Y/UB-6

ENVIRONMENTAL MONITORING REPORT

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

OAK RIDGE FACILITIES

Calendar Year 1976

UNION CARBIDE

NUCLEAR DIVISION
OAK RIDGE, TENNESSEE

prepared for the **U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**
under **U.S. GOVERNMENT** *Contract W-7405 eng 26*

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Paper Copy $4.50; Microfiche $3.00 (domestic); $4.50 (foreign)

Y/UB-6
Date of Issue: May 1, 1977

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Calendar Year 1976

UNION CARBIDE CORPORATION – NUCLEAR DIVISION
Oak Ridge Gaseous Diffusion Plant
Oak Ridge National Laboratory
Oak Ridge Y-12 Plant

Office of Health, Safety, and Environmental Protection
Post Office Box Y
Oak Ridge, Tennessee 37830

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INTRODUCTION

Oak Ridge is located in East Tennessee in a broad valley which lies between the Cumberland Mountains on the northwest and the Great Smoky Mountains on the southeast. The Energy Research and Development Administration (ERDA) Reservation is located in the Valley and Ridge physiographic province which is characterized by parallel ridges of sandstone, shale, and cherty dolomite, separated by valleys of less weather-resistant limestone and shale. The ridges are oriented southwest-northeast. Topography of the area is due to differential erosion of severely folded and faulted rocks ranging in age from Early Cambrian to Early Mississippian. Elevations range from 740 feet to 1360 feet above mean sea level with a maximum relief of 620 feet. The area includes gently sloping valleys and rolling to steep slopes and ridges. The Tennessee Valley Authority's (TVA) Melton Hill and Watts Bar Reservoirs on the Clinch River form the southern and western boundaries of the Reservation while the City of Oak Ridge (approximately 28,000 population) is on the northern boundary.

The local climate is noticeably influenced by topography. Prevailing winds are usually either up-valley, from west to southwest, or down-valley, from east to northeast. During periods of light winds, daytime winds are usually southwesterly and nighttime winds usually northeasterly. Wind velocities are somewhat decreased by the mountains and ridges, and tornadoes rarely occur. In winter, the Cumberland Mountains have a moderating influence on the local climate by retarding the flow of cold air from the north and west. Temperatures of 100°F or higher and 0°F or below are unusual. Low-level temperature inversions occur during approximately 56 percent of the hourly observations. Winter and early spring are the seasons of heaviest precipitation with the monthly maximum normally occurring during January to March. The mean annual precipitation is approximately 54 inches.

The topography of the Oak Ridge Area is such that all drainage from the ERDA Reservation flows into the Clinch River which has its headwaters in southwestern Virginia and flows southwest to its mouth near Kingston, Tennessee. The Clinch River flow is regulated by several dams which provide reservoirs for flood control, electric power generation, and recreation. The principal tributaries through which liquid effluents from the plant areas reach the Clinch River are White Oak Creek, East Fork Poplar Creek, and Poplar Creek.

With the exception of the City of Oak Ridge, the land within 5 miles of the ERDA Reservation is predominantly rural being utilized largely for residences, small farms, and pasturage for cattle. The approximate location and population of the towns nearest the ERDA Reservation are: Oliver Springs (pop. 3400) 7 miles to the northwest; Clinton (pop. 4800) 10 miles to the northeast; Lenoir City (pop. 5300) 7 miles to the southeast; Kingston (pop. 4100) 7 miles to the southwest; and Harriman (pop. 8700) 8 miles to the west. Knoxville, the major metropolitan area nearest Oak Ridge, is located about 25 miles to the east and has a population of approximately 175,000.

The ERDA Reservation contains three major operating facilities: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Y-12 Plant; all of which are operated by Union Carbide Corporation, Nuclear Division. In addition, two smaller ERDA facilities are in the area: the Comparative Animal Research Laboratory, and the Oak Ridge Associated Universities.

The Oak Ridge National Laboratory is a large multipurpose research laboratory whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, the Laboratory conducts research in all fields of modern science and technology. The Laboratory's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

The Oak Ridge Gaseous Diffusion Plant (ORGDP) is a complex of production, research, development, and support facilities located west of the city of Oak Ridge. While the primary function of ORGDP is the enrichment of uranium hexafluoride (UF_6) in the uranium-235 isotope, extensive efforts are also expended on research and development activities associated with both the gaseous diffusion and gas centrifuge processes. In addition, the barrier material used by all three Energy Research and Development Administration-owned gaseous diffusion plants is manufactured at ORGDP. Numerous other activities (maintenance, nitrogen production, steam production, uranium recovery, fluorine production, water treatment, laboratory analysis, administration, etc.) lend support to these primary functions and are thus essential to the operation of this plant.

The Oak Ridge Y-12 Plant which is located immediately adjacent to the City of Oak Ridge has four major responsibilities: (1) production of nuclear weapon components, (2) fabrication support for weapon design agencies, (3) support for the Oak Ridge National Laboratory, and (4) support and assistance to other government agencies. Activities associated with these functions include the production of lithium compounds, the recovery of enriched uranium from unirradiated scrap material, and the fabrication of uranium and other materials into finished parts and assemblies. Fabrication operations include vacuum casting, arc melting, powder compaction, rolling, forming, heat treating, machining, inspection, and testing.

Operations associated with the ERDA research and production facilities in Oak Ridge give rise to several types of waste materials.

Radioactive wastes are generated from nuclear research activities, reactor operations, pilot plant operations involving radioactive materials, isotope separation processes, uranium enrichment, and uranium processing operations. Nonradioactive wastes are generated by normal industrial-type support operations that include water demineralizers, air conditioning, cooling towers, acid disposal, sewage plant operations, and steam plant operations.

Nonradioactive solid wastes are buried in a centralized sanitary landfill or designated burial areas. Radioactive solid wastes are buried in designated burial areas or placed in retrievable storage either above or below ground depending upon the type and quantity of radioactive material present and the economic value involved.

Gaseous wastes generally are treated by filtration, electrostatic precipitation, and/or chemical scrubbing techniques prior to release to the atmosphere. The major gaseous waste streams are released through stacks to provide atmospheric dilution for materials which may remain in the stream following treatment.

Liquid radioactive wastes are not released but are concentrated and contained in tanks for ultimate disposal. Process water which may contain small quantities of radioactive or chemical pollutants is discharged, after treatment, to White Oak Creek, Poplar Creek, East Fork Poplar Creek, and Bear Creek, which are small tributaries to the Clinch River.

SUMMARY

The Environmental Monitoring Program for the Oak Ridge area includes sampling and analysis of air, water from surface streams, several food products, vegetation, and soil for both radioactive and nonradioactive materials. This report presents a summary of the results of the program for calendar year 1976.

Surveillance of radioactivity in the Oak Ridge environs indicates that atmospheric concentrations of radioactivity were not significantly different from other areas in East Tennessee. Concentrations of radioactivity in the Clinch River and in fish collected from the river were less than 8.1 percent of the permissible concentration and intake guides for individuals in the offsite environment. While some radioactivity was released to the environment from plant operations, the concentrations in all of the media sampled were well below established standards.

The total body dose to a "hypothetical maximum exposed individual" at the site boundary was calculated to be 7.2 mrem/yr which is 1.4 percent of the ERDA Manual Chapter 0524 standard. The maximum 50-year dose commitment to the critical organ of an individual from the aquatic food chain was calculated to be 150 millirem to the bone which is 10 percent of the allowable annual standard. The maximum dose commitment to individuals living nearest the site boundary from airborne releases, assuming continuous residence, was 0.4 millirem to the total body and 7.4 millirem to the lung. These doses are 0.08 percent and 0.5 percent, respectively, of the annual standards. The average total body dose to an Oak Ridge resident was estimated to be 0.05 millirem as compared to approximately 100 mrem/yr from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.7 millirem. The cumulative total body dose to the population with a 50-mile radius of the Oak Ridge facilities resulting from 1976 effluents was calculated to be 5.3 man-rem. This dose may be compared to an estimated 80,000 man-rem to the same population resulting from natural background radiation.

Surveillance of nonradioactive materials in the Oak Ridge environs shows that established limits were not exceeded for those materials possibly present in the air as a result of plant operations with the exception of fluorides which exceeded the limits on several occasions. Several abatement projects which have been completed to reduce fluoride emissions should become operational in 1977. The ORGDP steam plant was out of compliance with State emission limits for particulates and visible emissions during the winter months when coal

was used as a supplemental fuel. A project is under way to provide for the installation of electrostatic precipitators for particulate removal. It is planned to meet SO_2 emission standards through the purchase of suitable quality coal.

The chemical water quality data in surface streams obtained from the water sampling program indicated that average concentrations resulting from plant effluents were in compliance with standards with the exception of fluorides and nitrates.

National Pollutant Discharge Elimination System (NPDES) permit compliance information has been included in this report.

MONITORING DATA
COLLECTION, ANALYSIS, AND EVALUATION

Environmental monitoring data for calendar year 1976 are summarized in Tables 1 through 29. In general, the data tables show the number of samples collected at each location, the maximum concentration, the minimum concentration, the average concentration, the relevant standard, and percent of standard for the average of each parameter. Averages are usually accompanied by plus-or-minus (±) values which represent the 95 percent confidence limits. The 95 percent confidence limits which are calculated from the standard deviation of the average, assuming a normal frequency distribution, are predictions of the variability in the range of concentrations based on a limited number of measurements. They do not represent the conventional error in the average of repeated measurements on identical samples. Data which are below the minimum detectable limit are expressed as less than (<) the minimum detectable value. In computing average values, sample results below the detection limit are assigned the detection limit value with the resulting average value being expressed as less than (<) the computed value.

Average environmental concentrations are compared with applicable standards, where such standards have been established, as a means of evaluating the impact of effluent releases. In some cases, for lack of an official standard, stream concentrations of nonradioactive pollutants have been compared with Tennessee State Health Department stream guidelines.

Liquid effluent monitoring data have been compared to the limits specified in the National Pollutant Discharge Elimination System (NPDES) permits issued to the Oak Ridge Facilities by the Environmental Protection Agency (EPA).

Air Monitoring

Radioactive – Atmospheric concentrations of radioactive materials occurring in the general environment of East Tennessee are monitored by two systems of monitoring stations. One system consists of nine stations (HP-31 through HP-39) which encircle the perimeter of the Oak Ridge area and provides data for evaluating releases from Oak Ridge facilities to the immediate environment, Figure 1. A second system consists of eight stations (HP-51 through HP-58) encircling the Oak Ridge area at distances of from 12 to 75 miles, Figure 2. This system provides background data to aid in evaluating local conditions. Sampling for radioactive particulates is carried out by passing air continuously through filter papers. Filter papers are evaluated weekly by gross beta and gross alpha counting techniques and composited quarterly by system for specific radionuclide analysis during normal operations. More frequent detailed analyses are performed if concentrations in the environment are significantly above normal. Airborne radioactive iodine is monitored in the immediate environment (HP-31 through HP-39) by passing air continuously through cartridges containing activated charcoal. Charcoal cartridges are evaluated for radioactive iodine by gamma spectrometry.

Data on the concentrations of radioactive materials in air and the quantities of radioactive materials released to the atmosphere in the Oak Ridge and surrounding areas are given in Tables 1 through 5.

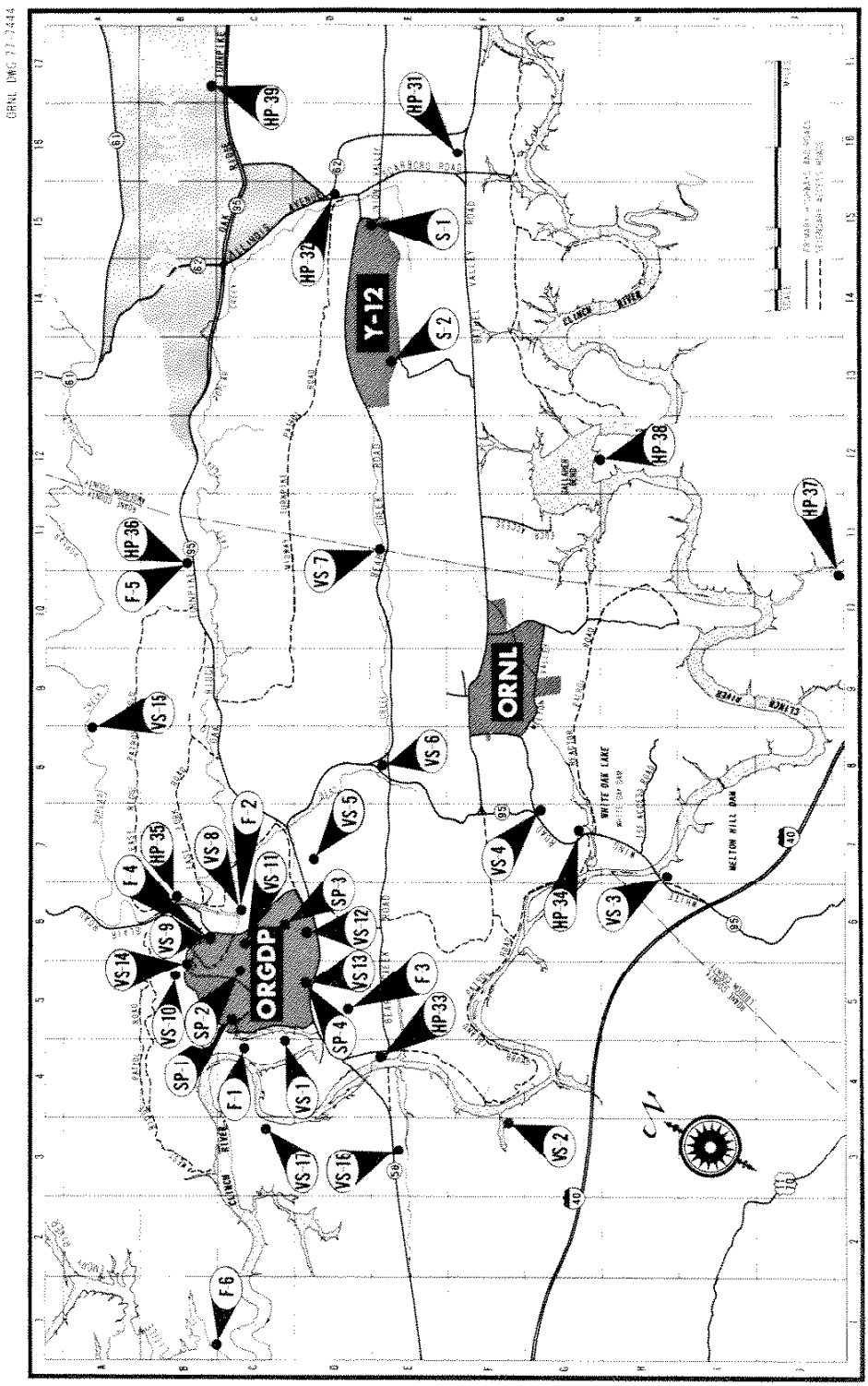

Figure 1
AIR, VEGETATION, AND SOIL SAMPLING LOCATIONS

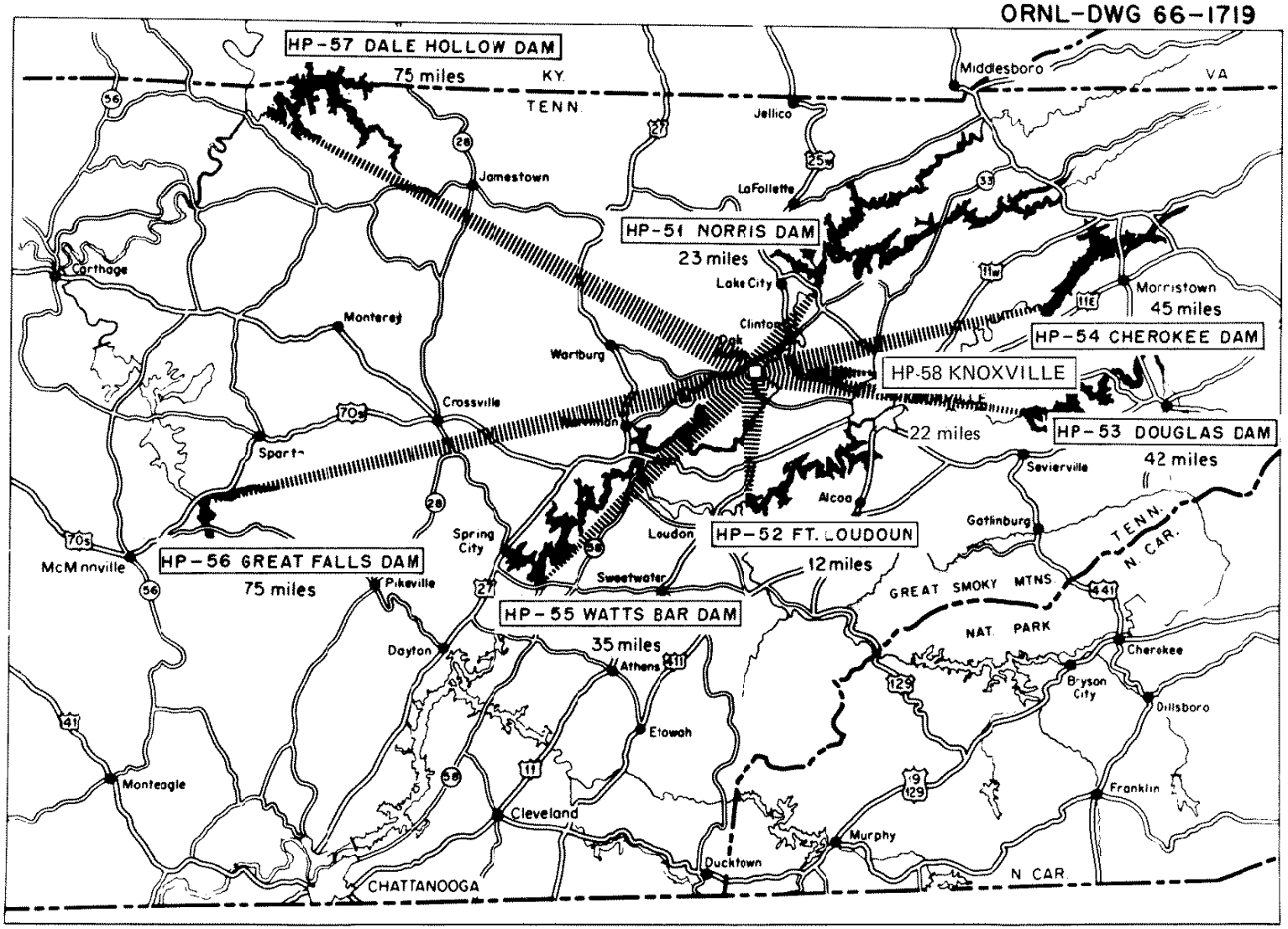

Figure 2
STATION SITES FOR REMOTE AIR MONITORING SYSTEM

The average gross beta concentrations of radioactivity from particulates in air measured by both the perimeter and remote monitoring systems were 0.03 percent of the applicable concentration guide (CG) as specified in the ERDA Manual, Appendix 0524[1] for individuals in uncontrolled areas (Table 1). These average values measured for 1976 are lower than those for 1975 by approximately 25 percent.

The average gross alpha concentrations in the perimeter and remote monitoring systems were 0.04 and 0.02 percent, respectively, of the CG for a mixture of uranium isotopes (Table 2). The elevated concentrations experienced at Stations HP-35 and HP-36 resulted from higher than normal releases from the Oak Ridge Gaseous Diffusion Plant during part of the year due to a minor operational problem with pollution control equipment on the purge cascade. Modifications to pollution control equipment were expeditiously effected following identification of the problem.

The results of specific radionuclide analyses of composited filters are given in Table 3. The higher levels noted for uranium in the perimeter system are attributed to airborne releases from uranium enrichment and processing operations at ORGDP and the Y-12 Plant. The environmental concentrations tabulated are all at least a thousand times less than the applicable ERDA concentration guides for the radionuclides detected.

The concentration of ^{131}I as measured by the perimeter air monitoring system was <0.01 percent of the inhalation concentration guide for individuals in uncontrolled areas (Table 4).

While some radioactivity was released to the atmosphere (Table 5), measurements in the Oak Ridge area show that environmental levels were well below established standards.

Nonradioactive – Environmental air samples are taken for the determination of fluorides, suspended particulates, and sulfur dioxide.

Sampling locations for fluorides are indicated by F-1 through F-6, Figure 1. Concentrations in the ppb range are determined by collecting 24-hour samples in caustic solution in a Boyce-Thompson type sampler on an eight day frequency and analyzing the resulting solution by specific ion electrode.

Suspended particulates are measured at locations SP-1 through SP-4, Figure 1. The method for the determination of suspended particulates is the high volume method recommended by EPA. Particulates are collected by drawing air through weighed filter paper. The filter paper is allowed to equilibrate in a humidity controlled atmosphere and the filter is reweighed. From the weight of particulates, the sampling time, and the air flow rate, the particulate concentration in micrograms per cubic meter is calculated. The sampling period is 24 hours.

Two continuous monitoring stations (S-1 and S-2) were installed in the Y-12 Plant area for the measurement of ambient concentrations of sulfur dioxide. Each station consists of a flame photometric continuous analyzer and recorder with associated equipment located in a temperature controlled shelter. Sulfur dioxide concentrations are interpreted on an hourly basis and averaged for 24 hour, monthly, and annual periods. Equipment failure at one of

these stations plus the potential for similar failure at the other resulted in the stations being inactivated for the first seven months of the year until problems could be corrected.

Air monitoring data for fluorides, suspended particulates, and sulfur dioxide are presented in Tables 6 through 8. These data indicate that average environmental concentrations of particulates and sulfur dioxide were in compliance with applicable standards[2] during calendar year 1976. Fluoride concentrations exceeded the standards on several occasions. However, the high concentration of fluorides at Station F-6, which is five miles from Oak Ridge operations, indicates that the ambient fluoride background levels may be generally high in the area and makes interpretation of the incremental addition from Oak Ridge operations somewhat difficult. Several abatement projects have been completed in the last year to reduce fluoride emissions. These facilities should become operational during 1977.

Steam plant operations were in compliance with State emission limits except for the steam plant at ORGDP. The particulate emissions for the ORGDP steam plant do not comply with Tennessee standards when coal is burned. The particulate standard states that no more than 0.2 pound of particulates may be discharged for each one million Btu's of heat input. The latest measurement of the ORGDP steam plant effluent indicates that 0.8 to 1.0 pound of particulates is released for each one million Btu's input when coal is burned. Electrostatic precipitators for removal of particulate matter are expected to be installed and operable by late 1977.

External Gamma Radiation Monitoring

External gamma radiation background measurements are made routinely at eight of the perimeter air monitoring stations, at one station located near Melton Hill Dam, and at the remote monitoring stations using calcium fluoride thermoluminescent dosimeters suspended one meter above the ground. Dosimeters at the perimeter stations and Melton Hill Dam are collected and analyzed monthly. Those at the remote stations are collected and analyzed semiannually.

Data on the average external gamma radiation background are given in Table 9. The slight difference between the average levels in the perimeter and remote environs is considered to be within the variation in background levels normally experienced in East Tennessee which is dependent upon elevation, topography, and geological character of the surrounding soil.[3]

External gamma radiation measurements were performed along the stream course of East Fork Poplar Creek to evaluate radioactivity which might be contained in the sediments as a result of effluent releases. Additionally, measurements were made along the bank of the Clinch River from the mouth of White Oak Creek several hundred yards downstream to evaluate gamma radiation levels resulting from effluent releases and sky shine from an experimental ^{137}Cs plot located near the river bank. Measurements were made using scintillation detectors and/or thermoluminescent dosimeters suspended one meter above the ground surface. The average background level determined at the perimeter stations was subtracted from the measured gamma radiation levels to determine the incremental increases resulting from plant operations.

Gamma levels along East Fork Poplar Creek ranged from 0 to 12 μR/hr above background. The external gamma radiation levels along the bank of the Clinch River ranged from 4 to 30 μR/hr above background. Potential doses to individuals in the environment from these elevated gamma radiation levels were evaluated and are included, where significant, in the dose assessment section of the report.

Water Monitoring

Radioactive — Water samples are collected in the Clinch River for radioactivity analyses at Melton Hill Dam (Station C-2) 2.3 miles above White Oak Creek outfall, at the ORGDP sanitary water intake (Station C-3) 6.3 miles downstream from the entry of White Oak Creek, at the ORGDP recirculating water intake (Station C-4) downstream from the Poplar Creek outfall, near Brashear Island (Station C-6), and at Center's Ferry (Station C-5) near Kingston, Tennessee, Figure 3. Samples are collected continuously at all locations except for Station C-5 and Station C-6 which are collected on a daily and monthly grab-sample basis, respectively. Samples are composited for monthly or quarterly analysis depending upon location.

Water samples also are collected for radioactivity analyses at White Oak Dam (Station W-1), at the outlet of New Hope Pond on East Fork Poplar Creek (Station E-1), in Bear Creek (Station B-1), and in Poplar Creek (Stations P-1 and P-2), Figure 3. The samples collected at Stations W-1, E-1, and B-1 are continuous proportional samples. Twenty-four hour composite samples are collected at Stations P-1 and P-2 on a weekly basis. All samples are composited for monthly analysis.

The concentrations of fission product radionuclides present in detectably significant amounts are determined by specific radionuclide analysis and gamma spectrometry. Uranium analysis is by the fluorometric method. Transuranic alpha emitters are determined by ion exchange and alpha range analysis. The concentration of each radionuclide is compared with its respective concentration guide (CG) value as specified in the ERDA Manual, Appendix 0524, and percent of concentration guide for a known mixture of radionuclides is calculated in accordance with the method given in Appendix 0524.

Data on the concentrations of fission product radionuclides, uranium in surface streams, and the quantities of radioactivity released to surface streams are given in Tables 10 through 12. The average concentrations of specific radionuclides in offsite surface streams at all points of measurement were less than 1 percent of the applicable concentration guides for uncontrolled areas.

The average concentration of transuranic alpha emitters in the Clinch River at Clinch River Mile (CRM) 20.8 resulting from effluent releases was 3×10^{-12} μCi/ml, which is less than 0.01 percent of the concentration guide for water containing a known mixture of radionuclides.*

Nonradioactive — Water samples are collected for the analysis of nonradioactive substances at the same locations discussed previously under radioactive water sampling. All samples are composited for monthly analysis. Samples are analysed for a variety of water quality

*CG determined by method given in ERDA Manual, Appendix 0524 for determining the concentration guide for a known mixture of radionuclides.

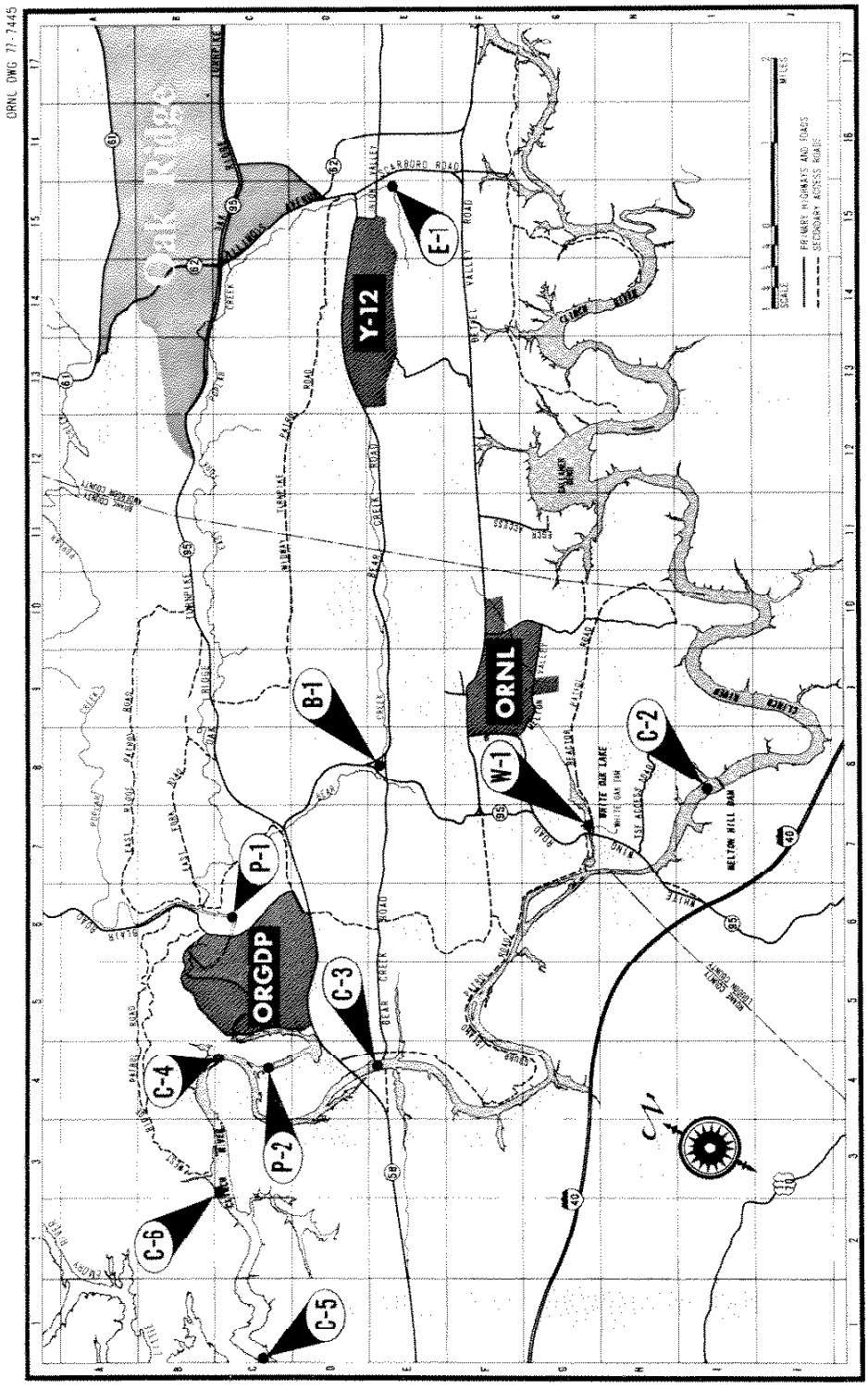

Figure 3
STREAM MONITORING LOCATIONS

parameters related to process release potential and background information needs by analytical procedures recommended by the Environmental Protection Agency.[4]

Data on chemical concentrations in surface streams are given in Tables 13 through 21. The average concentrations of all substances analyzed were in compliance with Tennessee stream guidelines[5] except for fluorides at Station E-1 and nitrates at Station B-1, which were 100 percent of the guidelines. An acid waste neutralization and recycle facility was placed on-stream at the Y-12 Plant in October 1976 which should reduce nitrate releases to the environment by approximately 90 percent.

Dissolved oxygen (DO) and pH measurements are made continuously at White Oak Dam (Station W-1). Measurements of dissolved oxygen and pH at White Oak Dam indicated DO values ranging from 4 to $>$ 15 mg/l and pH values from 6.7 to 11.3. The dissolved oxygen was out of compliance with the State standard[6] on 9 occasions and the pH was out of compliance with the State standard on 58 separate occasions. Noncompliance of DO and pH at White Oak Dam was attributed to natural causes.

National Pollutant Discharge Elimination System (NPDES) permits were issued by the Environmental Protection Agency (EPA) for each of the Oak Ridge facilities operated by Union Carbide Corporation - Nuclear Division in 1975. The permits established a number of discharge locations at each installation and listed specific concentration limits and/or monitoring requirements for a number of parameters at each discharge location. Table 22 contains the discharge locations at each installation, the parameters at each location for which limits have been established, the permit limits for each parameter, and the percentage compliance experienced. A number of pollution control projects are under way to minimize the frequency of noncompliance.

Food Sources

Milk Monitoring — Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from 11 sampling stations located within a radius of 50 miles of Oak Ridge. Samples are normally collected weekly at each of seven stations located near the Oak Ridge area; however, no milk was available from Station 7 during 1976. Four stations, located more remotely with respect to Oak Ridge operations, are sampled at a rate of one station each week. Milk sampling locations for all stations are shown in Figures 4 and 5. Samples are analyzed by ion exchange and gamma spectrometry; results are compared to intake guides specified by the Federal Radiation Council (FRC).[7]

The average concentrations of ^{131}I and ^{90}Sr in raw milk are given in Tables 23 and 24, respectively. If one assumes the average intake of milk per individual to be one liter per day, the average concentration of ^{131}I in the milk in both the immediate environs of the Oak Ridge area and in the environs remote from Oak Ridge were within FRC Range I, except for Station 51 which was in FRC Range II. The increased concentration at Station 51 was attributed to weapons testing fallout. The average concentrations of ^{90}Sr in milk from both the immediate and remote environs were within the FRC Range I. The concentration of ^{90}Sr in milk is different at different locations; part of the variation has been found to result from differences in farming methods used at different farms. Pastureland

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SG

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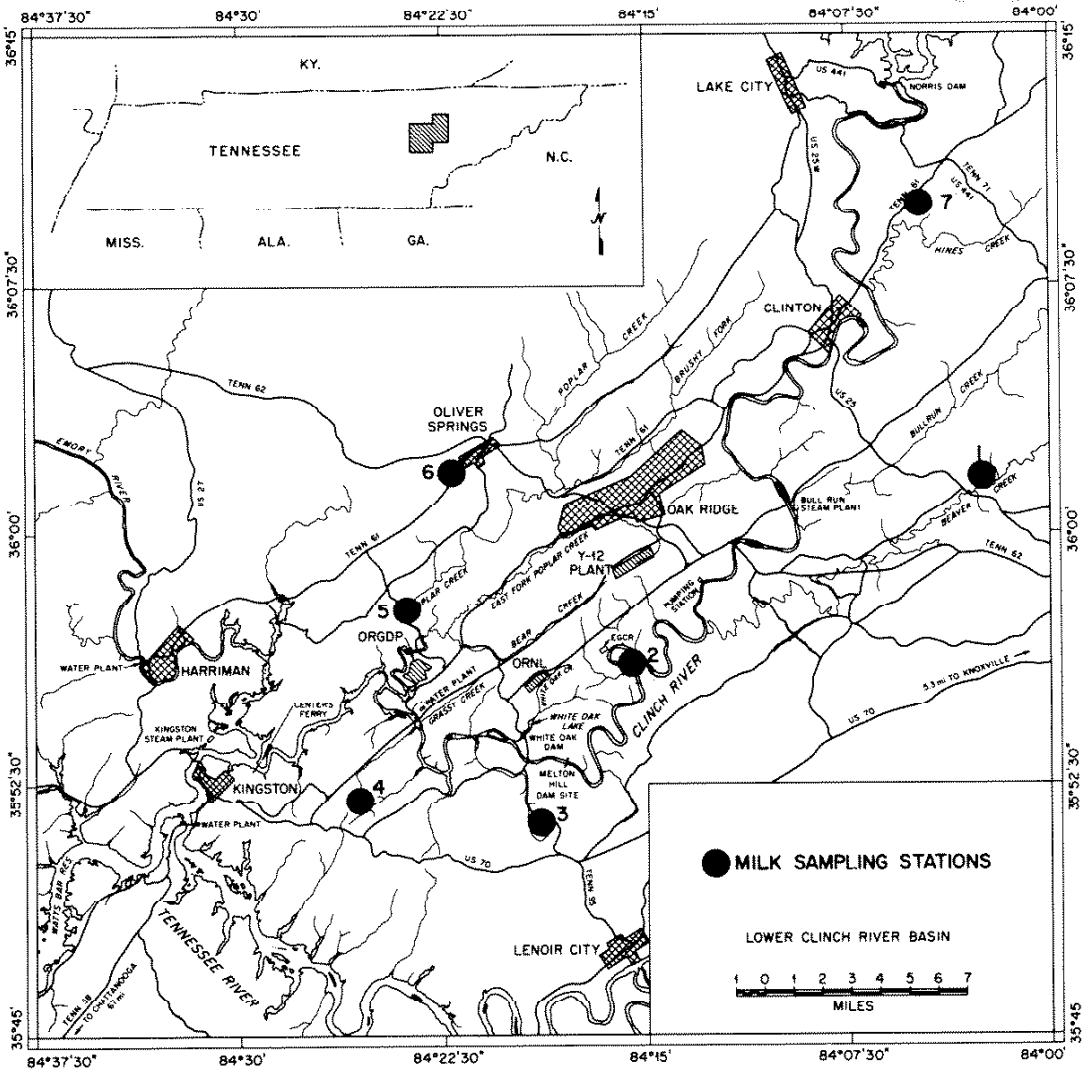

Figure 4
IMMEDIATE ENVIRONS MILK SAMPLING LOCATIONS

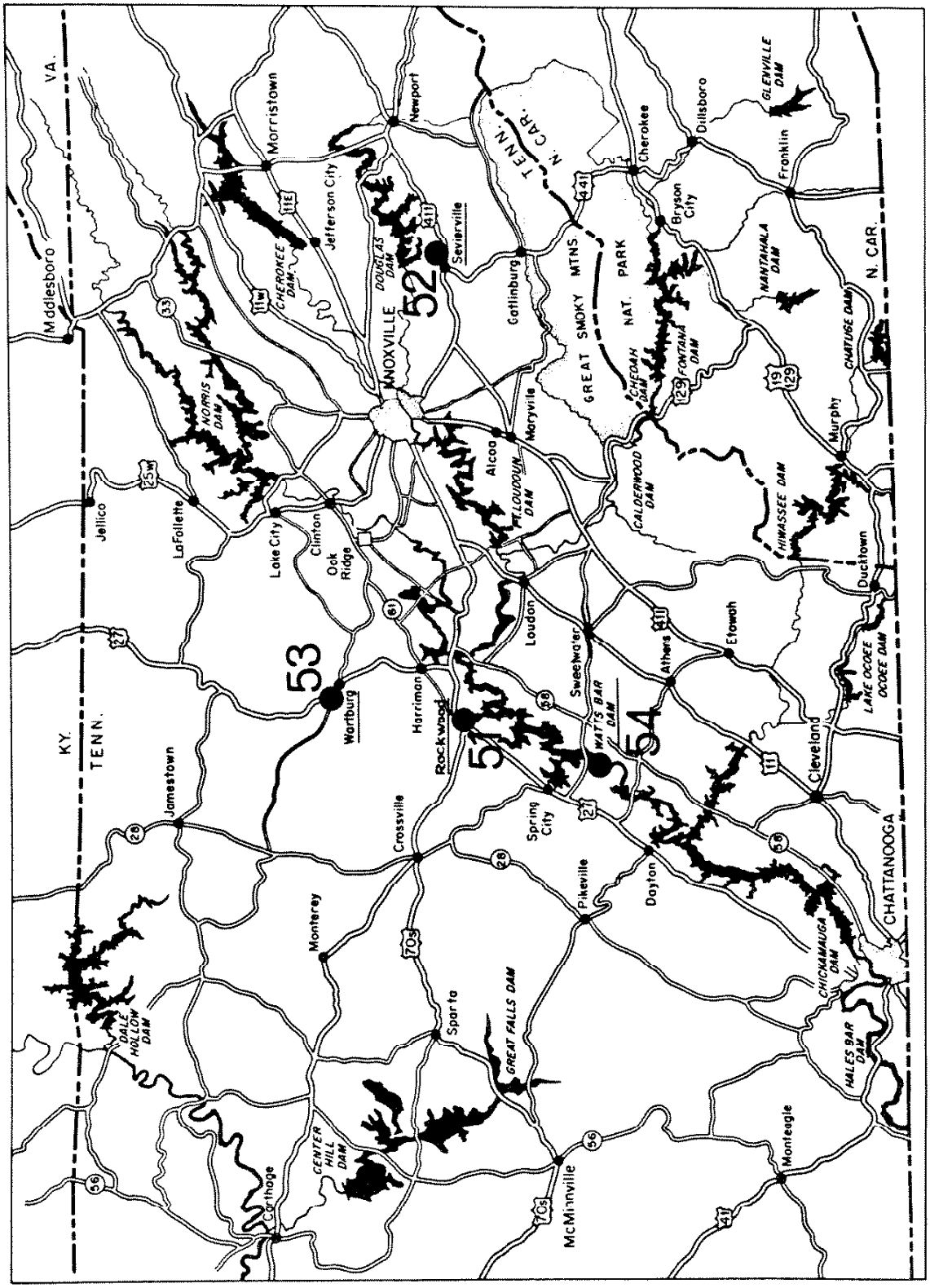

Figure 5
REMOTE ENVIRONS MILK SAMPLING LOCATIONS

that is not fertilized and is overgrazed (a not too uncommon practice in this area) apparently results in a higher than normal concentration of ^{90}Sr in milk from cows pastured on this land.

Fish Sampling – Several species of fish which are commonly caught are taken from the Clinch River and Melton Hill Lake during the spring and summer of each year. The scales, head, and entrails are removed from the fish before ashing. Ten fish of each species are composited for each sample, and the samples are analyzed by gamma spectrometry and radiochemical techniques for the critical radionuclides which may contribute significantly to the potential radiation dose to man.

Data on the concentrations of radionuclides in Clinch River and Melton Hill Lake fish are given in Table 25. Consumption of 37 pounds of white crappie per year[8] taken from the river near White Oak Creek outfall results in approximately 8 percent of the maximum permissible intake, which represents the highest dose potential to the public from fish consumption. The maximum permissible intake is calculated to be equal to a daily intake of 2.2 liters of water, over a period of one year, containing the concentration guide of the radionuclides in question.

Vegetation and Soil

Vegetation – Samples of pine needles and grass are collected semiannually from 17 areas (Stations VS-1 through VS-17, Figure 1) and analyzed for uranium and fluoride content. Fluorometric analysis is used for the determination of uranium and colorimetric analysis is used for the determination of fluorides.

Data on the uranium and fluoride content in vegetation are presented in Table 26. The fluoride concentration in grass at all sampling points was below the 30 ppm level considered to produce no adverse effects when ingested by cattle.[9] Uranium concentrations were below levels of environmental concern.

Soil – Soil samples are collected annually from near the Perimeter and the Remote Air Monitoring Stations, Figure 1 and 2. Nine samples, approximately three inches in diameter and one centimeter thick, are collected in a one-square-meter area at each location, composited, and analyzed by gamma spectrometry and radiochemical techniques for variety of radionuclides.

Data on specific radionuclide concentrations in soil are given in Table 27. The plutonium concentrations found were comparable to the value of 0.05 pCi/g considered to be a representative concentration of plutonium in U.S. surface soil.[10]

Sediments

A sediment sampling program, containing 8 sampling locations, was initiated in 1975 to determine the concentrations of various metallic ions in the sediment of Poplar Creek. This program was expanded in 1976 to a total of 17 sampling locations, including one sampling location in the Clinch River above the Poplar Creek outfall and 16 sampling

locations in Poplar Creek. The 16 sampling locations in Poplar Creek are at various intervals along the stream course, beginning upstream of the ORGDP discharge points and extending to the mouth of the creek. Samples are collected twice during the year and analyzed by atomic absorption.

Evaluation of the ORGDP impact on sediment concentrations is complicated by the fact that Poplar Creek at ORGDP is, during much of the year, a part of Watts Bar Reservoir and thus, along that portion of the stream, simulates a settling basin for both Poplar Creek and East Fork Poplar Creek. A meaningful interpretation of the data cannot currently be made due to the relatively short time period over which the data have been collected. Stream sediment data are presented in Table 28.

Calculation of Potential Radiation Dose to the Public

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations.

The site boundary for the Oak Ridge complex was defined as the perimeter of the ERDA-controlled area.

Gaseous effluents are discharged from several locations within each of the three Oak Ridge facilities. For calculational purposes, the gaseous discharges are assumed to occur from only one vent from each site. Since the release points at ORGDP and the Y-12 Plant do not physically approximate an elevated stack, their discharges are assumed to be from ground level; releases from ORNL are through elevated stacks. The meteorological data collected at the ORNL site were used for dispersion calculations. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 50 miles from the Oak Ridge facilities with the Gaussian plume model developed by Pasquill[11] and Gifford[12] incorporated in a computer program.[13] The concentration has been averaged over the crosswind direction to give the estimated ground level concentration downwind of the source of emission.[14] The deposition velocities used in the calculations were 10^{-6} cm/sec for krypton and xenon, 10^{-3} cm/sec for tritium, and 1 cm/sec for particulates and iodine.[15]

Potential pathways of exposure to man from radioactive effluents released by the Oak Ridge operations that are considered in the dose estimates are presented in Figure 6. The pathways shown in the figure are not exhaustive, but they include the principal pathways of exposure based on experience.

Exposures to radionuclides that originate in the effluents released from the Oak Ridge facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection,[16-21] other recognized literature on radiation protection,[22-24] and computer programs incorporating some of these models and data.[25,26] Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until removed

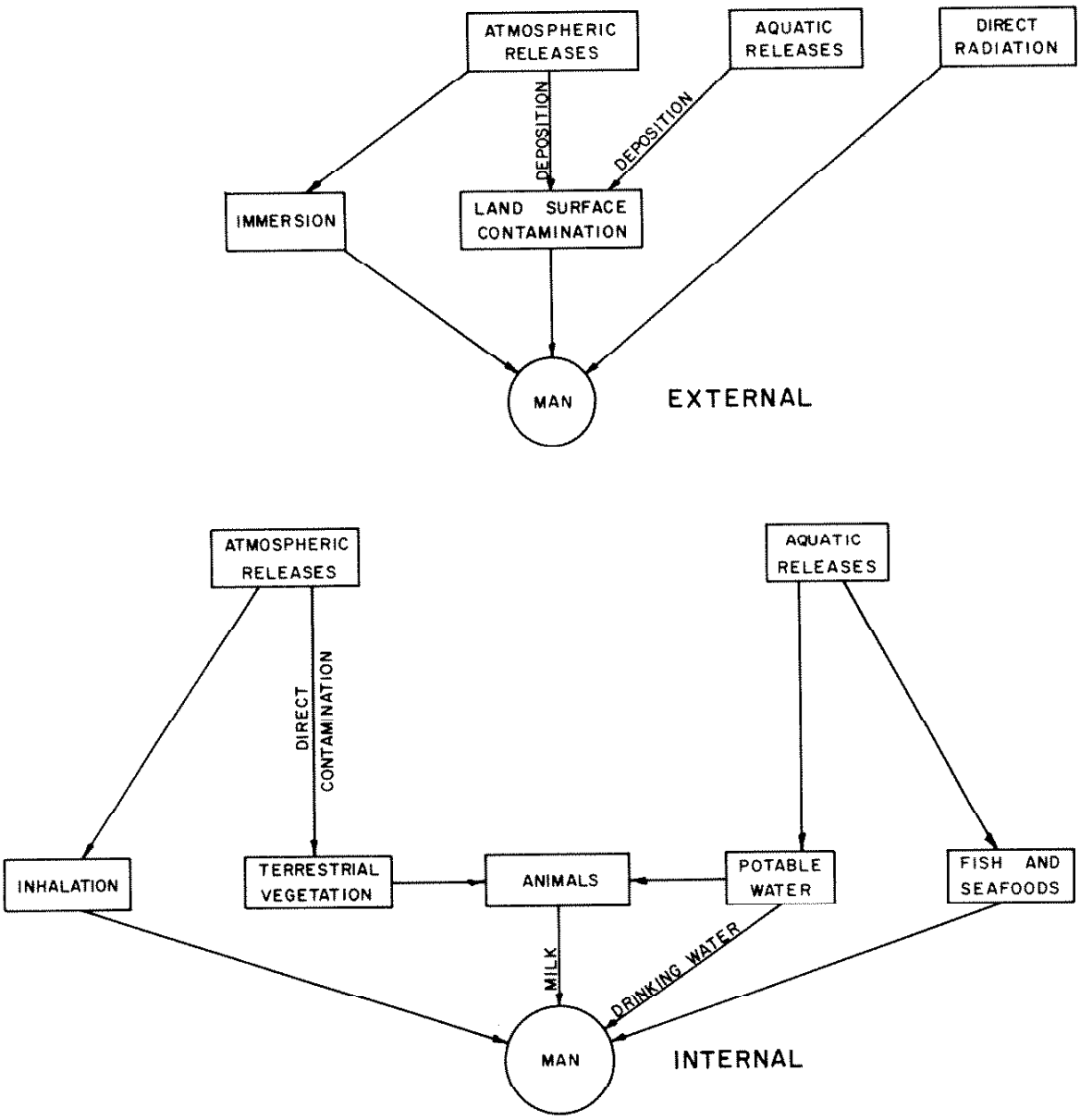

Figure 6

EXPOSURE PATHWAYS

by processes of metabolism and radioactive decay; thus the estimates for internal dose are called "dose commitments;" they are obtained by integrating over the assumed remaining lifetime (50 years) of the exposed individual.

The radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal, but they may vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, and gastrointestinal tract were considered for pathways of exposure based on parameters applicable to an average adult.[16, 21] The population dose estimate (in man-rem) is the sum of the total body doses to exposed individuals within a 50-mile radius of the Oak Ridge facilities.

Maximum Potential Exposure at the Site Boundary — The point of maximum potential exposure ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky-shine" from the plot. A maximum potential total body exposure of 260 mrem/yr was calculated for this location assuming that an individual remained at this point for 24 hours/day for the entire year. The calculated maximum potential exposure is 52 percent of the allowable standard.[1] This is an atypical exposure location and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total body dose to a "hypothetical maximum exposed individual" at the same location was calculated using a more realistic residence time of 240 hours/yr. The calculated dose under these conditions was 7.2 mrem/yr which is 1.4 percent of the allowable standard[1] and represents what is considered a probable upper limit of exposure.

A more probable exposure potential might be considered to occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and is based on an inhalation rate for the average adult of 2×10^4 liters/day. The calculated dose commitments at this location were 7.4 millirem to the lung (the critical organ) and 0.4 millirem to the total body; uranium -234 is the important radionuclide contributing to this dose. These levels are 0.5 percent and 0.08 percent, respectively, of the allowable annual standard.

The most important contribution to dose from radioactivity within the food-chain is by the atmosphere-pasture-cow-milk food-chain pathway. Measurements of the two principal radionuclides entering into this pathway, ^{131}I and ^{90}Sr (see Table 23 and 24), however, indicated that milk concentrations in the immediate Oak Ridge environs were less than, or not significantly different from, the concentrations measured in the environs remote from Oak Ridge; thus, dose commitments in this exposure pathway from facility effluents during 1976 were considered to be not significantly different from zero.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located approximately 16 miles downstream at Kingston, Tennessee. The intake to the

water filtration plant is located on the Tennessee River approximately one-half mile upstream from the confluence of the Clinch and Tennessee Rivers. Normally, Tennessee River water is used for the Kingston water supply but under certain conditions of power generation, backflow can occur. Under backflow conditions, Clinch River water may move upstream in the Tennessee River and be used as the source of water for the Kingston filtration plant. It is estimated that these conditions would prevail a maximum of 20 percent of the time. Measurements of untreated river water samples at Kingston (see Table 10) indicate that the maximum dose commitment resulting from the ingestion of 20 percent of the daily adult requirement (about two liters per day) is 0.3 millirem to the bone; ^{90}Sr present in the waters upstream of the Oak Ridge facilities accounts for 33 percent (0.1 millirem) of this dose. The resulting 0.2 millirem is about 0.01 percent of the annual standard.

Estimates of the 50-year dose commitment to an adult were calculated for consumption of 37 pounds of fish per year from the Clinch River. The consumption of 37 pounds[8] is about 2.5 times the national average fish consumption[27] and is used because of the popularity of fishing in East Tennessee. From the analysis of edible parts of the fish examined (see Table 25), the maximum organ dose commitment to an individual from eating 37 pounds of white crappie taken from the river near White Oak Creek outfall is estimated to be 150 millirem to the bone from ^{90}Sr. The maximum total body dose was calculated to be 4 millirem. These doses are 10 percent and 0.8 percent, respectively, of the allowable annual standard. Fish samples taken from Melton Hill Lake were analyzed to determine background conditions.

Summaries are given in Table 29 of the potential radiation doses to adult members of the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

Dose to the Population – The Oak Ridge population received the largest average individual total body dose as a population group. The maximum potential dose commitment to an Oak Ridge resident was calculated to be 7.4 millirem to the lung. This calculated dose is 0.5 percent of the allowable annual standard.[1] The average total body dose to an Oak Ridge resident was estimated to be 0.05 millirem as compared to approximately 100 mrem/yr from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.7 millirem.

The cumulative total body dose to the population within a 50-mile radius of the Oak Ridge facilities resulting from 1976 plant effluents was calculated to be 5.3 man-rem. This dose may be compared to an estimated 80,000 man-rem to the same population resulting from natural background radiation. About 30 percent of the collective dose from the effluents of the Oak Ridge facilities is estimated to be to the Oak Ridge population.

Table 1
CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Beta Activity of Particulates in Air
1976

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-13} μCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
		Perimeter Area[d]				
HP-31	Kerr Hollow Gate	53	1.9	0.03	0.22 ± 0.04	0.02
HP-32	Midway Gate	52	2.4	0.07	0.26 ± 0.05	0.03
HP-33	Gallaher Gate	53	2.6	0.01	0.27 ± 0.05	0.03
HP-34	White Oak Dam	53	2.1	0.09	0.25 ± 0.04	0.02
HP-35	Blair Gate	53	5.1	0.10	0.42 ± 0.10	0.04
HP-36	Turnpike Gate	52	4.1	0.07	0.36 ± 0.08	0.04
HP-37	Hickory Creek Bend	52	1.2	0.03	0.18 ± 0.03	0.02
HP-38	East of EGCR	53	2.8	0.09	0.30 ± 0.06	0.03
HP-39	Townsite	53	2.9	0.11	0.31 ± 0.06	0.03
Average					0.29 ± 0.02	0.03
		Remote Area[e]				
HP-51	Norris Dam	53	2.4	<0.01	<0.18 ± 0.04	<0.02
HP-52	Loudoun Dam	53	1.6	0.02	0.25 ± 0.05	0.02
HP-53	Douglas Dam	53	5.2	0.01	0.34 ± 0.10	0.03
HP-54	Cherokee Dam	53	7.6	0.05	0.42 ± 0.14	0.04
HP-55	Watts Bar Dam	53	2.0	0.01	0.20 ± 0.04	0.02
HP-56	Great Falls Dam	53	2.3	0.04	0.21 ± 0.04	0.02
HP-57	Dale Hollow Dam	53	1.2	0.07	0.22 ± 0.03	0.02
HP-58	Knoxville	50	2.7	0.05	0.25 ± 0.06	0.02
Average					<0.26 ± 0.03	<0.03

[a] Maximum weekly average concentration.

[b] Minimum weekly average concentration — minimum detectable level is 5×10^{-6} μCi per sample.

[c] CG is 10^{-10} μCi/ml for unidentified radionuclides (ERDA Manual, Appendix 0524, Annex A, Table II).

[d] See Figure 1.

[e] See Figure 2.

Table 2
CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Alpha Activity of Particulates in Air
1976

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-15} μCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
			Perimeter Area[d]			
HP-31	Kerr Hollow Gate	53	4.7	0.5	1.1 ± 0.11	0.03
HP-32	Midway Gate	52	4.5	0.6	1.7 ± 0.15	0.04
HP-33	Gallaher Gate	53	7.9	0.5	1.7 ± 0.22	0.04
HP-34	White Oak Dam	53	3.5	0.5	1.2 ± 0.10	0.03
HP-35	Blair Gate	53	23	0.6	3.1 ± 0.68	0.08
HP-36	Turnpike Gate	52	19	0.5	2.2 ± 0.46	0.06
HP-37	Hickory Creek Bend	52	3.0	0.1	0.9 ± 0.08	0.02
HP-38	East of EGCR	53	7.2	0.5	1.1 ± 0.15	0.03
HP-39	Townsite	53	7.1	0.6	1.4 ± 0.18	0.04
Average					1.6 ± 0.10	0.04
			Remote Area[e]			
HP-51	Norris Dam	53	2.9	0.5	1.1 ± 0.09	0.03
HP-52	Loudoun Dam	53	2.5	0.5	0.9 ± 0.07	0.02
HP-53	Douglas Dam	53	4.4	0.3	1.0 ± 0.09	0.02
HP-54	Cherokee Dam	53	2.8	0.5	1.1 ± 0.09	0.03
HP-55	Watts Bar Dam	53	2.1	<0.1	<0.9 ± 0.07	<0.02
HP-56	Great Falls Dam	53	4.1	<0.1	<1.0 ± 0.09	<0.02
HP-57	Dale Hollow Dam	53	2.7	0.5	0.9 ± 0.07	0.02
HP-58	Knoxville	50	4.7	<0.1	<1.1 ± 0.12	<0.03
Average					<1.0 ± 0.03	<0.02

[a] Maximum weekly average concentration.

[b] Minimum weekly average concentration – minimum detectable level is 2×10^{-6} μCi per sample.

[c] CG is 40×10^{-13} μCi/ml for a mixture of uranium isotopes. (ERDA Manual, Appendix 0524, Annex A, Table II).

[d] See Figure 1.

[e] See Figure 2.

Table 3
CONTINUOUS AIR MONITORING DATA
Specific Radionuclides in Air
(Composite Samples)
1976
Units of 10^{-15} μCi/ml

RADIONUCLIDE	PERIMETER STATIONS 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average	REMOTE STATIONS 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average
^{7}Be	120	180	160	104	140	130	162	149	93	134
^{60}Co	ND*	0.13	ND	ND	$\leq$ 0.13	0.055	ND	ND	ND	$\leq$ 0.055
^{90}Sr	0.91	1.2	0.48	0.47	0.77	0.48	1.0	0.30	0.41	0.55
^{95}Zr	0.07	$<$ 0.08	ND	15	$\leq$ 5.05	0.055	$<$ 0.088	ND	17	$\leq$ 5.7
^{95}Nb	0.07	$<$ 0.08	ND	21	$\leq$ 7.1	0.055	$<$ 0.088	ND	24	$\leq$ 8.05
^{103}Ru	ND	ND	ND	19	$\leq$ 19	ND	ND	ND	18	$\leq$ 18
^{106}Ru	0.88	1.5	0.27	ND	0.88	0.59	1.1	0.39	ND	$\leq$ 0.76
^{125}Sb	0.014	0.43	ND	ND	0.22	0.023	0.33	0.19	ND	$\leq$ 0.18
^{137}Cs	0.46	0.85	0.43	0.47	0.55	0.43	0.74	0.33	0.36	0.47
^{144}Ce	1.0	2.2	0.75	5.7	2.4	1.6	2.0	0.70	5.7	2.5
^{228}Th	0.022	0.021	0.0058	0.0050	0.014	0.028	0.024	0.0014	0.0045	0.014
^{230}Th	0.029	0.018	0.029	0.019	0.024	0.026	0.016	0.011	0.016	0.017
^{232}Th	0.011	0.013	0.015	0.010	0.012	0.010	0.0092	0.0077	0.0082	0.0088
^{234}U	2.6	2.5	4.4	0.90	2.6	0.095	0.11	0.16	0.093	0.115
^{235}U	0.11	0.11	0.18	0.012	0.10	0.0086	0.019	0.0059	0.0026	0.0090
^{238}U	0.52	0.54	0.99	0.48	0.63	0.028	0.076	0.059	0.075	0.059
^{238}Pu	0.00042	0.00063	0.0012	0.0027	0.0012	0.000052	0.00047	0.00024	0.0025	0.00082
^{239}Pu	0.0046	0.0090	0.016	0.0057	0.0088	0.0068	0.0088	0.0067	0.0042	0.0066
^{140}Ba	ND	ND	ND	7.8	$\leq$ 7.8	ND	ND	ND	17	$\leq$ 17
^{140}La	ND	ND	ND	13	$\leq$ 13.0	ND	ND	ND	11	$\leq$ 11
^{141}Ce	ND	ND	ND	22	$\leq$ 22.0	ND	ND	ND	23	$\leq$ 23

*NOT DETECTABLE.

Table 4
CONCENTRATION OF ^{131}I IN AIR AS MEASURED
BY THE PERIMETER AIR MONITORING STATIONS[a]
1976

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-14} μCi/ml			% CG[d]
			MAXIMUM[b]	MINIMUM[c]	AVERAGE	
HP-31	Kerr Hollow Gate	53	3.00	0.29	0.78	<0.01
HP-32	Midway Gate	52	4.64	0.36	1.0	0.01
HP-33	Gallaher Gate	53	4.60	0.23	0.77	<0.01
HP-34	White Oak Dam	53	2.45	<0.20	<0.77	<0.01
HP-35	Blair Gate	53	2.42	0.26	0.76	<0.01
HP-36	Turnpike Gate	53	4.42	0.28	0.93	<0.01
HP-37	Hickory Creek Bend	52	2.09	0.18	0.91	<0.01
HP-38	East of EGCR	53	2.33	0.32	0.81	<0.01
HP-39	Townsite	53	4.87	0.21	0.79	<0.01
Average					<0.84	<0.01

[a] See Figure 1.

[b] Maximum weekly average concentration.

[c] Minimum weekly average concentration – minimum detectable amount of ^{131}I is 3×10^{-6} μCi per sample.

[d] CG is 1×10^{-10} μCi/ml (ERDA Manual, Appendix 0524, Annex A, Table II).

Table 5

DISCHARGES OF RADIOACTIVITY TO THE ATMOSPHERE

1976

RADIONUCLIDE	CURIES DISCHARGED
Uranium[a]	0.25
^{131}I	1.3
^{3}H	< 1,000
^{133}Xe[b]	<56,000
^{85}Kr[b]	<11,500
^{99}Tc	6.8
Pu[c]	4×10^{-6}
Alpha[d]	2×10^{-8}

a Uranium of varying enrichments – curie quantities calculated using the appropriate specific activity for material released.

b Upper limit values based on direct radiation instrument measurements in the stack gas stream and an assumed mixture of noble gases.

c Mixture of all isotopes.

d Unidentified alpha.

Table 6

AIR MONITORING DATA – FLUORIDES

1976

LOCATION[a]	NUMBER OF SAMPLES[b]	MAXIMUM 24-HOUR SAMPLE (ppb)	TIMES 24-HOUR STANDARD[c] EXCEEDED	MAXIMUM 30-DAY AVERAGE (ppb)	TIMES 30-DAY STANDARD[c] EXCEEDED	ANNUAL AVERAGE (ppb)
F-1	48	13.0	1	<3.1	5	<0.9 ± 0.6
F-2	47	9.8	5	3.2	5	<1.0 ± 0.6
F-3	48	3.5	0	1.7	7	<0.9 ± 0.2
F-4	45	22.0	4	6.6	4	<1.2 ± 1.1
F-5	51	12.0	1	2.8	3	<0.7 ± 0.5
F-6[d]	51	10.9	2	2.9	5	<0.9 ± 0.5

[a] See Figure 1.

[b] Sample duration – 24 hours.

[c] Tennessee Air Pollution Control Regulations –

4.5 ppb for 12 hour averaging interval
3.5 ppb for 24 hour averaging interval
2.0 ppb for 7 day averaging interval
1.5 ppb for 30 day averaging interval

All values are maximum – not to be exceeded more than once per year.

[d] Station F-6 is approximately 5 miles from ORGDP upwind of the predominant prevailing wind direction, thus may be considered representative of general ambient background concentration.

NOTE: Data not amenable to comparison with 12 hour and 7 day standards.

Table 7

AIR MONITORING DATA – SUSPENDED PARTICULATES

1976

LOCATION[a]	NUMBER OF SAMPLES	CONCENTRATION, $\mu g/m^3$			% STD.[b]
		MAXIMUM	MINIMUM	AVERAGE	
SP-1	28	90.0	3.0	38.8 ± 7.0	52
SP-2	28	129.4	1.8	39.1 ± 9.3	52
SP-3	26	54.8	3.6	34.9 ± 6.0	47
SP-4	24	70.6	2.7	37.4 ± 6.7	50

[a] See Figure 1.

[b] Tennessee Air Pollution Control Regulations – Primary standard based on annual geometric mean is 75.0 $\mu g/m^3$.

Table 8
SULFUR DIOXIDE MONITORING DATA
1976

MONTH	MAXIMUM 24 HR. AVERAGE (PPM)		MONTHLY AVERAGE (PPM)	
	STATION S-1	STATION S-2	STATION S-1	STATION S-2
January		(Instrument inoperable)		
February		(Instrument inoperable)		
March		(Instrument inoperable)		
April		(Instrument inoperable)		
May		(Instrument inoperable)		
June		(Instrument inoperable)		
July		(Instrument inoperable)		
August	0.02	0.08	0.010	0.014
September	0.02	0.01	0.007	0.006
October	0.004	0.04	0.003	0.010
November	No Data	0.04	No Data	0.012
December	0.05	0.06	0.015	0.014
Annual Arithmetic Mean			0.009	0.011

Tennessee Ambient Standards
Maximum 24 hr. Average – 0.14 ppm
Annual Arithmetic Mean – 0.03 ppm
Minimum Detectable Limit – 0.005 ppm

Table 9
EXTERNAL GAMMA RADIATION MEASUREMENTS
1976

STATION NUMBER	LOCATION	BACKGROUND μR/hr	BACKGROUND mR/yr
	Perimeter Stations[a]		
HP-31	Kerr Hollow Gate	9.2	81
HP-32	Midway Gate	11	96
HP-33	Gallaher Gate	8.0	70
HP-35	Blair Gate	13	114
HP-36	Turnpike Gate	7.4	65
HP-37	Hickory Creek Bend	7.6	67
HP-38	East of EGCR	7.5	66
HP-39	Townsite	7.8	68
HP-40	Melton Hill	5.8	51
Average		8.6	75
	Remote Stations[b]		
HP-51	Norris Dam	6.5	57
HP-52	Loudoun Dam	9.0	79
HP-53	Douglas Dam	8.1	71
HP-54	Cherokee Dam	8.0	70
HP-55	Watts Bar Dam	7.9	69
HP-56	Great Falls Dam	6.9	60
HP-57	Dale Hollow Dam	9.8	86
HP-58	Knoxville	12	105
Average		8.5	74

[a] See Figure 1.

[b] See Figure 2.

Table 10
RADIONUCLIDES IN THE CLINCH RIVER
1976

LOCATION	NUMBER OF SAMPLES	RANGE	CONCENTRATION OF RADIONUCLIDES OF PRIMARY CONCERN UNITS OF 10^{-9} μCi/ml				% CG[c]
			^{90}Sr	^{137}Cs	^{106}Ru	^{3}H	
C-2 CRM 23.1[a]	4	Max.	0.09	0.05	0.18	770	
		Min.	0.05	<0.01	0.09	460	
		Avg.	0.08 ± 0.01	<0.02 ± 0.01	0.13 ± 0.02	610 ± 65	<0.05
CRM 20.8[b]	12	Max.	2.6	0.20	0.08	4000	
		Min.	0.17	0.01	0.01	320	
		Avg.	1.28 ± 0.23	0.07 ± 0.02	0.04 ± 0.01	2000 ± 317	0.51
C-3 CRM 14.5[a]	4	Max.	0.36	0.05	0.23	3500	
		Min.	0.14	0.01	0.09	590	
		Avg.	0.26 ± 0.05	0.03 ± 0.01	0.14 ± 0.03	1700 ± 655	0.15
C-5 CRM 4.5[a]	4	Max.	0.41	0.05	0.27	2600	
		Min.	0.14	0.01	0.09	1000	
		Avg.	0.24 ± 0.06	0.02 ± 0.01	0.15 ± 0.04	1900 ± 400	0.15

[a] Measured values in the Clinch River.

[b] Values given for this location are calculated values based on the concentrations measured at White Oak Dam (Station W-1) and the dilution afforded by the Clinch River. They do not include radioactive materials (e.g., fallout) that may enter the river upstream of White Oak Creek outfall (CRM 20.8). The yearly average dilution factor was 422.

[c] Most restrictive concentration guide for each isotope used for calculating percent concentration guide. The method for calculating percent of concentration guide for a known mixture of radionuclides is given in ERDA Manual, Appendix 0524, Annex A.(1)

Table 11

URANIUM CONCENTRATION IN SURFACE STREAMS

1976

STATION NUMBER[a]	LOCATION	NUMBER OF SAMPLES	UNITS OF 10^{-8} μCi/ml			% CG[b]
			MAXIMUM	MINIMUM	AVERAGE	
P-1	Poplar Creek	12	5.6	0.2	1.2 ± 1.0	<0.1
P-2	Poplar Creek	12	7.8	0.2	1.4 ± 1.3	<0.1
C-3	Clinch River	12	2.0	0.1	0.5 ± 0.4	<0.1
C-4	Clinch River	12	1.7	<0.1	<0.6 ± 0.3	<0.1
C-6	Clinch River	11	1.3	<0.2	<0.5 ± 0.2	<0.1
E-1	East Fork Poplar Creek	12	9.5	2.2	4.0 ± 1.5	0.1
B-1	Bear Creek	12	12.8	3.7	6.8 ± 1.6	0.2

[a] See Figure 3.

[b] CG is 3×10^{-5} μCi/ml for a mixture of uranium isotopes (ERDA Manual, Appendix 0524, Annex A, Table II).

Table 12
DISCHARGES OF RADIOACTIVITY TO SURFACE STREAMS
1976

RADIONUCLIDE	CURIES DISCHARGED
^{137}Cs	0.2
^{60}Co	0.9
^{3}H	7,420
^{131}I	0.03
^{106}Ru	0.2
^{90}Sr	4.5
^{99}Tc	24
Uranium[a]	1.3
^{232}Th	0.02
Transuranics[b]	0.01

[a] Uranium of varying enrichments -- curie quantities calculated using the appropriate specific activity for material released.

[b] Value based on gross transuranic alpha emitter analysis.

Table 13
CHEMICAL WATER QUALITY DATA – WHITE OAK DAM
(Location W-1, Figure 3)
1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	12	0.06	0.009	0.02 ± 0.02	0.05	40
Zn	12	0.07	0.02	0.03 ± 0.02	0.1	30
NO_3(N)	12	1.2	0.09	0.7 ± 0.3	10	7
Hg	12	0.0002	0.0001	0.0002 ± 0.00005	0.005	4

[a] Tennessee Stream Guidelines.

Table 14

CHEMICAL WATER QUALITY DATA – MELTON HILL DAM

(Location C-2, Figure 3)

1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	12	0.005	<0.0001	<0.003 ± 0.002	0.05	< 6
Zn	12	0.03	0.008	0.02 ± 0.02	0.1	20
NO_3(N)	12	0.4	0.01	0.1 ± 0.1	10	1
Hg	12	<0.0001	<0.0001	<0.0001	0.005	< 2

[a] Tennessee Stream Guidelines.

Table 15
CHEMICAL WATER QUALITY DATA – ORGDP SANITARY WATER PUMPING STATION
(Location C-3, Figure 3)
1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.04	< 0.005	< 0.008 ± 0.006	0.05	<16
CN	11	0.01	< 0.0005	< 0.003 ± 0.002	0.01	<30
NO_3(N)	11	0.6	0.2	0.5 ± 0.1	10	5
Pb	12	0.02	< 0.005	< 0.01 ± 0.003	0.05	<20
$SO_4^{=}$	11	31	15	21 ± 3	250	8
T.D.S.	11	287	113	169 ± 36	500	34
Zn	12	0.1	0.005	0.04 ± 0.02	0.1	40
F^-	11	< 0.1	< 0.1	< 0.1	1.0	<10
Hg	12	0.001	< 0.001	< 0.001	0.005	<20
Ni	12	0.04	< 0.005	< 0.015 ± 0.009	0.1	<15

[a] Tennessee Stream Guidelines.

Table 16

CHEMICAL WATER QUALITY DATA – ORGDP RECIRCULATING WATER PUMPING STATION

(Location C-4, Figure 3)

1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.05	< 0.005	< 0.01 ± 0.008	0.05	<20
CN	11	0.009	< 0.0005	< 0.003 ± 0.002	0.01	<30
NO_3(N)	11	0.6	0.1	0.4 ± 0.1	10	4
Pb	12	0.02	< 0.005	< 0.01 ± 0.003	0.05	<20
$SO_4^{=}$	11	29	16	20 ± 2	250	8
T.D.S.	11	317	125	191 ± 45	500	38
Zn	12	0.03	0.005	0.016 ± 0.005	0.1	16
F^-	11	< 0.1	< 0.1	< 0.1	1.0	<10
Hg	12	0.002	< 0.001	< 0.001 ± 0.0002	0.005	<20
Ni	12	0.05	< 0.005	< 0.012 ± 0.008	0.1	<12

[a] Tennessee Stream Guidelines.

Table 17
CHEMICAL WATER QUALITY DATA – CLINCH RIVER DOWNSTREAM OF ORGDP
(Location C-6, Figure 3)
1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	11	0.01	< 0.005	< 0.007 ± 0.002	0.05	<14
CN	11	0.009	< 0.0005	< 0.003 ± 0.002	0.01	<30
$NO_3(N)$	11	2.6	0.2	0.7 ± 0.5	10	7
Pb	11	0.02	< 0.005	< 0.01 ± 0.003	0.05	<20
$SO_4^{=}$	11	28	15	21 ± 3	250	8
T.D.S.	10	267	134	170 ± 32	500	34
Zn	11	0.4	0.01	0.06 ± 0.08	0.1	60
F^-	11	0.4	< 0.1	< 0.13 ± 0.006	1.0	<13
Hg	11	0.001	< 0.001	< 0.001	0.005	<20
Ni	11	0.08	< 0.005	< 0.02 ± 0.015	0.1	<20

[a] Tennessee Stream Guidelines.

Table 18

CHEMICAL WATER QUALITY DATA – EAST FORK POPLAR CREEK

(Location E-1, Figure 3)

1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.002	< 0.002	< 0.002	0.01	<20
Cl^-	12	14	< 1	< 11 ± 2	250	< 4
Cr	12	< 0.01	< 0.01	< 0.01	0.05	<20
F^-	12	1.9	0.6	1.0 ± 0.2	1.0	100
Hg	12	0.0008	< 0.0005	< 0.0005	0.005	<10
$NO_3(N)$	12	3.8	1.0	2.7 ± 0.6	10	27
Pb	12	0.02	< 0.01	< 0.01 ± 0.003	0.05	<20
$SO_4^=$	12	57	22	40 ± 7	250	16
T.D.S.	12	269	185	212 ± 16	500	42
Zn	11	0.05	< 0.02	< 0.02 ± 0.006	0.1	<20

[a] Tennessee Stream Guidelines.

Table 19
CHEMICAL WATER QUALITY DATA – BEAR CREEK
(Location B-1, Figure 3)
1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	<0.002	< 0.002	0.01	<20
Cl^-	12	12	4	6 ± 1	250	2
F^-	12	0.5	0.1	0.3 ± 0.007	1.0	30
$NO_3(N)$	12	23	3	10 ± 3	10	100
$SO_4^=$	12	26	8	13 ± 4	250	5
Zn	12	< 0.02	<0.02	< 0.02	0.1	<20

[a] Tennessee Stream Guidelines.

Table 20

CHEMICAL WATER QUALITY DATA – POPLAR CREEK ABOVE BLAIR BRIDGE

(Location P-1, Figure 3)

1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.01	< 0.005	< 0.006 ± 0.001	0.05	<12
CN	11	0.016	< 0.0005	< 0.004 ± 0.003	0.01	<40
$NO_3(N)$	11	2.6	0.2	1.3 ± 0.5	10	13
Pb	12	0.02	< 0.005	< 0.01 ± 0.003	0.05	<20
$SO_4^=$	11	43	12	30 ± 5	250	12
T.D.S.	11	451	133	251 ± 65	500	50
Zn	12	0.07	0.01	0.02 ± 0.01	0.1	20
F^-	11	0.4	< 0.1	< 0.2 ± 0.1	1.0	<20
Hg	12	0.002	< 0.001	< 0.001 ± 0.0002	0.005	<20
Ni	12	0.7	< 0.005	< 0.07 ± 0.13	0.1	<70

[a] Tennessee Stream Guidelines.

Table 21

CHEMICAL WATER QUALITY DATA – POPLAR CREEK NEAR CLINCH RIVER

(Location P-2, Figure 3)

1976

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.05	< 0.005	< 0.014 ± 0.01	0.05	<28
CN	11	0.018	< 0.0005	< 0.004 ± 0.004	0.01	<40
NO_3(N)	11	1.8	0.3	0.8 ± 0.3	10	8
Pb	12	0.04	< 0.005	< 0.02 ± 0.01	0.05	<40
$SO_4^{=}$	11	38	21	28 ± 4	250	11
T.D.S.	11	277	130	199 ± 33	500	40
Zn	12	0.15	0.02	0.06 ± 0.03	0.1	60
F^{-}	11	0.4	< 0.1	< 0.2 ± 0.1	1.0	<20
Hg	12	0.003	< 0.001	< 0.001 ± 0.0005	0.005	<20
Ni	12	0.1	< 0.005	< 0.02 ± 0.02	0.1	<20

[a] Tennessee Stream Guidelines.

Table 22
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) EXPERIENCE
1976

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
ORNL				
001				
(White Oak Creek)	Dissolved Solids	—	2000	100
	Oil and Grease	10	15	100
002				
(Melton Branch)	Chromium (total)	—	0.05	100
	Dissolved Solids		2000	100
	Oil and Grease	10	15	100
	pH (pH units)	—	6.0 – 9.0	100
003				
(Main Sanitary Treatment Facility)	Ammonia (N)	—	5	15
	BOD	—	20	44
	Chlorine Residual	—	0.5 – 2.0	97
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	92
	pH (pH units)	—	6.0 – 9.0	100
	Suspended Solids	—	30	92
	Settleable Solids (ml/l)		0.5	94
004				
(7900 Area Sanitary Treatment Facility)	BOD	—	30	79
	Chlorine Residual	—	0.5 – 2.0	83
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	100
	pH (pH units)	—	6.0 – 9.0	100
	Suspended Solids	—	30	69
	Settleable Solids (ml/l)	—	0.5	89
Y-12 PLANT				
001				
(Kerr Hollow Quarry)	Dissolved Solids	—	2000	100
	Lithium	—	5	100
	ph (pH units)	—	6.0 – 9.0	100
	Suspended Solids	—	50	100
	Zirconium	—	3	No Disposals

Table 22
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
002				
(Rogers Quarry)	pH (pH units)	—	6.0 – 9.0	73
	Suspended Solids[a]	30	50	100
	Settleable Solids (ml/l)[a]	—	0.5	100
003				
(New Hope Pond)	Ammonia (N)	—	1.6	100
	Chromium	0.05	0.08	100
	Dissolved oxygen (Min.)	5	—	100
	Dissolved Solids		2000	100
	Fluoride	1.5	2.0	100
	Lithium	—	5	100
	Oil and Grease	10	15	100
	pH (pH units)	—	6.0 – 9.0	100
	Phosphate (as MBAS)	5	8	100
	Suspended Solids[a]	—	20	100
	Settleable Solids (ml/l)[a]	—	0.5	100
	Total Nitrogen (N)	—	20	100
004				
(Bear Creek)	Oil and Grease	10	15	83
	pH (pH units)	—	6.0 – 9.0	100
ORGDP				
001				
(K-1700 Discharge)	Oil and Grease	10	15	100
002				
(K-1410 Metal	Cyanide		None Detectable	100
Plating Facility)	Oil and Grease	10	15	100
	pH (pH units)	—	6.0 – 9.0	67
004				
(K-1131 Steam	pH (pH units)	—	6.0 – 9.0	100
Condensate Discharge)	Flow (MGD)	0.005	0.008	100
005[d]				
(K-1203 Sanitary	Ammonia (N)	5[b]	7[c]	83
Treatment Facility)	BOD	15[b]	20[c]	94
	Chlorine Residual	—	0.5 – 2.0	83
	Dissolved Oxygen (Min.)	5	—	100

Table 22
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	83
	pH (pH units)	—	6.0 – 9.0	100
	Suspended Solids	30[b]	45[c]	100
	Settleable Solids (ml/l)	—	0.5	100
006				
(K-1007B Holding	COD	20	25	94
Pond)	Chromium	—	0.05	98
	Dissolved Oxygen (Min.)	5	—	99
	Fluoride	1.0	1.5	98
	Oil and Grease	10	15	100
	pH (pH units)	—	6.0 – 9.0	85
	Suspended Solids[a]	30	50	100
007				
(K-901A Holding	Chromium (total)	—	0.05	0
Pond)	Fluoride	1.0	1.5	100
	Oil and Grease	10	15	100
	pH (pH units)	—	6.0 – 9.0	38
	Suspended Solids	30	50	100
008				
(K-710 Sanitary	BOD	30[b]	45[c]	100
Treatment Facility)	Suspended Solids	30[b]	45[c]	100
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	100
	pH (pH units)	—	6.0 – 9.0	99
	Chlorine Residual	—	0.5 – 2.0	72
	Settleable Solids (ml/l)	—	1.0	100
009[d]	Suspended Solids[a]	30	50	100
(Sanitary Water	Aluminum	—	250	100
Plant)	Sulphate	—	1400	100
	pH (pH units)	—	6.0 – 9.0	100

(a) Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface run-off resulting from precipitation.

(b) Monthly Average.

(c) Weekly Average.

(d) Permit limits effective July 1, 1976.

Table 23
CONCENTRATION OF ^{131}I IN RAW MILK
1976

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF 10^{-9} μCi/ml			COMPARISON WITH STANDARD[b]
		MAXIMUM	MINIMUM[a]	AVERAGE	
			Immediate Environs[c]		
1	46	19	<0.45	< 1.3	FRC Range I
2	48	17	<0.45	< 1.4	FRC Range I
3	47	36	<0.45	< 3.2	FRC Range I
4	41	64	<0.45	< 4.9	FRC Range I
5	25	50	<0.45	< 3.4	FRC Range I
6	48	54	<0.45	< 3.7	FRC Range I
Average				< 3.0 ± 0.9	
			Remote Environs[d]		
51	5	42	<0.45	<14.30	FRC Range II
52	9	14	<0.45	< 2.43	FRC Range I
53	8	3	<0.45	< 0.83	FRC Range I
54	9	30	<0.45	< 4.15	FRC Range I
Average				< 5.4 ± 2.3	FRC Range I

[a] Minimum detectable concentration of ^{131}I is 0.45×10^{-9} μCi/ml.

[b] Applicable FRC standard, assuming 1 liter per day intake:

Range I	0 to 1×10^{-8} μCi/ml	— Adequate surveillance required to confirm calculated intakes.
Range II	1×10^{-8} μCi/ml to 1×10^{-7} μCi/ml	Active surveillance required.
Range III	1×10^{-7} μCi/ml to 1×10^{-6} μCi/ml	— Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[c] See Figure 4.

[d] See Figure 5.

Table 24
CONCENTRATION OF ^{90}Sr IN RAW MILK
1976

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF 10^{-9} μCi/ml			COMPARISON WITH STANDARD[b]
		MAXIMUM	MINIMUM[a]	AVERAGE	
		Immediate Environs[c]			
1	45	6.82	1.8	2.9	FRC Range I
2	49	3.00	1.1	2.0	FRC Range I
3	49	5.6	0.68	2.4	FRC Range I
4	41	4.1	0.68	2.0	FRC Range I
5	28	6.6	1.8	3.8	FRC Range I
6	49	5.5	1.8	3.8	FRC Range I
Average				2.8 ± 0.6	FRC Range I
		Remote Environs[d]			
51	5	4.1	2.7	3.5	FRC Range I
52	9	2.2	0.68	1.4	FRC Range I
53	8	3.4	1.1	2.7	FRC Range I
54	9	6.1	1.8	3.4	FRC Range I
Average				2.8 ± 0.16	FRC Range I

[a] Minimum detectable concentration of ^{90}Sr in milk is 0.5×10^{-9} μCi/ml.

[b] Applicable FRC standard, assuming 1 liter per day intake:

Range I	0 to 2×10^{-8} μCi/ml	—	Adequate surveillance required to confirm calculated intakes.
Range II	2×10^{-8} μCi/ml to 2×10^{-7} μCi/ml	—	Active surveillance required.
Range III	2×10^{-7} μCi/ml to 2×10^{-6} μCi/ml	—	Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[c] See Figure 4.

[d] See Figure 5.

Table 25

RADIONUCLIDE CONTENT OF CLINCH RIVER AND MELTON HILL LAKE FISH

pCi/kg Wet Wt. — Flesh

SPECIES	LOCATION	NUMBER OF SAMPLES[b]	^{95}Zr-Nb	^{90}Sr	^{60}Co	^{106}Ru	^{125}Sb	^{134}Cs	^{137}Cs	^{226}Ra	^{232}Th	^{239}Pu	^{40}K	ESTIMATED % MPI[a]
Shad	CRM 12.0 Below Mouth of Poplar Creek	1	6	8	21	29	9	—	184	19	7	0.29	2444	0.083
White Crappie	CRM 20	1	112	1100	67.4	302	116	174	3417	105	37	0.23	1517	8.1
Shad	Below Mouth of	1	17	26	25	59	270	69	438	32	15	0.27	3081	0.26
Bass	White Oak Creek	1	163	420.9	79	143	49	96	5155	96	31	0.02	2261	3.5
Buffalo Carp	CRM 22.0	1[c]	4	7	6	18	7	—	133	12	4	0.03	2254	0.067
Shad	Below Melton Hill Dam and above Mouth of White Oak Creek	1	21	25	51	43	25	57	857	26	10	0.40	1055	0.28
Crappie	CRM 32	1	ND[d]	2.3	7.8	17	4.6	ND	28	13	3.8	0.05	2600	0.023
Blue Gill	Above Melton	1	ND	8.2	12	24	6.4	ND	21	13	5.5	ND	1300	0.065
Carp	Hill Dam	1	ND	6.4	3.2	6.4	2.1	ND	2.7	4.6	1.5	1.5	1200	0.047
Bass		1	ND	26	7.7	17	4.9	ND	80	6.4	4.0	0.18	2000	0.19
Bluegill	CRM 41	1	ND	26	6.2	24	6.2	ND	33	6.2	5.4	0.3	1600	0.19
Shad	Bay close to CARL	1	ND	5.1	4.7	15	4.9	ND	4.1	78	3.5	0.2	1500	0.039

[a] Maximum Permissible Intake – Intake of radionuclide from eating fish is calculated to be equal to a daily intake of 2.2 liters of water, over a period of one year, containing the concentration guide of radionuclides in question. Consumption of fish is assumed to be 37 lb/yr of the species in question. Only man-made radionuclides were used in the calculation.

[b] Composite of 10 fish in each species, unless otherwise noted.

[c] Sample is one individual, 22 lbs total wet weight.

[d] Not detectable.

Table 26
VEGETATION SAMPLING DATA
1976

STATION NUMBER[a]	F^- CONCENTRATION[b] μg/g (ppm)		U (TOTAL) CONCENTRATION[b] μg/g (ppm)	
	GRASS	PINE NEEDLES	GRASS	PINE NEEDLES
VS 1	21	No Sample	0.5	No Sample
VS 2	15	17	0.1	<0.1
VS 3	14[c]	12	0.1	0.1
VS 4	15	13	0.7	0.1
VS 5	19	12	0.2	0.4
VS 6	18	12	0.2	0.1
VS 7	16	12	0.1	0.1
VS 8	19	18	0.3	0.2
VS 9	16	18	0.1	0.2
VS 10	15	12	0.1	0.1
VS 11	20	15	0.4	0.3
VS 12	15	18	0.2	0.2
VS 13	16	No Sample	0.1	No Sample
VS 14	18	16[c]	0.3	<0.1
VS 15	14	14	0.1	<0.1
VS 16	14	14[c]	0.1	0.2[c]
VS 17	13	14	0.1	0.1

[a] See Figure 1.

[b] Average concentration of two sample collections, January and July. Analytical results are on a dry weight basis.

[c] Only one sample analyzed.

NOTE: Applicable guides for flora have not been established. However, for comparison the *American Industrial Hygiene Association Journal* for January-February 1969 (pp. 98-101) states that dairy cattle is the species of livestock most sensitive to fluorides in grasses. For comparative purposes the following fluoride concentrations and their effect on dairy cattle are given.

30 ppm	—	no adverse effects
30 to 40 ppm	—	borderline chronic
40 to 60 ppm	—	moderate chronic
60 to 110 ppm	—	severe chronic
above 250 ppm	—	acute

Table 27

SOIL SAMPLES FROM NEAR PERIMETER AND REMOTE AIR MONITORING STATIONS

(Units of pCi/g – Dry)[a]

1976

SAMPLING LOCATION[b]	NUMBER OF SAMPLES[c]	^{40}K	^{60}Co	^{90}Sr	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{226}Ra	^{228}Th	^{230}Th	^{232}Th	$^{234-235}U$	^{238}U	^{238}Pu	^{239}Pu
							Perimeter									
HP-31	1	11	≤0.26	0.39	0.07	≤ 1.3	0.30	1.4	0.9	0.50	0.28	0.38	0.56	0.86	0.0027	0.021
HP-32	1	35	≤0.30	0.51	0.02	≤ 2.0	0.30	1.8	0.8	0.44	0.25	0.35	0.68	0.41	0.0041	0.026
HP-33	1	12	≤0.25	1.2	ND	≤ 1.3	ND*	1.4	0.9	0.42	0.26	0.31	0.40	0.31	0.0018	0.021
HP-34	1	19	≤0.12	0.41	ND	≤ 0.98	ND	2.8	0.8	0.71	0.29	0.54	0.41	0.28	0.0045	0.031
HP-35	1	5.1	≤0.18	0.71	0.05	≤ 1.5	0.20	1.5	0.8	0.48	0.33	0.44	0.59	0.47	0.0018	0.021
HP-36	1	7.9	≤0.96	2.1	ND	≤ 0.92	ND	2.4	0.8	0.43	0.28	0.37	0.55	0.38	0.0023	0.041
HP-37	1	11.4	≤0.16	NA**	0.04	≤ 1.0	ND	0.3	0.6	NA	NA	NA	NA	NA	NA	NA
HP-38	1	5.3	≤0.21	NA	0.02	≤ 1.1	0.20	1.1	1.0	NA	NA	NA	NA	NA	NA	NA
HP-39	1	12.9	≤0.11	0.65	ND	≤ 1.1	0.30	1.7	1.1	0.50	0.43	0.42	0.29	0.26	0.0041	0.021
Average		13.3	≤0.28	0.85	0.022	≤ 1.2	0.14	1.6	0.86	0.50	0.30	0.40	0.50	0.42	0.0030	0.026
							Remote									
HP-51	1	7.5	≤0.039	<0.45	ND	≤ 0.36	0.12	1.1	0.93	0.28	0.32	NA	0.46	0.33	NA	NA
HP-52	1	8.5	≤0.063	<4.5	ND	≤ 0.45	0.13	1.3	1.2	0.13	0.11	0.086	0.66	0.61	≤0.0018	0.021
HP-53	1	5.2	≤0.044	<0.59	ND	≤ 0.31	0.13	1.3	1.6	1.0	1.1	NA	0.94	0.71	NA	NA
HP-54	1	6.9	≤0.059	<1.4	ND	≤ 0.54	0.13	1.3	1.4	0.64	0.39	0.39	0.41	0.24	0.0018	0.018
HP-55	1	3.4	≤0.054	<5.0	ND	≤ 0.45	0.10	0.88	1.4	0.27	0.19	0.19	0.33	0.22	≤0.0018	0.017
HP-56	1	3.5	≤0.055	<0.77	ND	≤ 0.41	0.077	0.18	1.1	0.63	0.55	NA	0.48	0.40	NA	NA
HP-57	1	6.1	≤0.007	<0.68	ND	≤ 0.50	0.023	2.6	0.90	0.31	0.49	NA	0.55	0.48	NA	NA
HP-58	1	28	≤0.090	<1.4	ND	≤ 0.45	0.14	1.3	1.3	0.52	0.35	0.30	0.44	0.40	0.0027	0.016
Average		8.6	≤0.051	<1.8		≤ 0.43	0.11	1.2	1.2	0.47	0.44	0.24	0.53	0.42	≤0.002	0.018

[a] Applicable guides for soil contamination have not been established.

[b] See Figures 1 and 2.

[c] Nine samples, approximately three inches in diameter and one centimeter thick, collected in a one-square-meter area at each location and composited for analysis.

* Not detectable.

** Not analyzed.

Table 28

STREAM SEDIMENT SAMPLES

July/November 1976

Average Concentration (μg/g dry weight basis)

STATION	U	Hg	Pb	Ni	Cu	Zn	Cr	Mn	Cd	Al	Th
CS-1	0.4	< 0.5	15	325	20	75	38	1320	<5	32,000	<0.1
PS-2	3.4	2	25	390	45	78	77	455	<5	29,500	<0.1
PS-3	4.1	11	95	425	55	138	95	545	<8	55,000	<0.1
PS-4	8.6	2	35	290	79	155	115	608	<5	42,000	<0.1
PS-5	11.1	8	48	399	65	210	200	775	<5	53,500	<0.1
PS-6	11.6	8	25	415	49	175	202	465	<5	32,500	<0.1
PS-7	59.5	68	48	300	71	192	183	490	<8	24,500	<0.1
PS-8	6.1	1	43	310	195	128	113	580	<5	36,000	<0.1
PS-9	17.8	10	28	335	50	140	198	937	<8	48,000	<0.1
PS-10	18.2	< 3	63	300	86	190	54	704	<5	53,500	<0.1
PS-11	2.4	< 5	20	215	45	94	128	1035	<5	42,000	<0.1
PS-12	4.8	< 3	42	295	135	138	81	668	<5	33,500	<0.1
PS-13	23.4	50	40	135	110	150	190	835	<8	34,000	<0.1
PS-14	6.3	2	38	101	104	121	120	818	<5	33,000	<0.1
PS-15	12.6	2	38	250	158	172	103	650	<5	28,500	<0.1
PS-16	62.1	3	20	1062	340	318	228	685	<5	28,000	<0.1
PS-17	4.5	1	28	73	28	93	195	764	<8	23,000	<0.1

NOTE: Station PS-17 is upstream of ORGDP on Poplar Creek and Station PS-2 is at the mouth of Poplar Creek. Station CS-1 is in the Clinch River upstream of Poplar Creek outfall.

Table 29

SUMMARY OF THE ESTIMATED RADIATION DOSE

TO AN ADULT INDIVIDUAL DURING 1976 AT LOCATIONS OF MAXIMUM EXPOSURE

PATHWAY	LOCATION	DOSE (MILLIREM)	
		TOTAL BODY	CRITICAL ORGAN
Gaseous effluents			
Inhalation plus direct radiation from air and ground	Nearest resident to site boundary	0.4	7.4 (lung)
Terrestrial food chains	Milk sampling stations	0 [a]	0 [a]
Liquid effluents			
Aquatic food chains	Clinch-Tennessee River system	4.0(^{137}Cs)	150 (bone-^{90}Sr)
Drinking water[b]	Kingston, Tennessee (^{90}Sr)	0.004	0.2 (bone)
Direct radiation along water, shores and mud flats	Downstream from White Oak Creek near experimental Cs field plots	7.2	7.2 (Total body)

[a] Not significantly different from zero; see text.

[b] Based on the analysis of raw (unprocessed) water; see text.

NOTE: Average background dose in the U.S. (28) 106 mrem/yr.

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