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**ENVIRONMENTAL LEVELS OF RADIOACTIVITY  
FOR THE OAK RIDGE AREA**

(Report for Period July - December, 1967)

Compiled by the

Health Physics and Safety Section

Health Physics Division

OAK RIDGE NATIONAL LABORATORY

**APPROVAL FOR RELEASE**

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FOR THE OAK RIDGE AREA (Report for Period  
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*Arvin S. Smith* 1/29/93  
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#497

## Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells. Low level liquid wastes are discharged, after preliminary treatment, to surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

This report presents data on the environmental levels of radioactivity for the Oak Ridge area and compares the data with established maximum permissible concentrations.

## Air Monitoring

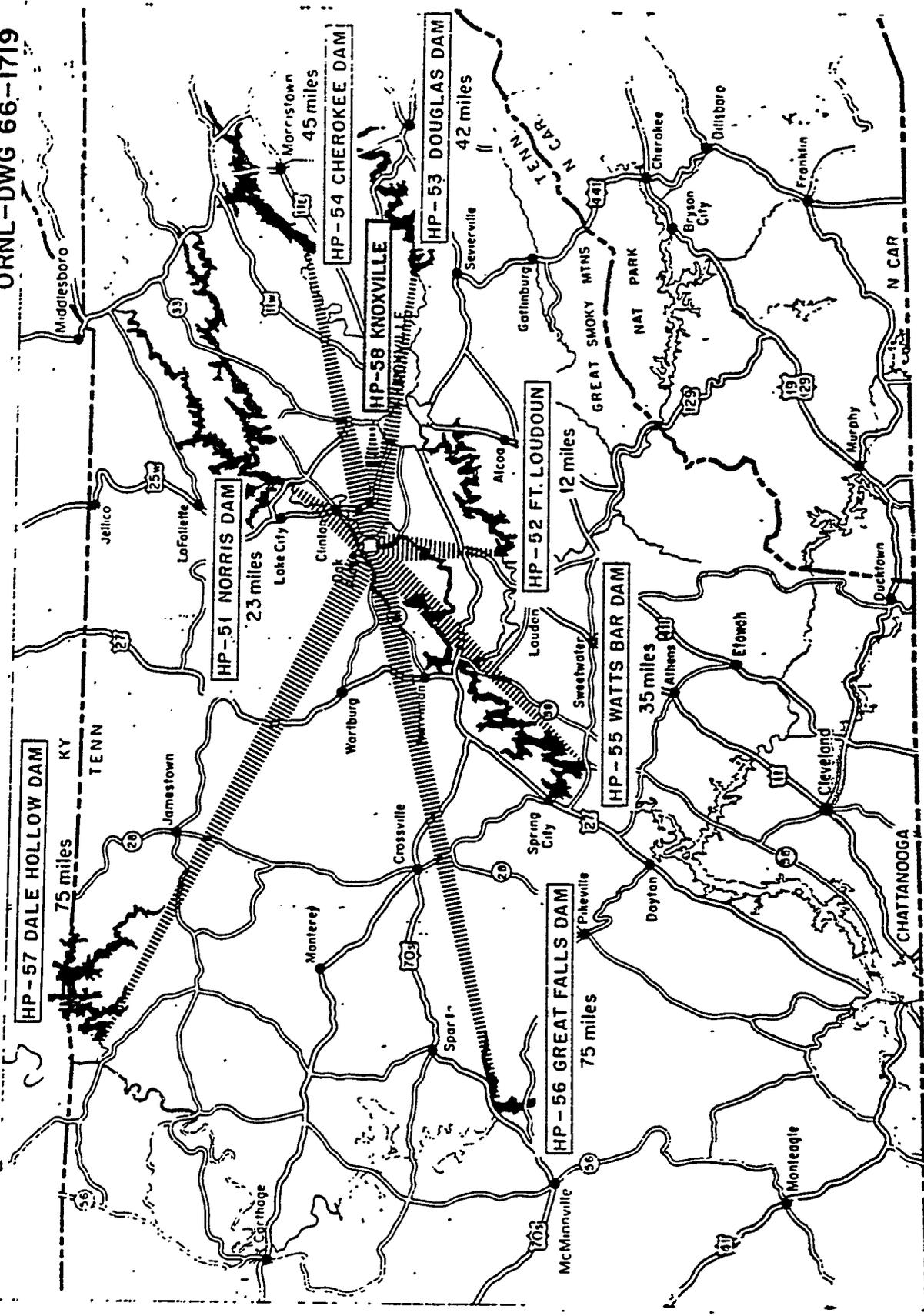
Atmospheric contamination by radioactive materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant area (Fig. 1) and provides data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Airborne radioactive iodine is monitored in the immediate environment of the plant area by passing air through a cartridge containing activated charcoal. Data collected are accumulated, tabulated, and averaged in units of  $\mu\text{Ci}/\text{cc}$  of air sampled.

## Milk Monitoring

Raw milk is monitored for  $^{131}\text{I}$  and  $^{90}\text{Sr}$  by the collection and analysis of samples from twelve sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to Oak Ridge Operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is two-fold: first, samples collected in the immediate vicinity of the Oak



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STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Figure 2

Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge Operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

### Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, to the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population groups in uncontrolled areas as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 3 and 4. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only, since cooling time and hold-up time in the waste effluent system are such that short-lived radionuclides are normally not present. The concentrations of those isotopes present in significant amounts are determined by analysis. A weighted average maximum permissible concentration for water,  $(MPC)_w$ , for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as specified by AEC Manual, Chapter 0524.<sup>1</sup> The average concentrations of gross beta activity in the Clinch River are compared to the calculated  $(MPC)_w$  values.

The concentration of uranium is compared with the specific  $(MPC)_w$  value for uranium.

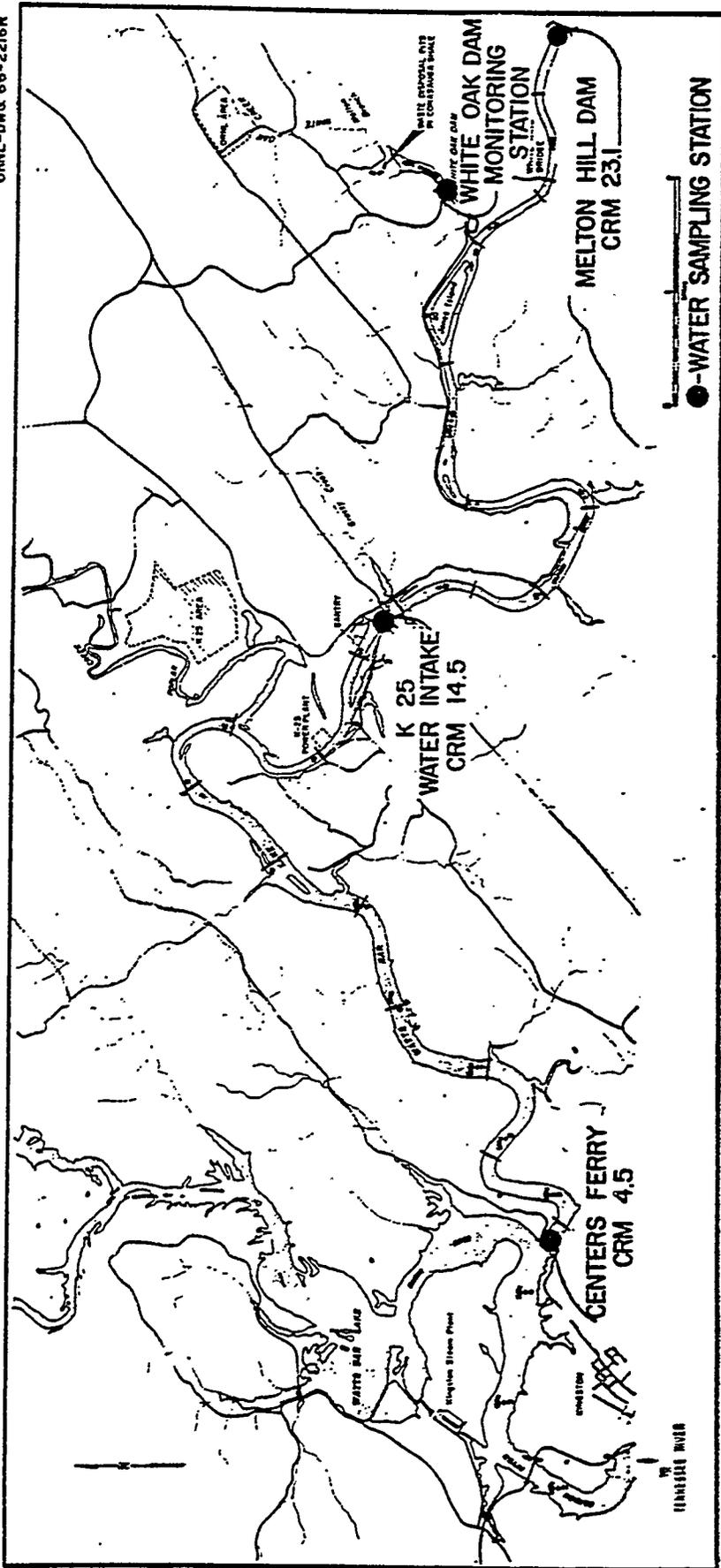
### Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

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<sup>1</sup>AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

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WATER SAMPLING LOCATIONS

Figure 3

ENVIRONMENTAL SAMPLING  
OAK RIDGE GASEOUS DIFFUSION PLANT

● SAMPLE POINTS

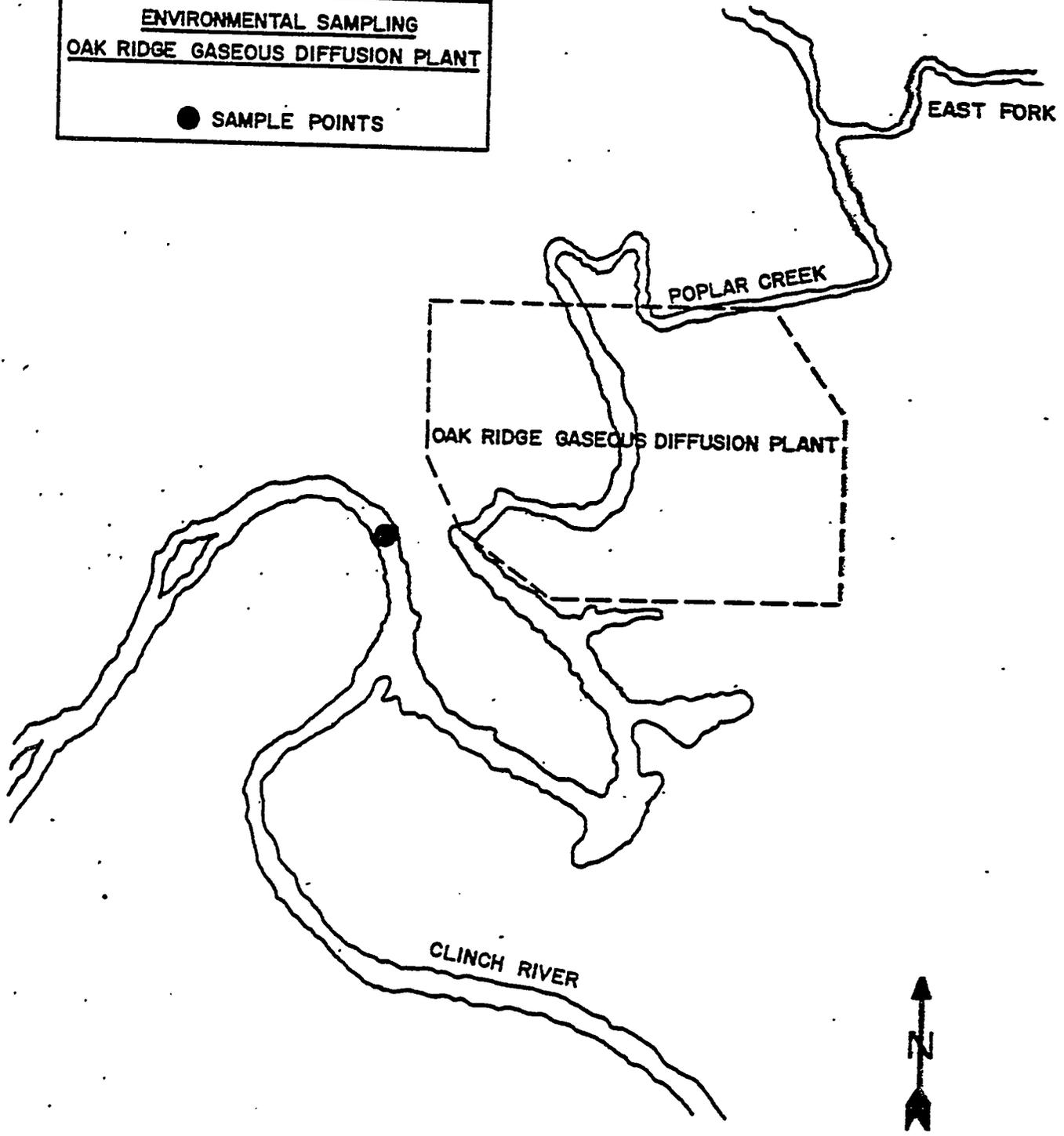


Figure 4

## Discussion of Data

Data on the environmental levels of radioactivity for the second half of 1967 in the Oak Ridge and surrounding areas are presented in Table I through Table IX.

The average air contamination levels for gross beta activity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.05% and 0.03%, respectively, of the maximum permissible concentration applicable to uncontrolled areas (Table I).

The average air contamination levels for gross alpha activity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.15% and 0.10%, respectively, of the (MPC)<sub>a</sub> for natural uranium for application to uncontrolled areas (Table II).

The average concentration of <sup>131</sup>I in air in the immediate environs of the plants was  $0.020 \times 10^{-12}$   $\mu\text{Ci/cc}$  (Table III). This is approximately 0.02% of the maximum permissible concentration for application to uncontrolled areas.

The average concentrations of <sup>131</sup>I in raw milk in both the immediate and remote environs of the Oak Ridge area were 5 pCi/l (Table IV). This level falls within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day.

The average concentrations of <sup>90</sup>Sr in raw milk for the immediate and remote environs of the controlled area were 28 pCi/l and 25 pCi/l, respectively. These levels fall near the lower limit of FRC Range II for transient rates of daily intake of <sup>90</sup>Sr for application to the average of suitable samples of an exposed population.

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and the measured average concentration at Mile 4.5, near Kingston, Tennessee, were  $0.80 \times 10^{-8}$   $\mu\text{Ci/ml}$  and  $0.44 \times 10^{-8}$   $\mu\text{Ci/ml}$ , respectively. These values are 0.67% and 0.49% of the weighted average maximum permissible concentrations (MPC)<sub>w</sub>.

The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was  $1.1 \times 10^{-10}$   $\mu\text{Ci/ml}$  which is approximately 0.01% of the weighted average (MPC)<sub>w</sub> value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge plants, was < 0.01% of the (MPC)<sub>w</sub> for uranium

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge area was 0.011 mR/hr, which is approximately the same as the level measured in the early period prior to Oak Ridge Operations.

### Conclusion

Surveillance of the radioactivity in the Oak Ridge environs indicated that the major part of the radioactivity detected continues to be the result of fallout from sources other than Oak Ridge Operations. While some low level radioactivity is being released to the environment from plant operations, the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and intake guides for the neighboring population.

TABLE I  
 CONTINUOUS AIR MONITORING DATA  
 Long-Lived Gross Beta Activity of  
 Particulates in Air

July - December, 1967

Station Number	Location	Number of Samples Taken	Units of $10^{-13}$ $\mu\text{Ci}/\text{cc}$			% (MPC) <sub>a</sub> <sup>c</sup>
			Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	27	1.1	0.03	0.36	0.04
HP-32	Midway Gate	27	3.3	< 0.01	0.71	0.07
HP-33	Gallaher Gate	27	1.5	< 0.01	0.31	0.03
HP-34	White Oak Dam	27	3.3	< 0.01	0.39	0.04
HP-35	Blair Gate	26	0.91	< 0.01	0.33	0.03
HP-36	Turnpike Gate	188 <sup>d</sup>	4.9	0.04	0.72	0.07
HP-37	Hickory Creek Bend	27	0.45	< 0.01	0.23	0.02
HP-38	East of EGCR	27	6.6	< 0.01	0.58	0.06
HP-39	Townsite	27	0.89	< 0.01	0.38	0.04
Average			2.64	0.01	0.45	0.05
<u>Remote Stations</u>						
HP-51	Norris Dam	27	0.81	< 0.01	0.31	0.03
HP-52	Loudoun Dam	27	1.4	< 0.01	0.29	0.03
HP-53	Douglas Dam	27	6.6	< 0.01	0.56	0.06
HP-54	Cherokee Dam	27	1.8	< 0.01	0.28	0.03
HP-55	Watts Bar Dam	26	0.48	< 0.01	0.24	0.02
HP-56	Great Galls Dam	26	0.93	< 0.01	0.26	0.03
HP-57	Dale Hollow Dam	27	0.64	< 0.01	0.25	0.03
HP-58	Knoxville	27	0.98	< 0.01	0.35	0.04
Average			1.7	< 0.01	0.32	0.03

<sup>a</sup>Maximum weekly average concentration.

<sup>b</sup>Minimum weekly average concentration.

<sup>c</sup>(MPC)<sub>a</sub> is taken to be  $10^{-10}$   $\mu\text{Ci}/\text{cc}$  as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>d</sup>Samples collected on daily schedule beginning 5/7/62. Maximum and minimum daily average concentrations were  $4.7 \times 10^{-13}$   $\mu\text{Ci}/\text{cc}$  and  $< 0.01 \times 10^{-13}$   $\mu\text{Ci}/\text{cc}$  respectively.

TABLE II  
 CONTINUOUS AIR MONITORING DATA  
 Long-Lived Gross Alpha Activity of  
 Particulates in Air

July - December, 1967

Station Number	Location	Number of Samples Taken	Units of $10^{-13}$ $\mu\text{Ci}/\text{cc}$			$\frac{\%}{(\text{MPC})_a^c}$
			Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	27	0.06	< 0.01	0.02	0.10
HP-32	Midway Gate	27	0.15	< 0.01	0.04	0.20
HP-33	Gallaher Gate	27	0.13	< 0.01	0.02	0.10
HP-34	White Oak Dam	27	0.05	< 0.01	0.02	0.10
HP-35	Blair Gate	26	0.08	< 0.01	0.03	0.15
HP-36	Turnpike Gate	188 <sup>d</sup>	0.38	0.02	0.09	0.45
HP-37	Hickory Creek Bend	27	0.05	< 0.01	0.02	0.10
HP-38	East of EGCR	27	0.09	< 0.01	0.02	0.10
HP-39	Townsite	27	0.08	< 0.01	0.03	0.15
Average			0.12	< 0.01	0.03	0.15
<u>Remote Stations</u>						
HP-51	Norris Dam	27	0.05	< 0.01	0.02	0.10
HP-52	Loudoun Dam	27	0.06	< 0.01	0.02	0.10
HP-53	Douglas Dam	27	0.05	< 0.01	0.02	0.10
HP-54	Cherokee Dam	27	0.07	< 0.01	0.01	0.05
HP-55	Watts Bar Dam	26	0.07	< 0.01	0.02	0.10
HP-56	Great Falls Dam	26	0.05	< 0.01	0.02	0.10
HP-57	Dale Hollow Dam	27	0.03	< 0.01	0.01	0.05
HP-58	Knoxville	27	0.05	< 0.01	0.03	0.15
Average			0.05	< 0.01	0.02	0.10

<sup>a</sup>Maximum weekly average concentration.

<sup>b</sup>Minimum weekly average concentration.

<sup>c</sup>(MPC)<sub>a</sub> used is  $20 \times 10^{-13}$   $\mu\text{Ci}/\text{cc}$ , the MPC for natural uranium as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>d</sup>Samples collected on daily schedule beginning 5/7/62.

TABLE III  
 CONCENTRATION OF  $^{131}\text{I}$  IN AIR  
 AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS

July - December, 1967

Number of Samples	Units of $10^{-12}$ $\mu\text{Ci/cc}$			$\%$ (MPC) <sub>a</sub> <sup>b</sup>
	Maximum	Minimum <sup>a</sup>	Average	
234	0.22	< 0.01	0.02	0.02

<sup>a</sup>Minimum detectable amount of  $^{131}\text{I}$  is 20 d/m. At the average sampling rate used, this corresponds to approximately  $0.010 \times 10^{-12}$   $\mu\text{Ci/cc}$ . In averaging, one-half of this value, 10 d/m, is used for all samples showing a total amount of  $^{131}\text{I}$  less than 20 d/m.

<sup>b</sup>(MPC)<sub>a</sub> is taken to be  $1 \times 10^{-10}$   $\mu\text{Ci/cc}$  as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE IV  
 CONCENTRATION OF  $^{131}\text{I}$  IN RAW MILK

July - December, 1967

Location	pCi/l		
	Maximum	Minimum <sup>a</sup>	Average
Immediate Environs	13	< 10	5.0
Remote Environs	< 10	< 10	5.0

<sup>a</sup> Minimum detectable concentration of  $^{131}\text{I}$  is 10 pCi/l. In averaging, one-half of this value, 5 pCi/l, was used for all samples showing a concentration less than 10 pCi/l.

TABLE V  
 CONCENTRATION OF  $^{90}\text{Sr}$  IN RAW MILK

July - December, 1967

Location	pCi/l		
	Maximum	Minimum <sup>a</sup>	Average
Immediate Environs	50	9.0	28
Remote Environs	34	14	25

<sup>a</sup> Minimum detectable concentration of  $^{90}\text{Sr}$  in milk is 2 pCi/l. In averaging, one-half of this value, 1 pCi/l, was used for all samples showing a concentration less than 2 pCi/l.

TABLE VI  
 CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY  
 IN THE CLINCH RIVER AT MILE 20.8

July - December, 1967

Number of Samples Taken	Units of $10^{-7}$ $\mu\text{Ci}/\text{ml}$			% of $(\text{MPC})_w$
	Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
188	0.42	0.01	0.08	0.67

<sup>a</sup>Maximum weekly average.

<sup>b</sup>Minimum weekly average.

TABLE VII  
 AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS  
 IN THE CLINCH RIVER

July - December, 1967

Location	Units of $10^{-8}$ $\mu\text{Ci/ml}$							Average Beta Activity	$(\text{MPC})_w^a$	% of $(\text{MPC})_w$
	$^{90}\text{Sr}$	$^{144}\text{Ce}$	$^{137}\text{Cs}$	$^{106}\text{Ru}$	$^{60}\text{Co}$	$^{95}\text{Zr} - ^{95}\text{Nb}$				
Mi. 23.1 <sup>b</sup>	0.04	< 0.01	< 0.01	0.02	*	*	0.07	50	0.14	
Mi. 20.8 <sup>c</sup>	0.06	< 0.01	0.02	0.04	0.02	< 0.01	0.80	120	0.67	
Mi. 4.5	0.14	0.02	0.14	0.05	0.07	0.01	0.44	90	0.49	

<sup>a</sup>Weighted average  $(\text{MPC})_w$  calculated for the mixture using  $(\text{MPC})_w$  values for specific radionuclides specified by AEC Manual, Chapter 0524, Appendix, Annex I, Table II.

<sup>b</sup>Sampling station moved from Clinch River Mile 41.5 to Melton Hill Dam, CRM 23.1 about January 1, 1966.

<sup>c</sup>Values given for this location are calculated values based on levels of waste released and the dilution provided by the river; they do not include amounts of radioactive material (e.g., fallout) that may enter the river upstream from CRM 20.8.

\*None detected.

TABLE VIII  
URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1967

Sampling Point	Type of Analyses Made	No. of Samples <sup>a</sup>	Units of 10 <sup>-8</sup> µCi/ml			% (MPC) <sub>w</sub>
			Maximum <sup>b</sup>	Minimum <sup>b</sup>	Average <sup>b</sup>	
Downstream from ORGDP	Uranium Concentration	2	< 0.1	< 0.1	< 0.1	2000 < 0.01

<sup>a</sup> Normal Sampling Frequency: Continuous, composited over one quarter.

<sup>b</sup> No uranium was detected in Clinch River water samples during this period. Minimum detectable concentration of uranium in river water is 0.1 x 10<sup>-8</sup> µCi/ml.

TABLE IX

## EXTERNAL GAMMA RADIATION LEVELS

mR/hr

July - December, 1967

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Solway Gate	0.011	0.011	0.011	*	0.009	0.011	0.011
2	Y-12, East Portal	0.010	0.014	0.009	*	0.011	0.010	0.011
3	Newcomb Road, Oak Ridge	0.011	0.011	0.014	*	0.011	0.010	0.011
4	Gallaher Gate	0.010	0.011	0.008	*	0.013	0.010	0.010
5	White Wing Gate	0.012	0.011	0.011	*	0.009	0.012	0.011
Average		0.011	0.012	0.011	*	0.011	0.011	0.011

Note: These readings were taken with a calibrated Geiger-Müller tube at a distance of three feet above the ground.

The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.

\*No measurement made.

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