gaseous			Continuous	β-Scintillation	10^{-6} Kr-85		
Reactor Service Area and Radwaste Area Exhaust	RSB	884'					
Particulate			Continuous	β-Scintillation	10^{-10} Cs-137	Gross Conc.	
Gaseous			Continuous	β-Scintillation	10^{-6} Kr-85		
CAPS Exhaust	RSB	884'				Gross Conc.	
Gaseous			Continuous	β-Scintillation	10^{-6} Kr-85		
Steam Generator Loop Cells Ventilation (3)	SGB	886'	Sample	--	--	Isotopic Conc.	Silica Gel Column used to collect sample analyzed in counting room by liquid Scintillation techniques
Tritium							
RAPS and CAPS Process Monitoring	RSB	765'	Continuous	β-Scintillation	10^{-6} Kr-85	Gross Conc.	
Gaseous							
Plant Discharge Effluent Liquid Composite	RSB - downstream of low Activity System	-	Sample	--	--	Isotropic Conc.	Sample analyzed in counting room using proportional and liquid scintillation counters and γ-α spectroscopy system
Inerted Cell Atmosphere Monitors	TBD						
Radwaste Disposal	TBD						

LEGEND

RCB - Reactor Containment Building
RSB - Reactor Service Building
IB - Intermediate Bay
TGB - Turbine Generator Building
CRB - Control Room Building

* TBD - To be determined

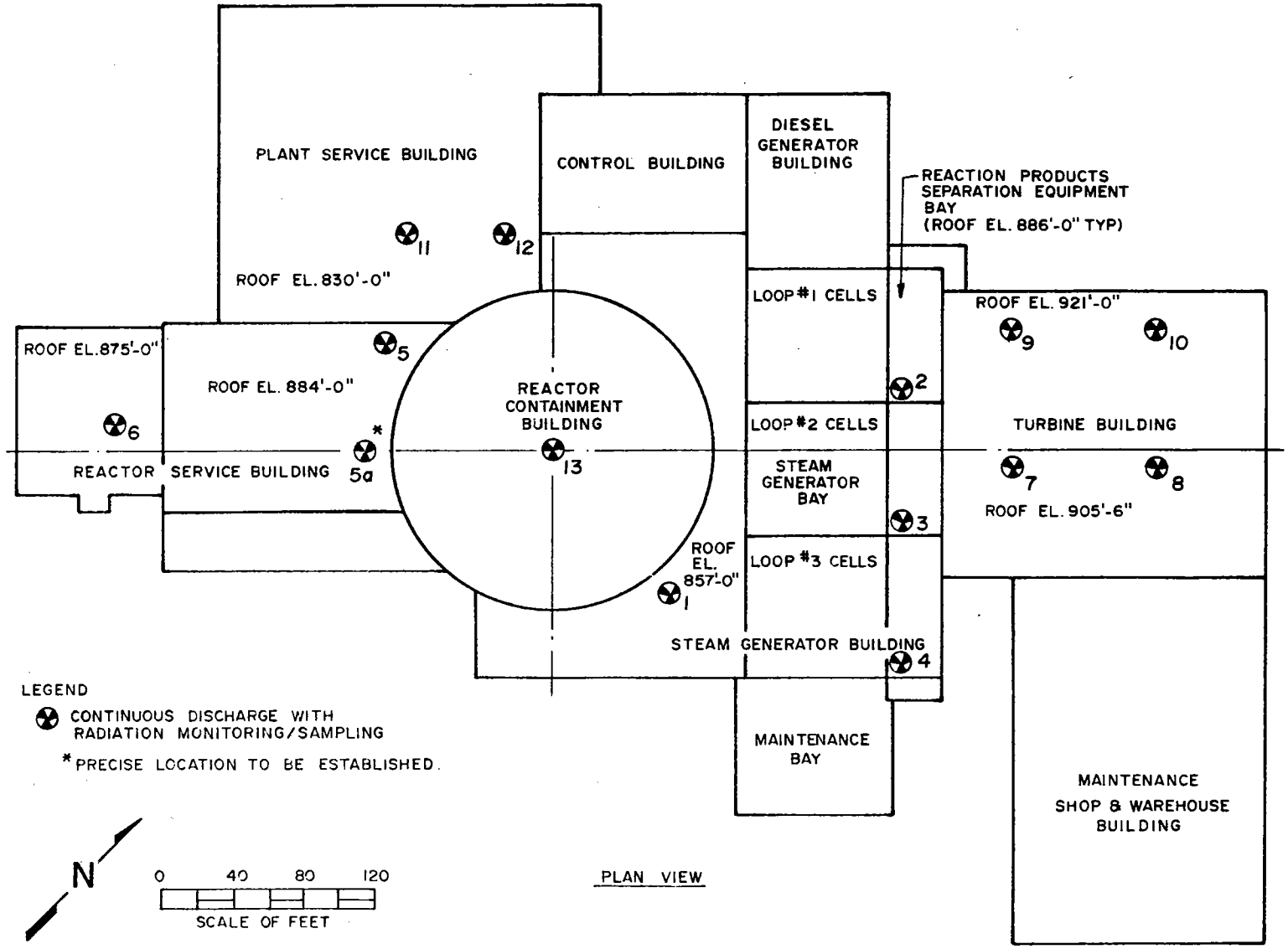

Figure 1 CRBRP RELEASE POINTS
(Item 010.7)

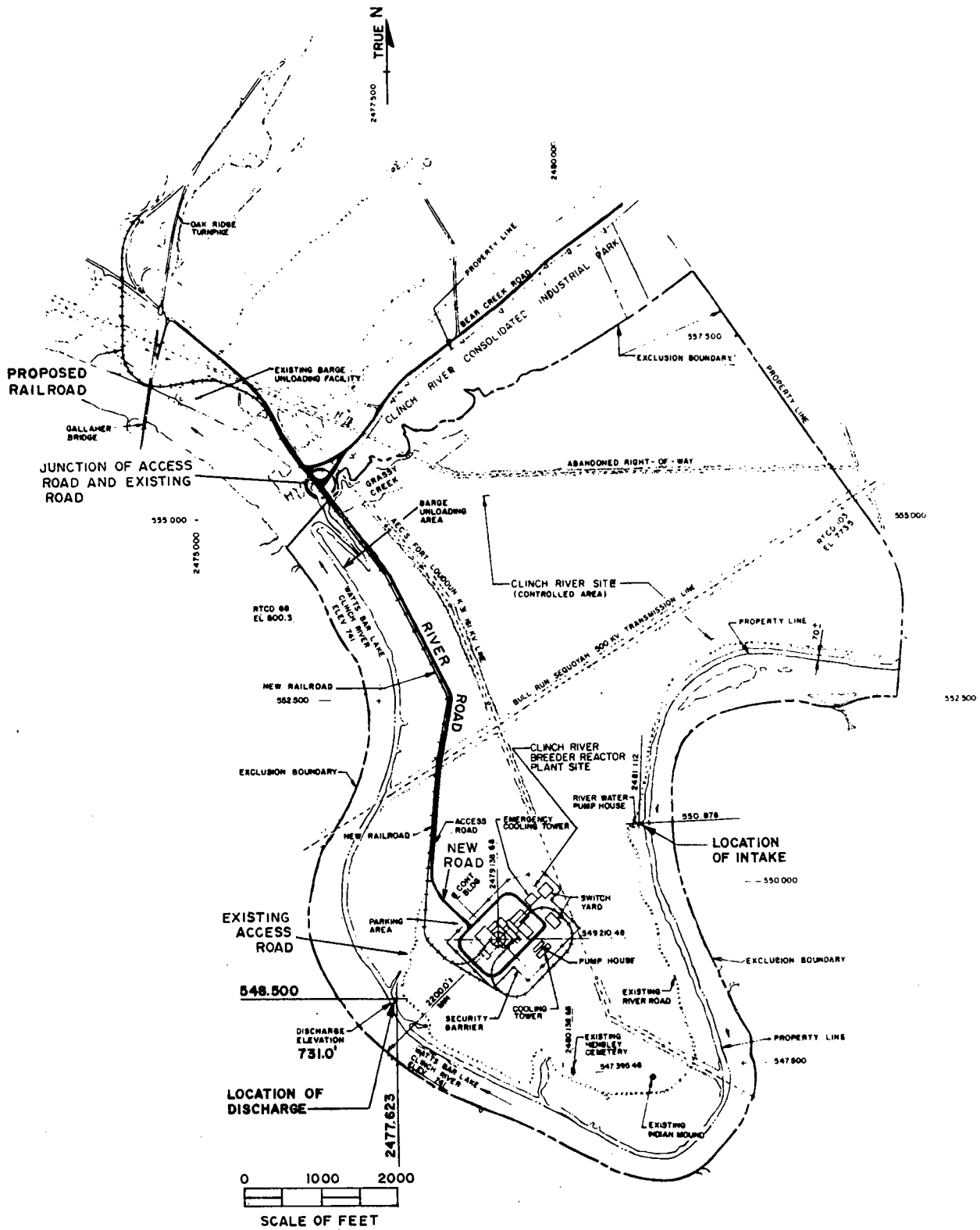

Figure 2 SITE LOCATION AND CRBRP LAYOUT
(Item 010.7)

ITEM 322.5 (Section 2.6.2.6 & Appendix to 2.6)

Meteorological data from the Oak Ridge X-10 Station tower is not considered representative of meteorological conditions at the CRBRP Site since that tower is located in another valley. The use of these data to evaluate atmospheric dispersion conditions at the Site is not acceptable. Joint frequency data with a recovery rate of less than 90% is not acceptable. Provide joint frequency distributions of wind speed and direction by atmospheric stability class using on-site data for at least a one full year period of record during which the joint data recovery rate was at least 90%, as called for by Regulatory Guide 1.23.

Atmospheric stability class should be determined by vertical temperature difference between either:

1. (preferably) the 10 meter level and at a level equivalent to the elevation above grade of the containment building or,
2. the 75-ft and 200-ft levels reduced to represent conditions between the 10 meter and containment height levels.

In the latter case it will be necessary to provide a correlation between actual measurements, made over a shorter but representative period of time, at the 10 meter and containment height levels and at the 75-ft and 200-ft levels. As indicated in Table 2.6A of the Appendix to Section 2.6, wind speeds of 6 knots or less account for over 80% of observed winds at the 75-ft level. The wind speed intervals in Table 2.6A do not adequately differentiate light wind speeds. The joint frequency

tables should include additional wind speed categories such as calm, 0.6-1.5, 1.6-3.4, 3.5-5.4 and 5.5-7.4 mph for both the 75-ft and 200-ft levels. Calm conditions are those during which the wind speed is lower than the starting speed of either the anemometer cups or wind vane, whichever is lower.

Two sets of joint frequency tables must be provided. One set should be based on wind speed and direction measured at the 75-ft level and atmospheric stability based on temperature difference between the 10 meter and containment height levels or a reduction of the 75-ft and 200-ft temperature difference as indicated above. The second set should be based on winds measured at the 200-ft level and stability based on vertical temperature difference between the 75-ft and 200-ft levels. Additional light wind categories, with calms reported separately as indicated above should be included. Joint data recovery rates must euqal to exceed 90%.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.2.6, pages 2.6-13 through 2.6-16.

ITEM 322.8 (Section 2.6.5)

Provide the accuracy specifications for the vertical temperature measuring system used to determine the stability categories presented in response to request 322.5.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.5, pages 2.6-19 through 2.6-21.

ITEM 322.11 (Section 3.5.2.5)

Provide a plan diagram of the plant structures indicating the location of all gaseous effluent release points and the distance to the nearest site boundary.

RESPONSE

This information is shown in Figure 1 (Item 322.11).

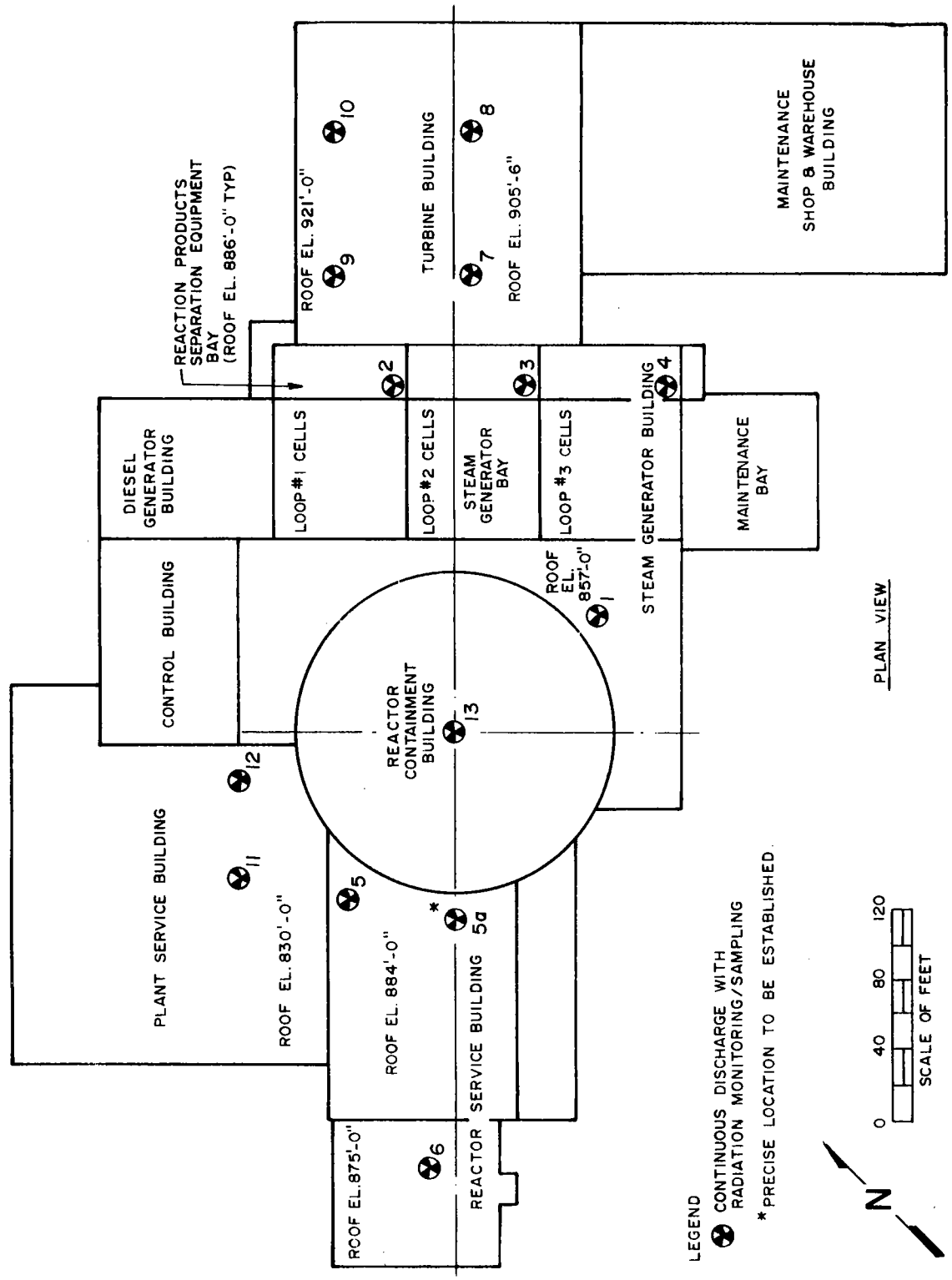

FIGURE 1 CRBRP RELEASE POINTS
(Item 322.11)

ITEM 322.14 (Section 5.1.8 & Appendix 10.1)

Provide a revised analysis of the atmospheric effects of the CRBRP cooling systems, based on data collected on-site which meet the criteria specified under 322.5.

RESPONSE

Tables 1, 2 and 3 (Item 322.14) provide the requested information.

TABLE 1--ITEM 322.14

FREQUENCY DISTRIBUTION OF VISIBLE PLUME AT CRBRP SITE FOR ALL STABILITY CLASSES

	Bearing (Compass Direction for Plant)															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Visible Plume Formation* (hrs/yr)	273	468	695	409	224	407	244	182	164	249	243	385	443	309	256	187
Frequency of Wind** (hrs/yr)	469	805	1,193	703	384	699	420	313	282	429	418	662	760	530	440	321

*For plumes attaining lengths of $\geq$ 300 feet

**From Table 2.6-18. Note that calm hours are not included in tabulations

TABLE 2--ITEM 322.14

ANTICIPATED AREAS OF FOG IMPACT FROM THE COOLING TOWERS

Sensitive Area	Distance Downwind, m	Direction From The Plant	Altitude Above Plant Grade, m	Horizontal Visibility		Number of Fog Hours Per Year*			
				Miles	Feet	Mechanical Draft Wet Cooling Tower Linear Array	Mechanical Draft Wet Cooling Tower Circular Array	Mechanical Draft Wet/Dry Tower 30% Plume Severity	Mechanical Draft Wet/Dry Tower 0% Plume Severity
ORNL	7,240	NE	0	1/2	2,640	0.26	0.26	0.00	0.00
				1/4	1,320	0.24	0.00	0.00	0.00
				1/10	528	0.00	0.00	0.00	0.00
Interstate 40	1,770	SSE	0	1/2	2,640	0.32	0.31	0.02	0.02
				1/4	1,320	0.31	0.30	0.02	0.00
				1/10	528	0.26	0.21	0.00	0.00
Gallaher Bridge	2,575	NW	0	1/2	2,640	0.34	0.17	0.18	0.04
				1/4	1,320	0.30	0.13	0.00	0.00
				1/10	528	0.04	0.00	0.00	0.00

*The values presented reflect the current state-of-the-art in plume modeling and are limited in accuracy to $\pm$ x 10.

TABLE 3--ITEM 322.14

ANTICIPATED SEVERE FOGGING* FROM THE COOLING TOWERS

Sensitive Area	Distance Downwind, m	Direction From The Plant	Altitude Above Plant Grade, m	Ground Fog, Hours Per Year			
				Mechanical Draft Wet Cooling Tower Linear Array	Mechanical Draft Wet Cooling Tower Circular Array	Mechanical Draft Wet/Dry Tower 30% Plume Severity	Mechanical Draft Wet/Dry Tower 0% Plume Severity
Hood Ridge	1,420	NE-ENE	100	0.62	0.62	0.62	--
Dug Ridge	1,210	SW	102	0.22	0.22	0.22	--
Chestnut Ridge	2,410	N	93	--	--	--	--
Chestnut Ridge	1,930	W	68	0.92	0.92	--	--
Chestnut Ridge	3,380	NNE	75	--	--	--	--
Chestnut Ridge	5,630	NNE-NE	75	--	--	--	--
Chestnut Ridge	7,720	NNE-NE	93	--	--	--	--
Chestnut Ridge	8,200	NE-ENE	68	--	--	--	--
Moore Ridge	2,010	ESE-SE	117	0.23	0.23	0.23	--
Moore Ridge	2,570	SE-SSE	126	0.31	0.31	--	--

*Horizontal visibility 1/10 mile or less

ITEM 340.1 (Section 9.2.4)

The last sentence on page 9.2.8 indicates that the Clinch River site is the only one of eleven potential new sites that "satisfied the new site selection criteria."

Provide a comparative discussion and information regarding the alternative sites, as prescribed in Section 9.2 of Regulatory Guide 4.2, to support that conclusion.

RESPONSE

Information regarding the eleven potential new sites that were considered is contained in Appendix A, Volume IV.

ITEM 350.3 (Section 2.7.2)

The environmental data presented covers only two months of the year--from the end of March to the end of May, whereas Regulatory Guide 4.2.1 calls for a preliminary evaluation of at least six months of field data and a commitment to furnish, within six months of filing the application, a final evaluation based on a full year of data. This meagerness in field data precludes meaningful analysis as required by NEPA. Furthermore, certain parameters were measured only once. This is the case of specific conductivity (Section 2.7.2.3.6), which was measured only during May 29-June 4. Six months of data (through the end of October) is required. In some cases, historical data from previous unrelated surveys have been added to data from the current survey, thus confusing and compromising the accuracy of the analysis.

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.

ITEM 350.4 (Section 2.7.2.4.1)

The analysis is based on only two surveys taken two months apart. Sampling should cover at least six months and preferably a full year. Clarify why the second survey (May 29) was chosen to be the baseline rather than the first survey.

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.1, pages 2.7-56 and 2.7-57.

ITEM 350.6 (Section 2.7.2.4.3)

Only two months of zooplankton data are presented. (See 350.3).

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.3, pages 2.7-62 through 2.7-65.

ITEM 350.7 (Section 2.7.2.4.4)

Only two months of periphyton data are presented and the data for May survey is questionable. It is evident by the paragraph starting on page 2.7-63 and continuing on page 2.7-64 that at least six months of consecutive, complete data are needed. The analysis presented in conjectural and inadequate.

On page 2.7-59 it is stated that a chlorophyll a/pheophytin a ratio midway between 1.0 and 1.7 indicates a "healthy" algal community. Yet on page 2.7-64 a ratio of 1.67 is "healthy" because it represents nondecaying intact organisms. Please clarify these confusing statements.

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.4, pages 2.7-65 through 2.7-70.

ITEM 350.8 (Section 2.7.2.4.7)

Only three months of fish population data are presented. (See 350.3).

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.7, pages 2.7-79 through 2.7-82.

ITEM 350.9 (Section 2.7.2.4.8)

Only three months of data on fish eggs and larvae are presented. (See 350.3).

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.8, pages 2.7-82 through 2.7-84.

ITEM 322.1 (Section 2.6.1)

Provide any revisions to the meteorological extremes presented in this section, including the tables, made necessary by meteorological events subsequent to the end of the period of record for the data presented in the section.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.1.

ITEM 322.2 (Section 2.6.2)

Provide any revisions to the meteorological extremes presented in this section, including the tables, made necessary by meteorological events subsequent to the end of the period of record for the data presented in the section.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.2.

ITEM 322.3 (Section 2.6.2.2)

Provide evidence that the number of calms observed at the X-10 Station from 1973 through 1968 were due to a malfunctioning instrument and that the discrepancy between the number of calms observed during the six-year period and the period of 6/71 - 11/72 was not due to an anomalous period of weather conditions.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.2.2, pages 2.6-10 and 2.6-11.

ITEM 322.4 (Section 2.6.2.3)

Provide evidence concerning the representativeness of the humidity data from Knoxville to conditions at the CRBRP site.

RESPONSE

On-site humidity data is not available at this time. Evidence of the representativeness cannot be provided on a quantitative basis, but on a qualitative basis. The Bull Run data is influenced by the ridges running northeast and southwest as well as by the Clinch River providing an abundant source of atmospheric moisture. This is similar to the situation at the CRBRP Site. A comparison can be made between Bull Run Steam Plant data and Knoxville data. Table 1 (Item 322.4) makes this comparison for the most adverse conditions; low temperature and high humidity.

Table 1 shows that 1/2 of the humidity data from the two locations have less than 10 percent difference, and 5/6 have less than 30 percent difference. The greatest differences occur in the 90-100 percent relative humidity data. Humidity data differences may be attributed to differing periods of record (Knoxville 1951-1960, Bull Run 1970-1973), instrumentation differences, and site-specific differences.

TABLE 1--ITEM 322.4

COMPARISON OF RELATIVE FREQUENCY DISTRIBUTION OF TEMPERATURE AND RELATIVE HUMIDITY

Relative Humidity, %

	70-79			80-90			90-100		
Temperature, °F	Knoxville	Bull Run	%Δ	Knoxville	Bull Run	%Δ	Knoxville	Bull Run	%Δ
25°	0.0099	0.0100	1.0	0.0076	0.0072	5.6	0.0019	0.0025	24.0
32°	0.0124	0.0142	12.7	0.0115	0.0119	3.4	0.0091	0.0039	57.1
37°	0.0158	0.0146	8.2	0.0138	0.0148	6.7	0.0111	0.0046	58.6
45°	0.0264	0.0281	6.05	0.0279	0.0391	28.6	0.0333	0.0248	25.5

ITEM 322.6 (Section 2.6.4)

Provide topographic cross-sections indicating the relationship between the present tower and instrument locations and present and proposed grading of the plant site.

RESPONSE

The response to this item was incorporated into the revised Section 2.6 as Figure 2.6-17, page 2.6-99.

ITEM 322.7 (Section 2.6.4)

Provide a large scale topographic map indicating the location of proposed plant structures with respect to the present and any other proposed meteorological towers.

RESPONSE

Enclosed with other responses is the information requested. At this time, no plans for the relocation of the CRBRP Meteorological Tower are formulated.

ITEM 322.9 (Section 2.6.6.1)

Provide revised short-term diffusion estimates based on the joint frequency data as requested under 322.5 above.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.6.1, pages 2.6-22 and 2.6-23.

ITEM 322.10 (Section 2.6.7.1)

Provide revised long-term diffusion estimates based on the joint frequency data as requested under 322.5.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.7.1, page 2.6-28.

ITEM 322.12 (Section 5.1.8.1)

Provide evidence that the humidity data from Bull Run Steam Plant, used in the evaluation of the atmospheric effects of the CRBRP cooling systems, is representative of conditions at the plant site.

RESPONSE

At this time, no accurate on-site relative humidity is available, the qualitative response of Question 322.4 will clarify the use of the Bull Run data.

ITEM 322.13 (Section 5.1.8 and Appendix to 10.1)

Provide the height above ground at which the meteorological data used in evaluating the atmospheric effects of each of the alternative cooling systems were obtained.

RESPONSE

The wind speed used in the evaluation was a mean speed from the 75-foot and 200-foot wind levels of the CRBRP Meteorological Tower. The frequency of wind direction was based upon the direction distribution of data from the 75-foot level at the same location. The temperature and relative humidity data was obtained from the TVA Bull Run Steam Plant where the height of the sensors aboveground was four feet.

ITEM 322.15 (Section 6.1.3)

Provide a more detailed description of the on-site meteorological program, including all instrumentation accuracy specifications, maintenance and calibration procedures, and data recording, processing and evaluation procedures.

RESPONSE

The response to this item was incorporated into the revised Section 2.6.5. Section 6.1.3 refers the reader back to Section 2.6.

ITEM 340.3 (Section 10.1)

What is the basis for the average capacity factor of 68.5 percent given in Table 10.1-8?

RESPONSE

The average plant capacity factor of 68.5 percent is based on the following plant loading schedule (Hrs/yr).

	Time Period (Yr.)			
Plant Load (%)	1-5	6-10	11-20	21-30
100	2066	5986	6477	3111
75	2880	557	515	2028
50	1064	209	221	879
25	250	209	147	744
0	2500	1799	1400	1998
	8760	8760	8760	8760

Capacity factor is the ratio of the average plant load for the period of time considered to the rated plant capacity. Therefore, the average plant capacity factors for the four time periods given above are:

First 5 years	55.2%
Next 5 years	75.1%
Next 10 years	80.2%
Final 10 years	60.2%

Over 30 years of plant operation the average capacity factor is 68.5 percent.

ITEM 340.4 (Section 10)

In a number of tables in Section 10 (Tables 10.1-9, 10.2-1, 10.7-9, and 10.8-7), variable or operating costs, sometimes said to be "capitalized" or expressed as "equivalent investment," are combined with fixed or capital costs to obtain total costs. In each case, the method of capitalizing or otherwise treating operating costs to combine them with capital costs should be explained. (It may be noted that the method of present worth has not been used).

RESPONSE

The costs in Table 10.2-1 are given as present worth following the computational procedures described in Table 2 of Monetized Bases for Generating Costs, USAEC Regulatory 4.2 Preparation of Environmental Reports for Nuclear Power Plants. The term "equivalent investment operating cost differential" can be replaced by "total variable cost."

ITEM 340.5 (Section 10.5)

Subsections 10.5.5 and 10.5.6 comparing alternative biocide systems do not give any quantitative indication of relative costs, relative amounts of chlorine required, or relative effects on plant performance.

RESPONSE

The Alternate Biocide Systems discussed in these subsections are:

1. chlorination
2. chlorination with mechanical cleaning during plant operation

Alternative 1 has a differential capital cost advantage relative to Alternative 2 of $177,000. This includes installed equipment costs, structural costs and condenser tube surface area savings.

Alternative 2 has differential savings in operating cost in present worth of approximately $115,000. Operating costs considered include auxiliary power, replacement parts, maintenance and chemicals. In addition, the present worth of improved condenser performance with mechanical cleaning is $30,000.

Therefore, the relative cost advantage of Alternate 1 is $32,000.

The reduction in chlorine for Alternate 2 is approximately 30 percent. The service water piping, the auxiliary heat exchangers, the circulating water piping and pumps, the condenser water boxes, and the cooling tower require chlorination to control biological growth. It should be noted that a 30 percent reduction may not be achievable due to the chlorine demand of the above sources and to the uncertain additional chlorine requirements that may be necessary to control Asiatic clams.

ITEM 350.1 (Section 2.5.1.3)

On page 2.5-4, the statement is made that "should the need arise for any regulation at Melton Hill Dam which would result in long periods of zero release, the operations would be coordinated to meet flow requirements at the CRBRP Site." A similar statement appears several other places in the ER. However, nowhere are the "flow requirements at the CRBRP Site" identified. Provide this information.

RESPONSE

The CRBRP can be safely shut down and maintained in a safe shutdown condition without makeup water required from the Clinch River. Thus, from the standpoint of safety, the CRBRP is completely independent of the flow in the Clinch River at the Site.

Although a long period of no flow of the Clinch River at the Site will not affect plant makeup (see Section 3.3 of the ER for plant water use), it could conceivably require some restriction of normal operation to ensure against exceeding applicable effluent restrictions. Sections 5.1, 5.4 and 5.5 of the ER examine the effects of thermal, chemical and biocide, and sanitary effluents, respectively, under various flow conditions of the Clinch River and conclude that no unacceptable impacts are expected even under the extreme case of 29 consecutive days of zero flow. Sections 5.2 and 5.3 of the ER have conservatively assessed the effects of radiation doses associated with 12 months of flow at typical summer conditions (4,777 cfs). Assuming the extreme case condition of 29 consecutive days of zero flow, the radiation doses calculated for the various exposure pathways will be increased by at most a factor of less than 5, based on the dilution factors developed in Appendix 10.3B. Even with this increase in dose from exposure to liquid effluents, the conclusion of Section 5.2 and 5.3 that there will be no detectable effects upon the population or biota is still valid. 6

As stated in the ER, the case of 29 consecutive days of zero release from Melton Hill Dam, as well as the next longest period of 11 days of zero release, resulted from special reservoir operations conducted to aid in controlling the growth of Eurasian water milfoil in Melton Hill Reservoir. Such special water level management requests for the water milfoil control program are granted only when compatible with all other TVA program interests including the CRBRP. Although periods of zero release may occur daily at Melton Hill Dam due to scheduled operations, it is not anticipated that an extended period of zero release will occur in the future.

Therefore, no restrictions on normal plant operations are anticipated based on flow of the Clinch River at the Site. In the unanticipated event of planned zero release from Melton Hill Dam for a period of time greater than 29 consecutive days, coordination of the operations of the Dam and CRBRP may be required to ensure compliance with all State and Federal standards.

ITEM 350.2 (Section 2.7.1.4.2)

Indicate when additional waterfowl data from the continuing survey will be submitted in supplement form.

RESPONSE

PROCEDURES FOR CONDUCTING WATERFOWL SURVEYS
IN VICINITY OF THE CRBRP SITE

Preliminary waterfowl investigations were conducted at the CRBRP Site during the period October-March 1972-1973 and 1973-1974. The purpose of these investigations was to document use of the site environs by wintering ducks, geese, raptors and shorebirds. Additionally, surveys of resident breeding wood duck populations were conducted during the period March 13, 1973 - June 26, 1973. Observations of other wetland bird species, as well as raptors, are also taken during wood duck counts. Further inventory of the CRBRP Site was resumed in December 1974.

Data summaries will be prepared and distributed twice yearly.

Spring and summer investigations

Spring and summer surveys are conducted during the March-June period.

A slow-moving outboard boat, manned by one operator-observer and one biologist, is used to obtain counts of wood ducks and shorebirds.

Counts begin at daylight or as soon thereafter as possible and are terminated by 11 a.m. (or earlier). The bow-observer tallies all birds seen by either person. To help reduce double-counting errors, ducks seen flying upstream (i.e., toward the observers) are not tallied.

Other pertinent information regarding time, weather, condition of water, etc., is recorded. Six to ten surveys will be conducted. The census route is 11 miles in length, extending from Melton Hill Dam downstream to the confluence of the Emory and Clinch Rivers.

Winter investigations

Winter surveys are conducted during the October-March period. Observations are made from a light aircraft manned by one pilot-observer and one observer. All water areas within a five-mile radius of the plant site are inspected while flying at 80-90 mph and 300-500 feet above the surface. Flight radii have been extended from one to five miles to better reflect the daily mobility of wintering waterfowl and, therefore, measure a more realistic impact area. Data recording is facilitated through the use of a small hand-held tape recorder. Weather parameters and water-level information are noted at each site.

ITEM 350.5 (Section 2.7.2.4.2)

The ER states that the number species of phytoplankton at the site is only 10 percent of the number of species measured 18 years ago. Since these waters were not identified as being under stress, verify the validity of these data.

Is the range 10×10^3 to 10.1×10^7 algae per liter really typical or is this what has been found? It appears unusual that a typical concentration range covers four orders of magnitude, while the range at the sample site covers only 0.4 orders of magnitude. This is especially true in light of the previous paragraph which implies that the number of species may range from 45 to 425.

Also present the basis and reference(s) for concluding that a chlorophyll a - pheophyton a ratio of 1.3 indicates a "healthy" algal community (p. 2.7-59).

The ER states that species diversity and total number of organisms per liter indicates little overall difference in phytoplankton among stations (p. 2.7-59). In fact, this may be more a result of inadequate sampling and counting. Furthermore, the apparently differing enumeration processes used between the March and May samples make quantitative comparisons suspect.

RESPONSE

The response to this item was incorporated into the revised Section 2.7.2.4.2, pages 2.7-58 through 2.7-62.

ITEM 350.11 (Section 3.4.3)

Describe more fully the proposed schedule for chlorination and the locations and details of monitoring chlorine in the discharge.

RESPONSE

Chlorine injection for bio-fouling control will occur at two locations. Provisions are being made for equipment and piping needed to inject chlorine into the space between the outer perforated pipe and the inner sleeve. The chlorinated water will travel through the internal sleeve into the main inlet pipe and the pump structure. Interlocks are provided to ensure that the chemical feed pump can operate only when the river water pump is taking suction from the inlet pipe so that chlorination will occur only when the perforated pipe inlets are in service. This will be a continuous low level addition during treatment periods occurring in the spring, summer, and fall. The amount of sodium hypochlorite added will be approximately 180 pounds per day during the treatment periods. This chlorination is expected to prevent the Asiatic clams from entering the Circulating Water System.

The other chlorination system will be employed to control primarily algae, slimes, and bacteria in the main condenser, cooling tower, circulating water piping, valves, pumps and auxiliary heat transfer surfaces. Approximately 450 pounds per day of sodium hypochlorite will be injected intermittently into the circulating water line upstream of the main condenser. Injection will be downstream of the blowdown take-off point (see ER Figure 3.4-1). Chlorine injection will occur for a duration of approximately 20 to 30 minutes, three or four times per day.

Chlorine dosage will be automatically controlled to satisfy the chlorine demand of the cooling water and will be determined during startup. Operation of the chlorine injectors will be coordinated by commercially

available feedback control instrumentation to prevent the daily average and one-day maximum free available chlorine concentration in the blowdown from exceeding Federal EPA limits. The amperometric-titration method will be the basis for defining "free available chlorine." Should the chlorine concentration, as measured by a recording analyzer, be greater than a preset value, alarms will sound and an automatically controlled valve on the blowdown line will close until the chlorine concentration has dissipated to an acceptable level. An acceptable level is one which ensures that the chlorine residual flow characteristics of the discharge comply with the EPA effluent limitations as cited in 40 CFR Part 423.

ITEM 350.13 (Section 6.1.1.1)

> There should also be a sampling transect just below the proposed intake to determine effects of entrainment and impingement above the mouths of Caney and Poplar Springs Creeks. Why are there no sampling stations in the shallows adjacent to the river banks?
>
> Present the rationale and calculations demonstrating that this sampling program's frequency, station location and depth will provide enough information to adequately characterize the Clinch River and to provide a basis for evaluating effects of plant construction and operation.

RESPONSE

The purpose of the aquatic baseline monitoring program at the Site, as stated on page 6.1-2 of the CRBRP-ER, was to identify and characterize: (1) physical and chemical parameters, (2) existing biological communities, and (3) endangered species. The effects of entrainment, as discussed on page 5.1-14 of the ER, can be estimated on the basis of the percentage of Clinch River flow taken into the plant and the corresponding numbers of plankton estimated in the volume of water taken into the plant. After the plant is in operation, an additional transect will be located below the intake to verify the estimated effect of entrainment.

Possible larval fish entrainment effects have been discussed in the ER (page 5.1-14) using data collected in the baseline survey program outlined on page 6.1-22. Preoperational larval fish sampling as described in page 6.1-28 will begin two years prior to plant operation at two stations. Postoperational larval fish samples will be taken at three stations: above the intake, at (immediately below) the intake, and below the discharge (page 6.2-17). Shoreline samples will be taken at all stations in both the preoperational and postoperational phases of monitoring for larval fish.

As noted in the ER (page 6.2-16), no impingement monitoring will be done, since any impingement that might occur will be on the perforated intake pipe which is located near the bottom of the Clinch River. The intake has been designed to minimize impingement as discussed on page 5.1-13 and in subsection 10.2.4.2 of the ER.

There are baseline sampling stations in the shallows adjacent to the river banks and near-shore sampling is conducted as described on page 6.1-3 of CRBRP-ER. Because water level fluctuates six feet or more during the year, near-shore periphyton and artificial substrate sampling stations are located so that they are not exposed during the extreme low water conditions. Monitoring of additional parameters in the shallows adjacent to the river bank will be conducted in the pre-construction monitoring program commencing in March 1975.

Rationale for the aquatic baseline program of the CRBRP is presented on pages 6.1-1 to 6.1-3 of the CRBRP-ER. The purpose of the baseline program is to provide information on important ecological characteristics of the Site and to serve as a basis for the more selective pre-construction, construction and operational programs. Sampling transect locations were selected on the basis of areas where major aquatic impact would be presumed to occur, as stated in the ER (page 6.1-3). Major physical, chemical and biological components of these areas were to be sampled for one year to determine seasonal and maximum variations in these parameters. Sampling of the biological communities, identified on page 6.1-3, was intensified during the spring, summer and fall period when the greatest variation in the numbers, components and biomass of these communities was expected to occur. Other areas, such as small creeks entering the Clinch River in the vicinity of the CRBRP, which may contribute chemical or biological material to the river were sampled in conjunction with the baseline survey of parameters in the river. Though no calculations were made prior to the initiation of the baseline program, project experience and survey data collected from March to September, 1974, presented in Section 2.7, indicate that the aquatic sampling program has adequately characterized the Clinch River ecosystem.

ITEM 350.14 (Section 9.2.4)

State whether recent aerial photographs of the eleven sites exist and can be provided on request with additional information identifying the general vegetational communities shown on the photographs and land-use characteristics of the sites.

RESPONSE

Aerial photographs of the eleven sites have been incorporated into Appendix A, Volume IV.

ITEM 350.16 (Table 2.7-75)

This table appears to have been constructed on the basis of very few phytoplanktors actually identified and counted. Extrapolation upwards was made by using a dilution factor of 11,111. The total number of cells actually seen is really 204 divided among six samples. This appears to be the reason why few species were found and diversity is so consistent.

RESPONSE

River samples collected in March had a high clay content. Attempts to concentrate the phytoplankton also concentrated the clay and made enumeration difficult. The numbers generated represent the number of six replicate samples and therefore adequately describe the composition of the sample.

ITEM 350.17 (Table 2.7-76)

What is the dilution factor(s) used to construct this table? If the dilution factor used in this table is smaller than in Table 2.7-75, then a larger number of species could be a reflection of greater reliability due to a larger sample size rather than a real difference between the March and May surveys.

RESPONSE

Dilution factor is 444 and is based on two replicate counts. Sample size is smaller than that used in Table 2.7-75 but phytoplankton density is greater.

ITEM 350.18 (Table 2.7-89)

The value of the May survey is seriously diminished because of lack of data from an upstream transect.

RESPONSE

The lost data from the May survey is a foregone event.

Continued sampling has characterized the similarities among transects. Comparison tables and discussion are provided in the revised Section 2.7.2.

ITEM 350.19 (Table 5.1-1)

Are the units acre-feet?

RESPONSE

Yes. Table 5.1-1 will be revised to indicate this.

ITEM 350.20 (Figure 6.1-10)

It is not clear from this map where the sampling locations are located. Please clarify.

RESPONSE

Sampling locations have been clarified in a revised version of Figure 6.1-10, page 6.1-63.

ITEM 350.21 (Figure 2.5-5 and 2.5-6)

Give reference surface elevation so that the elevations in the discussion of intake and discharge structures can be interpreted.

RESPONSE

Revised Figures 2.5-5 and 2.5-6 have been incorporated in the ER on pages 2.5-65 and 2.5-66, respectively.

PURPOSELY BLANK

AMENDMENT II

Additional Information for Detailed
Environmental Assessment of the Clinch
River Breeder Reactor Plant (CRBRP) Site

INTRODUCTION - PART II, Responses to NRC letters of February 13, 1975 and April 23, 1975

Amendment I, Part II, to the Clinch River Breeder Reactor Plant Environmental Report contains copies of questions submitted to the Project in a letter from Gordon K. Dicker, Chief, Environmental Projects Branch 2, Nuclear Regulatory Commission (NRC) on February 13, 1975 and the responses to these questions. Part II also contains questions from an April 23, 1975 NRC letter sent to the project by G. K. Dicker in which additional information was requested or previous questions were repeated.

The NRC questions were divided into the following seven categories:

A - Meteorology
B - Terrestrial Ecology
C - Aquatic Ecology
D - Hydrology
E - Chemical and Sanitary
F - Socioeconomic, Benefit-Cost, Alternatives
G - General

Responses to the majority of the questions in the February 13, 1975 letter were submitted to NRC on March 14, 1975. Responses to questions in the April 23, 1975 letter were submitted on May 15, 1975.

QUESTION A1

Provide information on other possible plume sources in the area of the site. If other sources exist, verify that plume interaction will be negligible.

RESPONSE

Contact was made with the Atmospheric Turbulence and Diffusion Laboratory of the National Oceanic and Atmospheric Administration located at Oak Ridge, Tennessee, to obtain information about other possible plume sources in the area of the Site. Drs. Garry Briggs, Steve Hanna and Ray Hawsker have studied many plume sources in the Oak Ridge area and have indicated that there are only five possible plume sources within a 15-mile radius of the CRBRP Site. These five possible plume sources are as follows:

Source	Distance From Site	Type
Kingston Steam Plant	9 miles	a) Nine 250- and 300-foot smoke stacks b) Two 1,000-foot smoke stacks
K-25 Gaseous Diffusion Plant	2.5 miles	Mechanical Draft cooling towers (88 cells)
X-10	5 miles	Small mechanical draft cooling towers
Y-12 Steam Generating Plant	9 miles	Several small smoke stacks and small mechanical draft cooling towers
Bull Run Steam Plant	15 miles	Several 800-foot smoke stacks

The K-25, X-10 and Y-12 facilities are closest to the CRBRP Site; however, the X-10 and Y-12 facilities are so small, interaction of plumes from these two locations would be negligible. The K-25 facility, which has many cells in the cooling tower system, is the largest and nearest plume source to the CRBRP Site.(1) There should be very negligible

plume interaction between the two facilities. The K-25 facility lies north of the CRBRP Site and has a wind frequency, from the K-25 facility to the CRBRP Site, of 0.02237 (196 hours) for stable atmospheric conditions. Only with constant wind direction from the northern sector and stable atmospheric conditions will the plume from the K-25 cooling towers reach lengths that would interact with the CRBRP plume.

The plumes from the Bull Run and Kingston Steam Plants will have little interaction with a plume from the CRBRP for two reasons. First, the distances are so great that only under the most severe conditions, with the right wind direction and speed, would a plume from the CRBRP begin to reach these two locations. Second, a plume from the CRBRP would be lower than plumes from the other two facilities since the site elevations of Bull Run and Kingston are 300 feet and 400 feet, respectively, above the elevation of the CRBRP Site. Therefore, any interaction between plumes would be negligible. This conclusion also was expressed by Drs. Briggs, Hanna and Hawsker.

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1. Hanna, S. R., "Meteorological Effects of the Mechanical Draft Cooling Towers of the Oak Ridge Gaseous Diffusion Plant," Atmospheric Turbulence and Diffusion Laboratory, Oak Ridge, Tennessee, March 1974.

QUESTION A2

Provide a joint frequency probability distribution table (in percent) of direction and incremental distances from the cooling towers of plume lengths on an annual basis. Information should be based on the on-site meteorological data.

RESPONSE

Table 1 (Question A2) provides the information requested. The table was constructed in three phases: (1) a prediction model was used to determine plume lengths for various ambient temperatures and relative humidities, (2) a frequency table of temperature and relative humidity was generated using data from the Bull Run Steam Plant and (3) a joint frequency distribution of wind direction and wind speed by Pasquill stability classes for the CRBRP on-site meteorological data at the 75-foot level was obtained. These three phases were then combined in an appropriate manner, with an assumption that the cooling towers operated at a level of 100 percent, to obtain the attached table which shows the percent frequency the plume will be elevated over an incremental distance in any compass direction.

TABLE 1--QUESTION A2

ANNUAL JOINT FREQUENCY PROBABILITY DISTRIBUTION TABLE (IN PERCENT) OF CRBRP COOLING TOWER PLUME LENGTHS FOR DIRECTION AND INCREMENTAL DISTANCES

BEARING FROM THE CRBRP SITE

Downwind Distance (miles)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.5	1.8	3.1	4.6	2.7	1.5	2.7	1.6	1.2	1.1	1.7	1.6	2.6	3.0	2.1	1.7	1.2
1.0	1.7	2.9	4.3	2.5	1.4	2.5	1.5	1.1	1.0	1.5	1.5	2.4	2.7	1.9	1.6	1.2
1.5	1.2	2.1	3.1	1.8	1.0	1.8	1.1	0.8	0.7	1.1	1.1	1.7	2.0	1.4	1.2	0.8
2.0	0.9	1.6	2.3	1.4	0.7	1.3	0.8	0.6	0.5	0.8	0.8	1.3	1.5	1.0	0.9	0.6
4.0	0.6	1.0	1.5	0.9	0.5	0.9	0.5	0.4	0.3	0.5	0.5	0.7	0.8	0.6	0.5	0.3
6.0	0.3	0.5	0.7	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.3	0.3	0.2
10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

QUESTION A3

Discuss the fog and ice observation program planned for the site.

RESPONSE

Plans for the fog and ice observation program have not been formalized. It is anticipated that this program will be limited to routine visual inspection by plant personnel of the cooling tower plume and the plume's relation to fog and ice occurrence at the site. The degree of program sophistication and other options will be investigated and details of the program defined approximately two years prior to plant operation.

QUESTION A4

Provide a joint frequency probability table (in percent) of direction and incremental distance from the cooling towers for fogging and icing due to cooling tower plume.

RESPONSE

Table 1 (Question A4) provides the requested information. The table was compiled by initially using a prediction model to determine the downwind area where potential fogging may occur for various temperatures and atmospheric stabilities. Assuming the relative humidity to be 90 percent or greater, the annual number of hours for each temperature, humidity and stability group was calculated for incremental downwind distances. The annual distribution of winds by direction from the 75-foot level of the CRBRP on-site meteorological tower was used to estimate the percentage of occurrence at various locations.

TABLE 1--QUESTION A4

ANNUAL JOINT FREQUENCY PROBABILITY DISTRIBUTION TABLE (IN PERCENT) OF POTENTIAL GROUND FOGGING AND ICING FROM THE CRBRP COOLING TOWER FOR DIRECTION AND INCREMENTAL DISTANCES

BEARING FROM CRBRP SITE

Downwind Distance (miles)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
200	0.04	0.07	0.11	0.06	0.04	0.06	0.04	0.03	0.03	0.04	0.04	0.06	0.07	0.06	0.04	0.04
600	0.05	0.09	0.14	0.08	0.04	0.08	0.05	0.04	0.03	0.05	0.05	0.08	0.09	0.06	0.05	0.04
1000	0.06	0.11	0.16	0.10	0.05	0.10	0.06	0.04	0.04	0.06	0.06	0.09	0.10	0.07	0.06	0.04
1400	0.07	0.11	0.17	0.10	0.05	0.10	0.06	0.04	0.04	0.06	0.06	0.09	0.11	0.07	0.06	0.04
1800	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
2200	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
2600	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
3000	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
3400	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
3800	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
4200	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
4600	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.03	0.02
5000	0.03	0.05	0.07	0.04	0.02	0.04	0.03	0.02	0.02	0.02	0.02	0.04	0.04	0.03	0.02	0.02
5400	0.03	0.04	0.07	0.04	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.03	0.02	0.02
5800	0.03	0.04	0.06	0.04	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.03	0.02	0.02
6200	0.03	0.04	0.06	0.04	0.02	0.04	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01
6600	0.02	0.03	0.04	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.02	0.01	0.01
7000	0.02	0.03	0.03	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00
7400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

QUESTION A5

Provide a joint frequency probability table of direction and incremental distance from the cooling towers for drift deposition.*

RESPONSE

The attached table provides the requested information for cooling tower drift deposition. The table was constructed by using a drift deposition model[1] to predict the amount of deposition expected at various downwind distances from the towers under the seven Pasquill stability classes and for various wind speeds. The amount of deposition at each downwind distance was distributed throughout the 16 compass directions by using the annual wind direction distribution from the 75-foot tower level of the CRBRP on-site meteorological tower. It was assumed that the plant will operate 100 percent of the time in one year. This represents the maximum potential drift deposition and is a conservative case. Wind data covered the period from July 1, 1973 through June 30, 1974.

In observing the distribution in Table 1, the largest amount of deposition is to be found about 0.3 miles northeast of the cooling towers. Evidence exists that excessive salt deposition can be injurious to vegetation.[1] Chlorides are considered the deposition material that will cause the most environmental impact. The circulating water contains 4.80 percent chlorides; therefore making the conservative assumption that all chlorides are deposited,

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*This question was repeated in the NRC letter of April 23, 1975.

(1) Roffman, A., and Grimble, R. E., "Drift Deposition Rates from Wet Cooling Systems," Cooling Tower Environment - 1974 Symposium, University of Maryland, College Park, Maryland, March 4-6, 1974.

the maximum deposition of chlorides is 2.51 pounds per acre per month. This should cause very little impact upon the environment considering that along the coasts, salt deposition from natural sea spray ranges from 1.5 to 15 pounds per acre per month.[2]

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(2) Roffman, A., et al, "The State of the Art of Salt Water Cooling Towers for Steam Electric Generating Plants," prepared for the U.S. Atomic Energy Commission, Division of Reactor Development, Contract No. AT(11-1)-2221, February 1973.

TABLE 1--QUESTION A5

DISTRIBUTION OF DRIFT DEPOSITION FOR VARIOUS DIRECTIONS AND INCREMENTAL DISTANCES FROM THE CRBRP SITE

Amount of Deposition from Cooling Towers, lb/acre-month
(Direction is bearing from plant)

Downwind Distance (miles)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	0.18	0.30	0.45	0.26	0.14	0.26	0.16	0.12	0.11	0.16	0.16	0.25	0.28	0.20	0.16	0.12
0.2	8.25	14.14	20.97	12.36	6.75	12.29	7.38	5.50	4.95	7.53	7.34	11.63	13.37	9.32	7.74	5.64
0.3	20.55	35.25	52.27	30.80	16.83	30.62	18.40	13.71	12.33	18.77	18.29	20.99	33.31	23.23	19.28	14.05
0.5	13.04	22.37	33.16	19.54	10.68	19.43	11.67	8.70	7.83	11.91	11.60	18.39	21.14	14.74	12.23	8.92
1.0	6.43	11.02	16.34	9.63	5.26	9.58	5.75	4.29	3.86	5.87	5.72	9.06	10.42	7.26	6.03	4.39
2.0	3.27	5.61	8.31	4.90	2.68	4.87	2.93	2.18	1.96	2.99	2.91	4.61	5.30	3.69	3.07	2.24
3.0	1.82	3.11	4.62	2.72	1.49	2.71	1.63	1.21	1.09	1.66	1.62	2.56	2.94	2.05	1.70	1.24
4.0	1.27	2.18	3.23	1.90	1.04	1.89	1.14	0.85	0.76	1.16	1.13	1.79	2.06	1.44	1.19	0.87
5.0	0.50	0.85	1.27	0.75	0.41	0.74	0.45	0.33	0.30	0.45	0.44	0.70	0.81	0.56	0.47	0.34
7.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00

QUESTION A6 (NRC Letter, February 13, 1975)

> From observation during the site visit, it appeared that on-site humidity data being taken is of questionable accuracy. State the sensor specifications and calibration and what can be done if greater accuracy is necessary.

RESPONSE

Currently in use is a Belfort Instrument Co. Model 5-594 hygrothermograph (4 feet aboveground, in a Stevenson Screen) with an ambient temperature chart range of -30 to +110 degrees F and relative humidity range of 0 to 100 percent. The maximum possible relative humidity error is $\pm$ 4 percent. The reading accuracy of temperature is to the nearest whole degree. Data is recorded on analog strip-charts and must be reduced manually.

A more elaborate relative humidity system, to be installed in the near future, will electronically record the amount of ambient water vapor in the air. A year's record is to be collected and analyzed for future utilization.

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER, April 23, 1975

> In addition to the response given above:
>
> a. State the reasons for collecting, at the CRBRP site, humidity data with accuracy tolerances that do not meet those required under Regulatory Guide 1.23. State plans for collecting more accurate humidity data at the site.

b. Justify use of humidity data from the Bull Run Steam Plant (15 miles from the site) for analyses of fogging and visible plume from the cooling tower, rather than on-site data or data from the X-10 meteorological station about 2.5 miles from the site.

c. Establish the representativeness of the Bull Run Steam Plant humidity data for the CRBRP site, taking into account the fact that Bull Run data were collected at a 4-foot level but the cooling tower plume will originate at a 60-foot level.

RESPONSE

Question A6a

The initial hygrothermograph was not intended for use in heat dissipation fogging analysis and admittedly did not meet the requirements for humidity or dew point monitoring specified in Regulatory Guide 1.23.

A new dew point system was installed at the on-site meteorological facility and began operation on April 3, 1975. The new system has a Cambridge mirror unit and is monitoring the dew point temperature at 10 meters above ground. The instrument accuracy meets the requirement of $\pm$ 0.5 degrees Celsius specified in Regulatory Guide 1.23.

Question A6b and A6c

The X-10 tower does not have humidity sensors. The closest available humidity data to the CRBRP Site is from the Bull Run Steam Plant. Section 2.6.2.3 of the ER was revised to describe these concerns expressed previously by NRC. The Project fully realized that the height at which the Bull Run data was taken and the height of the plume were substantially different.

The humidity sensors which meet Regulatory Guide 1.23 have been in operation at the Site since April 3, 1975. A correlation study between the results of Bull Steam Plant humidity data and the CRBRP on-site data will be conducted for the one-month period from April 4, 1975 to May 4, 1975 and forwarded to NRC by June 15, 1975.

QUESTION B1

Estimate the range of annual litter-fall and mineral content for the sampled forest types on the Site.

RESPONSE

Estimates of annual leaf litter-fall and mineral content are presented in the following table:

Community	Annual litter-fall (tons/acre)	Mineral Content (pounds/acre)
Minor ridge hardwood (A, D, J)	9.5 - 10	670 - 700
Chestnut Ridge hardwood (K, L)	13 - 15	920 - 1060
Successional pine (C, G, H)	10 - 11	700 - 780
Loblolly pine plantation (B)	16	1130
White pine plantation (I)	17	1200
Hardwood-cedar (F)	9	640
Red cedar glade (E)	7	500

QUESTION B2

Discuss practices to be used in applying any herbicides to transmission line rights-of-way.

RESPONSE

Construction of the proposed transmission lines into the Clinch River Breeder Reactor Site will require the clearing of approximately 58 acres of woodland and old field communities. Removal of vegetation will be accomplished by the "shear clearing" method except where outcropping of rocks, steep slopes, proximity to streams and roads make it impractical. Hand clearing or spanning of vegetation will be utilized where these exceptions are encountered. It is expected that nearly all of the clearing will be done by bulldozers with Roman cutter blades which mechanically remove all vegetation at ground level and no herbicides will be used during the clearing operations.

Transmission line maintenance requires that vegetation be controlled so it will not interfere with the safe and reliable operation of the lines nor impede restoration of service when outages occur. Growth of vegetation will be controlled by mechanical or hand cutting and the limited use of herbicides. The use of herbicides will be restricted to the hand application of Tordon 10K pellets to an occasional large stump not removed during the clearing operation. Tordon 10K pellets are approved for this use by the Environmental Protection Agency and the Federal Working Group on Pest Management.

QUESTION B3

Give quantitative estimates of small mammal populations on the Site including sampling methods, locations and times.

RESPONSE

Seasonal on-site small mammal trapping surveys were completed for winter (early March), spring (May), summer (August) and fall (November) of 1974. Trapping was conducted in twelve different areas of the Site.

Live trapping was conducted in five selected study areas, as shown in Table 1 and Figure 1 (Question B3). Sherman live traps were used at a spacing of 42-foot intervals on a one-acre grid in each study area for four consecutive nights. This resulted in 20 trap nights per grid per night for a minimum of four nights.

Snap trapping was conducted in seven study areas (five community types), as shown in Table 2 and Figure 1 (Question B3). In each area a line of traps was set at ten stations along a transect with three traps at each station. All traps were set for two consecutive nights in each location with a total of 60 trap nights per study area each season. Both live and snap traps were baited with peanut butter.

Data for the live and snap trap sites is presented in Tables 1 and 2 (Question B3). The population estimates based on live trapping were determined by two mark-recapture methods; the Lincoln index and the Schnabel method of estimating populations. The Lincoln index involves a precensus period -- capturing, marking and releasing animals within each grid -- and a subsequent census period -- animals are again captured within each grid.

An estimate of the total population was then computed from the ratio of marked to unmarked individuals. The formula used was:

$$N:T::n:t \text{ or } N = \frac{T}{t/n} \text{ or } \frac{nT}{t}$$

where

T = number of animals marked in the precensus period

t = number of marked animals trapped in the census period

n = total number of animals trapped in the census period

N = the population estimate

A variation of the Lincoln index, the Schnabel method accumulates, captures and recaptures daily. Population estimates were calculated using the formula:

$$N = \frac{\Sigma\ A \times B}{\Sigma C}$$

where

A = number trapped

B = number of marked animals in area

C = number of recaptures

N = the population estimate

The snap trap estimate is presented as a trap night index which is the percentage of captures based on number of traps in the field using the formula:

$$I = \frac{C}{TN}$$

where

TN = total number of trap nights

C = number of captures

I = trap night index

Both the snap trap and live trap data indicate that the two most common species are the white-footed mouse and the golden mouse. The white-footed mouse is a resident of the hardwood forest while the golden mouse is found in the honeysuckle-covered pine forest, particularly in the low lying sites.

The live trapping method is a more accurate method of estimating population numbers than snap trapping; however, the low number of captures reflected by the low population estimates is probably due to the presence of adequate habitat resulting in low trap success. This is particularly true during periods when natural food is in abundance. Using the calculated population figures in Table 1 (Question B3) as minimum estimates, the white-footed mouse populations range from zero to 4.0 individuals per acre with the highest populations occurring in dry-mixed hardwood sites throughout the year. The relatively sterile environment of the loblolly pine plantation proved the least productive throughout the year. Captures ran higher in the fall when populations were expected to reach peak numbers.

The snap trap data indicate that this method is more selective than live trapping; hence, it is used only for characterization purposes.

The small mammal trapping program indicated that there are no unusual occurrences on the Site. No endangered or threatened populations were encountered on the study sites.

TABLE 1--QUESTION B3

CLINCH RIVER SITE
SMALL MAMMAL POPULATIONS PER ACRE FOR
WINTER, SPRING, SUMMER AND FALL 1974 (DETERMINED BY LIVE TRAPPING)

Community	WINTER		SPRING		SUMMER		FALL	
	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**
Loblolly Pine Plantation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mesic Mixed Hardwoods	0.0	0.0	0.0	0.0	0.0	0.0	3.5 - 4.0	0.0
Mixed Hardwood Cedar	0.0	0.0	0.0	0.0	2.0 - 4.0	0.0	1.0	0.0
Virginia-shortleaf Pine (Successional)	0.0	(1)	0.0	(1)	(1)	(1)	0.0	(1)
Dry Mixed Hardwoods	3.0	0.0	2.0	0.0	2.0 - 4.0	0.0	2.0 - 4.0	0.0

* *Peromyscus leucopus*
** *Peromyscus nutalli*
( ) Indicates number of animals caught where number was not sufficient to calculate population.

Other mammals captured:
Blarina brevicauda - mixed hardwoods
Mus musculus - loblolly pine plantation

NOTE: Where a range of values is shown the Lincoln and Schnabel Methods produced two different values.

TABLE 2--QUESTION B3

CLINCH RIVER SITE
SMALL MAMMAL TRAP NIGHT INDEX
FOR WINTER, SPRING, SUMMER AND FALL 1974 (DETERMINED BY SNAP TRAPPING)

Community	WINTER		SPRING		SUMMER		FALL	
	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**	White-footed Mouse*	Golden Mouse**
Eastern Red Cedar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mesic Mixed Hardwoods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Virginia-shortleaf Pine (Successional)	0.02	0.0	0.0	0.02	0.0	0.0	0.0	0.0
White Pine Plantation	0.0	0.0	0.33	0.02	0.0	0.0	0.0	0.0
Transmission Line R-O-W (161 kv)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* *Peromyscus leucopus*
** *Peromyscus nutalli*

Other mammals captured:
Blarina brevicauda - Transmission Line R-O-W.

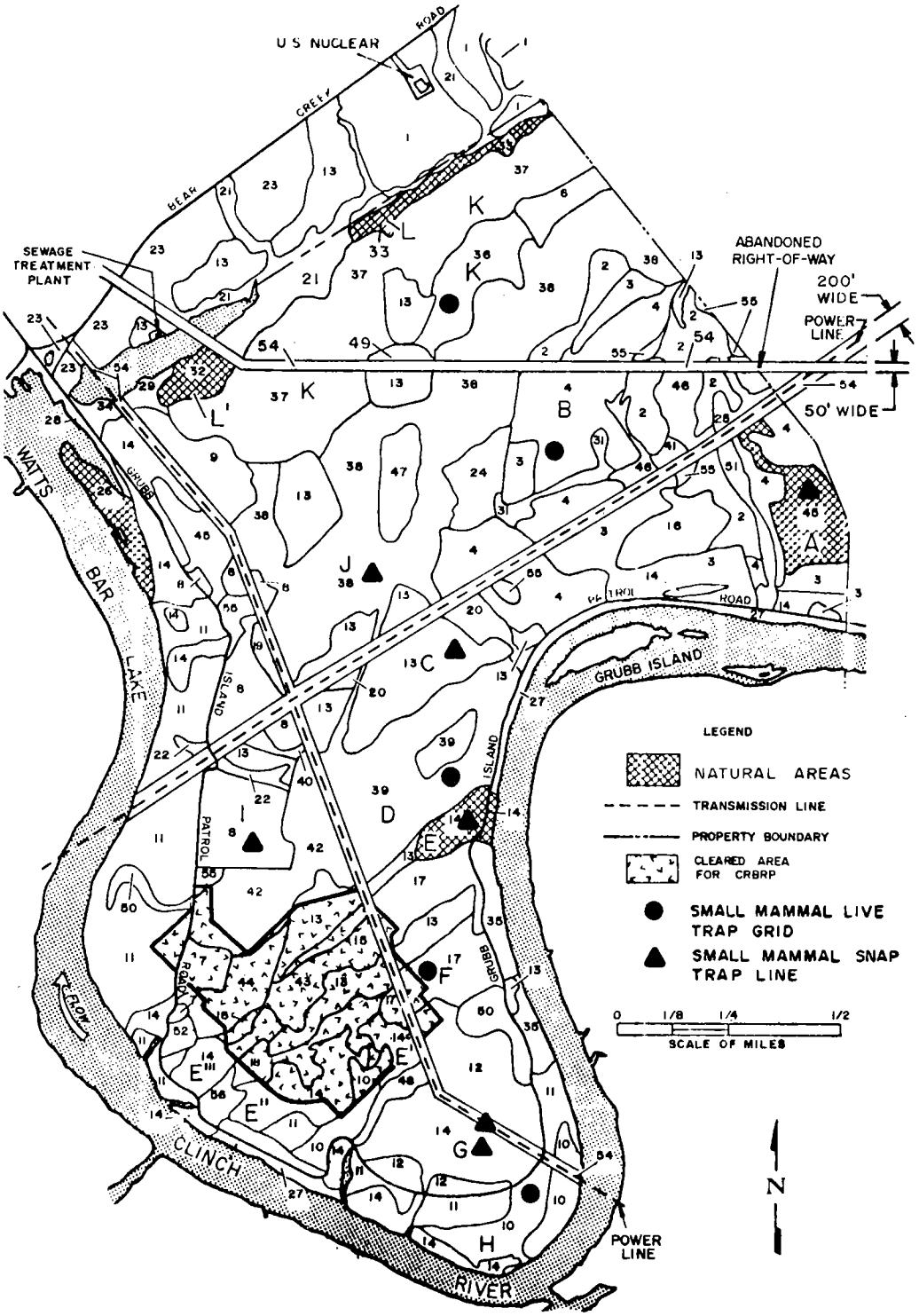

Figure 1 SMALL MAMMAL SAMPLING LOCATIONS ON THE CLINCH RIVER SITE
(Ques. B3) (Legend as for Figure 2.7-6)

QUESTION B4

Give quantitative estimates of bird populations on the Site including sampling methods, locations and times.

RESPONSE

Sampling techniques relative to species diversity and population density determination on 12 transects were as follows. Measured transects on representative habitat plots were established in major vegetation types. Populations within the transect areas were measured during the course of seven survey trips along each of the 12 transects both in late May and in mid-December. All birds occurring within the transects (extended 208 feet to both sides of the transect line center) were included. The location, extent and station numbers of each transect are shown on an accompanying map of the property area (Figure 1, Question B4). Stations were spaced along the transects at intervals of 208 feet representing the edge of a one-acre square. Starting and ending stations of each transect were marked by wooden surveyor stakes and red flagging tape. The intervening course of the transect between stations was marked with blue tape.

Transect counts, made on May 25 through May 30 and on June 1, were repeated on December 4 through December 18. Each count began as early in the day as light and other conditions permitted and continued until a count was made on each transect. The order of the transects visited was varied to offset the differences in count efficiency at different time periods. Each count was conducted by starting at one end of the transect and walking at a rate of one to three miles per hour along the transect. At each station a stop of one minute was made in the summer and three minutes in the winter. These stops were necessary due to the interference of the sounds made by walking in dry leaves with the detection of bird songs and calls. The winter counts were made using

the same technique as the spring ones except that in the last 1.5 minutes at each stop, the observers made squeaking and shushing sounds in an attempt to elicit a response from birds that would enable the observers to see or hear them. Both late-spring and early winter studies consisted of seven counts.

Individual bird contacts were recorded by species on outline maps of transect areas including nature of contact -- singing, non-song vocalization or sighting -- and location relative to the transect center line. Transect area summaries, based on the first five-acre units sampled to make information comparative, are included in Tables 1 and 2 (Question B4). Species and number of individuals observed also are included in the tables. When a bird was contacted twice in the course of seven counts it was considered to have a part, or perhaps all, of its territory on the transect areas as recommended for bird census work. A territory was considered to contain a pair of birds (or pair-equivalent in the case of nonterritorial species, e.g., the brown-headed cowbird). A bird represented by a single contact was considered to be nonterritorial and counted as a single individual except where single contacts were with a pair of birds in which case two individuals were credited to the transect area. The spring population measurements generally are of pairs of birds which are on a territory and stationary. In winter many of the birds are not territorial and they do not form pair bonds. Some of the local species occur in social groups which may include more than one species. The winter bird population estimate is the average number of birds per count of each species seen in the course of the counts made on each transect area.

TABLE 1--QUESTION B4

BIRD SPECIES OBSERVED DURING SPRING 1974 SURVEYS OF THE CLINCH RIVER SITE*

Species	Plot A		Plot B		Plot C		Plot D		Plot E		Plot F		Plot G		Plot H		Plot I		Plot J		Plot K		Plot L		Total	
	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals	Territories	Individuals
Ruffed grouse																			0	1					0	1
American woodcock									0	1					0	1									0	2
Yellow-billed cuckoo	0	1			1	2	1	2	0	1	0	1					1	2	0	1	0	1	1	2	4	13
Screech owl					1	2																			1	2
Ruby-throated hummingbird															0	1									0	1
Pileated woodpecker																					0	1			0	1
Red-bellied woodpecker																									0	0
Hairy woodpecker	0	1									0	1													0	2
Downy woodpecker											0	1													0	1
Great crested flycatcher																									0	0
Acadian flycatcher																			0	1			0	1	0	2
Eastern wood pewee																									0	0
Blue jay							1	3	0	1	1	2	0	1	0	1			0	1					2	9
Common crow					0	1																			0	1
Carolina chickadee	1	2					0	1	0	2	0	1					0	2	1	2	0	1	1	2	3	13
Tufted titmouse	1	2			0	1	1	2											1	3	1	2	1	2	5	12
Carolina wren	1	2			0	1	1	2					1	2	1	2					1	2	0	1	5	12
Mockingbird											0	1													0	1
Wood thrush	1	2																			1	2			2	4
Blue-gray gnatcatcher									0	1									1	2					1	3
White-eyed vireo									1	2	0	1	1	2	2	5									4	10
Yellow-throated vireo																									0	0
Red-eyed vireo	1	2	1	2			1	3											1	2	2	4	1	2	7	15
Black-and-white warbler							0	1											1	2	1	2			2	5
Prothonotary warbler																									0	0
Worm-eating warbler																					0	1			0	1
Yellow-throated warbler																									0	0
Pine warbler			1	2	1	3									0	1									2	6
Prairie warbler					1	3			1	2	0	1			1	3									3	9
Ovenbird	0	1			0	1					0	1							1	2	2	4	1	2	4	11
Kentucky warbler																							0	1	0	1
Common yellowthroat					1	2									0	1									1	3
Yellow-breasted chat													0	1	1	3									1	4
Hooded warbler			1	2									0	1			0	1			1	2			2	6
Common grackle							0	1			0	1													0	2
Brown-headed cowbird											0	1													0	1
Scarlet tanager																	0	1			0	1			0	2
Summer tanager	1	2					1	2			0	1							0	1	1	2			3	8
Cardinal	1	2	1	2	1	2	1	3	1	2	1	2	1	2	1	2	1	3	1	2			1	2	11	24
Indigo bunting			0	1																					0	1
American goldfinch									0	1															0	1
Rufous-sided towhee			0	1					1	2	0	1			0	2									1	6
TOTAL	7	17	4	10	6	18	7	20	4	15	2	16	3	9	6	22	2	9	7	21	10	25	6	15	64	196
Species Diversity Index	3.262		2.522		3.196		3.209		3.240		3.750		2.502		3.137		2.196		3.463		3.524		3.107			

* Surveys were conducted on 12 plots on the Property Area and number of territories and individuals recorded on five acre units of each plot. Species diversity indexes are given for a five acre unit of each plot.

TABLE 2--QUESTION B4

BIRD SPECIES OBSERVED DURING WINTER 1974 SURVEYS OF THE CLINCH RIVER SITE*

Species	Plot A	Plot B	Plot C	Plot D	Plot E	Plot F	Plot G	Plot H	Plot I	Plot J	Plot K	Plot L	Total	
	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals	Plusses
Great blue heron					+									1
Sharp-shinned hawk					+									1
Ruffed grouse		+												1
Barred owl										+				1
Common flicker														0
Pileated woodpecker			1				+				+		1	2
Red-bellied woodpecker	+													1
Yellow-bellied sapsucker														0
Hairy woodpecker			1	+			+						1	2
Downy woodpecker	+		1	+						+	+	+	1	5
Eastern phoebe														0
Blue jay					+									1
Common crow														0
Carolina chickadee	1		2		+	1	1	+	1		1	+	7	3
Tufted titmouse			1								+		1	1
White-breasted nuthatch			+											1
Brown creeper			+						+	+				3
Winter wren		+	+				+	+			+			5
Carolina wren		+	+	+			1	+		+	+		1	6
Robin	+	+						+						3
Hermit thrush		1	1			+	1	+	+				3	3
Golden-crowned kinglet	1	1	2	2	+	1	1	1	2	+	1		12	2
Ruby-crowned kinglet			1		+	+	1	1	+				3	3
Yellow-rumped warbler			1		+		1						2	1
Cardinal								+	+					2
Purple finch	1							+				+	1	2
American goldfinch								+						1
Rufous-sided towhee								+						1
Dark-eyed junco								+	2	+			2	2
Field sparrow								1					1	
White-throated sparrow							1	4					5	
Swamp sparrow														0
Song sparrow								1					1	
Individuals	3	2	11	2	0	2	7	8	5	0	2	0	42	
Plusses	3	4	4	3	7	2	3	10	4	6	5	3		54

* Surveys were conducted on 12 plots on the property area and the average number of individuals per trip on the five-acre units of each plot calculated. Plus signs (+) indicate the presence of a species which occurred on a five-acre unit with an average number of individuals per trip of less than 0.5.

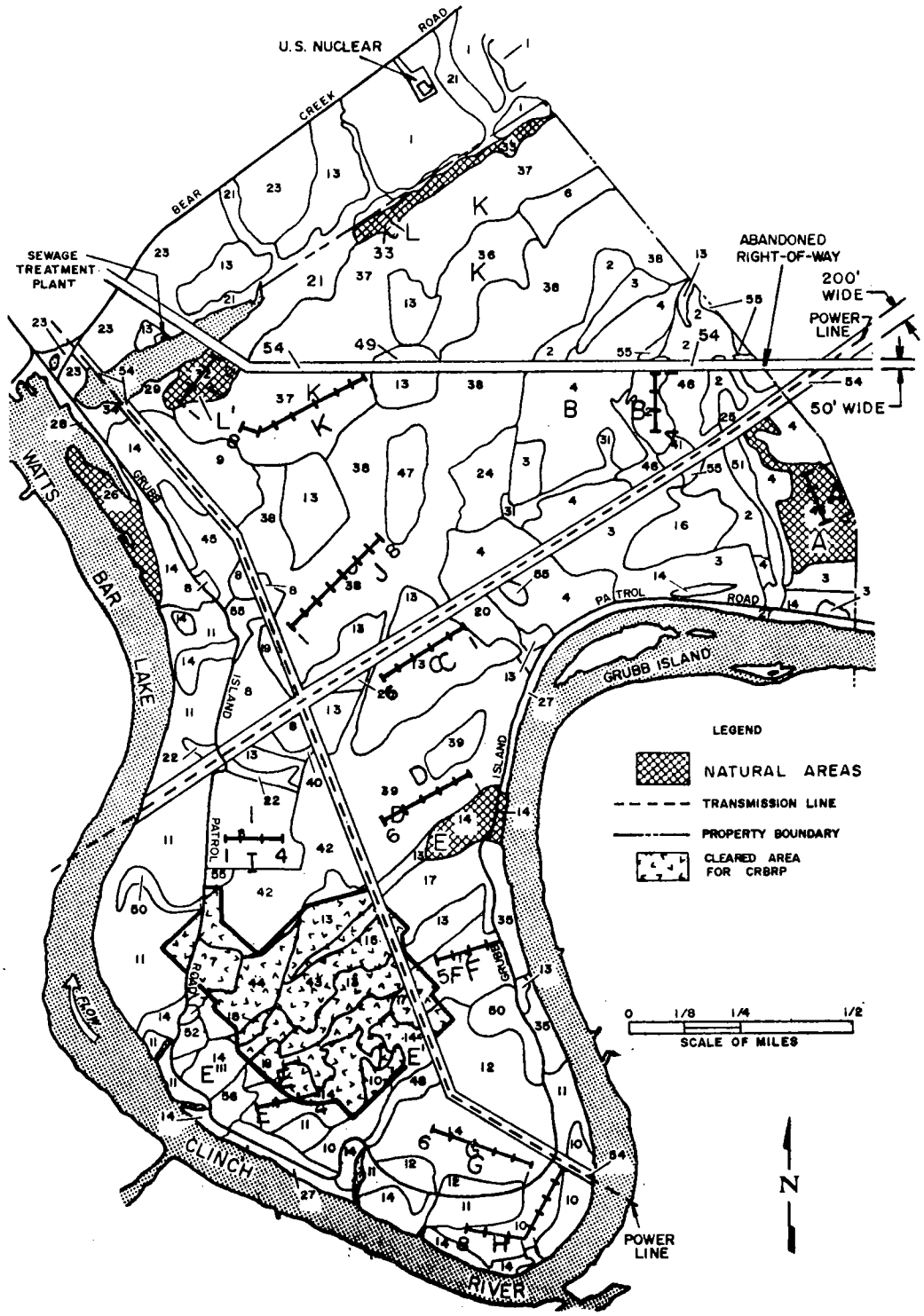

Figure 1 LOCATIONS OF BIRD OBSERVATION TRANSECTS
(Ques. B4) ON THE CLINCH RIVER SITE

QUESTION B5

Indicate relative abundance of game birds and game mammals on the Site.

RESPONSE

Game Mammals - The three game species important to the Site are the whitetail deer, cottontail and gray squirrel. The whitetail deer density in Roane County is roughly one deer per 2,000 acres. Populations on the CRBRP Site probably run higher, perhaps one deer per 500 to 600 acres (Bob Hatcher, Tennessee Game and Fish Department). If this rough figure is used as a guide, there should be approximately two to three deer on the Site. However, this estimate is probably low, based on sightings during the 1974 survey. The population may range as high as 10 to 12 deer based on actual observations. This is probably due to prohibition of hunting on the Site.

Based on 1974 sightings and using a scale of abundance, common and uncommon, the cottontail would be rated as common along the transmission line right-of-way, in recently cut over hardwood areas and in old fields. This species is uncommon in the pine plantations and successional pine stands.

The gray squirrel or its sign was observed in 1974 in the mature mixed hardwood areas on Site. The squirrel is common only in these areas.

Game Birds - Four species of upland game birds were found on the Site, including the bobwhite quail, ruffed grouse, mourning doves and American woodcock. The most abundant of these species was the bobwhite quail. A total of six covies (4 to 6 individuals per covy) were observed in open fields and brushy habitat areas during the May and July surveys.

Another common gamebird species observed on the Site was the ruffed grouse. Five individuals were heard drumming during the spring and summer survey periods in various locations. A single individual was identified during the midwinter survey in Area B (see Figure 1, Question B4).

Mourning doves were observed throughout the Site area. A total of nine individuals were observed during the spring and summer surveys. One pair mated, nested and produced two young in Area C.

The American woodcock was commonly found in wet fields and border areas in early spring. Five individuals were identified during the survey work.

QUESTION B6

Specify whether or not present land management practices (ERDA-OR Forest Management Program) will be continued for the undisturbed parts of the site. If not, specify what management practices will be used.

RESPONSE

TVA has given ERDA-OR permission to continue its Forestry Management Program until the site is needed for development. ERDA-OR has agreed to terminate their program on any part of the site at TVA's request when that part is needed for development.

We would expect that the ERDA-OR Forestry Management Program could continue on any portions of the site not disturbed by construction activities.

QUESTION B7

Referring to Figure 2.7-6 of the Environmental Report, give the community type in which rare plant species occur and estimate its approximate distance from the area to be cleared for construction of the CRBRP.

RESPONSE

Three plant species which are recognized as threatened include black snakeroot (Cimicifuga rubifolia Kearney), ginseng (Panax quinquefolium Linnaeus) and Carey's saxifrage (Saxifraga careyana Gray)[1,2] The known range of black snakeroot has been indicated in Figure 2.7-8 of Section 2.7. On the Site, black snakeroot occurs in Cover Type 21 approximately 1.4 miles north of the CRBRP. Ginseng occurs in Community J (Cover Type 38) approximately 1.3 miles north-northeast of the CRBRP. Carey's saxifrage occurs on the eastern periphery of Community D (Cover Type 39) approximately 0.5 miles northeast of the CRBRP.

Ten unusual but not rare plant species on the CRBRP Site include Adam-and-Eve orchid (Aplectrum hyemale [Muhlenberg ex Willdenow] Torrey), Wister's coral-root (Corallorhiza wisteriana Conrad), southern buckthorn (Bumelia lycioides (L.) Persoon), common adder's tongue (Ophioglossum vulgatum L.), Lizard's tail (Saururus cernuus L.), Vasey's trillium (Trillium vaseyi Harbison), large twayblade (Liparis lilifolia (L.) Richard), Wild ginger (Asarum canadense L.), black cohosh (Cimicifuga racemosa (L.) Nuttall) and white baneberry (Actaea pachypoda Ell.). Of these ten species, lizard's tail, Wister's coral-root, Adam-and-Eve orchid and wild ginger are least common.[3,4] Lizard's tail occurs in Cover Type 14 on the border of a small inlet approximately 0.3 mile west-southwest of the CRBRP. Wister's coral-root occurs in Cover Type 17 on a north-facing slope approximately 0.3 mile northeast of the CRBRP. Adam-and-Eve orchid occurs in Cover Type 13 on a south facing slope 0.8 mile north of the CRBRP. Wild ginger occurs in Cover Type 21 at the base of the northwest facing slope, 1.2 miles north of the CRBRP.

Southern buckthorn occurs commonly on the coastal plain from southeast Virginia to Eastern Texas and north in the U. S. Interior to southern Indiana and Illinois:[5] the species is uncommon in east Tennessee. Southern buckthorn occurs on a minor hilltop in Cover Type 17 (Community F) 0.2 mile east of the CRBRP. Large twayblade, a relatively uncommon orchid species, occurs throughout the eastern U.S.[5] It was collected in a white pine plantation northwest of Community B, 1.3 miles north-northeast of the CRBRP. Common Adder's tongue, a very widespread species[5] but uncommon in the Site area, occurs in Communities G (0.3 mile southeast of the CRBRP) and L' (1.1 miles north of the CRBRP). Black cohosh, a species found in the Appalachian Mountain region,[5] occurs in Cover Types 29 and 21 near Grassy Creek on the northwestern Site boundary 1.1 to 1.2 miles north of the CRBRP. Vasey's trillium a species found in the southern Appalachian Mountains of North Carolina, Georgia and Tennessee and sometimes treated taxonomically as a variety of Trillium erectum L., [3] occurs in Cover Type 21, 1.2 miles north of the CRBRP. White baneberry, a species common to the Appalachian Mountains but rare in neighboring regions,[3] occurs in Cover Type 21, 1.2 miles north of the CRBRP.

B-7 REFERENCES

1. Sharp, A. J., Rare Plants of Tennessee, The Tennessee Conservationist, Vol XL, No. 7, July 1974, pp 20-21.

2. Smithsonian Institution, Report on Endangered and Threatened Plant Species of the United States, Presented to the Congress of the United States of America, House Document No. 94-51, Serial 94-A, U.S. Government Printing Office, Washington, D. C., 1975, pp 149-150.

3. Radford, A. E., Ahles, H. E. and Bell, C. R., Manual of the Vascular Flora of the Carolinas, University of North Carolina Press, Chapel Hill, North Carolina, 1968.

4. Fernald, M. L., ed., Gray's Manual of Botany, Eighth Edition, D. Van Nostrand Co., New York, 1950, Corrected by Rollins, R. C. 1970, pp 483, 484 and 486.

5. Gleason, H. A., The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada, Hafner Press, New York, 1952, Vol 1, pp 456 and 473, Vol 2, pp 200 and 605.

QUESTION B8

Specify the objectives, the general techniques to be employed and the frequency of ecological monitoring of the terrestrial ecosystem to be done in the construction phase.

RESPONSE

The basic objective of the terrestrial nonradiological construction monitoring program is to develop necessary programs to protect and preserve critical ecological elements identified in the baseline studies (e.g., rare or endangered species, unique vegetation associations).

Prior to initiation of plant construction, ecologists will meet with the plant construction project manager and provide him with necessary maps and photos showing locations of critical ecological elements (as outlined in WESD response to Question B7). Semiannual visits will then be made to the plant sites to visually inspect, on the ground, species and community locations.

The main source of impact to those areas would be construction activities such as excavation. By providing construction personnel with maps and photos and inspecting the sites periodically these areas should not be adversely affected.

In addition to the above, annual spring, summer and fall-winter waterfowl and shorebird inventories will be conducted during the construction phase. Riparian habitats represent valuable, highly productive communities and are a diminishing resource in the region. Overflight of the Clinch River area within a five-mile radius of the Site will be conducted during the period of November to February to monitor waterfowl populations.

Spring and summer motorboat float counts will be made from April to September on breeding waterfowl and other riparian species. Riparian bird data will be assembled in report form annually.

QUESTION B9

Clarify the location of the "existing railroad" in Figure 4.1-1.

RESPONSE

The railroad shown on Figure 4.1-1 is all new; the figure has been changed to indicate this. The existing railroad runs northeast-southwest at the northern boundary of the figure and it is expected that the connections between new and existing railroads would be made at the northwest tip of the new railroad shown on Figure 4.1-1.

QUESTION C1

Discuss in more detail the possible problem of Eurasian water milfoil's shutting down the Melton Hill Dam and the possibility of the milfoil's causing problems with the plant intake structure.

RESPONSE

Control of Eurasian water milfoil is accomplished through reservoir water level management and treatment with a herbicide. Herbicide treatment in the past has been conducted during periods of low or no flow from Melton Hill Dam in order to increase its effectiveness.

It is not anticipated that it would ever become necessary to close down Melton Hill Dam solely for control of Eurasian water milfoil. Water milfoil control operations, when required on Melton Hill Reservoir, are scheduled as much as possible to take advantage of water level management operations scheduled for other interests. Special water level management requests for the water milfoil control program have low priority and are granted only when compatible with all other TVA program interests.

Over the past years we have experienced very little water milfoil in the Clinch River arm of Watts Bar Reservoir. In 1974 only 12 cumulative acres were treated from river mile 5 to 17, with the majority of the colonies occurring downstream from river mile 15. Bull Run Steam Plant on Melton Hill Reservoir has had no appreciable problems from water milfoil at its plant intake structure. Therefore, it is our opinion that no problems will be experienced at the CRBRP intake structure.

QUESTION C2

For the area's commercial fish catch, state numbers, value and catch location. Rank the catch with those from other areas of the state (p. 2.7-82). 6

RESPONSE

Information on the commercial fish catch in East Tennessee for the calendar year 1972 was included in the ER on page 2.7-86 as follows:

"An attempt was made to gather information pertaining to commercial and sport fishing in the area of the Site. No data were available on sport-fishing harvest from either Watts Bar Reservoir or Melton Hill Reservoir.(81) Commercial catches in 1972 within a 10-mile radius of the Site were negligible and amounted to about one percent of the total catch from Watts Bar Reservoir or around 1,000 pounds.(82)" 6

Data on the commercial catch was collected by Fisheries and Wildlife Development, Tennessee Valley Authority and reported by Allen.(1)

The pounds and value of commercial species harvested from Watts Bar Reservoir in 1972 are as follows:

Species		Pound	Value
Catfish		22,708	$7,039
Buffalofish		48,395	5,323
Carp		9,658	290
Drum		1,192	95
Paddlefish		12,355	2,347
	Totals	94,308	$15,094

1. Letter, Allen, E. C., U.S. Department of Commerce, National Oceanic and Atmospheric Administration, citing Hubert, W., TVA to Colick, J., WESD, March 1, 1974.

Commercial catches within a 10-mile radius of the Site in 1972 were about 1,000 pounds or approximately one percent of the total reported from Watts Bar Reservoir. This amount is considered negligible in terms of the total commercial catch in Watts Bar Reservoir.

A 1971 TVA survey of commercial fish catches in the western TVA reservoirs reported 657,000 pounds from Wilson Reservoir, 1,582,000 pounds from Wheeler Reservoir and 1,789,000 pounds from Guntersville Reservoir. Fort Loudoun and Chickamauga Reservoirs, both eastern TVA reservoirs, reported 1972 commercial yields of 413,000 and 373,000 pounds, respectively.

QUESTION C3

For the area's sport fishing, identify the type caught, size of the catch and its location (p. 2.7-82). 6

RESPONSE

As stated in the ER on page 2.7-86 no data are available on sport fishing harvest from Watts Bar Reservoir or Melton Hill Reservoir. A creel survey was begun on Melton Hill Reservoir in July 1974 and will be completed in July 1975. 6

Species of fish which are classified as game fish by the Game and Fish Laws of Tennessee and which have been recorded in the vicinity of the Site are the centrarchids, predominantly bluegill, the percids, predominantly sauger, and the percichthyids, predominantly white bass.[1]

Sport fishing in Watts Bar Reservoir is concentrated at the Watts Bar Dam tailwater area and at the Kingston Steam Plant discharge basin. TVA public safety service officers have been counting the fishermen utilizing the tailwater for almost 20 years and report an average of 47,000 fishing trips per year.[2] In the winter and early spring white bass, white crappie and sauger are concentrated in the tailwater of the dam. In May and June the catch is mostly blue, channel and flathead catfish. The warm-water discharges of the Kingston Steam Plant attract large numbers of shad during the winter months. Fishing is good when sauger and white bass move into the area to feed on the shad.[2] Sport fishing activity is poor in the immediate area of the Site. During the aquatic

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1. Letter, Sharber, J., Tennessee Wildlife Resources Agency, Nashville, Tennessee, to Valiulis, G., WESD, June 18, 1974.

2. Watts Bar Fish and Fishing, Tennessee Valley Authority, Tennessee Game and Fish Commission, 1965.

baseline survey approximately 280 hours during the period of March through October were spent collecting samples in the vicinity of the Site but less than ten fishing parties were observed during this time. No official creel survey has been conducted at the Site location but TVA reports comparatively little fishing in Watts Bar Reservoir and at the Site. The best fishing is reported to occur in the tailwaters of the Melton Hill Dam.[3]

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3. Telecon, Holbrook, J., Fisheries and Waterfowl Resources Branch, Tennessee Valley Authority, Norris, Tennessee to Tweed, S. M., WESD, January 10, 1975.

QUESTION C4

Discuss why zero flow from Melton Hill Reservoir is not anticipated in the future and how reservoir operations will be coordinated to meet flow requirements at the CRBRP (p. 2.5-4).

RESPONSE

The two longest periods of zero release from Melton Hill Reservoir were the result of special operations to aid in controlling the growth of Eurasian water milfoil in the Melton Hill Reservoir. It was possible to schedule these operations of Melton Hill Reservoir at these times because there was sufficient flood control storage in Norris Reservoir, Bull Run Steam Plant was not in commercial operation and not a major factor, and there were no downstream commitments for releases from the reservoir. Prior to the operations in 1966, Melton Hill Reservoir was drawn to five feet below normal minimum level which would not be permissible in the future because the location of utility water intakes would not permit lowering the reservoir to this level.

Although periods of zero release may occur daily at Melton Hill Dam due to scheduled operations, it is not aniticipated that an extended period of zero release will occur in the future. Operations at TVA dams, including Melton Hill are coordinated between TVA's Division of Water Control Planning and Division of Power System Operations. Should there be an extended period of zero generation at Melton Hill Dam, a minimum amount of water will be released through the gates to meet flow requirements at the CRBRP Site.

QUESTION C5

Provide more information on how the water pumphouse, inlet pipe, discharge pipe and barge unloading facilities will be built. Estimate the amounts of material to be dredged, and the duration of adverse effects on various forms of aquatic life (4.1.2.3).

RESPONSE

Service facilities to and from the river will include: (a) water pumphouse and inlet pipe; (b) discharge pipe; and (c) barge unloading facilities.

Excavation for the inlet pipe, located east and north of the plant complex along the west bank of the Clinch River, will remove about 4,500 cubic yards of sand, mud, clay, rocks or gravel-type material. Construction of the water pumphouse and inlet pipe is expected to require 18 months.

The discharge pipe, located west and slightly south of the plant, will require excavation of 250 cubic yards of sandy silt and rock material. This installation will be completed in less than six months.

The barge unloading facility will be located to the north and west of the plant, recessed into the east bank of the river. It will require excavation of about 19,000 cubic yards (18,000 cubic yards below normal water level, elevation 741) of sandy silt material and will take six to nine months of construction to complete. 7

In addition a total of approximately 1,125 cubic yards of material will be removed prior to placement of fill material required for access road improvement and construction of the railroad spur to the plant site. Additional information is available in ER Section 4.1 and the Project's application for an Army Corps of Engineers permit.

QUESTION C6

State the reasons why a biological sampling transect was not located at the proposed intake structure (p. 6.1-2).

RESPONSE

The purpose of the aquatic baseline monitoring program at the Site, as stated on page 6.1-2 of the CRBRP-ER, was to identify and characterize: (1) physical and chemical parameters; (2) existing biological communities; and (3) endangered species. This baseline program was intended to serve as a basis for evaluating the aquatic ecosystem in the vicinity of the Site and to provide information for subsequent, more intensive monitoring programs. It was recognized that one of the four areas of major aquatic impact would be at or near the proposed intake structure of the plant. To provide baseline information for evaluating this effect it was necessary to locate a control transect above the area where this impact would occur. When the aquatic survey was initiated the location of the intake structure was uncertain so Transect 1 was located above the suggested intake area. For the purpose of the baseline study, Transect 1 adequately reflects the environmental conditions in the area of the proposed intake.

QUESTION C7

Provide data on the vertical stratification of organisms in the river near the Site (2.7 and 6.1).

RESPONSE

Vertical stratification of zooplankton species has been estimated by pumping zooplankton samples from different depths in the water column. Results of these samples are presented in Table 1 (Question C7) which is the same as Table 2.7-53 of the ER. Discussion in the ER, pages 2.7-66 and 2.7-67 is as follows:

> Zooplankton densities for pumped samples in Table 2.7-53 show some vertical stratification in the May 29, 1974 samples. These differences are primarily reflected in the distribution of *Asplanchna priodonta* and *Conochilus* (*unicornis*?), and to a lesser extent by *Synchaeta* (*pectinata*?).(37) June 27, 1974 samples show some strong stratification. Abundance of *Bosmina longirostris* is responsible for most of the differences, while *Polyarthra vulgaris* and *Synchaeta* (*pectinata*?) also have some effect. Fairly strong stratification occurred at Transects 4 and 5 for July 1974 samples. Species contributing to the surface abundance were mainly the rotifers; *Asplanchna priodonta*, *Conochilus unicornis*, *Polyarthra* spp. and *Synchaeta* sp. Generally, differences in densities among transects are not appreciable. However, surface densities for July 23, 1974 samples at Transect 1 are somewhat reduced from values at Transects 4 and 5. This difference may be a result of zooplankton being added to the river from Poplar Springs Creek and Caney Creek, between Transects 1 and 4. Comparison of pumping and towing results for this period is given in Table 2.7-55.
>
> After the July 23, 1974 pumping samples demonstrated that the zooplankters could be stratified in the water column, surface tow samples were initiated to quantify the type and number of plankton in the surface layers. A series of surface tows from September 1974 through April 1975 are compared with the vertical tow samples from the same sampling period in Table 2.7-56. Arthropod distribution in the surface tows is not significantly different from the distribution in the vertical tows. Rotifera species, predominantly *Keratella earlinae*, *Polyarthra vulgaris* and *Keratella cochlearis*, are most abundant in the surface tows of September and November 1974 and cause the surface tow density to average twice the vertical tow density. Dominant organisms from the surface tows are shown in Table 2.7-57.

Vertical stratification was greatest from July 27 to September 26. Early samples from March through June show a less pronounced stratification. Zooplankton surface densities during the July through September period were two to four times greater than bottom densities. Arthropod species shows little vertical stratification as indicated in Table 2 (Question C7) which is the same as Table 2.7-55 of the ER, but Rotifera species density increased significantly in the surface samples. Rotifera species which were abundant in the surface samples were Keratella earlinae, Polyarthra vulgaris and Keratella cochlearis.

TABLE 1--QUESTION C7

ZOOPLANKTON - PUMPING*

NUMBER PER LITER AT EACH SAMPLING STATION - CLINCH RIVER

COLLECTED MARCH 27 THROUGH JULY 23, 1974

	Transect 1-Station 5			Transect 4-Station 3			Transect 5-Station 5			
Collection Date	S (No./l)	M (No./l)	B (No./l)	S (No./l)	M (No./l)	B (No./l)	S (No./l)	M (No./l)	B (No./l)	Mean (No./l)
March 27	0.98	0.88	1.59	1.74	1.78	1.38	2.52	1.68	1.47	1.56
May 29	63.50	50.89	33.52	48.58	62.49	38.75	47.84	54.63	19.81	46.67
June 27	15.79	9.94	17.49	32.15	13.46	13.93	40.22	23.46	18.83	20.59
July 23	33.52	11.07	9.00	111.02	11.57	6.08	119.71	9.37	6.46	35.31
Mean	28.45	18.20	15.40	48.37	22.33	15.04	52.57	22.29	11.64	

*Each sample is a composite of two, 2-minute pumpings, the water being strained through a No. 20 plankton net. Surface (S), mid-depth (M) and bottom (B) samples were collected at each station.

TABLE 2--QUESTION C7

ZOOPLANKTON - PUMPING AND TOWING*

MEAN NUMBER PER LITER FOR EACH COLLECTION** - CLINCH RIVER

COLLECTED MARCH 26 THROUGH AUGUST 26, 1974

Species	March 26 Tow (No./l)	March 27 Pump (No./l)	May 29 Tow (No./l)	May 29 Pump (No./l)	June 27 Tow (No./l)	June 27 Pump (No./l)	July 23 Tow (No./l)	July 23 Pump (No./l)	Aug. 26 Tow (No./l)
ARTHROPODA									
Immature *Bosmina longirostris*	--	--	--	--	--	--	0.09	--	--
Bosmina longirostris	0.37	0.42	4.31	3.65	1.63	2.83	0.79	0.58	1.74
Chydorus sp.	--	--	--	--	--	<0.01	--	--	--
Pleuroxus sp.	--	--	<0.01	--	<0.01	--	--	--	--
Ceriodaphnia reticulata	--	--	--	--	--	--	--	<0.01	0.05
Daphnia ambigua	<0.01	<0.01	--	--	--	--	--	--	--
Daphnia parvula	--	--	0.08	0.05	0.01	0.03	--	--	--
Daphnia retrocurva	<0.01	<0.01	0.09	0.05	0.46	0.58	0.42	0.30	0.37
Moina micrura	--	--	--	--	--	--	--	--	0.34
Scapholeberis kingi	--	--	--	--	<0.01	--	--	--	--
Leptodora kindtii	--	--	0.03	0.03	0.19	0.12	--	--	0.21
Diaphanosoma leuchtenbergianum	0.02	0.01	0.31	0.24	1.43	1.66	0.41	0.19	0.83
Calanoid copepodids (immature)	<0.01	0.01	0.10	0.16	0.12	0.04	--	0.01	0.01
Diaptomus pallidus	<0.01	--	--	--	0.03	0.03	--	--	0.03
Diaptomus (reighardi)	--	--	--	--	--	--	0.03	--	--
Cyclopoid copepodids (immature)	0.06	0.04	0.67	0.53	0.24	0.31	0.30	0.21	0.67
Cyclops bicuspidatus thomasi	--	--	0.04	0.29	--	--	--	--	0.03
Cyclops vernalis	--	--	--	<0.01	0.08	0.03	0.02	<0.01	--
Eucyclops agilis	--	--	--	--	--	--	--	<0.01	--
Mesocyclops edax	--	--	--	--	<0.01	0.02	--	0.03	0.02
Ergasilus sp.	--	--	--	--	<0.01	--	--	--	--
Harpacticoid copepods	<0.01	<0.01	--	--	--	--	--	--	--
Elaphoidella bidens coronata	--	--	--	--	--	<0.01	--	--	--
Nauplii	1.10	0.70	0.69	0.54	0.46	0.84	1.21	1.45	1.73
Chaoborus sp.	--	--	0.01	--	0.02	0.02	0.02	0.03	0.03

(Continued)

TABLE 2--QUESTION C7 (Continued)

Species	March 26 Tow (No./l)	March 27 Pump (No./l)	May 29 Tow (No./l)	May 29 Pump (No./l)	June 27 Tow (No./l)	June 27 Pump (No./l)	July 23 Tow (No./l)	July 23 Pump (No./l)	Aug. 26 Tow (No./l)
ROTIFERA									
Asplanchna amphora	<0.01	--	--	--	--	--	--	--	2.88
Asplanchna priodonta	0.06	0.02	27.11	11.38	0.03	0.18	4.19	6.97	2.95
Brachionus angularis	0.07	<0.01	0.22	0.09	0.44	1.25	0.37	0.37	0.58
Brachionus budapestinensis	--	--	--	--	0.89	2.51	1.60	1.24	7.37
Brachionus calyciflorus	0.02	--	0.54	0.32	<0.01	<0.01	--	0.02	3.24
Brachionus caudatus	--	--	0.02	<0.01	0.01	<0.01	0.11	0.03	0.56
Brachionus havanaensis	--	--	--	--	--	--	0.04	--	--
Brachionus quadridentata	0.08	<0.01	0.05	0.05	--	--	--	--	0.01
Brachionus urceolaris	0.04	<0.01	--	--	--	--	--	--	--
Euchlanis dilatata	0.02	0.04	--	--	--	--	--	--	--
Kellicottia bostoniensis	0.07	<0.01	--	--	--	--	0.08	--	0.05
Keratella americana	--	--	9.65	3.99	--	--	--	--	--
Keratella cochlearis	0.09	0.01	3.65	1.38	0.64	1.15	0.72	0.22	1.50
Keratella earlinae	--	--	--	--	--	--	1.03	0.79	2.98
Mytilina sp.	--	--	--	--	<0.01	<0.01	--	--	--
Notholca acuminata	<0.01	--	--	--	--	--	--	--	--
Platyias patulus	--	--	--	--	--	--	--	0.04	0.02
Platyias quadracornis	<0.01	--	--	--	--	--	--	--	--
Trichotria sp.	0.01	--	--	--	--	--	--	--	--
Trichotra tetractis	0.03	--	--	--	--	--	--	--	--
Collotheca pelagica	0.34	0.08	0.19	0.03	0.08	0.30	0.63	0.24	0.44
Conochilus unicornis	--	--	69.44	15.24	0.08	0.31	11.87	9.28	20.95
Floscularia sp.	--	--	--	--	<0.01	--	--	--	--
Gastropus stylifer	--	--	--	--	0.42	0.89	0.44	0.30	1.35
Hexarthra sp.	--	--	0.10	--	--	--	0.12	--	--

(Continued)

TABLE 2--QUESTION C7 (Continued)

Species	March 26 Tow (No./l)	March 27 Pump (No./l)	May 29 Tow (No./l)	May 29 Pump (No./l)	June 27 Tow (No./l)	June 27 Pump (No./l)	July 23 Tow (No./l)	July 23 Pump (No./l)	Aug. 26 Tow (No./l)
ROTIFERA (Continued)									
Monostyla (*lunaris*?)	--	--	--	--	--	--	0.02	<0.01	--
Monostyla quadridentata	--	--	--	--	--	--	--	--	0.14
Monostyla quadrata	--		--	--	--	<0.01	--	--	--
Cephalodella sp.	0.01	0.01	--	--	<0.01	0.14	--	--	--
Notommata sp.	<0.01	<0.01	--	--	--	--	--	--	--
Ploesoma sp.	--	--	0.50	0.29	--	--	--	--	--
Ploesoma truncatum	--	--	--	--	0.66	2.18	0.82	0.82	1.13
Polyarthra dolichoptera	0.05	0.02	12.75	4.85	--	--	--	--	--
Polyarthra remata	--	--	--	--	--	--	1.00	--	0.44
Polyarthra spp. (*remata* + *vulgaris*)	--	--	--	--	--	--	--	2.93	--
Polyarthra vulgaris	--	0.01	5.64	0.06	0.51	2.84	6.05	--	5.50
Synchaeta (*pectinata*?)	1.36	0.02	8.95	3.38	0.32	1.54	6.68	--	--
Synchaeta spp.	--	--	--	--	--	--	--	8.72	4.52
Filinia longiseta	0.09	0.04	0.63	0.02	0.05	0.55	0.05	0.01	0.10
Filinia longispina	--	--	--	--	--	--	--	<0.01	--
Pompholyx sulcata	<0.01	--	--	--	--	--	--	--	--
Testudinella patina	0.02	0.02	--	--	--	--	--	--	--
Trichocerca cylindrica	--	--	--	--	--	--	--	--	0.73
Trichocerca multicrinis	<0.01	<0.01	0.06	--	--	--	--	0.11	--
Trichocerca similis	--	--	0.28	0.03	0.02	0.04	0.05	0.26	0.12
Trichocerca sp.	--	--	--	--	0.09	0.15	0.05	0.11	--
Bdelloid rotifer	<0.01	0.02	0.02	--	--	--	--	--	--
Habrotrocha sp.	--	--	0.05	--	--	--	--	--	--
TARDIGRADA	0.04	0.04	0.05	--	<0.01	--	--	--	--
Total	3.95	1.51	146.23	46.65	8.91	20.54	39.21	35.26	63.62

*Each pump sample is a composite of two, 2-minute pumpings, the water being strained through a No. 20 plankton net. Surface, mid-depth and bottom samples were collected at each station. Each vertical tow sample was collected using a No. 20 mesh, one-half meter plankton net with attached inside and outside flow meters.

**The values in this table represent the mean number of organisms of each species collected at all sampling stations during one field trip.

QUESTION C8

Discuss the adequacy of using only gill nets and electroshocking methods for fish surveys (p. 6.1-20).

RESPONSE

Methods for fish surveys have recently been reviewed by the IBP[1] and by the EPA.[2] Both reviews recognize that all sampling gear is selective because of the efficiency of the gear and the variety of habitats sampled. It should also be noted that the efficiency of collecting gear for a particular species may vary in different habitats.[2]

Sampling gear can be classified as either passive or active. Active methods are recognized as the least selective method of sampling fish.[2] The selectivity of the gear can be analyzed in terms of three components: (1) characteristics of the gear; (2) fish behavior and (3) differences in fish distribution. Ricker[1] suggests that two sampling methods are necessary to determine the selectivity of the gear used in a fish survey.

Gill netting and electroshocking were chosen for use in the baseline study because use of mixed gill nets, as outlined in the ER on page 6.1-20, is a passive method that provides a more nearly equal proportion of fish from a wide range of sizes[1] and use of electroshocking is an active method that provides the least selectivity for fish sampling.[2] Consideration of environmental factors in the Clinch River in the vicinity of the Site also contributed to the type of sampling gear used. Steep

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1. Methods for Assessment of Fish Population in Fresh Waters, International Biological Programme, 7 Maylebone Road, London NWI, 1971.

2. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1973.

banks and numerous sunken logs prevented the use of seining gear. Baited hoop nets were used to sample populations in the river channel in September but no fish were caught.

The objective of the baseline survey was to determine the species present and the relative abundance of these species. With this objective in mind there is no reason to believe that other sampling methods would supply better estimates of the Clinch River fish populations.

QUESTION C9

Provide justification for sampling ichthyoplankton only near the bottom of the river (p. 6.1-22).

RESPONSE

The objective of the ichthyoplankton baseline sampling program was to determine areas where fish eggs and larvae may be concentrated in the vicinity of the CRBRP Site.

Three types of fish eggs that may possibly occur in this area are demersal, semibuoyant and buoyant. Most freshwater fish lay demersal or semibuoyant eggs. Although attached demersal eggs would most likely not be sampled by bottom netting, this method does provide estimates of the number of semibuoyant eggs present in the river. Buoyant eggs would best be sampled near the surface, but these eggs are not a common freshwater type.

Observation of the river suggests that because of the lack of shallow areas, very little spawning occurs in the Clinch River in the area of the Site. As shown in the two attached tables, Tables 1 and 2 (Question C9), eggs recovered by bottom netting were most numerous in the May to June period and no significant differences were observed between transect locations. Because of the scarcity of nesting sites, the abundance of eggs in spring and the uniform distribution of eggs, it is felt that this sampling method has adequately estimated the potential egg production in the Clinch River at the Site.

During the preoperational and operational monitoring programs, sampling stations will be located in the shallow water areas adjacent to the banks.

TABLE 1--QUESTION C9

FISH EGGS AND LARVAE-STATIONARY NETTING*

ENUMERATION - CLINCH RIVER

COLLECTED MARCH 28 - AUGUST 29, 1974

7

Collection Date	March 28		April 18		May 1		May 16		June 2	
	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3
EGGS										
Fertilized	1	<0.01	--	--	5	0.02	106	0.48	169	0.48
Unfertilized	1	<0.01	--	--	--	--	1	<0.01	--	--
LARVAE	1	<0.01	--	--	--	--	--	--	--	--

Collection Date	June 17		June 25-26		July 12		July 25		August 9		August 29	
	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3
EGGS												
Fertilized	3	< 0.10	7	< 0.02	1	0.01	1	< 0.01	--	--	--	--
Unfertilized	--	--	1	<0.01	--	--	--	--	--	--	--	--
LARVAE	--	--	13	< 0.03	--	--	--	--	--	--	--	--

7

*Samples were collected one foot above the bottom using a 1,000 micron mesh, one-half meter diameter plankton net with attached inside and outside flow meters. For each sample the net was placed in a stationary position facing upstream for 10 minutes.

TABLE 2--QUESTION C9

FISH EGGS AND LARVAE - STATIONARY NETTING*
ENUMERATION PER SAMPLING STATION - CLINCH RIVER
COLLECTED MARCH 28 - AUGUST 29, 1974

	Transect 1-Station 3		Transect 2-Station 3		Transect 3-Station 3		Transect 4-Station 3		Transect 5-Station 3	
	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3	No. Counted	No./m^3
EGGS										
Fertilized	44	0.12	57	0.16	58	0.19	69	0.20	49	0.11
Unfertilized	--	--	1	< 0.01	--	--	1	< 0.01	1	< 0.01
LARVAE										
Percidae	--	--	--	--	1	< 0.01	--	--	--	--

7

Location	Poplar Springs Creek**		Caney Creek**	
	No. Counted	No./m^3	No. Counted	No./m^3
EGGS				
Fertilized	3	< 0.01	13	0.07
Unfertilized	--	--	--	--
LARVAE				
Clupeidae	12	0.01	1	< 0.01

7

*Samples were collected one foot above the bottom using a 1,000 micron mesh, one-half meter diameter plankton net with attached inside and outside flow meters. For each sample the net was placed in a stationary position facing upstream for ten minutes.

**Mid-depth tow samples were obtained using a slow speed tow on April 18, June 2 and June 26 and August 29, 1974.

QUESTION C10

Discuss the effectiveness of using a 1,000 μ mesh ichthyoplankton net. Will a significant portion of the eggs pass through the net (p. 6.1-22)?

RESPONSE

A 1,000 μ mesh ichthyoplankton net is moderately effective for sampling fish eggs and quite adequate for sampling fish larvae.

Most common fresh water fish lay adhesive, demersal eggs which when recently spawned would adhere to each other and would be caught as a cluster of eggs. Some species such as the channel catfish, striped bass, sauger, carp and drum lay eggs which are large enough to be retained by this net.[1]

It must be noted that collections made with this size sampling net have demonstrated that egg abundance is greatest in the river in late May and early June. The river has been shown to be a poor area for fish larvae because only one sauger larva was collected in the river during the sampling period. During this period several larvae were collected at the mouths of Caney and Poplar Springs Creeks. This distribution of eggs and larvae supports the view that the Clinch River in the area of the Site is not a major nursery ground for fish species collected during the baseline survey. The 1,000 μ mesh net has adequately characterized the fish egg and larval population of the Clinch River according to the stated purpose of the baseline survey.

During the preoperational and operational monitoring programs ichthyoplankton will be sampled with a 794 μ mesh net.

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1. Scott, W. B., and Crossman, E. J., Freshwater Fishes of Canada, Bulletin 184, Fisheries Research Board of Canada, Ottawa, 1973.

QUESTION C11

Provide information supporting the statement, "Collected data characterize the area as being a typical, fairly clean flowing system (p. 2.7-65)."

RESPONSE

Data collected by the aquatic baseline survey for the period of March 1974 through May 1975 has been presented in Section 2.7.2 of the ER. 6
Analysis of this data indicates that in terms of species this area of the Clinch River is typical of other East Tennessee river communities. No rare, endangered or unusual species have been identified from the Site location. Analysis of data reported by WESD consultants who are familiar with biological communities in the east Tennessee area indicate that the successional trends in species abundance observed at the Site are common for other rivers in the TVA system.[1,2]

Results of water quality data and the use of benthic indicator organisms in Section 2.7.2 of the ER support the conclusion that the Clinch River in the vicinity of the Site is fairly clean at the present time. Chironomid larvae have been used as indicator organisms,[3] and the presence of intolerant larvae provide further evidence that the Clinch River in the area of the Site can be characterized as clean water with little organic contamination.[4]

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1. Letter, Bunting, D., University of Tennessee, Knoxville, Tennessee, to Valiulis, G., WESD, July 6, 1974.

2. Personal Communication, Findley, D., Austin Peay State University, Clarksville, Tennessee, to Valiulis, G., WESD, July 2, 1974.

3. Mason, W. T., Chironomidae (Diptera) as Biological Indicators of Water Quality, presentation given at symposium on "Organisms and Biological Communities as Indicators of Environmental Quality" at Center for Tommorrow, Ohio State University, Columbus, Ohio, March 25, 1974.

4. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1973.

QUESTION C12

Provide information on the sampling frequency in the limnological monitoring program during the preconstruction-construction phase of preoperational monitoring and the location of stations and transects (6.1.1.2.2).

RESPONSE

See revised Section 6.1.1.2.2 under "Limnological".

QUESTION C13

Provide information on how and when juvenile and adult fish will be sampled during preoperational monitoring (construction phase) (6.1.1.2.2).

RESPONSE

No sampling is planned during the preconstruction and construction phases. Generally, turbidity and siltation resulting from construction are temporary and documentation of fish avoidance of these effects is unnecessary. These effects are further discussed in response to Question C14. Sampling of juvenile and adult fish will commence two years prior to plant operation to reestablish a baseline on which to assess operational effects.

QUESTION C14

Provide the rationale for not sampling fish in the areas of excessive siltation and turbidity during construction. Cite the short-term and long-term effects of increased turbidity and siltation on fish and fish-food organisms (6.1.1.2.2).

RESPONSE

Fish are known to avoid areas of high turbidity if they can. In addition, high turbidities are usually of short duration which makes it difficult to sample fish to find out whether or not they are avoiding turbid areas. Therefore, we do not plan to conduct any studies to determine the effects of turbidity on the fish population.

Siltation effects should be most pronounced in the shallow water overbank areas immediately downstream of any construction. Through aerial photography and river bottom topography measurements, the acreages which are effected by siltation can be determined. This will allow documentation of any habitat changes which might result from construction siltation.

The short-term and long-term effects of construction, specificially turbidity and siltation, have been discussed in Chapter 4.0 of the ER, specifically on pages 4.1-5, 4.1-13, 4.2-3 and 4.2-5. Those discussions indicate that turbidity and siltation effects of construction will be minimized and will be of short-term duration.

QUESTION C15

Discuss further the adequacy of the perforated pipe intake for not impinging fish or river debris. Estimate the expected frequency of cleaning the pipes by back-flushing. Describe the means to be used for determining when the pipes are clogged and the extent of fish impingement. Give references (5.1.4).

RESPONSE

Fish Protection. In a conventional intake structure the fish may be trapped in a confined waterway leading to water screens. This cannot happen in the case of the perforated pipe intake due to its location offshore, surrounded on all sides by the river. The inlet approach velocities are very low and become too small to measure within inches from the face of the perforated pipe. In addition, the river current passing the perforated pipe will normally tend to carry fish away from the intake area.

Only fish coming in actual contact with the pipe, will be exposed to any danger. The probability of this occurrence is low. The average net velocity through the perforations is below 0.3 fps (both pipes in operation) and, from actual model tests for another project, the velocity 3/4" away from the perforated pipe is expected to be only 3/5 of 0.3 fps or 0.12 fps. Because of this extremely low velocity adjacent to the perforated face of the inlet pipe, the fish can easily swim away even when they come close to the pipe.

Model tests have shown that the inlet velocity through the perforations can be made uniform if an inner perforated sleeve is inserted as proposed for this project. Thus, there will be no local high velocities as are common with conventional screening methods.

Protection from Debris Impingement. The very low velocities, not measurable within inches of the pipe, will not only reduce fish damage, but are also expected to keep debris impingement over the perforations to a minimum.

As was done recently for another similar project utilizing this type of intake, a model study will be performed to determine the best method of handling large debris which might tend to hang up or damage the inlet facility. Protective dolphins or deflection devices may be provided. The model tests will also investigate movement of bottom sediment as a result of river flow past deflection devices, if any, and the inlet facility. The river bottom will be stabilized by rip rap if necessary to avoid sedimentation of the perforated section.

Clearing of the pipes by back flushing will be done as required. 6

Means for Measuring Pipe Clogging. To determine the extent of blockage of the perforated sections, provisions will be made to measure the water level differential between the river and pump well. A guage in the control room and another guage at the pump structure will indicate this differential. When the water level differential reaches a predetermined limit, an alarm will sound in the control room to indicate unacceptable blockage.

QUESTION C16

Discuss timing of those construction activities which are pertinent to aquatic organisms' reproduction and migration cycles.

RESPONSE

Construction activities which may have an impact on the aquatic environment are the construction of: (1) inlet pipe; (2) discharge pipe; and (3) barge facilities.

Significance of construction impact is related to the area affected, the precautions taken and the timing of these activities. As stated in Section 4.1 of the ER, only a small area of the river will be influenced by the building of the inlet and discharge pipes. Considerably more area may be impacted by the construction of barge unloading facilities. In all cases cofferdams and fill will be used to minimize the effect of siltation.

Timing could significantly influence the impact of construction activities. Because of the natural high silt loads in late winter and early spring additional small amounts of silt from construction activities would not interfere with aquatic organism reproduction and migration cycles. Summer and fall construction activities would effect only small local sedentary populations. The greatest impact would come if construction activities caused extreme erosion during the spring migration and spawning of the most common game fish species. Even this effect would be localized and would not affect the total river so that the impact on aquatic species would not be extensive or permanent.

The exact schedule for construction activities has not been established but an effort will be made to schedule these activities so as to mitigate their environmental impact.

QUESTION C17

State the anticipated internal velocities for the perforated pipes of the intake structure. Are there any dead spaces and/or velocities low enough to allow Corbicula larvae to settle?

RESPONSE

Corbicula infestation and any other potential buildup of organisms or debris on the inside the perforated pipe inlet sections will be assessed as follows:

1. The total head loss between the river and the inside of the pump structure will be continuously measured by automatic monitoring equipment. When this head loss reaches a designated value, to be determined in the field, the inlet sections will be backwashed using the procedures described in the reply to Question C18. It is also possible that backwashing will be done on a regular basis, say once per shift, simply as a routine maintenance procedure whether required by head loss or not.

2. During the first year of operation, periodic inspections will be made of the surface condition of the perforated pipe by scuba divers. Some of these inspections will be timed to match those seasons in which Corbicula can be expected to cause the most trouble.

3. At least once in the first year of operation, at a time when Corbicula infestation might reasonably be expected, one or more sections of the perforated inlet will be removed and inspected to determine the effectiveness of painting and the need, if any, for adjusting maintenance procedures.

QUESTION C18

Provide detailed information and illustrations on the maintenance of the perforated pipes. Do they come apart in sections? If so, how will that be accomplished and how large are the sections? What are the procedures to be taken in the event Corbicula causes clogging problems with the pipes?

RESPONSE

Maintenance of the perforated pipe sections will normally be accomplished in three stages as follows:

1. Water backwashing as a normal operating procedure;
2. In-place surface cleaning by a scuba diver; and
3. Removal of perforated pipe sections.

Backwashing is accomplished by closing the gate provided at the pump structure end of each lead-in pipe. With one of the two pipes thus closed off and the other providing water to the pumps, the backwash valve is opened and a substantial part of the pump flow is discharged back through the gated pipe. The amount of flow used for this purpose can be regulated by the backwash valve. Brief reduction of flow to the plant will not interfere with plant operations. The backwash water is expected to flush any loose material that may be blocking the perforations. Experience with other perforated pipe inlets has indicated that backwash is seldom necessary.

In-place surface cleaning of the pipe will be done by a scuba diver if and when necessary. The outer surfaces of the pipe can be wirebrushed or otherwise scrubbed to remove any encrustations which may have developed.

At normal low water, the top of the perforated sections are approximately 10 feet below the water surface.

For major maintenance, repainting and repair, each of the four individual perforated pipe sections can be removed without interfering with the operation of the other three sections. On removal of any pipe section, a light blank flange will be placed over the open end. Simple pin connectors will be incorporated into the design providing the capability for easy disconnect and removal by a scuba diver. The entire section can then be lifted to a barge by a small hoist.

Maintenance can be done on the barge or on shore. The entire perforated pipe section has been designed for easy disassembly. First, the nose cone is removed by unbolting, then the inner sleeve can be slipped out. Each section is six feet long and will weigh about 2,100 pounds, including the nose cone.

Although it is expected that only one of the four sections at a time will be removed, the system can operate at full flow with only two sections functioning and at half flow with only one section operating without exceeding the very low inlet velocity limitations. The design is thus very conservative.

Lead-in pipes will normally require no maintenance, however these pipes will be chlorinated, as required, for control of any growth.

QUESTION C19

Provide information on how any Corbicula problems will be assessed. Will scuba divers be used? Will there be routine maintenance checks during the spawning season and planktonic stages of the Corbicula larvae? If so, provide procedures.

RESPONSE

The perforated pipe inlet will be designed for a maximum flow velocity of 0.5 fps through the perforations in the outer face. The low maximum velocity, established for fish protection, will occur when one lead-in pipe to the pump structure is closed down (i.e., during backwashing) with system flow at the maximum design value of 10,000 gpm. 6

Model tests for a similar design have shown that a nearly uniform inflow velocity will be achieved along the length of the perforated section.

The flow velocity will increase to 3.4 fps through the inner perforations. As the water passes from the outer face through the inner sleeve to the main lead-in pipe, the average velocity will drop to approximately 2.3 fps. The flow in the 24-inch diamter lead-in pipe from the inlet to the pump structure will have a maximum average velocity of approximately 8 fps. 6

It is expected that for normal operation both lead-in pipes will be functioning where flows of less than 10,000 gpm per pipe will be the rule. If the flow is only 5,000 gpm and all perforated sections are in operation the velocities through the perforations will drop to one quarter of those velocities set forth above.

The inner pipe sleeve, with a total open area of only 7 percent, will have large areas of unperforated surface across which the local velocities

will be very low as the water passes from the outer perforations through the inner perforations. Other relatively dead spaces will be encountered at the points where the removable perforated sections meet the fixed pipe. At those points where the pipe size changes from 30 inches to 36 inches, there may be local eddies at the shoulder. | 6

Sufficient information is not available to know for certain that Corbicula will be present and settle in the low velocity pipe sections. Accordingly, | 6
several design features are being investigated to preclude the development of the problem. These are as follows:

1. Chlorination of the lead-in pipes. Provisions are being made to inject chlorine into the space between the outer perforated pipe and the internal sleeve should it become necessary.
2. Painting of all surfaces of the removable perforated sections with anti-fouling paint, to control both algae and Corbicula. Painting is presently being investigated to determine suitability of application.
3. Maintenance of the pipes by scrubbing in place and by removal and reconditioning as described in the reply to Question C18.

QUESTION D1 (NRC Letter, February 13, 1975)

Provide the following additional information related to temperature and thermal stratification of the river (2.5.1.6, 2.7.2.3.5, 5.1).

a. Describe the stratification expected for the flow condition that could result in water of the colder Clinch River entering the mainstream of the Tennessee River along the stream bottom while the warmer Tennessee River water flows upstream in the Clinch River past the Site (2.5.1.6).

b. Provide additional data measured at or near the Site for all seasons to indicate the degree of stratification in the river throughout the year. Discuss possibilities for stratification during periods of no river flow, and provide data to support the discussion.

c. If available, supply river temperature data at or near the Site during the 1966 and 1967 extended periods of no flow from the Melton Hill Dam (5.1).

RESPONSE

Question D1a

Primarily because of the submerged withdrawal from Norris Dam, the temperature of the Clinch River is generally colder than either the Tennessee River or the Emory River which joins the Clinch at CRM 4.4. The heated effluent and the intake arrangement at the TVA Kingston Steam Plant at mile 2.5 on the Clinch River add further complication to the thermohydrodynamics of the lower reaches of the Clinch River. When Melton Hill Dam (CRM 23) has substantial discharge (i.e., 10,000 cfs or greater),

velocities of more than a half foot per second are typical along the Clinch River below the dam and little stratification exists because of the vertical mixing. However, during periods of low flow, the Clinch River may become stratified in its lower reaches and because of the low densimetric Froude numbers the warmer surface waters may move slowly upstream. Conceivably, if there were extended periods of little or no flow through Melton Hill Dam, the warm surface water could reach the CRBRP Site at CRM 16. Factors influencing this upstream penetration include the difference in density between the two water masses, the duration of no-flow from Melton Hill Dam, natural heating or cooling, underwater topography and natural river turbulence such as generated by wind. The extent of the upstream penetration is expected to be greater in the spring and summer.

TVA has conducted several boat surveys to measure river temperatures and velocities in the vicinity of the Kingston Steam Plant. During two such surveys conducted under low-flow conditions in the Clinch River, the upstream wedge of warm surface water was traced and recorded. For the June 1973 survey, there had been no flow through Melton Hill Dam since midnight of the previous day and the warm water wedge had penetrated upstream to approximately mile 6 of the Clinch River as shown in Figure 1 (Question D1a). Velocities as well as temperatures were recorded during the July 1973 survey. There had been no discharge through Melton Hill Dam since 7:30 p.m. of the previous day. Results of this survey, shown in Figure 2 (Question D1a), reveal a slight upstream drift of the upper five feet of the Clinch River. When considering the speed at which the warm water wedge was moving upstream (i.e., approximately 0.1 fps) and the fact that the CRBRP Site is 10 miles further upstream, these conditions must persist for almost a week before the wedge could penetrate to the CRBRP Site.

In addition to the boat surveys, temperature profiles at CRM 14.4 (i.e., 1.6 miles downstream of the CRBRP Site) were measured once a month during

1974. These data are presented in Figure 3 (Question D1a). The June and July readings revealed a stratified layer less than five feet deep which probably resulted from diurnal heating. The mean daily flows for the six days previous to these two measurements range between 5,000 and 7,000 cfs.

Question D1b

A more detailed response is included in the response to NRC letter of April 23, 1975 (see page A1-164).

Question D1c

The daily maximum, minimum and average water temperatures at Clinch River mile 21.6, during extended periods of zero release at Melton Hill Reservoir are as follows:

Date	Max.	Min.	Aver.	Date	Max.	Min.	Aver.
2/25/66	48	45	46	3/13/66	55	48	50
2/26/66	48	44	46	3/14/66	56	49	52
2/27/66	46	45	45	3/15/66	53	51	52
2/28/66	47	45	46	3/16/66	55	51	52
3/ 1/66	50	45	47	3/17/66	57	51	53
3/ 2/66	51	45	47	3/18/66	56	50	52
3/ 3/66	50	47	48	3/19/66	56	52	53
3/ 4/66	51	48	49	3/20/66	57	50	53
3/ 5/66	48	47	48	3/21/66	59	51	55
3/ 6/66	47	45	46	3/22/66	61	52	56
3/ 7/66	47	44	45	3/23/66	60	54	58
3/ 8/66	48	43	45	3/24/66	55	52	53
3/ 9/66	50	43	46	3/25/66	58	50	54
3/10/66	51	44	46	4/28/67	64	59	61
3/11/66	53	46	49	4/29/67	63	60	61
3/12/66	52	45	48	4/30/67	63	61	62

(Continued)

Date	Max.	Min.	Aver.	Date	Max.	Min.	Aver.
5/ 1/67	63	62	63	5/ 5/67	64	60	62
5/ 2/67	63	61	62	5/ 6/67	63	61	62
5/ 3/67	65	61	63	5/ 7/67	63	62	62
5/ 4/67	63	61	62	5/ 8/67	63	62	62

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER, APRIL 23, 1975

Question D1b

Provide additional data measured at or near the site to indicate the degree of stratification in the river under various conditions. Alternatively, justify adapting the data measured 1.6 miles downstream of the site to modeling conditions existing at the discharge.

RESPONSE

The response to this question is based in some measure on the results of the University of Iowa, Institute of Hydraulic Research laboratory model study of the CRBRP discharge; accordingly, the response to Question D8 should be read to obtain background information for the following discussion.

The Clinch River may, in some cases, be thermally stratified. The question relevant to the behavior of the thermal plume, then, is what effect, if any, the ambient stratification will have on the plume characteristics. The model data presented in connection with the response to Question D8 shows that, in all cases studied, the heated effluent rapidly mixes vertically, so that beyond a short distance from the jet origin the heated area extends from the bed to the water surface. In so doing, the plume has overcome prototype temperature differentials

(between the effluent and ambient fluids) of up to 46.8 degrees F. This leads to the conclusion that the jet-induced mixing easily could overcome a few degrees of ambient vertical temperature stratification.

To examine a very extreme and completely hypothetical case, it was assumed that there was such a strong temperature gradient at an elevation of 733 feet that the thermal plume became completely "trapped" below this level. This was accomplished in the model by lowering the water surface to this prototype elevation. A model test then was made corresponding to typical summer temperature conditions. Even in this extreme case, the length of the plume to the 2 degrees F surface isotherm was less than 75 feet, and the prototype area enclosed within this isotherm was less than 500 square feet.

The conclusions regarding the influence of stratification may be summarized as follows:

1. The mixing produced by the high velocity jet can overcome any ambient stratification encountered in this relatively shallow zone. The effluent still will mix vertically from bottom to top of the receiving body in a relatively short distance, and thereafter will continue to mix laterally with the receiving fluid.
2. Even if the plume were to become "trapped" by a steep temperature gradient at a prototype elevation of 733 feet, it still would be diluted rapidly by ambient fluid; the 2 degrees F isotherm would enclose an area of less than 500 square feet for typical summer temperature conditions.

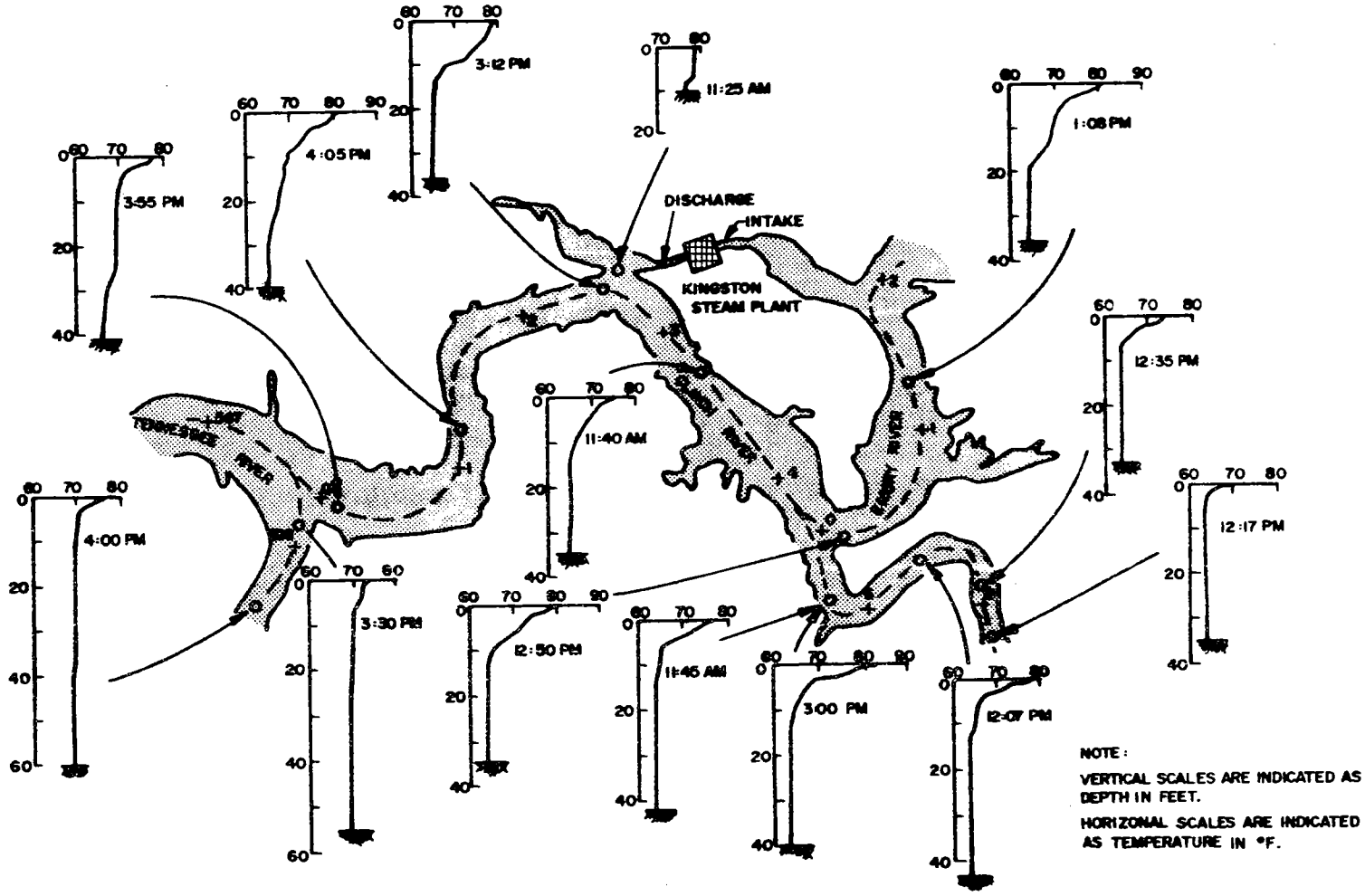

Figure 1 WATER TEMPERATURE SURVEY, JUNE 19, 1973
(Ques. D1a)

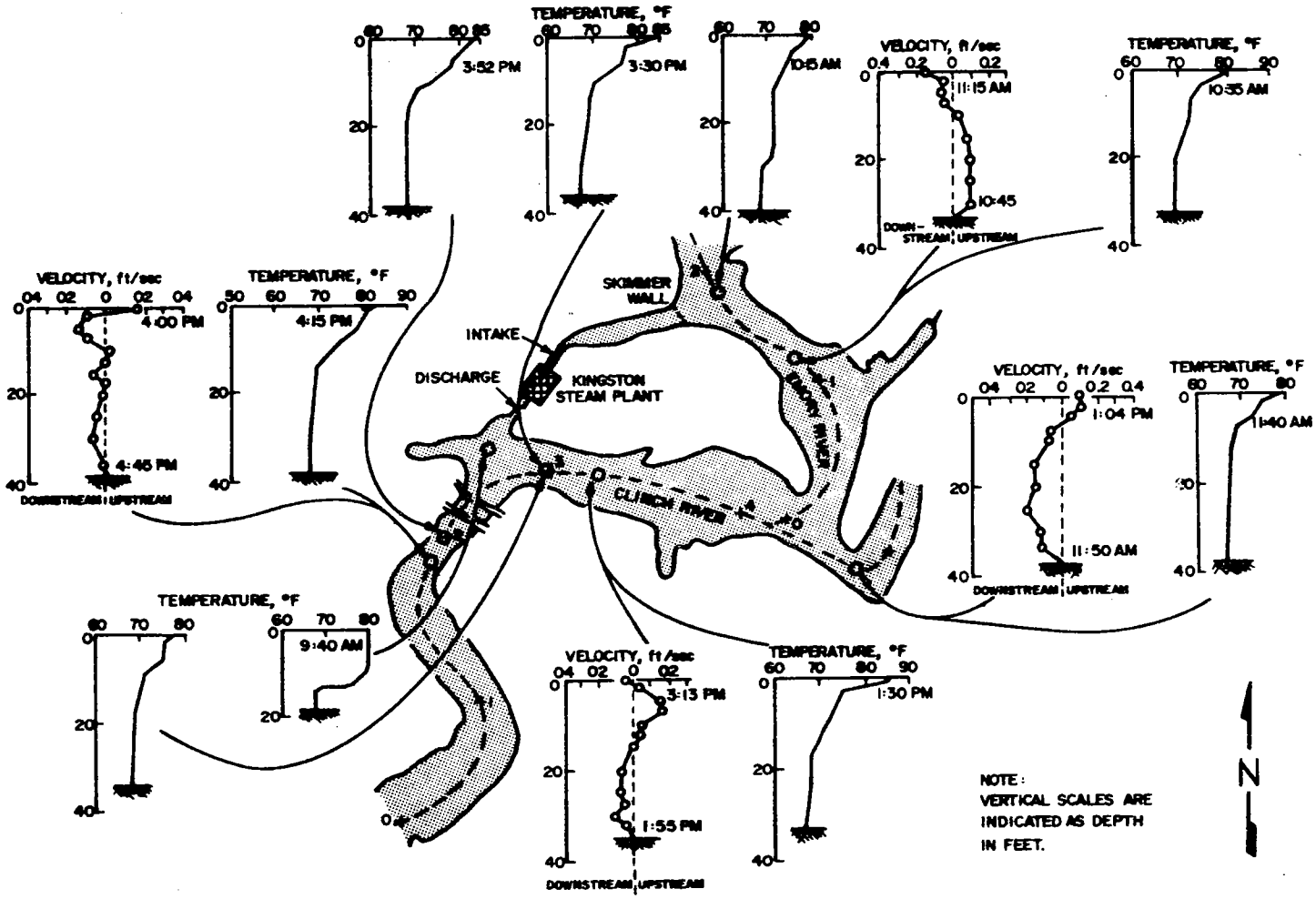

Figure 2 WATER TEMPERATURE SURVEY, JULY 3, 1973
(Ques. D1a)

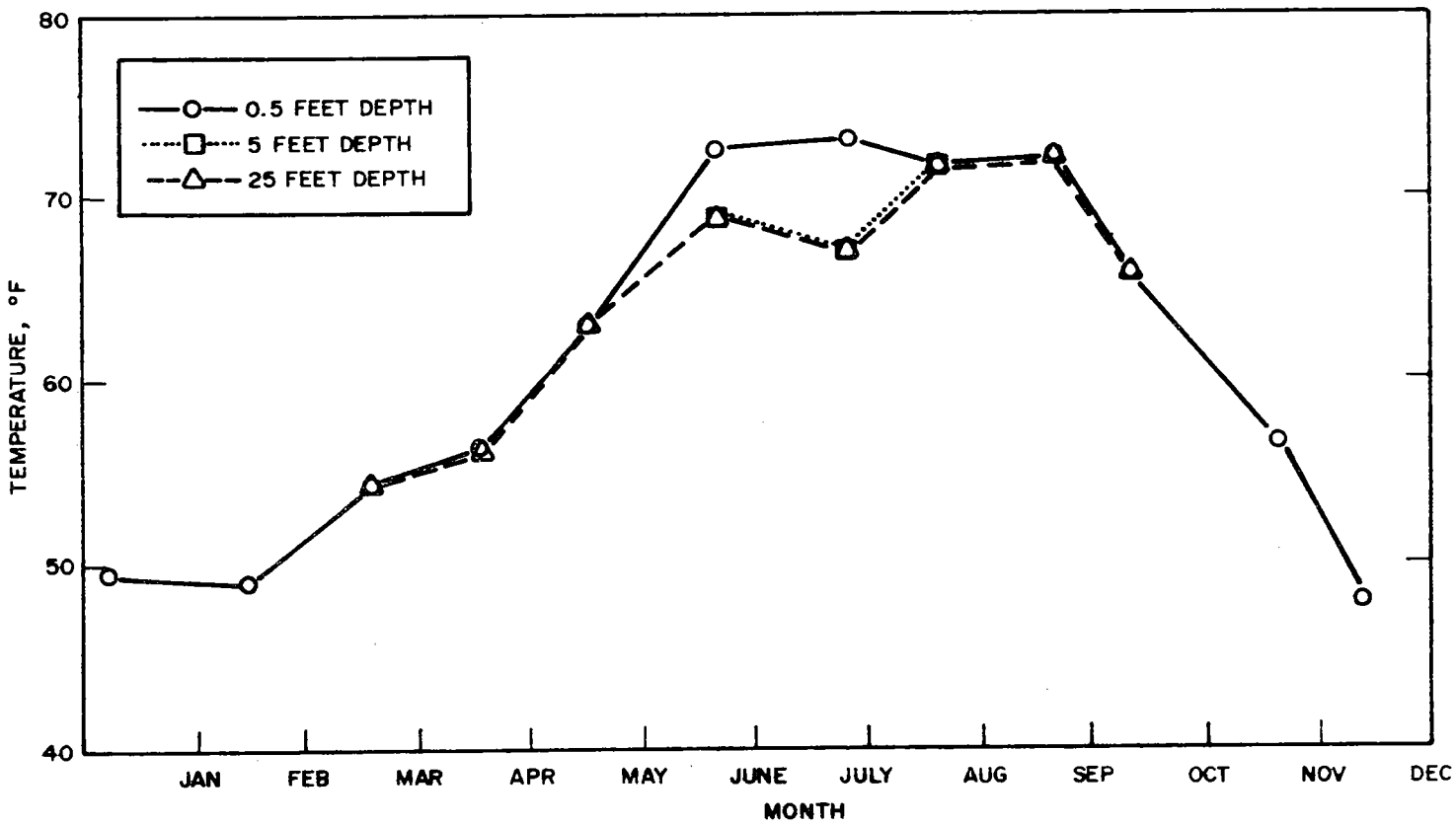

Figure 3 WATER TEMPERATURE SURVEY, CLINCH RIVER MILE 14.4
(Ques. D1a)

QUESTION D2

Discuss the possibilities for clogging of the perforated intake pipes under conditions of no-flow and high debris in the river. Comment specifically on the susceptibility of the intake structure to clogging when large quantities of leaves are likely to enter the river in the fall season (3.4, 10.2).

RESPONSE

See page 10.2-13 of the CRBRP-ER. Debris removal is accomplished by flow reversal in the intake piping.

See responses to Question C15.

QUESTION D3 (NRC Letter, February 13, 1975)

Provide lengths and diameters for the perforated intake pipes (3.4).

RESPONSE

There are two perforated pipe intake assemblies each with an overall length of approximately 24 feet. The perforated pipes have an outside diameter of 2.5 feet. 8

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER, APRIL 23, 1975

State the diameter of the inner pipe on the intake structure (3.4).

RESPONSE

The inner pipe on the intake structure has a diameter of 2 ft., as shown on revised Figure 3.4-6. These dimensions will be subject to change, however, pending the results of a hydraulics study of the intake system. 8

QUESTION D4

Discuss environmental effects during the intake construction: amount of excavation, river turbidity, placement of spoils, possible hydrologic effects (4.2).

RESPONSE

Information on amount of excavation, river turbidity, and placement of spoils has been provided in Section 4.1.2.3 (Amendment 7). Additional information is available in the Project's Army Corps of Engineers permit application. No hydrological effects are expected during the intake construction. 8

PURPOSELY
BLANK

QUESTION D5

Provide the following additional information regarding river velocities:

a. Discuss the manner in which river velocities used in the plume analyses were computed (14.6).

b. The cross-sectional area of the river for winter low pool conditions is given in Section 14.6; provide additional values for cross-sectional areas of the river in the vicinity of the discharge corresponding to summer flow conditions of 740 feet MSL and 741 feet MSL (14.6).

c. Provide additional details regarding river velocities in the vicinity of the discharge structure, including comparisons of measured river velocities in the shallow channel near the discharge structure with measured velocities in the deeper channel on the opposite side of the river (2.5.1.7, 2.7.2.3.4).

RESPONSE

Question D5a & b

For the typical cases of river flow examined, flow velocities were computed according to the following formula:

$$V = Q/A$$

where Q, is the river flow rate in cfs and A is the river cross-sectional area at the CRBRP discharge point. The cross-sectional area was determined from bathymetric data developed during surveys in the field.

For the winter case (pool elevation of 736 ft MSL), an average river width of 612 feet and depth of 6.26 feet were used to yield a river velocity of 1.39 fps. An average river width of 657 and depth of 11.58 feet were used to derive a summer (pool elevation of 741 ft MSL) river velocity of 0.63 fps.

Question D5c

As part of the CRBRP Aquatic Baseline Monitoring Program, water velocities were measured at selected points along the Clinch River near the Site. Results of these measurements are discussed in ER Section 2.7.2.3.4 and presented in the CRBRP Aquatic Baseline Survey Report - March 1974 to May 1975. 6

QUESTION D6

Discuss previous experience with the (cooling tower blowdown) shutoff mechanism that would prove reliability of the device to stop automatically the blowdown when chlorine content exceeds the specified level.

RESPONSE

Since EPA's effluent chlorine limitations were only issued October 8, 1974, no power plants, to our knowledge, currently stop blowdown during chlorination cycles. Several stations, however, are considering closing the blowdown valve during chlorination cycles with time delay controls set to match the time-residual characteristics of the system. These stations include; Hanford Unit 2, Washington Public Power Supply System, Gilbert Station, Jersey Central Power and Light, and Karn 3 and 4, Consumers Power Co. The control valve, timer, residual chlorine analyzers and other instrumentation is typical and considered to be reliable.

Shutoff mechanism failure would result in a continuous discharge of cooling tower blowdown containing 3 mg/l chlorine residual for a period of 30 minutes duration.

"Worst-case chemical plume calculations" are discussed in the Response to Question D8c. Worst-case chemical mixing conditions are identified with the hypothetical worst case (thermal) winter and summer cases for extended zero river flow periods. As indicated in the discussion, for short periods of no flow (such as the 30 minute duration of accidental chlorine release) stable chemical isopleths representing 3.2 and 4.3 percent (of the difference between initial discharge and ambient river concentrations) are formed for the worst winter and summer conditions, respectively. These values correspond to residual chlorine levels of

0.10 and 0.13 mg/l. Small areas of the river in the immediate vicinity of the discharge will experience residual chlorine concentrations somewhat higher (0.15 mg/l corresponding to the winter 2.3 degrees F isotherm as shown in Figure 7-Question D8 and 0.26 mg/l, corresponding to the summer 1.0 degrees F isotherms as shown in Figure 8-Question D8). In general, the above four concentrations are all below reported acute chlorine toxicity levels for exposure times of <24 hours.[1] Additionally, it should be noted that complexation, oxidation and dissipation of the chlorine residual will occur in the river and act to impede the attainment of the maximum concentrations predicted and promote a rapid decline in concentration once the flow of chlorinated water ceases.

As discussed in ER Section 5.4-3, complexation of the residual chlorine with ammonia compounds to form the more stable chloramines (NH_2Cl) may occur. An extreme and improbable case can be assumed in which there is 100 percent complexation of the 30 minute, 3 mg/l chlorine discharge. The resultant maximum chloramine concentrations in the Clinch River (2.3°F worst case-winter and 1.0°F worst case-summer isotherms) would be 0.11 and 0.19 mg/l for the winter and summer no-flow cases, respectively. Chloramine acute toxicity (<24 hour exposures) levels generally fall below the above concentrations.[1]

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1. Becker, C. D., and Thatcher, T. O., Toxicity of Power Plant Chemical to Aquatic Life, WASH-1249, June 1973.

QUESTION D7

List the references called out in 14.6 and provide any not readily obtainable.

RESPONSE

Reference list for Section 14.6 (Appendix to 10.3) was inadvertently omitted from the ER. This list is provided below:

1. Harleman, D. R. F., Jirka, G., and Adams, E. E., A Feasibility Study of Alternate Condenser Water Discharge Schemes for the Maalaea Bay Station, Hawaii, Westinghouse Electric Corporation, August 1972.

2. Ditmars, J. D., Temperature Distributions in the Far-Field Region--Partial Mixing, Chapter 9 of Engineering Aspects of Heat Disposal From Power Generation, Massachusetts Institute of Technology Summer Session, June 28- July 2, 1971.

3. Albertson, M. L., Dai, Y. B., Jensen, R. A., and Rouse, H., Diffusion of Submerged Jets, Trans. ASCE, 115, 1950.

4. Stolzenbach, K. D., Adams, E. E., and Harleman, D. R. F., A User's Manual for Three-Dimensional Heated Surface Discharge Computations, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Report No. 156, Massachusetts Institute of Technology, September 1972.

5. Shirazi, M. A., and Davis, L. R., Workbook of Thermal Plume Prediction: Volume 1, Submerged Discharge, Environmental Protection Agency EPA-R2-72-005a, August 1972.

A copy of Reference No. 1 (the only one not readily obtainable) was submitted to NRC at the site visit on January 21-22, 1975.

QUESTION D8 (Letter of April 23, 1975)

The staff has reveiwed the applicant's Discharge Plume Study; Modeling Concepts and Computational Procedures (Preliminary Draft) dated March 20, 1975, and is of the opinion that the procedures would lead the underestimates of the temperatures and concentrations within plumes from submerged discharges into the relatively shallow Clinch River. The staff's opinion is also that the procedures would not provide adequate estimates of the potential for disturbance and possible scouring of the river bottom. The applicant is therefore requested to provide revised estimates of plume dispersion, including the following:

a. Utilize procedures that are most likely to yield upper-bound estimates of the temperature and concentration fields for each case. Also, examine the potential for bottom scouring, and provide an estimate for each case of an upper-bound area of the bottom that may be disturbed. Estimate the velocity field in the area subject to potential disturbance.

b. Describe in detail the procedures used to perform the revised predictions. Estimate the uncertainity associated with the procedures, and discuss the basis on which uncertainty estimate is made. Identify sources for the procedures that are selected; and, for mathematical modelling, cite experimental investigations, other applications, and/or critical reviews, if any, that would support adequacy of the models for use in estimating plume dispersion under conditions that would exist for the proposed discharge.

c. Include revised estimates of plume dispersion for the cases presented in the environmental report.

d. Discuss the environmental impacts associated with the discharge plumes for the various cases.

e. Cite references supporting use of a spreading function from the work by Albertson et al. (Ref. 3 of applicant's response) as "... a generally accepted technique for computing two-dimensional spreading at plume impingement with the surface ..."

RESPONSE

Question D8a

To provide upper-bound estimates of the temperature fields resulting from CRBRP thermal discharges, two hypothetical extreme cases were developed. Each incorporates values for water and atmospheric temperatures and river pool elevation and flow characteristics that constitute the worst set of conditions for mixing (see Table 1 - Question D8). The winter Hypothetical Worst Case represents an attempt to obtain an upper-bound initial temperature differential by superimposing upon the lowest recorded river water temperature for a 9-1/3 year data set (Clinch River water temperatures at White Wing Bridge, river mile 21.6, 6/63-9/72) the highest recorded atmospheric wet-bulb temperature in a 4 year data set (Bull Run Steam Plant, 1/70-12/73) for the same calendar month. The Summer Hypothetical Worst Case represents an attempt to obtain upper-bound temperatures in the river by superimposing upon the highest recorded water temperature the highest atmospheric wet-bulb temperature.

Recently, additional work has been performed to characterize thermal and chemical plume formation during extended periods of zero river flow past 6

the Site. The basis for this analysis is a mathematical modeling effort undertaken by Iowa Institute of Hydraulic Research. The Institute's report of findings is presented in Appendix II to Appendix 10.3B. Their results are analyzed in Appendix 10.3A. 6

Upper-bound chemical concentrations will be associated with extended periods of zero river flow as discussed in Appendix 10.3A. 6

Bottom scouring is discussed in the Response to Question D22.

Question D8b

Three different approaches presently are in general use for making predictions of the characteristics and behavior of thermal plumes. In order of increasing reliability these are

1. Mathematical modes, either numerically based or expressed in closed form equations.
2. Small-scale, thermal-hydraulic models.
3. Prototype measurements.

In the absence of prototype data for the CRBRP discharge, or from one that is quite similar to it, use of scaled undistorted, thermal-hydraulic models offers the best means of determining the geometrical configurations and temperature regimes of thermal plumes. Accordingly, to provide improved predictions of the plumes produced by the CRBRP discharge, a laboratory model study was undertaken by the Iowa Institute of Hydraulic Research of the University of Iowa. The model was constructed at an undistorted scale of 1:12, and was operated in accordance with generally accepted procedures for tests of this type. The basin in which the tests were conducted is approximately 12 ft. wide and 22 ft. long; therefore, the model included only about one-fifth of the full river width. This was adequate, however, to encompass the near-field zones

of the plumes modelled. It was not judged necessary to reproduce the details of the river bed geometry in the model, because the bed of the Clinch River in the region covered by the plume of the proposed discharge structure is nearly flat. The bed of the model was set at a prototype elevation of 729 ft.

Due to the physical limitations of the model plume, the desired prototype river velocities could not be attained. Somewhat lower velocities were, therefore, modelled. As reduced plume mixing is associated with decreasing river velocities, the use of these lower values tends to overestimate plume temperature and extent. Consequently, no significant alteration of results is produced.

It is not possible to model thermal plumes discharged into a laboratory basin with no cross-flow because the temperature of the receiving water would increase continuously and steady-state conditions would never be reached. Therefore, in the tests of cases involving quiescent receiving water, a small ambient current was provided in the model basin to carry away the imposed heat load. The principal effect of a weak cross-flow is to deflect the isotherms, without otherwise altering significantly their shapes or the areas they enclose.

Question D8c

The results obtained from the thermal-hydraulic model of the CRBRP discharge are presented in Figures 1 through 4 - Question D8. The thermal plumes from the model are superimposed upon Clinch River profiles in Figures 5 through 8 - Question D8. River surface areas encompassed by the 1 and 2F degree isotherms are given in Table 2 - Question D8.

Chemical isopleths for the typical cases are determined by correlation with the isotherms from the physical modes. An assumption is made that heat, as excess temperature, and chemical constituents act conservatively

in the mixing process. Although a difference exists in the dispersion rates of excess temperature (temperature rise above ambient) and jet momentum, i.e., excess temperature migrates horizontally off the jet centerline faster than momentum effects, this difference is small and not considered significant in determining the chemical concentrations in the plumes.

The relationship between the dispersion of waste heat and chemicals can be illustrated through the following expressions:

$$100 \frac{1}{\text{Dilution}} = \% \text{ of initial concentration} = \frac{T_M - T_A}{T_I - T_A} \times 100$$

$$\% \text{ of initial temperature difference} = \frac{1}{\text{Dilution}} \times 100 = \frac{T_M - T_A}{T_I - T_A} \times 100$$

where T_M is the temperature of the effluent at some point of interest, T_A is the ambient temperature and T_I is the initial blowdown temperature. An equivalent expression can be developed for the chemical isopleths as

$$\% \text{ of initial chemical concentration difference} = \frac{1}{\text{Dilution}} \times 100 = \frac{C_M - C_A}{C_I - C_Z} \times 100$$

where C_M is the chemical concentration of the effluent at some point of interest, C_A as ambient chemical concentration and C_I is the initial blowdown chemical concentration. The value assigned to a chemical isopleth thus represents a percentage of the difference between initial blowdown and river ambient chemical concentrations.

Chemical concentrations in the river resulting from the CRBRP discharge for the typical cases are given in Table 3 - Question D8.

Dispersion of chemicals during extended zero river flow occurrences such as the 29 day event of 1966 is discussed in Appendix 10.3A. 6

concentrations). These chemical concentration differentials are applicable for the winter and summer thermal worst case plumes for short periods (up to several days) of no flow.

As the heat transport mechanisms of convection and evaporation at the air-water interface do not contribute to the removal of excess chemicals, extended periods of no flow will be accompanied by an accumulation of chemicals in the discharge area. This accumulation will occur as the plume interacts with the opposite shoreline causing it to tend to become re-entrained upon itself. Under completely quiescent river conditions, the discharge jet, which rapidly mixes from top to bottom of the water column, will force ambient water out of the plume area as the boundary effects of the opposite shore become pronounced. As a result, an area in the discharge vicinity will form in which the plume will experience increasing chemical concentrations. The theoretical maximum level that can be approached during this period is the concentrations in the plant effluent itself. The ultimate concentrations in the portion of the river subject to this accumulation of chemicals will be determined by the rate of transport of chemicals acorss the plume boundaries. Although the Clinch River has been assumed to be a completely quiescent body of water in the development of this discussion, in reality wind-generated wave action would be expected to be an important mechanism contributing to the dilution of plume chemical concentrations over an extended period of zero flow.

In addition, wave action stimulated by river craft activity may be anticipated, some degree of uptake by sediments will occur and the comparatively slow-acting process of molecular diffusion will tend to lower chemical concentrations at the plume boundaries. In summary, these various mechanisms will act to prevent the attainment of near-effluent chemical concentrations in the discharge area.

Quantitative measures of the concentrations and affected areas associated with an extended no flow event would be difficult to generate and ques-

tionable in accuracy. However, as an upper bound estimate, it may be hypothesized that chemical concentrations equivalent to those present in the plant effluent are approached towards the end of an extended period of zero river flow in an area of the river in the immediate discharge vicinity. The levels of the various chemical constituents would, thus, be essentially those indicated by the average concentrations given in Table 1-Question E1 for the plant discharge. (Consideration of the maximum values in the table would be inappropriate as continuous discharge at maximum levels could not be expected to occur over a prolonged time period.) In general, these concentrations represent a factor 2.5 applied to the river ambient levels. The only significant chemical additions made by the CRBRP discharge are residual chlorine (0.2 mg/l) and copper (0.2 mg/l). As chlorine is rapidly dissipated and acutely toxic concentrations of copper are generally above 0.2 mg/l,[1] no adverse environmental impact would be anticipated from even this extreme case of extended no flow with undiluted effluent concentrations present in the vicinity of the discharge.

The potential for recirculation of the chemical plume through the CRBRP intake during extended no flow occurrences is a function of the rate of travel of the plume outward from the discharge point. As demonstrated in the physical model, the plume rapidly mixes from top to bottom in the water column; thus, under completely quiescent conditions in the river, entrainment of ambient fluid from underneath plume would not occur and no outward momentum would be provided from this source. Consequently, the discharge jet and the withdrawal of water at the intake will be the principal driving forces for the upstream migration of the chemical plume. Even at the highest (summer) discharge and intake flow rates, given the river cross-sectional area, the velocity of upstream travel generated by these flows is small enough that recirculation would not commence within the longest historical period of continuous zero river flow (29 days).

In conclusion, the following points should be noted regarding worst case chemical plumes:

1. Occurrences of extended periods of no flow are historical and are not associated with current Melton Hill Dam operation (see Table 4-Question D8).

2. Should an extended no flow period occur at some future date, the accumulation of chemicals in the discharge vicinity and approach to the level of chemicals in the plant effluent will be tempered by the diluting influence of wind and river craft generated wave action, sediment uptake and molecular diffusion.

3. An upperbound and extreme assumption of effluent concentrations in a region of the river immediately adjacent to the discharge will not lead to conditions of significant environmental impact.

4. The driving forces (intake and discharge flows) that would act to cause recirculation of the chemical plume under extended no flow conditions would not be strong enough to achieve this over any time period associated with even historical no flow durations.

Question D8d

Three areas of environmental impact are associated with the submerged single port discharge design:

1. entrainment of organisms in the heated plume;
2. impingement of the plume on bottom populations;
3. removal of bottom sediments by plume scour.

These impacts have been discussed for the general case in Section 5.1.3 of the CRBRP ER. With the information obtained from the thermal-hydraulic model, it is now possible to discuss in more detail the effects of all three of these impacts.

In general, the physical modelling results indicate that the discharge is small and mixes rapidly with the Clinch River. A temperature rise greater than 2F degrees will only occur on the surface at a maximum of 250 feet from the discharge pipe under hypothetical winter worst conditions and for summer typical conditions will not be detectable at the surface. Rapid mixing limits the area encompassed by the 2F degrees isotherm to less than 25 percent of the cross-sectional area of the river during the winter worst case. Bottom scouring will be limited to an estimated area of 400 square feet. For temperature relationships that were stated in the ER, the environmental impact from this discharge will be minimal.

Effect of entrainment of phytoplankton and zooplankton species in the thermal plume is not expected to be significant because plume volume is small, temperature increase above ambient is small and entrainment time will be short. Patrick[2] reports that a power plant on the Delaware River with temperature rise of 14.4F degrees did not affect either the numbers or types of species between the upstream and downstream areas. Normal zooplankton dominance of Bosmina in the winter

and Daphnia in the summer was not altered in a British lake where a power plant increased water temperatures by 21 and 10F degrees.[3]

As discussed in the ER (pages 5.1-7 and 5.1-8), fish species with the acclimation conditions listed in Table 5.1-3 could potentially experience lethal temperatures during the typical summer condition if it were possible for them to inhabit the area of substantially undiluted effluent in the immediate area of the discharge nozzle for an extended period of time. Such an event, however, would not occur as the effluent exits the discharge nozzle as a high velocity (>20 fps) jet and plume temperatures rapidly fall below the lethal levels cited above well before jet velocities are reduced to a point which would permit extended residence of fish within the developing plume. Under typical summer conditions at approximately 18 feet from the discharge point, sufficient mixing has been achieved that maximum plume temperatures are less than 2F degrees above ambient. As shown by studies of game fish in Lake Monona in Wisconsin,[4] fish tend to position themselves in a discharge plume according to their temperature preferences and would not be expected to approach the region of substantially undiluted temperature directly in front of the discharge nozzle.

Although the area encompassed by the 1F degree isotherm during the hypothetical winter worst case may extend across the main channel of the river, no effective thermal blockage would be anticipated. Fish populations identified in this area of the Clinch River would not be expected to migrate under the conditions of near-freezing water temperatures (and lowered pool levels) that are associated with any potential for the extension of elevated temperatures into the main river channel.

Thermal plume impact on benthic organisms is essentially the same as that discussed in Section 5.1.3.2 of the ER. A temperature rise greater than 3F degrees occurs over a small area of the bottom (less than one-tenth

of an acre) only for the hypothetical worst case in winter. Coutant studied the riffle fauna above and below a power station on the upper Delaware River[5] and concluded that the normal population structure was not altered by a temperature increase of 20 degrees above ambient. Clinch River benthic populations in the area of the discharge include tolerant tubificid worms and chironomids that would not be affected by the small temperature increases resulting from the CRBRP discharge.

As the most conservative estimate, scouring is assumed to completely remove benthic species from an area of about 400 square feet under worst case winter conditions. Loss of this small bottom area will not have a significant impact on the Clinch River communities because the area does not contribute any rare or unique species to river communities. Benthic populations from this area are similar to populations found in other areas of the river with the same sediment type. There is no evidence from the data presented in 2.7.2 of the ER to consider this area a spawning location of fish or as an area of high fish concentrations.

In summary, the assessment of the environmental impact of this small thermal discharge as supported by the physical model results, is similar to that considered in the ER. Extent of the scouring effects were not reported in the ER, but as stated on the ER page 5.1-15 "no significant scouring effects and associated impacts on benthic organisms in the vicinity of the discharge are anticipated" due to the small area impacted and the species affected.

Question D8e

The revised plume analyses are based on the results of thermal-hydraulic modelling, consequently the work of Albertson is no longer used, and this question is no longer relevant.

TABLE 1--QUESTION D8

INPUT PARAMETERS FOR PHYSICAL MODELLING OF THE CRBRP DISCHARGE

	Plant Discharge				Ambient River Conditions					Initial Jet Parameters			
	Atmospheric Wet Bulb (°F)	Blowdown Temp. (°F)	Blowdown Flow[e] (gpm)	(cfs)	Water Temp. (F°)	Flow Rate (cfs)	Velocity (fps)	Pool Elevation[h] (ft MSL)	Strati-fication	ΔT_o (F°)	V_o (fps)	F_o	Z/D
Typical Cases													
- Winter (Jan/Feb/Mar)	43.3[a]	74.9[c]	2500	5.57	43.9[c]	5338[g]	1.39	736	No	31.0	15.96	67.8	7.5
- Summer (Jul/Aug/Sep)	73.2[a]	89.3[c]	3240	7.22	65.7[c]	4777[g]	0.63	741	No	23.6	20.68	77.1	15.0
Worst Cases													
- Winter (Jan)	56.2[b]	79.8[d]	2810	6.26	33[f]	0	0	735	No	46.8	17.93	68.2	6.0
- Summer (Jun)	74.4[b]	89.6[d]	3280	7.31	78[f]	0	0	739	Yes	11.6	20.94	84.3	12.0

[a] ER Table 3.4-3
[b] Bull Run Steam Plant Data, 1/70-12/73
[c] ER Table 3.4-4
[d] ER Figure 3.4-2; account taken of cooling effect of makeup flow
[e] ER Figure 3.4-4
[f] Clinch River (m 21.6) Data, 6/62-9/72
[g] ER Table 2.5-3
[h] ER Table 2.5-5

TABLE 2--QUESTION D8

AREAS INSIDE SURFACE ISOTHERMS DETERMINED FROM MODEL TESTS (ft^2)

Case	$(\Delta T)p = 1°F$	$(\Delta T)p = 2°F$
Winter, Typical	2,200	0
Winter, Worst	43,000*	4,300*
Summer, Typical	200	0
Summer, Worst	0	0

*Estimated from extrapolated dimensions (length and width) of areas enclosed by isotherms.

TABLE 3--QUESTION D8

AREAS INSIDE SURFACE ISOPLETHS DETERMINED FROM MODEL TESTS (ft^2)

Case	River Area (ft^2)	Chemical Conc. Diff. (%)
Winter, Typical	2,200	3.2
Summer, Typical	200	4.2

TABLE 4-QUESTION D8

MELTON HILL DAM

NUMBER OF OCCURRENCES OF ZERO RELEASE[++]

Calendar Year	Occurrences of zero release for the following number of consecutive days									
	1	2	3	4	5	6	7	8	11	29
1963[*]	4	6	4	3						
1964	5	15	4	1	1					
1965	6		1				1			
1966	12	6	3	3						1[+]
1967	7	3							1[3]	
1968	17	11	2		1		1	1[3]		
1969	24	18	4							
1970	25	4	3	1						
1971	11	8	1	1						
1972	6	1								
1973	8	1								
1972[**]	4									

[*] May-December

[**] January-October

[+] Reservoir operated to aid in controlling growth of Eurasian watermilfoil in the Melton Hill Reservoir

[++] Hydraulic Data Branch, Tennessee Valley Authority, March 21, 1975

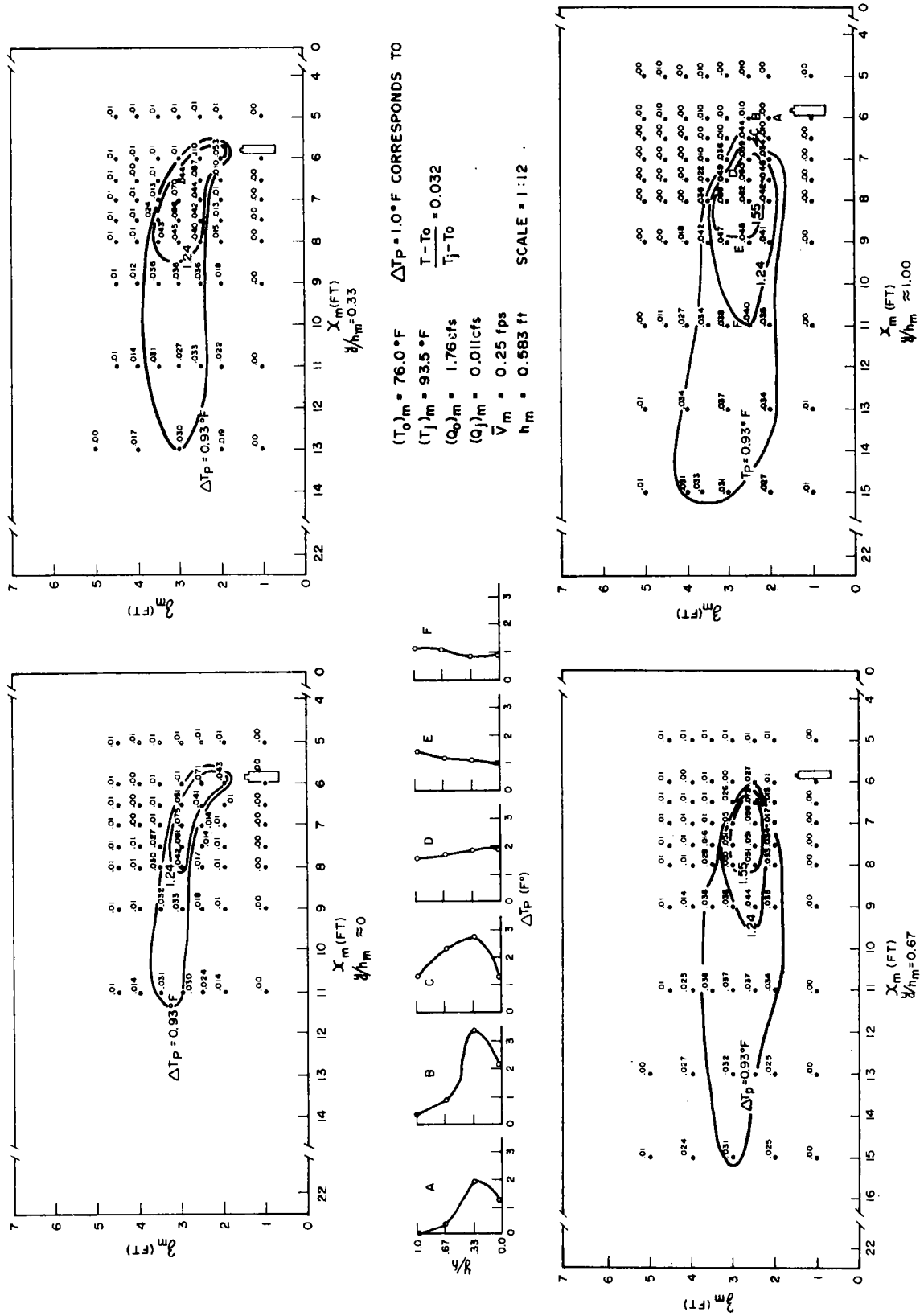


Figure 1 PHYSICAL MODEL RESULTS FOR TYPICAL CASE-WINTER (Ques. D8)

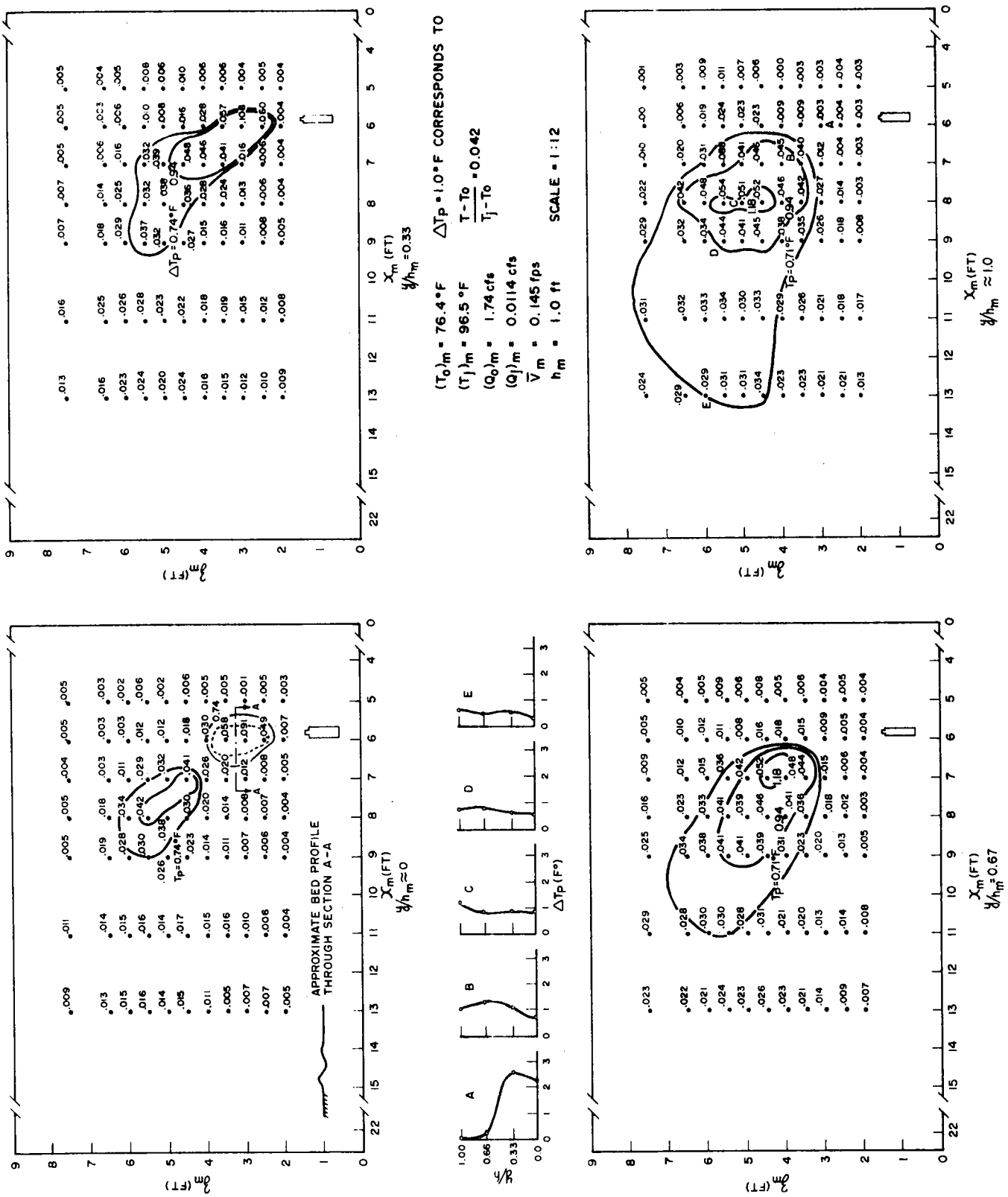


Figure 2 PHYSICAL MODEL RESULTS FOR TYPICAL CASE-SUMMER (Ques. D8)

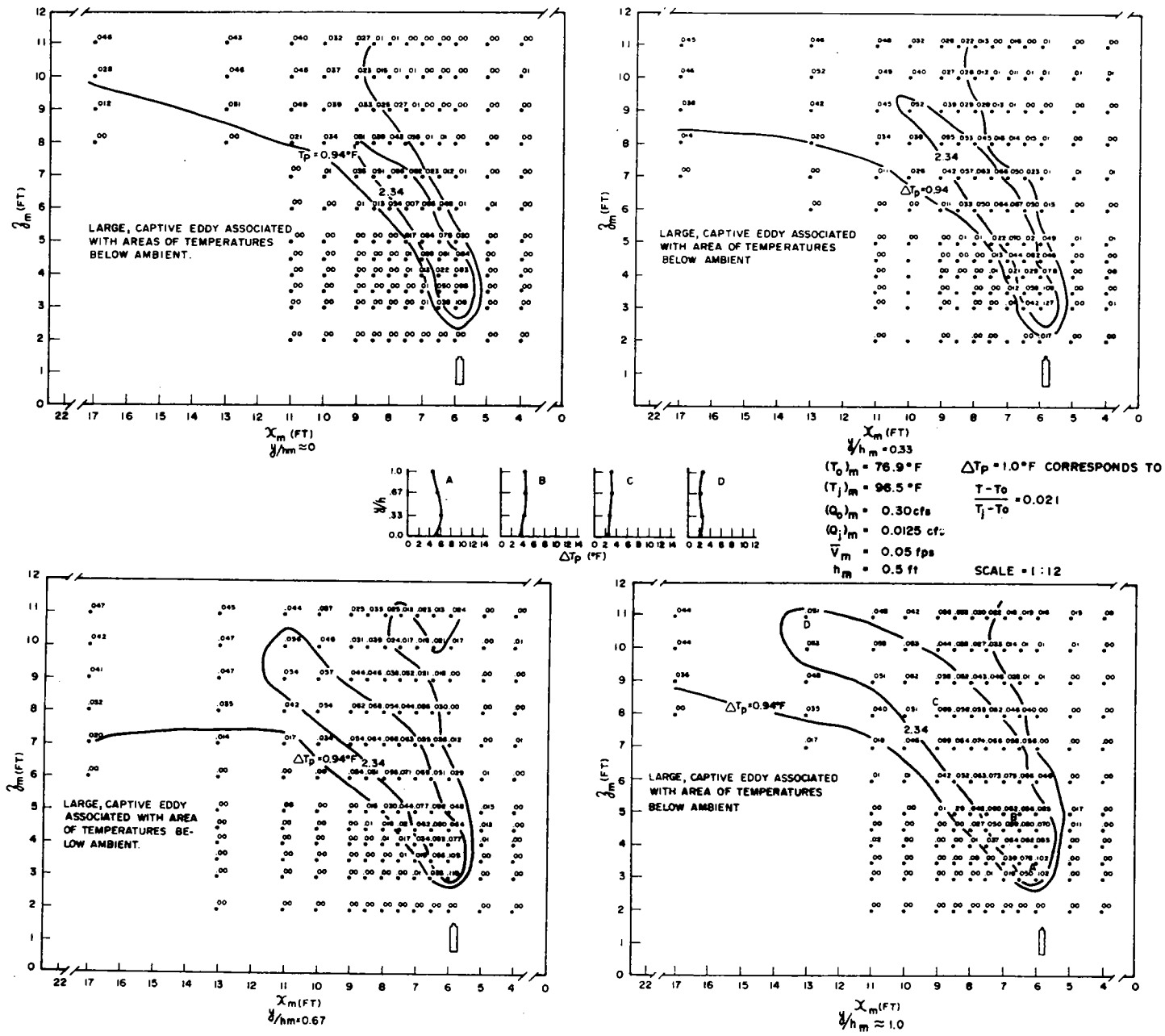


Figure 3 PHYSICAL MODEL RESULTS FOR HYPOTHETICAL
(Ques. D8) WORST CASE-WINTER

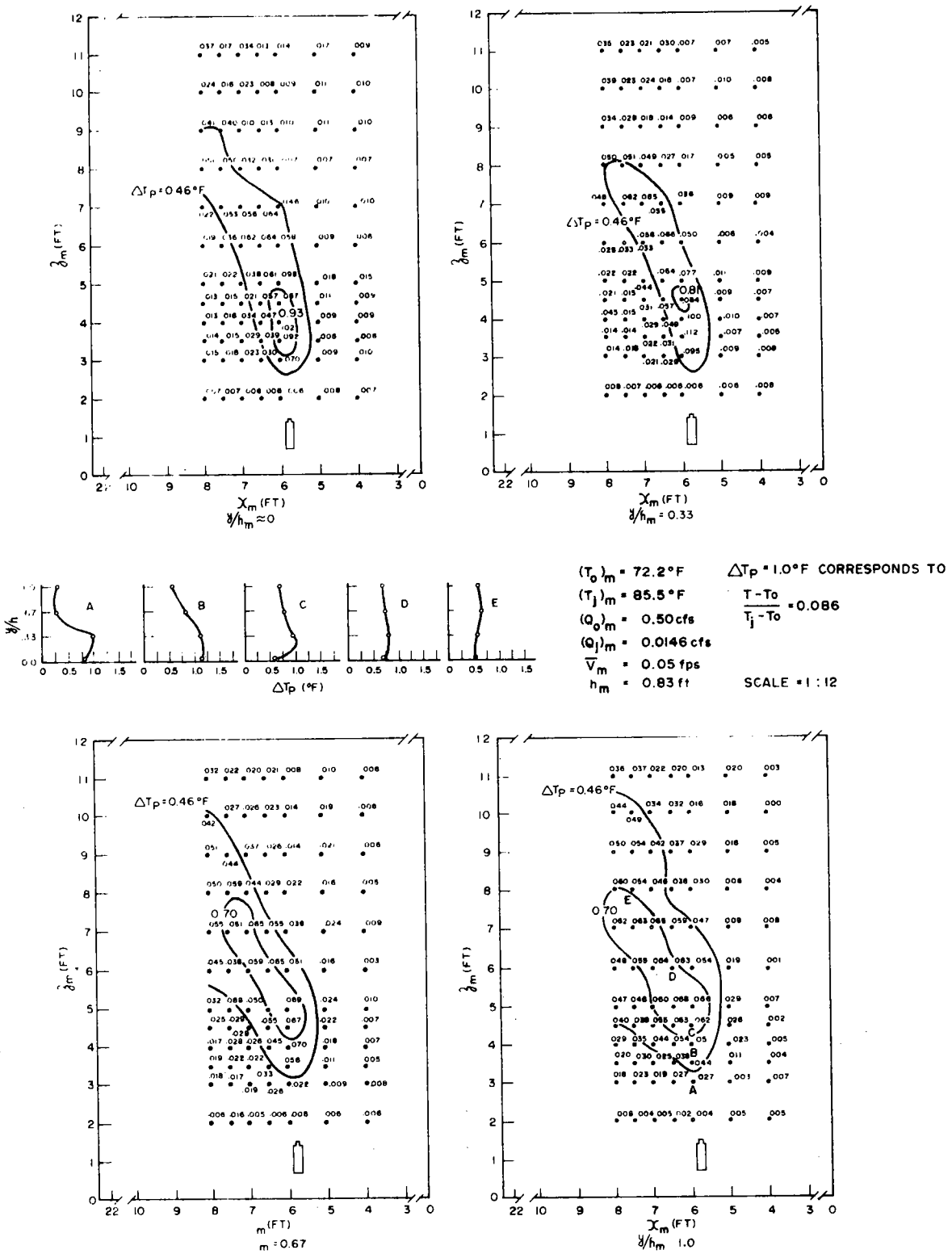
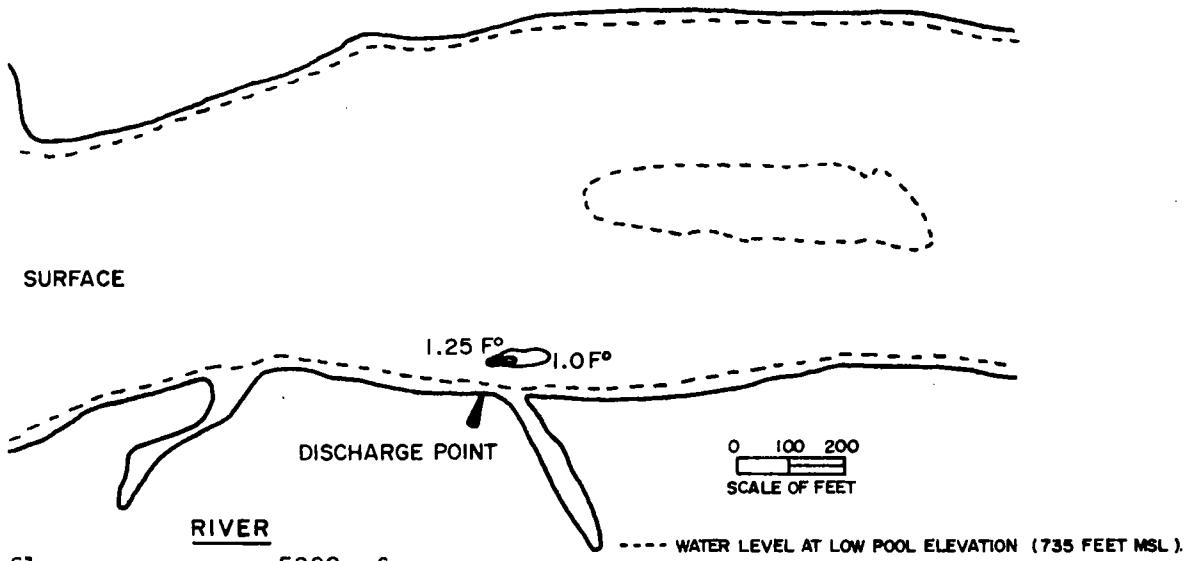


Figure 4 PHYSICAL MODEL RESULTS FOR HYPOTHETICAL
(Ques. D8) WORST CASE-SUMMER



RIVER

flow = 5338 cfs
velocity = 1.39 fps (0.87)*
pool elevation = 736 ft MSL

DISCHARGE JET

flow = 5.57 cfs
velocity = 15.96 fps
temp. diff. = 31.0F°

*Prototype velocity based on hydraulic model velocity. Reflects physical limitations of the flume.

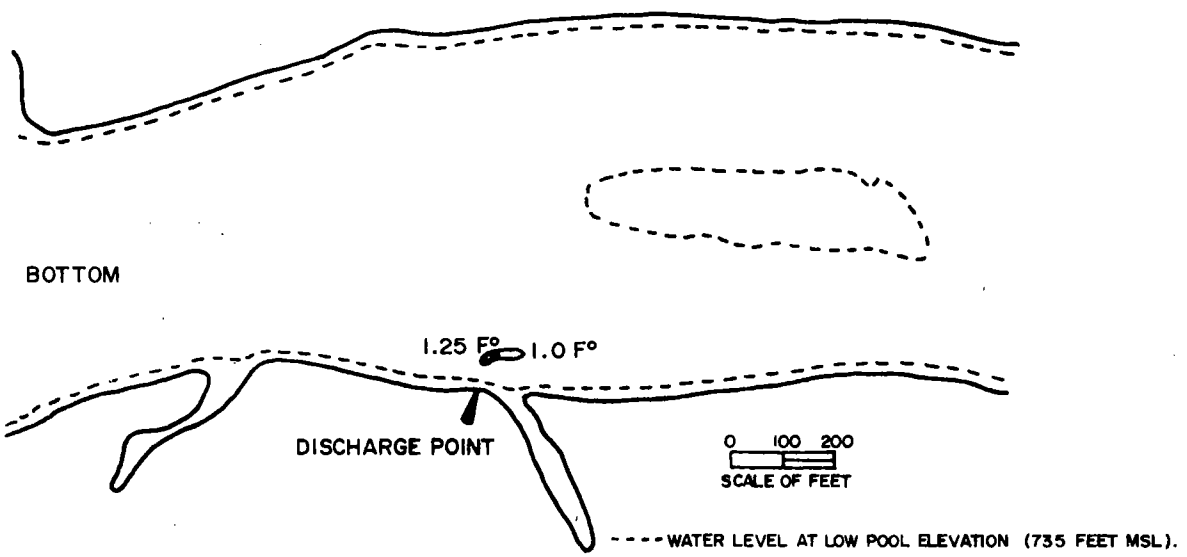
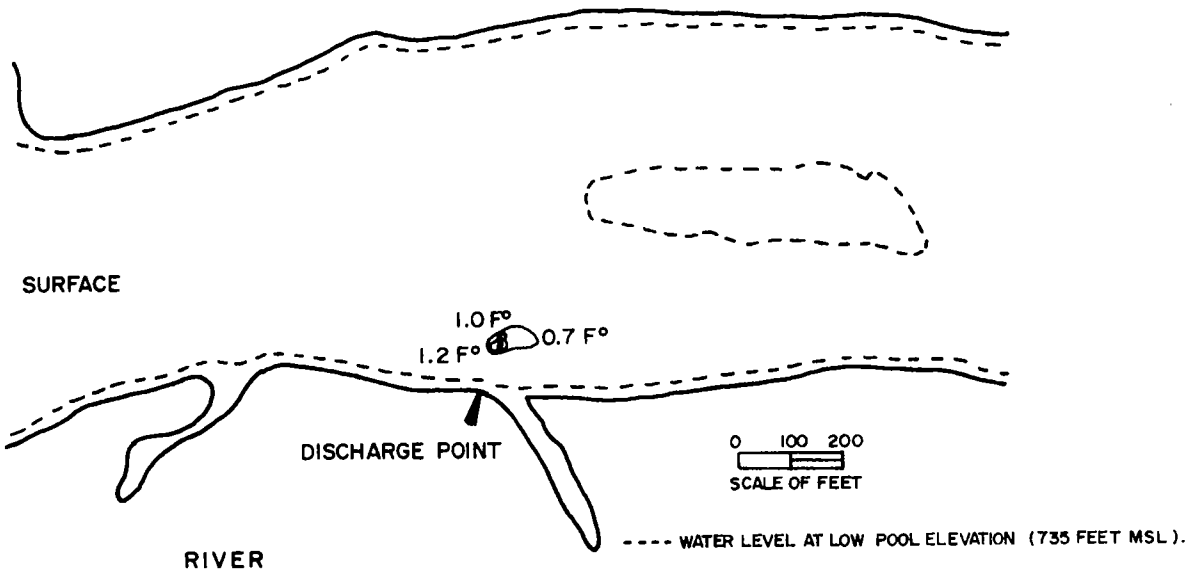


Figure 5 TYPICAL CASE-WINTER
(Ques. D8)



RIVER

flow = 4777 cfs
velocity = 0.63 fps (0.50)*
pool elevation = 741 ft MSL

DISCHARGE JET

flow = 7.22 cfs
velocity = 20.68 fps
temp. diff. = 23.6F°

*Prototype velocity based on hydraulic model velocity. Reflects physical limitations of the flume.

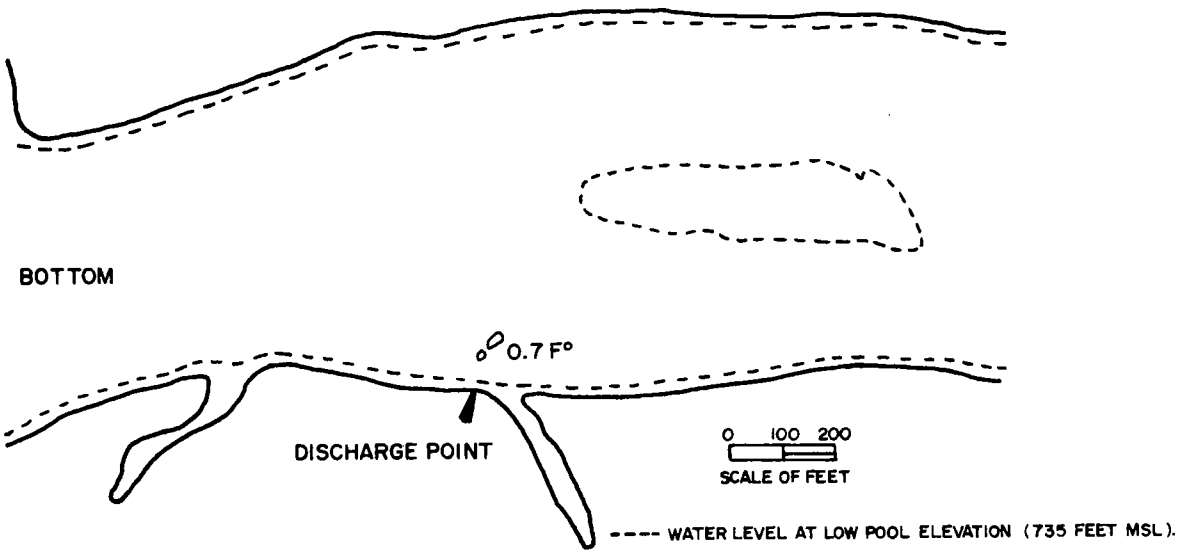
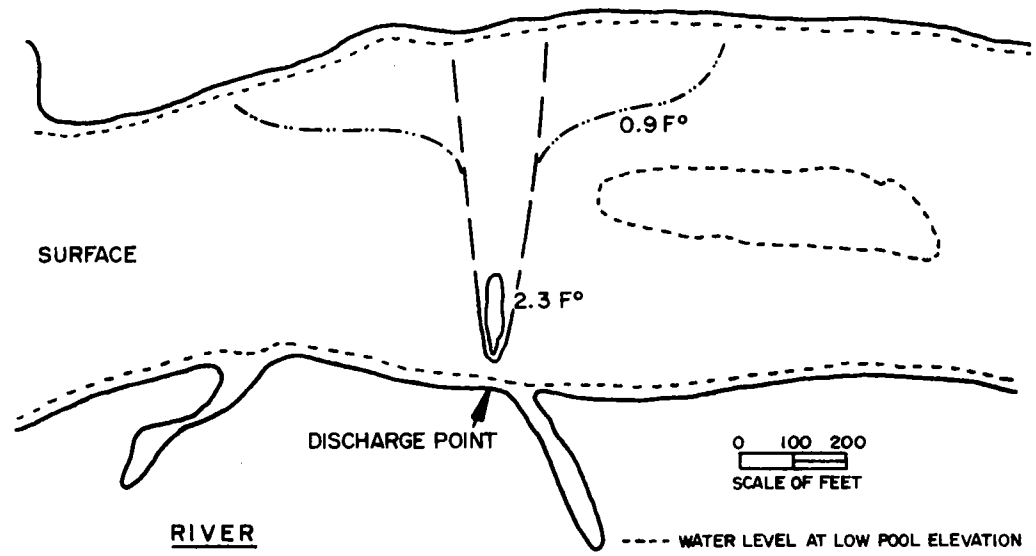


Figure 6 TYPICAL CASE-SUMMER
(Ques. D8)



RIVER

flow = 0
velocity = 0 (0.17 fps)*
pool elevation = 735 ft MSL
temperature = 33°F

---- WATER LEVEL AT LOW POOL ELEVATION (735 FEET MSL).

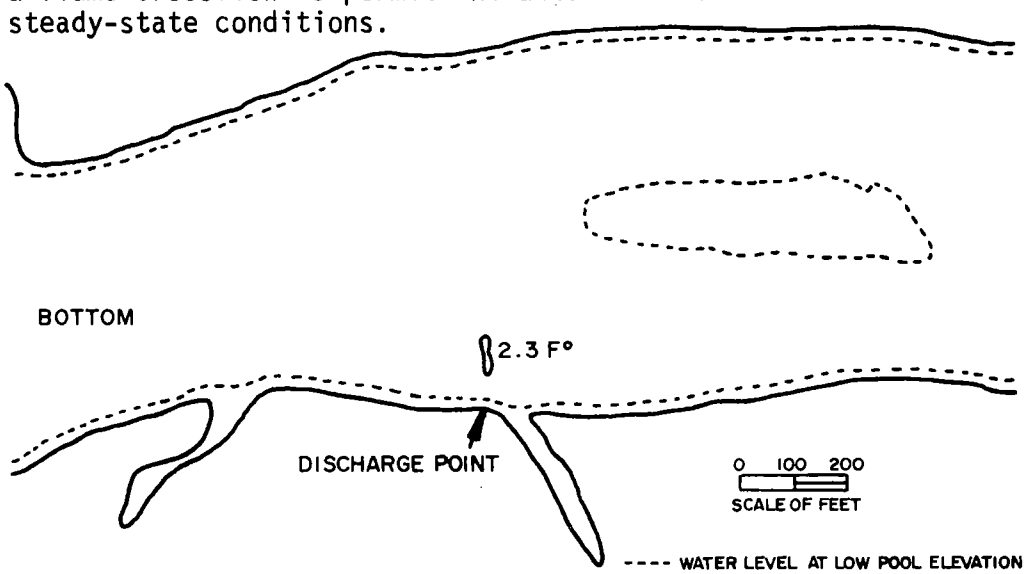
—— EXTRAPOLATION OF PLUME WIDTH GROWTH BASED ON PHYSICAL MODEL DATA.

—·— ESTIMATION OF PLUME DISTORATION DUE TO INTERACTION WITH OPPOSITE SHORE.

DISCHARGE JET

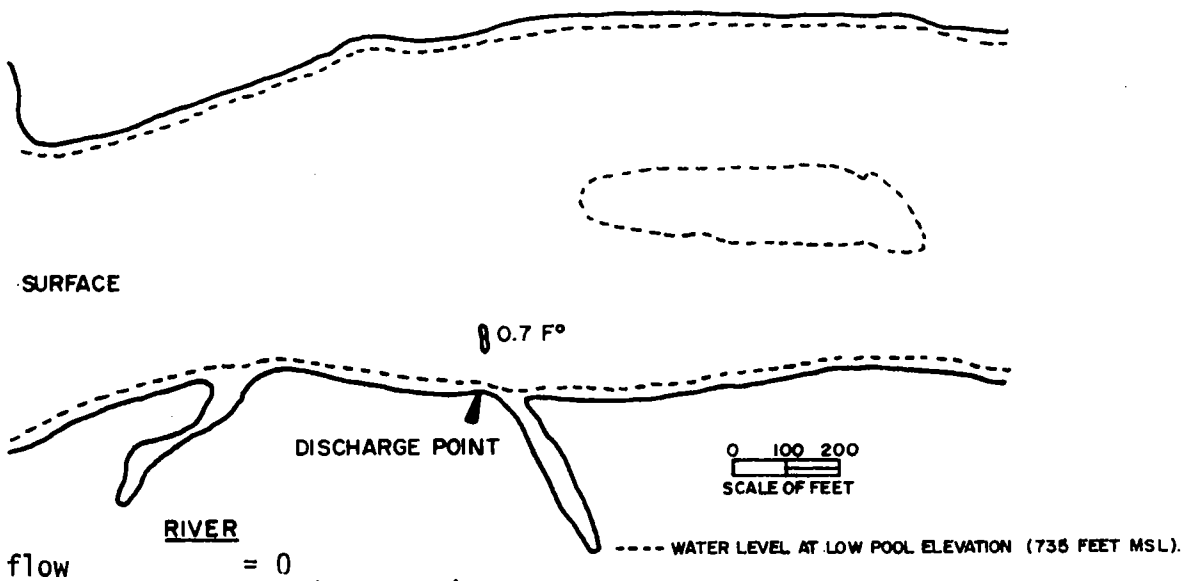
flow = 6.26 cfs
velocity = 17.93 fps
temp. diff. = 46.8F°

*Prototype velocity based on hydraulic model velocity. Reflects necessity of maintaining a flume crossflow to permit the attainment of steady-state conditions.



---- WATER LEVEL AT LOW POOL ELEVATION (735 FEET MSL)

Figure 7 HYPOTHETICAL WORST CASE-WINTER
(Ques. D8)



RIVER

flow = 0
velocity = 0 (0.17 fps)*
pool elevation = 739 ft MSL
temperature = 78°F

DISCHARGE JET

flow = 7.31 cfs
velocity = 20.94 fps
temp. diff. = 11.6F°

*Prototype velocity based on hydraulic model velocity. Reflects necessity of maintaining a flume crossflow to permit the attainment of steady-state conditions.

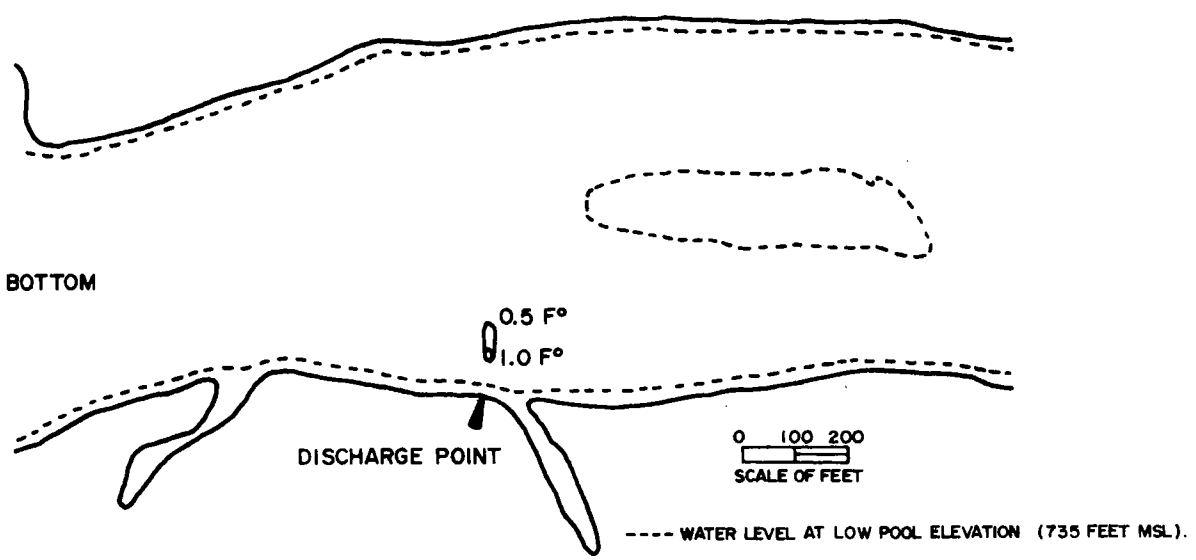


Figure 8 HYPOTHETICAL WORST CASE-SUMMER
(Ques. D8)

QUESTION D8 REFERENCES

1. Becker, C. D., and Thatcher, T. O., Toxicity of Power Plant Chemical to Aquatic Life, prepared by U.S. AEC, WASH-1249, June 1973.

2. Patrick, R., Some Effects of Temperature on Freshwater Algae Biological Aspects of Thermal Pollution, Proc. of National Symposium on Thermal Pollution, June 3-5, 1968, Vanderbilt Univ. Press, Nashville, Tennessee, 1969.

3. Whitehouse, J. W., Some Aspects of the Biology of Lake Trawsfynydd, a Power Station Cooling Pond, Hydbiologia, 38 (2), 1971, pp 253-288.

4. Neill, W. H., and Magnuson, J. J., Distributional Ecology and Behavioral Thermoregulation of Fishes in Relation to Heated Effluent From a Steam-Electric Power Plant (Lake Monona, Wisconsin), The University of Wisconsin Water Resources Center, 1972.

5. Coutant, C. C., The Effect of a Heated Water Effluent Upon the Macroinvertebrate Riffle Fauna of the Delaware River, Proceedings of Pennsylvania Academy of Science, Vol 35, 1962, pp 58-71.

QUESTION D9

Clarify the relationship between the chemical plume boundaries and the chemical isopleths. The reason is not clear (p.14.6-11) for the chemical isopleth's being greater than zero at the plume boundaries (14.6).

RESPONSE

The use of precise boundaries (isopleths) to describe a chemical or thermal plume is a mathematical means of characterizing a complex physical occurrence. It is necessarily an oversimplification and the results obtained must be utilized with this fact firmly in mind. In Figures 5 through 8 (Question D8) the various outer isotherms are not absolute boundaries beyond which ambient temperatures are instantaneously achieved; rather, they represent approximate lines of demarcation beyond which the temperatures vary from the stated values to ambient. There are 0.5, 0.25, 0.10, etc., isotherms that lie beyond these lines; however, the size limitations of the physical model make the identification of these isotherms difficult.

The attempt made in physical model and subsequent mathematical computations was to define the chemical and thermal plumes to the degree that would be of importance in the assessment of environmental impact. Consequently, identification of 0.25, 0.10, 0.05°F isotherms was not considered necessary as no adverse impact on the aquatic environment would be anticipated for these barely perceptible temperature rises. The same logic holds true for the chemical plume analysis where isopleths representing concentrations of 0.5, 0.05, etc. were not identified. The plume boundary, therefore, should not be construed as the line beyond which the measurement of zero chemical or thermal differential is assured.

QUESTION D10

Relate velocity measurements in the river during "no-flow" conditions to the assumptions made for plume calculations under conditions of no-river flow (5.1 and 14.6).

RESPONSE

The no-flow cases evaluated in the discharge plume analysis (ER Section 14.6) were based on the assumption of zero velocity at all points in the water column. Velocity measurements made in the river were not purposefully correlated with the occurrences of zero discharge from Melton Hill Dam; however, velocity measurements on several occasions obviously indicate a no-flow condition. These are presented in Figure 1 and Tables 1 and 2 (Question D10).

TABLE 1--QUESTION D10

CHEMICAL AND PHYSICAL FIELD MEASUREMENTS, JUNE 27, 1974 - CLINCH RIVER

TRIP NUMBER 7 - JUNE 24-28, 1974

Location	Depth (meters)	Light Penetration (foot-candles)	Light Penetration (% transmittance)	Water Velocity** (ft/sec)	Water Temperature (°C)	Water Temperature (°F)	Dissolved Oxygen (ppm measured)	Dissolved Oxygen (% saturation)	Specific Conductivity (µmhos/cm)	pH
Transect 1 Station 3	0.3	3666.7	83.8	0.0	20.0	68.0	8.5	92.4	210	8.6
	1.0	2000.0	45.7	0.0	20.0	68.0	8.5	92.4	--	--
	2.0	500.0	11.4	0.1	20.0	68.0	8.4	91.3	--	--
	3.0	166.7	3.8	0.1	20.0	68.0	8.4	91.3	--	--
	4.0	62.5	1.4*	0.1	20.0	68.0	8.4	91.3	215	8.5
	5.0	25.0	0.6	0.0	20.0	68.0	8.4	91.3	--	--
	6.0	10.4	0.2	0.0	19.5	67.1	8.3	89.2	--	--
	7.0	2.7	0.1	0.0	19.5	67.1	8.3	89.2	215	8.5
	Total Water Depth = 7.3 m Air Temperature = 22.5°C (72.5°F) Ambient radiation recorded on photometer deck cell = 4375.0 foot-candles									
Transect 1 Station 5	0.3	3500.0	++	0.2	20.5	68.9	8.6	94.5	215	8.7
	1.0	2333.3	++	0.1	20.0	68.0	8.5	92.4	--	--
	2.0	500.0	++	0.1	20.0	68.0	8.4	91.3	--	--
	3.0	166.7	++	0.1	20.0	68.0	8.3	90.2	--	--
	4.0	62.5	++	0.2	20.0	68.0	8.3	90.2	215	8.6
	5.0	22.9	++	0.2	19.5	67.1	8.3	89.2	--	--
	6.0	9.4	++	0.2	19.5	67.1	8.3	89.2	--	--
	7.0	2.9	++	0.2	19.5	67.1	8.2	88.2	215	8.6
	Total Water Depth = 7.6 m Air Temperature = 23.5°C (74.3°F) Ambient radiation recorded on photometer deck cell = ++									
Transect 1 Station 7	0.3	4100.0	65.6	0.1	20.5	68.9	8.5	93.4	215	8.7
	1.0	1833.3	29.3	0.2	20.0	68.0	8.5	92.4	--	--
	2.0	666.7	10.7	0.2	20.0	68.0	8.3	90.2	--	--
	3.0	208.3	3.3	0.3	19.5	67.1	8.3	89.2	--	--
	4.0	83.3	1.3*	0.2	19.5	67.1	8.3	89.2	215	8.6
	5.0	29.2	0.5	0.1	19.5	67.1	8.2	88.2	--	--
	6.0	11.3	0.2	0.2	19.5	67.1	8.2	88.2	--	--
	6.2	3.0	0.0	0.2	19.5	67.1	8.2	88.2	215	8.6
	Total Water Depth = 6.4 m Air Temperature = 24.0°C (75.2°F) Ambient radiation recorded on photometer deck cell = 6250.0 foot-candles									

(Continued)

TABLE 2--QUESTION D10

CHEMICAL AND PHYSICAL FIELD MEASUREMENTS, SEPTEMBER 24, 1974 - CLINCH RIVER

TRIP NUMBER 12 - SEPTEMBER 23-26, 1974

Location	Depth (meters)	Water Velocity** (ft/sec)	Water Temperature (°C)	Water Temperature (°F)	Dissolved Oxygen (ppm measured)	Dissolved Oxygen (% saturation)	Specific Conductivity (μmhos/cm)	pH
Transect 5 Station 7	0.3	0.0	20.0	68.0	6.8	73.9	245	7.9
	1.0	0.1	20.0	68.0	6.7	72.8	--	--
	2.0	0.0	20.0	68.0	6.7	72.8	--	--
	3.0	0.0	19.9	67.8	6.7	72.8	--	--
	4.0	0.1	20.0	68.0	6.6	71.7	245	7.9
	5.0	0.0	20.0	68.0	6.6	71.7	--	--
	6.0	0.0	20.0	68.0	6.6	71.7	--	--
	7.0	++	20.0	68.0	6.6	71.7	245	7.9

Total Water Depth = 7.9 m
Air Temperature = 15.5°C (59.9°F)
Light penetration* recorded on Secchi disc = 4.25 feet

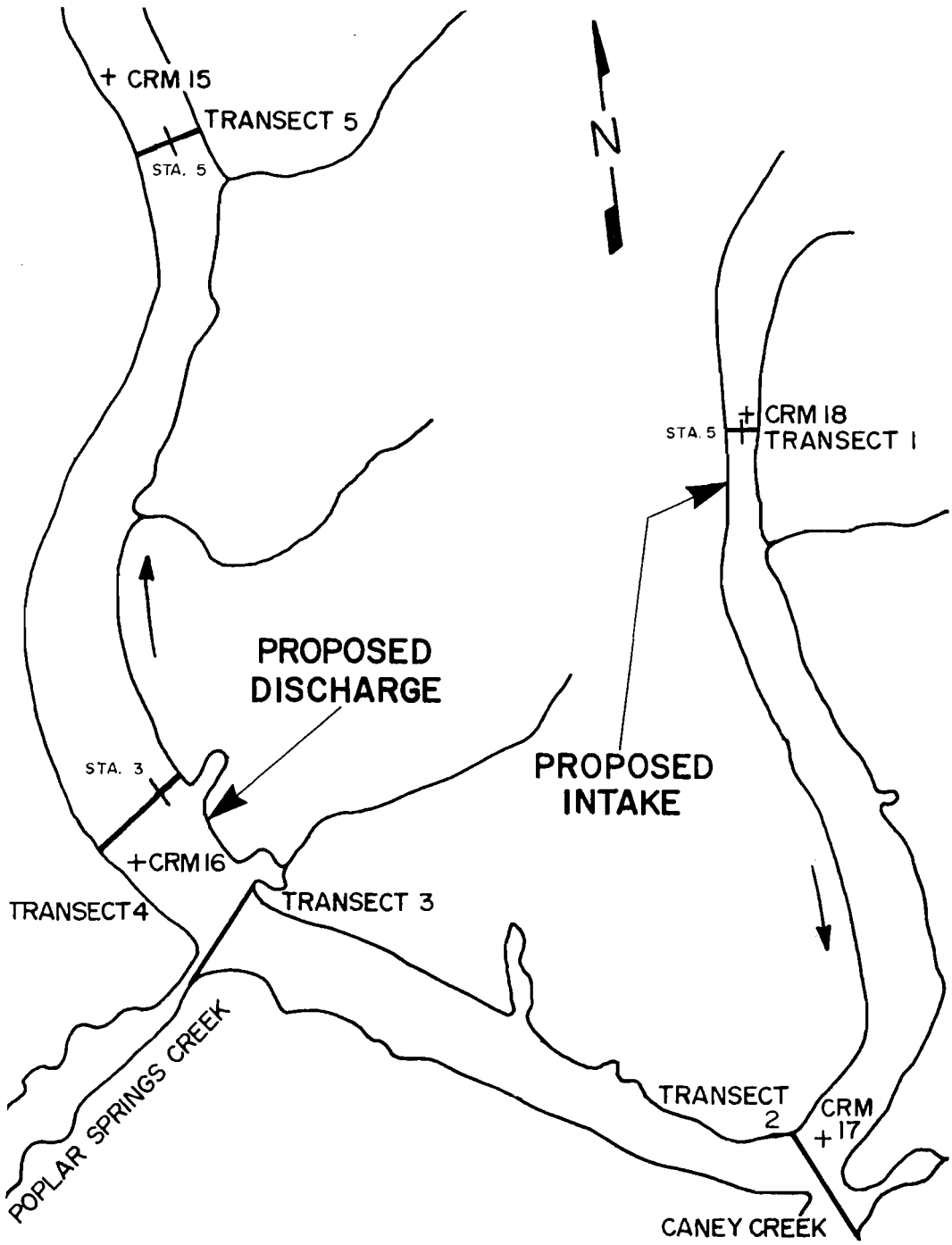


Figure 1 (Ques. D10) LOCATION OF SAMPLING STATIONS FOR ZOOPLANKTON (PUMPING AND TOWING), PHYTOPLANKTON AND WATER SAMPLES FOR PHYSICAL AND CHEMICAL ROUTINE LABORATORY ANALYSES AND BACTERIOLOGICAL ANALYSES FOR THE BASELINE MONITORING PROGRAM

QUESTION D11

Provide results from additional calculations for worst-case conditions of river flow, river temperature, blowdown flow, and ambient temperature, taking into consideration the following (5.1 and 14.5):

a. Model the worst-case plumes corresponding to both winter low-pool and summer high-pool levels, and for each of the pool levels include results for both stratified and unstratified conditions. Take into account the stratification measured in a 1974 TVA survey at river mile 14.4 (1.6 miles downstream of the site), or other data, if available, that would indicate more severe stratification.

b. Base the outfall - river temperature differences and the cooling tower blowdown flow rates on worst-case seasonal combinations of daily maximum and minimum temperatures from which the monthly average values in Tables 3.4-3 and 3.4-4 were computed.

c. Account for discharge flows contributing to worst-case thermal and chemical plumes, taking into consideration all inputs to the discharge and not restricting the flow rates to chose predicted from Figure 3.4-4, which relates blowdown flow only to atmospheric wet bulb temperature.

d. Use lowest pool levels corresponding to the winter and summer conditions. Plume calculations included in Section 14.6 for summer conditions are not based on the lowest pool level; the level used is 741 feet while Section 2.5.1.4 indicates that the summer pool elevation is as low as 740 feet.

e. In addition to calculations for periods of no river flow, discuss the extent and consequences of possible recirculation for predicted conditions (described in 2.5.1.7) of upstream flow.

f. Discuss in detail the procedures used to perform the calculations.

RESPONSE

Question D11a

The modelling of worst-case plumes is presented in the Response to Question D8c. Stratification is discussed in the Response to Question D1b.

Question D11b

The derivation of the temperature combinations selected for the worst-case analyses is explained in the Response to Question D8a.

Question D11c

The CRBRP will employ a closed recirculating cooling system with a mechanical draft wet tower. Blowdown from the cooling tower basin will be the dominant factor in the plant discharge both in terms of flow and thermal and chemical additions. By comparison to the annual average blowdown flow of 2210 gallons per minute (gpm), the other contributors to the plant discharge will be minor: liquid radwaste system effluent (1 gpm), neutralized plant wastes (average - 3.7 gpm, maximum - 35 gpm) and sanitary system effluent (5 gpm). None of these other flows contain significant amounts of waste heat. Although the neutralized plant wastes represent a high total dissolved solids tream, the discharge chemical concentration does not influence the thermal-hydraulic modelling results. 6

Consequently, consideration of only the cooling tower blowdown in the modelling of the dispersion of the plant discharge flow does not materially affect the results obtained.

Question D11d

The lowest Clinch River pool elevations as recorded in ER Table 2.5-5 were used in the Hypothetical Worst Cases (see Table 1 - Question D8).

Question D11e

Although reverse flows of up to 1.0 ft/sec velocity have been predicted at the Site, the data presented in ER Figure 2.5-10 indicates that recirculation of the discharge plume to the plant intake would not be expected for a reverse flow scenario because

1. periods of reverse flow (>0.5 ft/sec) are not sustained but are limited to a maximum duration of approximately 2 hrs,
2. over the 72 hr period of prediction, reverse flow occured less than 50% of the time and
3. the 72 hr period may be characterized by a 3 ft/sec positive flow during the first 24 hrs followed by 2 days of low amplitude oscillatory flow that was in actuality a period of net zero flow.

Question D11f

The description of the procedures used in performing the thermal-hydraulic modelling and subsequent mathematical computations are given in the Responses to Questions D8b and c and will be incorporated into the Environmental Report.

QUESTION D12

Describe the program for monitoring thermal effluent, taking into consideration the results of effluent dispersion studies that have been completed (6.2).

RESPONSE

See revised Section 6.2.3.

PURPOSELY BLANK

QUESTION D13

Provide data to support the assumption that no groundwater flow could pass beneath the river, particularly down the southeasterly-dipping strata under the river (2.2.3, 2.5.2).

RESPONSE

Weathering in carbonate aquifers is a result of vertical and lateral circulation of groundwater within the aquifer. Thus, in these aquifers, the zone in which significant weathering occurs is indicative of the zone of active groundwater circulation, and so this zone represents the significant aquifer in a carbonate terrane.

The site investigation indicated that significant weathering has occurred only within the upper level of the bedrock, and that below this level there was no evidence of significant weathering which would indicate active groundwater movement. Thus, it was concluded that the only zone beneath the Site in which groundwater movement is significant is the zone extending from the ground surface to the top of continuous rock. Groundwater occurs within this zone essentially under water table conditions, although occasional confined conditions probably occur in areas where less permeable surficial soils may act as a confining layer to more permeable weathered zones. This condition is most likely to occur during periods of high groundwater levels and occurs within the water table aquifer described above. There is no evidence that confined aquifers exist at the Site below the water table aquifer.

In order for flow in the water table aquifer to pass beneath the Clinch River, a piezometric gradient must exist within the aquifer beneath the river. Groundwater levels measured in wells within a two-mile radius of the Site and groundwater levels measured in observation wells installed

gravity discharge to the river. The inflow parameter will consequently be evaluated with a high degree of reliability during the excavation phase.

over the Site indicate that the groundwater on either side of the Clinch River generally flows toward the river.

If a gradient from the river were generated by local pumping, the river would act as a source of recharge to the well. Borings made on the Site and in the river indicated the elevation of the top of continuous rock, which effectively defines the bottom of the aquifer, lies above an elevation of about 700 MSL. The elevation of the bottom of the channel is approximately 720 MSL and thus, the thickness of the aquifer beneath the river is about 20 feet. This dimension is small relative to the width of the river; thus, the presence of the river is the predominate factor influencing the groundwater flow system. An analysis of the flow system with line sources and sinks on opposite sides of the river showed that even such extreme conditions will not induce flow to cross beneath the river.

Boring data indicating the top of continuous rock at the Site are available in the PSAR. Boring data in and near the river are furnished as a part of the response to Question D24. 8

QUESTION D14

Provide data on permeabilities in the more weathered zones of the aquifer, and estimates of the maximum permeabilities of the aquifer at the Site (2.5.5, p. 2.5-15 and Table 2.5-17).

RESPONSE

Aquifer permeabilities in weathered and unweathered zones within the aquifer are presented in ER Table 2.5-17. More recent inflow permeability tests run as part of a test grouting program in the weathered zones of the aquifer in the Chickamauga Unit A upper Siltstone indicated permeabilities in the same range as those reported in the above mentioned table. The maximum measured permeability in the Site aquifer was 1,510 feet per year (measured in the Unit A upper Siltstone) as reported in the PSAR. A permeability value of 2,000 feet per year was used in the PSAR to produce a conservative estimate of travel time. The more recent permeability values are all lower than 1,510 feet per year, the previously measured maximum value. Thus, the more recent permeability data indicate that the initial testing provided a representative range of permeabilities for the Site in the upper siltstone, which is the bearing layer for the Plant Island. 8

Substantial weathering and minor solutioning was encountered in borings penetrating the weathered limestones bordering the Unit A upper Siltstone stratum and consequently many pumping tests would be required to evaluate the range in permeability that might be expected in the more pervious aquifers. During construction it is planned to grout the permeable zones as necessary to control seepage into the excavation. This grouting will decrease the permeability of the aquifer around the Plant Island. Seepage will be monitored by constructing drainage ditches on all excavation berms and pumping the resulting effluent to settling basins prior to 8

QUESTION D15

Discuss applicability to computations of travel times of the statement in 2.5.2.5 that movement of groundwater usually occurs in a direction normal of the groundwater contours. Discuss the validity of that assumption for the jointed, weathered, folded carbonate terrane existing in the vicinity of the Site.

RESPONSE

A knowledge of the direction of movement of groundwater is necessary in the computation of travel times, since the direction of movement determines the destination of the groundwater as well as the length of the path which the groundwater must traverse to reach that destination.

The statement that groundwater moves in a direction normal to contours of constant head is true whenever the flow is occurring through a medium whose hydraulic properties do not change with location or direction. Such a medium is called homogeneous and isotropic. A medium whose properties change from point to point is called inhomogeneous. A medium whose properties vary with direction at a point is called anisotropic. Flow in inhomogeneous or anisotropic media does not necessarily occur in a direction normal to the groundwater contours, but may be deflected toward directions of higher permeability which offer less resistance to flow.

No natural deposit is homogeneous and isotropic if considered on a small scale. Natural bedded deposits such as the limestones and siltstones in the vicinity of the Site are generally anisotropic, with preferential directions often aligned along bedding planes within the formation. Jointing of such formations in directions normal to the bedding planes lessens the anisotropy of these deposits. Other complexities exist in the 8

formation which may further reduce the anisotropic behavior of the deposits. When considered on a large scale, the point by point variations within the medium are blended, with the result that the medium may be considered, for computational purposes, to be homogeneous and isotropic within the more weathered zones in which the groundwater flow will occur.

QUESTION D16

Discuss quantitatively the effects on the groundwater environment of dewatering for construction of the Plant Island, and the effects of stopping dewatering after construction (2.5.2.6).

RESPONSE

Dewatering during the construction of the Plant Island will be accomplished by pumping from open sumps located on selected berms and at the base of the excavation and by installing inclined drains into the exposed rock faces. The base of the excavation is at an elevation 712.5'. The sumps will be a minimum of six feet below this elevation, thus enabling water to be maintained below the 712.5' level. The lowering of the groundwater at the Plant Island will cause a general lowering of the water table within the groundwater sub-basin formed by the ridges to the northwest and southeast of the Plant Island and by the Clinch River. Effects of the groundwater lowering may extend to distances as far as the boundaries of the groundwater sub-basin. Significant effects on the groundwater environment are not expected beyond these boundaries. Within the basin, the portions of the aquifer upgradient from the excavation will be essentially dewatered during dry weather and maintained at below natural levels during periods of recharge. Flow may be reversed in the low areas of the Site, with a gradient from the river toward the excavation induced by the dewatering. 8 8

During construction, the more permeable zones of the aquifer will be grouted as necessary to control seepage into the excavation. After construction, groundwater levels are expected to return to natural levels except where construction has induced changes in the character of the aquifer, such as decreased aquifer permeabilities caused by the grouting of permeable zones, and increased permeabilities around the Plant Island where the natural aquifer material will be replaced by cohesionless backfill material.

QUESTION D17

Explain how the Tennessee Water Quality Criteria (5.1.2) for maximum temperature rise and maximum rate of change of water temperature are met in the vicinity of the discharge. In light of the fact that no provision is made in the Water Quality Criteria for a near field mixing zone, discuss agreements made with the Tennessee Water Quality Control Board regarding the mixing zone for the discharge. Include in the discussion precedents set for discharges from other thermal power plants in Tennessee. Discuss compliance with additional federal or state standards, if applicable, regarding volumes of water associated with discharge isotherms in the near and far field regions (5.1).

RESPONSE

The Tennessee Water Quality Criteria for Temperature are summarized below:

Max. ΔT = 3°C = (5.4°F)

Max. T = 30.5°C (86.9°F)

Max. $\frac{\Delta T}{\Delta t}$ = 2°C/hr (3.6°F/hr).

Within the near-field, the thermal plumes resulting from the CRBRP discharge mix sufficiently with ambient river water to achieve compliance with the above criteria for all cases of typical seasonal and hypothetical worst cases conditions examined.

Graphic depictions of the thermal plumes predicted from the physical model are presented for both typical seasonal and worst case mixing conditions in Figure 1 through 4 - Question D8. Only for the hypothetical worst case in winter are temperature rises above the maximum ΔT of 5.4 degrees F observed and this occurs only in the centerline of the discharge jet at

distances of <16 feet from the nozzle. As the State of Tennessee has recognized the validity of a reasonable mixing zone (see ER Section 14.1), compliance with the state criteria is anticipated even for this improbable mixing condition.

In Figures 5 through 8 - Question D8, the physical model results are superimposed upon Clinch River profiles. For all four mixing cases examined, compliance with the maximum ΔT (5.4°F), maximum T (86.9°F) and maximum $\Delta T/\Delta t$ (3.6°F/hr) of the State criteria is indicated.

Applicable governmental thermal standards in addition to the State of Tennessee General Water Quality Criteria include the determination of mixing zone size by the State and the EPA Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards (40 CFR 423). As discussed above, the identification of any reasonable mixing zone that exempts the small area directly in front of and close to the discharge nozzle itself will result in compliance of the CRBRP thermal discharge with the applicable State criteria. The EPA thermal standard specifies that the only permitted discharge of waste heat is via cold-side blow-down from a closed recirculating cooling system. The CRBRP is designed to be in compliance with this standard.

The thermal effluent monitoring program will be used to determine whether discharges from the CRBRP meet the Tennessee Water Quality Criteria for maximum temperature and maximum rate of change of water temperature. The temperature sensors upstream and downstream of the discharge will be scanned periodically, and these data will be observed and recorded to ensure compliance.

No general definitions for mixing zones have been formulated as the Tennessee Water Quality Control Board determines the mixing zones for thermal discharges on a case-by-case basis. As stated in the ER (Section 3.4.3) thermal effluent discharges will be made through a submerged single

port diffuser designed to meet the applicable thermal discharge limits. The project will obtain the concurrence of the Water Quality Control Board to assure compliance with all applicable state standards.

No precedents for mixing zone determination have been set for discharges from other Tennessee thermal power plants. The Tennessee Division of Water Quality Control has reviewed plans for thermal monitoring programs at TVA's John Sevier, Bull Run, Kingston, Gallatin, and Johnsonville Steam Plants.

To the best of our knowledge, there are no Federal or state standards applicable to the CRBRP regarding volumes of water associated with discharge isotherms.

QUESTION D18

Provide details regarding the final location of the intake structure, including its position relative to the shore, cross-sectional contour of the river bottom in the vicinity of the intake, location of bathymetric chart (Figure 2.5-5), and depth below minimum water level (3.4.2).

RESPONSE

The requested details of intake location are provided in Figures 1, 2 and 3 (Question D18).

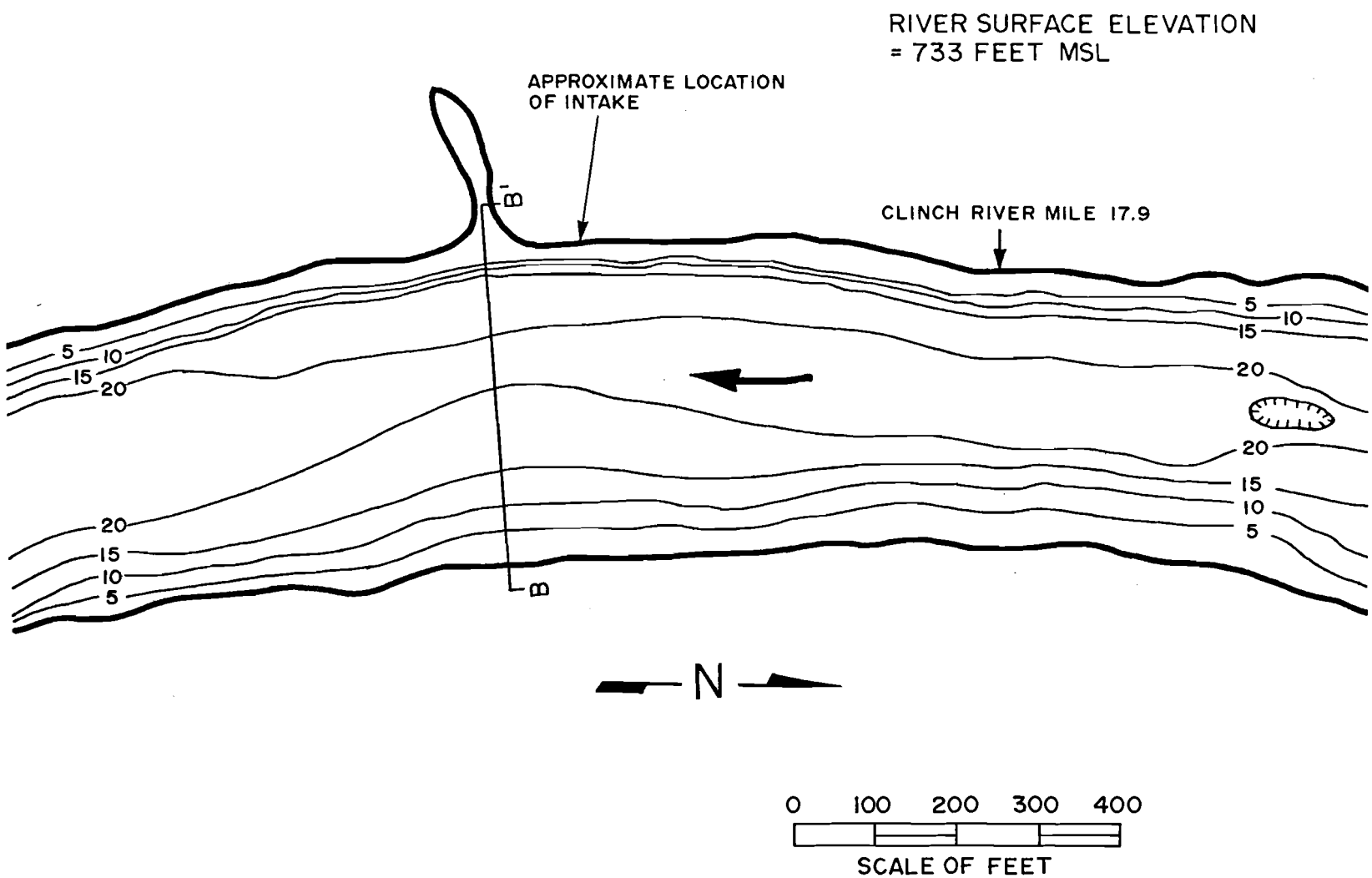


Figure 1 BATHYMETRIC CHART OF CLINCH RIVER IN THE VICINITY OF THE INTAKE
(Ques. D18)

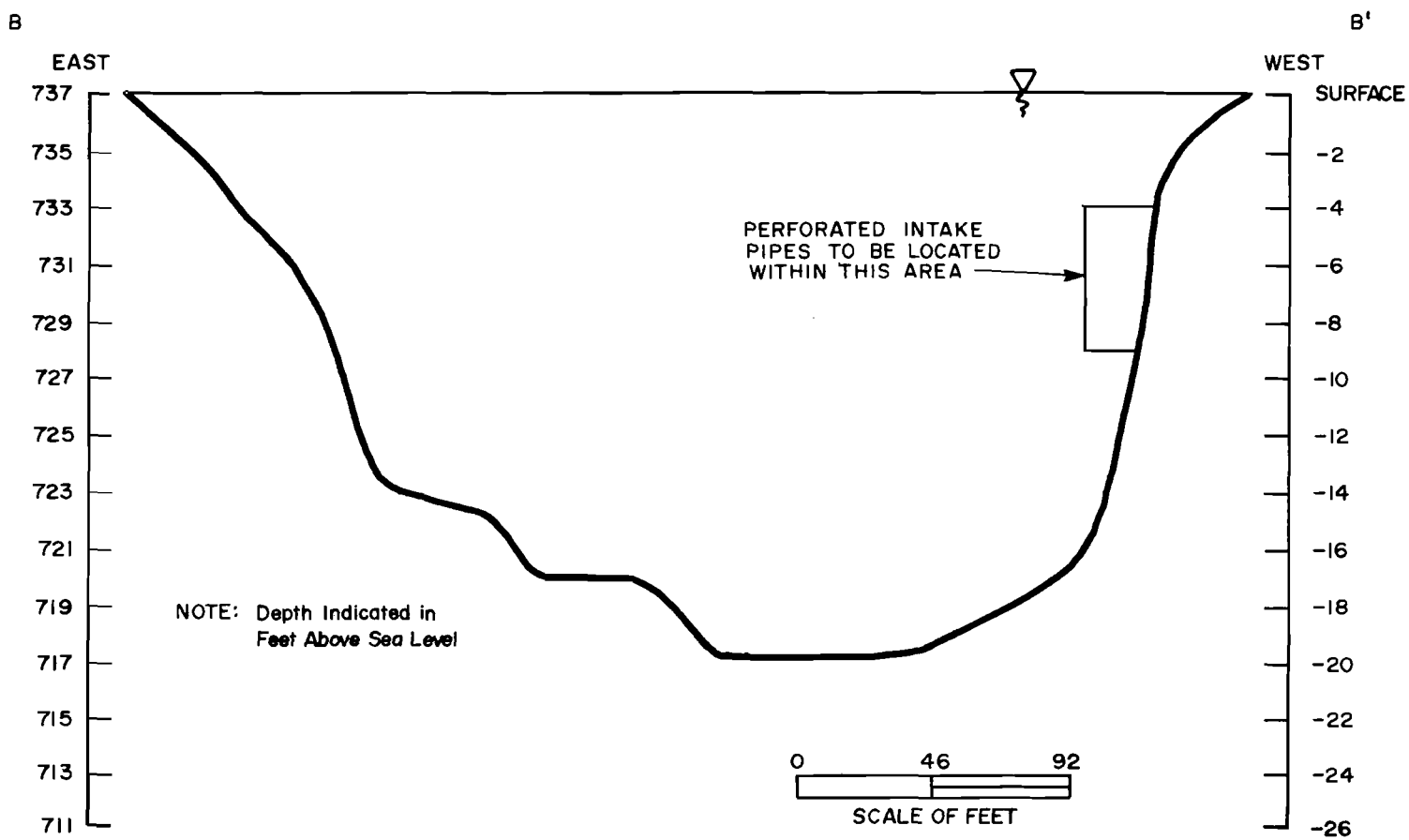


Figure 2 (Ques. D18) CROSS-SECTIONAL PROFILE OF CLINCH RIVER IN THE VICINITY OF THE INTAKE

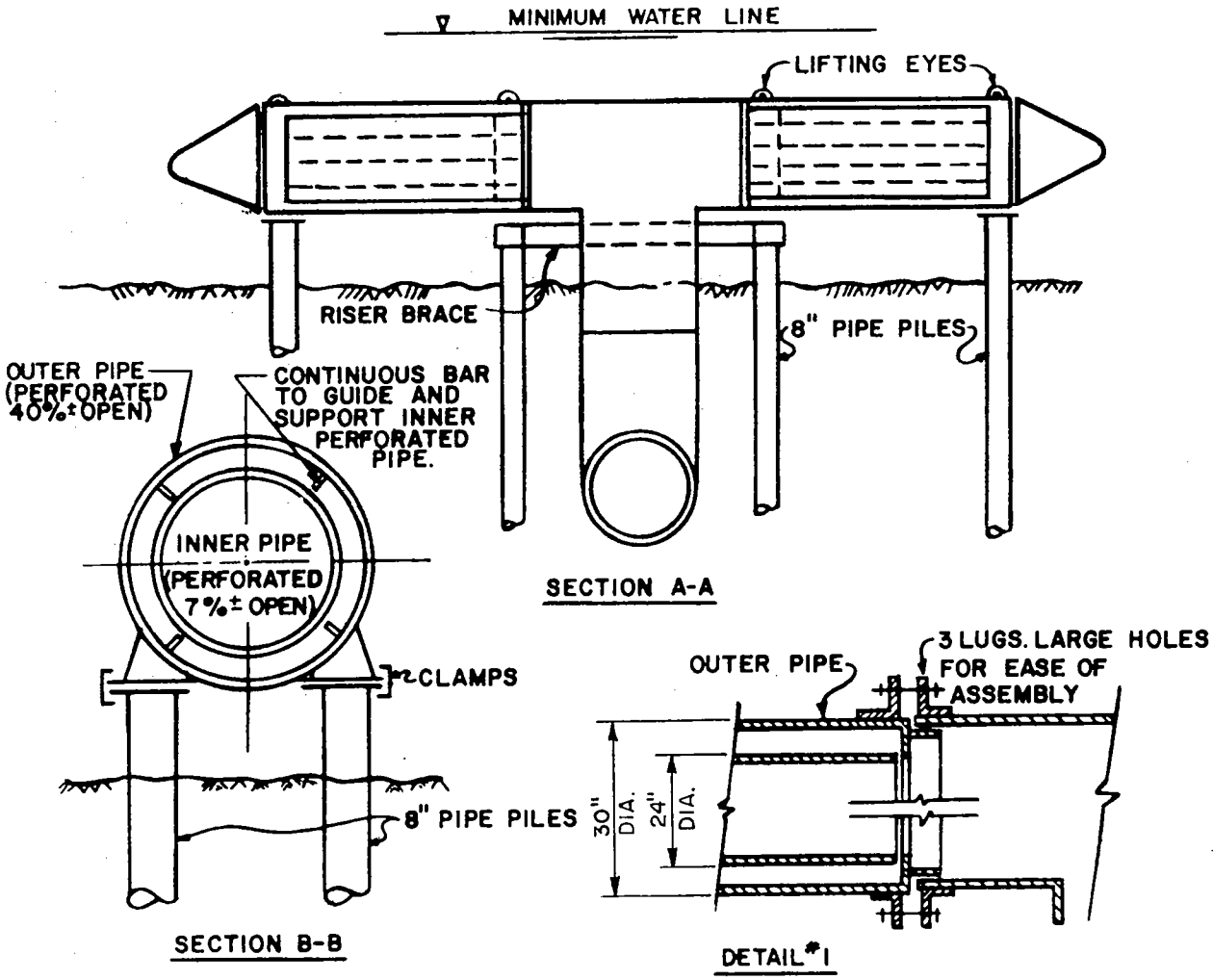


Figure 3 PERFORATED PIPE INLET SECTIONAL VIEW
(Ques. D18)

QUESTION D19

Provide additional details regarding location of the discharge, including its position relative to the shore, elevation of the outlet above the river bottom, location on bathymetric chart if final location differs from that in Figure 2.5-6, and cross-sectional contour of the river bottom in the vicinity of the discharge (3.4.3).

RESPONSE

This information is already contained in the ER (Sections 10.3 and 14.6) and is reproduced on the following pages as Figures 1 through 4 (Question D19).

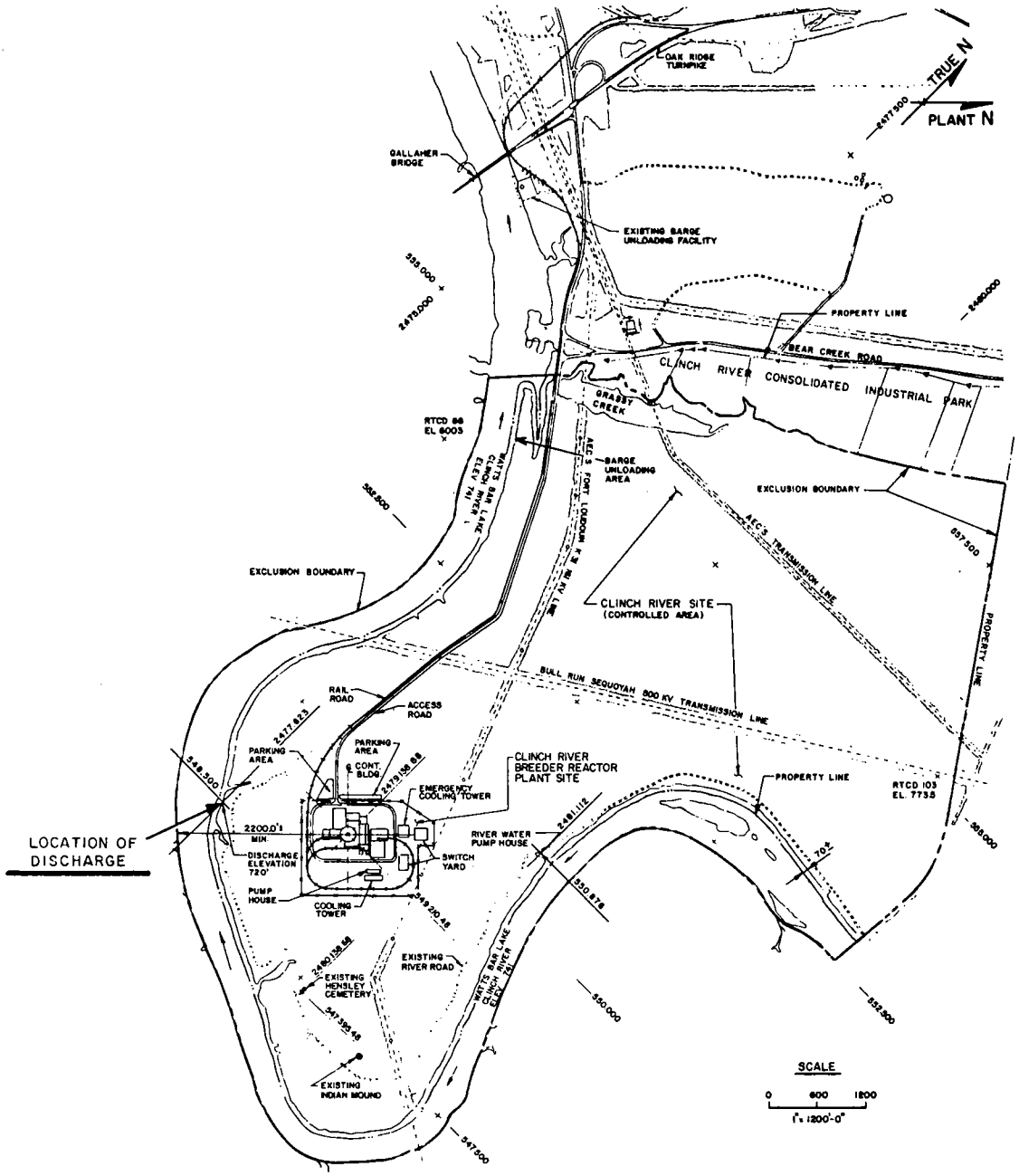


Figure 1 LOCATION OF CRBRP DISCHARGE
(Ques. D19)

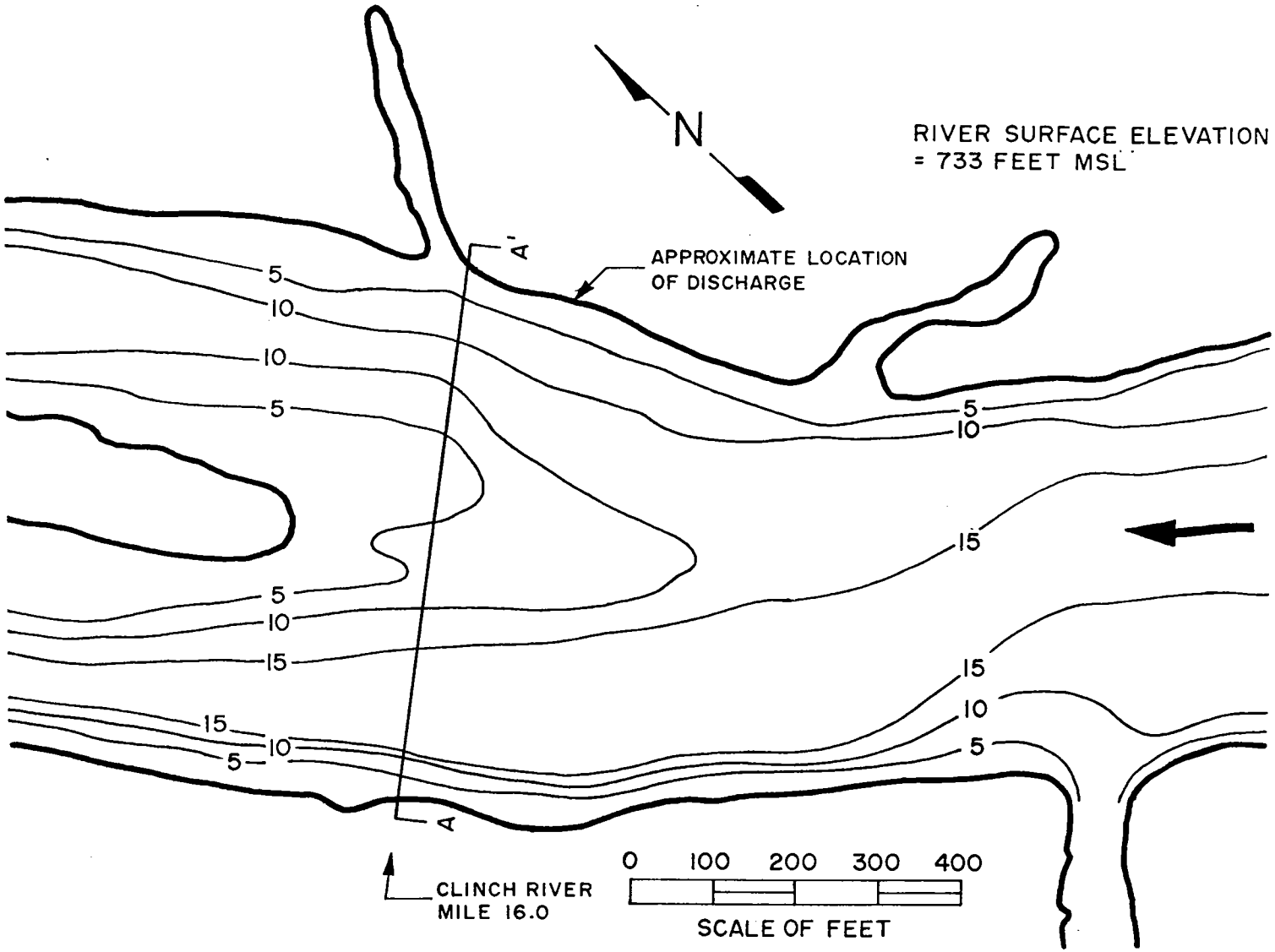


Figure 2 BATHYMETRIC CHART OF CLINCH RIVER IN THE VICINITY OF THE DISCHARGE (Ques. D19)

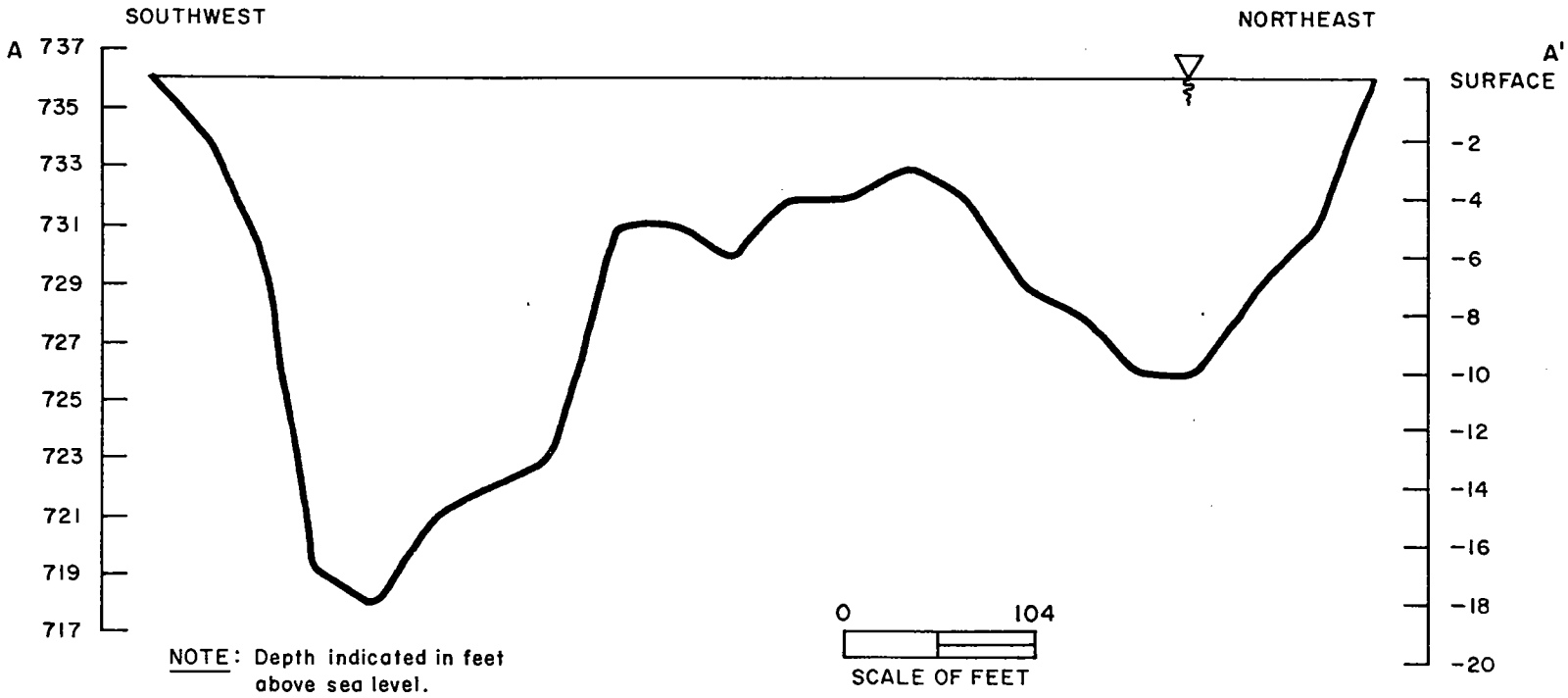
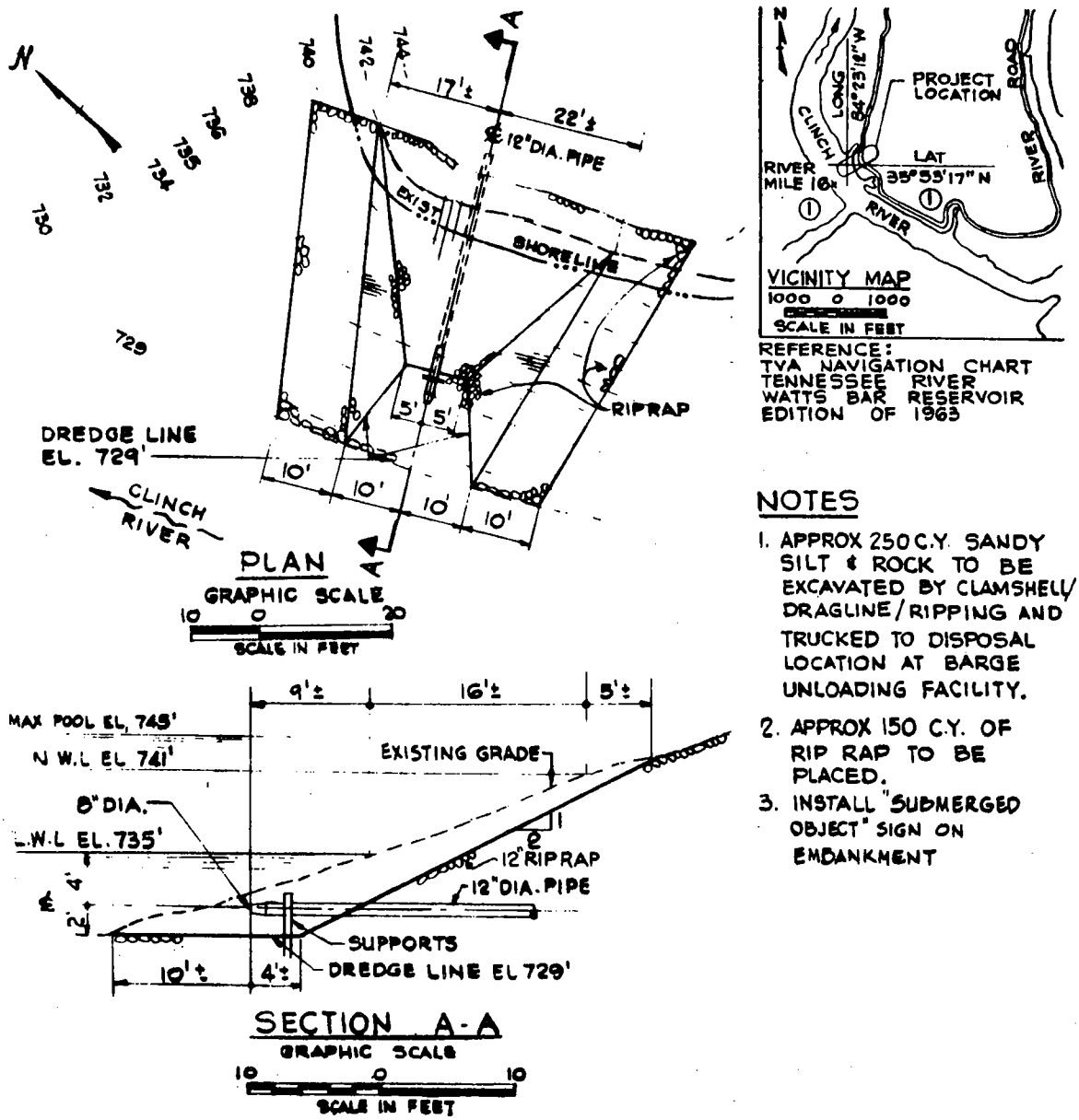


Figure 3 CROSS-SECTIONAL PROFILE OF CLINCH RIVER IN THE VICINITY OF THE DISCHARGE (Ques. D19)



NOTES

1. APPROX 250 C.Y. SANDY SILT & ROCK TO BE EXCAVATED BY CLAMSHELL/ DRAGLINE/RIPPING AND TRUCKED TO DISPOSAL LOCATION AT BARGE UNLOADING FACILITY.
2. APPROX 150 C.Y. OF RIP RAP TO BE PLACED.
3. INSTALL "SUBMERGED OBJECT" SIGN ON EMBANKMENT

7

Figure 4 SUBMERGED DISCHARGE
(Ques. D19)

QUESTION D20

Resolve the following discrepancy: The island shown in Figure 2.5-6 as extending above the river surface is referred to in subsection 5.1.1.1 as being submerged. Discuss river flow conditions for which the island extends above the river surface, if any. Correct the bathymetric chart (Figure 2.5-6).*

RESPONSE

The island shown in ER Figure 2.5-6 is a sand bar. Its degree of exposure above the water surface is a function of the Clinch River pool elevation which varies on a seasonal basis by as much as six feet. In the winter (pool elevation approximately 735 feet MSL) the sand bar is exposed such that it can be walked upon. In the summer (741 feet MSL) it is submerged with only the tops of the most prominent vegetation penetrating the water surface.

The Environmental Report, docketed on April 10, 1975, contains the reference pool elevation for the bathymetric chart.

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*This question was repeated in the NRC letter of April 23, 1975.

QUESTION D21

Resolve the following discrepancy: River water temperatures listed in Table 3.4-4 differ from those in Table 2.5-7. Clarify which temperatures are most applicable to the proposed site, and where they were measured in relation to the proposed site.

RESPONSE

Water temperature data in both Tables 2.5-7 and 2.4-4 are at the temperature station at the White Wing Bridge, Clinch River mile 21.6. Table 2.5-7 gives the average daily maximum and minimum temperatures for each month averaged over the period June 1963 through December 1971 while the maximum and minimum temperatures listed in Table 3.4-4 are extreme maximum and minimum temperatures for each month averaged over the period June 1963 through October 1972.

The discrepancies in the average temperatures are primarily because the figures on Table 2.5-7 are rounded to the nearest degree, while the figures in Table 3.4-4 covers a slightly longer period than the data in Table 2.5-7.

QUESTION D22

Cite additional evidence in support of the statement that no scouring effects are anticipated. Plume width growth may be rapid enough for possible entrainment of bottom material.

RESPONSE

Alluvial rivers are flows of not just water, but of water and sediment. Accordingly, the beds of these rivers are continually shifting, and generally are characterized by the migration of large dunes which move with the flow, and by shifts in the mean bed elevation. This is assuredly the case for the Clinch River in the vicinity of the CRBRP discharge for the larger flow velocities that occur there.

A disturbance in an alluvial stream, such as a bridge pier or a jet, modifies the local distributions of velocity and sediment discharge, by producing locally higher flow velocities and locally increased sediment transport capacity of the flow. However, after steady state conditions are reached the rate of sediment transport across a section downstream from the disturbance must equal that across a section upstream. What happens is that the bed elevation is reduced locally by scour, until the flow velocity near the bed and tractive force on it are reduced to the point that sediment is transported into and out of the affected area at equal rates.

The physical model described in response to Question D8b had an erodible bed composed of coarse sand. In each of the four cases studied, the dimensions of the bed disturbance produced were measured; the results, with the corresponding prototype dimensions shown, are presented in Figure 1 - Question D22. The depth of scour and the lateral dimensions of the scour hole are seen to be very modest. If finer bed material

had been used, the dimensions of the scoue hole would have been slightly larger. However, there is ample evidence, notable that obtained by Scimemi at Padua and Blaisdell at Minneapolis, that the equilibrium dimensions of scour holes are quite insensitive to sediment size, provided the flow is strong enough to produce an active state of sediment motion. If fine sand ($D \sim 0.1$ mm or smaller) had been used in the model, it is anticipated that the dimensions of the scour hole would have been affected by no more than a factor of two.

As the prototype ambient flow velocity changes, the plume will be shifted back and forth to produce a scour hole with roughly the shape of a truncated fan with a subtended angle of roughly 90 degrees to 100 degrees. The characteristic depth of this scour hole will be of the order of the depths shown in Figure 1 - Question D22. The radial extent will be comparable to those shown in the figure.

In summary, it may be stated that the proposed discharge structure for the CRBRP will produce only a localized scour hole of modest dimensions. After steady state conditions are reached the sediment transport character of the stream will be virtually the same with or without the jet-induced disturbance. The dimensions of the scour hole will be, no doubt, small in comparison to those of the dunes that migrate past the site, and the scour depth will be small in relation to the dune heights and to shifts in bed elevation that occur naturally.

The biological impacts associated with the small amount of scouring predicted are discussed in the Response to Question D8d.

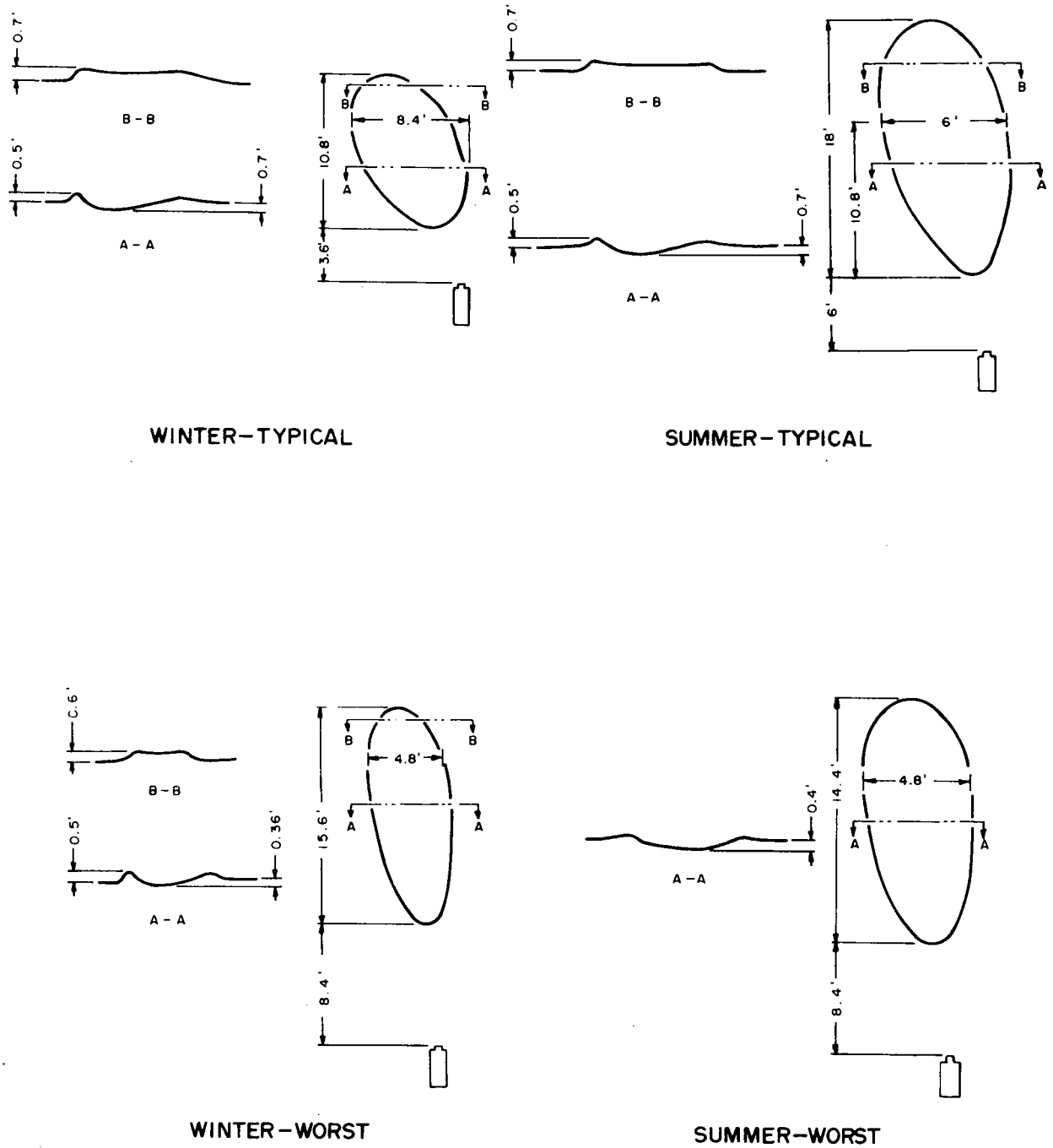

Figure 1 AREAS OF BOTTOM SCOURING
(Ques. D22)

QUESTION D23 (Letter of April 23, 1975: Parts a and b)

Provide the following additional information regarding discharge velocities and temperatures:

a. Provide additional evidence to justify considering only cooling tower blowdown in the discharge plume calculations.

b. Explain the assumptions on which the curve in Figure 3.4-4 is based, and estimate the error bounds on the slope.

c. Methods for computing the cooling tower blowdown temperature.

RESPONSE

Question D23a

The information requested is given in the Response to Question D11c.

Question D23b

The cooling tower blowdown has previously been shown to be a function of evaporation. The variation in cooling tower evaporation was estimated to be a 30 percent decrease in evaporation for a 40 degree F decrease in wet bulb temperature (from cooling tower vendor). The annual average evaporation was estimated to be 0.08 x cooling tower range (°F) = % of circulating water flow (also from cooling tower vendor). The annual average evaporation of 0.08 x 20 = 1.6%, .016 x 265,000 gpm - 4240 gpm was assumed to occur at the average wet bulb temperature of 52 degrees F and the change in evaporation with wet bulb given above was used to determine an exact operating curve. It also should be noted that the evaporation is bound at the maximum with 100 percent of the heat load dissipated by evaporation.

This would occur at about 75 degrees F wet bulb from the curve drawn with the above assumptions.

$$\dot{m}_{Max} = \frac{\dot{Q}}{\lambda} = \frac{2.65x10^{9}BTU/hr}{1050\ BTU/lb} = 2.523x10^{6}\ \frac{lb}{hr} = 5054\ gpm$$

This information, along with estimates for the drift, fixes the blowdown curve, the maximum blowdown curve and the maximum blowdown under normal operation at 3240 gpm.

If an error of ±10 percent on the evaporation curve is assumed, the blowdown curve would vary by ±6.73 since as was previously shown

$$B \approx \frac{E}{(NC-1)} = \frac{E}{1.5}\ .$$

This variation in blowdown, based on the maximum rate would be ±216 gpm; and variation based on the annual average blowdown of 2700 gpm would be ±180 gpm. This analysis shows the blowdown flow curve given is relatively insensitive. An exact error band on the curve is not currently available. However, an exact evaporation versus wet bulb curve can be provided by the vendors during the bid period after the cooling tower design is finalized and the specification sent out. This would allow an exact blowdown curve to be determined.

Question D23c

Cooling tower blowdown temperatures for the typical seasonal cases were determined from ER Table 3.4-4. For the winter case, the mean of the average blowdown temperatures for the months of January, February and March was used. The mean of the months of July, August and September was used for the typical summer case blowdown temperature.

Blowdown temperatures for the hypothetical worst cases were determined from ER Figure 3.4-2 utilizing the atmospheric wet-bulb temperatures

obtained from the Bull Run Steam Plant data set (see Table 1 - Question D8). In addition, the cooling influence of the makeup water flow to the cooling tower basin was accounted for in the final determination of discharge temperature. This resulted in a discharge temperature 1.2F degrees lower than the cold water temperature from ER Figure 3.4-2 for the winter case.

QUESTION D24

Provide the following additional details regarding the river bottom (2.5.1): a. Type of material (sand, rock, etc.) and estimated values of the Chezy and/or Manning Coefficients. b. Approximate composition (loose sand, rock) as a function of depth.

RESPONSE

Borings were made in the river bottom to evaluate foundation conditions at selected intake and discharge sites. Boring locations are shown on Figure 1 (Question D24). The geologic logs of the borings in and near the river are contained in a report submitted to Burns & Roe, Inc.[1] These borings indicated a thin (0-2 feet) layer of sandy, clayey silt overlying bedrock. Bedrock in these areas was limestone and siltstone. The type of bedrock in other areas can be determined from PSAR Figure No. 2.5-5.

Manning coefficients in the river adjacent to the Site were determined by TVA by calibrating an unsteady flow model to historical flows. The coefficients so determined were 0.022 at CRM 16.8, 0.024 at CRM 17.85 and 0.029 at CRM 18.9.

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(1) Report of Preliminary Foundation Investigation, Geotechnical Report Number 3, CRBRP, S.A.-679, Law Engineering, February 12, 1975.

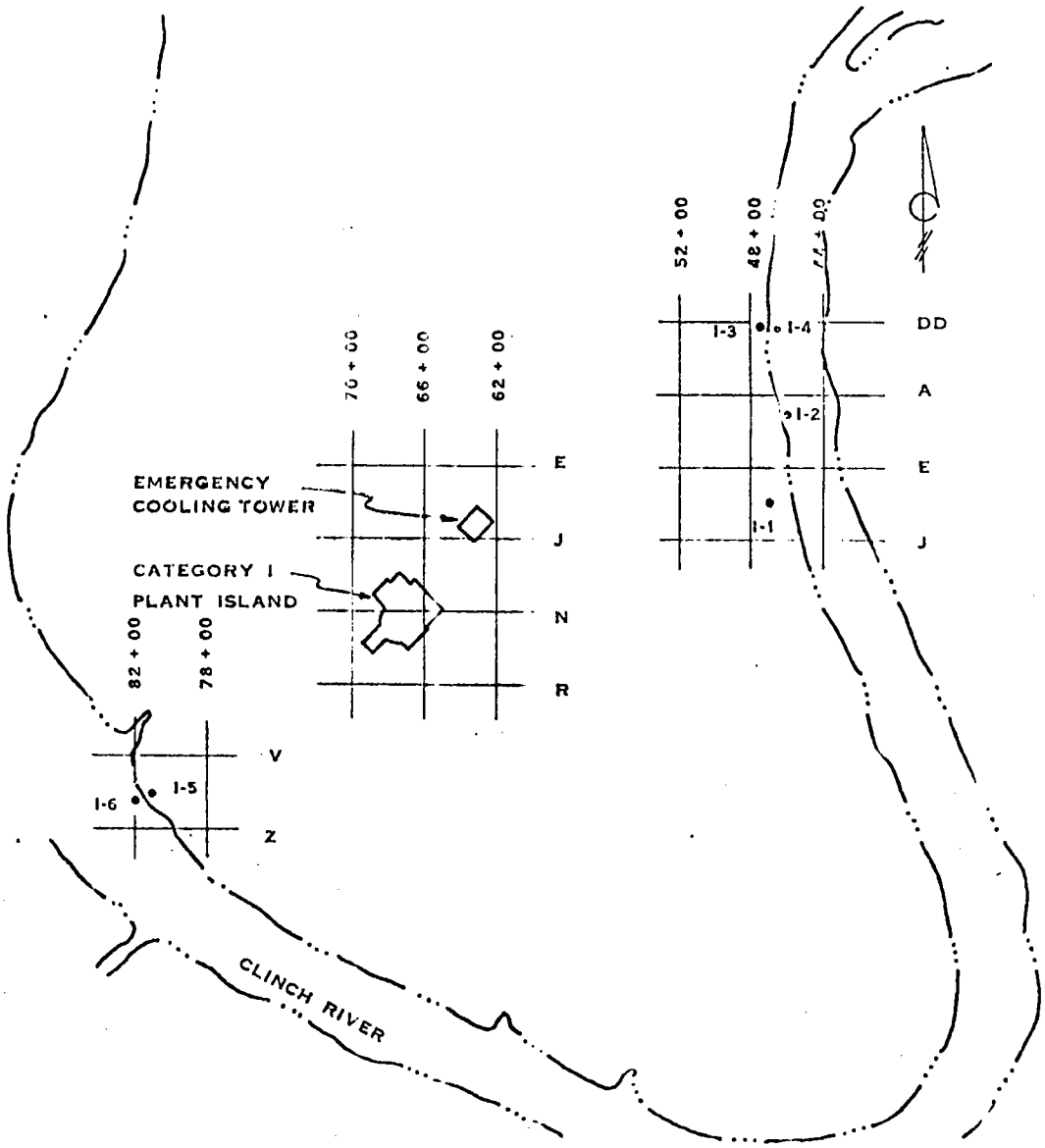

Figure 1 BORING LOCATIONS AT THE CRBRP SITE
(Ques. D24)

QUESTION D25

Provide the following information regarding the intake located at CRM 14.4, downstream of the discharge: possible effects of worst-case thermal and chemical plumes (for river no-flow as well as flow conditions on the river water in the vicinity of the intake, and the consequences of these effects for use of the water withdrawn at the intake 2.2.3.1, 5.1, 5.4).

RESPONSE

The intake located at Clinch River mile 14.4 provides the potable and service water requirements of the K25 facility of the ORNL Gas Diffusion operation. Water withdrawn for potable usage is treated via clarification, sand filtration and chlorination prior to distribution while service water is demineralized to ensure required quality.

Only for the improbable occurrence of an extended period (>10 days) of zero release from Melton Hill Dam during the summer months would any thermal influence of CRBRP operation be felt 1.5 miles downstream at the K25 intake. As a temperature elevation above ambient of less than 1.0F° would be experienced at K25 (see Figure A-3, Appendix 10.3A), no adverse impact on the potable water supply would be anticipated.

In regard to chemicals, a review and comparison of the U.S. Public Health Service drinking water (mandatory) limits of concentration as cited in ER Table 5.4-1 and the National Technical Advisory Committee recommended (permissible) surface water criteria for public water supplies (ER Table 5.4-2) with the CRBRP discharge chemical concentrations given in Table 1 (Question E1) and Clinch River ambient chemical concentrations listed in ER Table 5.4-5 will indicate the following:

1. The undiluted plant effluent conforms to the Public Health Service limits.

   a. Most of the constituents listed in ER Table 5.4-1 (arsenic, cadmium, chromium, cyanide, selenium and silver) are not present in the CRBRP discharge except as 2.5-fold concentrations of their ambient river levels which are below the limits of detection (see ER Table 5.4-5).

   b. Even the maximum concentration of lead expected to be present in the discharge (Table 1-Question E1) is below the mandatory limits.

2. A very modest dilution of 6-fold during the 1.5 mile travel of a CRBRP chemical plume from the discharge point to the K25 intake is sufficient to establish even a chemical plume containing the maximum concentrations of all constituents in Table 1 (Question E1) as a suitable public drinking water supply according to the National Technical Advisory Committee criteria (ER Table 5.4-2).

On the basis of these findings, it is concluded that conditions would not be anticipated under which the chemical discharges from the CRBRP could adversely affect the K25 water intake located at CRM 14.4.

QUESTION D26

Discuss whether plans for flow management of the river include any possibilities for changing flow conditions from those now maintained at the Site. If so, describe the possible changes in flow conditions, and the effects on the thermal and chemical plumes (2.5).

RESPONSE

There are no plans at this time for changing flow conditions from those now maintained at the Site.

QUESTION D27

Provide the daily temperatures upon which the monthly temperatures in Table 3.4-4 are based, including temperatures for both the river water and the cooling tower blowdown.

RESPONSE

The requested river temperature data have already been submitted. The cooling tower blowdown temperatures were computed from atmospheric wet-bulb data recorded at the Knoxville Airport; copy of this data is provided as Table 1 (Question D27).

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER, April 23, 1975

Provide the daily temperatures on which the monthly cooling tower blowdown temperatures in Table 3.4-4 are based. If wet-bulb atmospheric temperatures are given, also provide the necessary equations and/or graphs for converting the wet-bulb temperatures to cooling tower blowdown temperatures.

RESPONSE

A copy of the daily temperature records was forwarded to Battelle-Northwest on April 18, 1975 (WESD Letter, ESD-PMC-306, H. F. Herr to E. Christopherson).

TABLE 1--QUESTION D27

CLIMATOLOGICAL DATA

AVERAGE JANUARY DAY

KNOXVILLE DATA: 1/68-1/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	34.6	32.0	75.2		
04	33.6	31.2	77.8		
07	31.6	30.0	79.4		
10	34.8	32.2	74.8		
13	40.6	36.0	64.2		
16	43.2	37.4	61.0		
19	39.4	35.0	65.2		
22	36.6	33.4	71.0		
Avg.	36.8	33.4	71.1		

AVERAGE FEBRUARY DAY

KNOXVILLE DATA: 2/68-2/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	34.6	31.8	69.6		
04	33.2	30.2	72.6		
07	31.6	29.6	75.0		
10	36.2	32.6	68.2		
13	42.6	36.4	56.8		
16	45.4	37.8	50.8		
19	41.4	35.4	56.4		
22	37.8	33.2	63.6		
Avg.	37.9	33.4	64.1		

(Continued)

TABLE 1--QUESTION D27 (Continued)

AVERAGE MARCH DAY

KNOXVILLE DATA: 3/68-3/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	42.6	38.4	66.6		
04	40.4	37.0	71.6		
07	38.6	35.8	75.0		
10	43.8	39.4	66.6		
13	52.8	44.2	51.4		
16	55.2	45.2	46.6		
19	51.0	42.6	51.8		
22	46.0	40.4	60.6		
Avg.	46.3	40.4	61.3		

AVERAGE APRIL DAY

KNOXVILLE DATA: 4/68-4/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	54.4	49.2	69.4		
04	51.6	47.6	74.2		
07	50.4	47.0	76.6		
10	59.2	52.2	61.8		
13	66.0	55.0	50.2		
16	69.0	56.0	46.6		
19	65.2	54.2	50.2		
22	58.6	51.2	60.8		
Avg.	59.3	51.6	61.2		

(Continued)

TABLE 1--QUESTION D27 (Continued)

AVERAGE MAY DAY

KNOXVILLE DATA: 5/68-5/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	60.8	56.2	75.0		
04	58.0	54.4	80.8		
07	58.2	55.0	80.8		
10	67.4	59.8	63.4		
13	73.4	61.6	52.4		
16	74.8	61.4	47.6		
19	71.4	60.6	53.8		
22	64.4	57.8	67.0		
Avg.	66.1	58.4	65.1		

AVERAGE JUNE DAY

KNOXVILLE DATA: 6/68-6/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	67.6	64.2	83.4		
04	65.2	63.0	87.6		
07	65.6	63.0	85.8		
10	74.8	67.6	69.4		
13	80.2	69.4	57.8		
16	81.2	69.0	55.2		
19	78.0	68.2	61.6		
22	71.2	66.2	77.2		
Avg.	73.0	66.3	72.3		

(Continued)

TABLE 1--QUESTION D27 (Continued)

AVERAGE JULY DAY

KNOXVILLE DATA: 7/68-7/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	71.4	68.4	85.0		
04	69.4	67.4	89.6		
07	69.4	67.2	89.0		
10	77.8	70.8	72.8		
13	82.8	72.4	61.2		
16	83.8	72.0	57.6		
19	80.4	71.2	65.0		
22	74.2	69.6	78.6		
Avg.	76.2	69.9	74.9		

AVERAGE AUGUST DAY

KNOXVILLE DATA: 8/68-8/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	70.6	67.8	86.6		
04	68.4	66.8	90.8		
07	67.4	66.2	91.2		
10	76.4	70.6	73.6		
13	82.8	72.4	60.0		
16	83.6	71.6	56.6		
19	80.0	71.2	65.4		
22	73.8	69.2	80.0		
Avg.	75.4	69.5	75.5		

(Continued)

TABLE 1--QUESTION D27 (Continued)

AVERAGE SEPTEMBER DAY

KNOXVILLE DATA: 9/68-9/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	66.4	63.8	86.6		
04	64.2	62.6	90.6		
07	63.0	61.6	91.6		
10	71.0	65.6	75.6		
13	78.2	68.2	61.2		
16	79.2	68.2	56.8		
19	74.2	66.6	67.8		
22	68.6	64.8	80.6		
Avg.	70.6	65.2	76.4		

AVERAGE OCTOBER DAY

KNOXVILLE DATA: 10/68-10/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	55.6	53.0	84.4		
04	53.4	51.2	87.2		
07	52.0	50.4	88.6		
10	59.4	54.8	75.6		
13	67.2	58.4	60.0		
16	69.6	59.0	52.8		
19	63.4	57.0	68.0		
22	58.4	54.4	79.0		
Avg.	59.9	54.8	74.5		

(Continued)

TABLE 1--QUESTION D27 (Continued)

AVERAGE NOVEMBER DAY

KNOXVILLE DATA: 11/68-11/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	44.2	41.2	77.0		
04	42.6	39.6	79.2		
07	41.2	38.4	81.2		
10	46.4	42.4	72.0		
13	53.2	46.2	58.2		
16	55.2	46.6	54.8		
19	49.4	44.2	65.2		
22	45.8	41.8	72.4		
Avg.	47.3	42.6	70.0		

AVERAGE DECEMBER DAY

KNOXVILLE DATA: 12/68-12/72

Time (hr)	Dry Bulb Temp. (°F)	Wet Bulb Temp. (°F)	Relative Humidity (%)	Wind Speed (mph)	Prevailing Direction (deg)
01	40.4	37.2	75.0		
04	39.2	36.4	77.2		
07	38.2	35.8	78.0		
10	41.4	38.2	73.6		
13	47.0	41.6	63.4		
16	48.8	42.4	59.8		
19	44.2	39.6	67.6		
22	41.8	38.4	72.6		
Avg.	42.6	38.7	70.9		

QUESTION E1

Provide, in tabular form, a complete characterization of the water discharged to the Clinch River as wastewater or blowdown. Include pounds of chemical discharged per year, in-plant source of chemical, frequency of discharge, average and maximum concentrations which will be discharged, background concentration of chemical in the Clinch River, concentration of the chemical in the river prior to discharge, percent increase in concentration in the river caused by discharges from the CRBRP. Include chemicals and waste from water and wastewater treatment processes (BOD, SS, DS, NH_3-N), cooling water biocide treatment (free residual and combined residual chlorine), ion exchange resin regeneration, machinery room drains (oil and grease), and routine plant cleaning operations. Explain methods used to determine the concentrations of the chemicals in the river after waste discharge.

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER OF APRIL 23, 1975

Complete the response by expanding the table (Item E1) to account for condenser tubing erosion/corrosion release; such as copper, nickel, zinc, tin and arsenic that may be discharged in the plant blowdown. State assumptions and methods used to determine the concentrations and annual mass discharges expected.

RESPONSE

The requested table (including condenser tube corrosion products) is provided as Table 1-Question E1. Percent increases in concentration in the river caused by chemical discharges and methods used to determine

the concentrations in the river are presented in the Response to Question D8c. The heavy metals copper, iron, lead, manganese and zinc are associated with 90-10 CuNi condenser tubes, Alloy 706. Concentrations given in Table 1-Question E1 are based on maximum percent composition in the alloy. A literature survey determined the estimated corrosion/erosion rates. In general, wastage rates occurring in surface condenser tubes under service conditions similar to those expected for CRBRP are much less than 1 mil per year. Therefore, average concentrations are conservatively taken to result from 0.2 mil per year wastage and maximum concentrations are based on 1 mil per year. Further conservatism is added by using a manufacturers' correlation for metal concentrations that assumes uniform wastage. Mass discharges and concentrations are based on annual average full power blowdown rate of 2210 gpm. Average values are based on a capacity factor of 68.5%; maximum values are based on a capacity factor of 80.2%. 6

TABLE 1--QUESTION E1

CHARACTERIZATION OF WATER DISCHARGED TO CLINCH RIVER

	Clinch River (Background)*		CRBRP Waste Streams					Discharge to River		
			Cooling Tower Blowdown**		Neutralized Plant Wastes+		Sanitary Wastes	Annual Quantity++	Concentration∇	
	Avg. Conc. (mg/l)	Max. Conc. (mg/l)	Based on Avg. River Conc. (mg/l)	Based on Max. River Conc. (mg/l)	Based on Avg. Discharge -3.7 gpm (mg/l)	Based on Max. Discharge -35 gpm (mg/l)	Based on the Design Loading (mg/l)	(10^4 lbs/yr)	Average (mg/l)	Maximum (mg/l)
Total Alkalinity (as $CaCO_3$)	96	116	240	290	<50	<50	--	NA	239	286
Ammonia Nitrogen (as N)	0.28	1.00	0.70	2.50	--	--	0.5	0.47	0.70	2.50
BOD	2.1	6.0	5.3	15.0	--	--	12	3.5	5.3	15.0
Calcium	34	43	85	108	224	96	--	57	85	108
Chloride	4.7	13.0	11.8	32.5	43	21	--	7.8	11.8	32.3
Chlorine Residual	--∇∇	--∇∇	0.2	0.5	--	--	1	0.1	0.2	0.5
COD	6.7	16.0	16.8	40.0	--	--	25	11.2	16.8	40.0
Copper †	<0.005	<0.01	0.20	0.93	--	--	--	0.13	0.20	0.93
Total Dissolved Solids (TDS)	142	174	355	435	13,738	11,920	--	249	377	614
Total Iron †	0.38	0.68	0.95	1.72	--	--	--	0.63	0.95	1.72
Lead	<0.03	<0.03	<0.03	<0.03	--	--	--	<0.01	<0.03	<0.03
Magnesium	7.8	8.5	19.5	21.3	75	32	--	13.0	19.6	21.4
Manganese †	0.05	0.07	0.13	0.18	1	0.4	--	0.09	0.13	0.18
Nickel †	<0.01	<0.01	0.02	0.11	--	--	--	0.01	0.02	0.11
Nitrate (NO_3)	1.3	2.2	3.3	5.5	3.2	1	66	2.3	3.4	5.6
pH	7.9	8.3	7.9	7.9	6.5 - 8.5	6.5 - 8.5	6-9	NA	6.5-8.5	6.5-8.5
Total Phosphate	0.05	0.4	0.13	1.00	1	0.4	5	0.10	0.14	1.00
Potassium	1.4	1.9	3.5	4.8	15	7	--	2.3	3.5	4.8
Silica (SiO_2)	3.9	6.1	9.8	15.3	27	12	--	6.5	9.8	15.3
Sodium	2.1	2.5	5.3	6.3	5,800	7,900	--	12.1	15.0	129
Sulfate (SO_4)	15	23	38	58	7,500	3,800	--	29.4	50	116
Total Suspended Solids (TSS)	13	46	33	115	<30	<30	5	21.9	33	114
Zinc †	0.02	0.03	0.05	0.08	--	--	--	0.03	0.05	0.08

*Based on the Aquatic Baseline Monitoring Program chemical data

**Includes several minor recycled waste streams (Make-Up Water System equipment rinses, backwashes and blowdown; non-radioactive floor drains). These do not measureably affect the Cooling Tower Blowdown Chemical Concentrations.

+Includes Make-Up Water Demineralizer and Steam Condensate Polisher regeneration wastes, Auxiliary Boiler blowdown and Non-Radioactive Lab and Sampling wastes

++Computed as follows: Quantity from Cooling Tower Blowdown = (Avg. Conc.) (Annual Avg. Blowdown = 2,210 gpm) (Plant Load Factor = 68.5%)
Quantity from Neutralized Plant Wastes = (Conc.) (Flow = 35 gpm) (24 hr/day operation) (26 operating days/yr)
Quantity from Sanitary Wastes = (Conc.) (Flow = 5 gpm) (24 hr/day operation) (365 operating days/yr)

∇ $\frac{\Sigma \text{ (Conc.) (Flow)}}{\Sigma \text{ (Flow)}}$, where Avg. Conc. is based on average river conc. (cooling tower blowdown) and average discharge flow (neutralized plant wastes) and Max. Conc. is based on max. river conc. and max. discharge flow.

∇∇Field measurements using the orthotolidine calorimetric method repeatedly showed the chlorine residual concentration to be below the limits of detection (<0.05 mg/l). As there are no nearby sources of chlorine additions to the river, it can be assumed that the ambient level is zero.

†Includes contribution to effluent quantities from condenser erosion/corrosion

QUESTION E2

Describe the analytical techniques which will be used to determine free residual and combined residual chlorine concentrations.

RESPONSE

The Amperometric Titration method will be employed as the primary standard to determine free and combined residual chlorine concentrations. This method is described in detail beginning on Page 112 of "Standard Methods for the Examination of Water and Wastewater", thirteenth edition, (1971).

QUESTION E3

Provide data on chlorine demand in Clinch River water. Include seasonal variations.

RESPONSE

Aquatic baseline data for chlorine demand in the Clinch River was collected in March and September. On both sampling dates the one hour chlorine demand, as described in "Standard Methods" on page 144 (Appendix 1, Question E3) was <0.5 mg/liter. This level of demand was at the lower limits of resolution of the analysis method. TVA sampled chlorine demand at Clinch River Mile 17.9 on May 8, 1973 and reported a value for a 1/2 hour chlorine demand of 0.2 mg/liter. Chlorine demand in the Clinch River in the area of the Site does not appear to vary seasonally.

APPENDIX 1 TO QUESTION E3

Excerpt from "Standard Methods for the Examination of Water and Wastewater," American Public Health Association, Washington, D. C., 1971, pp 144-146.

115 CHLORINE DEMAND

The chlorine demand of a water is caused by such inorganic reductants as ferrous, manganous, nitrite, sulfide and sulfite ions. Ammonia and cyanide consume considerable chlorine during the free residual chlorination process. Chlorine substitutes on phenols and other similar aromatic compounds to form chloro derivative compounds, but may also oxidize the aromatic compounds when larger amounts of chlorine are added. It may also react with ammonia and naturally occurring amino compounds to form chloramines with an active or oxidizing chlorine atom. The destruction of the chloramine compounds can be achieved by the addition of more chlorine and subsequently, with the addition of enough chlorine, a free available residual (hypochlorous acid or hypochlorite) may be attained.

The chlorine demand of water is the difference between the amount of chlorine applied to a treated supply and the amount of free, combined or total available chlorine remaining at the end of the contact period. The chlorine demand of any given water varies with the amount of chlorine applied, time of contact, pH, and temperature. For comparative purposes it is imperative that *all test conditions be stated.* The smallest amount of residual chlorine considered significant is 0.1 mg/l Cl. Presented here are a method for laboratory use and a field procedure which gives less exact results.

115 A. Laboratory Method

1. Discussion

The laboratory method is designed to determine the so-called immediate demand as well as other demands at longer contact periods. Chlorine demand determinations are made to determine the amount of chlorine that must be applied to a water to produce a specific free, combined, or total available chlorine residual after a selected period of contact. If the amount of chlorine applied to waters containing ammonium or organic nitrogen compounds is not sufficient to reach what is termed the "breakpoint," chloramines and certain other chloro derivatives which react as combined available residual chlorine are produced. When

sufficient chlorine has been added to reach the breakpoint, which depends on pH, ratio of chlorine to nitrogenous compounds present, and other factors, subsequent additions of chlorine remain in the free available state.

2. Apparatus

COLORIMETRIC EQUIPMENT—One of the following is required:

a. Spectrophotometer or filter photometer, for use in the wavelength range of 400–490 mμ and providing a light path of 1 cm or longer.

b. Comparator, color- and turbidity-compensating.

c. French square bottles, capacity 1 or 2 oz.

3. Reagents

a. Standard chlorine solution: A suitable solution may be obtained from the chlorinator solution hose or by bubbling chlorine gas through distilled or tap water. The stability of the chlorine solution may be improved by storing in the dark or in brown glass-stoppered bottles. Even so, it will lose strength and must be standardized each day that it is used. Alternatively, household hypochlorite solution, which contains about 30,000–50,000 mg/l chlorine equivalent, may be diluted to suitable strength. This is more stable than a chlorine solution, but should not be used more than a week without restandardizing. The solution used for determining chlorine demand should preferably be the same kind of chlorine solution as is actually applied in plant treatment. The preparation of temporary standards for calibrating a photometer entails the fewest problems with hypochlorite. Depending on the intended use, a suitable strength of chlorine solution will usually be between 100 mg/l and 1,000 mg/l. If used for chlorine demand determination, it should be sufficiently strong that the volume of treated portions will not be increased more than 5% by addition of the chlorine solution.

STANDARDIZATION: Place 2 ml acetic acid and 10 to 25 ml distilled water in a flask. Add about 1 g potassium iodide, estimated on a spatula or small spoon, after prior familiarization with the quantity by several weighings. Measure into the flask a suitable volume of the chlorine solution. In choosing a convenient volume, note that 1 ml of 0.025*N* thiosulfate titrant to be used for titrating is equivalent to about 0.9 mg chlorine.

Titrate with standardized 0.025*N* sodium thiosulfate titrant until the yellow iodine color is almost gone. Add 1 to 2 ml starch indicator solution and continue the titration to disappearance of the blue color.

Determine the blank by adding identical quantities of acid, KI, and starch indicator to a volume of distilled water corresponding to the sample used for titration.

$$\text{mg/ml Cl} = \frac{(A \pm B) \times N \times 35.45}{\text{ml sample}}$$

where A = ml titration for sample, B = ml titration for blank which may be positive or negative, and N = normality of $Na_2S_2O_3$.

b. Acetic acid, conc (glacial).

c. Potassium iodide crystals.

d. Standard sodium thiosulfate titrant, 0.025*N:* Prepare as directed in Residual Chlorine, Section 114A.2d preceding.

e. Starch indicator solution: Prepare as directed in Residual Chlorine, Section 114A.2e preceding.

f. Orthotolidine reagent: Prepare as

directed in Residual Chlorine, Section 114C. 3c.

g. Sodium arsenite solution: Prepare as directed in Residual Chlorine, Section 114D. 3b.

4. Procedure

a. Volume of sample: Measure at least 10 equal portions of the sample, preferably into brown glass-stoppered bottles or erlenmeyer flasks of ample capacity to permit mixing. If the object of the test is to determine chlorine demand, measure 200-ml portions; if it is to relate chlorine demand to bacterial removal, the effect on taste and odor, or the chemical constituents of the water, use portions of 500 ml or more. Properly sterilize all glassware for bacteriologic investigation.

b. Addition of chlorine water: Add an amount of chlorine to the first portion which leaves no chlorine residual at the end of the contact period, especially if low demands are being studied. Add increasing amounts of chlorine to the successive portions in the series. Increase the dosage between portions in increments of 0.1 mg/l for determining low demands, and up to 1.0 mg/l or more for higher demands. Mix while the chlorine solution is being added to the sample. Dose the portions of the sample according to a staggered schedule that will permit the determination of chlorine residuals at the predetermined contact time.

c. Contact time: The usual purpose of a chlorine demand test is to determine the amount of chlorine required to produce a specific free, combined or total available chlorine residual after a definite time interval which may vary from a few minutes to many hours. To this end, carry out the test over the desired contact period. If the objective of the test is to duplicate in the laboratory the temperature and the plant contact time, make several preliminary chlorine determinations during different reaction periods, such as 15, 30, and 60 min, in order to ascertain the chlorine consumption with respect to time —information which can be valuable in treatment plant control. Record the contact time. Protect the chlorinated samples from strong daylight throughout the test.

d. Examination of samples: At the end of the contact period, determine the free and the combined available residual chlorine by the OTA test—Section 114D—or other adequate test on a small aliquot from each portion. Plot the residual chlorine or the amount consumed versus the dosage to aid in studying the results. If necessary, remove samples for bacteriologic examination at desired intervals.

e. Taste and odor: Observe the taste and odor of the treated samples at ordinary temperatures with or without dechlorination. For odor observation at elevated temperatures, dechlorinate the samples before heating. Choose the dechlorinating agent with due regard to its effect on the odor in the water under examination. Generally, sodium sulfite is satisfactory if only a slight stoichiometric excess is used.

QUESTION E4

Identify the purpose of the raw water intake near the boat landing location during our site visit of January 21 and provide information on the volume of water withdrawn per day, the type of treatment provided, and the ultimate use of the treated water.

RESPONSE

The water intake located on the north bank of the Clinch River at (approximately) CRM 14.5 is used by the Oak Ridge Gaseous Diffusion Plant (ORGDP) for sanitary and potable purposes. Approximately four million gallons per day are pumped from the Clinch River to a nearby treatment plant, processed through a sand filtration unit, chlorinated and distributed to ORGDP.

QUESTION E5

Discuss any alternative plans for controlling Asiatic clams in the spring and fall (3.5.2) in view of the new EPA regulations (Steam Electric Generating Point Source Category: Effluent Guidelines and Standards, Federal Register, October 8, 1974) allowing discharge of free available or total residual chlorine for no more than 2 hrs/day. The new regulations do not allow continuous chlorination except under a condition of undetectable free available and total residual chlorine in the blowdown (<0.005 mg/l total residual chlorine).

RESPONSE

It is possible that clams might start growing on the inner or outer surfaces of the perforated pipes and inner sleeves and in the main lead-in pipes.

Provisions are being made in the design of perforated pipes to unbolt them and bring them to the surface for disassembly and cleaning if clams or algae are adhering to the outer or inner surfaces.

In addition, provisions are being made for equipment and piping needed to inject chlorine into the space between the outer perforated pipe and the inner sleeve, should it become necessary to do so. The chlorinated water will travel through the internal sleeve into the main inlet pipe and the pump structure. Interlocks are provided to ensure that the chemical feed pump can operate only when the river water pump is taking suction from the inlet pipe so that chlorination will occur only when the perforated pipe inlets are in service. This chlorination is expected to prevent the Asiatic Clams from entering the Circulating Water System.

The chlorinated water from the riverwater pumphouse is then diluted with the circulating water. Because of the dilution in the Circulating Water System and dissipation of chlorine by organic material, the total residual chlorine content may be reduced below the EPA limit of 0.005 mg/l in the blowdown being returned to the river.

QUESTION E6

State the duration of blowdown flow stoppages and their daily frequencies (5.1.7).

RESPONSE

When blowdown is stopped because of excessive residual chlorine concentration, it is estimated that the duration of such blowdown flow stoppage will be 20 to 30 minutes. The estimated frequency of blowdown flow stoppage is up to four times a day. Actual operating experience will determine frequency and duration of flow stoppages.

QUESTION E7

Estimate the length of time which will be required to regenerate ion exchange resins.

RESPONSE

Three to five hours per unit is the expected time required for regeneration of ion exchange resins, depending on unit being regenerated.

QUESTION E8

Explicitly discuss sodium disposal methods.

RESPONSE

The project has considered two potential alternatives for sodium disposal for the small quantities of sodium wastes associated with the CRBRP.

One method is the inert carrier process. This process was demonstrated at the United Technology Center at Coyote, California. Attendance at the demonstration included representatives of Atomics International, the AEC and the Power Reactor Development Corporation. The demonstration, held in December 1974 involved a process in which sodium is heated under normal paraffin hydrocarbons (NPH) to the melting point of sodium. Agitation is then applied and this results in the formation of fine (5 mil diameter) sodium particles. The suspension is then chilled, solidified and kept in suspension. The paraffin suspension is then pumped to a chamber in which a controlled reaction with water results in the formation of NaOH in solid salt form. The NaOH is reduced to a crystal form suitable for burial.

The other method is expected to utilize existing CRBRP cleaning, liquid radwaste and solid radwaste systems. Sodium would be reacted with controlled amounts of water (moist gas) with the resulting liquid evaporated and the NaOH evaporator bottoms solidified into cement suitable for burial.

The Project, therefore, has at least two alternatives from which to develop its sodium disposal method. The first method is a proprietary process with United Technology ready to provide the system. Representatives of the Power Reactor Dev. Corp. have expressed interest in the United Technology concept regarding utilization in the decommissioning of the

Fermi reactor. If so utilized, the process will have a firm base of experience for assessment by the CRBRP project.

The second method is believed to be a feasible approach that will be utilized with other CRBRP solid radwaste such as evaporator bottoms.

The Clinch River Breeder Reactor Project will also be utilizing, as appropriate, FFTF related research and development efforts at the Hanford Engineering and Development Laboratory concerning the packaging, transporting and deposition of sodium bearing wastes.

The Project will evaluate such alternatives and other developing technologies before a firm decision on specific sodium disposal methods is made. Methods chosen will be consistent with the solid radwaste system design objectives of meeting applicable DOT and CFR regulations and release of no radioactivity to the environment.

QUESTION E9

State individual heavy metal and pesticide concentrations in the river near the Site. Include PCB in bottom sediments. Discuss the adequacy of determining baseline conditions from one-time sampling for those materials at single station (pp. 2.7-52 and 2.7-53).

RESPONSE

Heavy metal and pesticide concentrations in the river near the Site were sampled in March and September and are shown in Table 1 (Question E9) (Table 2.7-38 from Section 2.7.2 of the ER). PCB values in bottom sediments were determined from samples collected in April during the baseline survey. Results of sample analyses are discussed in ER Section 2.7.2.3.19. 6

Baseline conditions for the heavy metals and pesticide concentrations were determined twice during the sampling program. The two samplings of these parameters occurred six months apart so that seasonal variations would be apparent. Results of sample analysis in Section 2.7.2 of the ER and Table 1 (Question E9) indicate that levels of these substances were low and that concentrations of these substances varied little during the sampling period.

TABLE 1--QUESTION E9

ADDITIONAL CHEMICAL ANALYSIS* - CLINCH RIVER

COLLECTED MARCH 26 AND SEPTEMBER 24, 1974

Date	March 26		September 24
Location	Transect 4 Station 3		Transect 4 Station 3
Parameter**			
Chlorine demand	< 0.5		< 0.5
Fluoride	< 0.1		0.18
Nitrogen gas	16.9		14.9
Silicate	7.7		2.2
Calcium	24.0		43.0
Magnesium	7.0		8.5
Molybdenum	< 0.03		< 0.03
Selenium	< 0.01		< 0.01
Tin	< 0.2		< 1
Aluminum	3.32		< 0.1
Manganese	0.07		0.02
Zinc	0.03		0.02
Copper	< 0.005		< 0.01
Mercury (ppb)	< 4		< 1
Silver	< 0.01		< 0.01
Arsenic	< 0.03		< 0.03
Cadmium	< 0.004		< 0.004
Chromium	< 0.01		< 0.01
Lead	< 0.03		< 0.03
Nickel	< 0.01		< 0.01
Cobalt	< 0.01		< 0.01
Iron (total)	0.68		0.08
Organic compounds			
Cyanide	< 0.005		< 0.005
Detergents-surfactants (MBAS)	< 0.01		0.1
Oil and grease (solvent extraction)	2.75		1.8
Phthalate esters++	< 0.01	< 0.00001	< 0.00001

(Continued)

TABLE 1--QUESTION E9 (Continued)

Date	March 26		September 24
Location	Transect 4 Station 3		Transect 4 Station 3
Parameter**			
Pesticides++			
Organochlorines (insecticides)			
BHC - total	< 0.001	< 0.00001	< 0.00001
Heptaepoxide	< 0.001	< 0.00001	< 0.00001
Dieldrin	< 0.001	< 0.00001	< 0.00001
DDE	< 0.001	< 0.00001	< 0.00001
DDD	< 0.001	< 0.00001	< 0.00001
DDT - total	< 0.001	< 0.00001	< 0.00001
Atrazine (herbicide)	< 0.01	< 0.00001	< 0.00001
2-4-D (herbicide)	< 0.01	< 0.0001	0.06

*Water samples were collected one foot below the water surface.

**All values are expressed in parts per million (ppm) unless indicated otherwise.

+This analysis was based on a water sample taken one foot below the water surface on May 29, 1974.

++Duplicate samples for phthalate esters and pesticide analyses were taken on September 24, 1974.

QUESTION E10

Describe, in detail, the ultimate disposal techniques which will be used for solid wastes from process water treatment, chemical waste treatment, and sanitary waste treatment.*

RESPONSE

The solid wastes from the CRBRP will be comprised of spent resins from process water demineralizers, sludge and settled solids from the chemical waste treatment system, and sludge from the sewage treatment plant, in addition to the normal amounts of garbage. All of the waste will be non-radioactive in nature, so no special handling is expected.

The non-radioactive solid waste generated at the CRBRP will be disposed of in either:

a. A sanitary landfill located on TVA land and operated by TVA in accordance with EPA guidelines; or

b. A state approved sanitary landfill on non-TVA land under supervision of a municipality, county, or private contractor.

Economics will determine whether TVA or a private contractor operates the collection and disposal systems. Adequate storage facilities, based on a minimum garbage collection frequency of twice a week, will be provided. Transport will be in a closed vehicle or container regardless of which method is utilized. The service provided will be continually monitored by the owner to assure conformance to applicable Federal and State regulations.

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*This question was repeated in the NRC Letter of April 23, 1975.

QUESTION F1

Justify using an escalation rate of 3.5 percent and a discount rate of 8 percent in deriving the present value of the CRBRP payroll and induced payroll (Tables 8.2-4 and 8.2-5).

RESPONSE

The current project cost estimate is based on an eight percent escalation rate. The costs described in the report are based on a previous cost estimate. The report will be revised in Amendment II to reflect the current project cost estimate.

QUESTION F2

Provide a breakdown of cost categories by year for the duration of the project that supports the total investment of $1,478,500,000 (8.3.1).

RESPONSE

Amendment VI to the Environmental Report contains the current total project cost estimate of $1,950,400,000 (plant investment of $1,361,000,000, plus $525,000,000 for development costs and $64,400,000 for operating costs). A breakdown of cost categories by year is given in Table 8.3-1. 7

QUESTION F3

Indicate which category the 735 workers in Table 8.3-3 fit into in Table 8.2-2 and provide a discussion of the supply and demand situation for the other 1375 (2050-735) workers.

RESPONSE

The referenced Table 8.3-3 on worker supply and demand is not included in the revised socio-economic analysis submitted in Amendment VI.

Selection of construction under migration rates are discussed in Section 8.3.2.1, Appendix C, and Section 4.3 of Reference 1 to Appendix C. 7

PURPOSELY BLANK

QUESTION F4

Provide a discussion of the increased local public sector services required by the primary and secondary work influx, their cost (if possible), and an estimate of the degree to which these costs will be offset by various tax or other revenues from the Project.

RESPONSE

Section 8, "Economic and Social Effects of Plant Construction and Operation", has been revised and a new Appendix C has been added in Amendment VI to quantify the increased local public sector Services that will be required by the CRBRP construction and operation. In addition, a fiscal analysis has been done to estimate the degree to which financial costs will be provided by Project related revenues. To facilitate this revised analysis, WESD utilized several computer analysis tools for modeling of CRBRP socio-economic effects. 7

Both the CRBRP and the land upon which it is situated will be owned by the Federal Government. Because of this, federal school impact aid from PL 81-874 will be received by the local governments providing school services to Project-connected pupils. However, the tax exempt status of the CRBRP Project and the available mechanisms for providing in lieu of taxes prevent, at this time, any recourse to quantitative means of measuring the amount of such payments to local governments. 4

In lieu of tax payments which might be made to local areas would be from ERDA. Presently the authority and provisions for payments by ERDA are contained in Section 168 of the Atomic Energy Act of 1954, as amended and the Atomic Energy Community Act of 1955, as amended. In addition, an amendment to the ERDA Authorization Bill presently before Congress would

provide authority for ERDA to consider the situation of Roane and Anderson Counties within the criteria set out in the Community Act. With their emphasis on just and reasonable determinations, neither statute prescribes a formula analogous to the specific procedures in Public Law 81-874 or Section 13 of the TVA Act. A discussion of these ERDA acts and how they have and may affect ERDA payments to Roane and Anderson Counties and the City of Oak Ridge are included at the end of this response.

At some future time, TVA may pay for and take permanent custody of the CRBRP and thereafter own and operate it as part of its power system. At such time, under the provisions of the TVA Act, TVA would make payments associated with the CRBRP to the State in lieu of taxes on its power properties and operations. A discussion of the CRBRP and TVA payments in lieu of taxes is included at the end of this reponse.

ERDA'S AUTHORITY IN THE FIELD OF PAYMENT IN LIEU OF TAXES AND FINANCIAL ASSISTANCE

5

Section 168 of the Atomic Energy Act of 1954, As Amended

Section 168 of the Atomic Energy Act of 1954, as amended, authorizes ERDA in its discretion to make payments in lieu of taxes to local governments on property acquired by the Commission (now ERDA), but requires ERDA to be guided by the policy of not making payments in excess of the taxes which would have been payable on such property in the condition in which it was acquired except in cases where <u>special burdens</u> are cast upon the local government because of activities of ERDA or its agents. In any case, <u>any benefit</u> accruing to the local government by reason of such activities shall be considered in determining the amount of the payment.

The preliminary qualifications of Section 168 should be noted, namely, that ERDA's authority under this statute reaches only those entities where ERDA activities are carried on and where ERDA has acquired property previously subject to taxation.

Due to the fact that the nature and extent of burdens and benefits will vary greatly at the various localities in which ERDA facilities are located, making it extremely difficult to devise specific criteria for uniform application, ERDA has not attempted to establish a set of specific factors for use in a determination whether activities of ERDA benefit or burden a local government to the exclusion of all other factors.

For purposes of Section 168, the phrase "ERDA activities" is intended to mean not just the activities within a plant site but the effect of ERDA and contractor employees and their families upon the local entity with respect to its revenues and expenditures. In the same context, burdens are generally considered to be costs of services and of capital improvements, loss of revenues through Federal acquisition of property, loss of Federal and State funds, and other factors on which reasonable dollar values can be placed, to the extent that such circumstances can be related to ERDA activities. However, the Section 168 reference to special burdens is taken to mean a burden that is unusual, substantial, or something beyond normal. Benefits, on the other hand, may take such forms as increases in revenues from local taxes or charges, Federal or State funds, reduction in expenditures or costs, provision of services or facilities directly by a Federal agency, as such may be related to the ERDA activities.

In any analysis of burdens and benefits, primary consideration would be given to the measurable burdens and benefits, although intangible burdens or benefits ought to be considered if they are substantial to a determination whether the entity is suffering a special burden, or is the recipient of a benefit. Whatever method may be used to identify and evaluate burdens and benefits, it is important that the association between the burdens and benefits cast upon the entity and the ERDA activities be a direct relationship, preferably a causative one.

"In Lieu" Tax Payments to Anderson and Roane Counties

ERDA makes payments in lieu of taxes to Anderson and Roane Counties under Section 168 of the Atomic Energy Act of 1954, as amended. Neither county has been eligible for assistance under the Atomic Energy Community Act which is specifically limited to Oak Ridge, Los Alamos, and Richland, the three former AEC communities.

In making the Section 168 payments, ERDA followed the statutory guidelines of not exceeding the taxes which would have been payable on the property in the condition it was acquired (i.e., exclusive of the Government investments since acquisition). Such payments are made only for the land remaining in ERDA's custody. As the counties have increased their tax rates and improved their assessment procedures, the "tax loss" payments to each county have risen from $15,000 to about $60,000 - $70,000 annually. These payments are based on valuations of ERDA land that are reasonably comparable to the assessments on private property in each county. The transfer of ~100 acres by TVA to ERDA for the CRBRP Project will result in a slight increase (<$1,000) in the tax loss payment to Roane County.

As discussed above, payments in excess of "tax loss" are also authorized by Section 168; but only in cases where special burdens have been cast upon the local entities by the activities of ERDA. In such cases, any benefits accruing to the local entity by reason of such activities also shall be considered in determining the amount of the payment. Both Anderson and Roane requested payments on the order of $1,000,000 annually on a general basis that burdens exceeded benefits. Anderson County's request for additional assistance was supported by a study, which the Atomic Energy Commission concluded did not constitute an adequate basis for arriving at a judgement as to whether additional Section 168 payments should or should not be made. Consequently, the AEC engaged the University of Tennessee to undertake a study of the impact of AEC activities upon Anderson and Roane, to ascertain the factual circumstances of burdens and benefits to assist the AEC in making an appropriate determination

under Section 168. The University (UT) undertook the study in February 1972 and completed it in June 1973. On December 10, 1973, Anderson County submitted a supplemental study which analyzed the UT study. It was the County's belief that the UT study corroborated the County's original request for $1,000,000 in additional payments. The Commission, however, concluded that none of the studies constituted an adequate basis for determining "special burdens" within the meaning of Section 168. Even though unable to find the condition for assistance stated in Section 168, the Commission concluded that on more general grounds the two local governments were faced with peculiar fiscal problems by reason of the location of the AEC operations and its employees within their boundaries.

It reasoned that in some ways their situations were similar to that of the City of Oak Ridge which was carved out of the two counties and which does receive substantial financial assistance under Section 91 of the Atomic Energy Community Act of 1955, as amended. Based on this similarity, the Commission concluded that equitable considerations would suggest payments to Anderson and Roane Counties in FY 1975 for $250,000 and $295,000, respectively. Sponsored by the Joint Committee on Atomic Energy, assistance to the two counties for FY 1975 was authorized and appropriated in the foregoing amounts by the Congress and approved by the President. These amounts were derived on the basis of the number of AEC-connected employees living in the counties outside of Oak Ridge and the AEC assistance paid to the City of Oak Ridge, with allowance for payments received by the counties in the form of AEC "tax loss" payments, AEC contractor "use taxes" and PL 874 school aid. Payments to the two counties were made in October, 1974.

Following a hearing in Oak Ridge in May 1975 by its Subcommittee on Communities, the JCAE recommended favorable Congressional action to amend the Atomic Energy Community Act to include Anderson and Roane Counties. Legislative text, providing for such an amendment, is included in the ERDA Authorization Bill presently before the Congress. Should this feature become law, it would provide authority to ERDA to consider the situation

of the two counties within the criteria set out in the Community Act. Although obviously it is too early to predict what payment might result under such authorization, the legislative history, as well as action by the Congress, in providing for payments of the sum specified above during fiscal year 1975 could be expected to bear on ERDA's determination.

Financial Assistance to the City of Oak Ridge

The City of Oak Ridge receives financial assistance from the Energy Research and Development Administration under the provisions of the Atomic Energy Community Act of 1955. Payments have been made for every one of the last 14-1/2 fiscal years, from FY 1960 through FY 1975, totaling $25,042,522. The assistance determination for FY 1976 amounts to $1,936,556, or about 18 percent of the City-Schools combined revenues. Assistance payments under the present agreement with the City will, in all likelihood, continue through FY 1979. ERDA authority to make assistance payments under present arrangements terminates on June 30, 1979. Payments after that date would need to be authorized on a year-to-year basis.

The financial assistance relationship between ERDA and the City is embodied in an agreement that was negotiated between AEC and the City. The agreement includes a formula that normally determines the amount of the assistance but supplementing the formula are (1) a few specific safeguards to protect ERDA from inequitable City actions, and (2) a general provision authorizing assistance payments in excess of the formula on the basis of justification offered by the City and acceptable to ERDA. Since its adoption in 1965, the formula has determined the annual assistance, but the avenue to increased assistance is set forth in the agreement and is available to the City. The formula provides that the City will receive a base amount of $1,252,000, which is to be adjusted up or down in the same proportion that the current tax rate exceeds or is less than a base rate of $1.24 per $100 assessed valuation on a 100 percent basis.

An important aspect of the agreement is the ERDA guarantee of the annual assistance determined to be necessary whether the appropriation is sufficient or not.

The theory behind the formula is that both the taxpayers and ERDA will share in cost increases or decreases as the tax rate changes. The objectives of this arrangement are to avoid the uncertainties of annual negotiations over the amount of ERDA payments and to support and encourage City financial planning. This planning must include the development and use of all reasonable, available means in achieving financial self-sufficiency so that the ERDA assistance may be reduced or terminated as envisioned by the Community Act. The Congress inserted this self-sufficiency objective in 1967 when it extended the authority to continue the assistance program.

The extent to which the City finds it necessary to respond to ERDA program impacts by increases in the tax rate will, under the formula, provide for increases in the financial assistance. Increases in the assistance beyond the formula computation are provided for in the agreement when in ERDA's judgement additional assistance is required to maintain school and other municipal services at a level which will not impede the recruitment or retention of personnel essential to the atomic energy program. Nevertheless the agreements' underlying premise and the City's own budgetary and financial management emphasizes the development and application, in a reasonable manner, of all other revenue sources which in turn should assure that increases in the tax rate and the ERDA assistance are based on sound municipal economics.

Beginning in FY 1971, the assistance has been funded from two sources: the AEC appropriation and Federal school aid from the Department of Health, Education and Welfare under Public Law 81-874 (school impact funds). However, ERDA remains responsible for the entire amount of assistance determined to be required, but reduces the total amount by the Federal school aid received from DHEW. In FY 1976, for example, ERDA

will finance the assistance determination of $1,936,556 less whatever amount the City receives in DHEW school aid, estimated to be $550,000 approximately.

THE CLINCH RIVER BREEDER REACTOR PROJECT AND TVA PAYMENTS IN LIEU OF TAXES

Under the provisions of Section 13 of the TVA Act, TVA makes payments to states and counties in lieu of taxes on its power properties and operations even though it is not subject to taxation in the usual sense by state or local governments. Payments to the states represent five percent of TVA's gross proceeds from power sales to customers other than federal agencies. The total in lieu of tax payment each year is divided among the states--one-half on the basis of the value of power property held by TVA within each state, and one-half on the basis of TVA's gross proceeds from power sales within the state. Payments are made directly to counties in replacement of ad valorem taxes formerly levied on (1) property operated for power purposes at the time of its acquisition by TVA and used by TVA as such thereafter, and (2) the portion of reservoir lands related to federally constructed dams operated by TVA and allocable to power. Such payments to a county are deducted from the payment otherwise due to the State.

The Clinch River Breeder Reactor Project will not involve acquisition of any power properties subject to state or local ad valorem taxation. The site selected for the CRBRP Demonstration Plant is a government-owned tract of land and the Demonstration Plant itself will consist entirely of new construction. Consequently, the development and operation of the Demonstration Plant will not furnish a basis for any payments by TVA directly to Roane County, Tennessee, in which county the Demonstration Plant will be located.

The CRBRP Demonstration Plant is a cooperative research and developmental venture financed by both the utility industry generally (including private and publicly owned utilities) and by federal agencies. Under

these circumstances, the Demonstration Plant will not initially constitute a part of the TVA power system. TVA may, however, at some future time pay for, and take permanent custody of, the Demonstration Plant and thereafter own and operate it as part of its power system. At such time the Demonstration Plant would be considered to be "power property" for purposes of dividing TVA's total in lieu of tax payment among the states. (As previously noted, one-half of this payment is divided on the basis of value of power property held by TVA within each state.) TVA's total payment to the State of Tennessee should at that time increase because the total value of power property held by TVA within the State of Tennessee would be increased by an amount equal to the value of the Demonstration Plant.

Each state is free to redistribute all or part of TVA's in lieu of tax payment to it among counties, cities and other local governmental units if it so desires. The State of Tennessee, in administering its redistribution statute, makes payments to both municipalities and counties on the basis of two particular types of property--power property purchased and operated by TVA, and reservoir lands which have been taken off the tax rolls and are allocated wholly or partly to power by TVA. The State of Tennessee normally includes land sites for TVA generating plants (other than hydroelectric plants) located within the state among those properties considered in determining the redistribution payments. In so doing, the state considers only the purchase cost (acquisition cost) of such land sites in their unimproved condition. In the event TVA acquires ownership of the Demonstration Plant it will be the responsibility of appropriate state officials to determine whether the site for the CRBRP Demonstration Plant will be treated, for purposes of administering the state's redistribution statute, in the same manner as a site for a TVA generating plant or in some other manner. Accordingly, whether Roane County will share in the redistribution by the state of TVA's total in lieu of tax payment to the state will be determined by the state.

QUESTION F5

Provide a basis for the assumption that the maximum number of construction workers originating from outside the Knoxville labor area will be 20 percent of 2050, or 410 workers.

RESPONSE

The estimate of the maximum number of CRBRP construction workers (craftsmen and non-manual) thought to in-migrate into the study area was based on TVA's experience. A series of surveys of construction workers have been taken at each of five TVA power plant construction sites (1-9), all since 1968, and from the compiled data construction worker migration rates can be projected. Because regional competition for labor is somewhat uncertain due to forecasts being based on some projects still in their initial planning stages, two migration rates are analyzed: (1) the rate for the CRBRP Project by itself and (2) that for the CRBRP Project in combination with other major projects in the immediate labor market. 7

Maximum migration rates into the study area occur under the second assumption, that of major local project competition. In accordance with this assumption, studies of TVA's proposed Hartsville Nuclear Plant[10,11] along with TVA's past experience were considered. Migration rates of between 50 percent to 60 percent (depending on wage differential considerations) were found for an employment peak of 5,400 in a rural isolated area 45 miles from Nashville. The combined employment level (including the CRBRP) in the Knoxville area might reach 4,000 to 4,500 based on present plants. If this case occurs, the overall construction migration rate for the CRBRP is estimated to be 40 percent or 951 workers. This overall rate is the result of combining a craftsman rate of 35 percent and a nonmanuals rate of 70 percent. For additional information on migration rates see Section 1.3 of reference 12.

REFERENCES

1. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Browns Ferry Nuclear Plant Construction Employment Impact, July 1973, Knoxville, Tennessee, May 1974.

2. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Sequoyah Nuclear Plant Construction Employment Impact, July 1972, Knoxville, Tennessee, May 1973.

3. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Sequoyah Nuclear Plant Construction Employment Impact, August 1974, Knoxville, Tennessee, December 1974.

4. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Cumberland Steam Plant Construction Employment Impact, May 1971, Knoxville, Tennessee, August 1971.

5. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Cumberland Steam Plant Construction Employment Impact, April 1973, Knoxville, Tennessee, July 1973.

6. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Estimated Employment Impact of the Watts Bar Nuclear Steam Plant, Knoxville, Tennessee, January 1971, revised September 1972.

7. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Watts Bar Nuclear Plant Construction Employment Impact, March 1973, Knoxville, Tennessee, July 1973.

8. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Watts Bar Nuclear Plant Construction Employment Impact, July 1974, Knoxville, Tennessee, November 1974.

9. Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Regional Planning Staff, Bellefonte Nuclear Plant Construction Employment Impact, April 1975, Knoxville, Tennessee, November 1975.

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10. Tennessee Valley Authority, Final Environmental Statement, Hartsville Nuclear Plants, Volume 1, 1975.

11. University of Tennessee, Department of Economics, Labor Force Study for the Mid-Cumberland and Upper Cumberland Development Districts, Knoxville, Tennessee, 15 August 1975. 7

12. Socioeconomic Impact Assessment of CRBRP Construction and Operation, Westinghouse Electric Corporation, Environmental Systems Department, April 1976.

QUESTION F6

What interest rate was assumed in discounting costs in Table 9.2-5 to 1972 dollars?

RESPONSE

The costs shown in Table 9.2-5 have not been discounted.

QUESTION F7

Provide annual costs (current dollars) for each of the summed and discounted cost factors for Table 9.2-5.

RESPONSE

Table 1 provides a summary of the economic comparison of LMFBR Demonstration Plant alternatives. The comparison did not include interest during construction and was made in total current dollars. A cash flow analysis was not performed except for the operating cost items during the demonstration period (Table 2). As shown in Table 1, an escalation allowance of 30 percent was used to estimate the total project cost.

TABLE 1--QUESTION F7

SUMMARY OF ECONOMIC COMPARISON OF LMFBR DEMONSTRATION PLANT ALTERNATIVES

	(Millions of 1972 Dollars)		
	Clinch River	Widows Creek	John Sevier
A. PLANT COST[1]			
Site Development[2]	20.8	--	--
Nuclear Plant (NSSI)[3]	227.5	227.5	225.8
Turbine Plant	46.2	--	--
Hook-on	--	31.9	37.7
Cooling Facilities	4.5	--	--
Switchyard	2.7	--	--
Subtotal (1972 $)	301.7	259.4	263.5
	Base	(42.3)	(38.2)
B. FIVE-YEAR DEMONSTRATION PERIOD OPERATING COST			
Nuclear Fuel Fabrication[3,4]	47.0	47.0	41.0
Fuel Oil	--	--	12.8
Non-Fuel O&M	27.7	26.5	25.8
Subtotal	74.7	73.5	79.6
Potential Power Credit @ 3.5 Mills	(30.7)	(28.8)	(29.2)
Net Operating Cost (1972 $)	44.0	44.7	50.4
	Base	+0.7	+6.4

(Continued)

TABLE 1--QUESTION F7 (Continued)

	(Millions of 1972 Dollars) Clinch River	Widows Creek	John Sevier
C. OTHER PROJECT COST			
Project Management	24.2	Same	Same
Contract Services	17.2	Same	Same
Property Insurance	21.0	Same	Same
Supporting R&D	130.3	Same	Same
Other ERDA Cost	?	Same	Same
Subtotal (1972 $)	192.7+	Same	Same
D. PROJECT COST			
A + B + C (1972 $)	538.4+	496.8+	506.6+
Escalation Allowance @ 30%	161.5	149.0	152.0
	699.9+	645.8+	658.6+
	Base	(54.1)	(41.3)

1. Plant Cost estimates include normal overhead and appropriate contingencies for each part of the plant estimate, but do not include interest during construction.
2. Site development costs for John Sevier and Widows Creek are small and included in the hook-on cost estimate.
3. Based on estimates from proposals submitted to PMC by the reactor manufacturers.
4. Nuclear fuel fabrication cost does not include the cost of other fuel cycle materials and services that will be provided by ERDA; the difference in cost indicated is due to the smaller reactor size at John Sevier.

TABLE 2--QUESTION F7

COSTS MILLIONS OF 1972 DOLLARS

	Clinch River (361 MWe)		Widows Creek (342 MWe)		John Sevier (346 MWe)		
Year	Non Fuel O & M	Power Credit	Non Fuel O & M	Power Credit	Non Fuel O & M	Power Credit	Fuel Oil
1972	.36		.34		.33		
1973	.32		.31		.30		
1974	.39		.37		.36		
1975	.75		.72		.70		
1976	1.57		1.51		1.47		
1977	1.70		1.63		1.59		
1978	2.34		2.24		2.19		
1979	2.66		2.55		2.48		
1980	2.78	1.35	2.66	1.00	2.60	1.07	.45
1981	2.89	2.77	2.76	2.62	2.70	2.65	1.16
1982	2.95	4.43	2.82	4.20	2.75	4.25	1.87
1983	2.98	5.54	2.86	5.25	2.79	5.31	2.33
1984	3.00	8.31	2.87	7.87	2.80	7.96	3.49
1985	3.01	8.31	2.88	7.87	2.81	7.96	3.49
TOTAL	27.70	30.71	26.52	28.81	25.87	29.20	12.8

QUESTION F8

Provide a better description of assumptions used in deriving the income benefits in Table 11.2-1 from the data in Tables 8.2-3, 8.2-4 and 8.2-5.*

RESPONSE

See Section 8.2.2 and Tables 8.2-1, -2, -3 and -4 of the Environmental Report as revised by Amendment VI. 7

*This question was repeated in the NRC letter of April 23, 1975.

QUESTION F9

Provide an explanation for establishing the value of the electricity produced as $\$9.4 \times 10^6$ annually (1974 dollars) (11.2.2).

RESPONSE

It is anticipated that total generation during the demonstration period will be approximately 9.6 billion kWh; this amounts to electricity valued at $71.8 million (1974 dollars). 7

See Table 8.3-1 for the annual breakdown during the demonstration period.

QUESTION F10

State the average value (mills/kWh) of electricity produced on the TVA system.

RESPONSE

The average cost of electricity produced on the TVA system by TVA generating plants in fiscal year 1974 (July 1, 1973, through June 30, 1974) was 4.929 mills/kWh including depreciation.

QUESTION F11

Whereas the total payroll, direct operational and induced, has been calculated and the benefits computed (8.2.2.2 narrative and Tables 8.2-3 through 8.2-5), no attempt was made to convert the dollars of income and wages to dollars of retail sales. Could not that be done by utilizing the IRS allowable portions of the state retail sales and applying the percentages to the total wages? Moreover, if there is a state sales tax with portions of it going to the communities, those benefits too could be accounted for by utilizing the sales tax coefficient.

RESPONSE

The Project, in Appendix C submitted with Amentment VI, has estimated selected project related local revenues which have included sales tax revenues and miscellaneous (e.g., beer, liquor) business tax revenues along with property tax revenues and state educational equalization funds. Although the analysis in Appendix C has not utilized the below methodology for calculating retail sales tax revenues the estimated net increase in retail sales and sales tax resulting from direct and indirect payrolls are shown below. It is estimated that 45 percent of payrolls will be spent on retail purchases. Further allowance is made for gasoline sales, which are not subject to retail sales tax; it is estimated that five percent of retail sales will be for gasoline. We do not consider the use of IRS allowable portions to be adequate because they do not necessarily reflect total aggregate sales or sales tax. Certain major categories of retail purchases are allowable in addition to the table value, including automobiles, boats, mobile homes and building materials under certain conditions. 7

	Estimated Retail Sales	Estimated State Sales Tax**	Estimated Potential Local Sales Tax*
1975	$ 4,320,000	$143,600	$ 61,600
1976	6,258,000	208,100	89,200
1977	8,271,000	275,000	117,900
1978	12,527,000	416,500	178,600
1979	19,299,000	641,700	275,000
1980	25,355,000	843,000	361,300
1981	28,750,000	955,900	409,700
1982	18,939,000	629,700	269,900
1983	10,505,000	349,300	149,700
1984	4,907,000	163,200	69,900
1985	4,288,000	142,600	61,100
1986	3,867,000	135,300	58,000
1987	3,488,000	115,900	49,700
1988	3,425,000	113,900	48,800
1989	2,325,000	77,300	33,100
1990	2,325,000	77,300	33,100

7

* Estimated tax available to local governments if all local areas adopt the maximum local tax rate of 1.5 percent.

** Estimated tax available to state government based on sales tax rate of 35 percent. The state has temporarily increased the sales tax rate an additional 1.0 percent to 4.5 percent which has been conservatively ignored. 7

QUESTION F12

Provide data on the "normal" employment trends and projections for the study area and superimpose plant construction employment over these normal levels.

RESPONSE

EMPLOYMENT OF RESIDENTS: HISTORICAL, 1970, AND BASELINE PROJECTION, 1980
CRBRP PROJECT AREA

	1970	1980
Agriculture, Forestry & Fisheries	2,199	1,400
Mining	904	800
Manufacturing	43,166	46,500
All Other	103,779	119,200
TOTAL	150,048	167,900

BASELINE PROJECTION OF "ALL OTHER" EMPLOYMENT CATEGORY AND PROJECTED CRBRP CONSTRUCTION EMPLOYMENT CRBRP PROJECT AREA

	Baseline Projection	Construction Employment
1976	112,800	68
1977	114,300	211
1978	115,900	667
1979	117,600	1,410
1980	119,200	2,105
1981	120,700	2,377
1982	122,400	1,376
1983	124,100	565

7

The two employment columns are not additive because the baseline projections are by place of residence and the construction employment are by place of work data. No place of work employment projections for the project area are presently available. Further, no projections have been prepared which provide a breakdown of the "All Other" category into a classification more closely corresponding to construction employment.

Baseline projections are "a best estimate of what can be expected to materialize if there are no policy or program changes of an unusual and unforeseen nature or magnitude in the factors which have been changing over time and which are expected to continue on course in the future" (U.S. Water Resources Council, CRERS Projections, Vol. 1, 1972). The baseline projection then, is assumed to be the "normal" growth path.

QUESTION G1

State the stretch thermal output and the corresponding plant gross and net electrical outputs.

RESPONSE

The stretch thermal output is 1121 MWt with gross generator output of 439 MWe. The plant power requirements have been increased to 60 MWe (vs 27 MWe previously reported) resulting in a net power of 379 MWe. The initial core net power production will show a similar reduction when the increased parasitic power requirements are taken into account.

QUESTION G2

Obtain from the Tennessee historical liaison officer a judgment as to the impacts of construction and operation of the plant and transmission lines upon (1) historic, cultural, archaeological, and architectural resources now included in the National Register of Historical Places and upon (2) like resources with identified potential for inclusion in the future.

RESPONSE

TVA submitted project plans and locations to the Tennessee Historical Commission on May 23, 1973, along with an archaeological survey of the Site. We asked the Commission to advise us of impact on any historical resources. The Commission responded by letter of June 5, 1973, that "it does not appear that any structures of historical significance or any archaeological sites that would qualify for the National Register would be affected." A recent letter from Joseph L. Benthall, the State Archaeologist, has been reproduced on the following page.

ADDITIONAL INFORMATION REQUESTED IN NRC LETTER, April 23, 1975

Provide the Benthall June 1973 letter. Since the appraisal soon will be 2 years old, obtain from the Tennessee historical liaison officer an updated appraisal taking into account properties added to the National Register since 1973, as well as properties representing potential additions that could not be identified at that time.

RESPONSE

No letter from Mr. Benthall dated in June 1973 exists to our knowledge. There is, however, a letter from Herbert Harper, Director of Field Services, Tennessee Historical Commission, dated June 5, 1973, clearing the site historically and suggesting that the state archaeologist be contacted regarding his comments. A copy of the June 5, 1973, letter is attached.

As recently requested, Dr. Lawrence C. Henry, Executive Director, Tennessee Historical Commission, and State Historic Preservation Officer, has reviewed investigations performed by Dr. Gerald F. Schroedl under the direction of Dr. William M. Bass, Head, Department of Anthropology, and Dr. Alfred K. Guthe, Director, McClung Museum, both University of Tennessee at Knoxville. Dr. Henry has written a letter to Mr. Edward H. Lesesne, Director of Water Control Planning, TVA. The letter dated May 1, 1975, a copy of which is attached, updates the information supplied to the AEC several years ago.

GRANVILLE HINTON
COMMISSIONER
PENN S. FOREMAN
ASSISTANT COMMISSIONER
TONY KOELLA
ASSISTANT COMMISSIONER

TENNESSEE DEPARTMENT OF **Conservation**

Division of Archaeology
5103 EDMONDSON PIKE • NASHIVLLE, TENNESSEE 37211

March 12, 1975

Mr. E. H. Lesesne
Director, Water Control Planning Division
Tennessee Valley Authority
448 Evans Building
Knoxville, TN 37902

Dear Mr. Lesesne:

I have reviewed the report submitted by Dr. Gerald F. Schroedl relating to the archaeological work done in the area of the Clinch River Liquid Metal Fast Breeder Reactor Facility and consider this work to be of excellent quality.

Dr. Schroedl's survey, judging by his report, was very through and brought to light many interesting archaeological and historic sites. His proposal to test the village area near the mound and the shell midden should provide valuable information on the Woodland and Archaic culture periods in the Clinch River area.

The Tennessee Valley Authority is to be commended for its interest and excellent support of the above archaeological research.

T.V.A. has properly considered all archaeological resources and has in my estimation asserted the proper mitigation. The results of the report and studies have shown that there are no sites worthy for nomination to the National Registry.

If you should have further questions or would like additional comments, please do not hesitate to call me.

Sincerely yours,

Joseph L. Benthall

Joseph L. Benthall
Director and State
Archaeologist

LMFBR PROJECT SECTION
MAR 17 1975
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HERBERT L. HARPER
DIRECTOR OF FIELD SERVICES

June 5, 1973

Mr. Robert Roark
Recreation Resources Branch
Division of Reservoir Properties
Tennessee Valley Authority
Knoxville, Tennessee 37902

Dear Bob:

This will acknowledge receipt of the material on the Clinch River Liquid Metal Fast Breeder Reactor Plant Area in Roane County.

From the information submitted, it does not appear that any structures of historical significance or any archaeological sites that would qualify for the National Register would be affected. However, the State Archaeologist should comment on this aspect.

Sincerely,

Herbert L. Harper

Herbert L. Harper

HLH:s

XC: Corydon W. Bell, Jr., 404 EB-K (per request 11/15/73)bg

DIVISION OF WATER CONTROL PLANNING
APR 30 1974

STATE OF TENNESSEE
TENNESSEE HISTORICAL COMMISSION
170 SECOND AVENUE, NORTH
NASHVILLE, TENNESSEE 37201
TELEPHONE (615) 741-2371

LAWRENCE C. HENRY, Executive Director
State Historic Preservation Officer

May 1, 1975

Mr. Edward H. Lesesne
Director of Water Control Planning
Tennessee Valley Authority
448 Evans Building
Knoxville, Tennessee 37902

Dear Mr. Lesesne:

This will acknowledge receipt of the report submitted by Dr. Gerald F. Schroedl on Historic Sites Reconnaissance in the Clinch River Breeder Reactor Plant Area.

We have reviewed this report and based on the information contained therein conclude that no structures of historical significance remain in the area. It is obvious that exhaustive efforts were put forth to make the report as complete as possible, and the results reveal that no properties eligible for entry in the National Register of Historic Places exist.

If I can be of further help, please let me know.

Sincerely,

Lawrence C. Henry

LCH/HLH/11

QUESTION G3

Correct the locations of features shown on Figure 2.1-1 and 2.1-2. For example, Oak Ridge is shown east of the site on 2.1-1 and northeast on 2.1-2. Identify the stream flowing into the Clinch River approximately at CRM 10 (Figure 2.1-2).

RESPONSE

Copies of Figures 2.1-1 and 2.1-2 that contain the necessary corrections are on the following pages. The revised Figures have been included in the Environmental Report.

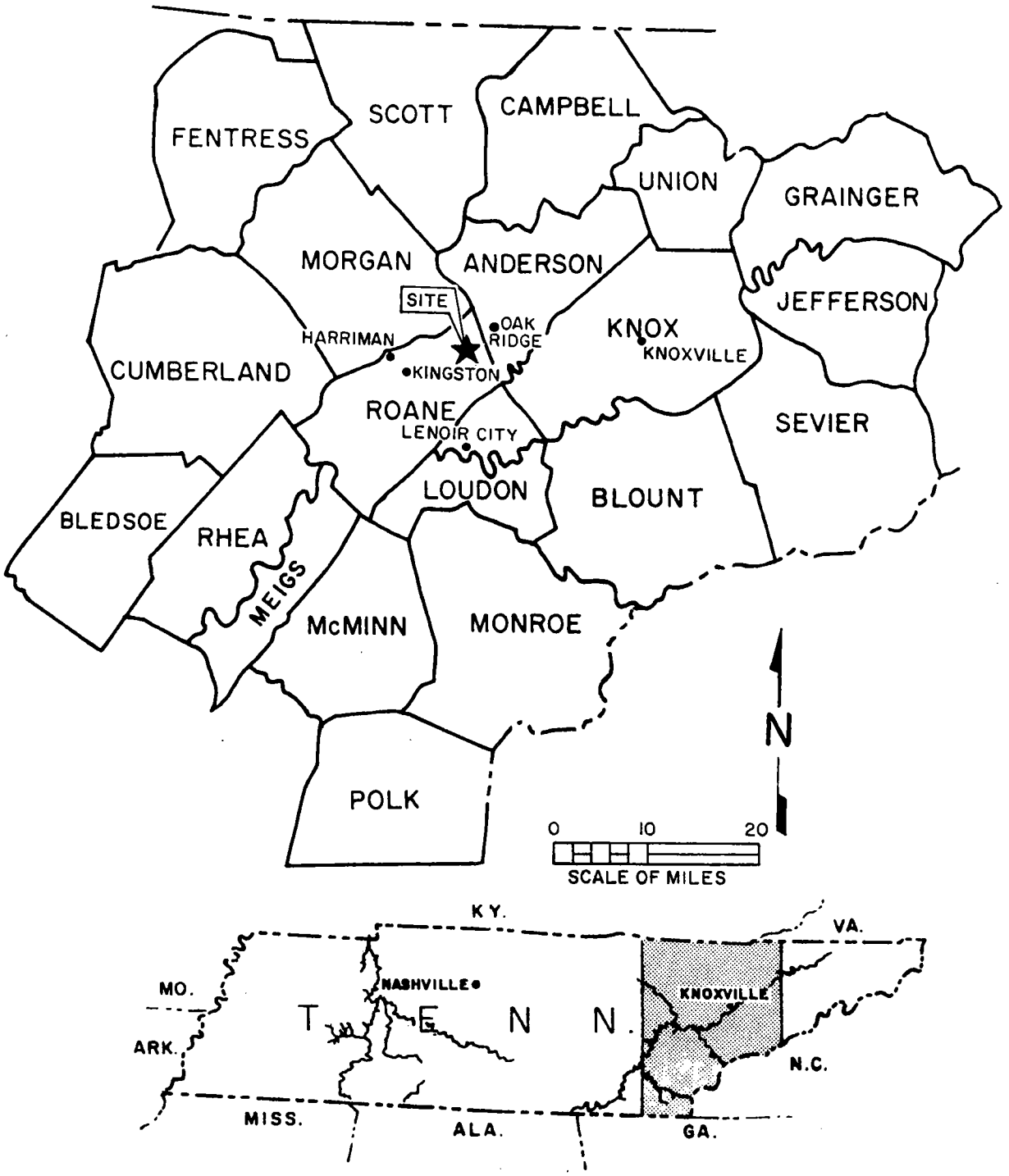

Figure 2.1-1 LOCATION OF CLINCH RIVER SITE IN RELATION TO COUNTIES AND STATE (revised)

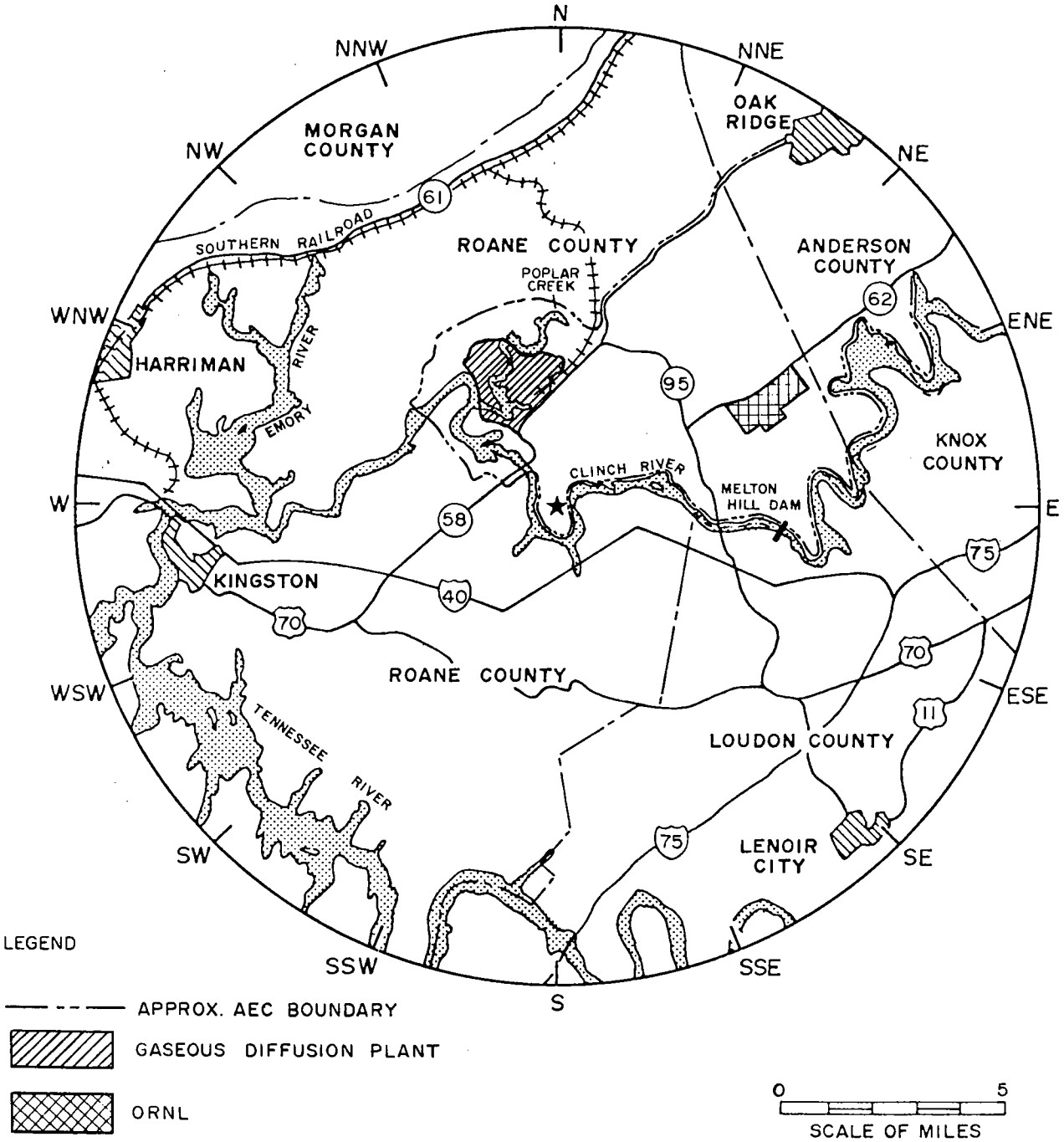

Figure 2.1-2 LOCATION OF SITE WITH RESPECT TO URBAN CENTERS, RAILROADS AND HIGHWAYS WITHIN A 10-MILE RADIUS OF THE SITE (revised)

QUESTION G4

On Figure 2.1-2 show the boundaries of (1) U.S. Government owned land, (2) Oak Ridge manufacturing facilities particularly the gaseous diffusion plant, and (3) ORNL. Name the railroads shown on the figure.

RESPONSE

On the following page is a copy of Figure 2.1-2 that contains the necessary additions. The revised Figure has been included in the Environmental Report.

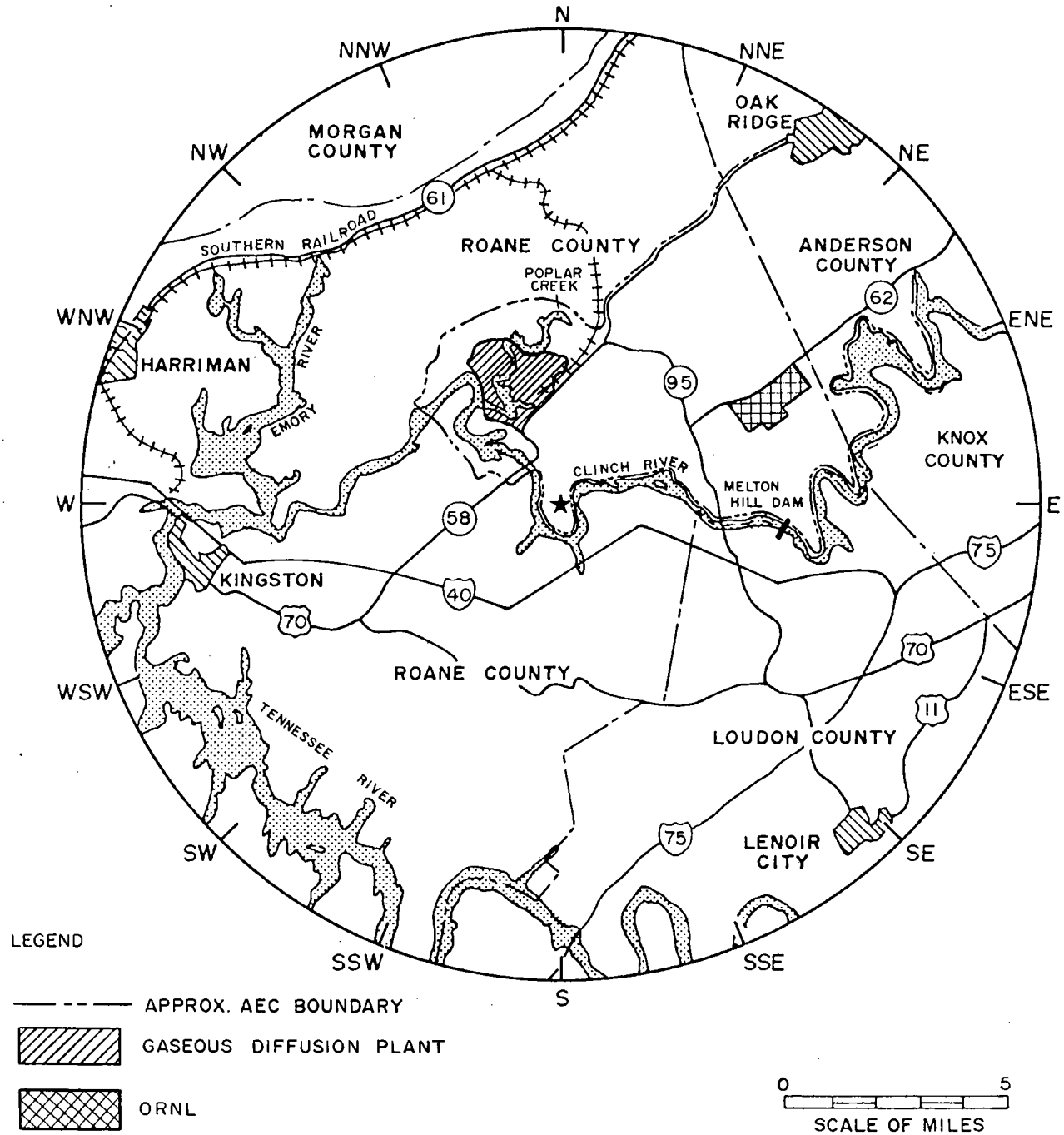

Figure 2.1-2 LOCATION OF SITE WITH RESPECT TO URBAN CENTERS, RAILROADS AND HIGHWAYS WITHIN A 10-MILE RADIUS OF THE SITE (revised)

QUESTION G5

On Figure 2.1-3, distinguish junctions of the new railroad and new highway access with existing routes.

RESPONSE

On the following page is a copy of Figure 2.1-3 that contains the necessary additions. The revised Figure has been included in the Environmental Report.

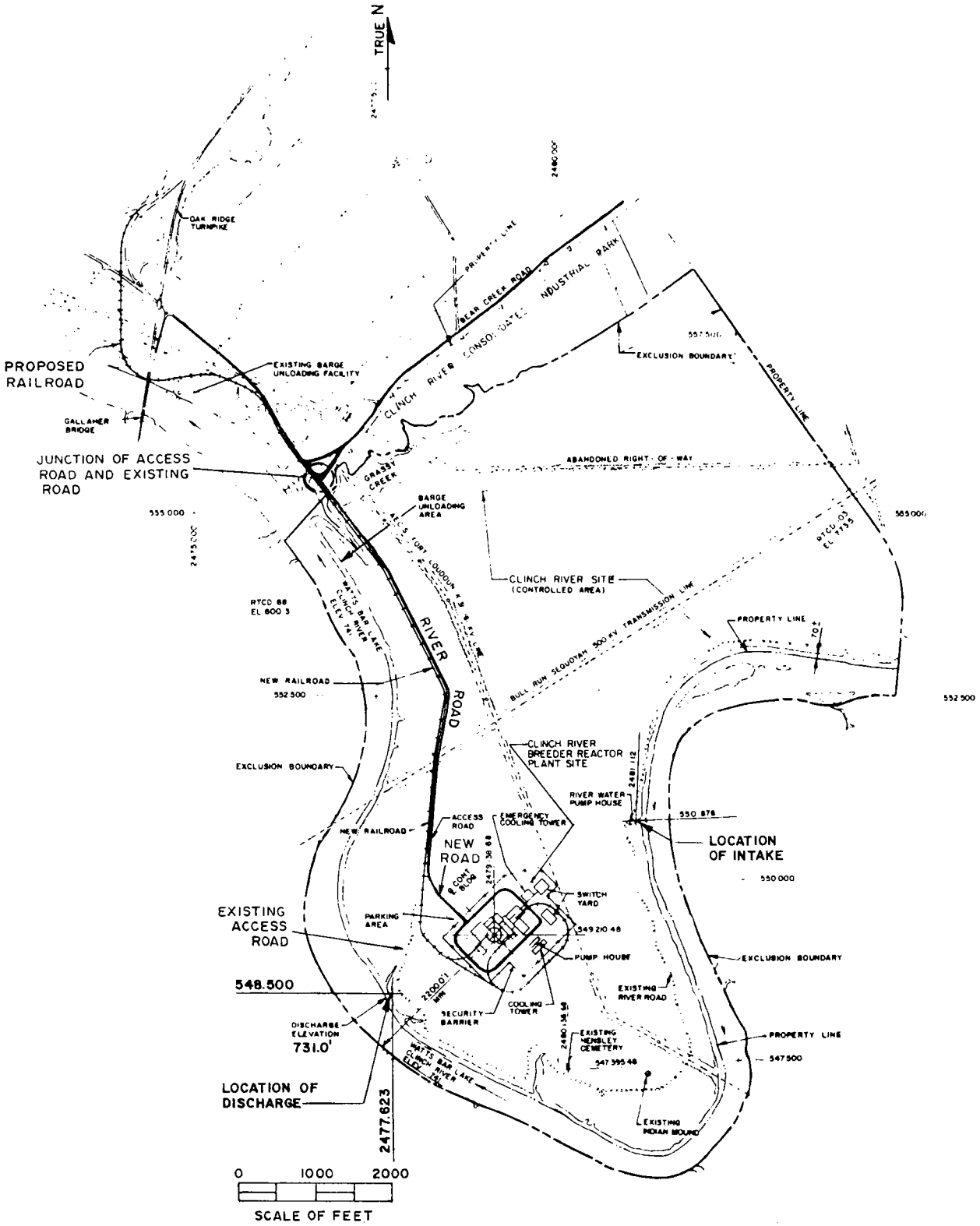

Figure 2.1-3 SITE LOCATION
(revised)

QUESTION G6

Over the plant's 30-year life, estimate in metric tons the natural uranium requirement, the Pu-239 requirement, the U-235 and U-238 consumption, and the Pu-239 production (5.8.3).

RESPONSE

Natural Uranium

See Page 5.8-3 of the CRBRP-ER. If the fuel cycle economics favor use of depleted rather than natural uranium, the virgin ore commitment for this plant would be eliminated. If one assumes an idealized recycle with one full core load tied up in the reactor and an additional one-third core plus one-sixth radial blanket load tied up in each end of the reprocessing refabrication cycle, then the virgin heavy metal commitment is only on the order of 1-2/3 cores plus 1-1/3 radial blanket loads. Uranium burnup and an assumed one percent heavy metal loss of each batch through the reprocessing-refabrication cycle results in a plant lifetime total heavy metal commitment of 56.6 MT of uranium.

Pu-239 Requirement

See page 5.8-3, 5.8-4 of the CRBRP-ER. Based on average isotopic content in the core and blanket, 2.06 MT plutonium-239 are required.

U-235 Consumption

See page 3.8-2, 5.8-3 and 5.8-4 of the CRBRP-ER. Based on the average isotopic content in natural uranium, .04 MT of uranium-235 will be consumed.

U-238 Consumption

See page 3.8-2, 5.8-3 and 5.8-4 of the CRBRP-ER. Based on the average isotopic content in natural uranium, 17.65 MT of uranium-238 will be consumed.

Pu-239 Production

See page 5.8-3, 5.8-4 of the CRBRP-ER. The amount of plutonium-239 produced is 2.06 MT.

QUESTION G7

Site guidelines used in selecting transmission line routes having minimum environmental impacts (3.9).

RESPONSE

In general, aesthetic impacts were minimized by following applicable portions of the U.S. Department of Interior/Agriculture publication Environmental Criteria for Electric Transmission Systems and the Federal Power Commission publication Electric Power Transmission and the Environment.

QUESTION G8

Cite erosion control practices, in addition to those in the ER, to be used during transmission line construction, particularly during stream crossings.

RESPONSE

Prior to clearing of the transmission line right-of-way, an engineer walks the right-of-way to estimate the cost of clearing and notes any unusual conditions where erosion control measures should be taken to avoid runoff and siltation. Based on the on-site visit and a review of the drawings, there are no stream crossings of any significance on the transmission line corridor. The construction of this line will be done during the dry time of the year which will not affect any wet weather streams. On slopes, contours or water swells are installed to check runoff and prevent erosion.

QUESTION G9

Discuss transmission line maintenance practices, including any restoration plans after emergency repair.

RESPONSE

Section 5.6.2 (Maintenance Effects) discusses these practices. Section 5.6.2.3 has been revised to include restoration plans after emergency repair.

QUESTION G10

Clarify the route of River Road between Bear Creek Road and the plant (Figure 4.1-1).

RESPONSE

On the following page is a copy of revised Figure 4.1-1 that contains a clarification of the route of River Road. The revised Figure has been included in the Environmental Report.

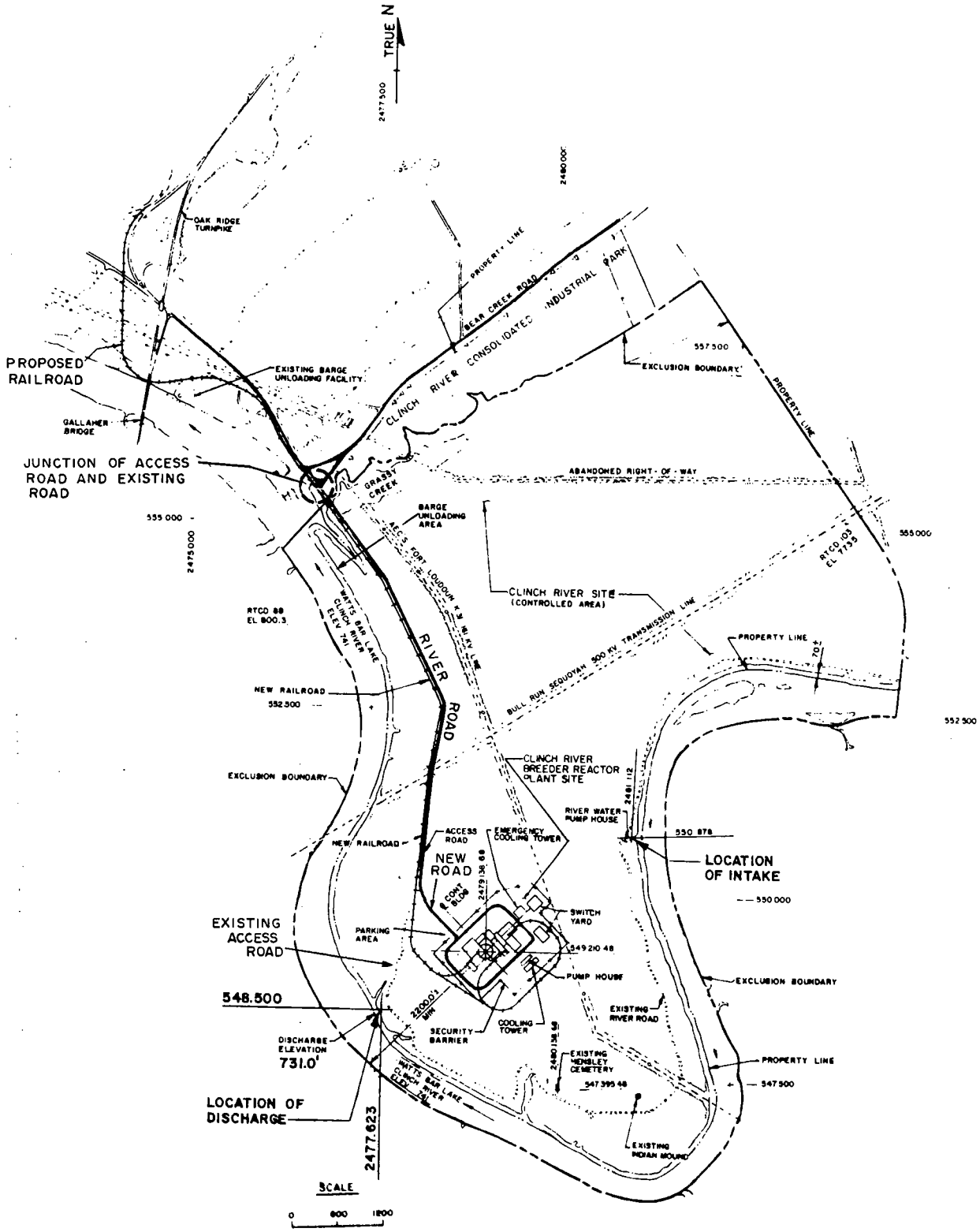

Figure 4.1-1 SITE LOCATION

QUESTION G11

Discuss mitigating actions under consideration, in the event of excessive highway congestion caused by construction worker movements between their homes and the site (P. 8.3-7).

RESPONSE

The project and ERDA-Oak Ridge Operations are actively working with representatives with the State of Tennessee Department of Transportation in order to develop a plan to alleviate traffic congestion in the vicinity of the CRBRP Site during the course of the construction of the CRBRP. 7

QUESTION G12

Describe the control program including periodic review of all construction activities to assure that appropriate mitigating actions will be taken to avoid unnecessary adverse environmental impacts during plant and transmission lines construction.

RESPONSE

The removal of vegetation from a transmission line right-of-way is performed by a clearing contractor through a contractual arrangement executed by TVA's Division of Power Construction. As a provision of the initial transmission line right-of-way clearing contract, specifications are provided which clearly identify areas in which special clearing methods are to be applied or vegetative screens are to be retained. A TVA right-of-way clearing agent is then assigned to guide and control the performance of the contractor. The agent is in daily field contact with the clearing contractor when clearing is being performed through non-sensitive areas. When clearing operations approach sensitive areas such as major highway crossings, rivers or other large bodies of water, a TVA agent will be present. The agent will remain in the field with the contractor until the clearing through these areas is complete.

The actual construction of the transmission facilities will be performed by TVA construction forces. Environmental feedback to assure minimization of environmental impacts during construction will be handled through TVA's administration control procedures. Initial decisions regarding modification of construction activities will be made by field construction personnel who can assess the relative importance of the activities being performed. In the event that the need arises to alter the manner in which an important activity is being performed to reduce impacts, the decision will be made at a higher administrative level on recommendation of personnel having the responsibility for environmental assessment.

PURPOSELY BLANK

AMENDMENT XV REVISIONS RESULTING FROM

ADDITIONAL OR UPDATED INFORMATION AND MINOR CORRECTIONS

3.4, 5.4	UPDATE COOLING TOWER RESIDUAL CHLORINE CONCENTRATION LIMITS
3.6	UPDATES PLANT EFFLUENT WATER CONCENTRATIONS
3.9	CORRECTS DESCRIPTION OF TRANSMISSION LINE
4.1	PROVIDES DESCRIPTION OF SOIL EROSION AND SEDIMENT CONTROL MEASURES AND RUNOFF TREATMENT POND FEATURES
5.2	PROVIDES CORRECTION TO RADIOLOGICAL IMPACTS FROM ROUTINE PLANT OPERATION
5.6	UPDATES AESTHETICS CONSIDERATION OF PLANT FACILITIES
6.1	DELETES PARAGRAPH INADVERTENTLY RETAINED FROM PREVIOUS AMENDMENT
10.3	CORRECTS PREVIOUS EROSION TABLE LISTING
APPENDIX F	PROVIDES UPDATED ALTERNATIVE SITING ANALYSIS OF DOE SITES
APPENDIX G	PROVIDES UPDATED ALTERNATIVE SITING ANALYSES OF TVA SITES
NRC QUESTION/RESPONSES	- INCORPORATES PREVIOUSLY RESPONDED TO QUESTIONS INTO THE ENVIRONMENTAL REPORT

QUESTION 230.1R

The geology and seismology literature search needs to be updated. The latest reference in the bibliography is 1974. Considerable research in geology and seismology has been done since that time (i.e., Appalachian COCORP Plan; recent studies of the Giles County Earthquake by Bollinger presented at the Earthquakes and Earthquake Engineering meeting in September, 1981 in Knoxville, Tennessee; TVA Appalachian Study; Studies related to the Charleston, S.C. 1886 earthquake; site investigations at TVA and other nuclear projects in the region; studies of other recent and historic Appalachian earthquakes; etc.)

Summary of Response:

The geologic and seismological literature search has been updated to include the years 1974-1981. The various categories into which the recent literature has been presented are identified. A discussion of the findings of the literature search is presented.

Major findings in the geologic literature since 1974 are generally related to interpretation of the origin and structure of the southern Appalachians. Much of this is based on seismic reflection profiles from COCORP and the USGS. These findings have no negative impact on the Site.

Mapping of alluvial terraces along the Little Tennessee River by Delcourt and his correlation of the terraces with terraces at the Watts Bar Nuclear Plant site may provide an additional line of evidence for dating faults and other geologic structures in the Valley and Ridge. However, because other lines of evidence indicate that no faulting has taken place in the Site area since late Paleozoic time, it is not considered necessary to pursue the terrace study further.

In reviewing the available geologic literature, no studies were found which were interpreted to invalidate safety related conclusions made in Section 2.5 of the PSAR.

The most significant seismological related finding since 1974 has been the Giles County earthquake study by Professor G. A. Bollinger which tentatively identified a northeast striking basement fault with ascribed maximum magnitude of Ms 7.0. Using the procedure outlined in the report to estimate the design intensities at distances away from Giles County, the CRBRP site intensity is estimated to be MM VI. Since CRBRP is designed to MM VIII, the current design is more conservative than that arrived at by using Bollinger's Report. Independent studies by TVA reached similar conclusions for the Watts Bar plant located in the same tectonic province. There is no evidence that other similar structures exist within the Southern Appalachian geologic province.

No other new knowledge exists which would imply the inadequacy of the site design maximum intensity (MMVIII).

RESPONSE

The geological and seismological literature search has been updated to include the years 1974-1981. The geologic literature search was designed to include references to recent work performed in the general site area pertaining to possible recent faulting, location of faults not previously recognized in the area, new interpretations of age of thrust faulting, and physical properties of the Paleozoic rock units.

The seismologic literature search was designed to include references to recent work related to understanding the causes and distribution of earthquakes in the eastern United States, recent results of seismic monitoring in specific areas, and recent work defining the tectonic setting of the eastern United States.

The literature search consisted of six data bases (National Technical Information Service, Georef, Geoarchive, Dissertation Abstracts, Government Printing Office, and Engineering Index), a review of reference lists from available recent site-related publications, and a telephone survey of geoscientists familiar with recent work performed in the area. The search generated approximately 300 references, of which fewer than 200 appear to be directly applicable to the geologic or seismologic conditions in the area.

The geologic publications generally fall into three categories: 1) the statigraphy of the Paleozoic rock units; 2) analyses of geophysical data, especially the COCORP seismic data; and 3) developments in the interpretation of the origin of the Southern Appalachians, including origins of and mechanisms for thrust faulting in the Valley and Ridge province. The seismologic literature falls generally into five categories: 1) intraplate tectonics; 2) Cretaceous and Cenozoic faulting; 3) Southern Appalachian tectonics; 4) research conducted in specific areas of the eastern United States; and 5) speculations concerning the causes of eastern United States seismicity.

Geological Literature Review

In reviewing the available geologic literature, no studies were found which were interpreted to invalidate safety related conclusions made in Section 2.5 of the PSAR.

Stratigraphy

Recent studies have served to further characterize the nature and distribution of the Paleozoic rocks in the Valley and Ridge province of Tennessee (27, 33, 34, 40, 41). Additionally, detailed geologic studies within portions of the Valley and Ridge have dealt with the petroleum potential resulting from the geologic structure of the province (13, 15, 28).

Significant recent studies concerning the effects of Quaternary glaciation in the southern Appalachians have been performed (7,8,16,31). In particular, Delcourt's (7,8) study of the terrace deposits along the Little Tennessee River Valley details the fluvial-depositional processes occurring in the Quaternary. This work serves as a framework for interpretation of the recent geologic history in the Tennessee River drainage basin of the Valley and Ridge. Nine sets of terraces above the current floodplain were identified by Delcourt. Delcourt's study may provide an additional means of age-dating geologic events in the Valley and Ridge province. The position taken in the CRBRP PSAR and the consensus of geologic opinion is that the most recent movement along faults in the Valley and Ridge occurred during the late Paleozoic. It is therefore not considered necessary to conduct a terrace study at the CRBRP site.

Analyses of Geophysical Data

Recent analyses of geophysical data including seismic reflection profiles, gravity and aeromagnetic surveys, and remote sensing imagery, have aided in the interpretation of crustal structures in the southern Appalachians. These analyses are an integral part of studies concerning the development of the southern Appalachians.

Seismic reflection profiles, from both the COCORP (1,4,5,6,-29,38,39) and the U.S. Geological Survey (15), provide the most detailed interpretation of the structure of the southern Appalachians. Cook et at. (4) interpret the COCORP profiles, which extend from Madisonville, Tennessee to the Modoc fault near the Coastal Plain overlap in Georgia, to show a continuation of Valley and Ridge sedimentary strata beneath an allochthonous crystalline thrust sheet. The sedimentary strata are suggested to extend at least as far east as the Elberton granite in the Piedmont of northeastern Georgia, and probably to the eastern end of the profile. Harris et al. (15) using U.S. Geological Survey reflection profiles in northern Tennessee and North Carolina, give a similar interpretation. Harris and Bayer (14) extend the master decollement underlying the southern Appalachians to the edge of the present continental shelf and suggest that the entire Appalachian orogen, from Canada to the southern United States, may be detached above a master decollement.

In a 1964 report, Watkins (37) used aeromagnetic and gravity data from Tennessee and Kentucky to suggest a contact between a tectonically active Appalachian crustal block and a stable cratonic block along the western margin of the Valley and Ridge province. In more recent work, Hatcher and Zietz (21,22) used regional aeromagnetic and gravity data to define areas underlain by granitic or mafic crust and areas of varying sediment thickness below the crystalline thrust sheet, and to outline

sutures in the Blue Ridge and Piedmont. They also suggest that the master decollement is rooted near the Kings Mountain Belt and that the Charlotte Belt/Carolina slate belt is autochthonous and separated from the allochthonous Inner Piedmont by one of the suture zones.

Remote sensing has been applied to interpretations of structure in the southern Appalachians by Johnston et at. (25). The imagery proved useful in the recognition and mapping of regional structure, jointing patterns, drainage patterns, fault and fracture traces, and rock types. Seay and Hopkins (36) interpreted gravity and aeromagnetic data, remote sensing imagery and seismicity to define tectonic structures in the southern Appalachians.

Development of the Southern Appalachians

Recent studies concerning the development of the southern Appalachians can be divided into two general categories: models developed to explain the tectonic evolution of the region, and research concerning the mechanisms, geometry, and timing of thrust faulting within the southern Appalachians.

Tectonic models have been developed which apply the existing geologic and geophysical data base of the southern Appalachians to the plate tectonics theory (3,10,17,18,19). These models serve as a basis for understanding the timing and mechanics of the formation of the southern Appalachian orogen, including the Valley and Ridge province.

Thrust faulting in the Valley and Ridge is generally accepted to result from "thin skin" tectonics which involves only the upper crust. The actual mechanisms are a subject of debate in the recent geologic literature. Some researchers believe the movement of thrust faults was initiated by gravity sliding along a

master decollement formed by the uplift of the Blue Ridge province to the southeast (9,11,26). Other researchers (2,12,17,18,20) either argue against the gravity-slide model, or in favor of a model that explains the initiation of thrusting along a master decollement by major compressive forces caused by a late Paleozoic collision between the African and North American plates. Chapple (2) developed a model based on existing geologic information as well as assumptions concerning the geometry and mechanical properties of the Appalachian geosyncline. He concluded that compressive forces are required to initiate large-scale thrusting such as that found in the Valley and Ridge.

The age of thrusting is a subject of limited debate. Most researchers (17,18,20,32) believe that the most recent movement along the thrust faults occurred during the Permian (late Paleozoic Alleghenian Orogeny). One recent study (24) argues that there was movement as late as the Cretaceous. Schafer (35) cites evidence from offsets in drill holes to document movement along existing thrust faults in the past 15 years within the Valley and Ridge of Tennessee. Odom and Hatcher (30) and Hatcher and Webb (23) interpret this movement to be the result of significant overburden removal in the vicinity of the drill holes (large-scale road excavations), and not related to reactivation of the Alleghenian thrust faults. Odom and Hatcher (30) state that these faults "....have almost no possibility of reactivation by their original driving mechanisms."

Seismological Literature Review

Based on the literature reviewed to date, it is concluded that the specific design assumptions related to the derivation of the Site seismicity for the CRBRP plant will not be impacted. A brief summary with bibliography is included below.

Intraplate Tectonism

Recent studies concerning the occurrence of earthquakes in the eastern United States suggest that seismicity is the result of reactivation of pre-existing zones of weakness by the present stress field. A thorough discussion of this subject is given in (1). The orientation and origin of the modern stress field in the central and eastern United States is discussed in (1) and (2).

Faulting

Recent work has been published pertaining to Cretaceous and Cenozoic faulting along the eastern United States continental margin [3,4,5,6,7,8]. It has been proposed that northeast trending reverse faults of Cretaceous and Cenozoic age are responsible for seismicity along the eastern seaboard [9,10,11].

Southern Appalachian Tectonic Structure

Recent geologic and geophysical evidence is interpreted to indicate that much of the crystalline Southern Appalachians consist of allochthonous slabs thrust from the southeast along a decollement separating the crystalline rocks from essentially flat-lying sedimentary strata [12,13].

The Bouguer gravity field of the region has been studied by several investigators. Decomposition of the gravity field by wavelength filtering reveals a gradient extending from Maine to Alabama. It has been proposed[14] that seismicity in the crystalline Appalachians is concentrated along this gradient and notably along its transverse offsets.

Regional magnetic and gravity data were correlated with seismicity, satellite photo-imagery and related geologic data (15). Results suggest that the Precambrian crust underlying the folded Southern Appalachians has a complex structural pattern which can be divided into a series of distinct tectonic subdivisions.

Specific Areas of the Eastern United States
Charleston, South Carolina:

During the past decade, much research has been directed toward identification of the structure that generated in the 1886 Charleston earthquake. In 1977, the U.S. Geological Survey published Professional Paper 1028, a collection of papers which summarizes preliminary findings (17,18,19,21,22). It is understood that studies are presently on going by USGS related to Charleston area seismicity.

Focal depths for recent seismicity in the Charleston area suggest that the 1886 shock occurred in the upper crust[16]. Drilling in the Summerville area has shown that the Coastal Plain sediments are underlain by a basalt layer of Jurassic age[17], which overlies red-bed deposits of earlier Mesozoic age. Further evidence of the graben-like deeper structure of the area comes

from seismic refraction[18,19], magnetic[20], and gravity data[21]. Seismic reflection profiles show a reverse fault in the Summerville area (Cooke fault) with possible northeast strike, which moved during Cenozoic time[5]. As yet, the relationship of this fault to seismicity is unclear[16]. Fault plane solutions for the Charleston seismicity show northwest-striking or sub-horizontal nodal planes[22,16].

Recently, it has been proposed that movement along the Appalachian decollement inferred from COCORP reflection data[12,13] may be the cause of the 1886 Charleston event[23]. However, whether or not the decollement extends under the Charleston area is as yet controversial[16].

In their update on information concerning the Charleston area requested for the St. Lucie SER[24], the U.S.G.S. summarizes the current understanding of the area as follows:

"The problem regarding identification of specific tectonic structures capable of generating large earthquakes in the east is far from resolution. Local structures near Charleston are imcompletely known at present and the larger structural element, the decollement, is as yet hypothetical. However, the concentration of seismicity in the Charleston earthquake epicenter both before and after the August 31, 1886, event and the lack of post Miocene faulting in the Coastal Plain or any evidence for localizing large earthquakes indicate that the likelihood of a Charleston-sized event in other parts of the Coastal Plain and Piedmont is very low. Consequently, earthquakes similar to the 1886 event should be considered as having the potential to occur in the vicinity of Charleston and seismic engineering parameters should be determined on that basis."

Giles County, Virginia

Important new information about seismicity in the Giles County, Virginia, area has recently been obtained from monitoring by a dense seismograph network[25,26,27]. The seismic monitoring has revealed that focal depths in the Giles County area range from 5 km to almost 25 km. Furthermore, the epicenters in the area reveal a northeast lineation in the seismicity pattern. Focal depths indicate that activity is below the Paleozoic section, within the Precambrian basement rocks and middle crust. The strike of the epicenter trend of N37^{o}E departs from the general trend of the Paleozoic Valley and Ridge axes in the area. This suggests that the seismicity is caused by a fault zone associated with an earlier trend.

Recently, an estimate has been made of the maximum possible earthquake for the Giles County area by Prof. G. A. Bollinger [28]. This represents the most significant finding since 1974 related to regional seismology. From the range of possible fault plane areas, values ranging from Ms 6.0 to Ms 7.0 were determined. In addition, hypothetical isoseismal maps representing the intensity effects of the maximum earthquake were prepared[28].

Attenuation from the Giles County area to the CRBRP site of the maximum hypothetical size earthquake would result in an event less than the design Intensity VIII and, consequently, will not impact the site seismicity.

TVA addressed this question in a recent response to NRC on evaluating the impact of the Bollinger hypothesis on the seismic design of the Watts Bar plant located in the same tectonic province and similar conclusions were reached (Ref. 31).

Speculations Concerning the Cause of Eastern United States Seismicity

The causes of eastern United States earthquakes are not yet understood. It has been noted that intraplate seismicity shows an association with igneous intrusive rocks[1], and hypotheses concerning the role of intrusive bodies in concentrating stress have been proposed[29,30]. It has been argued that both seismicity and igneous intrusives are fundamentally related to rift zones, areas of pre-existing crustal weakness which may be reactivated by the modern stress field[1,16].

Two recently proposed hypotheses attempt to explain the origin of seismicity in the Piedmont and Coastal Plain provinces of the eastern United States. Under one hypothesis[23], the 1886 Charleston event is attributed to gravitational backslip along the Southern Appalachian decollement. Another hypothesis [9, 10, 11] proposes that seismicity along the Atlantic Coast is related to reactivated reverse movement on scattered northeast trending faults formed during Mesozoic rifting. However, these hypotheses are not viable in the folded Southern Appalachian area. Recent data from Giles County, Virginia, suggest that a reactivated, northeast trending, high angle, dip slip fault formed in early Paleozoic time may be responsible for the seismicity in that area [25].

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Question 230.2R (NRC letter dated 10/26/81, response dated 12/22/81)

Based on the site investigation data presented in the PSAR, the upper siltstone horizon of Unit A, within which the structure foundations are to be placed, is relatively devoid of solution features below foundation grade. However, it is not obvious that the underlying limestone unit of the Chickamauga Group, Unit A and the much deeper Knox group do not contain significant cavities. Determine the maximum size cavity, based on regional studies of karst features in these rock units, that could exist beneath the plant without being detected by the investigations performed. Evaluate the capability of the foundation rock unit (Unit A, upper siltstone) to bridge such cavities.

Summary of Response

1) The potential for cavities and other karst features within the Unit A Limestone of the Chickamauga Group below the proposed base excavation level for the Nuclear Island is considered minimal. It is believed that existing boring data, results of the test grouting program, and the planned bedrock verification program as addressed in the PSAR will be sufficient to confirm the homogeneity of the Unit A Limestone. This verification program is scheduled to commence shortly and results will be provided upon completion.

2) Research studies on the regional geology have shown that weathering in the Knox has been encountered to depths up to 200 feet. Geotechnical investigations at the site have indicated a depth of weathering in the Knox not exceeding 100 feet. Consequently, with a minimum depth of cover above the Knox of 450 feet, subsidence problems will not occur beneath the CRBRP site.

Response

EVALUATION OF THE POTENTIAL CAVITIES IN THE KNOX FORMATION

The size, shape, frequency, and extent at depth of karstic cavities depend upon 1) the extent of the weathering zone, 2) the presence or absence of impervious strata, and 3) local geologic structures (faults). In general, solution cavities, both ancient and recent, may be open, or completely filled with clastic material, or may be water-filled conduits. Ancient, or paleokarst cavities, are typically filled with recemented material and are as competent as the host rock around them.

Weathering within the Oak Ridge reservation is usually limited to the upper 100 feet of the surface. The weathering of rock is most severe in the local limestone and dolomite units, leaving karstic terrain with clay and chert residuum for soil. Below the weathering zone, the rock is generally jointed, but sound, with joint strength increasing and open joint frequency decreasing with depth.

The development of karst features at the surface and at depth in the rocks of the Knox Group is well documented. Sinkholes and cavities are very frequent and have created many problems in the foundation of structures throughout the entire region. The Knox Group has been described as a massive dolomite with a paleokarst upper unit. This upper unit reflects an ancient karstic erosional surface which was subsequently beveled and covered by the Chickamauga Group. According to local experts and available references, this paleokarst unit is now a very competent rock. The ancient solution cavities, joints and caves, were filled with residuum and recemented to the point that it is now difficult to detect the paleokarst unit from the overlying and underlying carbonate units. These paleokarst features are well documented in the zinc district of northeastern Tennessee where they are always filled and cemented and do not represent a hazard.

The only areas of karst with active solutioning exist within zones of active weathering, at or close to the contact between the Knox and the Chickamauga groups, and at depths ranging from 0 to 200 feet. The size of the cavities varies from enlarged joints to several tens, and occasionally hundreds of feet in span. Geotechnical investigation at the site indicated a maximum depth of weathering not exceeding 100 feet.

To summarize our own experience and available data the following can be concluded: 1) Frequent and large open cavities (up to several hundred feet) occur within the Knox Group. These solution features are exclusively developed at shallow depth (no deeper than 200 feet) and in relation to the zone of weathering. 2) Many cavities appear to be located at or close to the unconformity existing between the Knox and Chickamauga Groups. When this unconformity is at depth beneath the zone of weathering the karst features are ancient and filled, and the filling material is recemented.

In conclusion, it would appear that subsidence is not a problem below the CRBRP site and in view of the shallow depth of weathering, it would not be necessary to conduct hypothetical analytical studies to determine the maximum size cavity related to depth and strength properties of overlying strata.

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Project Management Corporation, 1975. Clinch River Breeder Reactor Plant, Environmental Report, Section 2.4.

QUESTION 230.3R (NRC letter dated 10/26/81, response dated 12/22/81)

Furnish a map and summary discussion of the relationship beneath the Pleistocene/Pliocene high terrace deposits and geologic structures at the site, particularly the shear zone encountered in core borings.

RESPONSE

In response to this question we are providing Figure 2.5-5 from the PSAR which is the site geologic map.

Although terrace deposit studies have been used as a tool to locate and date faulting and other geologic structures, they were not used for this purpose during the CRBRP licensing investigation. The age of geologic structures at and near the site (Copper Creek, White Oak Mountain, and other faults as well as the shear zone within the Chickamauga Group) were determined by other lines of evidence. At the time of the original PSAR development in 1973 and 1974, no other such terrace study had been carried out in eastern Tennessee within the Valley and Ridge geologic province. Since that time, one such study had been identified. This study was performed by P. A. Delcourt of the University of Tennessee (Knoxville) along the Little Tennessee River from Chilhowee Dam to the Tellico Dam (approximately 10 miles southeast of the CRBRP site). Delcourt* has mapped nine different terrace deposits along the river and has radiocarbon age dates on the three youngest terraces.

*Delcourt, P. A., 1981, Personal Communication to Law Engineering Testing Company.

The distribution and state of presentation of the terrace deposits along the Clinch River is not documented in the geologic literature; therefore, no assessment can be made concerning their relationship to the terrace deposits mapped by Delcourt along the Little Tennessee River or directly to the structures identified at the site. However, during the geologic mapping at the site, the general distribution of terrace material was plotted (PSAR Figure 2.5-5). Terrace deposits form a veneer over portions of the site. This material is high-level alluvium deposited by the Clinch River when stream levels were much higher than at the present. Such deposits are generally regarded as Pleistocene to Pliocene in age. The terrace deposits consist mainly of orange and red silty clay with thin layers of rounded quartz, chert, and quartzite gravel. A limited number of borings have penetrated the terrace deposits extending to depths ranging from 8 to 19.5 feet below the ground surface.

For a study to be conducted on the terrace deposits, it would first be necessary to establish whether sufficient material exists in the near vicinity of the CRBRP site to permit developing a correlation with geologic structures at the site including the shear zone encountered in the Chickamauga Group. Detailed surface mapping and surveying in conjunction with subsurface mapping (trenching with a backhoe) would be required. Correlation of individual terraces would have to be done by age dating (radiocarbon or palynology), comparison of lithologic composition of the terraces, or possibly by heavy mineral analyses of terrace material. Plotting the distribution of the terraces on longitudinal profiles would allow for detection of offsets in the terraces on the regional scale, while smaller scale offsets would have to be recognized in the field, generally from the trench study.

It is considered that a program of work of the nature described above is not warranted for the CRBRP site because, as outlined in

the PSAR, other lines of evidence were sufficient to conclude that all structural elements including the shear zone are ancient and are not considered capable.

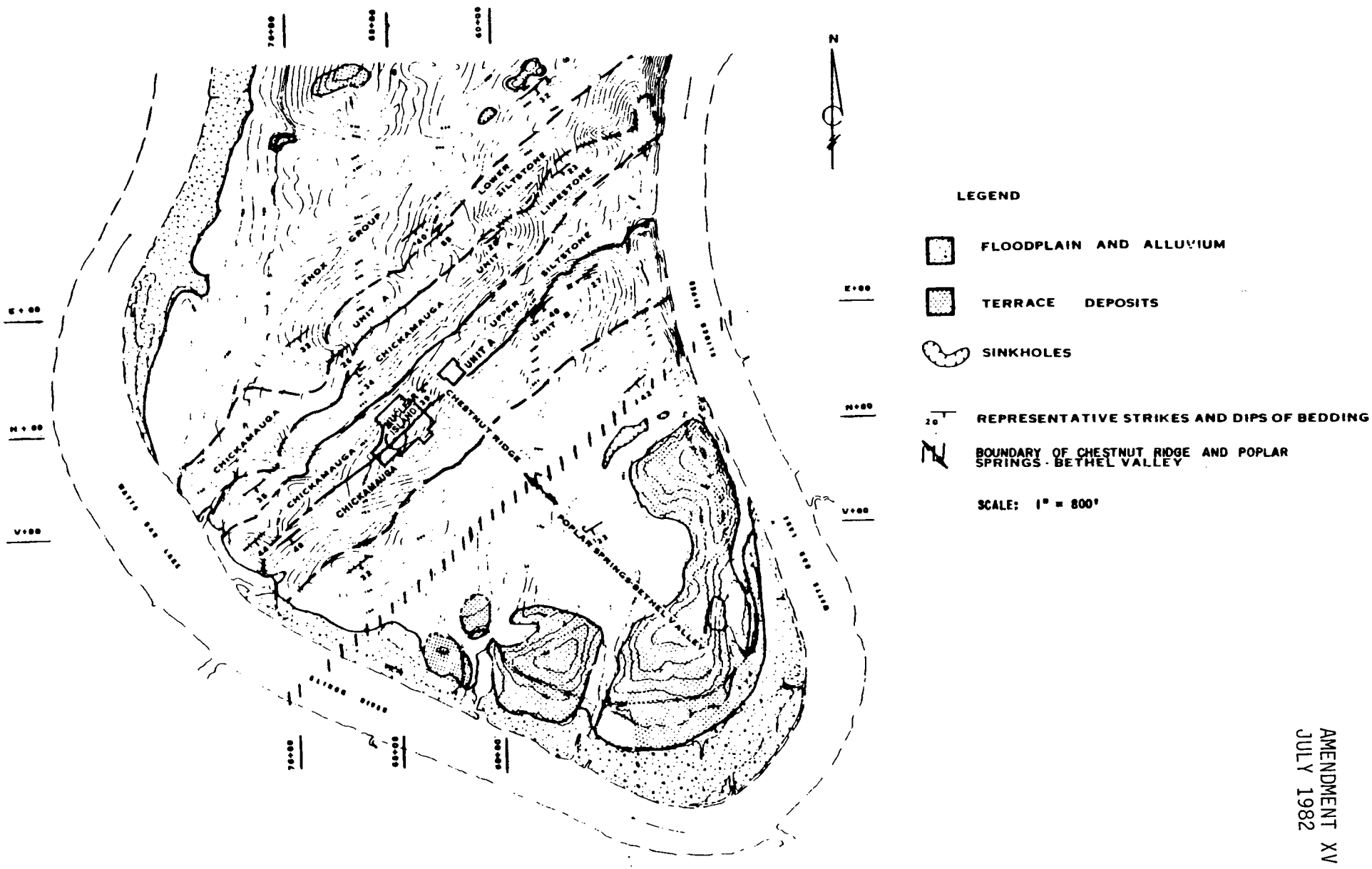

Figure 2.5-5 Site Geologic and Physiographic Map

QUESTION 230.4R

What is the current status of the radioactive waste injection well on the Oak Ridge Reservation approximately 4 miles east of the site?

RESPONSE

The injection well at the experimental shale fracturing facility has been retired from service. It was used for the injection of approximately 2 million gallons of waste grout over a 16 year period. The maximum determined extent of the grout sheets from these injections was approximately 700 ft* from the well.

A new injection well has been installed about 800 ft. south of the experimental facility. This well will be used for future injections of waste grout, starting in June, 1982.

The characteristics of both wells are given in the Environmental Impact Statement for the New Hydrofracture Facility - ERDA 1553.

*Management of Intermediate Level Radioactive Waste, ORNL ERDA 1553, Sept. 1977

QUESTION 230.5R

The geology section for the Clinch River site in the Alternate Site write-up should be updated. It is written as if only four core borings have been drilled there and the geologic conditions are unknown. This can be done by referring to Chapter 2.4.

RESPONSE

An extensive geological survey was conducted following the selection of the Clinch River site for the demonstration plant. The results of the survey were documented in Section 2.4 of the ER and were updated by Amendment IX.

Section 9.2.5.3.4, "Geology" of the Alternative Energy Sources and Sites Section has been updated by referring to Section 2.4.

QUESTION 240.1R

Information Requirements Relating to Executive Order 11988 on Floodplain Management.

(Definition of Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including at a minimum that area subject to a one percent or greater chance of flooding in any given year.)

1. Provide descriptions of the floodplains of all water bodies, including intermittent water courses; within or adjacent to the site. On suitable scale map provide delineations of those areas that will be flooded during the one-percent chance flood in the absence of plant effects (i.e., pre-construction floodplain).

2. Provide details of the methods used to determine the floodplains in response to 1. above. Include your assumptions of and bases for the pertinent parameters used in the computation of the one-percent flood flow and water elevation. If studies approved by Flood Insurance Administration (FIA), Housing and Urban Development (HUD) or the Corps of Engineers are available for the site or adjoining area, the details of analyses need not be supplied. You can instead provide the reports from which you obtained the floodplain information.

3. Identify, locate on a map, and describe all structures, construction activities and topographic alterations proposed in the floodplains.

4. Discuss the hydrologic effects on all items identified in 3. above. Discuss the potential for altered flood flows and levels, both upstream and downstream. Include the potential affect of debris accumulating on the plant structures. Additionally, discuss the effects of debris generated from the site on downstream facilities.

5. Provide the details of your analysis used in response to 4. above. The level of detail is similar to that identified in item 2. above.

6. Identify non-floodplain alternatives for each of the items (structures, construction activities and topographic alterations) identified in 3. above. Alternately, justify why a specific item must be in the floodplain.

7. For each item in 6. above that cannot be justified as having to be in the floodplain either show that all non-floodplain alternatives are not practicable or commit to re-locating the structure, construction activity or topographic alteration out of the floodplain.

RESPONSE

1. Two streams are adjacent to or within the CRBRP site: the Clinch River and Grassy Creek. In addition, there are eight small, intermittent drainageways that flow through the site area, as shown in Figure 240.1R-1 and Figure 240.1R-2. Storm runoff from these drainageways will be controlled by site grading and a storm drainage system as described in PSAR Section 2.4.2.3.

   The 1-percent-chance floodplain of the Clinch River at the site and along the access road and railroad leading to the site are delineated on figures 240.1R-1 through 240.1R-6. The 1-percent chance floodplain of Grassy Creek is controlled by the Clinch River flood level as shown in Figure 240.1R-3. Figure 240.1R-3 also provides the 1-percent-chance floodplain of the Clinch River in the vicinity of the barge unloading area.

2. Details of the analyses used in the computation of the 1-percent-chance floodflows and water elevations are described in the study "Flood Insurance Study, Roane County, Tennessee, (Unincorporated Areas)" made by TVA for FIA and published in March 1980. Copies of the sections of this report that describe the hydrologic and hydraulic analyses (pages 8-15), together with the list of report references (pages 29-30) and Clinch River profiles (figure 02P), are provided in Exhibit 1.

3. Construction activities proposed in the 1-percent-chance floodplain include a limited amount of clearing and grubbing and those associated with the construction of three runoff treatment ponds, the river water intake structure, the

barge unloading facility, discharge outfall facility and portions of the plant access road and railroad. These structures, along with the clearing and grubbing limits, are shown on figures 240.1R-1 through 240.1R-6.

4. & 5. The proposed construction activities or structures that are located in the floodplain will not alter floodflows or elevations. The drainage areas--3,380 square miles at Clinch River mile 15.5 and 3,368 square miles at Clinch River mile 17.8--are not altered and the reduction in flow area at the site is infinitesimal and at the fringe of the flooded area. The site will be well-maintained and any debris generated from it will be minimal and will present no problem to downstream facilities.

6. (a) River Water Intake Structure

No non-floodplain alternative exists for the River Water Intake (Figure 240.1R-1). The intake pipe must be located in the river in order to draw water. Maintenance of a 2:1 slope and placement of rip rap along the river bank leading from the intake structure will mitigate any impact from the 1 percent chance flood occurrence.

(b) Barge Unloading Facility

The primary function of the Barge Unloading Facility (Figure 240.1R-3) is to furnish an economical, practical transportation means for major plant components, e.g., reactor vessel, etc.

Alternate transportation systems, i.e., road and rail, can accommodate neither the component sizes nor the weights.

The facility must be located in the river in order to service the barges. As a result, no non-floodplain alternative exists for the Barge Unloading Facility. The 1 percent chance flood will intersect on roads leading to and from the facility and on the railroad all of which will have a 2:1 slope and grassed berms to mitigate any impact from the 1 percent chance flood occurrence.

(c) Discharge Outfall Facility

The function of the Discharge Outfall Facility (Figure 240.1R-1) is to integrate all plant discharges into the main body of the Clinch River as rapidly and as thoroughly as possible in order to minimize environmental impacts. Consequently, non-floodplain alternatives cannot satisfy the functional requirements of the Discharge Outfall Facility. Maintenance of a 2:1 slope and placement of rip rap along the river bank leading from the Discharge Outfall Facility will mitigate any impact from the 1 percent chance flood occurrence.

7. (a) Runoff Treatment Ponds

The prime function of the Runoff Treatment Ponds is to settle/filter surface runoff during both construction and plant operation to effect suspended solids removal prior to discharge to the Clinch River.

Runoff treatment ponds "A", "B" and "E" are located in low lying areas within the projected one-percent-chance floodplain. (Refer Figures 240.1R-7, 8 & 9, respectively.) Practical

design constrains the pond bottom elevations to approximate the receiving water body (Clinch River) elevation. Such an arrangement affords a minimum pond expanse while eliminating downstream pond discharge problems associated with high discharge velocities.

Alternate location of presently proposed ponds and appurtenances are not practical for the following reasons:

Pond "A" - Moving Pond "A" out of the flood plain would cause relocation of necessary construction laydown/storage and shop areas. Main fill extension to accommodate displaced laydown and shop needs would require substantial clearing/grubbing and earthwork. (Figure 240.1R-7.)

Pond "B" - The sewage treatment plant, waste treatment lagoon/equalization basin and warehouse would have to be relocated to less desirable and practical sites. (Figure 240.1R-8.)

Pond "E" - Physical constraints prevent this pond from being constructed within adjacent railroad/access road fill. Alternate railroad and access road siting would require drastic realignment either through hills toward the east or the flood plain on the west. Alternately, rugged upstream topography precludes suitable and practicable pond relocation. (Figure 240.1R-9.)

As an additional alternate, should Ponds "A" & "B" be relocated so as to be contained within nearby undisturbed natural high terrain (Figures 240.1R-7 & 8), the following consequences would result:

- the resulting toe of natural slope embankments would in turn be subject to the one-percent-chance flood backwaters
- additional construction expenditures would be required for clearing/grubbing, earthwork and rock excavation

Thus, any alternative location of these ponds will still require construction of either alternate structures and/or alteration of topographic features presently within or adjacent to the floodplain; be economically unsound and/or be an impracticable alternate from the standpoint of the functional requirements of the runoff treatment ponds. Therefore, there is no practical alternative to locating these ponds within the 1-percent-chance floodplain. Measures such as grated gravel, or crushed rock and grass will be placed to minimize adverse floodplain impacts to the runoff treatment ponds.

(b) Road and Railroad Alignments

Onsite Road

The plant access road and rail spur (Key Plan, Figure 240.1R-10) provide necessary transportation modes for material and personnel. The presently proposed onsite road alignment closely follows an existing river patrol road (Figures 240.1R-1 through 240.1R-6). Road gradients, geometric alignment, clearances, etc., must be upgraded to accommodate the transportation requirements for the project. Alternate road route(s) would either be located totally within the floodplain or pass through terrain requiring excessive clearing, excavation and fill for embankments.

Onsite Railroad

The onsite railroad work has been incorporated with the proposed access road earthwork (Figures 240.1R-3 and 240.1R-4). Such alignment minimizes floodplain encroachment by restricting the rail route to the floodplain perimeter. Alternate onsite routes would either pass totally within the projected floodplain or via adjacent steep hills, thereby necessitating extensive earthwork at excessive cost.

Offsite Railroad

Alternate offsite railroad routes were investigated during the design process. The selected offsite layout represents the most practical, feasible route free of the following physical constraints: (Figures 240.1R-10 through 14).

- Gallaher bridge superstructure
- Oak Ridge Turnpike embankment
- Oak Ridge Turnpike overpass at Bear Creek Road
- Bear Creek Road travelway and shoulder
- Rugged topography of Pine Ridge (east side of Bear Creek Road in the vicinity of Oak Ridge Turnpike)

No practical alternate offsite railroad alignment exists. Adverse floodplain impacts will be minimized by:

- Maximizing high ground routing where railroad is not adjacent to Bear Creek Road (Figures 240.1R-12 and 13.)

- Placing required railroad supporting fill at the floodplain perimeter where the railroad is adjacent to existing Bear Creek Road (Figure 240.1R-14).

- Providing the site access road and railroad berms with a 2:1 grassed slope, except for those areas of culvert crossing (Grassy Creek and upstream of Grassy Creek) which will be rip rap for interface between the river water and the road and railroad embankments.

While alternate transportation modes exist, not all required products and materials are adaptable to the alternate transportation modes. Point of origin, shipment size, shipping economics and specialty components, etc., determine the transportation method utilized, i.e., not everything can be transported via road or water. For example, turbine stators are historically rail shipped via special rail cars.

Consequently, non-floodplain alternatives cannot satisfy the functional and practicable requirements of railroad and access road, both alignment and mode.

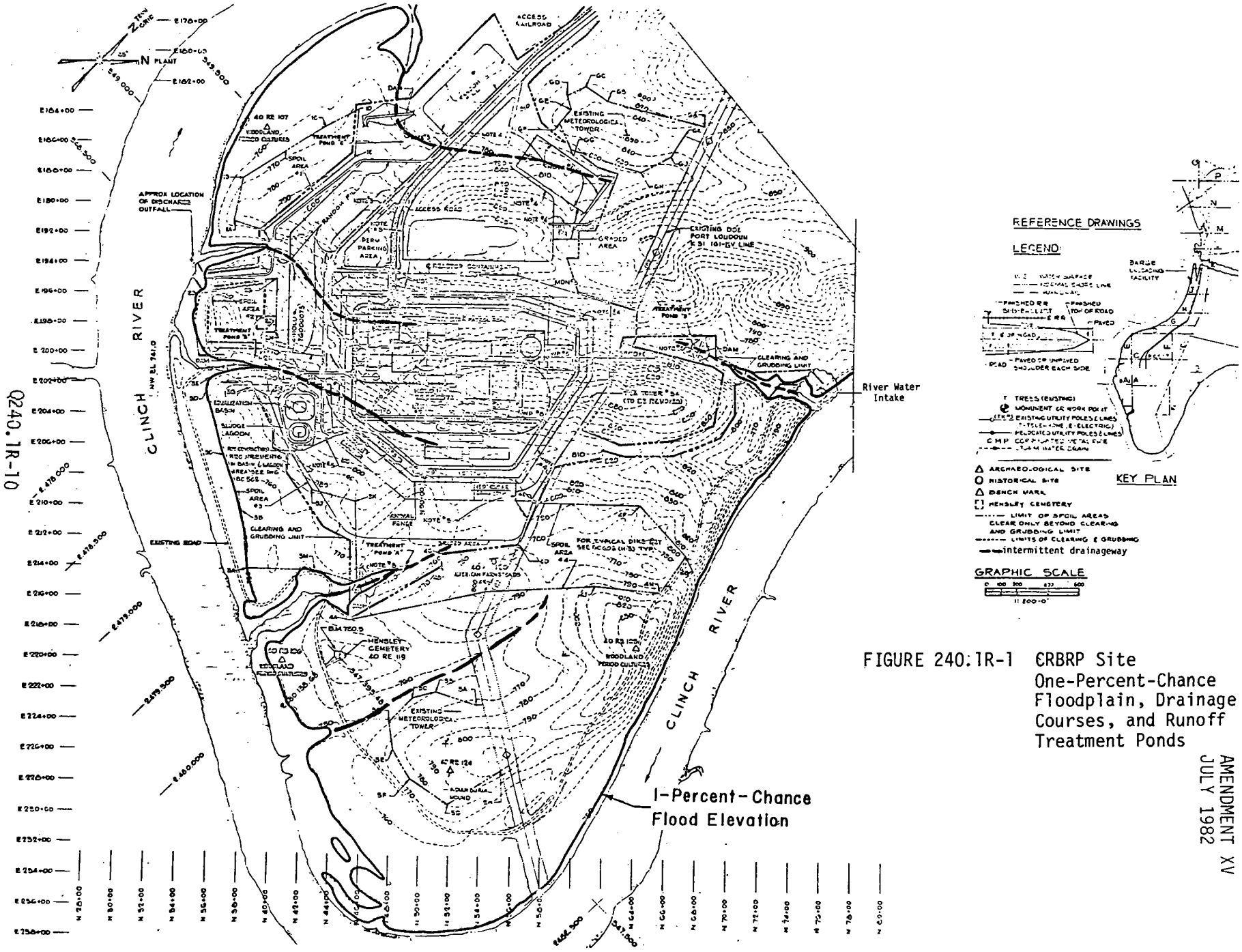

FIGURE 240.1R-1 CRBRP Site One-Percent-Chance Floodplain, Drainage Courses, and Runoff Treatment Ponds

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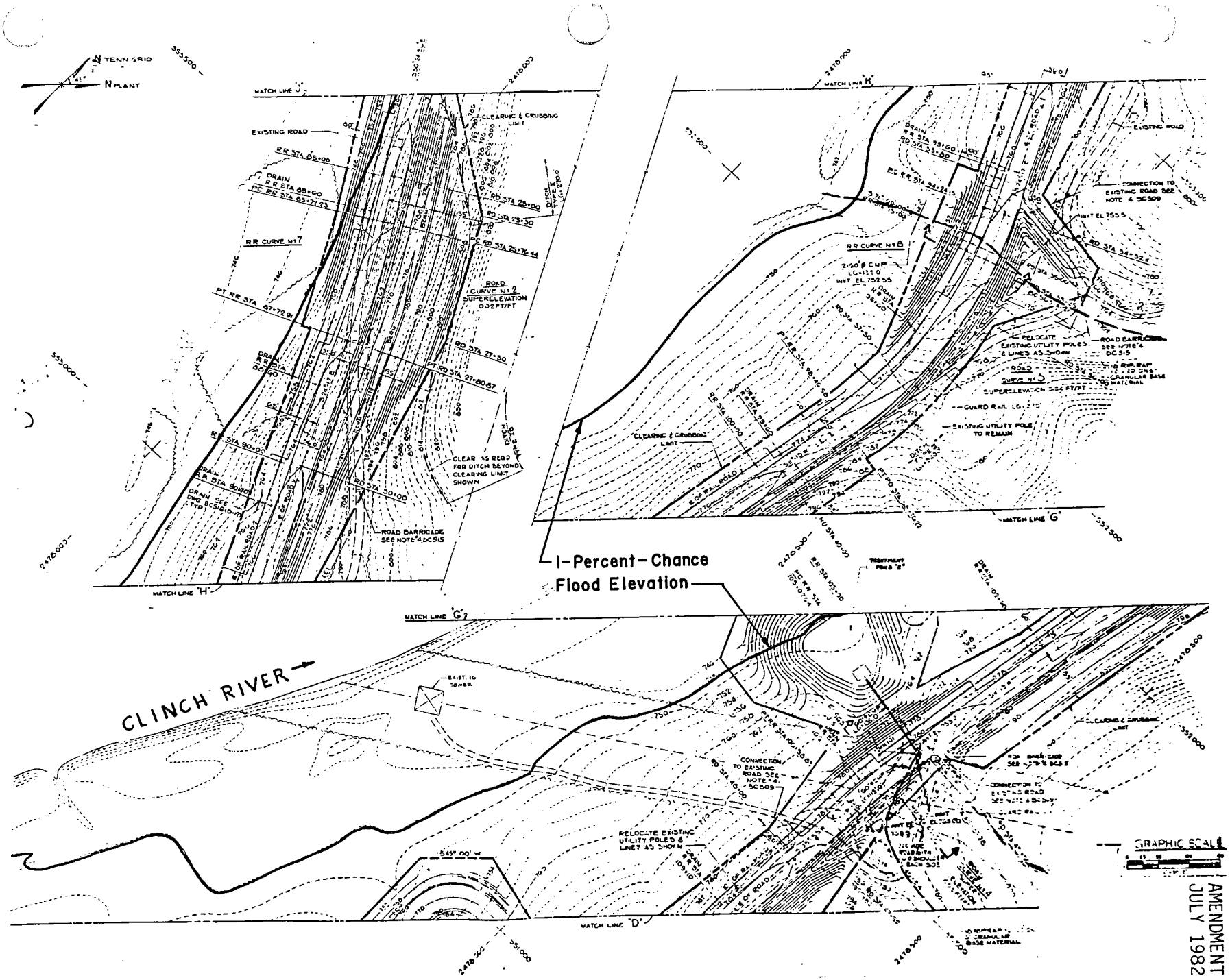


Figure 240.1R-2 CRBRP Site Access Road and Railroad One-Percent-Chance Flood Plain

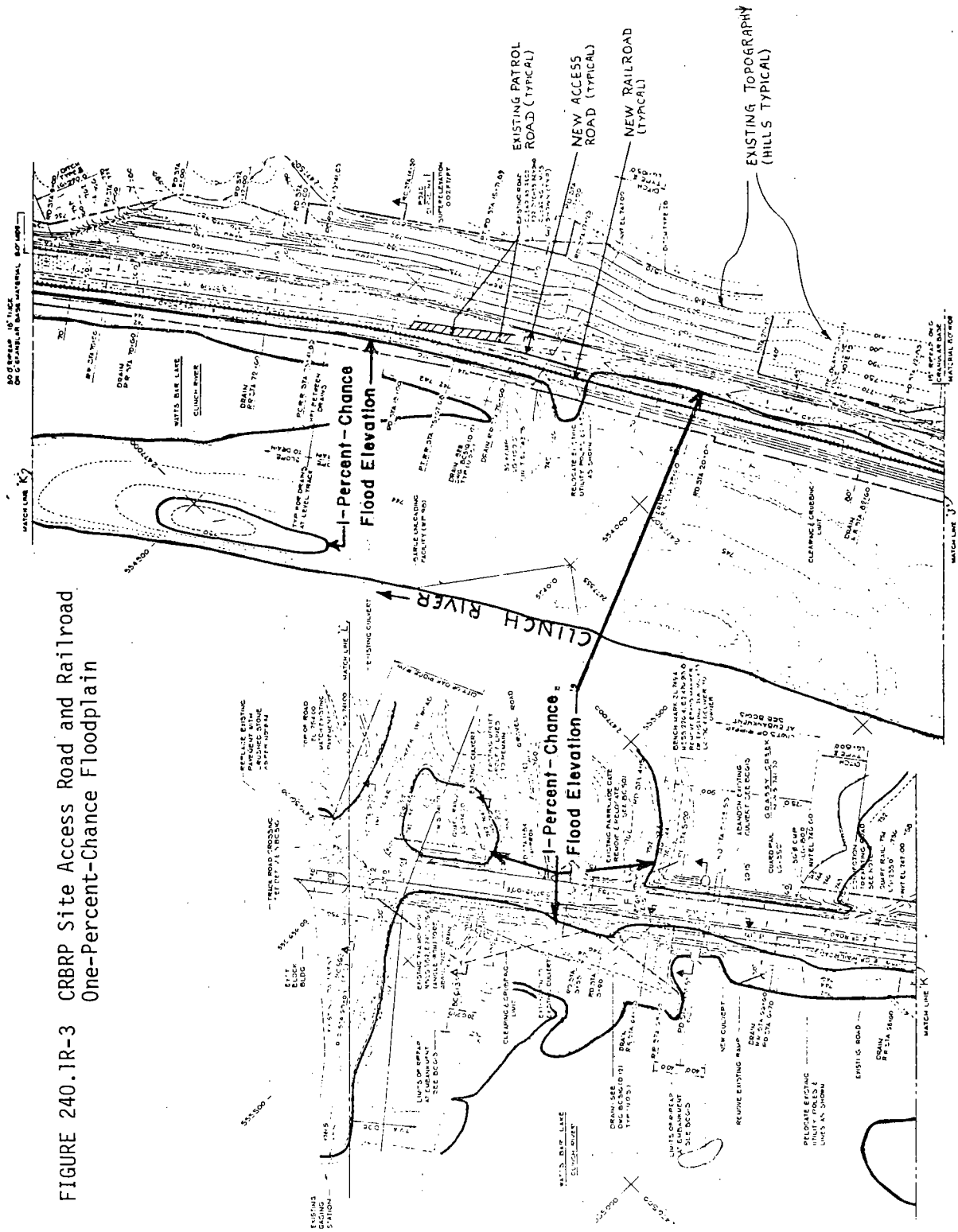
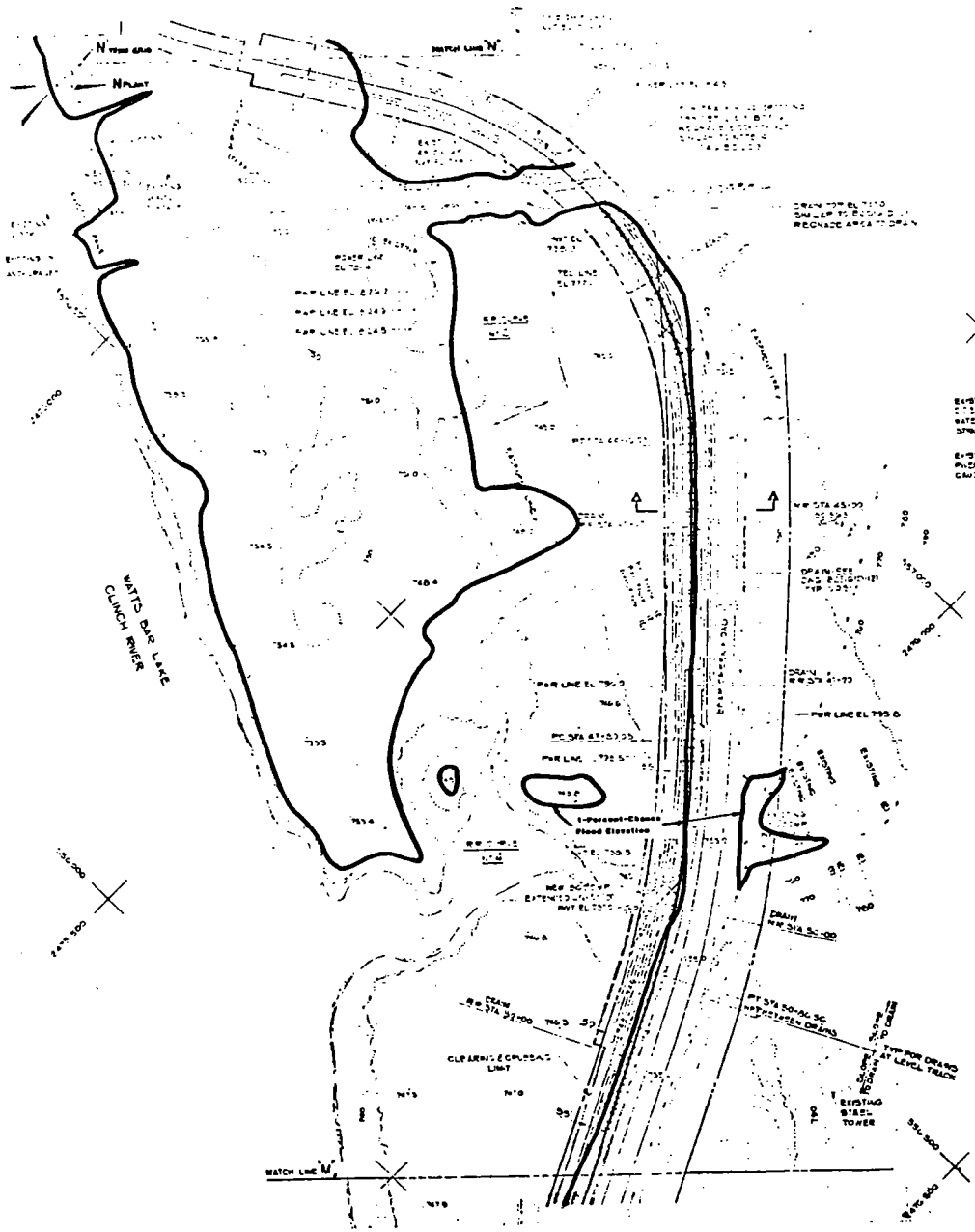


FIGURE 240.1R-3 CRBRP Site Access Road and Railroad One-Percent-Chance Floodplain



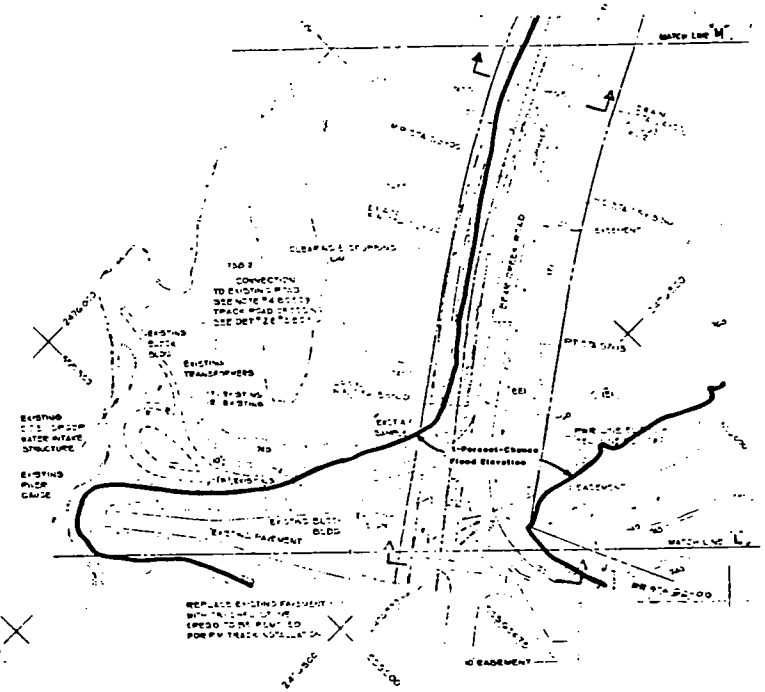


FIGURE 240.1R-4 CRBRP Site Access Road and Railroad One-Percent-Chance Floodplain

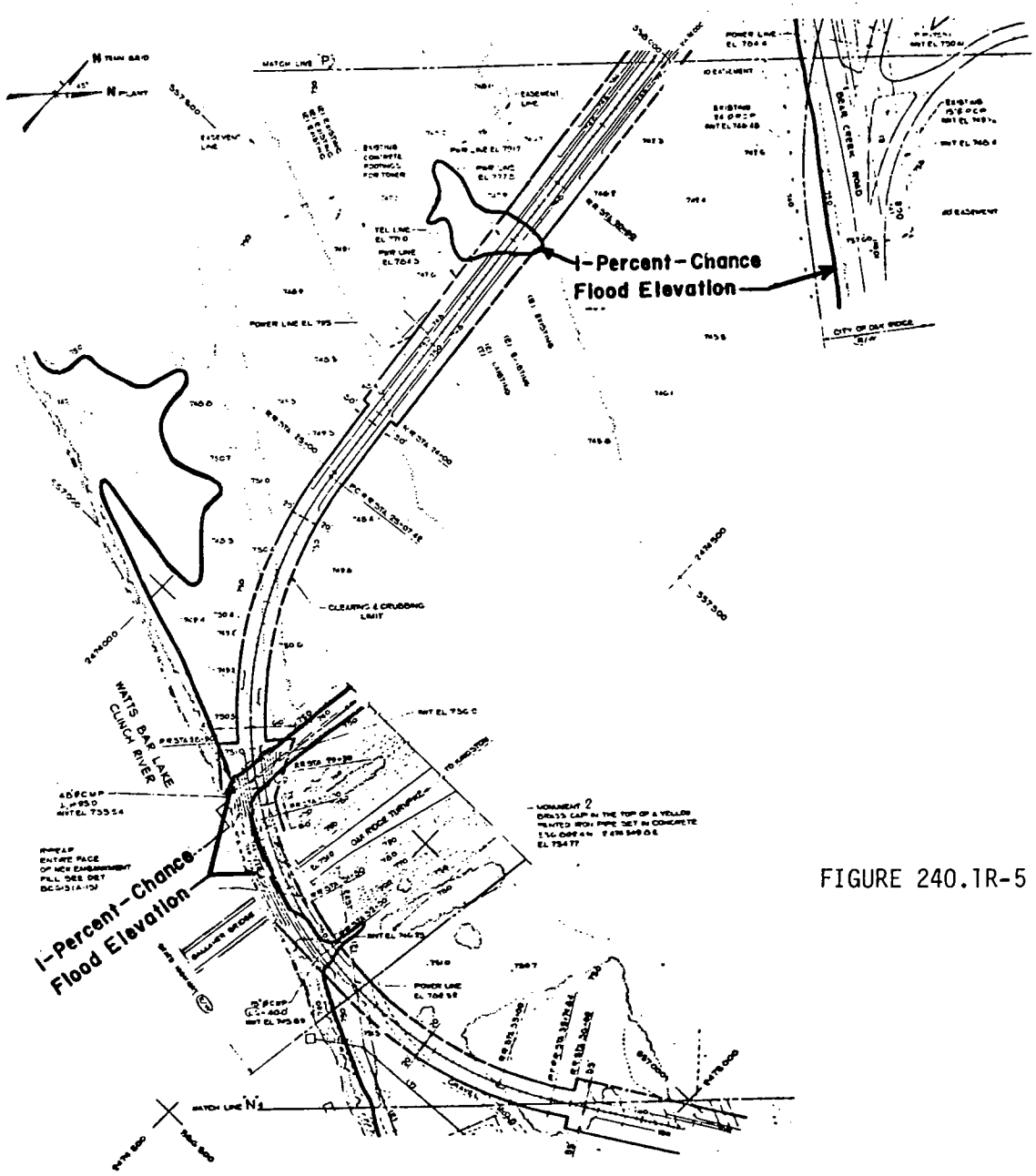


FIGURE 240.1R-5 CRBRP Site Access Road and Railroad, One-Percent-Chance Floodplain

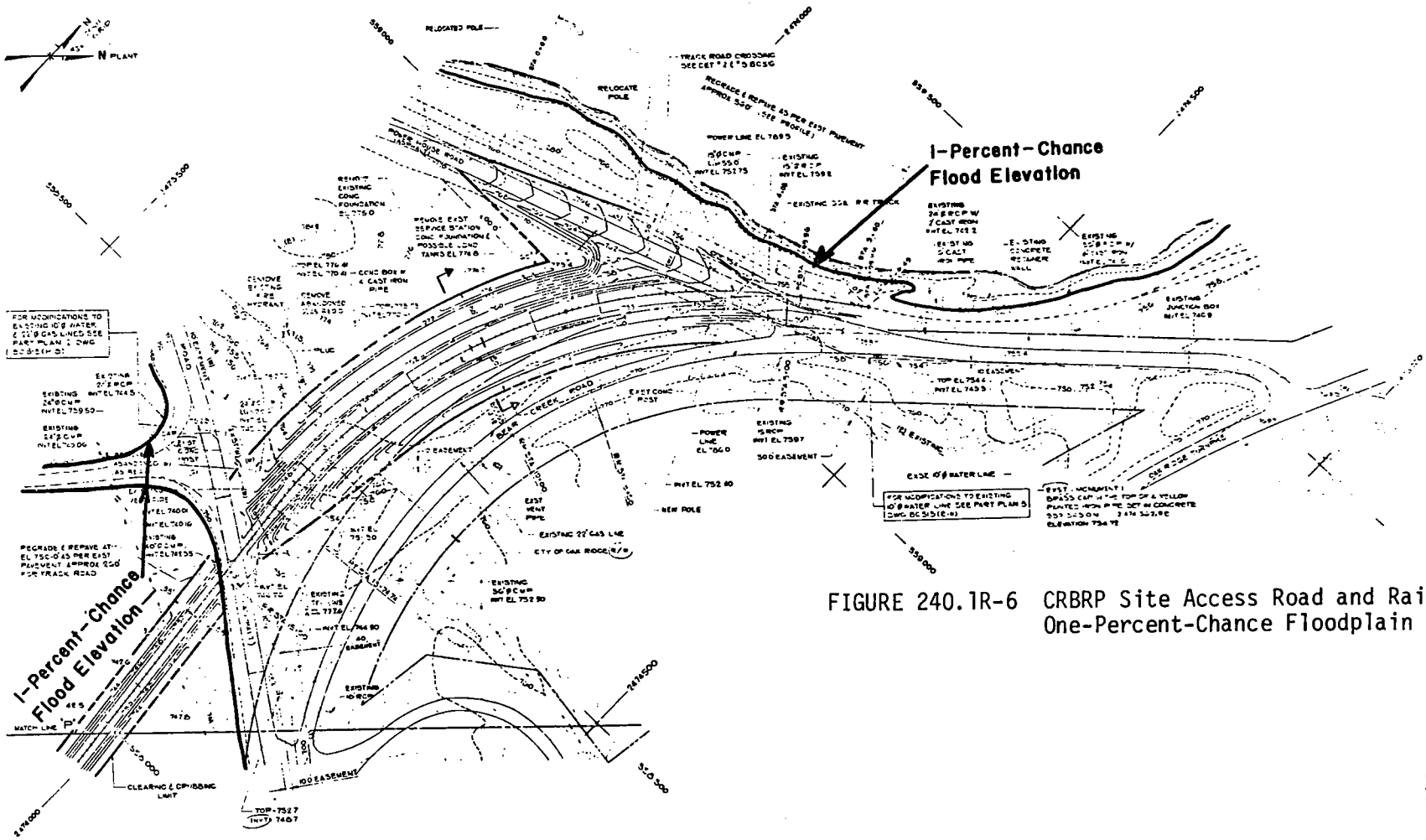


FIGURE 240.1R-6 CRBRP Site Access Road and Railroad One-Percent-Chance Floodplain

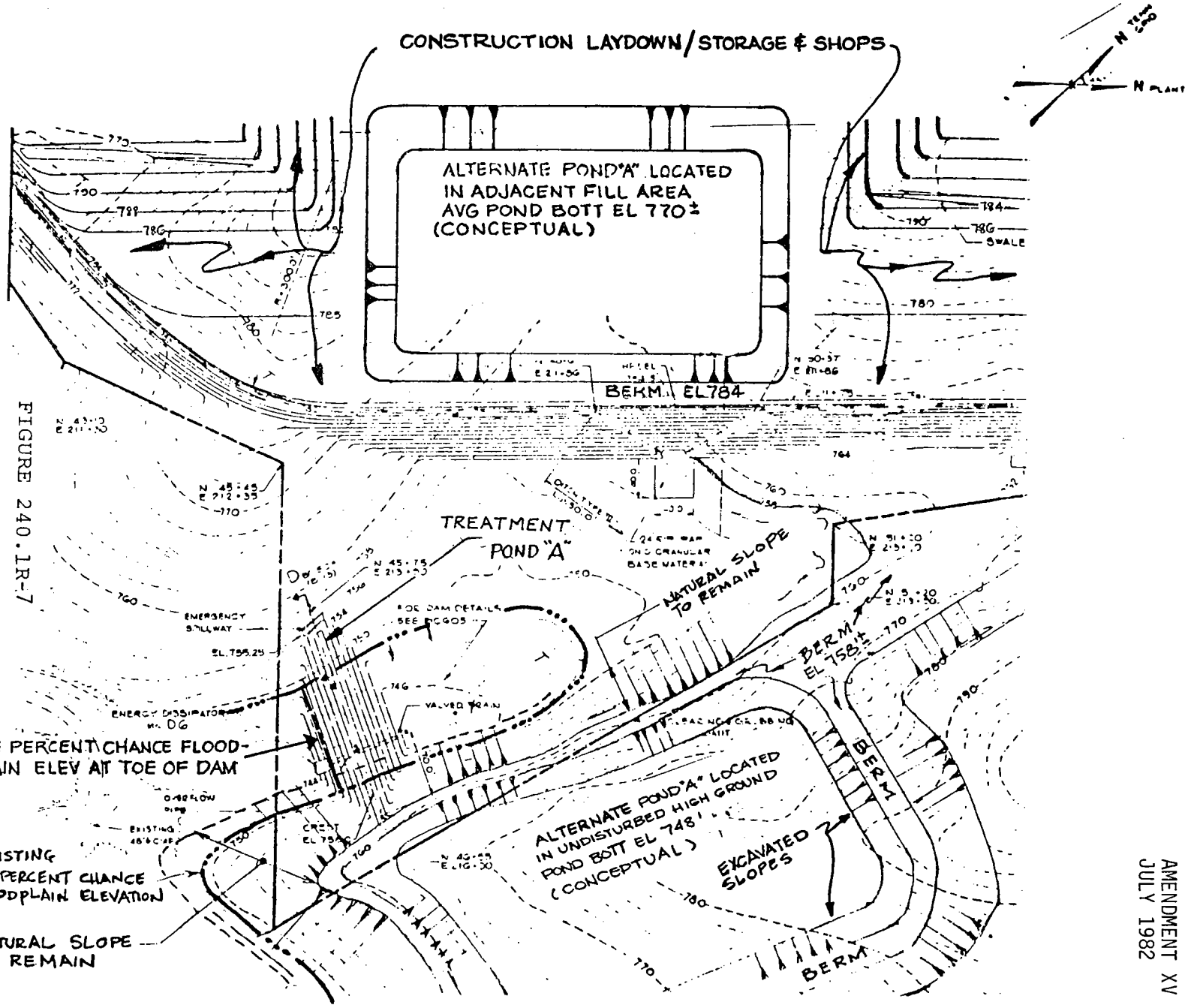


FIGURE 240.1R-7

Treatment Pond 'A' Vicinity

FIGURE 240.1R-8

Treatment Pond 'B' Vicinity

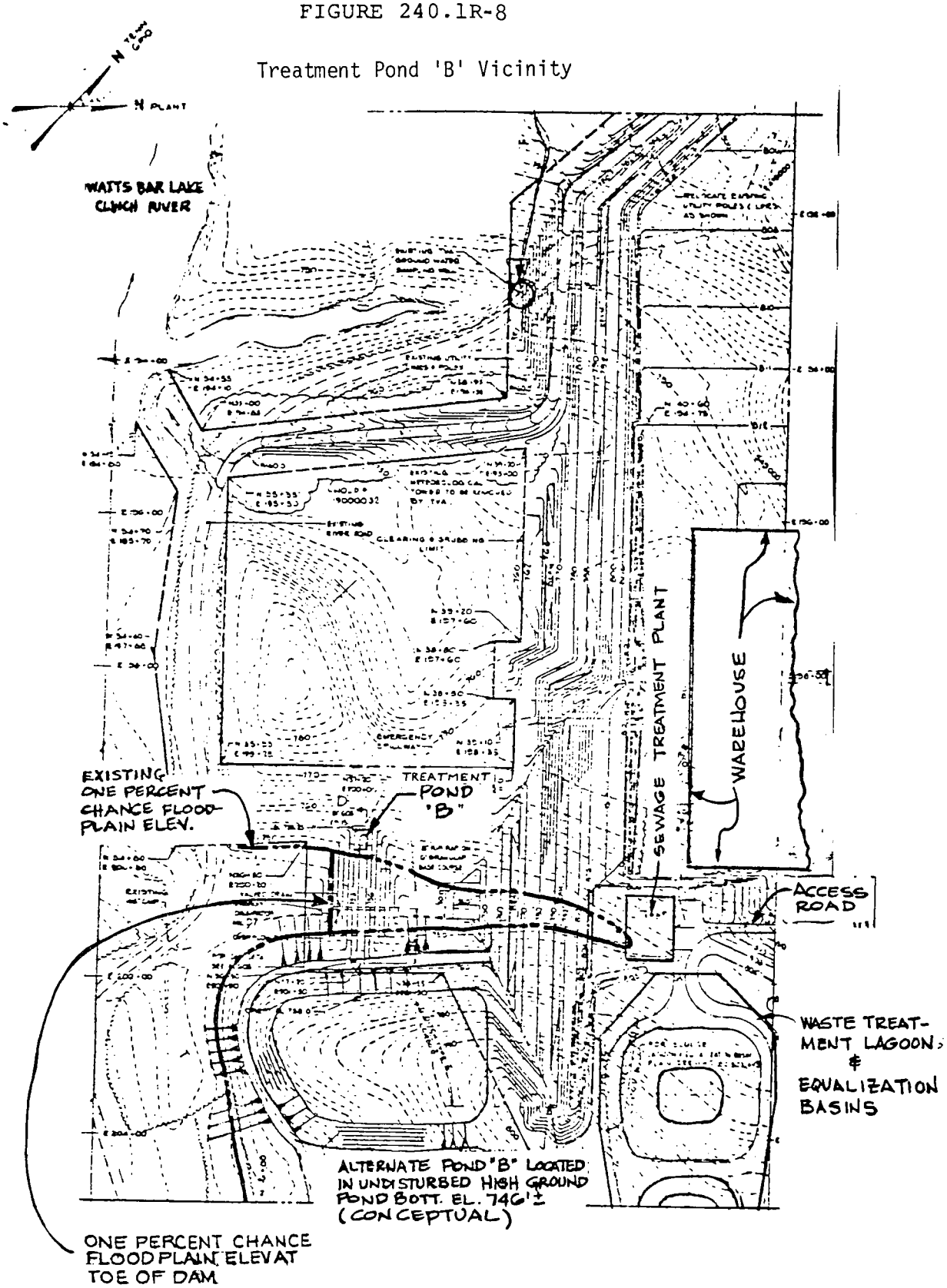


FIGURE 240.1R-9

Treatment Pond 'E' Vicinity

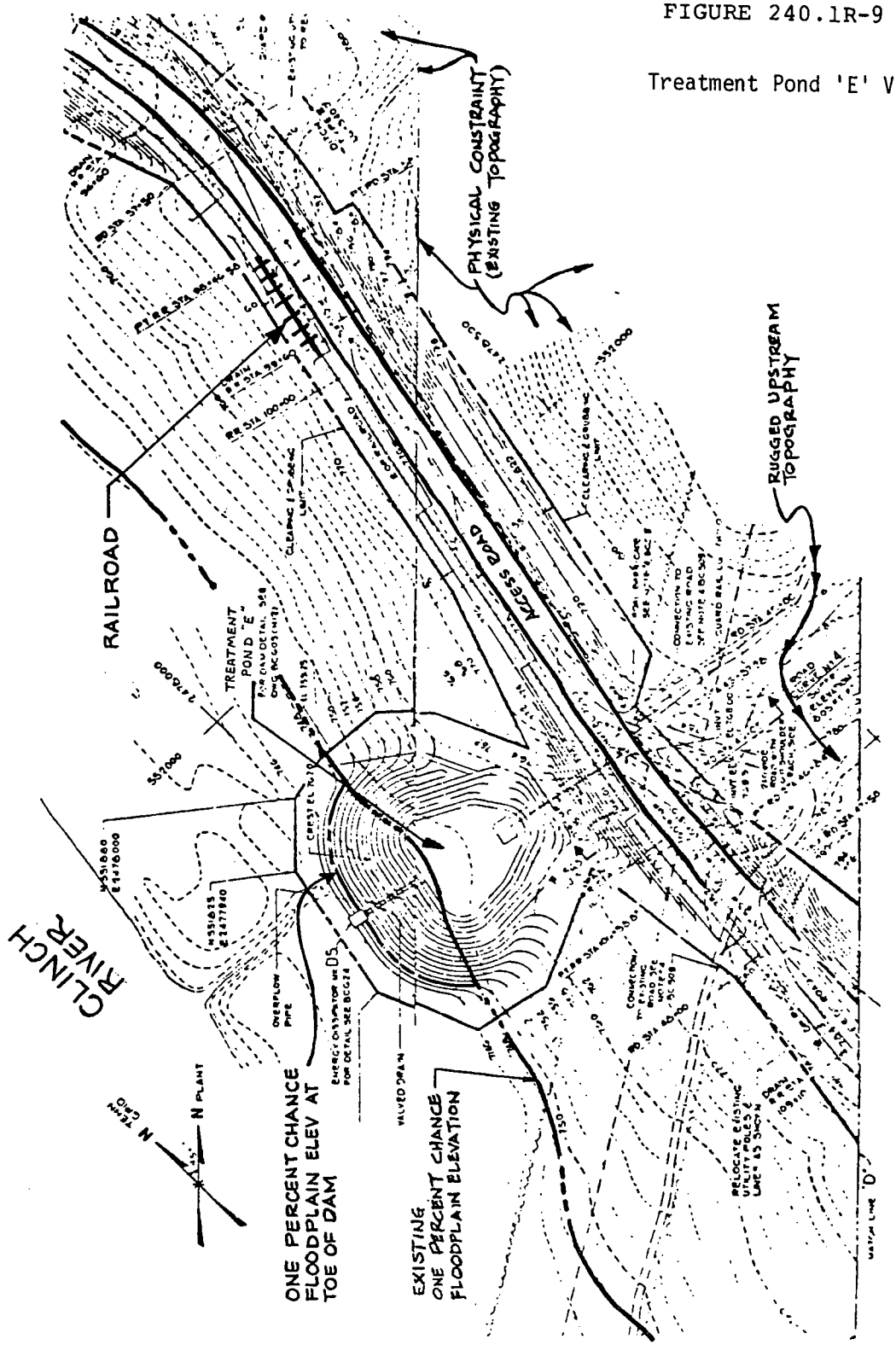


FIGURE 240.1R-10

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Access Road and Railroad Key Plan

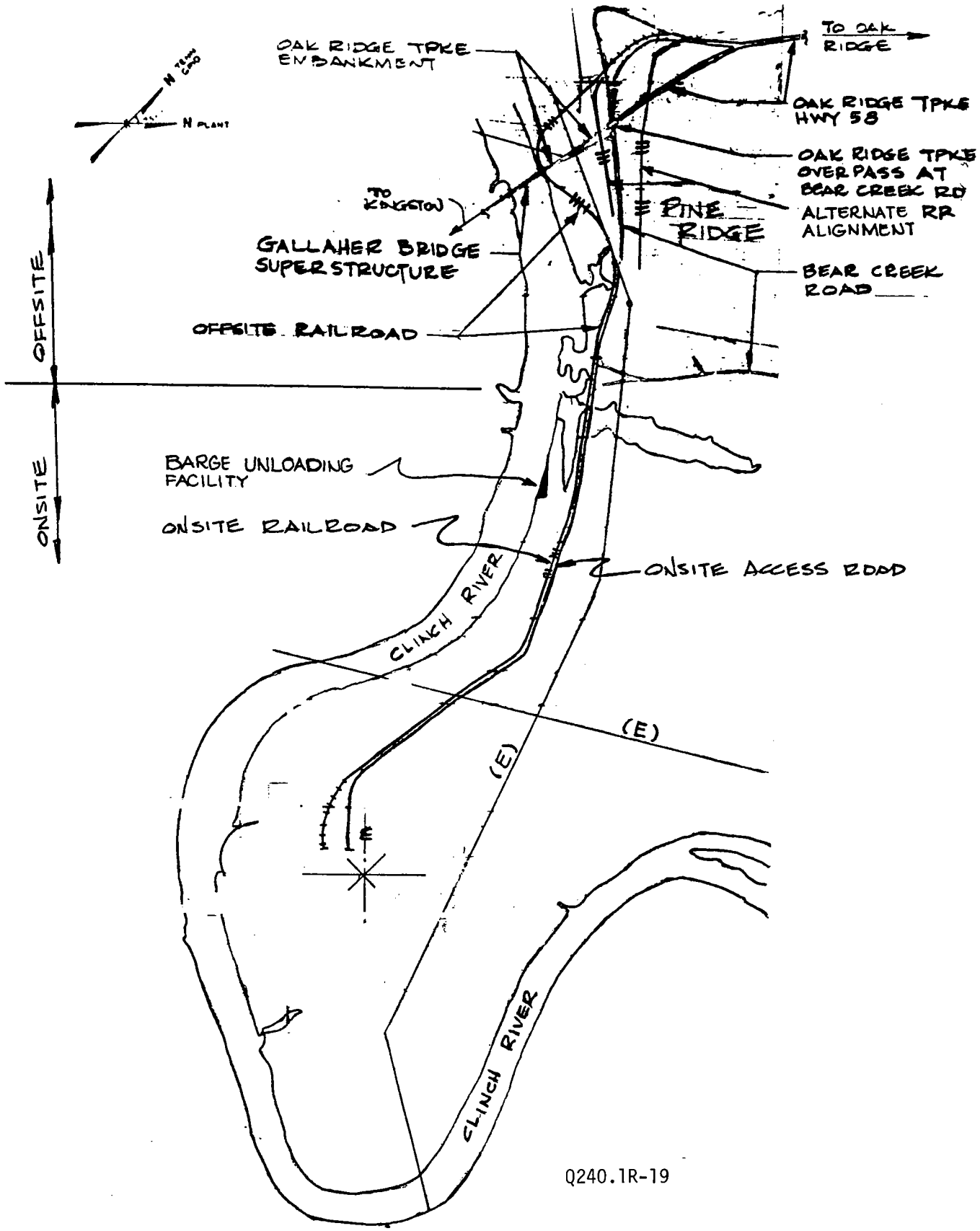
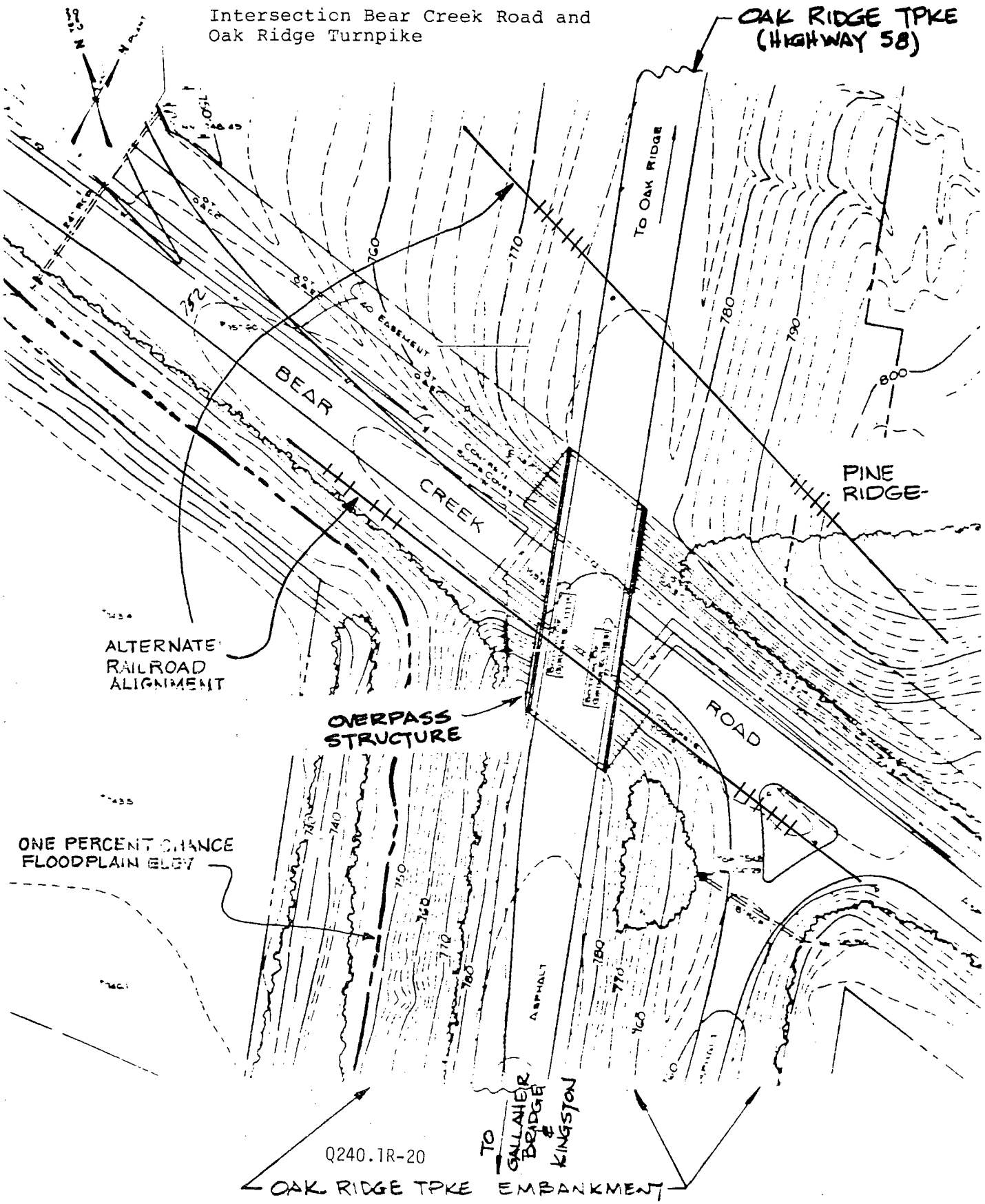


FIGURE 240.1R-11

Intersection Bear Creek Road and Oak Ridge Turnpike



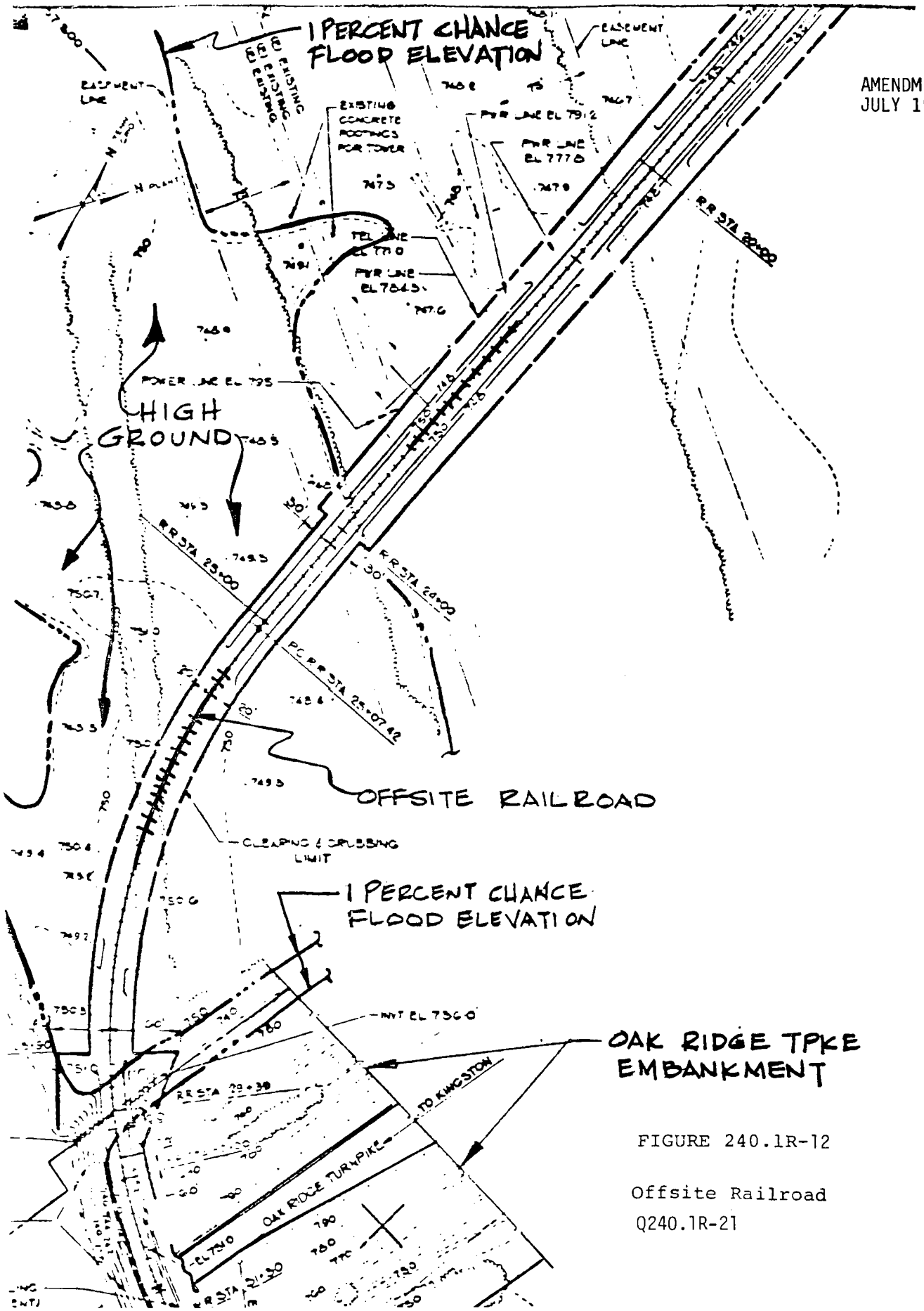


FIGURE 240.1R-12

Offsite Railroad

Q240.1R-21

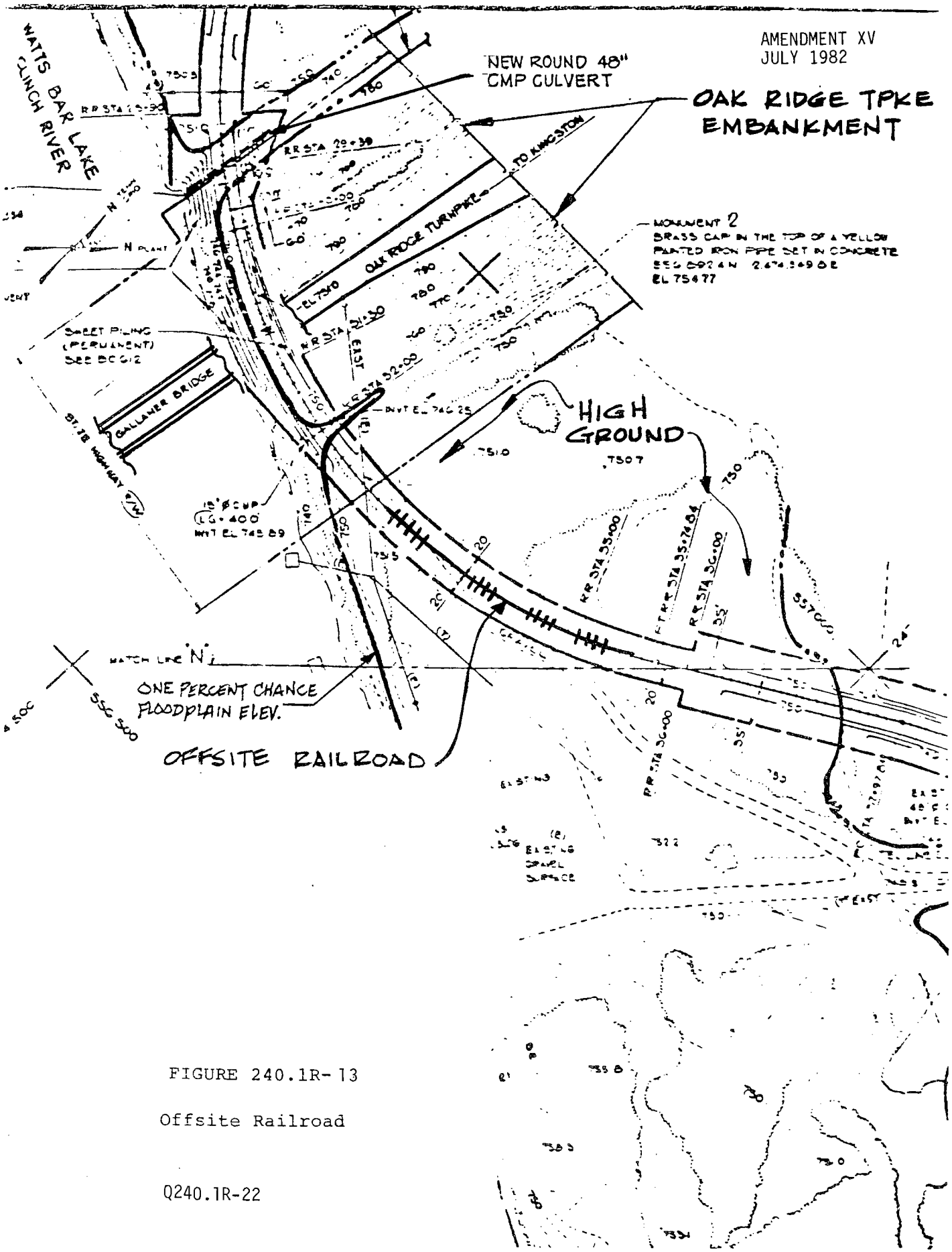


FIGURE 240.1R-13

Offsite Railroad

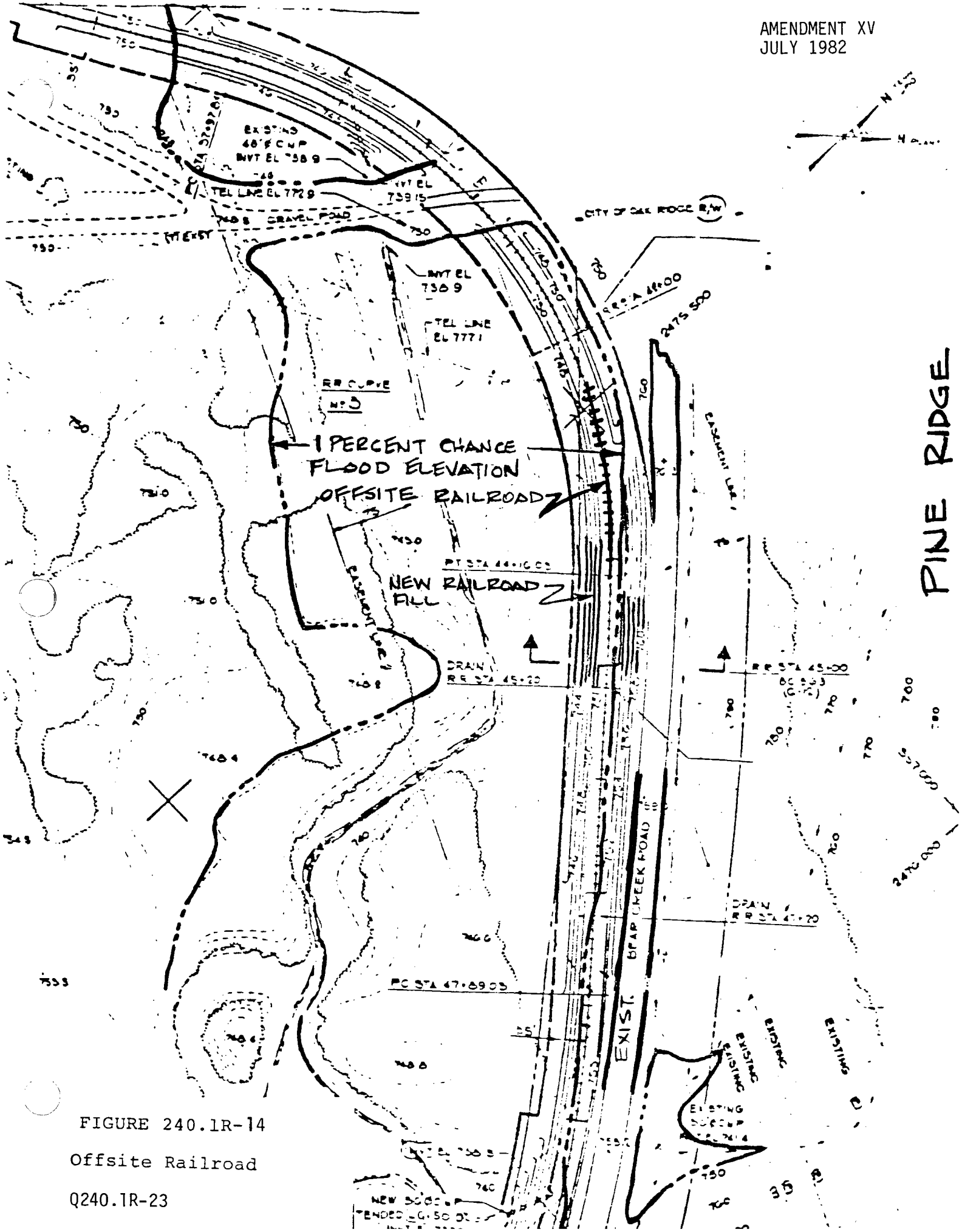


FIGURE 240.1R-14

Offsite Railroad

Q240.1R-23

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3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, and 500-year period (recurrence intervals), have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50 year period is about 40 percent (four in 10), and for any 90 year period, the risk increases to about 60 percent (six in 10). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail in Roane County.

Tennessee River discharges for the study limits mile 543.6-583.8 and the lower end of Clinch River have been progressively altered by the closure upstream main river and tributary dams. Further regulation will be attained with the closure of Tellico Dam on the Little Tennessee River at mile 0.3. Frequency is based upon anticipated post Tellico conditions.

Flood profiles panel 01P is a plot of elevation-frequency profiles for the Tennessee River from mile 543.6 to mile 583.8.

The standard log-Pearson Type III statistical analysis was not used for Tennessee River and Clinch River frequency studies because the method is not applicable to elevation data or where there is regulation from upstream dams.

Clinch River flows have been regulated by Norris Dam, Clinch River mile 79.8 since closure in March 1936. Closure of Melton Hill Dam, mile 23.1, in May 1963 has not altered discharge probabilities.

Clinch River flow-frequency relationships were determined from graphical analysis of records from 1941-1966 at the USGS gaging station at Scarboro, Tennessee, mile 29.0 (References 7 and 8) and from graphical analysis of unpublished TVA records of Melton Hill Dam discharge from 1964-1973.

Downstream from Melton Hill Dam to the mouth of Clinch River elevation-frequency was determined by backwater computations. Analysis began at the mouth of the Clinch River with elevations determined from records at the TVA gaging station near Kingston from 1944 to 1973 (Reference 9). Flood profile panel is a plot of elevation frequency profiles for the Clinch River from miles 0.00 to 21.15.

The Tennessee River study reach is in Watts Bar Reservoir; consequently, elevations are influenced by both discharge and Watts Bar Dam headwater elevations. Elevation frequency for this reach was determined by standard step method backwater analysis using a computer program developed by the TVA similar to but with some alteration to the COE HEC-2 backwater program (Reference 10) and by elevation-frequency curves determined graphically from the following records:

Location	Mile	Drainage Area, Sq. Miles	Period of Record	Agency
At Fort Loudon Dam Tailwater, Tennessee (unpublished)	602.3	9,550	1944-1973	TVA
At Lenoir City, Tennessee (Reference 8)	600.5	12,200	1944-1955	USGS
At Loudon, Tennessee (Reference 9)	591.6	12,220	1944-1955	USGS
Near Kingston, Tennessee (Reference 8)	568.2	12,470	1944-1973	TVA

The above four gages do not have gate numbers.

The following stream gages were used to determine a principal base for estimating flow frequency for Caney Creek, Whites Creek, and Emory River:

USGS gage number 03538130 at Caney Creek near Kingston
USGS gage number 03541500 at Whites Creek near Glen Alice
USGS gage number 03540500 at Oakdale, Tennessee (Emory River)

Flow estimates on these streams were determined using drainage area relationships drawn parallel to the regional relationship and through the flow-frequency valves at the gages as determined from the gaged records.

The computed frequency profiles for the Emory River were verified against an elevation-frequency curve by graphical analysis of stage records from 1945-1975 from the TVA gage at mile 12.1 (Reference 1).

The USGS gaging stations 03538225 on Poplar Creek near Oak Ridge and 03538200 on Poplar Creek at Oliver Springs were the principal data base for defining flow-frequency relationships for Poplar Creek. Discharge-frequency estimates for intermediate locations were determined by straight line interpolation between gage stations on a log-log plot of drainage area versus discharge graph.

The USGS and TVA do not maintain any stream gages on Little Emory River, Pawpaw, Black, Indian, and Tributary to Indian Creeks. In order to define discharge-frequency data for these streams a regional relationship of peak discharge and drainage area was developed from stream flow records at the gaging stations, Table 1 - Gaging Stations.

TABLE 1 - GAGING STATIONS

Gaging Station	Gage No.	Drainage Area Sq. Miles	Period of Record	Agency
Obed River Tributary near Crossville, Tennessee	03538800	.72	1955-1970	USGS
Forked Creek near Oakdale, Tennessee	03541200	2.44	1967-1975	USGS
Millican Creek near Douglas Dam, Tennessee	03469010	4.20	1942-1962	TVA
Rock Creek near Sunbright, Tennessee	03538300	5.54	1955-1971	USGS
Caney Creek near Kingston, Tennessee	03538130	5.50	1961-1975	USGS
East Fork Poplar Creek near Oak Ridge, Tennessee	03538250	19.50	1935-1975	USGS

Richland Creek near Dayton Tennessee	03544500	50.20	1935-1975	USGS
Poplar Creek near Oliver Springs, Tennessee	03538200	55.90	1954-1975	USGS
Poplar Creek near Oak Ridge, Tennessee	03538225	82.50	1961-1977	USGS
Emory River near Wartburg, Tennessee	03538500	83.20	1935-1975	USGS
Whites Creek near Glen Alice, Tennessee	03541500	108.00	1935-1977	USGS
Emory River at Oakdale, Tennessee	03540500	764.00	1928-1977	USGS

(References 11 and 12)

These stations are located on streams having similar hydrologic characteristics to the detail streams. A frequency curve was computed using the procedure outlined in Bulletin 17A (Reference 13) including the skew map, plate 1, and was adjusted for historical flood information wherever available. The adopted regional peak flow-drainage area relationship was compared with those developed by the USGS and Tennessee Department of Transportation (1976) (Reference 14). The regionalized relationship that was adopted produced discharge values about 50 percent greater than those of the USGS. The greater discharge values were caused by lengthy record which included the 1977 flood and attention paid to gaged watersheds near the study area.

Peak discharge rates for Black Creek where sufficient urbanization has occurred to alter flood peaks were estimated by using the following relationship,

$Q_{pu} = I^x Q_{pn}$, where:

Q_{pu} = Discharge for selected probability, p, for urban conditions.

I = Percent imperviousness or urban area.

x = A factor which varies with flood probability.

Q_{pn} = Discharge for selected probability, p, for natural conditions.

The relationships and values of x were developed from equations by Espey and Winslow (Reference 15) which relate discharge at selected frequencies to watershed and climatic factors and percent impervious I. The relationships and x values were compared and found to be consistent with studies by others. Percent imperviousness (I) was estimated using ratios of imperviousness to urban area (Reference 16) and urban areas determined from 7.5-minute topographic maps.

Indian Creek has limited historical flood information and only the 1928 and 1967 floodmarks were used in this study.

Peak discharge for the 10-, 50-, 100-, and 500-year floods for the detail streams are tabulated as follows:

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
TENNESSEE RIVER					
Mile 544.8	16,980	164,000	190,000	200,000	260,000
Mile 578.9	12,360	88,000	130,000	150,000	220,000
CLINCH RIVER					
Mouth	4,413	120,000	185,000	220,000	300,000
Mile 4.4 (below mouth of Emory)	4,405	120,000	185,000	220,000	300,000
Above Emory	3,540	42,750	52,750	56,500	82,500
EMORY RIVER					
Mouth	865	112,000	172,000	205,000	285,000
Mile 5.2	811	107,000	163,000	197,000	275,000
LITTLE EMORY RIVER					
Mouth	41.7	6,300	9,900	11,500	16,500
Mile 1.6	40.6	6,000	9,400	11,100	16,000
Mile 3.0	35.7	5,500	8,700	10,100	14,900
Mile 4.2	34.3	5,300	8,500	9,800	14,500

TABLE 2 - SUMMARY OF DISCHARGES (cont.)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WHITE CREEK					
Mile 6.1	120	31,000	54,000	64,000	98,000
Mile 6.6	108	28,000	48,800	59,600	90,130
Mile 8.0	102	27,500	48,000	58,000	89,100
BLACK CREEK					
Mile 0.0	11.8	3,250	5,100	6,400	8,500
Mile 3.0	8.0	2,400	3,900	4,800	6,600
Mile 4.70	5.9	1,900	3,100	3,800	5,500
CANEY CREEK					
Mile 0.0	8.27	2,300	3,050	3,300	4,500
Mile 0.8	7.80	2,200	2,400	3,200	4,300
Mile 1.6	6.55	1,950	2,550	2,800	3,800
PAWPAW CREEK					
Mile 0.0	10.3	2,250	3,650	4,300	6,200
Mile 1.53	8.71	2,000	3,200	3,800	5,500
Mile 2.5	5.20	1,400	2,250	2,690	3,900
POPLAR CREEK					
Mile 13.8	82.5	9,800	15,200	17,800	24,800
Mile 16.1	58.5	7,800	12,500	14,500	21,000
INDIAN CREEK					
Mouth	22.6	5,400	9,700	12,000	17,000
Mile 3.55	18.1	4,600	8,000	10,000	14,900
TRIBUTARY TO INDIAN CREEK	1.36	530	830	1,050	1,500

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in Roane County were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the flood sources.

Water-surface elevations of floods for the selected recurrence intervals on the Clinch and Tennessee Rivers were computed through use of a step method backwater computer program developed by TVA similar to but with some alterations to the COE HEC-2 backwater program (Reference 10). Water-surface elevations on all other detailed streams were computed using the COE HEC-2N computer program (Reference 17). Stream cross sections for all streams except the Tennessee and Clinch Rivers were field surveyed at bridges and other strategic locations and supplemented with valley cross sections taken by photogrammetric methods at sufficiently close intervals to accurately compute water-surface elevations. The Tennessee and Clinch Rivers cross sections were based on silt range surveys and detailed topographic maps. Locations of selected cross sections used in the hydraulic analysis are shown on the Flood Boundary and Floodway Maps (FBFM) (Exhibit 3).

Channel roughness factors (Manning's "n") for these computations were determined on the basis of field inspection of channel and flood plain areas, on previous studies by TVA, and computed coefficients based on known flood profiles.

The range in values for Manning's "n" are tabulated below.

Stream	Channel	Overbank
Tennessee River	0.021-0.047	0.06-0.14
Clinch River	0.023-0.027	0.07-0.14
Emory River	0.02-0.045	0.060-0.15
Little Emory River	0.03-0.045	0.095-0.15
Whites Creek	0.022-0.07	0.09-0.19
Black Creek	0.029-0.09	0.057-0.195
Caney Creek	0.035-0.040	0.08-0.15
Pawpaw Creek	0.025-0.040	0.05-0.15
Poplar Creek	0.040-0.080	0.09-0.19
Indian Creek	0.030-0.072	0.058-0.15
Tributary to Indian Creek mile 2.33	0.04	0.070-0.105

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). Starting elevations for flood frequency profiles on the Tennessee and Clinch Rivers were developed from known data. Watts Bar normal full pool elevation 741 was used as starting elevations for flood frequency profiles on Whites Creek, Caney Creek, and Little Emory River. Starting elevations for Black, Pawpaw, Poplar, and Indian Creeks were obtained by slope-area calculations using the slope of the streambed. Flood frequency profiles for Emory River and Tributary to Indian Creek were started using backwater elevations from the Clinch River and Indian Creek respectively.

All elevations are measured from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

The flood elevations as shown on the profiles are considered valid only if hydraulic structures in general remain unobstructed, operate properly, and do not fail.

No detailed studies were made for several smaller streams in Roane County, Tennessee, that were affected by Watts Bar backwater or where there was a lack of current or planned development.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the county.

For each stream studied in detail, the boundaries of the 100- and the 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using expanded topographic maps at a scale of 1:4,800 with a contour interval of 20 feet (Reference 18). In cases where the 100- and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

Small areas within the flood boundaries may lie above the flood elevations and therefore not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain

Poplar Creek near Oliver Springer, Tennessee:

Year	Discharge (CFS)
1902	10,230
1920	9,860
1926	10,580
1928	11,300
1929	10,940
1944	9,500

This study is authoritative for the purposes of the flood insurance program and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Federal Emergency Management Agency, Insurance and Mitigation Division, 1375 Peachtree Street, N.E., Atlanta, Georgia 30309.

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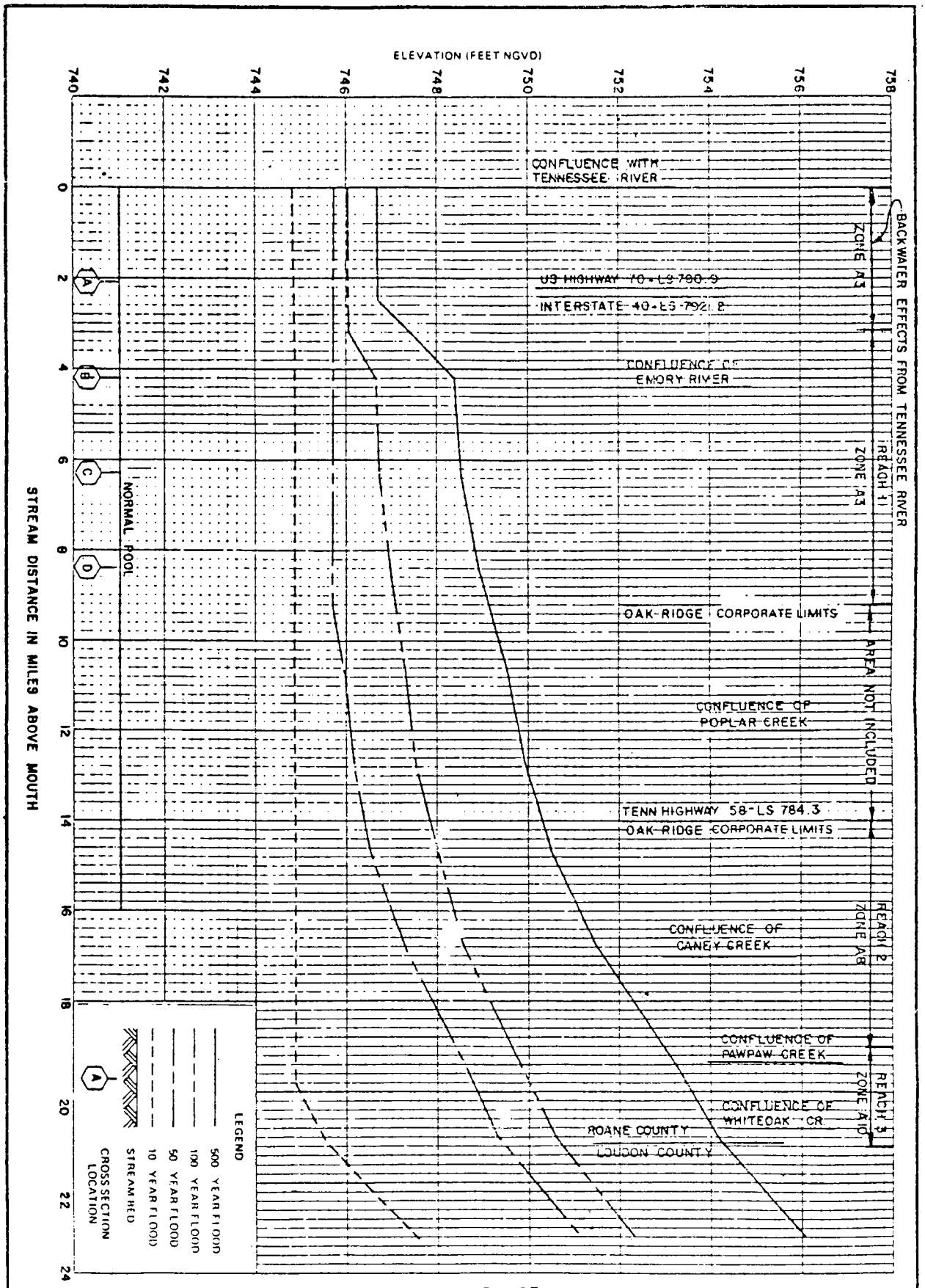

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02P	FEDERAL EMERGENCY MANAGEMENT AGENCY Federal Insurance Administration ROANE COUNTY, TN (UNINCORPORATED AREAS)	FLOOD PROFILES CLINCH RIVER

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QUESTION 240.2R

Information Requirements Relating to Liquid Pathway Releases

Calculate the radiological consequences of a liquid pathway release from a postulated core melt accident. The analysis should assume, unless otherwise justified, that there has been a penetration of the reactor basemat by the molten core mass and that a substantial portion of core debris was released to the ground. Doses should be compared to those calculated in the NRC Liquid Pathway Generic Study (NUREG-0440, 1978). Provide a summary of your analysis procedures and the values of parameters used (such as permeabilities, gradients, populations affected, water use). It is suggested that meetings with the staff of the NRC Hydrologic Engineering Section be arranged so that we may share with you the body of information necessary to perform this analysis.

RESPONSE

The Clinch River Breeder Reactor has been designed to prevent initiators and event sequences which might lead to a core melt. Nonetheless, the project has evaluated hypothetical core disruptive accidents and has concluded that a postulated core melt resulting in penetration of the reactor vessel and guard vessel will not penetrate the basemat and enter the earth below. However, in order to provide a conservative assessment of the radiological consequences of a liquid pathway release following core melt, complete basemat penetration is assumed to occur. In the approach taken here, the more significant parameters and models used in NUREG-0440 to evaluate a liquid pathway release following the core melt of a land-based plant are compared to the corresponding parameters and models used for CRBRP.

With the exception of Cd-113 and Pu-238, the equilibrium core inventory values listed in NUREG-0440 are on the order of about 2 to 32 times higher than those for CRBRP (See Table I). The slightly larger CRBRP plutonium-238 inventory would not significantly influence the outcome of the overall dose comparison of NUREG-0440 to CRBRP. The radionuclide leach mechanism modeled in NUREG-0440 would be applicable to CRBRP, since the chemical form of a postulated CRBRP core melt would be essentially the same as that for a similar LWR core melt.

Parameters relating to the movement of radionuclides leached into the groundwater system are tabulated in Table II. Further pertinent data can be found in the Geology and Hydrology Sections (2.4 and 2.5) of the CRBRP Preliminary Safety Analysis Report. The radionuclide transport river model used in NUREG-0440 was based on studies of the Clinch-Tennessee-Ohio-Mississippi River systems. Therefore the model is appropriate for CRBRP which is located on the Clinch River. Although the combined sport and commerical harvest of fish expected downstream of the CRBRP site is approximately an order of magnitude larger than that assumed in NUREG-0440 (see response to NRC questions 240.6R and 290.7R, and NUREG-0440, Section 4.3.3.1), the total population dose from a hypothetical melt-through for a particular source would not be changed by more than about a factor of 2 (see NUREG-0660, Table 6.2.17).

In summary, the contained radionuclide source in the postulated CRBRP core melt would be significantly less than the source hypothesized for the NUREG-0440 study. In addition, the transportation of radionuclides via groundwater at the CRBRP site would be bounded by the assumptions of NUREG-0440, and the

small river transport and dose conversion models from NUREG-0440 are appropriate for assessing CRBRP. Therefore, it is concluded that the doses from the postulated CRBRP core melt would fall within those calculated in NUREG-0440 for a LWR on a small river site.

TABLE I.

RADIONUCLIDE SOURCE TERM COMPARISON

Isotope	NUREG-0440 LWR Core Inventory (Ci)	CRBRP Core Inventory End of Cycle (Ci)	Ratio NUREG Value / CRBR Value
^{3}H	5.9×10^{4}	2.34×10^{4}	3
^{89}Sr	9.2×10^{7}	1.60×10^{7}	6
^{90}Sr	6.1×10^{6}	6.79×10^{5}	9
^{90}Y	6.4×10^{6}	7.11×10^{5}	9
^{91}Y	1.2×10^{8}	2.04×10^{7}	6
^{95}Nb	1.7×10^{8}	3.48×10^{7}	5
^{103}Ru	1.4×10^{8}	5.26×10^{7}	3
^{103m}Rh	1.4×10^{8}	5.26×10^{7}	3
^{105}Rh	6.7×10^{7}	3.85×10^{7}	2
^{106}Rh	7.6×10^{7}	1.96×10^{7}	4
^{106}Ru	5.1×10^{7}	1.96×10^{7}	3
^{110m}Ag	3.5×10^{5}	4.33×10^{4}	8
^{111m}Ag	4.3×10^{6}	2.57×10^{6}	2
^{113m}Cd	1.0×10^{3}	1.91×10^{3}	1/2
^{115m}Cd	6.2×10^{4}	3.55×10^{4}	2
^{115}Cd	8.8×10^{5}	5.46×10^{5}	2
^{123}Sn	9.4×10^{5}	3.62×10^{5}	3
^{125}Sn	1.5×10^{6}	7.58×10^{5}	2
^{125}Sb	7.4×10^{5}	3.96×10^{5}	2
^{125m}Te	2.5×10^{5}	7.88×10^{4}	3
^{127}Sb	8.3×10^{6}	3.76×10^{6}	2

TABLE I. (Continued)

RADIONUCLIDE SOURCE TERM COMPARISON

Isotope	NUREG-0440 LWR Core Inventory (Ci)	CRBRP Core Inventory End of Cycle (Ci)	Ratio NUREG Value / CRBR Value
^{127m}Te	$1.6x10^{6}$	$5.40x10^{5}$	3
^{127}Te	$8.1x10^{6}$	$3.69x10^{6}$	2
^{129m}Te	$6.6x10^{6}$	$2.65x10^{6}$	2
^{129}Te	$3.9x10^{7}$	$9.71x10^{6}$	4
^{129}I	2.9	$6.7x10^{-1}$	4
^{131}I	$1.0x10^{8}$	$3.00x10^{7}$	3
^{132}Te	$1.4x10^{8}$	$4.00x10^{7}$	4
^{133}I	$1.9x10^{8}$	$5.15x10^{7}$	4
^{134}Cs	$2.1x10^{7}$	$6.60x10^{5}$	32
^{136}Cs	$5.8x10^{6}$	$2.65x10^{6}$	2
^{137}Cs	$8.6x10^{6}$	$1.70x10^{6}$	5
^{140}Ba	$1.8x10^{8}$	$4.19x10^{7}$	4
^{140}La	$1.8x10^{8}$	$4.22x10^{7}$	4
^{141}Ce	$1.7x10^{8}$	$4.29x10^{7}$	4
^{144}Ce	$1.1x10^{8}$	$2.02x10^{7}$	5
^{144}Pr	$1.1x10^{8}$	$2.02x10^{7}$	5
^{238}Pu	$2.5x10^{5}$	$3.29x10^{5}$	4/5
^{239}Np	$2.1x10^{9}$	$9.48x10^{8}$	2

TABLE II

SITE SPECIFIC PARAMETER COMPARISON

Parameter	CRBRP Site Specific Value	NUREG 0440 Value
Length in feet from core basemat melt point to river.	1600	1500
Average soil porosity	.3 (measured values, 5 to 33%)	.2
Permeability (flow velocity)	2000 ft/yr (1510 highest measured) or 6.56 ft/day	2446 ft/yr or 6.7 ft/day

Question 290.1R

Provide a succinct summary and discussion in table form, by ER section, of differences between currently projected station design and environmental effects (including those that would degrade, and those that would enhance environmental conditions) and the effects discussed in the environmental reports submitted in 1975, Amendments 1 through 7.

Response

The changes to CRBRP design which have occurred since 1977 and the expected environmental effects of these changes are summarized succinctly by ER section in the attached table, entitled "CRBRP ENVIRONMENTAL REPORT REVIEW."

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
1.1	1.1-1, -2	Introduction	Rewritten to reference LMFBR Program	Environmentally Inconsequential.
1.2	1.2-1	Objectives	Rewritten to reference LMFBR Program	Environmentally Inconsequential.
1.3	1.3-1 thru 1.3-6	Meeting Objectives	Rewritten and updated	Environmentally Inconsequential.
1.4		Consequences of Delay	Deleted	
1.5		Summary	Deleted	
2.1	2.1-1 thru 2.10	Plant	Construction site acreage increased. Plant arrangements updated. Five impounding ponds were identified and located on Figure 2.1-3.	See Section 4.0
2.2	2.2-1 thru 2.2-67	Demography, Land & Water Use	Regional demography, land and water uses were updated using preliminary results of the 1980 U.S. Census. The revised figures showed population growth slightly below projections of 1976. However, the deviations would make CRBRP-inspired growth more easily assimilated.	A slightly favorable environmental effect.
2.3	2.3-1 thru 2.3-25	Regional Cultural Historic & Archeological Features	Updated to reflect an evaluation of previously unsurveyed cultural, historic and archeological features. The evaluation is consistent with the provisions of the National Historic Preservation Act of 1979, as amended. No new significant data were developed.	Environmentally Inconsequential.
2.4	2.4-15 thru 2.4.22	Geology	Changed to provide data for 24 additional boreholes, taken from September 1976 to June 1977.	Environmentally Inconsequential.
2.5				
2.5.1	2.5.1 thru 2.5-10	River	Updated river levels, flows, temperatures, etc.	Environmentally Inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
2.5.2				
2.5.2.1			No change.	
2.5.2.2			No change.	
2.5.2.3			No change.	
2.5.2.4	2.5-18	Ground-water	Established piezometric gradient.	Environmentally inconsequential.
2.5.2.5			No change.	
2.5.2.6			No change.	
2.5.2.7			No change.	
2.6	2.6-1 thru 2.6-63	Meteor-ology	Updated to include data accumulated using permanent meteorological tower.	Environmentally inconsequential.
2.7				
2.7.1				
2.7.1.1	2.7-1a	Forest Manage-	Incorporates ORNL forest management activities from 1976 through 1980.	No change in estimated environmental effects for CRBRP. Mitigation measures for Southern Pine Beetle and Pitch Canker Infestations.
2.7.1.2			No change.	
2.7.1.3	2.7-7 thru 2.7-9	Flora	Update vegetation inventory reporting.	Environmentally inconsequential.
	2.7-24, -37	Flora	Correct pine designation.	Environmentally inconsequential.
	2.7-38l, -38m	Flora	Revise category designation from "threatened" to "rare" to reflect current terminology.	Environmentally inconsequential.
2.7.1.4	2.7-38o thru 2.7-38t	Fauna	Update wildlife occurrence data.	Environmentally inconsequential.
	2.7-38ee	Insects	Update reporting concerning insect pests.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
	2.7-38ff	Fauna	Revised to include possibility of eastern cougar occurrence on Oak Ridge Reservation.	Occurrence on CRBRP site not confirmed. Also, cougar home range is sufficiently extensive to absorb effect of CRBRP installation. Environmentally inconsequential.
	2.7-38gg	Avifauna	Adds mention of osprey nest occurrence at Watts Bar Lake.	Osprey nesting at CRBRP site has not been observed. Environmentally inconsequential.
2.7.1.5			No change.	
2.7.1.6	2.7-38tt	Avifauna	Update classification of American osprey.	Occurrence of nesting at site has not been observed.
2.7.1.7	2.7-38ww	Surveys	Report on 1980 reconnaissance surveys.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
2.7.2				
2.7.2.1			No change.	
2.7.2.2			No change.	
2.7.2.3			No change.	
2.7.2.4	2.7-87g	Fish	Report of occurrences of the blue sucker in Watts Bar Lake. Blue sucker is identified as a threatened species.	Occurrence not reported near Site. Environmentally inconsequential.
2.7.2.5	2.7-87h -87i	Aquatic Surveys	Report on 1980 reconnaissance surveys.	Stocking activities have resulted in reported increases in gamefish. No change in estimated environmental effects due to CRBRP.
2.8	2.8-1 thru 2.8-109	Background Radiation	Complete update reflecting latest ORNL, TVA and similar organization studies and scientific papers.	Data better characterizes the actual site and the surrounding areas. Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.0				
3.1	3.1-1	External Appearance	A five foot high animal fence was added at a distance of 33 feet from the security fence.	Preclude small animals from plant site and and restrict them to more natural environs. Environmentally inconsequential.
3.1.1	3.1-2	Plant Bldg. & Facilities	Gatehouse, circulating water pump house and fire protection pump house were identified. The switch yard relay house was added.	Environmentally inconsequential.
			The configuration and location of the emergency cooling tower structure were revised.	Environmentally inconsequential.
3.1.2	3.1.4	Plant Site	Five foot high animal fence added.	Environmentally inconsequential.
3.1.3	3.1-4	Other Facilities	The size of paved parking area was reduced for accommodation of 155 cars instead of 250 before.	Environmentally inconsequential.
3.2				
3.2.1			No change.	
3.2.2	3.2-3	Core	Replaced homogeneous core with heterogeneous arrangement resulting in eliminating one fuel enrichment zone (was 2, now 1), reducing number of fuel assemblies from 198 to 156, reducing number of radial blanket assemblies from 150 to 126, adding 82 inner blanket assemblies, and increasing Pu enrichment in fuel assemblies from 18.7-32% to 32-33%.	Net change judged to be insignificant.
3.2.3			No change.	
3.3				
3.3.1	3.3-1	Overall Plant	Average annual consumptive water use figures were revised to be consistent with those in Tables 3.3-1, 3.3-2 and 3.3-3.	Environmentally inconsequential.
3.3.2	3.3-2	Cooling Tower	Flowrate to cooling tower from condenser increased from 209,200 gpm to 212,200 gpm.	Slight increase in plume size will not produce significant environmental impact.
3.3.3	3.3-2	Process Water Treatment System	Added makeup water treatment system	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.3.4	3.3-3	Waste Water Disposal System	All process waste water including floor drains, go to Waste Water Disposal System instead of being routed to either cooling tower basin or neutralization and settling facilities.	Results in higher quality of water discharged.
3.3.5	3.3-3	Radwaste Systems	Updated description.	See Section 3.5.
3.3.6	3.3-4	Potable Water Sources	Potable water is supplied by DOE's Bear Creek Road Filtration Plant instead of the Make-up Water Treatment System.	Environmentally inconsequential.
Table 3.3-1	3.3-5	Plant Flowrates During Maximum Power	Increase in plant make-up flow rate from 5835 gpm to 6145 gpm.	Environmentally inconsequential.
			Increase in cooling tower evaporation rate from 3475 gpm to 3623 gpm.	Environmentally inconsequential.
			Increase in cooling tower drift rate from 105 gpm to 106 gpm.	Environmentally inconsequential.
			Increase in cooling tower blowdown rate from 2210 gpm to 2306 gpm.	Environmentally inconsequential.
			Decrease in Process Waste Treatment flow rate from 125 gpm to 110 gpm.	
			Waste Water Disposal System Flowrate designed at 100 gpm.	Environmentally inconsequential.
			Increase in plant discharge rate from 2,251 gpm to 2,411 gpm.	Environmentally inconsequential.
			Increase in total consumptive use of river water from 3,584 gpm to 3,733 gpm.	Environmentally inconsequential.
Table 3.3-2	3.3-6	Plant Flow-rates During Minimum Power	Increase in Plant Make-up Flowrate from 2,361 gpm to 2,527 gpm.	Environmentally inconsequential.
			Increase in cooling tower evaporation rate from 1,390 gpm to 1,450 gpm.	Environmentally inconsequential.
			Increase in cooling tower blowdown rate from 884 gpm to 925 gpm.	Environmentally inconsequential.
			Decrease in process water treatment flow-rate from 125 gpm to 110 gpm.	Environmentally inconsequential.
			Waste Water Disposal System flowrate designed at 100 gpm.	Environmentally inconsequential.
			Increase in plant discharge rate from 925 gpm. to 1.030 gpm.	Environmentally inconsequential.
			Increase in total consumption use of river water from 1,436 gpm to 1,496 gpm.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
Table 3.3-3	3.3-7	Plant Flow-rates During Tem-porary Shutdown	Increase in plant makeup flowrate from 625 gpm to 715 gpm.	Environmentally Inconsequential.
			Increase in cooling tower blowdown flowrate from 221 gpm to 231 gpm.	Environmentally Inconsequential.
			Increase in cooling tower evaporation rate from 348 gpm to 363 gpm.	Environmentally Inconsequential.
			Decrease in process water treatment flowrate from 125 gpm to 110 gpm.	Environmentally Inconsequential.
			Waste Water Disposal System flowrate designed as 100 gpm.	Environmentally Inconsequential.
			Increase in plant discharge flowrate from 262 gpm tp 336 gpm.	Environmentally Inconsequential.
			Increase in total consumptive use of river water from 363 gpm to 378.	Environmentally Inconsequential.
Table 3.3-4	3.3-8	Plant Water Usage Seasonal Variation	Seasonal Flowrates in Table have been adjusted to reflect present design.	Environmentally Inconsequential.
3.4.1	3.4-1	Cooling Tower	Updated Makeup water addition from 5835 to 6035 gpm.	Environmentally Inconsequential.
3.4.2	3.4-3	River Water Pumps	Design flowrate for river water pumps decreased from 10,000 gpm each to 9,000 gpm each.	Environmentally Inconsequential.
3.4.3			No change.	
Table 3.4-1	3.4-5	Heat Dissipa-tion Design Parameters & Conditions	Heat rejected from a cooling tower increased from 2.172×10^9 BTU/HR to 2.256×10^9 BTU/HR.	Environmentally Inconsequential.
Table 3.4-2	3.4-6	Component Descriptions	Updated Design Parameters.	Environmentally Inconsequential.
Table 3.4-4	3.4-8	Cooling Tower Blowdown Temp.	Average monthly cooling tower blow-down temperatures increased slightly.	Environmentally Inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.5				
3.5.1		No change.		
3.5.1.1	3.5.2	Decontamination Factor	Update for iodine and tritium.	Environmentally inconsequential.
3.5.1.2	3.5-3	IALL	Updates description of cleaning process. A filter deleted from the liquid radwaste system. Revises description of shielding. Updates filter handling.	Environmentally inconsequential.
3.5.1.3	3.5-5, -6	LALL	Updates parameters applied to Low Activity Level Liquid System.	Environmentally inconsequential.
3.5.1.4	3.5-6	Assumptions	Revises assumptions used as the bases for calculations.	Environmentally inconsequential.
3.5.2				
3.5.2.1	3.5-7	Noble Gases	The ^{39}Ar and ^{41}Ar produced by direct activation of ^{38}Ar and ^{40}Ar is now included in the radioactive source terms used for design work.	The additional Argon from this source is negligible and the environmental impact is considered insignificant.
3.5.2.2	3.5-8	Treatment and Release System	Design has been changed so that ^{85}Kr from RAPS is no longer bottled but is processed thru CAPS and released to H&V.	The site boundary beta skin dose is increased by approximately a factor of 2, but the potential for accidental exposure due to ^{85}Kr storage and shipping is removed. The net change in environmental effects is judged to be insignificant.
			Previously all leakages of cover gas or recycled cover gas were processed thru CAPS Now most of the cells containing components which could leak cover gas vent to H&V.	The site boundary beta and gamma doses are increased; a slightly adverse effect. The beta dose increased by approximately 1.5, gamma dose by approximately 4.
3.5.2.3	3.5-9, 10	RAPS & CAPS	Process flow for RAPS & CAPS updated. Tritium removal unit has been redesigned in CAPS. Venting to atmosphere incorporated.	The site boundary beta and gamma doses are increased; a slightly adverse effect. The beta dose increased by approximately 1.5, gamma dose by approximately 4.
3.5.2.4	3.5-11	Head Seals	The reactor cover gas leakage rate was reduced from 0.012 SCC per minute to 0.0044 SCC per minute. The diffusion of Tritium through piping walls into PHTS and auxiliary Na cells has been added to design assumptions. Any significant amount of Tritium has been included in the current radiological source terms.	The site boundary beta and gamma doses are decreased; a slightly favorable environmental effect. The additional radioactivity contributed by the small amount of Tritium diffusing through piping walls is insignificant compared to the radioactivity contained in the cover gas which is assumed to leak into cells at the rate of 1 cc/min. The impact is judged insignificant.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.5.2.5	3.5-12 thru 3.5-14	Release Points	Ventilation exhaust rates at radiological release points have been revised. Examples are the release point in the SGB Intermediate Bay which increased from 50,000 scfm to 54,500 scfm and the exhaust point on top of the RCB which decreased from 415,000 scfm to 400,000 scfm.	Higher exhaust rates could potentially have more environmental impact due to shorter hold-up of radionuclides. However, the doses resulting from plant releases remain well below guideline limits.
			Ventilation exhaust temperature ranges at radiological release points have increased. An example is a release point in the RSB that did have a range of 65°F to 120°F and now ranges from 55°F to 140°F.	This change in temperature range will have no impact. Density variations which could release more or less radioactive material are accounted for in the preceding changes in exhaust rates.
			The CAPS Reactor Service Building H&V Exhaust has been deleted. CAPS now exhausts through the RSB exhaust with safety-related exhaust radiation monitors.	No environmental impact for normal release. Improved protection against release of above normal radioactivity from the plant due to off-normal conditions - a slightly favorable effect.
			RAPS process components have been moved from the RSB to the RCB.	No environmental impact for normal operation. Improved protection against release of radioactivity from the plant following RAPS accidents - a slightly favorable effect.
			Release point descriptions have been further updated to reflect latest design changes.	Environmentally inconsequential.
3.5.2.6	3.5-14, -15	Assumptions	Revises gaseous release data based on relocated RAPS, updated burnup and release point data, and most recent meterology.	No environmental impact for normal operation. Improved protection against release of radioactivity from the plant following RAPS accidents - a slightly favorable effect.
3.5.2.7	3.5-15, -16	Balance of Plant	Turbine generator building ventilation exhaust location change from elevation 905'6" to 878'0", release rate decrease from 17,500 cfm to 8,000 cfm, exhaust flow velocity increase from 585 feet/min. with a temperature range of 85 to 120°F to 900 feet/min. with a temperature range from 55°F to 120°F.	Environmentally inconsequential.
			Plant Service Building ventilation exhaust location changed from elevation 830'0" to 831'2". Number of release points decreased from 2 to 1.	Environmentally inconsequential.

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ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.5.3 (3.5.3.1 3.5.3.2)	3.5-16, -17	Solid Radwaste System Equipment	Solid radwaste equipment is now is now identified as including a cement filling station, a decanting station, a concentrated waste collection tank, a drumming station, a filter handling machine and a compactor. (See also Tables 3.5-10 and 3.5-11).	Environmentally inconsequential.
3.5.3.3	3.5-18	Noncompactible Solids of Radwaste Sys.	There will be a total of 112 (instead of 202) 55 gallon drums per year used to store the low activity, non-compactible solids after treatment at the solid radwaste system.	Environmentally inconsequential.
3.5.3.4	3.5-18	Radioactive Sodium	There are now 2 drums of waste metallic sodium per year with an activity level of 20 Ci/drum instead of 6 drums/year with an activity level of 1.5 Ci/drum stored and/or processed on site.	Environmentally inconsequential.
3.5.3.5	3.5-19	Sodium Bearing Solids	The disposal of sodium bearing waste, which was not previously identified, has been selected. No currently licensed off-site disposal facility will accept sodium bearing wastes, therefore, for off-site disposal of these wastes, the sodium will be removed. Where sodium removal is not practical, the waste will be stored on-site.	Environmentally inconsequential.
		Activity	Individual primary cold trap contained activity of Tritium increased from 8.7 x 10^3 Ci to 1.85 x 10^5 Ci, and activity of fission and corrosion products increased from 1 x 10^3 Ci to 1.41 x 10^5 Ci. The contained activity will not be removed or released from the cold traps. The EVST cold trap contained activity increased from 6.7 x 10^3 Ci to 7.6 x 10^3 Ci. The Tritium activity increased from 150 Ci to 180 Ci.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
Table 3.5-1	3.5-20,-21	IALL System	Some of the assumptions that Table 3.5-1 had been based upon have changed: 1) Intermediate activity concentration for the first rinse computed assuming 10% (instead of 40%) of plated out activity and 100% of sodium activity adhering to the process components is dissolved in 100,000 (instead of 37,000) gallons of water per year. 2) Processed components involve an average annual volume of 1,600 (instead of 14,700) gallons.	Environmentally inconsequential.
Table 3.5-2	3.5-22, -23	IALL System	Some of the assumptions that Table 3.5-2 had been based upon have changed: 1) Iodine DF=10^4 included. Monitoring tank volume decreased from 2,500 gallons to 2,400 gallons. 2) Iodine DF=10^4 included.	Environmentally inconsequential.
Table 3.5-3	3.5-24, -25	IALL System	Some of the assumptions that Table 3.5-3 had been based upon have changed: Low Activity Liquid Waste Assumptions: 1) Iodine DF=10^4 and Tritium DF=1 included. Intermediate Activity Liquid Waste Assumptions: 1. Liquid waste discharged to the common plant discharge header (instead of the coolant water blowdown stream). Iodine DF=10^4 and Tritium DF=1 included.	Environmentally inconsequential.
Table 3.5-10	3.5-33	Expected Weight, Volume and Activity of Solid Radwaste	Values in table have been changed to reflect current design. Total estimated volume of solid radwaste generated decreased from 3,094 ft^3/yr to 2,365 ft^3/yr. Total estimated activity of solid radwaste generated decreased from 6.6 x 10^4 Ci/yr. to 3.4 x 10^3 Ci/yr.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
Table 3.5-11	3.5-34	Expected Solid Radwaste Shipments Per Year	Expected containers per year of solidified liquid radwaste decreased from 170 to 136. Expected containers per year of filters and resins decreased from 120 to 34. Table expanded to include other solidified liquids.	Environmentally inconsequential.
Figure 3.5-1	3.5-35	Basic Flow Design	Inlets of collecting tanks now include filters.	Environmentally inconsequential.
Figure 3.5-5	3.5-39	Basic Flow Design	Completely revised to reflect vendor design.	Environmentally inconsequential.
3.6			No change.	
3.6.1			No change.	
3.6.2	3.6-3	Sodium Hypochlorite Injection	Capability of injecting sodium hypochlorite into cooling tower basin, on a continuous or intermittent basis.	Environmentally inconsequential.
3.6.3	3.6-4	Demineralizer	Delete limits on demineralizer chemicals.	Environmentally inconsequential.
3.6.4	3.6-5	Sewage Disposal	Chlorine limits set to meet NPDES permit limits.	Environmentally inconsequential.
Figure 3.6-1	3.6-7		Incorporate changes as described in text.	Environmentally inconsequential.
3.7			No change.	
3.7.1	3.7-1	Sanitary Sewage System	Addition of pretreatment and extended aeration of activated sludge. Compares effluent concentrations to NPDES permit limits (Table 3.7-1).	Environmentally inconsequential.
3.7.2	3.7-3	Trash Disposal	Specifies off-site trash disposal by licensed contractor. Updates effluents from routine Diesel unit testing.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.8				
3.8.1.1	3.8-1, -2	Core Design	Replaced homogeneous core arrangement with heterogeneous core arrangement resulting in reducing the number of fuel assemblies from 198 to 156, increasing the Pu enrichment from 18.7 to 32% fissile to 33.2% total.	Decreases the heavy metal commitment (U or U + Pu) in the axial blankets and core from 5.4 MT to 4.2 MT and from 6.5 MT to 5.2 MT, respectively. Environmentally inconsequential.
			Deleted option to use natural uranium as alternate material to depleted uranium as feed material for fuel pellets.	Environmentally inconsequential.
			Revised refueling scheme from replacing approximately one-third annually to batch replacement of all the fuel and inner blanket assemblies at two year intervals with mid-interval replacement of 6 inner blankets with fresh fuel assemblies.	Average number of yearly shipments of fresh fuel would therefore become about 14. Environmentally inconsequential.
3.8.1.2	3.8-2	Core Design	Replaced homogeneous core arrangement with heterogeneous core arrangement resulting in increasing the total number of blanket assemblies from 150 (radial) to 208 (82 inner and 126 radial).	Increases the heavy metal (U) commitment from 16.4 MT to 21.6 MT. Environmentally inconsequential.
			Revised dimensional parameters of blanket rods (outside diameter decreased from 0.520 in. to 0.506 in.) and assembly weight increased (from 525 lbs. to 536 lbs.).	Environmentally inconsequential.
			Revised refueling scheme from annual refueling to batch refueling at two-year intervals.	Average number of yearly shipments of fresh blanket assemblies will therefore become 12. Environmentally inconsequential.
Figure 3.8.1	3.8-10	Reactor	Revised to show heterogeneous core layout.	Environmentally inconsequential.
Figure 3.8.2	3.8-11	Fuel	Dimensions removed.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
3.8.2.1	3.8-3, -4	Core Design	Replaced homogeneous core arrangement with heterogeneous core arrangement and revised refueling scheme from annual refueling to batch refueling at two year intervals resulting in increasing the average number of fuel assemblies discharged yearly from 66 to 81, decreasing the fuel assembly burnup from 200,000 MWD/Ton average to 80,000 MWD/Ton average, and the peak burnup to 110,000 MWD/Ton, decreasing the average burnup in the axial blankets from 4,000 MWD/Ton to 2,200 MWD/Ton, and reducing the amount of bred fissile Pu from 1 kg/assy. to 0.3 to 0.4 kg/assy.	Shipping schedule for spent fuel increases from 8 to 12 shipments per year to an estimated 14 shipments per year. Changed judged to be slightly adverse.
			Revised weight and dimensions of spent fuel shipping cask.	Environmentally inconsequential.
3.8.2.2	3.8-4, -5	Core Design	Replaced homogeneous core arrangement with heterogeneous core arrangement and revised refueling scheme from annual to batch resulting in increasing the number of blanket assemblies discharged from the plant per year from 25 to 69, increasing the burnup per assembly from 5,700 MWD/Ton to 8,000 MWD/Ton, increasing the average and peak heat generation from 1 kw average (radial) to 2.6 kw (inner) and 1.6 kw (radial) and from 7 kw peak (radial) to 19.7 kw (inner) and 12 kw (radial).	Increases the number of spent blanket assembly shipments from 3 to 6-7 per year. Change judged to be slightly adverse.
3.8.3				
3.8.3.1	3.8-5 thru 3.8-7	Core Design	Replacement of homogeneous core arrangement with heterogeneous core arrangement results in reducing the number of primary control assemblies from 15 to 9 and in increasing the number of secondary control assemblies from 4 to 6.	Change judged to be slightly favorable.
			If lifetime considerations permit, control rods could remain in the reactor for two cycles, also the driveline lifetime has been increased from 10 to 15 years.	Change judged to be slightly favorable.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
			Revised configuration of radial shield assembly from stacked hexagonal plates to closely packed rods in a hex duct and decreased assembly weight from 750 to 360 lbs.	Environmentally inconsequential.
			Because of the change to the heterogeneous core arrangement the lifetime of the first row of shield assemblies has increased from 3 to 10-to-15 years, part of the second row lifetime has increased from 6-to-12 to 10-to-25 years, and the third and fourth rows are not expected to require replacement during plant lifetime.	This greatly reduces the number of shipments of irradiated shield assemblies. Change judged to be favorable.
3.8.3.2	3.8-8	Waste Handling	Updated to agree with Section 3.5	Environmentally inconsequential.
	3.8-8,	Primary Cold Trap	The tritium levels were updated from 1.8 x 10^4 Ci to 1.85 x 10^5 Ci and the fission products and corrosion products increased from 1 x 10^3 Ci to 1.41 x 10^5 Ci.	Material will not be released so the changes are judge to be environmentally inconsequential.
			Cold traps are to be stored on site since no currently licensed disposal site will accept sodium-bearing wastes.	
3.9				
3.9-1			No change.	
3.9-2			No change.	
3.9-3			Updated to describe Forest Management	Environmentally inconsequential.
3.9-4	3.9-3,-4	Flora	Updated to account for ORNL forest management activities since 1976.	No change in environmental effects due to CRBRP.
3.9-5			No change.	
3.9-6			No change.	
3.9-7			Updated to describe transmission line configuration and acerage affected.	Environmentally inconsequential.
3.9-8			Revised to delete details of tower configuration.	Environmentally inconsequential.
3.9-9			Circuit spacings have been increased, requiring widening of rights-of-way.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
4.1	4.1-1, -2	Site Prep. and Plant Cons-truc-tion	Deletion of borrow area, increase of site temporary acreage to 292 acres from 195 acres required for plant construction, 37 acres identified inside security barrier, quarry increase from 25 acres to 45 acres, provide crusher facility at quarry (Table 4.1-1, Figure 4.1-1).	Environmentally inconsequential.
4.1.1				
4.1.1.1	4.1-2	Clearing	Choice to use open burning during site clearing.	Change judged to have a slight negative environmental effect.
		Concrete Batch Plant	Batch plant description	Environmentally inconsequential
	4.1-3, -4	Quarry	Excavation depths increased. Eliminate consideration of borrow pit. Described concrete batch plant.	Change judged to be slightly favorable. Onsite availability of material will reduce offsite hauling requirements.
4.1.1.2			No change.	
4.1.1.3	4.1-5	Access Facility	Modify Barge Unloading Facility.	Change judged to be slightly favorable. Redesign minimizes dredging.
4.1.1.4			No change.	
4.1.1.5			No change.	
4.1.1.6	4.1-7 thru 4.1-8b	Site Extent	Update terrestrial ecological effects of site clearing and construction. (Table 4.2-1 and Table 4.1-3)	Change judged to have slightly negative environmental effect due to increased acreage.
			Include ORNL forest management plan.	No change to estimated environmental effects due to CRBRP.
			Updates impacts on wildlife.	No change to estimated environmental effects due to CRBRP.
4.1.1.7	4.1-11	Human Activ-ities	Peak construction force estimate increased to 5400.	Environmentally inconsequential.
			Eliminates borrow area. Reduces construction activities near cemetery.	Change judged to be slightly favorable; borrow area was in vicinity of Hensley family cemetery.
4.1.1.8	4.1-11 thru 12a		Provides soil erosion and sediment control measures	Change judged to be favorable in reducing soil erosion to Clinch River

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
4.1.2				
4.1.2.1	4.1-13	Water Use	Construction water consumption estimates have been increased from 40,000 gallons per day to 60,000.	Environmentally inconsequential. Additional water consumption still is only a very small fraction of the available Clinch River flow.
4.1.2.2			No change.	
4.1.2.3	4.1-15	Barge Unload-ing Facility	Relocation and redesign will reduce dredging.	Change judged to be slightly favorable.
4.1.2.4	4.1-15a	Runoff Treat-ment pond	Provides description of runoff treatment pond design feature which limits suspended solids discharge to Clinch River to less than 50 mg/l.	Change judged to be favorable
4.2	4.2-1,-6,-8		Transmission corridor acreages and affected community plant coverage undated	Environmentally inconsequential.
Table 4.2-1	4.2-9	Trans-mission Corridor	Transmission corridor acreages and affected community plant coverage undated	Environmentally inconsequential.
4.3	4.3-1 thru 4.3-3	Re-sources	Updated to account for revised affected areas, and addition of quarry.	Net effect of all changes is judged to be environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
5.1			No change.	
5.1.1			No change.	
5.1.1.1	5.1-3, -4	Cooling System	Updated to reflect effects of cooling system redesign.	Change demonstrates that latest design produces effects that are enveloped by previous (approved) designs.
5.1.1.2	5.1-5	"No Flow" Plumes	Updated plume configurations to reflect effects described in 5.1.1.1.	Change falls within effects that are enveloped by previous approvals.
5.1.2	5.1-6, -7	Thermal Dis-Charge Standards	Revised to include reference to NPDES Permit requirements	NPDES requirements exert positive controls on effluent quality.
5.1.3			No change.	
5.1.3.1	5.1-12 thru	Fish Habitat	Discusses recent studies of fish (striped bass and sauger) behavior in the Clinch River. Includes habitats, migration and spawning.	Environmentally inconsequential.
5.1.3.2			No change.	
5.1.3.3			No change.	
5.1.3.4			No change.	
5.1.3.5			No change.	
5.1.4			No change.	
5.1.5	5.1-22	Con-denser Entrainment	Update condenser water design flow rate. Also updates Clinch River flow data.	Environmentally inconsequential.
5.1.6			No change.	
5.1.7			No change.	
5.1.8			No change.	
Table 5.1-13	5.1-51	Cooling Systems	Updated Cooling System parameters	Environmentally inconsequential.
5.2	5.2-1 thru 5.2-41	Radiological Impact	This section has been completely rewritten to include impacts on both man and organism other than man. The revised calculations result in reduced dose estimates.	Change judged to be favorable.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
5.3			Deleted. Included in new Section 5.2	
5.4	5.4-1	Effects of Chemical & Biocide Discharges	Editorial change to clarify and explain that an acid feed system is provided. Its use would adjust pH for control of corrosion and scaling, and to assure that the blowdown is in compliance with the the Draft NPDES permit limits.	Environmentally inconsequential.
			Defined the limits of chlorine concentration.	Environmentally inconsequential.
5.4.1	5.4-2	Waste Water Disposal	Adds discussion of changes to waste water disposal system that have been previously described.	Environmentally inconsequential.
5.4.1.1	5.4-4a	Coolant System Discharge	Total volume discharged increased slightly with no changes in chemical concentrations.	Environmentally inconsequential.
5.4.1.2	5.4-5 thru 5.4-8	Discharge Plume	Changed per cent differential between ambient and blowdown concentrations.	Environmentally inconsequential.
		Striped Bass	Described bass response to chemical plume.	Environmentally inconsequential.
		Water Quality	Identifies elements not meeting drinking water standards at 6% isopleth during periods of extended no flow.	Environmentally inconsequential.
			Included consideration of the more stringent of state or federal requirements. (Tables 5.4-1, 5.4-2 and 5.4-5).	Environmentally inconsequential.
5.4.2	5.4-12	Effects of Biocide Discharges	Includes discussion of trihalomethanes (THM's) (Table 5.4-1)	Environmentally inconsequential.
5.4.3	5.4-12a	Storm Water	Instead of being directly discharged to the Clinch River via catch basins, storm water collected by the roof and yard drains is sent via the storm drainage system to runoff treatment ponds for settlement and filtering prior to discharge to the river.	The incorporation of this system provides further assurance that the final effluent discharged to the river via the runoff treatment pond is within applicable effluent standards. The effect is judged to be environmentally favorable.
5.4.4			No change.	
5.4.5			No change.	

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ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
5.5			No change.	
5.5.1	5.5-1, -2	Effects from Sanitary Wastes	Editorial change to clarify that a package treatment plant will be used during the construction period. A slow sand filter unit will be installed following the CRBRP construction period to form a part of the permanent plant for the normal operation of the plant.	Environmentally inconsequential.
			Third paragraph deleted since the description of the treatment plant is given in Section 3.7.	Environmentally inconsequential.
			Treated effluent discharges will be processed to meet the Draft NPDES permit limits instead of "all State and Federal discharge regulations".	Environmentally inconsequential.
			Discharges from cooling tower blowdown were revised to be consistent with Table 3.3-4.	Environmentally inconsequential.
5.5.2			Revised to update Diesel unit emissions and add the third Diesel generator unit. Emissions are lowered.	Environmentally inconsequential.
5.6			No change.	
5.7	5.7-1	Other Operating Effects	No change.	
5.7-1	5.7-1 thru 5.7-58	Fuel Cycle	Completely rewritten and expanded to discuss the fuel fabrication, fuel reprocessing, waste management and transportation phases. For each phase, potential facilities, effluent types and quantities, radiological effects, safeguards provisions and financial cost estimates were evaluated.	Environmentally inconsequential.
5.7-2	5.7-68 thru 5.7-73	Noise Impacts.	Updated US Department of Housing and Urban Development external noise exposure categories.	Environmentally inconsequential.
5.8			No change.	
5.8.1	5.8-1	Plant Site	Total acreage committed updated. Changes will be provided in a future amendment.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
5.8.2	5.8-2	Water Resources	Water consumption updated to reflect latest estimates.	Environmentally inconsequential.
5.8.3	5.8-2 thru 5.8-4	Core Design	Replaced homogeneous core arrangement with heterogeneous core arrangement resulting in reducing the number of fuel enrichment zones from 2 to 1, increasing the Pu enrichment in the fuel from 18.7-to-27.1 to 33.2%, reducing the number of fuel assemblies from 198 to 156. This change also increases the number of blanket assemblies from 150 (radial) to 208 (inner and radial).	Change decreases the heavy metal commitments in the fuel (U + Pu) from 6.5 MT to 4.2 MT, reduces the stainless steel commitments in the fuel from 26.3 MT to 20.7 MT. The heavy metal commitment in the blanket went from 21.7 MT (radial & axial) to 25.2 MT (inner, radial & axial), and increases the stainless steel commitment in the blankets from 17.3 MT to 26.8 MT. Change judged to be environmentally inconsequential.
			Revised Pu isotopic composition to be similar to FFTF grade instead of characteristic of LWR discharge.	Environmentally inconsequential.
			Revised refueling scheme from annual to batch which results in increasing the total number of fuel assemblies, required during plant life, from 2,300 to 2,427; increasing the total number of blanket assemblies from 850 to 2,106.	This results in increasing the total heavy metal commitments based on a once through fuel cycle: from 20 MT Pu to 27 MT Pu, from 210 MT U to 332 MT U and from 410 MT stainless steel to 595 MT. If reprocessing is assumed, then the total net heavy metal commitment of uranium decreases from 17.7 MT to 14.2 MT and the net gain of bred plutonium increases from 2.9 MT to 3.2 MT. Change judged to be slightly adverse.
5.8.4			No changes.	
5.9	5.9-1	Plant Site	Permanent plant acreage is increased.	Environmentally inconsequential.

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ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
6.0			No change.	
6.1	6.1-1	Pre-construction Monitoring Program	Changed to indicate that program was conducted.	Environmentally inconsequential.
6.1.1				
6.1.1.1	6.1-1 thru 6.1-24	Baseline Monitoring Program	Completion of baseline aquatic monitoring program description (results of baseline program reported in Section 2.7).	Environmentally inconsequential.
6.1.1.2	6.1-25 thru 6.1-28e	Pre-construction Aquatic	Provides a summary description and conclusions of the pre-construction aquatic environmental monitoring.	Environmentally inconsequential. Change provides data base for determination of environmental effects dueu to construction as monitored by the construction environmental monitoring program.
6.1.2	6.1-29	Groundwater	Updated to incorporate reference to the pre-construction monitoring program (1976-1977).	Environmentally inconsequential.
6.1.2.1	6.1-29, -29a	Pre-construction Groundwater Quality	Provides summary conclusions of the pre-construction groundwater quality monitoring program.	Environmentally inconsequential. Change provides data base for the construction monitoring program.
6.1.3	6.1-30 thru 6.1-33	Meteorology	Updates meteorological description to incorporate description, instrumentation and data acquisition system for the on-site permanent meteorological monitoring stations.	Environmentally inconsequential. Permanent meteorological facilities will be used during plant construction and operation for on-site meteorological analyses.
			Deletes description of on-site temporary meteorological monitoring station.	Environmentally inconsequential.
6.1.4				
6.1.4.1	6.1-35 thru 6.1-37	Geology	Provides update of site geology investigation (results provided in Section 2.4).	Environmentally inconsequential.
6.1.4.2	6.1-38, -39	Land Use & Demographic Surveys	Discusses the evaluation of demographic changes. The data are presented in Section 2.2.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
6.1.4.3	6.1-39 thru 6.1-41	Terrestrial Ecology	Provides update discussion of baseline terrestrial monitoring program. (Conclusions provided in Section 2.7).	Environmentally inconsequential.
	6.1-42	Construction Monitoring	Provides reference to on-site construction environmental monitoring program.	Environmentally inconsequential.
6.1.5			No change.	
6.1.5.1	6.1-42a thru 6.1-43	Preconstruction Radiological Monitoring	Provides complete description and results of pre-construction radiological (river water, groundwater, sediment) monitoring program.	Change is judged to be slightly favorable. Provides basis for improved determination of radiological disturbance as monitored during the construction radiological monitoring program.
6.2			No change.	
6.2.1				
6.2.1.1	6.2-1 thru 6.2-2b	Gaseous Effluents	Updates plant gaseous effluent monitoring locations (32 locations from 13 locations.) 1 - steam generator building 9 - reactor containment buildings 2 - reactor service building 1 - radwaste area 1 - plant service building 12 - turbine generator buildings 6 - steam generator buildings	Change is judged to be slightly favorable. System will provide - continuous monitors at those locations which could conceivably undergo significant increase in detectable levels - periodic sampling for areas as necessary.
		PSB Liquid Effluents	Liquid effluents go to liquid radwaste system for reprocessing.	Environmentally inconsequential.
6.2.1.2	6.2-3 thru 6.2-10	Pre-operational Radiological Monitoring	Provides current (atmospheric, terrestrial, aquatic, groundwater) radiological monitoring programs for the pre-operational and operational phases.	Environmentally inconsequential.
6.2.2			No change.	
6.2.3			No change.	
6.2.4			No change.	
6.2.5			No change.	
6.3	6.3-1	Other Monitoring Programs	Deletes monitoring stations at TVA's Kingston's steam plant and Bull Run steam plant.	Environmentally inconsequential.

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ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
7.1				
7.1.1				
7.1.1.1	7.1-2	Meteor-ology	Meteorology data contained in Section 2.6 provided by Amendment IX are used in the computations.	Environmentally inconsequential.
7.1.1.2	7.1-2 thru 7.1-6	Method-ology	Beta dose calculations deleted.	Environmentally inconsequential.
7.1.1.3	7.1-6	Sodium Fire Analysis	Updates description of computer code capabilities.	Environmentally inconsequential.
7.1.2				
7.1.2.1			No change.	
7.1.2.2	7.1-7, -8	Steam Drum Valve (2.1)*	The amount of tritiated water released to the environment is 353,000 lbs. Instead of 450,000 lbs. The tritium concentration has increased from $.25 \times 10^{-6}$ Ci/g to $.62 \times 10^{-6}$ Ci/g.	The combined effect of these changes is to increase the site boundary whole body dose from 1.77 mrem to 5.50 mrem; both are environmentally inconsequential.
		Conden-sate Storage Tank Leak (2.2)	The tritium concentration in the Condensate Storage Tank increased to $.62 \times 10^{-6}$ Ci/g from $.25 \times 10^{-6}$ Ci/g.	The short-term downstream tritium concentration in the Clinch River increased from 1.18×10^{-12} Ci/g to 2.89×10^{-12} Ci/g after the postulated leak; both are environmentally inconsequential.
7.1.2.3	7.1-9 thru 7.1-14	RAPS	Describes cell containment provisions. RAPS components moved to RCB. The accident postulations are adjusted to reflect this change.	The environmental effects are judged to be favorable. RAPS leakage is processed through the RCB HVAC.
		Radwaste System Failures (3.1)	The tritium concentration in the storage tank water has increased to $.62 \times 10^{-6}$ Ci/g from $.25 \times 10^{-6}$ Ci/g. Storage tank cell parameters have changed such as the floor area increase to 1,000 ft^2 from 800 ft^2 and the volume increase to 39,000 ft^3 from 30,000 ft^3. Sump pump flow capacity increased to 50 gpm from 10 gpm.	The combined effect of these changes is to reduce the postulated spill cleanup time and increase the whole body dose at the site boundary to 1.01×10^{-5} mrem from 9.4×10^{-6} mrem, but both are environmentally inconsequential.

*Refer to accident number in Environmental Report.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
		Liquid Radwaste System Tank (3.2)	Tritium concentration in storage tank water has increased due to change in interface diffusion coefficients. Concentration is now $.62 \times 10^{-6}$ Ci/g in SGS.	The combined effect of these changes is to increase the site boundary whole body dose from this postulated accident to 2.13×10^{-2} from 5.0×10^{-3} mrem; both are environmentally inconsequential.
			Spill cleanup time is reduced to 6.7 hours by using higher capacity sump pumps.	
		RAPS Noble Gas Storage Vessel Rupture (3.3)	Accident redefined due to relocation of RAPS components.	The environmental effects are judged to be favorable.
		Rupture of Equalization Line (3.4)	Deleted. Noble Gas Storage Vessel Rupture replaces Equalization Line Rupture as enveloping postulated accident for the RCB.	
7.1.2.4	7.1-14 thru 7.1-20	Sodium Fire Accidents (4.1)	Analyses revised to update computations.	For Accident 4.1, the resultant whole body dose increases from 1.4×10^{-2} rems to 2.37×10^{-2}. For Accident 4.2 the whole body dose decreases from 1.5×10^{-2} to 8.75×10^{-3} rems.
		(4.2)		Both are environmentally inconsequential.
7.1.2.5	7.1-22 thru 7.1-24	Fuel Failures (5.1)	The current plant design has a higher purge rate of the cover gas which has reduced the available Xenon and Krypton activity to 56,600 Ci from 65,816 Ci.	The net effect of the changes is to reduce the site boundary whole body dose to 8.4×10^{-5} mrem from 3.4×10^{-4} mrem; both are environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
		Steam Generator Tube Rupture (5.2)	A revised DBL for the steam generator results in 465 lbs. of sodium mixing with with water instead of 337 lbs. of sodium. The tritium concentration in SGS is now $.62 \times 10^{-6}$ Ci/g and in the IHTS is $.13 \times 10^{-6}$ Ci/g.	The net effect of the changes is to increase the site boundary whole body dose to 8.3×10^{-2} mrem from 2.1×10^{-2} mrem: both are insignificant.
			Deleted the centrifugal separator from the Sodium-Water Reactor Pressure Relief Subsystem (SWRPRS).	This change is judged to be adverse, since this could potentially result in the release of more sodium-water reaction particulates into the atmosphere.
			The duration of the SWRPR venting to the atmosphere was increased from 15 to 28 seconds as a result of an updated TRANSWRAP code analysis of this event. This more detailed analysis tracks the primary sodium which might leak into the intermediate sodium. It considers the length of piping between the IHX and the superheater inlet, and the reduced sodium flow during blowdown and predicts that no primary sodium will reach the superheater during this event for subsequent release to the atmosphere.	No change to estimated environmental effects.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
7.1.2.6	7.1-26 thru 7.1-31	Spent Fuel Cladding Failure in the EVTM (6.1)	Earliest scheduled time for fuel assembly handling is increased to 8 days from 87 hours. Revised ORIGEN isotope library was used to generate fission product inventories.	The combined effect of the changes is to increase the site boundary whole body dose from 1.5×10^{-2} mrem to 2.13×10^{-2} mrem; both are environmentally inconsequential.
		Spent Fuel Cladding Failure in the EVTM (6.2)	The same changes that applied to Accident 6.1 apply here.	The net result of the changes is to increase the site boundary whole body dose for this postulated accident from 1.5 mrem to 2.1 mrem, both are environmentally inconsequential.
		Accidentally Opening a Floor Valve (6.3)	Revised ORIGEN isotope library was used to generate fission product inventories Revisions were based on newer calculational schemes.	The combined effect of the changes to increase the site boundary whole body dose to 1.08 mrem from .07 mrem; both are environmentally inconsequential.
7.1.2.7	7.1-32	Spent Fuel Cask Drop (7.1)	Isotope inventories were revised using updated ORIGEN libraries. The ORIGEN changes were due to revisions in the library calculational schemes. The fuel has undergone an 80 day cooling period instead of 100 days. The loading is changed to 6 fuel assemblies and 3 blanket assemblies from 5 and 4, respectively.	The combined effect of the changes is to decrease the site boundary whole body dose to 2.8×10^{-4} mrem from 9.3×10^{-3} mrem; both are environmentally inconsequential.

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ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
7.1.2.8	7.1-33 thru 7.1-43	Primary Sodium Drain Tank Failure (8.1)	Primary sodium isotope inventory has changed due to revisions in the ORIGEN library calculational schemes. Cell 102A dimensions have changed. For example, the cell volume is 45,000 $ft.^3$ and was 68,000 $ft.^3$. The potential sodium spill volume has increased to 35,000 gallons from 32,000 gallons.	The combined effect of the changes is to reduce the site boundary whole body dose from 9.7×10^{-4} rem to 8.4×10^{-5} rem; both are environmentally inconsequential.
		Primary Coolant Sodium Spill (8.2)	The postulated sodium spill has been reduced to 135,000 lbs. from 193,000. It was conservatively assumed that the aerosol leaked to the RCB was vented directly to the environment. Previously a leak rate of .1 vol%/day at 10 psig. was assumed as the leak rate.	The combined effect of the changes is to increase the site boundary whole body dose from 8.3×10^{-4} rem. to 1.25×10^{-2} rem; both are environmentally inconsequential.
		Ex-Containment Primary Coolant Sodium Spill (8.3)	The postulated spill has been reduced from 90,000 gal. to 45,000 gal. of sodium. This is the result of a failure of one of two storage vessels in the cell rather two. The leak rate of aerosol was based on the cell design leak rate of .6 vol%/day at 3.9 psig. rather than 100 vol%/day at 10 psig which was previously used.	The net effect of the changes is to reduce the site boundary whole body dose from 1.3×10^{-5} rem to 4.2×10^{-5} rem; both are environmentally inconsequential.
		Ex-Vessel Storage Tank Coolant Rupture (8.4)	Aerosol leakage to the RSB from the cell was calculated based on a cell design leak rate of .36 vol%/day at 12 psig. rather than 100 vol%/day at 10 psig. This approach will release less aerosol into the environment. Cell dimensions were updated.	The net effect is to increase the site boundary whole body dose from 2.1×10^{-4} mrem to 4.3×10^{-4} mrem; both are environmentally inconsequential.
		Large Steam Line Break (8.5)	The SGS tritium concentration has increased to $.62 \times 10^{-6}$ Ci/g from $.25 \times 10^{-6}$ Ci/g. This is the result of changes in diffusion coefficients across system interface boundaries. The newer design basis results in 312,000 lbs. of water being released from the PRV instead of 479,000 lbs. The power relief vent period has been increased from 1.5 to 5.7 hours.	The combined effect is to increase the site boundary whole body dose to 4.7 mrem from 1.9 mrem; both are environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
7.1.3			No change.	
7.2.1	7.2-1	Hydrogen Gas Storage	The total amount of hydrogen gas stored has not changed; however, the volume has been restated in terms of standard volume (28,000 SCF) rather than bottled storage capacity.	Environmentally inconsequential.
7.2.2	7.2-5a, -5b	Oil and Hazard-ous Material Spills	Systems/Buildings involved with the storage, transfer, or loading/unloading of any oil or hazardous material are provided with secondary containment systems capable of containing the largest source of an oil or hazardous material spill without any adverse environmental impact.	Incorporation of these features in station design provides further protection against spill of oil and hazardous material reaching the local environment. Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
8.0			No change.	
8.1 8.2 8.3	8.1-1 thru 8.3-22	Socio- economic	Complete assessment of socio-economic parameters of CRBRP plant construction and operation is provided. The assessment is based on current construction manpower requirements, 1980 census and 1981 community service and infra-structure data.	This change is judged to be slightly favorable. It provides current data base for evaluation of socio-economic assessment.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
9.1	9.1-1	Alternative Approaches	This section has been revised to reference the supplement to the LMFBR Program Final Environmental Statement (PFES).	Environmentally inconsequential.
9.2	To Be Provided	Alternative Sites & Plant Arrangements	This section will be addressed in the supplement to the LMFBR Program Final Environmental Statement (FES). For discussion of Hook-on arrangements refer to response to Question 320.1R and 320.2R. Further discussion of candidate sites will be provided in the near future. Section 9.2.5.3.4 will be updated to reflect response to Question 230.5R.	Environmentally inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
10	10.0-1	Plant Design Alternatives	Revised to establish position that the the relative effectiveness rankings of the various design alternatives have not changed over the past five years, and that a comprehensive update of all the alternatives is not required. The descriptions of the chosen alternatives were updated to be consistent with the rest of the ER.	Environmentally Inconsequential.
10.1	10.1-9	Cooling System	Updated description of the mechanical draft wet cooling tower in a linear arrangement.	Environmentally Inconsequential.
	10.1-21		Deleted discussion of relative merits of circular versus linear cell array since the linear arrangement has been selected.	Environmentally Inconsequential.
10.2	10.2-14	Intake System	Revised discussion of entrainment effects to indicate that studies are now complete and the effects are acceptable.	Environmentally Inconsequential.
	10.2-18		Updated to reflect completion of baseline surveys. Game fish species present went from 2 to 3.	Environmentally Inconsequential.
	10.2-20		Deleted reference to baseline surveys being in progress. Revised to include results of completed studies.	
10.3	10.3-1, -2	Discharge System	Revised to update Clinch River parameters and specify requirement for discharges to comply with NPDES Permit limitations.	Environmentally Inconsequential.
	10.3-5		Increase pipe diameter from 12 to 20 inch diameter.	Environmentally Inconsequential.
10.4	10.4-1 thru 10.4-18	Waste water Treatment System	Revised throughout to change system designation from Chemical Waste Treatment to Waste Water Treatment. Updated the discussion of waste streams, the description of the process, the alternatives and the bases for selecting the chosen system.	Environmentally Inconsequential.
10.5	10.5-6,-7	Biocide System	Revised discussion of blowdown flow control to assure control of high chlorine concentration. Updated flow rates.	Environmentally Inconsequential.
10.6	10.6-1 thru 10.6-10a	Sanitary Waste System	Revised to include discussion of an extended aeration/chlorination system that is the current chosen alternative.	Environmentally Inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
10.7	10.7-1a	Liquid Radwaste	Incorporated reference to Section 3.5	Environmentally Inconsequential.
	-4	System	Update component designations and system details.	Environmentally Inconsequential.
10.8	10.8-1 thru 10.8-12a	Gaseous Radwaste System	Incorporated System 6, patterned after the FFTF system, as the chosen system. Editorial changes to assure proper designation of System 4 as the "originally selected" system.	Change judged to have a slightly negative environmental effect.
10.9		Transmission Facilities	No change.	
10.10	10.10-2	Other System	Revised to provide for three diesel generator units.	Environmentally Inconsequential.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
11			No change.	No change.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
12	12.0-1 thru 12.0-7	Permits	Provides revised listing of Non-NRC permits, purpose, legislation, and regulation enacting permit approval or notificaiio .	No changes in estimated environmental effects due to this tabulation.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
13	13.0-3 thru 13.0-50	References	Update to include appropriate references.	No environmental effects.

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE	ENVIRONMENTAL EFFECT
14 (Appendix to Section 2.5)	14.1-2 thru 14.1-81	Clean Water Act of 1977	Incorporates 1977 amendment to the State of Tennessee Water Quality Criteria Incorporates the 1977 clean water act amendments to the Federal Water Pollution Control Act.	The change is judged to be slightly favorable. It provides criteria for CRBRP design for reduction of impact on the environment.
14 (Appendix to Section 2.7)	14.3-3	Sauger	Provides update information on spawning of sauger.	No environmental effects.
14 (Appendix to Sections 5.2 and 5.3)	14.4-1	Dose Calculation Models	Deleted. Incorporated into revised Section 5.2	Environmentally inconsequential.
14 (Appendix to Section 10.3)	14.6-3	Cooling Tower	Updates cooling tower blowdown rate provides current design blowdown temperature values.	The increase in cooling tower blowdown is judged to be insignificant compared to the Clinch River flow rate.
Appendix C	C-1 thru C-71	Socio-Economic	Reports the results of a qualitative assessment of the socio-economic effects of CRBRP construction and operation assuming inmover migration rates of 26% and 40%. The effects of the 1981 assessment are compared to those estimated in 1976.	

Indicator	Difference (1980-1976) for 26%	for 40%	
Population	800	1840	Environmentally inconsequential
Housing	456	924	Housing demand for 40% inmover case may create tight housing market
Education			
Students	97	321	Environmentally inconsequential
Classrooms	1	11	Environmentally inconsequential
Health Care			
Hosp. Beds	-2	-	Environmentally inconsequential
Drs.&Dentists	-	1	Environmentally inconsequential

ER SECTION	REVISED	ITEM	DESCRIPTION OF CHANGE				ENVIRONMENTAL EFFECT
			Public Safety	Data not comparable			EI
			Water Supply	53	161	(10^3gpd)	EI
			Waste Disposal				
			Liquid Wastes	60	184	(10^3gpd)	EI
			Solid Wastes	31	74	(10^2#/d)	EI
			Commuter Traffic	B to C	C to D	Level of of Service	Change judged to be only slightly adverse. Effects are mitigated by possible use of staggered shifts, recent intersection improvements, etc.
				Level of service on SR 95 between I-40 and Bear Creek Rd. could be Level E during peak commuter times			
			Expenditures and Revenues	Changes discussed elsewhere in ER			Environmentally inconsequential

QUESTION 290.2R

Describe any changes in station design that would result in a change in the water quality of the station blowdown or stations water use, or in water intake or discharge structures.

RESPONSE

The only significant change in station design has been the redesign of the Waste Water Disposal System.

Previously, station wastes were handled as follows:

1. Floor and equipment drainage wastes were treated and discharged to the Cooling Tower Basin.

2. Process water wastes (primarily ion exchange regeneration wastes) were treated, integrated with Cooling Tower Basin Blowdown and discharged to the river.

Presently, the design provides for pretreatment of segregated waste streams as follows:

1. Floor and equipment drainage is processed by an oil/water separator

2. Process water wastes are neutralized

3. Clarifier blowdowns and filter backwashes are routed to sludge lagoons.

These waste streams are routed to the equalization basins for equalization of chemical characteristics and temperature.

Following equalization, plant wastes are processed by the Waste Water Disposal System to meet the following NPDES Permit effluent limits;

> Oil and Grease: 15 mg/l daily average, 20 mg/l daily max., Total Suspended Solids: 30 mg/l daily average, 100 mg/l daily max., PH: Shall not be less than 6.0 nor greater than 9.0, and there shall be no discharge of floating solids or visible foam in other than trace amounts.

Thereafter, the plant wastes are either blended with Cooling Tower Basin blowdown for discharge to the river, or recycled to the Cooling Tower Basins as makeup to the Circulating Water System. While this change to station design will result in a significant improvement to the water quality of the individual waste streams, the impact on station blowdown will be minimal since these wastes streams combine with the cooling tower blowdown which has a very large flow rate.

Station water use, and consequently discharge to the river, has increased by approximately 5% due to refinement in design numbers resulting from design development. This increase has not impacted the design of water intake or discharge structures.

Question 290.3R

Identify and make available for staff inspection during the site visit any new or updated information pertaining to water quality, water use, aquatic, biology, or terrestrial resources in the vicinity of the site published or generally available since submission of the ER. Sources of this information should include, but not limited to, DOE, ORNL, TVA, University of Tennessee at Knoxville, State of Tennessee, U.S. Department of the Interior, local governments, or regional planning groups.

RESPONSE

An evaluation of the current aquatic and terrestrial ecological status of the Clinch River site was transmitted to the NRC on October 16, 1981, as part of Amendment IX to the Environmental Report. This evaluation included data from recent generally available ecological studies made by such organizations as ORNL, the Tennessee Technological University, TVA and similar organizations. A bibliography of the sources cited in support of that evaluation was provided in revised Section 13 of the ER. New sources added as part of the revision were identified in the margins of the replacement pages. These added studies constitute the principal sources of new and updated information pertaining to the aquatic, biological or terrestrial resources in the vicinity of the site.

This and other material as well as staff expertise in the areas of interest were made available during the NRC site visit on October 27, 1981.

Question 290.4R

Identify and describe any post 1976 differences in use of the Clinch River by others. Provide current plans of TVA for regulation of flow in the Clinch River noting especially any plans for maintenance of a minimum flow past the site.

RESPONSE

Environmental Report Tables 2.2-15 and 8.1-16 (Amendment X) provide recent industrial and municipal supply capacity and use. There has been no significant change in the industrial water supplies within a 20 mile radius of the Site since 1976. Most municipal water systems have increased their capacities in Anderson, Roane and Knox counties while Loudon county has remained unchanged.

Recent Clinch River flow hydrology is provided in Section 2.5 of the ER (Amendment IX). Periods of zero release from the Melton Hill Dam are identified in Table 2.5-2. At this time TVA has no plans to maintain a minimum flow (discharge) from Melton Hill Dam.

Question 290.5R

Provide any additional information on the population levels, spawning activity, or other site specific information on Corbicula sp. known to inhabit the Clinch River in the vicinity of the site.

RESPONSE

Benthic macroinvertebrate fauna in the vicinity of the proposed CRBRP was sampled on a monthly basis in 1975 and a seasonal basis in 1976 and 1977 using a Ponar grab sampler. *Corbicula manilensis* was collected more frequently than any other taxa during all three years. Percent occurrence for *Corbicula manilensis* was 91, 81, and 75 percent for 1975, 1976, and 1977, respectively. Abundance of *Corbicula* ranged from $0.0/m^2$ at several stations to $141.3/m^2$ at CRM 19.0 in September 1976 (Ref. 1).

The relatively low density of *Corbicula* in the vicinity of the CRBRP site is primarily because of the predominance of hardpan substrate, deep water, and cold releases from Melton Hill Dam.

Spawning generally begins when water warms to about 16° C in the spring and continues intermittently until late autumn. Although the abundance of *Corbicula* is low at the plant site, there are large populations of asiatic clams in overbank areas upstream, and these can be expected to contribute large numbers of larvae near the CRBRP site.

Ref. 1 This information is taken from Ref. 111 listed in Chapter 13 of the ER (Amend. IX), which is: Woosley, L. H., Jr., Taylor, M. P., Toole, T. W. and Wells, S. R., *Status of the Nonradiological Water Quality and Nonfisheries Biological Communities in the Clinch River Prior to Construction of the Clinch River Breeder Reactor Plant, 1975-1978*, Tennessee Valley Authority, Chattanooga, Tennessee and Muscle Shoals, Alabama, February 1979, 143 pp. and appendices.

Question 290.6R

Provide an estimate of the maximum probable yearly recreational harvest of finfish, shellfish, and molluscs harvested from waters downstream of the station to the Mississippi River that potentially could be contaminated by radionuclides due to a maximum probable accident. The harvest estimates should be summarized by species and location of capture (water body segment) and provide an explanation of how the estimate was obtained.

RESPONSE

The Clinch River Breeder Reactor Plant has been designed such that no "maximum probable accident" can result in significant radionuclide release to the adjacent water body. Even so the requested estimates are provided.

Estimates of maximum sport fish harvest of individual species were obtained from most recent creel data available for Watts Bar, Chickamauga, Nickajack, Wheeler, and Kentucky Reservoirs. These estimates have been increased by 40% to conservatively account for the uncertainty of the information. While harvests from individual bodies of water may exceed the estimated total, the system-wide total is considered realistic. Total harvests were then estimated for Guntersville, Wilson, and Pickwick Reservoirs based on harvest in adjacent reservoirs and a subjective comparison of the relative quality of their fisheries (Table 290.6R-1).

There is no known harvest of shellfish or molluscs for sport in the Tennessee Valley.

Since a conservative margin of 40% has been applied to the information gathered on sport fish harvests and since the approximately 40 mile reach of the Ohio River between its mouth and the mouth of the Tennessee River represents less than 10% of the total river miles considered, it is concluded that the absence of specific fisheries information for the Ohio River will not seriously affect the information presented here. Furthermore, this portion of the river is farthest from the Plant site (approximately 580 river miles) and therefore, would receive the greatest benefit from the effects of dilution.

TABLE 290.6R-1 - MAXIMUM PROBABLE SPORT FISHING HARVEST IN THE TENNESSEE RIVER BELOW CRBRP SITE

Species	Harvest Pounds								Grand Total
	Watts Bar Reservoir	Chick-mauga Reservoir	Nick-ajack Reservoir	Gunters-ville Reservoir	Wheeler Reservoir	Wilson Reservoir	Pickwick Reseroir	Kentucky Reser-voir & Tailwaters	
Paddlefish	1,764	2,440	732					28,064	
Buffalo		11,956						600	
Carp	2,940	5,612	2,928					145,716	
Flathead Catfish	1,176	25,376	2,562		902			98,070	
Blue Catfish	11,466		6,954		5,884			741,039	
Channel Catfish	50,568		14,823		39,780			369,735	
Bullhead			183		263			6,500	
Drum	6,762	6,588	28,182		1,824			119,613	
Rainbow Trout	264		183					600	
Striped Bass	15,876	33,916	732					8,064	
White Bass	27,048	28,548	6,588		4,248			225,678	

TABLE 290.6R-1 - MAXIMUM PROBABLE SPORT FISHING HARVEST IN THE TENNESSEE RIVER BELOW CRBRP SITE

Species	Harvest Pounds								Grand Total
	Watts Bar Reservoir	Chick-mauga Reservoir	Nick-ajack Reservoir	Gunters-ville Reservoir	Wheeler Reservoir	Wilson Reservoir	Pickwick Reseroir	Kentucky Reser-voir & Tailwaters	
Yellow Bass	294	488	5,307					9,864	
Sauger	28,812	24,400	1,098		150			1,066,810	
Largemouth Bass	48,216	33,184	21,777		15,961			209,664	
Smallmouth Bass	8,820	3,172	183		4,869			4,032	
Spotted Bass	294	4,880	1,647		75			20,160	
White Crappie	51,450	36,600	28,300		100,730			1,559,803	
Black Crappie	2,940	4,636	1,098					28,224	
Blue Gill	33,516	17,080	54,351		8,422			135,456	
Red Ear Sunfish		244	12,444		1,541			90	
Other Sunfish		4,148	2,013		1,578			16,428	

TABLE 290.6R-1 - MAXIMUM PROBABLE SPORT FISHING HARVEST IN THE TENNESSEE RIVER BELOW CRBRP SITE

Species	Harvest Pounds								Grand Total
	Watts Bar Reservoir	Chick-mauga Reservoir	Nick-ajack Reservoir	Gunters-ville Reservoir	Wheeler Reservoir	Wilson Reservoir	Pickwick Reseroir	Kentucky Reser-voir & Tailwaters	
Rock Bass			732		620			740	
Wall Eye	1,764	732	183		20				
	294,000	244,000	193,000	280,000	187,000	119,000	252,000	4,795,000	6,354,000

Question 290.7R

Using data from the last 5 years from National Marine Fisheries, or the States within the Tennessee and tower Ohio watersheds, provide an estimate of the maximum probable yearly commercial harvest of finfish, shellfish, and molluscs harvested from waters downstream of the station to the Mississippi River that potentially could be contaminated by radionuclides due to a maximum probable accident. The harvest estimates should be summarized by species and location of capture (water body segment). Provide an explanation of how the estimate was made.

RESPONSE

The Clinch River Breeder Reactor Plant has been designed such that no "maximum probable accident" can result in significant radionuclide release to the adjacent water body. Even so the requested estimates are provided.

Commercial fish harvest estimates were made by taking most recent harvest data for each region of the Valley. These estimates have been increased by 40% to conservatively account for the uncertainty of the information. The estimates are then apportioned among the reservoirs of each region, based on the knowledge of the standing crop of fish in each reservoir and data from individual fish markets serving each reservoir (Table 290.7R-1).

There is no known shellfish or mollusc harvest for food in the Tennessee Valley. Shells of freshwater mussels are harvested to be used as nuclei for cultured pearls in Japan. No estimates

are available for individual bodies of water, but based on our current knowledge of the resource, total maximum expected harvest for the Tennessee River below the CRBRP site is about the amount of 1978 harvest (1000 tons).

Since a conservative margin of 40% has been applied to the information gathered on commercial fish harvests and since the approximately 40 mile reach of the Ohio River between its mouth and the mouth of the Tennessee River represents less than 10% of the total river miles considered, it is concluded that the absence of specific fisheries information for the Ohio River will not seriously affect the information presented here. Furthermore, this portion of the river is farthest from the Plant Site (approximately 580 river miles) and therefore would receive the greatest benefit from the effects of dilution.

TABLE 290.7R-1 - MAXIMUM EXPECTED COMMERCIAL FISH HARVEST FOR LOWER EIGHT TENNESSEE RIVER RESERVOIRS

	RESERVOIR								
Commercial Fish Groups	Kentucky (Pounds)	Pickwick (Pounds)	Wilson (Pounds)	Wheeler (Pounds)	Guntersville (Pounds)	Nickajack (Pounds)	Chickamauga (Pounds)	Watts Bar (Pounds)	TOTAL
Paddlefish	249,830	21,713	7,812	33,807	34,206	12,631	43,117	47,502	450,618
Carp	140,104	44,288	15,936	68,960	69,775	9,146	31,223	34,398	413,830
Buffalo	2,059,114	781,593	281,246	1,216,982	1,231,378	109,813	374,674	414,960	6,469,760
Catfish	1,513,737	337,919	121,596	526,157	532,382	24,172	82,270	90,636	3,228,868
Drum	27,423	18,858	6,786	29,364	29,711	851	2,974	3,276	119,243
TOTAL	3,990,208	1,204,371	433,376	1,875,270	1,897,452	156,613	534,258	590,772	10,682,319

Question 290.8R (NRC letter dated 10/26/81, response letter dated 12/22/81)

> Indicate if any federally recognized threatened or endangered species have either been reported from the site or the immediate vicinity or historically known from the site and recently placed on the list of protected species since issuance of the ER.

RESPONSE

Reconnaissance field surveys of the Clinch River site were conducted in August, 1980. The purpose of these surveys was to evaluate current conditions at the Site relative to those described in the CRBRP Environmental Report and in the NRC's final Environmental Statement which was issued in Febuary, 1977. Based on the surveys and an evaluation of recent published literature, it was established that no changes have occurred on site since that time with respect to recognized threatened or endangered species. This determination and the supporting data were provided to the NRC as part of Amendment IX to the ER.

Question 290.9R

Give the status of the NPDES Permit, the Clean Water Act 401 Certification, and other permits and approvals required prior to station operation.

Response

The specific details of individual permits and approvals are as follows:

1. U.S. Environmental Protection Agency (Region IV)

   a. Permit - The National Pollutant Discharge Elimination System (NPDES) Permit

   b. Status - A Draft NPDES Permit was initially issued November 4, 1976, however, due to the National Policy Debate concerning the future of the CRBRP Project, the draft permit was not further resolved. An up-to-date draft of the NPDES Permit application was prepared in late November 1981 and was transmitted to the EPA and the State of Tennessee in early December 1981. Recent discussions with the EPA indicate that a final draft NPDES permit is expected to be completed for inclusion in the NRC update to the CRBRP Final Environmental Statement (NUREG-0139), which is scheduled for publication on June 22, 1982.

2. State of Tennessee, Bureau of Environmental Health Sciences, Division of Water Quality Control

   a. Permit - Clean Water Act - Section 401 Certification

   b. Status - The State was provided information in early December 1981 relative to Section 401 Certification of the NPDES Permit. The State will review the information to assure compliance with applicable State requirements and to assure resolution of State concerns prior to issuance of the final draft NPDES permit. The State has indicated that a Section 401 Certification will be issued for the CRBRP NPDES Permit.

3. State of Tennessee, Department of Conservation, Division of Water Resources.

   a. Approvals - Registration of withdrawal of 50,000 or more gallons of water per day from the waters of Tennessee.

   b. Status - The registration form may be sent in as early as February 15, 1982 or whenever site work dictates a 50,000 gallons per day river water demand.

4. Federal Aviation Administration, Air Space and Procedures Branch

   a. Permit - Permits for tall structures--necessary for any structures 200 feet in height above the ground level at its base.

b. Status - Permits have been obtained for those structures presently existing on site. No additional structures requiring such permits are presently planned.

5. Federal Aviation Administration, Air Space and Procedures Branch

a. Permit - Permit for landing area (i.e., heliport) construction.

b. Status - Permits necessary for such construction will be initiated at least 60 days prior to heliport construction.

6. Federal Communication Commission (FCC), National Telecommunication and Information Agency (NTIA)

a. Permits - (1) Assignment of frequency authorization and approvals to operate two-way radios during the plant's construction phase.

(2) Assignment of a frequency authorization and approvals to operate a radio communications (i.e., microwave receiver/ transmitter system) system during the plant's operational phase.

b. Status - (1) The frequency authorization and the approval to operate two-way radios for the construction phase have been secured. Other necessary frequency authorizations will be secured as appropriate.

(2) The frequency authorization for the plant's operational phase will be secured prior to plant operation.

7. U.S. Coast Guard, Aids to Navigation Branch

a. Approval - An approval that insures that adequate lights and other markings are provided on structures near navigational channels such as the barge facility.

b. Status - U.S. Coast Guard approval was given November 30, 1981 that the Project's planned actions were adequate.

8. State of Tennessee, Bureau of Environmental Health Services, Division of Air Pollution Control

a. Permits - Permits are needed to both construct and operate the following emission sources:

Concrete Batch Plant
Rock Crusher Facility
Cooling Towers
Diesel Generators
Any stationary internal or external combustion units

b. Status - The necessary information for these permits is being assembled and the proper procedures for complying with their requirements are being followed. An assessment has been

conducted which identifies the potential to emit air contaminants from all sources. Individual permits will be processed to secure permits in a timely manner.

9. U.S. Army Corps of Engineers, Operation Division, Regulatory Function Branch

   a. Permits - A permit is required to perform the following:

      (1) to discharge dredge or fill materials into navigable waters,

      (2) to construct water intake and discharge facilities,

      (3) to construct barge facilities, and

      (4) to provide an access road and railroad fills. (below normal water level, elevation 741 feet, 225.86 meters).

   b. Status - The Corps of Engineers Permit (No. 42,362) was initially issued May 6, 1977 and was extended on January 29, 1981, and will remain valid until May 4, 1984.

10. Tennessee Valley Authority, Division of Land and Forest Resources

   a. Permit - A TVA Section 26a Permit is needed to perform the following activities:

      (1) construction of water intake and discharge structures,

(2) construction of the barge facilities, and

(3) construction of access road and railroad fill permits.

b. Status - The TVA Section 26a Permit was initially issued April 19, 1977 and was extended on June 10, 1981, and will remain valid indefinitely; however, it is subject to revocation.

11. U.S. Coast Guard and U.S. Army Corps of Engineers

a. Permit - Permit to place thermal monitors in the Clinch River.

b. Status - A computerized model is being developed by the TVA for use in their nuclear plants. This model performs thermal monitoring of river water using intake temperature and outfall temperature only. It is anticipated that this technique will be used at CRBRP and would eliminate the need for installing monitoring stations in the river. However, if this technique cannot be used, permits will be obtained and time is available to do so.

12. Tennessee Department of Transportation

a. Permit - Permit for excess weight/size vehicles.

b. Status - Permits for excess weight/size vehicles on the State highway system are secured on a case-by-case basis by the activity responsible for use of such vehicles. The vehicle/load description

is provided to TDOT twenty-four hours in advance. TDOT provides a written (teletype) permit. To date, five permits have been requested and received for movement of five sodium pump drive motors.

13. Tennessee Department of Transportation

    a. Permit - Grant of easement.

    b. Status - The CRBRP railroad crossing of the Highway 58 right-of-way and beneath Gallagher Bridge is the only identified requirement of this type. TDOT has reviewed the location and design drawings of the crossing of the right-of-way and found them acceptable. Change to the existing grant of easement to the State for Highway 58 through Federal property is being developed.

14. City of Oak Ridge

    a. Permit - Grant of easement.

    b. Status - Two changes to the City of Oak Ridge's grant of easement from DOE for Bear Creek Road have been identified - one for the CRBRP water line crossing and one for the CRBRP railroad spur paralleling Bear Creek Road. Changes to the existing grant of easement will be initiated shortly with the City of Oak Ridge.

Question 290.10R

Provide an estimation of the # of acres of prime and unique farmlands (Fed. Reg. 4030-4033 Vol. 43, #21, January 31, 1978), on the Clinch River site. Also indicate how many acres of prime and unique farmlands, if any, will be disturbed by construction activities.

RESPONSE

The CRBRP site is predominately rolling (8 to 15% slope) to hilly (15% to 30% slope) and is not classed as prime or unique farm land. The Roane County soil survey issued May, 1942 by the U. S. Department of Agriculture in cooperation with the Tennessee Agricultural Experiment Station and TVA shows two main soil types. One type is the Clarksville Cherty Silt Loam Hilly Phase and is derived from the Cherty Limestone and would be classed as poorly suited for agricultural crops. The second type, the Upshur Silty Clay Loam Valley Phase soil type is a very shallow soil that is derived from shaley limestone, contains outcrops of limestone, and is considered poor for cultivated crops.

QUESTION 290.11R

The U.S. Fish and Wildlife Service has notified the NRC that 11 species of endangered freshwater mussels may be present in the vicinity of the CRBR site. The 11 species of mussels are Plethobasis cooperianus, P. cicatricosus, fusconaia cuneolus, E. f. florentina, Lampsilis virescens, L. o. orbiculata, Dromus dromas, Pleurobema plenum and Cenradilla caelata. Provide any records of any of these species taken from the Clinch River in the vicinity of the site, or from Watts Bar Reservoir. Include the date, the location and the number of specimens collected. Describe the program that resulted in the collection of these species. Provide a discussion on the potential for the presence of any of these species on the shallow submerged island located in the Clinch River just downstream of the planned discharge structure.

RESPONSE

Freshwater mussel populations in the lower reach of the Clinch River have not been the specific subject of any investigation in over 50 years; however, several studies have evaluated macro-invertebrate fauna in the vicinity of the Clinch River Breeder Reactor Project (CRBRP) site (Project Management Corporation, 1975; Exxon Nuclear Company, Inc., 1976; TVA, 1979). Although several endangered mussel species inhabit the Clinch River system, and in time past have occurred near the CRBRP site (Attachment 1), none have recently been recorded in the lower portion of the river. Recent studies by TVA (1979) and Oak Ridge National Laboratory (1981) identified only two silt tolerant species (Quadrula pustulosa and Anodonta sp.) in the vicinity of the Site. TVA divers (biologists) working at the Site have reported the benthic substrate as unsuitable for significant mussel populations with the major (channel) part of the river having a bottom of bedrock and localized overbanks being composed

of sand. Due to the limited amount of suitable substrate and the failure of several surveys to encounter significant mussel populations, potential for the occurrence of endangered mussels in the vicinity of the CRBRP site is remote.

REFERENCES

Exxon Nuclear Company, Inc., 1976. Nuclear Fuel Recovery and Recycling Center Environmental Report, Vols. I and II. Docket No. 50-564, December 16, 1976.

Oak Ridge National Laboratory, 1981. Ecological studies of the Biotic Communities in the vicinity of the Oak Ridge Gaseous Diffusion Plant. Environmental Science Division. Pub. No. 1744, October 1981.

Project Management Corporation, 1975. Clinch River Breeder Reactor Environmental Report, Vols. I and II. Docket No. 50-537, April 10, 1975.

Tennessee Valley Authority, 1979. Status of the Nonradiological Water Quality and Nonfisheries Biological Communities in the Clinch River Prior to Construction of the Clinch River Breeder Reactor Plant, 1975-1979, pp. 145.

ATTACHMENT 1

Records of presently-listed endangered freshwater mussels collected within 40 river miles of the CRBR Site (Clinch River Mile 15-17).

Species	Stream & Site	Date & Reference
3) Fusconaia cuneolus	Clinch River (Solway) Rm 44	1914-Ortmann, 1918
	Poplar Creek (Roane Co.) at mouth at Rm 12.0	Before 1918-Ortmann, 1918

		Emory River (Harriman) Rm 11	1915-Ortmann, 1918
4)	Fusconaia edgariana	Clinch River (Pattons Ferry)	Before 1918-Ortmann, 1918
		Poplar Creek (Roane Co.) at mouth Rm 12.0	Before 1918-Ortmann, 1918
		Clinch River (Edgemoor) Rm 48	1915-Ortmann, 1918
7)	Plethobasus cooperianus	Clinch River (Pattons Ferry) Rm 14	Before 1918-Ortmann, 1918
		Tennessee River Rm 595.0	1978-Gooch, et. al. 1979
		Clinch River (Edgemoor) Rm 48	1915-Ortmann, 1918
1)	Dromus dromas	Clinch River (Solway) Rm 44	1914-Ortmann, 1918
		Clinch River (Edgemoor) Rm 38	1915-Ortmann, 1918
5)	Lampsilis orbiculata	Clinch River (Solway) Rm 44	1914-Ortmann, 1918
		Tennessee River Rm 588.4	1978-Gooch, et. al. 1979

6)	Lampsilis virescens	Emory River (Harriman) Rm 11	1915-Ortmann, 1918
2)	Epioblasma turgidula	Emory River (Harriman) Rm 11	1915-Ortmann, 1918

REFERENCES

Ortmann, A. E., 1918, The Nayades (Freshwater Mussels) of the Upper Tennessee Drainage. With notes on synonymy and distribution. Proceedings of the American Philosophical Society, 57:521-626.

Gooch, C. H., Pardue, W. J. and Wade, D. C., 1979. Recent mollusk investigations of the Tennessee River, 1978. Draft report of the Water Quality and Ecology Branch, Division of Environmental Planning, Tennessee Valley Authority, pp. 126.

Follow on information on QUESTION 290.11R

Additional information relating to this response has been provided, as follows:

1. Narrative comments about substrate characteristics and likelihood of finding endangered mussels were supplied by Donald C. Wade, TVA biologist. The tabular list of

endangered mussel records was compiled by John J. Jenkinson, TVA biologist (malacoligist).

2. Literature citations for Ortmann, 1918 and Gooch, et. al., should have been attached to the end of the table. They are as follows:

Ortmann, A. E., 1918. The Nayades (freshwater mussels) of the Upper Tennessee Drainage. With notes on synonymy and distribution. Proceedings of the American Philosophical Society, 57:521-626.

Gooch, C. H., Pardue, W. J. and Wade, D. C., 1979. Recent mollusk investigations of the Tennessee River, 1978. Draft report of the Water Quality and Ecology Branch, Division of Environmental Planning, Tennessee Valley Authority, 126 pp.

3. All twelve freshwater mussel species on either the U.S. Fish and Wildlife Service or on the TVA generated lists are typically found on stable gravel or cobble substrates. Marginal habitats for the Plethobasus species, Lampsilis orbiculata, Dromus dromas and Pleurobema plenum might extend to sand or clay substrates if the bottom material was current-swept, stable and penetrable enough to allow the mussels to dig in. Solid bedrock or shifting mud or sand substrates, which characterize the river bed in the vicinity at and downstream of the CRBRP site, are unsuitable habitats for nearly all freshwater mussel species including all of the species on either of the lists prepared by the CRBRP site.

4. Known ranges of species involved (live records 1975-date):

Cenradilla caelata	-middle reach of the Powell River (RM 95-120) -middle reach of the Clinch River (RM 184-219, 253, 273)

	-middle reach of the Elk River (RM 70 and 83) - not live but fresh, empty shells. -middle reach of the Duck River (RM 132-179)
Dromus dromas	-middle reach of the Clinch River (RM 170-190) -middle reach of the Powell River (RM 67-136) -one short reach of the Tennessee River below Watts Bar Dam (RM 520-521) -one site on the Cumberland River below Cordell Hull Dam (RM 296)
Epioblasma florentina florentina	-no recent records; presumed to be extinct
Epioblasma torulosa gubernaculum	-one site record from the middle reach of the Clinch River (RM 187)
Epioblasma turgidula	-last collected (1972) on the Duck River (RM 250) in an area now covered by Normandy Reservoir; presumed extinct
Fusconaia cuneolus	-middle reach of the Powell River (specific sites not available) -extensive reach of the Clinch River (RM 156-226, 268-322) -one site on the Paint Rock River (RM 48)

Fusconaia edgariana	-middle reach of the Powell River (RM 67-136) -an extended reach of the Clinch River (RM 184-279) -upper reach of the North Fork Holston River (RM 84-92) -upper reach of the Paint Rock River (RM 44-59) -middle reach of the Elk River (RM 70-118)
Lampsilis orbiculata	-one site on the Clinch River (RM 185) -a number of separated sites on the Tennessee River (RM 22, 164-170, 183, 197-202, 251-252, 334-33 , 344-346, 417, 518-528, 588-592) -a single record from the Ohio River near Paducah, Kentucky (near Rm 940) -several sites in the reach of the Cumberland River that has been studied (RM 275-305) -nine sites in the lower 55 miles of the Merawec River, Missouri. Also reported from the Little Black River, St. Francis River, Sac River, Gasconade River and Osage River--all in Missouri.
Lampsilis virescons	-upper Paint Rock River system (RM 59-60 and Hurricane Crock)
Plethobasus ciatricosus	-one record from the Tennessee River near Savannah, TN (near RM 190)

Plethobasus cooperianus	-a few widely scattered sites on the Tennessee River (RM 153, 170, 183, 197, 205, 345, 595) -a single record from the Ohio River near Paducah, Kentucky (near RM 940)
Pleurobema Plenum	-two sites on a middle reach of the Clinch River (RM 179 and 185) -at least one non-specific record from the Tennessee River near Savannah, Tennessee (near RM 190) -records also exist for the Green River, Kentucky

Note: this page was not included in AM15 copy provided by printer

QUESTION 310.1R (NRC letter dated 10/26/81)

Provide current data on purchase of materials (concrete, lumber, stone, sand, etc.) and services (excluding local construction labor) to be made in the four-county impact area during the construction period.

RESPONSE

The Applicant has not conducted an analysis to estimate purchases of materials (concrete, lumber, stone, sand, etc.) and services (excluding local construction labor) to be made in the four-county impact area during the construction period. However, the Applicant does assume that large purchases of these materials and/or services will be made in the four-county impact area.

QUESTION 310.2R

Provide current data on labor force requirements and schedules, intra-structure capacity and demand, tax rates and fiscal resources, population, land use and competing construction projects.

RESPONSE

The requested information was updated to a 1980-1981 data base in ER Amendments X and XIV, dated December, 1981 and May, 1982, respectively.

QUESTION (1)

Section 2.2.1.3

The Applicant should describe the methods and assumptions used to derive resident equivalents from the data on transportation, daily, and seasonal transients.

RESPONSE (1)

The translation of transportation, daily, and seasonal transients into resident equivalents (i.e., the number of persons who would be in the area all year) requires a number of assumptions:

o Transportation Transients

The main sources of transportation transients within five miles of the site are local highways. Using the Average Daily Traffic (Table 2.2-4) for the highways discussed in Section 2.2.1.3, the following calculations were made:

- The length of the various highway segments is:

I-40	--11 miles
Tenn 58	---8 miles
Tenn 95	---5 miles

- Assuming the average speed of vehicles if 55 miles per hour, this distance translates into an average vehicle transit time for each highway.

I-40	--12 minutes
Tenn 58	---9 minutes
Tenn 95	---6 minutes

- The product of the proportion of a day that a vehicle is within 5 miles of the site and the total traffic volume is the resident equivalent. For example, for I-40, the calculation is:

$$\frac{12 \text{ minutes}}{(24 \text{ hours})\ (60 \text{ minutes/hr})}(21{,}130 \text{ vehicles}) = 176 \text{ vehicles}$$

- To convert vehicles to persons, it is assumed that there are 2.0 persons per vehicle.

$$(176 \text{ vehicles})\left(2.0 \frac{\text{persons}}{\text{vehicle}}\right) = 352 \text{ persons}$$

Table 2.2-5 shows the resident equivalents due to transportation, and the population wheel sectors into which they fall.

o Daily Transients

The major source of daily or commuter transients within ten miles of the site is the Oak Ridge complex. There are three major industrial facilities; the Oak Ridge Gaseous Diffusion Plant (ORGDP), the Oak Ridge National Laboratory (ORNL), and the Y-12 plant. Table 2.2-6 shows the employment at these facilities. Each facility has people present all day, every day of the week. The resident equivalents were calculated in two ways:

- For the weekday and shift personnel, the fraction is 40/168 = 0.24 workhours/week. Thus there are (0.24)(4820) = 1157 or 1160 persons for the regular shift.

- For the weekend shift personnel, the fraction is only 16/168 or .095 workhours/week. Thus (.095)(120) = 11 persons.

The distributuion of the resident equivalents for the Oak Ridge complex is given in Table 2.2-7.

o Seasonal Transients

Table 2.2-8 presents estimated average peak hour visitation and visitation projections for recreation areas within ten miles of the CRBRP. Almost all of these areas will be used for only part of the day. It is estimated that visitors will stay less than four hours at these areas. Use of peak hour estimates is conservative in that actual use of the facilities is overestimated.

Conversion of the estimates into transient equivalents was accomplished by:

- Using the peak hour estimates for each recreational site, e.g., the commercial campground (Site 1). Most campers are present overnight and in the camp for 12 hours or more. Using the peak hour estimate thus overestimates the number of campers present all day.

- Multiplying all visitation estimates for sites other than Atomic Speedway and the commercial campground by four. Considering that most visitors are present at the facility less than four hours, this step overestimates the number of persons present each 24-hour day.

Atomic Speedway was not included in the calculations. Use of the speedway is very sporadic, and it is felt that its resident equivalent is negligible compared to the other facilities.

The equivalents for seasonal transients are presented in Table 2.2-9.

QUESTION (2)

Section 2.2.1.5

The Applicant should explain the apparent discrepancy between the number of schools operating in 1981 and the number of schools indicated in Table 2.2-11.

RESPONSE (2)

The number of schools operating in 1981 within a 10-mile radius of the site listed in the text of Section 2.2.1.5 should be twenty-one schools rather than twenty-two schools as shown. The number of schools listed in Table 2.2-11 is correct. These corrections were provided in Amendment XIII.

QUESTION (3)

Section 2.2.2

The Applicant should explain the apparent discrepancy between the following two sentences in the noted section:

> "No wildlife preserves, sanctuaries or hunting areas are within 10-mile radius of the site. A waterfowl refuge which is part of the Long Island Wildlife Managment area is located on the Tennessee River approximately eight radial miles..."

RESPONSE (3)

In section 2.2.2, the first sentence which describes the type, location, and distance of wildlife preserves, sanctuaries, or hunting areas from the site should be changed to read as follows:

> "No wildlife preserves, sanctuaries, or hunting areas are within a 5-mile radius of the Site."

All of the sentences that follow this sentence within section 2.2.2 regarding wildlife management areas are correct as presented. This change was made in Amendment XIII.

QUESTION (4)

Section 2.2.2.2.

In what year was the Clinch River Consolidated Industrial Park established? Of the 33 acre total, how many acres are occupied by Eagle Picher, Inc.? Does Eagle Picher have tax exempt status or benefit from any state and/or local development subsidy? What are the prospects for additional industrial development of the site?

RESPONSE (4)

The Clinch River Consolidated Industrial Park was established in 1972. Eagle Picher, Inc. currently occupies 10 acres and has an option on 20 additional acres within this 112 acre park. Eagle Picher does not have a tax exempt status and does not benefit from any state and/or local development subsidies. The prospects for additional industrial development of the park are believed to be excellent if the CRBRP is constructed according to the Oak Ridge Chamber of Commerce.

Question (5)

Section 2.2.3.1

Are there any recreational or commercial fishing uses of surface? If either or both activities occurs, the applicant should describe the activities in detail.

RESPONSE (5)

Total recreational and commercial fish harvest from Watts Bar Reservoir were provided in response to Questions 290.6R and 290.7R, respectively. For fish management purposes, Melton Hill Reservoir is currently closed to commercial fishing. Watts Bar Reservoir is closed to fishing with entanglement gear, and current commercial activity on the reservoir is restricted to trot lines, snag lines, slat boxes, and hoop nets. Commercial fishing pressure in the area of the CRBRP is generally low because of the cold nature of the Melton Hill Reservoir releases and low populations of catfish in that portion of the reservoir. There is some seasonal fishing for paddlefish using snag lines and buffalo using bait lines. This activity is generally of short duration and limited to periods when these fish are migrating past the proposed site (late winter and spring).

The most recent information available on sport fishing in Watts Bar Reservoir is a 1980 creel survey done by the Tennessee Wildlife Resources Agency. Data from this survey indicates that there were about 17,700 fishing trips made in the Clinch River arm of Watts Bar Reservoir, and anglers harvested an estimated 42,700 fish weighing 31,500 pounds. These numbers are derived from estimates for the upper portion of Watts Bar Reservoir which includes both the Clinch River and Tennessee River arms and assumes that 50 percent of this pressure occurs in the Tennessee River.

Most of the fishing pressure in the Clinch River arm of Watts Bar Reservoir, particularly in the vicinity of the CRBRP site, occurs in winter and early spring when sauger and white bass migrate through the area. Although no specific data are available to document the magnitudes of differences, most of the fishing pressure occurs close to Melton Hill Dam and at Kingston Steam Plant while pressure around the CRBRP site is much lower than at either of these areas.

QUESTION (6)

Table 2.2-1

This table and others which follow are based on preliminary 1980 Census data. As final 1980 data are available, the Applicant should supply revised tables.

RESPONSE (6)

The final 1980 Census Report was not available for use when the socioeconomic update was prepared (amendment X). The preliminary 1980 population numbers for the 20 cities and towns presented in Table 2.2-1 and the final 1980 Census numbers are almost identical (less than a 1 percent difference) except for Kingston, Oliver Springs, Dayton, and Etowah. The final population numbers for Kingston, Oliver Springs, and Etowah are different from the preliminary numbers by about 1.6 percent. Only the city of Dayton, located 45 radial miles from the Site is significantly different on the final report (14.4 percent higher). Because the final population numbers are so close to the preliminary report numbers used in the analysis, it seems reasonable and appropriate to maintain the use of population census data presented in Table 2.2-1. Use of the final 1980 Census numbers would not result in any minor or major differences in information and conclusions presented in amendment X to the CRBRP ER.

QUESTION (7)

Section 6.1.4.2.2

The Applicant should update population projections for Tennessee by using the latest population projections prepared by the State Department of Public health on June 17, 1981.

RESPONSE (7)

Section 6.1.4.2.2 Population Projections, was prepared prior to the update population projections prepared by the State Department of Public Health on June 17, 1981. Appropriate state and local agencies were contacted to obtain their available population projections prior to beginning the CRBRP population projection work. The data used in this population work has been coordinated with local and district planning agencies prior to finalizing the work presented in amendment X. Because the projections prepared by the Public Health Department are viewed as department projections rather than final state projections, it is not believed they are any more reliable than those used in the CRBRP analysis.

QUESTION (8)

Section 8.1.3.2

Information in this section is apparently focused on publicly supported schools. The Applicant should furnish information on private sectarian and non-sectarian schools.

RESPONSE (8)

There are 128 approved private or parochial elementary and secondary schools in the State of Tennessee. Overall, private schools in the State have approximately 3.5 percent of the total student enrollment. In the four-county affected area, approximately 2 percent of elementary and secondary students are enrolled in approved private and parochial schools.

QUESTION (9)

Section 8.1.3.6

The information in this section is directed toward public recreational facilities. The Applicant should identify opportunities available at privately supplied recreational activities (e.g., movies, bowling, hunting, fishing).

RESPONSE (9)

It seems inappropriate to attempt to quantify the number, type, and location of privately-owned recreation facilities within the study area. The focus of the analysis was on impacts to public services, facilities, and programs. Privately supplied recreational activities were not quantified. The size of the inmoving population is extremely small compared to the population size of the metropolitan area, which will result in insignificant effects to privately-owned recreation activities. It would be sufficient merely to mention that there are many privately-owned recreational facilities located throughout the four-county area.

QUESTION (10)

Section 8 The Applicant should describe the planning institutions in the four-county area, specifically:

(a) The control of land use decisions and zoning;
(b) special purpose ordinances, e.g., mobile homes, farmland preservation, floodplains; and
(c) comprehensive plans and planning.

RESPONSE (10)

The following discussion summarizes the planning function in the four-county area:

(a) In Anderson County all cities and towns have adopted comprehensive plans, zoning ordinances, and subdivision regulations. The county does not have an adopted comprehensive plan at this time. Neither cities nor the county have specific farmland preservation ordinances. Mobile home use is restricted in Oak Ridge but generally allowed everywhere else in mobile home parks.

(b) Knox County and Knoxville city have comprehensive plans, zoning ordinances, subdivision regulations but neither the county nor the city have a specific farmland preservation ordinance. In Knoxville, mobile homes are restricted to mobile home parks, while in Knox County, mobile homes are treated like any other single family dwelling regarding site restrictions.

(c) In Loudon County, all municipalities and the county have comprehensive planning, zoning ordinances, and subdivision regulations. A farmland preservation ordinance

has not been passed by any planning commission in Loudon County. Mobile homes in both municipalities and the county are treated like any other single-family dwelling regarding site restrictions.

(d) The major municipalities and towns in Roane County all have comprehensive plans, zoning ordinances, and subdivision regulations. The county has never adopted a comprehensive plan, but sectors of the county do have subdivision regulations. In Rockwood, mobile homes are generally allowed everywhere, whereas in Oliver Springs, Harriman, and Kingston, their location is restricted to mobile home parks or certain residential districts.

All four counties and cities within the four-county area have floodplain ordinances to control land development in floodplain areas.

All communities and counties in the study area have active planning commissions. Cities like Knoxville and Oak Ridge have their own staff-supported planning agencies. However, in most cases throughout the study area, planning guidance and technical assistance is provided by contracted service with either the East Tennessee Development District or the Tennessee State Planning Office.

QUESTION (11)

Table 8.1-3

The State of Tennessee Department of Public Health State Center for Health Statistics has revised 1980 projections for the four-county impact area. Because these data are based on the 1980 Census, the staff believes that projections based on the state's data would be more accurate than those presented in the table cited above. Therefore, the Applicant should provide a revised Table 8.1-3 using the most recent data from the state.

RESPONSE (11)

See response to question 6 regarding the use of department projections in place of the preliminary projections prepared by the Bureau of the Census.

QUESTION (12)

Table 8.1-4

This table indicated declining population in the 5-19 (school-age) cohort; the state's latest projections for 1985 and 1990 also indicate declines in the school-age cohort at the county level (6/17/81). However, with two exceptions, Appendix Table 2.2-7 indicates that school superintendents expect increasing enrollment, exclusive of project-related children. The Applicant should explain this apparent discrepancy.

RESPONSE (12)

The Applicant does not have a specific explanation for this discrepancy.

QUESTION (13)

Table 8.1-17

In the NRC Final Environmental Statement (February 1977), the treatment capacity and average daily flow of the Kingston system were 1,500,000 gpd and 750,000 gpd, respectively. As these figures are considerably higher than those now presented by the Applicant, the Applicant should explain this discrepancy.

RESPONSE (13)

The treatment capacity and average daily flow numbers for the Kingston system presented in Table 8.1-17 amendment X were rechecked January 7, 1982, and determined to be correct. The treatment capacity and average daily flow numbers presented in the original ER Table 8.1-17 of 1,500,000 and 750,000 gpd, respectively, were apparently listed incorrectly.

QUESTION (14)

Section 8.2.2.1

The income data in this section implies a large impact on the four-county area. However, some portion of the total income earned will be spent outside the area by inmovers with families, by inmovers who are unaccompanied by family members, and by daily commuters from outside the four-county area (See FES-CP, Section 4.5.4). In addition, the amount of income earned by residents (nonmovers) should be reduced by an amount equal to their earning potential in the absence of CRBR. The Applicant should use these considerations to develop an income figure which indicates the net dollar impact within the four-county area.

RESPONSE (14)

The numbers presented in section 8.2.2.1 are gross employment and income totals which will be spread over the project recruitment area. Therefore, the positive impact received from CRBRP project-related employment and income in the four-county area would be less than the gross totals presented in this section.

QUESTION (15)

Section 8.2.2.2

In view of the Appalachian Regional Commission's research on the study area, what is the Applicant's rationale for using a lower multiplier than those developed in the ARC study?

RESPONSE (15)

The ARC multipliers are more indicators of the type of economy each county has than indicators of the size of employment change which would be brought about by a change in basic employment. That is, the ARC multipliers include secondary employment from such things as central trades and service functions (e.g., banking and stock exchange); inleakage from nearby counties to major stores or restaurants; and expenditures by tourists. The applicant concluded that the Chamber of Commerce multiplier was a better estimate to use for this analysis but to be conservative, it was rounded downward to 1.6.

QUESTION (16)

Section 8.2.2.3

What is the current status of P.L. 81-875 for FY 1982?

RESPONSE (16)

We understand that the public law number should have been 81-874. The totals for P.L. 81-874 are 4 percent below the levels approved in the Office of Management and Budget (OMB) 1982 budget document dated March 1981. The U.S. House of Representatives Appropriations Committee staff has not yet received an actual breakdown of the various funding categories. Based on the Continuing Resolution figures, below are rough estimates as to levels of payment:

--"A" payments: approximately 85 percent of FY 81 payments

--"B" payments: 65 percent to 70 percent of FY 81 levels in districts 20 percent or more of average daily attendance (ADA) comprised of "B" children

--"B" payments: 30 percent to 35 percent of FY 81 levels in districts with less than 20 percent "B" children

--"(3)D(2)B" payments: payments for those districts with 50 percent or more of "A" and "B" children is "fully funded" and "not pro-rated" based on the 1982 request

Notwithstanding the Continuing Resolution, OMB is calling for a recission of all impact aid money, except $185 million for payments to super A districts at 84 percent of the FY 81 A payment level. Therefore, all B money and all non-super A (super A district being a school with 20 percent or more of ADA comprised of A pupils) would be eliminated.

QUESTION (17)

Tables 8.2-1 and 8.2-2

Do these tables reflect the onsite employment of maintenance, security, and other contract personnel? If they do not reflect these categories of workers, the tables should be revised.

RESPONSE (17)

Tables 8.2-1 and 8.2-2 do reflect the onsite employment maintenance, security, and other contract personnel.

QUESTION (18)

Section 8.3.2.1

The Applicant should provide copies of references 2 through 7 cited in this section.

RESPONSE (18)

These references have been provided to the NRC in a letter to Paul Check from John Longnecker "Response to NRC Questions 1-39," January 22, 1982.

QUESTION (19)

Section 8.3.2.1

What are the bases and assumptions for the specific assignments of in-moving workers to the individual jurisdictions?

RESPONSE (19)

The specific assignment of in-moving workers to individual jurisdictions is based on a comparative case study of the residential patterns experienced at six nuclear plants being constructed by TVA (references 2-7 provided in response to question 18). Factors such as municipal population size, distance to the site, housing add-ons by type, and location and capacity of highways, etc., were evaluated to determine similarities and differences in settlement patterns that could occur in the CRBRP four-county impact area. Knowledgeable planners from local planning agencies were consulted prior to finalizing the settlement pattern presented in amendment X.

QUESTION (20)

Section 8.3.2.1.2

As previously indicated (see comment no. 8), the information in this section should reflect conditions at private schools. Therefore, the Applicant should supply information on private sectarian and non-sectarian schools.

RESPONSE (20)

See response to question no. 8.

QUESTION (21)

Section 8.3.2.1.3

The Applicant assumes that three highway "intersections will be upgraded to sufficiently accommodate the projected traffic." Specifically, what improvements would have to be made to achieve the stated objective? Are these improvements currently programmed by appropriate authorities? If these improvements are not currently programmed, what is the likelihood that they would be implemented?

RESPONSE (21)

Reconstruction of the intersection of S.R. 58 and S.R. 95 to provide separated grades and ramps is underway.

The specific improvements proposed for the intersection of Bear Creek Road and S.R. 58 are the addition of ramps to the existing separated grade intersection. The schedule for accomplishing the improvement is to be developed with the Tennessee Department of Transportation.

Studies to determine specific improvements at the intersection of Bear Creek Road and S.R. 95 are underway.

QUESTION (22)

Section 8.3.2.1.3

Does the Applicant foresee an increase in either accidents or road maintenance as a result of increased traffic volumes? With respect to road maintenance, do the counties and/or state have load limits for roads?

RESPONSE (22)

The amount of road maintenance and the number of accidents are both anticipated to increase with increased traffic volumes. The State of Tennessee does have load limits for roads. The maximum allowable weight limit for five-axle tractor trailer rigs traveling on Tennessee state roads is 80,000 pounds. Weight limits for trucks other than five-axle vehicles on state roads are lower than the 80,000 pound maximum limit and vary in accordance with the type of truck. Load limits are also required on country roads and are based on the type of vehicle.

QUESTION (23)

Section 8.3.2.1.5

What is the Applicant's basis for concluding that no "recreation program will be significantly adversely affected"? What is the analysis which indicates that Roane County's recreational facilities are already in short supply?

RESPONSE (23)

The conclusion that no recreation program will be significantly adversely affected is based on the expectation of a relatively small peak population influx in the four county area. The conclusion regarding existing shortages in Roane County's recreational facilities was based on comparisons between the current population, limited existing facilities (Table 8.1-20), and standards of the National Recreation and Park Association.

QUESTION (24)

Section 8.3.2.1.5

Would the site be visible from nearby vantage points such as historic sites, areas of recreation, or housing developments? Would the containment building be visible from such vantage points?

RESPONSE (24)

The CRBRP site will be visible from various vantage points near the plant site. Both the site and the containment building will be visible from portions of both I-40 and S.R. 58. Both the site and the containment building will be visible from recreation sites 1 and 2 listed on Table 2.2-8. The site will not be visible from any housing development within the study area but will be easily seen from many of the single-family homes from across the Clinch River. Finally, to the best of our knowledge, neither the containment building nor the plant site will be visible from any significantly offsite historical site or structure within the study area. (See also ER Sections 2.3 and 5.6.2.4).

QUESTION (25)

Appendix-Introduction

The Applicant should prepare a table similar to Table 8.3-2 but assuming Migration Condition B.

RESPONSE (25)

CRBRP ESTIMATED POPULATION EFFECTS PEAK YEAR OF CONSTRUCTION FOR MIGRATION CONDITION B+

Projected Employment	5,400
Population Effects	
Number of movers	1,990
Movers with families (70%)	1,390
Movers without families (30%)	600
School age children*	980
Total population influx**	5,040

+Information provided in Appendix C (P.C-3) Amendment XIII
*Assuming .7 school age children per family.
**Assuming 3.2 people per family.

QUESTION (26)

Appendix-Introduction

In Section 8, Migration Condition A was indicated as 25 percent, while this level of migration is defined as 26 percent in the Appendix. The Applicant should explain this apparent discrepancy.

RESPONSE 26

In the introduction of Section 8, Migration Condition A is indicated as 26 percent, the same as the level of migration defined in the Appendix.

QUESTION (27)

Appendix-Table 2.2-8

Project enrollment for Knox County differs significantly from data in Table 8.3-2.

RESPONSE (27)

We assume there was a typographical error and Table 8.3-5 is the table in question rather than Table 8.3-2. Appendix Table 2.2-8 provides project enrollment for the 40 percent mover rate while Table 8.3-5 provides project enrollment for the 26 percent movers rate. The numbers for Knox County differ significantly because of the comparison of project enrollment from two different mover rates.

QUESTION (28)

Appendix-Section 2.4

What is the basis for the Applicant's conclusion that no expansion of fire protection services would be necessary during the construction period? Do current fire protection services meet or exceed guidelines established by the national insurance rating organization, the American Insurance Association?

RESPONSE (28)

The conclusion that no expansion of fire protection services would be necessary is based on the expectation of a relatively small peak population influx that should also be widely distributed among area communities. Maintenance of current levels of service, not national insurance rating guidelines, were used as the basis for the assessment. Thus, the relation of current fire protection services to those insurance guidelines was not considered.

QUESTION (29)

Appendix-Section 2.5

The Applicant's analysis of and conclusion on the adequacy of water supply facilities does not appear to take into account population growth between 1981 and 1985. Considering this increment of growth and the influx of project-related population, would these facilities be adequate?

RESPONSE (29)

Existing and proposed water supply facilities will be able to accommodate the demand for use of water from both the population growth between 1981 and 1985 and the projected CRBRP project-related demand.

QUESTION (30)

Appendix-Section 2.6

The comment and question in item (29) applies to this section.

RESPONSE (30)

Existing and proposed wastewater and solid waste disposal facilities will be able to accommodate the demand for use of these type of public services from both the population growth between 1981 and 1985 and the projected CRBRP project-related demand.

QUESTION (31)

Appendix-Section 2.6

The amount of solid waste generated by the inmoving population is overstated by a factor of 10 and the amount of total solid waste handled per day differs from the total figure in Section 8.1.3.3.3. The Applicant should check these data and correct as necessary.

RESPONSE (31)

The calculations presented in Appendix section 2.6 for the amount of solid waste generated by the inmoving population were rechecked and found to be correct. The number of tons of solid waste handled per day in the four counties listed on page C-42 as (about 1,025 tons) should be changed to read (about 525 tons). This change was included in Amendment XIII.

QUESTION (32)

Appendix-Section 3.2

In what instances would an "assessment lag" apply? Who would be responsible for an assessment lag if it did occur?

RESPONSE (32)

An assessment lag is simply the time required for a new addition to the property tax rolls to pay its full share of taxes. It would be expected to occur in most, if not all, instances and would not be considered an unusual occurrence.

QUESTION (33)

Appendix-Section 3.2

The Applicant mentions state funds--state foundation and equalization--in the analysis of local expenditures and revenues. Do the level of these funds or any other intergovernmental transfer funds to local jurisdictions change with changing local revenue levels?

RESPONSE (33)

State foundation funds are apportioned equally to all school systems in the state on a per ADA basis with additional funding related to vocational and special education needs. In contrast, equalization funds are apportioned on the basis of each jurisdiction's capacity to generate property tax revenue, i.e., local property assessment values. Depending on values statewide, an increase in those values could possibly result in a decrease in equalization funds. However, for purposes of the fiscal analyses, it was assumed that the current level of both educational revenues would remain constant.

QUESTION (34)

Appendix-Section 3.2

The Applicant states that no necessary education-related capital improvements were identified. However, Tables 2.2-5 and 2.2-6 indicate that 15 classrooms and 29 classrooms would be needed under Migration Conditions A and B, respectively. The Applicant should explain this apparent discrepancy and provide the bases for the conclusion.

RESPONSE (34)

Tables 2.2-5 and 2.2-6 indicate that 15 classrooms and 29 classrooms would be needed under Migration Conditions A and B, respectively. This does not mean that up to 29 classrooms would have to be built to accommodate project-related students. Under migration Condition B (the worst case scenario) 980 students would have to be housed for a period of no more than one year by the 8 school systems (see Appendix Table 2.2-8). Because of the low number of students added to each system (to be assigned to various schools grades K-12 located throughout each school system) and because of the short time period of maximum project-related demands, it is concluded that no school system would choose to construct a new school facility to accommodate project-related students. Instead, they would assign individual students to exisitng rooms with available space and in cases of demand exceeding capacity, assign students to school areas excluded in the capacity numbers used in Appendix Table 2.2-7.

QUESTION (35)

Appendix-Table 3.2

The table and text are unclear as to whether the sales and beverage tax data reflect local collections (with a smaller amount being dispersed to the municipalities by higher levels of government) or the actual dispersements to local government. The Applicant should clarify. Also, by assuming that the project-related (inmoving) population have the same per capita income as residents, the Applicant is conservatively estimating sales tax and beverage tax revenues. Does the Applicant agree that its estimates of sales and beverage tax revenues are conservative?

RESPONSE (35)

The sales and beverage tax data reflect actual disbursements to local governments. We agree that the estimates of sales and beverage taxes are conservative.

QUESTION (36)

Table 3.1

What are the specific values and assumptions underlying the data in the column titled, "Inmover-Related Taxable Assessed Value"? This information should be presented for each housing type and jurisdiction.

RESPONSE (36)

Refer to the table below. Those values are estimated from the range of values included in the various sources referenced in Table 3.1 of Appendix C.

AVERAGE HOUSING VALUES

Location	Single-Family Homes	Mobile Homes	Multi-Family*
Clinton	$37,000	$9,000	$13,000
Oak Ridge	55,000	9,000	15,000
Lenoir City	24,000	9,000	13,000
Kingston	44,000	9,000	13,000
Rockwood	30,000	9,000	13,000
Harriman	33,000	9.000	13,000
Anderson Co.	37,000	9,000	13,000
Knox Co.	55,000	9,000	15,000
Loudon Co.	33,000	9,000	13,000
Roane Co.	44,000	9,000	13,000

*Per unit

QUESTION (37)

Tables 3.3 and 3.12

The Applicant should specify the population figures used for each jurisdiction to derive the general fund and school fund revenues. How do these numbers differ from those contained in or underlying Table 8.2-1, 8.3-3, and 8.3-4? Also, in this series of tables, how are sales taxes apportioned between general fund and school fund revenues?

RESPONSE (37)

The population figures used to estimate the general fund and school fund revenues are either found in or derived from Tables 8.3-3 and 8.3-5. The employment figures in Table 8.2-1 were not used in estimating revenues but instead provide the basis for the analysis population and housing estimates. For the purposes of estimating per capita revenues, half of the population estimated for each municipality, except for Oak Ridge and Knoxville, was assumed to be located outside of the municipal limits but in the general area. For example, about 240 persons would be expected to locate within the city limits of Kingston (see Table 8.3-3). The housing distribution data in Table 8.3-4 were used in estimating property tax revenue for each jurisdiction. Table 8.3-5 contains the data, number of students by jurisdiction, used in estimating per pupil educational revenue. The per capita sales tax revenue figures contained in Table 2.2 of Appendix C are based on the amount of sales tax revenue historically received by either the general or school funds. Therefore, there was no apportionment between the two funds.

QUESTION (38)

Appendix-Table 3.13

In addition to salary, what are the components of the cost/teacher data?

RESPONSE (38)

The cost/teacher data are based on salary only.

QUESTION (39)

Appendix-References

The Applicant should provide a copy of citation 8.

RESPONSE (39)

This reference was provided to the NRC in a letter Longnecker to Check, "Response to NRC Questions 1-39," January 22, 1982.

Question (40)

Appendix Section 1.0 What is the basis for the percentage distribution of operating work force in the counties? Why wouldn't the percentage distribution in Table 8.1-7 be a more accurate estimate of where CRBRP employees will choose to live than the distribution in Section 1.0?

Answer (40)

The distribution of the operating movers is based on the same factors utilized in the distribution of construction movers, i.e., distance and direction to the site, area housing availability, and data on location patterns from TVA employee surveys. Table 8.1-7 indicates the existing location of DOE employees, many of whom have been area residents for a long period of time. Therefore, the data do not reflect recent housing trends, the most important of which is the tremendous growth in west Knox County in the past decade. In addition, the proportion of DOE employees residing outside Oak Ridge has been increasing in the past several years.

Question (41)

Tables 3.3 to 3.12 Please prepare a series of tables similar to those indicated which show the revenues generated by the operating work force. Explain all assumptions and calculations.

Answer (41)

The assumptions used to estimate the construction-related nonproperty tax revenue were based on resident per capita figures, instead of specific construction worker characteristics. This results in a conservative estimate of revenues. Therefore, it is reasonable to utilize those same assumptions and calculations for the operational influx. The attached revenue projections were prepared by applying operation to construction population ratios for each governmental jurisdiction to the projections contained in Tables 3.3 - 3.12 of the ER. For example, the size of the operational population influx for Oak Ridge (50) is about 7 percent of that projected for Migration Condition A (760). Thus, the amount of nonproperty tax revenue generated by the operational influx is estimated to be about 7 percent of that revenue estimated for Migration Condition A.

The property tax revenue estimates could not be ratioed because housing characteristics of operational and construction movers are expected to be different. Based on the relative permanence of the operational movers and data from surveys of operational movers at three TVA nuclear plants, it was assumed that, in general, a large percentage of them would occupy single family homes (70 percent). The housing choice of the remaining movers is assumed to be evenly split between mobile homes and apartments (15 percent each). These overall percentages were varied somewhat among jurisdictions based on local housing charac-

teristics. For example, Oak Ridge is not expected to have any movers occupying mobile homes. The property tax estimates were calculated with the same average housing values and tax rates used for the construction period estimates.

Our estimated distribution of the location of immoving operational employees is attached. For the purposes of these revenue calculations, half of the projected movers expected to reside in the vicinity of each municipal area, except for Oak Ridge and Knoxville, are assumed to locate outside the city limits. An identical assumption was made for the construction period revenue calculations.

CRBRP

DISTRIBUTION OF OPERATIONAL MOVERS

	Movers	Total Population Influx	School Age Children
Anderson County			
Oak Ridge	19	50	10
Clinton Area	6	20	4
Knox County			
Knoxville	6	15	3
West Knox County Area	50	125	22
Loudon County			
Lenoir City Area	13	30	6
Roane County			
Kingston Area	19	50	14
Rockwood Area	6	15	3
Harriman Area	6	15	3

TABLE 1

SELECTED REVENUES FOR ANDERSON COUNTY
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	5,500
Sales Tax	NA
Beer and Alcoholic Beverage Tax	10
Fines, Fees, Charges	100
TOTAL	$5,600
School Fund Revenues	
Property Tax	8,100
Sales Tax	NA
State Funds	700
TOTAL	$8,800

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 2

SELECTED REVENUES FOR CLINTON
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	600
Sales Tax	500
Beer and Alcoholic Beverage Tax	100
Fines, Fees, Charges	40
TOTAL	$1200
School Fund Revenues	
Property Tax	1300
Sales Tax	NA
State Funds	700
TOTAL	$2000

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 3

SELECTED REVENUES FOR OAK RIDGE

FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	7,500
Sales Tax	1,200
Beer and Alcoholic Beverage Tax	100
Fines, Fees, Charges	200
TOTAL	$9,000

School Fund Revenues	
Property Tax	4,800
Sales Tax	100
State Funds	4,400
TOTAL	$9,300

Note: Estimates are for typical year of operation.

TABLE 4

SELECTED REVENUES FOR KNOX COUNTY
FROM CRBRP OPERATIONS-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	6,600
Sales Tax	NA
Beer and Alcoholic Beverage Tax	100
Fines, Fees, Charges	400
TOTAL	$7,100
School Fund Revenues	
Property Tax	3,900
Sales Tax	2,200
State Funds	12,000
TOTAL	$18,100

NA = Not Applicable

Note: Estimates are for typical year of operation.

TABLE 5

SELECTED REVENUES FOR LOUDON COUNTY
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

<u>General Fund Revenues</u>	
Property Tax	900
Sales Tax	NA
Beer and Alcoholic Beverage Tax	10
Fines, Fees, Charges	200
TOTAL	$1,100
<u>School Fund Revenues</u>	
Property Tax	2,300
Sales Tax	200
State Funds	1,500
TOTAL	$4,000

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 6

SELECTED REVENUES FOR LENOIR CITY
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	900
Sales Tax	200
Beer and Alcoholic Beverage Tax	0
Fines, Fees, Charges	200
TOTAL	$1,300

School Fund Revenues	
Property Tax	1,200
Sales Tax	100
State Funds	600
TOTAL	$1,900

Note: Estimates are for typical year of operation.

TABLE 7

SELECTED REVENUES FOR ROANE COUNTY
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	3,200
Sales Tax	NA
Beer and Alcoholic Beverage Tax	30
Fines, Fees, Charges	300
TOTAL	$3,500
School Fund Revenues	
Property Tax	2,000
Sales Tax	700
State Funds	6,400
TOTAL	$9,100

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 8

SELECTED REVENUES FOR KINGSTON
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	1,600
Sales Tax	700
Beer and Alcoholic Beverage Tax	200
Fines, Fees, Charges	10
TOTAL	$2,500
School Fund Revenues	
Property Tax	NA
Sales Tax	NA
State Funds	NA
TOTAL	--

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 9

SELECTED REVENUES FOR ROCKWOOD
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

General Fund Revenues	
Property Tax	500
Sales Tax	200
Beer and Alcoholic Beverage Tax	40
Fines, Fees, Charges	100
TOTAL	$800
School Fund Revenues	
Property Tax	NA
Sales Tax	NA
State Funds	NA
TOTAL	--

NA = Not Applicable

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

TABLE 10

SELECTED REVENUES FOR HARRIMAN
FROM CRBRP OPERATION-RELATED POPULATION INFLUX

<u>General Fund Revenues</u>	
Property Tax	300
Sales Tax	200
Beer and Alcoholic Beverage Tax	20
Fines, Fees, Charges	10
TOTAL	$500
<u>School Fund Revenues</u>	
Property Tax	1,000
Sales Tax	300
State Funds	1,500
TOTAL	$2,800

Note: Totals rounded off to nearest 100.
Estimates are for typical year of operation.

Question 320.1R

Provide updated economic comparison of Clinch River and viable hook-on sites. Level of detail should be consistent with data presented in Table 9.4 of the CRBR FES. Original source of this data was letter to NRC from A. R. Buhl, CRBR Project Office, January 10, 1977, also, see ER Section 9.2.6.2.

RESPONSE

Economic analysis has shown that a stand alone plant at the Clinch River site is preferred. As noted in the question, this conclusion was based on data provided by the Project in a letter dated January 10, 1977. Subsequent to the suspension of licensing interaction with the NRC (April 1977), Congress continued funding of engineering design and procurement of CRBRP equipment. With the CRBRP in its present state of design and procurement maturity a hook-on arrangement is no longer considered viable. This conclusion is supported by the following factors:

(1) The CRBRP Project has firm orders for approximately 10% of the BOP equipment valued at $63 million, of this, equipment valued at $5 million has already been delivered.

(2) Hook-on sites have aged in the intervening years and become less attractive than in the original economic study.

(3) Site specific engineering is at an advanced stage of completion. The rework of these designs to be compatible with a hook-on site would result in substantial economic and schedular penalties.

In light of the above, a detailed update to the economic comparison of Clinch River Project and viable hook-on sites cannot credibly alter the conclusion that the CRBRP at the Clinch River site is preferred over viable hook-on sites.

Question 320.2R

Discuss capacity losses and age of turbines associated with each hook-on arrangement identified in response to Q.320.1.

RESPONSE

As discussed in the response to Question 320.1R, detailed review of the age and capacity of turbines at hook-on sites cannot credibly alter the conclusion that the CRBRP at the Clinch River site is preferred over viable hook-on sites.

QUESTION 320.3R

Update those sections of Appendix E (Amendment VII - February 1977) to the CRBRP ER dealing with costs of delay associated with relocating the proposed plant. Specifically, provide new cost data for Tables 1 and 2 of Appendix E for all alternatives previously considered plus the cost associated with a move to potential sites on the TVA system. Additional discussion should include new Clinch River schedule, estimated months of delay associated with move, and date corresponding to reference time 0. Also, if timing requirements of the Project are still important, identify new critical dates for commercial operation and decision on full-scale LMFBR commercialization.

RESPONSE

This question was responded to in a letter from J. Longnecker to P. Check, dated 2/05/82. Since that response, Appendices A through E have been re-evaluated and the information contained there in reconfirmed, revised or supplemented in Appendices F (DOE sites) and G (TVA sites). Appendices F and G are incorporated into the ER by Amendment XV.

The cost associated with relocation to a TVA site is presented in Table 3, Appendix G. The cost to relocate to a DOE site is presented in Table 8, Appendix F. The key CRBRP milestone dates are provided in Table 7, Appendix F.

Question 320.4R

Provide updated $ estimates of the program benefits associated with LMFBR commercialization (see Program FES (ERDA-1535), Table III F-10 of Volume 1, and Section 11.5.1 of the ER). Also, provide $ estimate of the loss of benefits associated with the delay assumed in response to Q3. (See Buhl, Dec. 29, 1976, p. 31 for estimate based on 52 month delay).

Response

The program benefits, and potential losses associated with delay are described in the cited passages of the ER and FES. Based on today's information, those values are a conservative representation of benefits and losses. In addition, however, the benefits of Clinch River are measured in terms of the information it will generate to satisfy the program and project objectives and analyses of the need for and benefits of the LMFBR program are outside the scope of the Commission's review of CRBRP. United States Energy Research and Development Administration et al. (Clinch River Breeder Reactor Plant). CLI-76-13, 4 NRC 67 (1976).

Question 320.5R

Provide current estimate of operating revenues expected during demonstration period from sale of energy to TVA system and revenues from potential 30 year operating life. Identify all underlying assumptions used in making these calculations.

RESPONSE

A. Current estimate of operating revenues+ (in constant 1981 dollars) expected during demonstration period from sale of energy to the TVA system is as follows:

Fiscal Year	Revenue 1981 $ million
1990	22.8
1991	33.5
1992	45.4
1993	61.9
1994	63.3
1995	36.9
	263.8

Underlying assumptions for A. are as follows:

1. Initial Criticality 9/30/89

2. Revenue rate is based on value of replacement power to TVA of $27.53 per megawatthour in 1981$.

3. Capacity factor based on 350 MWe net is as follows:

Time Period*	Capacity Factor
7 months**	20.2
6 months	36.4
12 months	40.
12 months	55.
12 months	75.
12 months	75.
6 months	75.

B. Current estimate of operating revenues expected from potential 30 year operating life is $1954 million in constant 1981$.

Underlying assumptions for B. are as follows:

1. Revenue through the five year demonstration period is as shown in A.

2. Revenue rate for the remaining 25 years is based on the same value per megawatthour as in A. This assumes that the same, or similar, arrangements will be made for sale of power to TVA after the demonstration period; or the power will be worth this same amount to TVA if it chooses to purchase the plant after the demonstration period.

3. Capacity factor, based on 350 MWe nominal: (Note that the stretch rating is 402.5 MWe).

Year After Demonstration Period	Capacity Factor
1-4	75
5-15	92***
16	90
17	86
18	81
19	76
20	71
21	67
22	62
23	58
24	53
25	40

+ Represents gross revenue and has not been offset by costs of operation and fuel.
* From initial criticality.
** Seven month test period before start of demonstration period.
*** Represents achieving stretch and 80 percent capacity factor the same year.

Question 320.6R (NRC letter dated 10/26/81, response letter dated 2/5/82)

Review Section 8 -- Need for the Proposed Facility -- of the CRBRP FES (NUREG 0139) and based on post-1977 developments regarding the CRBR project identify all revisions and updates necessary to make this section factually consistent with the current status of the program.

Response

Conclusions made in Section 8 of the CRBRP FES (NUREG 0139), support the need for CRBRP as a key part of the LMFBR development program. Post 1977 developments do not alter these conclusions. Current actions and policy decisions by Congress and the Reagan administration are evidence that the conclusions drawn in the CRBRP FES are still valid. The President's October 8, 1981, nuclear energy policy statement established this Administration's definitive policy on the LMFBR program and CRBRP project, as follows:

> "I am directing that government agencies proceed with the demonstration of breeder reactor technology, including completion of the Clinch River Breeder Reactor. This is essential to ensure our preparedness for longer-term nuclear power needs."

Continuing Congressional support is evidenced by the enactment of the Omnibus Budget Reconciliation Act of 1981.[1] This continued the authorization for the CRBRP and set the stage for additional funding. The Conference Report accompanying this legislation[2] explicitly states the intent of Congress that the Project is a key step in the development of the LMFBR, and that the Project must be constructed in a timely and expeditious manner, so that a

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[1]Omnibus Budget Reconciliation Act of 1981 (Pub. L. No. 97-35).
[2]House Conference Report No. 97-208, 97th Cong., 1st Sess., 2 at 827 (1981).

a decision on the commercialization and deployment of breeder reactors can be made on the basis of information obtained in the operation of the plant.

On August 30, 1976 the Nuclear Regulatory Commission established the guidelines for the consideration of specific issues in the CRBRP construction permit proceeding. The Commission specified that any inquiry into the need for the CRBRP must be limited to consideration of the likelihood that the CRBRP will meet the objectives of the demonstration plant project.

The demonstration objectives of the CRBRP remain unchanged:

- to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric powerplant in a utility environment;
- to confirm the value of this concept for conserving important nonrenewable natural resources.

The role of the CRBRP in the LMFBR development program is essentially unchanged since 1976. The schedule for CRBRP and the overall LMFBR development program has changed but the importance of the demonstration plants to the program is undiminished. NRC staff concluded in 1977 that the probability of CRBRP meeting its objectives was high. Progress in the development of the CRBRP design, since 1977, provides further assurance that the CRBRP will meet its objectives.

CRBRP Program Summary

Significant progress has been made to date in the design, development, and hardware procurement areas of the CRBRP. The project is in a position to begin site clearing and construction upon receipt of the necessary approvals from the NRC. The

following list includes some of the significant accomplishments to date:

- Overall plant design about 90% completed and project-funded research and development about 95% completed;
- About 7,000 architect-engineering drawings of the required 9,400 prepared;
- Procurement contracts for over $500 million of hardware representing approximately 60% of the total required project hardware placed;
- Manufacture of approximately $251 million of hardware completed and about $120 million of effort accomplished on other hardware in process;
- Contributions made to advancement of the worldwide state-of-the-art on LMFBR plants, such as the heterogeneous core;
- Continuous evaluation and updating of the plant design to remain current with changing regulatory requirements;
- Issuance in 1977, by the NRC, of the Site Suitability Report and the Final Environmental Statement, which concluded that the site is suitable for the plant and that the action called for under the National Environmental Policy Act is the issuance of a construction permit;
- Licensing activities were resumed with the Nuclear Regulatory Commission staff in 1981; and
- Prototype steam generator and prototype primary pump delivered to Energy Technology Engineering Center for testing in sodium.

Base Technology Program Progress

The base technology program is structured to satisfy the goal of developing the technological data required to support LMFBR power plant design, construction, and safe operation. The elements of the base program include safety, components, materials and structures, fuels and other core materials and physics. For each

of these program elements, significant accomplishments since the mid-1970's are reviewed below:

Safety

- The reliability of the reactor shutdown system and shutdown heat removal system has been established through extensive out-of-reactor laboratory testing.
- Experiments conducted with molten fuel have provided important data for validation of analytical methods to be applied to fuel movement from breached pins. As a result, self-termination of unprotected overpower accidents, unprotected loss of flow, it can be shown that extensive system damage is unlikely.
- The experimental data base, together with computer codes that extrapolate those data to prototypic accident conditions, indicates that the inherent nature of fuel motion under molten core conditions makes the core self-dispersive, and that recriticality is therefore unlikely.
- Earlier uncertainty over the limit which can be placed on the extent of the damage associated with a postulated whole core accident has been substantially reduced. For the CRBRP, the adequacy of the plant design to withstand such an accident has been established.

Components

- Tests were completed on the FFTF prototype pump in 1977. The test facilities at the Energy Technology Engineering Center (ETEC) were subsequently modified to accommodate CRBRP-size components.
- A CRBRP prototype pump and steam generator have been fabricated and are being installed for testing in 1982.
- Prototype components representative of large plant components are being fabricated for eventual testing in the ETEC.

Materials and Structures

- Developed design rules which have been adopted by the ASME Code and which are being applied worldwide in the design of LMFBR plants.
- Advanced the technology base for materials data, fabrication, nondestructive examination, advanced

alloys, sodium technology, and high temperature design methods and criteria.

Physics

- Critical experiments in a CRBRP mockup core were completed in the Zero Power Plutonium Reactor. Analysis of these experiments will verify much of the CRBRP neutronic design and safety parameters.

- Studies of the FFTF physics measurements were initiated to confirm developmental LMFBR design methodology and to improve knowledge of the FFTF test irradiation environment.

Fuels

- Reference FFTF fuels and cladding were successfully tested to goal burnup and beyond clad breach in the EBR-II. The mechanical design of the FFTF fuel pin is identical to that of the CRBRP.

- Fabrication of pins for four FFTF cores was completed.

- Control assembly lifetimes were doubled.

- Improved alloys that promise significantly extended lifetimes for fuel pin cladding were developed. The list of candidate alloys has been narrowed to three.

Facilities

- Criticality of the Fast Flux Test Facility was achieved in February 1980. Full power was demonstrated in December 1980 and natural circulation was demonstrated in 1981.

- The Experimental Breeder Reactor II operated and supplied electrical power to the grid at 71-77% capacity while serving as a fuels and materials test facility from 1976-1980.

With respect to the specific CRBRP demonstration objectives reviewed by the staff in NUREG 0139, progress since 1977 is especially noteworthy in LMFBR technical performance and realiability.

Technical Performance and Reliability

Technical performance and reliability have been demonstrated in the foreign sector by the operation of Phenix at a 65% capacity factor, as well as operation of the BN-350 and Joyo reactors.

Confidence in U.S. capability is based on continuing EBR-II performance after 19 years of operation and recent FFTF startup and operation at full power. There is apparently no remaining question about technical feasibility, at least through intermediate plant size. Super Phenix, currently under construction, should remove technical feasibility questions.

An important remaining issue is the cost of commercial size LMFBR's. The cost will help determine when the LMFBR can be competitive with alternates. Continued development is the only satisfactory way to resolve that question.

Timing

The Prototype Large Breeder Reactor (PLBR) referred to in NUREG 0139 as the plant to follow the CRBRP, is no longer part of DOE planning. Design studies have been carried out on a 1000 MWe LMFBR developmental plant, during 1978-81 under the name Conceptual Design Study (CDS) and more recently as the Large Developmental Plant (LDP) project. A decision to proceed with construction of the LDP could come as early as FY 1984, with operation in the mid-1990's.

Should construction of the LDP begin in the mid-1980's, it would overlap CRBRP construction by 3-4 years. In NUREG 0139, LDP and the CRBRP construction were scheduled to overlap by about one year. The potential increased overlap now contemplated, does not significantly increase the technical risk associated with the LDP. To the contrary, it is DOE's belief that an overlap of 3-4 years is considered to be consistent with most efficient use of LMFBR program resources.

The current schedule with a potential construction overlap allows for assimilation of knowledge gained in design, construction, and licensing of the CRBRP. Overlap will allow for a more efficient use of the design team through continuity of effort as well as

assimilation of all available project information. Such key information as base program R&D, construction and planning techniques, and equipment manufacturing experience is already being used in concept studies for the LDP. Results of CRBRP component tests will be available in 1982 for use in the preliminary engineering design of the LDP. CRBRP startup and testing data that will be particularly useful in the large plant effort include data associated with sodium systems and inert gas systems.

Experience gained from design of the CRBRP was factored into the conceptual design studies of the LDP and further benefits would be realized as the design continues. For example, CRBRP equipment design and fabrication experience will be directly applicable to the LDP as most of the CRBRP components will be fabricated before preliminary engineering design of the LEDP is initiated.

CRBRP construction planning and techniques are currently being incorporated into LDP construction planning evaluations. CRBRP construction experience will provide valuable input for the final planning and implementation of a cost-effective and schedule-oriented LDP construction plan.

Start-up testing of systems at the CRBRP will provide equipment confirmation data useful in design activities and subsequent test operations for LDP. This testing input can be particularly useful in the liquid metal and inert gas systems.

Operation of the CRBRP will provide additional on-line information useful for verification of designs and component concepts common to the LDP and the CRBRP and will provide additional input for testing procedures in such areas as remote fuel handling. CRBRP operating experience will also be factored into the procurement specifications of such LDP systems as the plant-wide computerized control system. In the event that early

CRBRP operation discloses an unexpected system problem, the phasing of the two projects provides time to implement corrections.

Additionally, operation of the CRBRP, in the course of demonstrating the technical performance, safety, and economics of an LMFBR plant in a utility environment, will develop information and expertise in plant start-up operation and maintenance. This experience will be valuable in the planning and implementation of these key functions for the LDP and in contributing to the broad base of experience and information that is important for commercial and industrial application of the LMFBR concept.

CRBRP experience is also applicable in large-plant confirmatory research and development work where much of the CRBRP work developed in the areas of safety, physics, fuels, materials, and component development is directly applicable. Nearly all this work will be completed before preliminary engineering design of the LDP. In addition, critical CRBRP components such as the steam generator and primary sodium pump will undergo thorough testing in 1982 and information developed during this testing program will be factored into the design process.

CRBRP operation and the follow-on operation of the LDP will serve to provide important experience and data regarding the LMFBR technology, environmental acceptability, economics, and value as a practical future option for generating electric power and conserving nonrenewable natural resources.

Technical Alternatives to the CRBRP

A key feature of the U.S. LMFBR development program remains avoiding premature foreclosure of technological alternatives. In any construction project, design choices must be made among feasible alternatives. To the extent possible during development, there is merit in keeping open options that might be

exercised later. For some of the technological alternatives examined by NRC staff in NUREG 0139, additional information is now available.

The design of the primary heat transport system in LMFBRs falls into two categories: the pool (where the entire primary system is contained within a relatively large primary vessel) or the loop (where piping external to the reactor vessel transports sodium to pumps and heat exchangers). Experience indicates that either concept can be constructed and operated safely and reliably. Indeed the French, British, Soviet, and U.S. programs have all included at least one shift in the loop/pool choice.

The DOE Conceptual Design Study (CDS) concluded that there was no overwhelming advantage to either concept.[3] There would be no environmental differences and safety differences would be insignificant. Participants, drawn from the industry, recommended a loop concept for what is now the LDP, but recognized that there may be merit in the pool concept for commercial plants.[3] Regardless of the choice, the developments that are required in components and other key base technology areas are much the same. For example, the steam generators are equally applicable to either concept, and the pump technology required for a pool system is probably less complex than that now being developed for a loop system. In both instances, the design, manufacturing, and operating experienced gained are an effective base for future plants. The conclusion is that the U.S. program, now on the loop path for the CRBRP, is not precluded from a future switch to a pool system. Thus, the program retains more flexibility than does a specific project, in which changes in choice of technology can add considerable expense.

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[3] "LMFBR Conceptual Design Study; Phase I Summary Technical Report," CDS-500-1, U.S. Department of Energy, p. 4-29 (1980).

An updated Table 8.1 is provided to reflect events since NUREG 0139 was issued.

Fuels

Another example of the flexibility build into the U.S. program deals with fuel type. In the Conceptual Design Study for a large plant, flexibility was maintained with respect of choice of fuel type by making the design of the reactor internals capable of accepting either the reference oxide fuel design, or a carbide fuel. Similarly, it has been shown that the CRBRP could operate satisfactorily on a variety of fuel cycles, and the reference core design was switched from homogeneous to heterogeneous without other significant changes in cost, environmental or safety aspects.

In the recent large plant studies (CDS and LDP), oxide fuel was selected for at least the first several cycles. Super Phenix will use oxide fuel, Thus the use of oxide fuel in the CRBRP not only does not foreclose future U.S. emphasis on other fuels, but is presently consistent with the consensus choice for larger plants.

Foreign Purchase

It has been proposed that another alternative would be for the U.S. to purchase foreign technology rather than to pay for our own domestic LMFBR fuel cycle development program. Such proposals often neglect to account for the extensive domestic development work that would still be necessary to assure the foreign breeder designs would satisfy unique U.S. licensing requirements. This may involve, among other things, the need to make substantial plant modifications to key safety features such as the reactor containment building, reactor safety systems, and shutdown heat removal systems.

In addition, one of the central features U.S. energy policy of the past four Administrations has been to reduce U.S. reliance on foreign sources of energy supply. Regardless of current alliances, political or commercial barriers 20-40 years hence could prevent a foreign LMFBR supplier from selling to the U.S. Even if reactors were sold, without a complete domestic fuel cycle capability, the U.S. would have to rely on foreign sources of reactor fuel supply. This could have national security implications that are not unlike those associated with current U.S. dependence on foreign supplies of oil.

WORLDWIDE FAST BREEDER REACTOR PLANT

Name	Country	Power Megawatts Thermal	Power Megawatts Electric	Pool or Loop	Initial Operation
DECOMMISSIONED					
Clementine	USA	0.025	---	Loop	1946
Experimental Breeder Reactor-1	USA	1	0.02	Loop	1951
BR-1/BR-2	USSR	0.1	---	Loop	1956
LAMPRE	USA	1	---	Loop	1961
Fermi	USA	200	60.9	Loop	1963
SEFOR	USA	20	---	Loop	1969
Dounreay Fast Reactor	UK	72	14	Loop	1959
Rapsodie	France	20/40[b]	---	Loop	1966[b]
OPERABLE					
BR-5/BR-10[a]	USSR	5/10[a]	---	Loop	1959[a]
Experimental Breeder Reactor-II	USA	62.5	18.5	Pool	1963
BOR-60	USSR	60	12	Loop	1969
BN-350	USSR	1000	150[c]	Loop	1972
Phenix	France	567	233	Pool	1973
Prototype Fast Reactor	UK	600	250	Pool	1974
Joyo	Japan	100[d]	---	Loop	1977
BN-600	USSR	1470	600	Pool	1980
Fast Flux Test Facil.	USA	400	---	Loop	1979
KNK-II[e]	W. Germany	58	20	Loop	1977
UNDER CONSTRUCTION					
Super-Phenix	France[g]	2900	1200	Pool	
SNR-300	W. Germany[f]	770	312	Loop	
Prova Elementi di Combustibile	Italy	140	---	Modified Pool	1987
PLANNED					
Monju	Japan	714	300	Loop	
Clinch River Breeder Reactor	USA	975	359	Loop	1989
Commercial Fast Reactor	UK	3230	1320	Pool	
SNR-2	W. Germany[g]	5000	1200-2000	Loop	1985-6
BN-1600	USSR	5000	1600	Pool	

[a] Initially operated at 5 megawatt thermal as BR-5; upgraded to BR-10 (10 megawatt thermal) in 1973.
[b] Initially operated at 20 megawatt thermal; power increased to 40 megawatt thermal in 1970 with "Fortissimo" core.
[c] Also produces the equivalent of 200 megawatt electric as process steam for desalination.
[d] To be operated initially at 50 megawatt thermal.
[e] Operated 1971 through 1974 as a thermal reactor, KNK-I.
[f] In cooperation with Belgium and the Netherlands.
[g] Tripartite effort of Franch, German and Italian electric utilities.

Question 320.7R (NRC letter dated 10/26/81, response letter dated 2/5/82)

Update the internal costs of the CR project. Maintain level of detail in Section 8.3.1 including Table 8.3-1 of the ER. Also, indicate portions of the internal cost to be borne by federal government, participating utilities, etc.

Response

The CRBRP Project cost estimate to the level of detail reflected in Section 8.3.1 including Table 8.3-1 of the Environmental Report has been updated (ER Amendment XIV) consistent with the current schedule baseline.

Question 320.8R

Provide updated justification for excluding other energy sources as viable alternatives to CRBRP. Currently, ER Section 9.1 dismisses depletable energy resources based on energy growth rates, nuclear expansion plans, costs, and estimates of energy resource stocks, all reflecting 1975 expectations. In addition, as a result of the passage of time and advances made in implementing the larger next state demonstration LMFBR, provide justification for not considering this as a viable alternative energy source.

Response

Other energy sources were excluded as viable alternatives to the CRBRP on the ground that the need for a demonstration plant facility, including its timing and objectives is to be taken as given in the Commission's review of CRBRP. United States Energy Research and Development Administration et al. (Clinch River Breeder Reactor Plant). CLI-76-13, 4 NRC 67 (1976). Further, the alternative of the next-larger-size demonstration plant can be excluded on the ground that the structure, pace, timing and objectives of the LMFBR Program are likewise to be taken as given. Id. DOE has prepared a Supplement to the LMFBR Program Environmental Statement DOE/EIS-0085-FS, May 1982, in which both technological (other energy sources instead of LMFBR's) and programmatic (LDP instead of CRBRP, and no action) alternatives were addressed. None of these alternatives were found to be acceptable.

Question 320.9R (NRC letter dated 10/26/81, response letter dated 12/22/81)

Update economic cost analyses developed in support of your decisions regarding alternative plant designs. Specifically, Sections 10.1.5 (Tables 10.1-9 and 10.1-10), 10.2.5 (Tables 10.2-1 and 10.2-2), 10.3.5 (Table 10.3-2) and 10.6.5.

Response

Although the economic costs presented in the tables identified in the question are not up-to-date in current prices, the analyses remain valid. Since the time of the evaluation of these analyses by the NRC (NUREG-0319, February 1977) the major change has been the effect of inflation on the costs (both economic and environmental) included in the analyses. However, general price inflation has not affected the relative ranking of the alternatives nor the relative balance of environmental costs to economic costs. The only change that would invalidate the analyses would be the development of an advantage (either technological or economic) not previously available for one of the alternatives. For the facility systems referenced in the question, i.e., cooling system, sanitary waste system, and intake and discharge systems, significant changes such as new technologies with a lower cost that would require reanalysis of alternatives have not developed.

Furthermore, the design, testing, and procurement of these facility systems are at advanced stages of completion. If a reanalysis were to be undertaken at this time, any alternative would have to demonstrate economic and environmental cost

advantages greater than the selected design's costs. These costs to be assessed against alternative systems would properly include the amounts expended to date on the selected systems to design, test and procure the equipment, the costs to terminate current contracts, and the environmental costs associated with scrapping fabricated components. In the case of the selected cooling system for the plant, i.e., a mechanical draft wet cooling tower, changes from this design could cause changes in plant performance parameters that might have costly cascading effects on the current design and procurement of the steam/water cycle equipment. All of these "sunk" costs would properly be included in any updated analyses because the applicant has proceeded on the basis of previously valid evaluations of alternatives.

QUESTION 451.1

In a letter dated 11/20/81 NRC requested,

> "Pursuant to the information needs of the staff identified in Section 2.3.3 of Regulatory Guide 1.70.29, "Information for Safety Analysis Reports - Meteorology", we request transmittal via magnetic tape of onsite meteorological data for our evaluation of the radiological consequences of normal and accidental releases to the atmosphere. Please use the enclosed guidance on format and tape attributes (Enclosures 1 and 1A) and provide hour by hour data for the period of record (July 1, 1975-June 30, 1976) which you have used to construct the diffusion estimates reflected in the Tables in Section 2.3 of the PSAR. Also, please include documentation identifying the parameters measured, instrumentation, period of record and a dump of the first block of data on the tape as shown in Enclosure 2. We have assigned question number 451.1 to this request. Please provide this information by December 21, 1981."

NRC further requested in their letter dated 11/30/81,

> "Please provide, in an amendment to the Environmental Report, the information identified in the Enclosure for our review of your application for a permit to construct the Clinch River Breeder Reactor Plant. This information is needed by December 15, 1981, in order to maintain our schedule for the review. Submittal of this information by letter on or before that date is sufficient if followed by an amendment.

In addition, please endeavor to furnish the magnetic tape with meteorological data by December 11, rather than December 21 as requested in our letter to you of November 20, 1981. These data should include the data gathered in 1977 and 1978."

RESPONSE

Transmittal of magnetic tapes of onsite meteorological data was provided to NRC in a letter dated 12/15/81 from G. W. Reynolds, TVA to Mr. I. Spickler and was supplemented to define the recording periods and locations in a letter dated 12/28/81 as follows:

> Your letter of November 20, 1981, requested transmittal of onsite meteorological data (magnetic tape) in accordance with specified format and tape attributes. The requested period of record was from July 1, 1975, to June 30, 1976. This information was requested to be provided to NRC by December 21, 1981. Your letter of November 30, 1981, requested that the meteorological data be provided by December 11, 1981, rather than December 21, 1981 as previously requested, and that the data include onsite meteorological data gathered during 1977 and 1978.
>
> There have been three onsite meteorological data sets used for the CRBRP construction permit application documents. In the ER, July 1975 - June 1976 temporary tower data were replaced by February 17, 1977 - February 16, 1978 permanent tower data in Amendment IX. For the PSAR, the July 1975 - June 1976 data were used in Section 2.3 and March 1976 - February 1977 temporary tower data were used in Appendix 2.3A. The PSAR was further amended (Amendment 65, February 1982) to replace the temporary tower data with permanent tower data for the recording period of February 19, 1977 through February 16, 1978. Section 2.3A was deleted at that

time. Magnetic tapes of each of these three data sets have been provided to Mr. Irv Spickler, NRC, under separate cover directly from TVA in a letter dated December 15, 1981.

These data tapes correspond to three distinct one-year sets of onsite meteorological data, two from the temporary tower, and one from the 110-meter permanent tower. They are (1) July 1975 to June 1976 Pulse-O-Matic cassette system data from the temporary tower, (2) March 1976 to February 1977 Nova computer system data from the temporary tower, and (3) February 17, 1977 to February 16, 1978 Nova computer system data from the permanent tower.

Tape (1) data, Pulse-O-Matic, were used for Section 2.3 of the CRBRP PSAR and tape (2) data, Nova, were used for Appendix 2.3A of the PSAR. These data have been replaced by Tape (3) data in Amendment 65 of the PSAR.

Tape (1) data, Pulse-O-Matic, were used in Section 2.6 of the CRBRP ER, but were replaced by tape (3) data in Amendment IX of the ER.

Question 460.1R

Have any design changes been made in the radwaste treatment systems since the FES was published 2/77?

RESPONSE

Yes. These design changes are stated and included in the response to Question 290.1R.

QUESTION 460.2R

Have any changes been made that would cause the source term to be altered? This could include fuel and coolant specifications and behavior as well as operational aspects.

RESPONSE

- There has been no change to the coolant specifications.

- There have been changes to the fuel specifications due to the core design change from the homogeneous core to the heterogeneous core and these changes do result in some change to the source term. The following table provides a comparison of homogeneous core and heterogeneous core fuel specifications and the target average and peak burnups.

Specification	Heterogeneous Current Core	Homogeneous Previous Core
Total heavy metal inventory in fuel (metric tons)	5.2	6.5
Plutonium enrichment in fuel (weight %)	33.2	18.7 to 32.0
Target Burnup (MWD/T)		
Average	80,000	100,000
Peak	110,000	150,000

- However, it should be noted that in determining the source terms, the isotopic composition of LWR discharge plutonium was used instead of the composition in the fuel specification for conservatism.

- The source terms in the cover gas have remained relatively unchanged from the basis used in the 1977 amendments to the ER.

- Changes in the inert gas processing system have had the following effects:

1) Noble gases are now sent from RAPS Noble Gas Storage Vessel to CAPS, rather than being bottled for disposal	Increases discharge from RSB HVAC
2) RAPS Cryogenic Charcoal Beds have been deleted	Increases activity to CAPS, but CAPS charcoal beds supply hold-up time - little effect on offsite releases
3) Re-evaluation of CAPS charcoal bed efficiency	Decrease in offsite releases
4) RAPS moved inside of RCB	No effect on normal operation, Favorable effect with regard to accidents

5)	Effluents from other systems to CAPS added to the total effluent (effluents from refueling system, fail fuel monitoring system and maintenance system)	Slightly increases discharge from RSB HVAC

These changes are contained in response to Question 290.1R.

Question 750.1R (NRC letter dated 10/26/81, response letters dated 2/5/82, 5/3/82)

Since there are no known commercial plans for participating in the CRBR fuel cycle on a licensed basis, it appears that the fuel cycle related to CRBR will have to be carried out by DOE in its own unlicensed facilities. Accordingly, it will be necessary for DOE to project its plans for carrying out the fuel cycle functions related to processing, safeguarding and transportation of fuels and for managing the handling and disposal of wastes.

In this regard, please provide an amendment to the environmental report that describes DOE's planned program and facilities for such functions related to CRBR, including estimates of the resource uses and effluents and assessments of the potential effects, including radiological, resulting from such activities. This report will serve as the basis for NRC to perform its independent evaluations of these functions for CRBR licensing purposes.

Response

The information requested in question 750.1R is provided in the ER Amendment XIV.

Question 750.2R

Provide a list of currently feasible candidate sites with current information to support comparison of them. As a minimum, the following should be considered:

1. Using the applicable portions of 10 CFR Part 51, Regulatory Guide 4.2 and the Proposed Rule on Alternative Sites (45 FR 24168-24178, April 9, 1980) as guidelines, review the previous site selection process. This reassessment should identify the region of interest and consider the potential sites within the region, select candidate sites with environmental diversity of land and water resources within the region of interest, and compare the final candidate sites with the proposed site.

   Verify that the data provided previously are still applicable and provide current information as necessary.

   The region of interest and selected candidate sites within the TVA service area should be representative of the environmental diversity reflected by the types of water bodies and floral and faunal diversity available within the region (upper and lower reaches of large rivers, small rivers, lakes, reservoirs, etc.)

2. Provide the rationale and supporting information for exclusion of potential candidate TVA sites along the Mississippi, the Ohio (at or in the vicinity of the Shawnee Steam Electric Plant), the Tombigbee (Black Warrior), the Coosa, the Green (Barren), and Pearl Rivers.

3. Reconsider the possible use of planned or existing power plant sites, including Phipps Bend, Hartville, Yellow Creek, Watts Bar, Browns Ferry, Sequoyah and Bellefonte. If CRBR were located at a site where some initial site work has been done, indicate whether savings in construction time and/or cost could be realized. Also, state whether there is any reason why the CRBRP should not be located on a common site with a light-water-reactor plant.

4. Discuss the present status of hook-on concept; if this is no longer a practical approach for the CRBRP, consider whether a complete CRBRP could be built at the hook-on sites previously compared to the proposed site.

5. Consider whether another suitable candidate site exists on the Clinch River including the possibility of locating the complete (non-hook-on) CRBRP at the Bull Run Steam Plant or the Kingston Steam Plant. If such a site is identified, what environmental or other constraints, if any, would be involved in so locating the CRBRP?

RESPONSE

See Appendix G to the CRBRP Environmental Report (Amendment XV).

Question 750.3R

Verify that the ERDA (DOE) sites previously considered in the alternative site review are presently acceptable as candidate sites and describe any additional DOE property that would qualify as candidate sites including any reasons why they should not be considered further. Review the information previously provided on these candidate sites and assure that it is adequate for comparison to the proposed site.

RESPONSE

See Appendix F to the CRBRP Environmental Report (Amendment XV).

Question 750.4R

If the Applicant's reassessment of the alternative sites indicated that any of them is environmentally preferable to the proposed site, provide economic costs (costs of delay, etc.) that would be associated with changing the site to such location and discuss any constraints or other reasons for not doing so.

RESPONSE

See Appendices F and G to the CRBRP Environmental Report (Amendment XV).

AMENDMENT XVI REVISIONS RESULTING FROM ADDITIONAL UPDATED INFORMATION AND MINOR CORRECTIONS

Sec. 2.1, 3.2	Revised to correctly identify plant design thermal power capability.
2.3	Updated to include the State of Tennessee Historic Preservation Office finding of no historic or archaeological effect on the proposed transmission line right-of-way.
2.5, 3.3, 3.4 3.7, 5.1, 5.4 5.8, 10.3	Updated for consistency with the NPDES permit and plant design parameters.
2.6	Updated to correct typographical errors entered in Amendment (11) tables.
2.7, 5.1	Updated to include the finding of a Blue Sucker and the initiation of the Sauger spawning study.
3.3	Updated to identify the potable water source.
3.5	Table 3.5-7 is updated to identify the correct value for the reactor refueling system contribution to the CAPS/RAPS heating and ventilating system (0.2 ci/day). Table 3.5-8 is updated to reflect the estimated curie release of noble gas (210 ci/year).
3.6	Updated to provide revised estimates of effluent water concentrations.
3.7	Updated to reflect current design description of the normal plant sewage disposal system.
3.8	Updated to correct heat load limits for the spent fuel shipping cask.
3.9	Updated to incorporate State Historic Preservation Office determination regarding field survey of transmission line right-of-way.

4.1, 5.4	Updated to identify location of dredge material disposal. Correctly identify treatment pond requirements during plant operation.
4.2, 4.3	Updated to correct transmission line sewage.
5.4	Revised to provide greater detail description of chemical effluents to the Clinch River from the common plant discharge.
5.7	Updated to provide further clarification of the Developmental Reprocessing Facility.
6.1.1.2	Updated to properly describe the sediment and erosion control requirements during plant construction activities, and the Sauger study as required by the EPA draft NPDES permit.
6.1.3	Updated to indicate resumption of on site meterological monitoring activities in addition to editorial clarification.
Section 14.4A (Appendix to 5.7)	Incorporated into ER to provide isotopic composition for recycle of CRBRP fuel.
13.0	Updates appropriate reference material.
Appendix F	Updates seismic relocation cost for Idaho National Engineering Laboratory (INEL). Incorporate recent information on the Northwest utilities willingness to participate in the LMFBR demonstration project.
Appendix G	Updated to provide additional clarification to alternative site relocation costs and editorial corrections.
Q230.1R	Updated to include the results of the foundation bedrock verification program.
240.1R	Updated to incorporate exhibit (1) inadvertently provided in response to NRC Question 240.2R (Amendment 15).

Question 230.2R (NRC letter dated 10/26/81, response dated 12/22/81)

Based on the site investigation data presented in the PSAR, the upper siltstone horizon of Unit A, within which the structure foundations are to be placed, is relatively devoid of solution features below foundation grade. However, it is not obvious that the underlying limestone unit of the Chickamauga Group, Unit A and the much deeper Knox group do not contain significant cavities. Determine the maximum size cavity, based on regional studies of karst features in these rock units, that could exist beneath the plant without being detected by the investigations performed. Evaluate the capability of the foundation rock unit (Unit A, upper siltstone) to bridge such cavities.

Summary of Response

1) The potential for cavities and other karst features within the Unit A Limestone of the Chickamauga Group below the proposed base excavation level for the Nuclear Island is considered minimal. It is believed that existing boring data, results of the test grouting program, and the recently completed foundation bedrock verification program (discussed below) confirm the homogeneity of the Unit A Limestone as demonstrated by the absence of solutioning below foundation grade. 16

2) Research studies on the regional geology have shown that weathering in the Knox has been encountered to depths up to 200 feet. Geotechnical investigations at the site have indicated a depth of weathering in the Knox not exceeding 100 feet. Consequently, with a minimum depth of cover above the Knox of 450 feet, subsidence problems will not occur beneath the CRBRP site.

Response

1. FOUNDATION VERIFICATION PROGRAM

A foundation verification program was conducted at the site between January and May, 1982, which consisted of 9 core borings and 25 percussion borings. The purpose of the program was to verify the homogeneity and satisfactory bearing capability of the Unit A Limestone. This was to be done by confirming the representivity of Boring 55, selected as the central boring in the test grouting program conducted in 1975 on the west side of the Nuclear Island. Results of the test grouting program demonstrated the adequacy of the Unit A Limestone.

All borings of the foundation verification program were advanced at least 100 feet into the Unit A Limestone. Depths of borings ranged from 181 feet to 263 feet. Upon completion of drilling, each boring was geophysically logged by means of down hole probes, and all extracted rock cores were visually examined. Results of the program indicated that the depth of significant weathering and solution zones is limited to at least 20 feet above the selected bearing elevation of the Nuclear Island (el. 715 feet). 16

Based upon these results, it is concluded that the representivity of Boring 55 as noted above has been confirmed; the homogeneity of the Unit 'A' Limestone below foundation grade of the Nuclear Island mat has been verified; no foundation treatment will be necessary since all weathered rock will be removed during excavation; and no further investigations are required in this area.

2. EVALUATION OF THE POTENTIAL CAVITIES IN THE KNOX FORMATION

The size, shape, frequency, and extent at depth of karstic cavities depend upon 1) the extent of the weathering zone, 2) the presence or absence of impervious strata, and 3) local geologic structures (faults). In general, solution cavities, both ancient and recent, may be open, or completely filled with clastic material, or may be water-filled conduits. Ancient, or paleokarst cavities, are typically filled with recemented material and are as competent as the host rock around them.

Weathering within the Oak Ridge reservation is usually limited to the upper 100 feet of the surface. The weathering of rock is most severe in the local limestone and dolomite units, leaving karstic terrain with clay and chert residuum for soil. Below the weathering zone, the rock is generally jointed, but sound, with joint strength increasing and open joint frequency decreasing with depth.

The development of karst features at the surface and at depth in the rocks of the Knox Group is well documented. Sinkholes and cavities are very frequent and have created many problems in the foundation of structures throughout the entire region. The Knox Group has been described as a massive dolomite with a paleokarst upper unit. This upper unit reflects an ancient karstic erosional surface which was subsequently beveled and covered by the Chickamauga Group. According to local experts and available references, this paleokarst unit is now a very competent rock. The ancient solution cavities, joints and caves, were filled with residuum and recemented to the point that it is now difficult to detect the paleokarst unit from the overlying and underlying carbonate units. These paleokarst features are well documented in the zinc district of northeastern Tennessee where they are always filled and cemented and do not represent a hazard.

The only areas of karst with active solutioning exist within zones of active weathering, at or close to the contact between the Knox and the Chickamauga groups, and at depths ranging from 0 to 200 feet. The size of the cavities varies from enlarged joints to several tens, and occasionally hundreds of feet in span. Geotechnical investigation at the site indicated a maximum depth of weathering not exceeding 100 feet.

To summarize our own experience and available data the following can be concluded: 1) Frequent and large open cavities (up to several hundred feet) occur within the Knox Group. These solution features are exclusively developed at shallow depth (no deeper than 200 feet) and in relation to the zone of weathering. 2) Many cavities appear to be located at or close to the unconformity existing between the Knox and Chickamauga Groups. When this unconformity is at depth beneath the zone of weathering the karst features are ancient and filled, and the filling material is recemented.

In conclusion, it would appear that subsidence is not a problem below the CRBRP site and in view of the shallow depth of weathering, it would not be necessary to conduct hypothetical analytical studies to determine the maximum size cavity related to depth and strength properties of overlying strata.

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