ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1978

on

RADIOLOGICAL AND NONRADIOLOGICAL PARAMETERS

to

UNITED STATES DEPARTMENT OF ENERGY
CHICAGO OPERATIONS OFFICE

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FOREWORD

This report was prepared by Health Physics Services with assistance of the Facilities' Engineering and Operation Section of Battelle's Columbus Laboratories (BCL). The radiological monitoring data were supplied by the health physics operations staff. The nonradiological data were compiled by the environmental protection representative of the Facilities' Engineering and Operation Section. The radioanalyses of environmental water, grass, food crop, sediment, and soil samples were performed by the Eberline Instrument Corporation's radiochemistry laboratory Albuquerque, New Mexico. Nonradiological analyses of environmental water samples were performed by the Columbus Water and Chemical Testing Laboratory, Columbus, Ohio.

SUMMARY[1]

Radionuclide releases to the environment from Battelle's West Jefferson Nuclear Sciences and King Avenue Sites were monitored for CY 1978. This included air and water emissions from the West Jefferson and King Avenue Sites and water, grass, fish, food crop, sediment, and soil samples taken from the area surrounding the West Jefferson Site. Nonradioactive effluents in water discharged from the West Jefferson Site were also monitored.

The weighted average concentration for plutonium-239 at the West Jefferson Site boundary due to atmospheric emissions was less than 0.0013% of the RCG value. The weighted average concentration for the alpha and beta mixture at the site boundary due to atmospheric emissions was less than 0.011% of the RCG value. The average weighted concentration at the site boundary of krypton-85 emitted from the West Jefferson Site was 1×10^{-6}% of the RCG values, respectively. The concentrations at the site boundary of all identified radionuclides emitted from the site were less than 0.002% of the values.

The average concentration of mixed alpha and beta activity in liquid effluents discharged from the West Jefferson Site was 15.1% of the RCG value and the average concentrations of identified radionuclides in the mixture were all less than 7% of their RCG values. Sediment samples collected from Big Darby Creek above and below the point of effluent discharge all showed concentrations at the minimum detectable limit (MDL) for strontium-90 and below the MDL for plutonium-238 and plutonium-239. Water samples collected from Big Darby Creek above and below the point of effluent discharge showed the average concentration of mixed alpha and beta activity to be less than the MDL for mixed activities.

No significant uptake of radionuclides by grass or food crops in the vicinity of the West Jefferson Site was observed. The maximum concentrations of strontium-90 detected in grass samples was 0.85 pCi/g. A comparison of concentration of strontium-90 in grass for 1977 and 1978 show an annual average increase of 0.48 pCi/g for 1978[2]. Levels of plutonium-238 and plutonium-239 remained the same; <MDL. A comparison of field corn analyses for these two years show an annual average increase of 0.09 pCi/g for strontium-90 in 1978. Levels of plutonium-238 and plutonium-239 remained the same; <MDL. The average concentration of strontium-90 in the seed of field corn, and the edible portions of sweet corn, beans, tomatoes, and carrots was 0.08 ± 0.05 pCi/g for strontium-90. Plutonium-238 and plutonium-239 in all samples of food crops were less than the MDL for plutonium-238 and plutonium-239 (0.01 pCi/g). Concentrations of plutonium-238 and plutonium-239 in silt samples were less than the MDL's for plutonium-238 and plutonium-239 (0.02 pCi/g dry weight).

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(1) RCG values referred to in the Summary are based on those stated in DOE Manual Chapter 0524.

(2) In intervening period between 1977 and 1978, two nuclear atmospheric detonations had been conducted by the Chinese Nationalist government.

Concentrations of strontium-90 in silt samples were less than MDL (0.05 pCi/g dry weight). The largest concentration of strontium-90 was 0.20 pCi/g, found in a composite soil sample taken 3.2 km east of the site, and reflects an annual average decrease of 0.014 pCi/g for 1978 over the average for 1977. The plutonium-238 and plutonium-239 concentrations in all soil samples taken were less than the MDL's of 0.05 pCi/g for both plutonium isotopes.

Continuous air sampling was performed at four site boundary locations during 1978. These air samples were analyzed weekly for mixed alpha and beta activities. The average concentrations of activity at each of the site boundary locations were less than the average mixed alpha and beta activities found on background samples obtained for 6 off site air sampling locations surveyed weekly at distances ranging from 5 to 44 miles from the Nuclear Sciences Area.

Fish samples were collected over a six months period during 1978 and analyzed specifically for those radionuclides of interest. The maximum concentration of strontium-90 in fish samples collected during 1978 was 0.58 pCi/g. Levels of plutonium-238 and plutonium-239 in fish was less than the MDL for plutonium-238 and plutonium-239 (0.01 pCi/g).

Water sampling of Battelle Lake was performed routinely in 1978. These water samples were analyzed for mixed alpha and beta activity. The average concentration of activity in the water sample was less than the MDL for mixed alpha and beta activity.

Liquid effluents discharged from the West Jefferson Site are subject to the restrictions of BCL's National Pollutant Discharge Elimination System permit.

The pH value monthly average was 7.98 for the liquid effluent and was within the permitted limits of 6.0 to 9.0. The average monthly temperature of 59.75° F for the JN-4 storm sewer is within the allowable average daily limit of 90° F.

The average concentration of mixed alpha and beta activity released in liquid discharges from the King Avenue Site was less than 1.7% of the RCG value.

Radiation doses to the public due to radioactivity in atmospheric discharges from the King Avenue Site are not included in this report for the following reasons:

1. Uranium operations at the site were sharply cut back late in May 1975 which continued through 1978. Most of these operations that were to be continued have been moved to the West Jefferson Site.

2. The total radioactivity in atmospheric emissions from this source in CY 1975 was 0.32 μCi; approximately 1.23% of the total released from the West Jefferson facilities for the same period.

3. Based on the above, atmospheric monitoring was suspended in June 1975.

Radiation doses to the public from atmospheric discharges from the West Jefferson Site were calculated using the Air Quality Display Model computer program.

The largest fraction of the maximum permissible exposure for atmospheric releases from the West Jefferson Site was found to occur to the kidney at the site boundary and was 0.002% of the limits recommended by ICRP.

Radiation doses to the public resulting from the discharge of radioactive Luquid effluents from the West Jefferson Site to Big Darby Creek could ensue from swimming in the creek or from eating fish taken from the creek. Fish consumption was assumed to be the dominant exposure pathway but doses from this source are a small fraction of that resulting from the natural background of less than 0.16 rem/yr (Table 19).

INTRODUCTION

Site Location and Environment

The activities performed under Contract No. W-7405-ENG-92 are conducted at BCL's King Avenue Site and the West Jefferson (Nuclear Sciences Area) Site. A 50-mile area map showing both sites is presented in Figure 1. Figure 2 and 3 show property boundaries. Various NRC licensed activities are also conducted at both sites but are not addressed in this report. However, the effluents considered in this reprot are a result of both contract and license activities.

King Avenue Site

A local vicinity map of the King Avenue Site is shown in Figure 2. The U-235 Processing Facility, located on the first floor of Building 3, is the nuclear materials management point for all transactions involving nuclear material at the King Avenue Site. Building 3 also houses the Melting Facility, first floor south end, and the Powder Metallurgy Laboratory, basement floor at the north end of the building. These are the only other areas in Building 3 utilizing contract material. Activities involving contract and license materials were very limited during 1978, therefore, effluent monitoring at Building 3 was limited to liquid discharges to the Columbus municipal sewerage system.

The 10-acre King Avenue Site is bounded on the north by an area of about 50 acres comprising the Ohio State University intramural sports practice field, on the west by the Olentangy River, and on the south and east by residential areas which consist primarily of small multiple-family dwellings (two to four families).

Nuclear Sciences Area (West Jefferson Site)

A local vicinity map of the Nuclear Sciences Area is shown in Figure 3.

The Nuclear Sciences Area is located on a 1000-acre tract approximately 17 miles west of the King Avenue Laboratories as shown in Figure 1. The JN-1 Hot Cell Facility and the JN-2 Vault Facility are presently the only facilities at the Nuclear Sciences Area where contract material is handled. These facilities, along with the decommissioned Research Reactor and the JN-4 Plutonium Laboratory which is being decontaminated are located within a 10-acre fenced security area.

A 10-mile-radius circle whose center is at the site includes a small portion of Columbus having a population of about 60,000. The only other significant population center near the site is West Jefferson, Ohio, located about 2 miles from the site, with a population of 5,747.(1) (See Table 1.)

FIGURE 1. REGIONAL MAP FOR KING AVENUE AND WEST JEFFERSON SITES

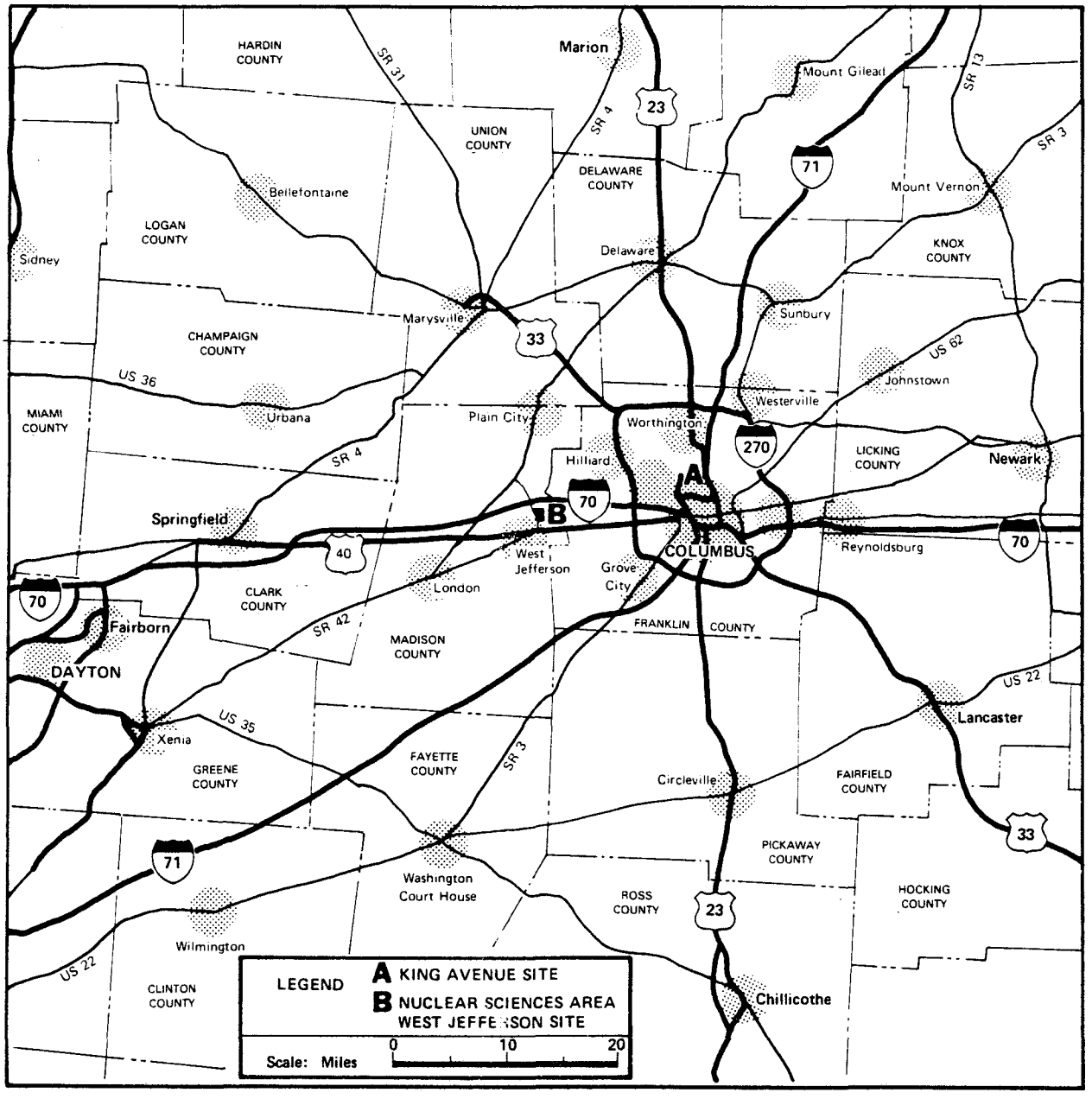


FIGURE 2. LOCAL VICINITY MAP OF KING AVENUE SITE

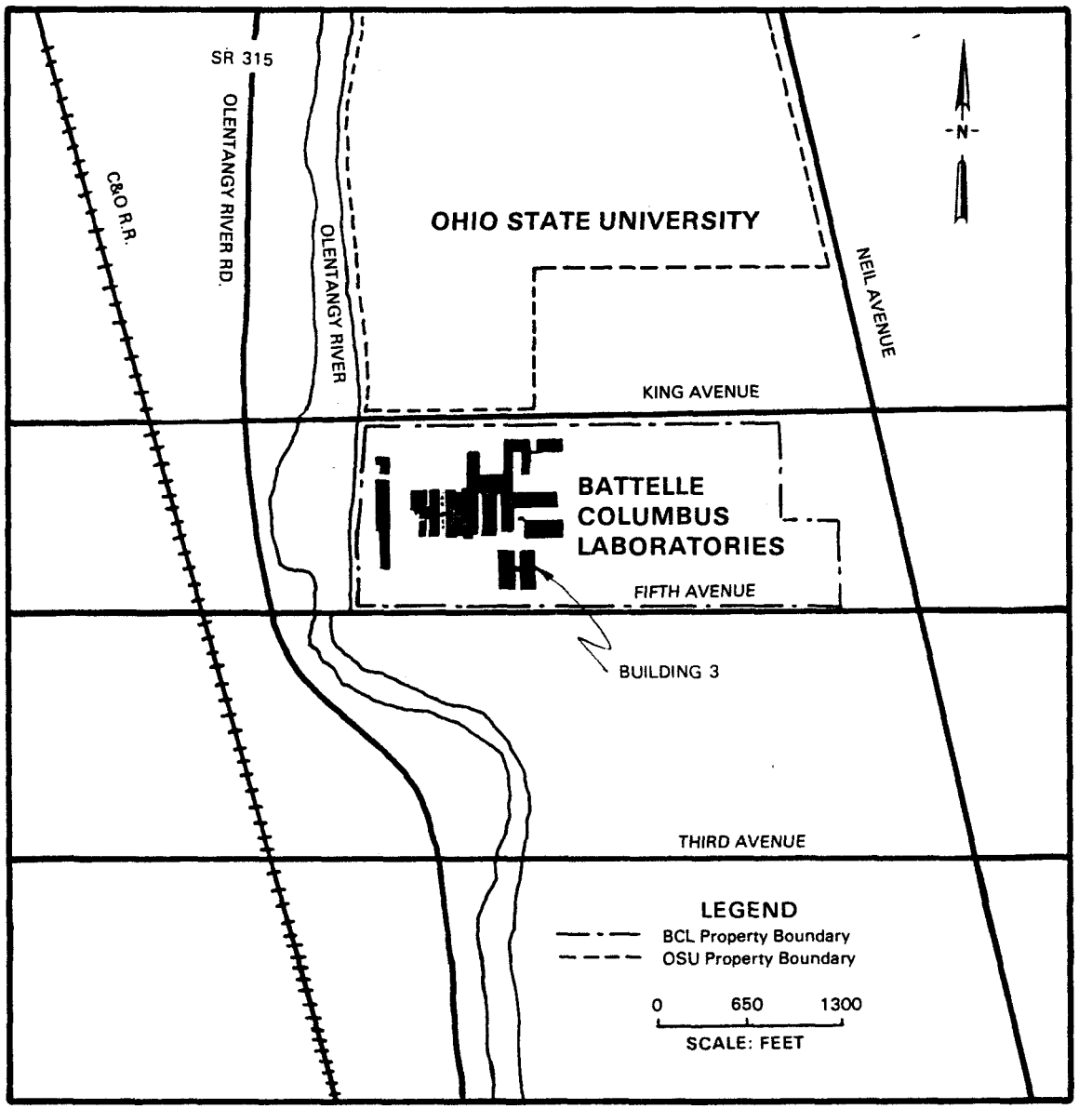
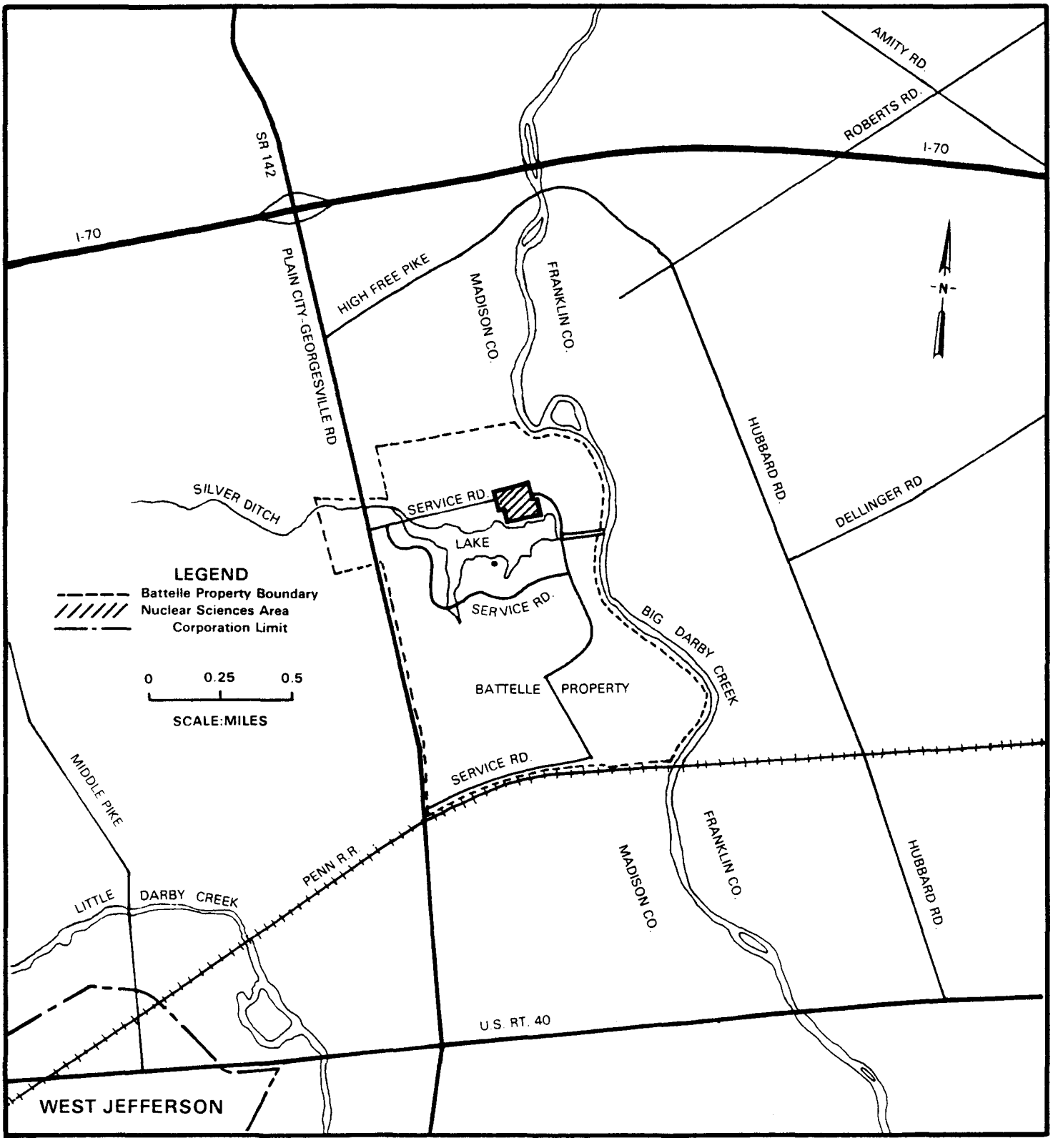


FIGURE 3. LOCAL VICINITY MAP OF NUCLEAR SCIENCES AREA WEST JEFFERSON SITE



Operations at the Nuclear Sciences Area include various activities such as irradiated reactor fuel element studies conducted at the JN-1 Hot Cell Facility and the materials accountability and storage operations conducted at the JN-2 Vault Facility.

TABLE 1. POPULATION DISTRIBUTION WITHIN VARIOUS RADII FROM SITE

Distance Radius	Population
1,500 feet	0
2,500 feet	0
1 mile	682
2 miles	3,000
5 miles	10,000
10 miles	100,000

There are 18 industries located within the 10-mile radius. Of these, there are only four which employ more than 100 people. These are White-Westinghouse Electric Corporation, General Motors, Janitrol Aircraft,and Capitol Mfg. Company. Each of these is located at least 8 miles from the facility. Closest to the site are three small industries within West Jefferson which individually employ less than 60 people. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10% of the land area in agricultural use is devoted to pasturing beef and dairy herds.

During the last 11 years two major highways have been completed near the West Jefferson Site, I-70 and I-270. The junction of these highways, which occurs near the eastern edge of the 10-mile perimeter around the Nuclear Sciences Area, has proven to be a popular area for industrial growth. It is estimated that the industrial population has shown an increase equivalent to that of the general population in this area, i.e., two and one-half times the 10-mile population distribution for 1965. Most of the growth has taken place near the outer limits of Columbus; however, the larger employers, e.g., General Motors and White-Westinghouse, have actually decreased their number of employees.

The predominant geographical feature in the two-county region surrounding the West Jefferson Laboratories is Big Darby Creek which flows from north to south on the border of Madison and Franklin counties. The Nuclear Sciences Area is located about 0.42 km (1380 ft) west of Big Darby Creek and about 1.6 km (1.0 mile) south of I-70.

The use of the creek is limited to fishing and occasional assumed swimming. It is too shallow for boating and is not used as a source for drinking water. The annual average flow is 3.28×10^{11} liters. Treated sanitary and laboratory waste water from the West Jefferson Site is discharged into the creek. The total measured volume during CY 1978 was 1.17×10^{4} liters.

A 32-acre man-made lake is located just south of the Nuclear Sciences Area on Battelle property. Water in this lake is not used for consumption and the use of the lake is limited to fishing and boating.

Weather conditions in the area are moderate. The average annual precipitation is approximately 95 cm (37 in.). Winds predominate out of the south or west except during the summer months when a higher frequency is observed out of the southwest. The average annual wind speed is about 19 km (12 miles) per hour.

The impact of BCL operations on the health and safety of employees and the public area is evaluated routinely at BCL by an environmental monitoring program which has been in existence since 1955. The basic objective of the Environmental Monitoring Program is to evaluate the effectiveness of the waste management program in maintaining the concentrations of radioactive and nonradioactive wastes so that effluent levels are maintained as low as practicable and well within applicable standards. All effluents involving polluting materials are contained within the operating facilities to the extent possible and are disposed of as packaged wastes by authorized services. Any releases of gaseous and liquid wastes to the environment are carefully controlled and dispersed to ensure that concentrations are as low as practical within recommended standards. Radionuclides in particulate form are removed from exhaust stack effluents by the use of high-efficiency particulate air (HEPA) filters. The air effluents are filtered first at the points of operations, i.e., glove boxes, hoods, test cells, and finally at the stack release point by one or two banks of HEPA filters in series. Solid radioactive wastes are packaged and shipped off site for burial at approved burial sites. Radioactive gases present in fuel pins under examination at the Hot Cell facility are drawn off for subsequent disposal with solid wastes. The residual gases trapped in the fuel matrix or otherwise released is monitored continuously by effluent monitors including a system for iodine-131 detection and diversion to a charcoal bed if warranted. During 1978 extensive modification of the Hot Cell facility exhaust ventilation system was made in order to improve filtration of particulate matter in stack emissions.

A sanitary sewerage system, which is operated in accordance with State of Ohio regulations, handles all sanitary sewage generated on the West Jefferson Site. The liquids are first treated in a 10,500-gallon septic tank and then released to a 5700-sq-ft sand and gravel filter bed. From the filter bed the effluent goes to chlorinating system prior to release to Big Darby Creek.

As part of the monitoring function of the program, water, grass, fish, food crops, sediment, and soil samples are collected routinely from the environment at distances up to 8 km (5 miles) from the West Jefferson Site boundaries. These samples are analyzed for the specific radionuclides handled at the nuclear facilities. The sampling techniques, analyses, and counting methods are those best suited for the determination of radionuclides of interest and are capable of detecting levels as low as normal background.

The results of the analyses for calendar year 1978 are provided in this report. Error limits, when given, reflect the counting error in the data at the 95% confidence level.

ENVIRONMENTAL MONITORING

West Jefferson Site

Air Radioactive

In-stack air samplers continuously monitor the exhaust stack effluent release from each facility to assess the effectiveness of systems controlling airborne emissions. Ten continuous stack monitors ensure detection of any inadvertent release of radioactive materials and provide data for the prompt assessment of the environmental impact, if any. (See Figure 4.) Particulate samples of the effluent are collected from each exhaust stack. The particulate samples are collected on two types of filter paper, GVB-60 and Type E glass fiber. The air is sampled at an average rate of 5.8×10^4 cm^3/min. The filters are changed weekly, which represents average sample volume of 588.1 m^3.

Analyses are performed on a weekly basis for plutonium-239 for stacks 006 through 009 and 012, gross alpha for stacks 001 through 003, 013, and 014, gross beta activities for stacks 001 through 003, 013, and 014. In the plutonium-239 analysis, an isotopically pure plutonium-239 source is used as an internal standard in the alpha pulse height analyses. The results reported represent total average annual concentrations at the stack and at the site boundary as calculated from stack sample data. The site boundary concentrations, reported in Tables 1 and 2, due to the various exhaust stack locations were calculated by dividing the individual stack concentration by the appropriate atmospheric dilution factor (ADF) which is obtained from the following equation,

$$ADF = \frac{8172 \times 10^{10}}{\text{Stack vol/yr in liters.}}$$

The annual atmospheric dispersion parameters were calculated using the Air Quality Display Model computer program (see Reference 7, page 42).

At the site boundary the weighted average concentration of plutonium-239 emitted from stacks 006 through 009 and 012 (Table 2) was less than 0.0013% of the RCG value listed for soluble material for uncontrolled areas. The RCG value for soluble plutonium-239 is applied since the solubility of the material is not known even though there is every reason to assume the material is the oxide and thus relatively insoluble. For averaging purposes, samples below the minimum detection limit are assumed to be the value of the limit. All particulate filters are analyzed after a minimum of 72 hours decay to reduce the contribution of short-lived radioactivity.

The weighted average concentration of the alpha and beta mixture, emitted from stacks 001 through 003, 014, and 015 was less than 0.011% of the RCG value at the site boundary. The results are summarized in Table 2.

FIGURE 4. NUCLEAR SCIENCES AREA WEST JEFFERSON SITE

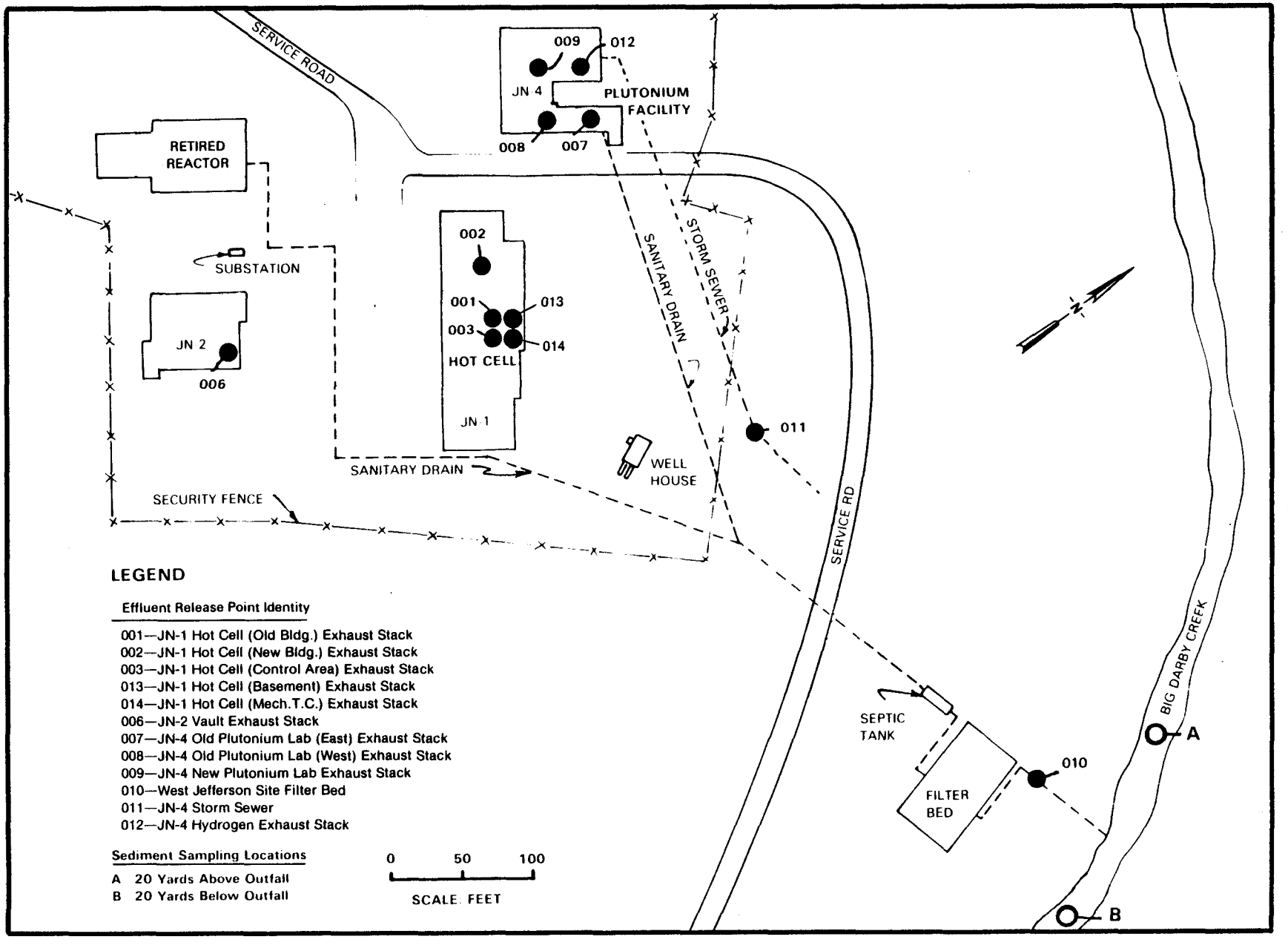


TABLE 2. SUMMARY OF ATMOSPHERIC RADIOACTIVE EMISSIONS - WEST JEFFERSON SITE

CY-1978

Species	Stack Locations	Number of Stack Samples	Stack Volume, 10^{10} liters/yr	Activity, μCi/yr	MDL, 10^{-14} μCi/ml	Range, 10^{-14} μCi/ml	Stack, 10^{-14} μCi/ml	Site Boundary(a) 10^{-18} μCi/ml	10^{-2} Percentage of RCG at Site Boundary(b)
Gross α	001	52	1.84	0.01	0.007	<MDL-0.84	0.06	0.14	3.91
Gross β	001	52	1.84	0.63	0.004	<MDL-44.80	3.41	7.68	
Gross α	002	52	11.67	0.01	0.007	<MDL-0.23	0.01	0.14	0.49
Gross β	002	52	11.67	0.07	0.004	<MDL-3.83	0.06	0.84	
Gross α	003	52	1.84	0.004	0.007	<MDL-0.32	0.02	0.04	0.10
Gross β	003	52	1.84	0.013	0.004	<MDL-7.10	0.07	0.16	
Gross α	013	52	1.84	0.002	0.007	<MDL-0.06	0.008	0.02	0.015
Gross β	013	52	1.84	0.007	0.004	<MDL-1.67	0.004	0.01	
Gross α	014	52	1.84	0.004	0.007	<MDL-0.71	0.02	0.05	0.29
Gross β	014	52	1.84	0.042	0.004	<MDL-27.40	0.23	0.53	
^{85}Kr	001	(c)	1.84	1784.60	--	--	9699.40	21839.00	0.0007
^{85}Kr	002	(c)	11.67	75.10	--	--	64.35	918.95	0.00003
^{131}I	001	12	1.84	ND(d)	--	--	--	--	--
^{131}I	002	12	11.67	ND(d)	--	--	--	--	--
^{239}Pu	006	52	0.39	0.010	0.01	<MDL-0.89	0.26	0.12	0.021
^{239}Pu	007	148	4.50	0.045	0.01	<MDL-0.56	0.10	0.55	0.092
^{239}Pu	008	148	4.50	0.056	0.01	<MDL-0.69	0.12	0.66	0.110
^{239}Pu	009	52	10.80	0.087	0.01	<MDL-0.16	0.08	1.06	0.176
^{239}Pu	012	33	0.94	0.94	0.01	<MDL-0.32	0.14	0.16	0.027

(a) Site boundary concentrations calculated from stack concentration data using annual atmospheric dispersion parameters calculated using the Air Quality Display Model (see Reference 7 page 42) computer program.

(b) RCG - for mixed alpha and beta activity, 2×10^{-14} μCi/ml; ^{85}Kr 3×10^{-7} μCi/ml; ^{131}I 1×10^{-10} μCi/ml; ^{239}Pu 6×10^{-14} μCi/ml.

(c) ^{85}Kr concentration calculated by dividing known activity of gas generated by volume of gas released.

(d) No detectable activity.

No detectable concentrations of iodine-131 were emitted from stacks 001 and 002, based on gamma ray analysis of in-line system charcoal cartridges. The air is monitored at a rate of 8.5×10^4 cm^3/min. This represents a weekly average sample volume of 861.9 m^3.

The weighted average concentration of krypton-85 released from stack 001 and 002 was 1×10^{-6}% of the RCG value. The concentrations were calculated by dividing the known activity of gas generated by the volume of gas released through exhaust stacks 001 and 002. The results are summarized in Table 2. (There is a discussion of RCG's in the appendix of this report.)

Identification of radionuclides in the JN-1 stack particulate emissions from stacks 001 through 003, 013, and 014 was made by monthly gamma ray analysis of weekly stack air sample filters composited over a 4-week period. Gamma ray analyses were performed using an intrinsic germanium detector coupled to a Canberra Model 8180 multi-channel analyzer. The concentration of the radionuclides identified were all less than 0.0001% of the applicable RCG values at the site boundary. (See Table 3.)

Supplementary air sampling was performed at four site boundary locations during 1978. (See Figure 6.) These air samples were collected continuously and analyzed on a weekly basis for mixed alpha and beta activities. The average concentrations of activity at each of the site boundary locations were less than the average mixed alpha and beta activities found on background samples obtained from 6 off site air sampling locations surveyed weekly at distances varying 5 to 44 miles from the Nuclear Sciences Area. (See Figure 10.)

Water Radioactive

Sampling of all liquid effluents to Big Darby Creek, generated at the Nuclear Sciences Area, is performed routinely on a weekly basis. This effluent consists of the liquid discharge from a conventional sanitary sewerage system incorporating a 10,500-gallon septic tank and 5700-ft^2 filter bed. (See Figure 4.) The effluent samples are routinely analyzed specifically for plutonium-238, plutonium-239, iodine-129, radium-226, and radium-228 as well as for gross alpha and gross beta activity in suspended and dissolved fractions. Any sample exceeding 3×10^{-8} μCi/ml* receives a supplementary gamma isotopic (GeLi) analysis and/or an alpha spectrometric analysis as necessary.

The weekly samples are held and invididually analyzed at the end of each month. The concentrations of gross alpha and gross beta activity in suspended and dissolved fractions as well as the concentrations of

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* RCG value for unidentified radionuclides in unknown concentrations released to an uncontrolled area, DOE Appendix 0524.(2)

specific radionuclides identified in the sample are summarized in Table 4. In most cases the activity in the samples is due to a mixture of nuclides. The average concentration of the mixture was 15.1% of the RCG. The average concentrations of identified radionuclides in the mixture were 6.83% of the RCG for iodine-129, <0.001% of the RCG for plutonium-238, <0.0006% for plutonium-239, 2.08% of the RCG for strontium-90, <0.074% of the RCG for cesium-137, 0.67% of the RCG for radium-226, and 0.33% of the RCG for radium-228.

Supplementary water samples were collected weekly 20 yards above and 20 yards below the sanitary drain outfall at Darby Creek. Weekly water samples were also collected below the Battelle Lake dam and in the drain spillway at Darby Creek. (See Figure 6.) The supplementary water samples were analyzed for mixed alpha and beta activity. The average concentrations of activity in the water samples were less than the MDL for mixed alpha and beta activity.

Water Nonradioactive

Presently, liquid effluents discharged from our West Jefferson Facility are subject to the restrictions of our National Pollutant Discharge Elimination System (NPDES) Permit, #N404-CD. This permit became effective October 31, 1977. Battelle monitors and reports on a monthly basis to the Ohio Environmental Protection Agency (OEPA) and the U.S. EPA. Table 5 includes a list of the parameters for which we are presently required to analyze and report. Those parameters may change or be subject to modification during 1979 and will be noted in the environmental report for the calendar year 1979.

The data listed in Table 5 represents an average of the monthly data collected during the ten month period commencing January 1, 1978, and ending December 31, 1978. That data being required under the limits or restrictions set forth in BCL's NPDES Permit #N404-CD which is an application of the Ohio EPA Regulation EP-1 (Revised Water Quality Standards) effective July 27, 1973. The table serves to illustrate actual performance against those limits or restrictions defined in BCL's NPDES Permit. As noted in Table 5 the pH value monthly average was 7.93. The Revised Water Quality Standards required that liquid effluent being discharged shall not have a pH value less than 6.0 or greater than 9.0 making the reported average of 7.98 within the allowable limits. The average monthly temperatures of 59.75° F for the JN-4 storm sewer is within the allowable average daily limit of 90° F. Of the parameters outlined in our NPDES Permit, only pH and temperature data from the JN-4 storm sewer (Location 011) is reported. Due to the extremely low flow rate from the North Sanitary System Sewer (Location 010) during 1978, sample collection was impossible, therefore, no data is available for this site.

The data provided for the JN-4 storm sewer was obtained in accordance with our NPDES Permit. Since the conditions of BCL's NPDES Permit were determined by the Ohio EPA following an extensive study of the Scioto River Basin, of which Battelle's West Jefferson Site is a part; and discharges are within the allowable discharge limits, the data reflect the effectiveness of BCL's management.

TABLE 3. GAMMA EMITTING RADIONUCLIDES IDENTIFIED IN THE JN-1 (HOT LAB) STACK EMISSIONS

CY-1978

Species	Stack Location Figure 4	Composite Stack Samples	Volume, 10^{10} liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{60}Co	001(a)	12	1.84	25.00	4.48	<MDL-107000.0	13590.00	306.00	102.00
	002(a)	12	11.67	1.20	7.61	<MDL-601.0	102.80	14.68	4.89
	003(b)	12	1.84	0.28	8.63	<MDL-1200.0	153.23	3.45	1.15
	013(b)	12	1.84	0.12	7.61	<MDL-428.0	65.29	1.47	0.49
	014(b)	12	1.84	0.17	7.61	<MDL-607.0	94.16	2.12	0.71
^{57}Co	001(a)	12	1.84	ND[d]	--	---	---	--	--
	002(a)	12	11.67	2.10	0.33	<MDL-247.0	28.36	4.05	0.07
	003(b)	12	1.84	0.03	0.37	<MDL-191.0	14.21	0.32	0.005
	013(b)	12	1.84	ND[d]	--	---	---	--	--
	014(b)	12	1.84	ND[d]	--	---	---	--	--
^{137}Cs	001(a)	12	1.84	3.36	1.78	<MDL-8370.0	1828.90	41.18	8.24
	002(a)	12	11.67	0.22	3.03	<MDL-62.3	19.05	2.72	0.54
	003(b)	12	1.84	0.07	3.44	<MDL-100.0	39.53	0.89	0.18
	013(b)	12	1.84	0.05	1.78	<MDL-100.0	24.87	0.56	0.11
	014(b)	12	1.84	0.71	1.78	<MDL-3630.0	388.17	8.74	1.75
^{65}Zn	001(a)	12	1.84	0.89	1.45	<MDL-4380.0	484.10	10.90	(f)
	002(a)	12	11.67	1.06	2.46	<MDL-1150.0	90.82	12.97	(f)
	003(b)	12	1.84	0.23	2.80	<MDL-1580.0	127.02	2.86	(f)
	013(b)	12	1.84	0.36	1.45	<MDL-1360.0	193.20	4.35	(f)
	014(b)	12	1.84	0.17	1.45	<MDL-1180.0	95.04	2.14	(f)

TABLE 3. (Continued)

Species	Stack Location Figure 4	Composite Stack Samples	Volume, 10^{10} liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Site[c] Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{134}Cs	001[a]	12	1.84	0.06	0.18	<MDL-278.0	32.87	0.74	0.19
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	0.19	0.31	<MDL-1070.0	107.04	2.41	0.60
^{212}Pb	001[a]	12	1.84	0.22	0.41	<MDL-421.0	119.03	2.68	0.45
	002[a]	12	11.67	0.41	0.69	<MDL-375.0	35.29	5.04	0.84
	003[b]	12	1.84	0.07	0.78	<MDL-382.0	39.53	0.89	0.15
	013[b]	12	1.84	0.06	0.69	<MDL-392.0	31.53	0.71	0.12
	014[b]	12	1.84	0.12	0.69	<MDL-392.0	63.07	1.42	0.24
^{214}Pb	001[a]	12	1.84	0.09	0.73	<MDL-276.0	51.08	1.15	(f)
	002[a]	12	11.67	0.16	1.23	<MDL-485.0	13.59	4.23	(f)
	003[b]	12	1.84	0.16	1.40	<MDL-426.0	86.16	1.94	(f)
	013[b]	12	1.84	0.08	1.23	<MDL-239.0	41.30	0.93	(f)
	014[b]	12	1.84	0.03	1.23	<MDL-219.0	16.43	0.37	(f)
^{203}Hg	001[a]	12	1.84	1.02	0.50	<MDL-5520.0	554.27	12.48	0.62
	002[a]	12	11.67	0.03	0.85	<MDL-20.80	2.17	0.31	0.02
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--

TABLE 3. (Continued)

Species	Stack Location Figure 4	Composite Stack Samples	Volume, 10^{10} liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Site[c] Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{113}Sn	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	0.13	0.19	<MDL-113.0	10.99	1.57	0.08
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{210}Pb	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	0.30	0.09	<MDL-264.0	25.77	3.68	46.00
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{214}Bi	001[a]	12	1.84	36.59	1.62	<MDL-117000.0	19888.00	447.80	(f)
	002[a]	12	11.67	0.56	2.75	<MDL-485.0	47.62	6.80	(f)
	003[b]	12	1.84	0.12	3.12	<MDL-561.0	63.96	1.44	(f)
	013[b]	12	1.84	0.15	2.75	<MDL-607.0	79.50	1.79	(f)
	014[b]	12	1.84	0.17	2.75	<MDL-554.0	93.27	2.10	(f)
^{144}Ce	001[a]	12	1.84	0.03	0.19	<MDL-139.0	13.77	0.31	0.16
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	0.04	0.31	<MDL-199.0	19.99	0.45	0.23

TABLE 3. (Continued)

Species	Stack Location Figure 4	Composite Stack Samples	Volume, 10^{10} liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Site[c] Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{103m}Rh	001[a]	12	1.84	0.65	1.68	<MDL-4250.0	353.53	7.96	0.0004
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{51}Cr	001[a]	12	1.84	1.91	0.64	<MDL-1270.0	1036.20	23.33	0.03
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{85m}Kr	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	0.02	0.11	<MDL-17.5	1.68	0.24	0.0002
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{138}Xe	001[a]	12	1.84	ND[d]	--	---	---	--	(f)
	002[a]	12	11.67	0.04	0.76	<MDL-20.9	3.50	0.50	(f)
	003[b]	12	1.84	ND[d]	--	---	---	--	(f)
	013[b]	12	1.84	ND[d]	--	---	---	--	(f)
	014[b]	12	1.84	ND[d]	--	---	---	--	(f)

TABLE 3. (Continued)

Species	Stack Location Figure 4	Composite Stack Samples	Volume, 10^{10} liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Site[c] Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{103}Ru	001[a]	12	1.84	1.02	0.13	<MDL-7640.0	554.27	12.48	0.42
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{95}Zr	001[a]	12	1.84	0.61	0.21	<MDL-3030.0	333.1	7.50	0.75
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{228}Ac	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	ND[d]	--	---	---	--	--
	003[b]	12	1.84	0.20	5.48	<MDL-1060.0	106.15	2.39	0.40
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{207}Bi	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	0.12	0.26	<MDL-106.0	10.36	1.48	0.30
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--

TABLE 3. (Continued)

Species	Stack Location Figure	Composite Stack Samples	Volume, 10^{10} Liters/yr	Activity, µCi/yr	MDL, 10^{-16} µCi/ml	Range, 10^{-16} µCi/ml	Average Concentration Site[c] Stack, 10^{-16} µCi/ml	Average Concentration Site[c] Boundary, 10^{-18} µCi/ml	10^{-6} Percent of[e] RCG at Site Boundary
^{125}Sb	001[a]	12	1.84	8.58	0.26	<MDL-22700.0	4664.50	105.03	11.67
	002[a]	12	11.67	1.06	0.44	<MDL-566.0	91.10	13.01	1.45
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--
^{160}Tb	001[a]	12	1.84	ND[d]	--	---	---	--	--
	002[a]	12	11.67	0.10	0.34	<MDL-110.0	8.40	1.20	0.12
	003[b]	12	1.84	ND[d]	--	---	---	--	--
	013[b]	12	1.84	ND[d]	--	---	---	--	--
	014[b]	12	1.84	ND[d]	--	---	---	--	--

(a) Identification of radionuclides in stack particulate and gaseous emissions was by gamma ray analysis of stack charcoal canisters and particulate air filters.

(b) Identification of radionuclides in stack particulate emissions was by gamma ray analysis of stack particulate air filters.

(c) Site boundary concentrations calculated from stack concentration data using annual atmospheric dispersion parameters calculated using the Air Quality Display Model (see Reference 7, page 42) computer program.

(d) ND - No detectable activity.

(e) RCG: ^{60}Co 3 x 10^{-10} µCi/ml; ^{57}Co 6 x 10^{-9} µCi/ml; ^{137}Cs 5 x 10^{-10} µCi/ml; ^{134}Cs 4 x 10^{-10} µCi/ml; ^{103}Ru 3 x 10^{-9} µCi/ml; ^{95}Zr 1 x 10^{-9} µCi/ml; ^{125}Sb 9 x 10^{-9} µCi/ml; ^{160}Tb 1 x 10^{-9} µCi/ml; ^{203}Hg 2 x 10^{-9} µCi/ml; ^{113}Sn 2 x 10^{-9} µCi/ml; ^{51}Cr 8 x 10^{-8} µCi/ml; ^{85M}Kr 1 x 10^{-7} µCi/ml; ^{210}Pb 8 x 10^{-12} µCi/ml; ^{212}Pb 6 x 10^{-10} µCi/ml; ^{228}Ac 6 x 10^{-10} µCi/ml; ^{103M}Rh 2 x 10^{-6} µCi/ml; ^{207}Bi 5 x 10^{-10} µCi/ml; ^{144}Ce 2 x 10^{-10} µCi/ml.

(f) No guidelines established for this radionuclide.

TABLE 4. SUMMARY OF LIQUID RADIOACTIVE EMISSIONS - WEST JEFFERSON SITE (MEASURE OF EFFLUENT FROM SANITARY SEWERAGE SYSTEM INTO BIG DARBY CREEK - FIGURE 4, DESIGNATION 010)[a]

CY-1978

Species	Number of Sample	Activity, μCi/yr	MDL, 10^{-8} μCi/ml	Range, 10^{-8} μCi/ml	Average Concentration, 10^{-8} μCi/ml	RCG, 10^{-8} μCi/ml	Percentage of RCG
Gross α	52	0.033	0.05	<MDL-0.9	0.28	10[c]	15.1
Gross β	52	0.14	0.02	<MDL-4.5	1.230		
^{90}Sr	12	0.073	0.10	<MDL-1.1	0.625[b]	30	2.08
^{238}Pu	12	<0.0006	0.001	<MDL-0.02	0.005[b]	500	0.001
^{239}Pu	12	<0.0004	0.001	<MDL-0.02	0.003[b]	500	0.0006
^{137}Cs	12	0.17	1.0	<MDL-3.0	1.48[b]	2000	0.074
^{129}I	42	0.048	0.2	<MDL-0.5	0.41	6	6.83
^{226}Ra	42	0.002	0.006	<MDL-0.05	0.02	3	0.67
^{228}Ra	42	0.001	0.009	<MDL-0.07	0.01	3	0.33

(a) Annual average flow in Big Darby Creek = 429 cu ft/sec = 3.82×10^{11} liters/yr. Rate at which liquid effluents discharge = 1.17×10^{4} liters/yr.

(b) Isotopic data for effluents released at this location other than ^{129}I, ^{226}Ra, and ^{228}Ra were obtained from monthly composite samples.

(c) RCG - Mixture of alpha and beta activity: 3×10^{-8} μCi/ml. (If it is known that ^{129}I, ^{226}Ra, and ^{228}Ra are not present, the limiting value of 1×10^{-7} μCi/ml may be used.) See Appendix.

Grass and Food Crops Radioactive

Grass and food crop samples are collected from the surrounding area. The intent of this portion of the Environmental Monitoring Program is to determine whether there is uptake and concentration of radionuclides by plants or animal life. Where possible, sampling sites are chosen at maximum deposition locations predicted by meteorlogical studies. Grass and food crop (field corn and vegetable) samples are collected at varying distances and directions within a 5-mile radius of the Nuclear Sciences Area as shown in Figure 5. The samples are analyzed for plutonium-239, plutonium-238, and strontium-90. A qualitative analysis by gamma scan (GeLi) is also performed. The results of the grass and food crop analyses are summarized in Tables 6 and 7. The maximum concentration of strontium-90 detected in grass samples was 0.83 pCi/g. The average concentration of strontium-90 in field corn and vegetables was 0.08 ± 0.05 pCi/g in all samples taken and plutonium-238 and plutonium-239 concentrations were less than the MDL for both plutonium isotopes (0.02 pCi/g) in all samples taken of grass and food crops.

Sediment Radioactive

Silt samples are collected semiannually at two locations, i.e., Darby Creek 20 yards above and 20 yards below the point of sanitary effluent release to Darby Creek. (See Figure 4.) The purpose of collecting silt samples is to initially estimate the inventory of certain radionuclides deposited in this waterway and document for future reference. The silt samples are analyzed for plutonium-239, plutonium-238, and strontium-90. A quantitative gamma isotopic (GeLi) analysis is also performed. The results of the analyses are summarized in Table 8. Concentrations of strontium-90, plutonium-238, and plutonium-239 in silt samples were found to be less than 0.05 pCi/g for strontium-90 and 0.02 pCi/g for plutonium-238 and plutonium-239.

Soil Radioactive

Soil samples are collected annually at fourteen locations at varying distances and directions within a 5-mile radius of the Nuclear Sciences Area. Locations falling into the same sector of a quadrant of the sites are composited. (See Figure 5.) The soil samples are analyzed for plutonium-238, plutonium-239, and strontium-90. The results of the analyses are summarized in Table 9. The largest concentration of strontium-90 in soil samples was 0.20 pCi/g, found in the composite soil sample collected 3.2 km east of the nuclear site.

Fish Radioactive

Fish samples were collected from Darby Creek and Battelle Lake over a six month period and composited for analyses on a quarterly basis. The fish samples were analyzed for plutonium-238, plutonium-239, and strontium-90. The results of the analyses are summarized in Table 11.

Levels of plutonium-238 and plutonium-239 in the fish samples were less than the MDL for plutonium-238 and plutonium-239 (0.01 pCi/g). The maximum concentration of strontium-90 in fish samples was 0.58 pCi/g.

Background Radiation Levels

The external radiation background levels at the West Jefferson site are continuously monitored at 39 dosimetry stations using commercially available environmental TLD packets. (See Figures 8 and 9.) All TLD packets are changed and evaluated each calendar quarter. The annual exposure average for the 39 dosimeter stations was less than 0.16 rem or 34% of the 0.5 rem limit established for the general public. The results are summarized in Tables 12 and 13.

King Avenue Site

Water Radioactive

Sampling of all liquid discharges from Building 3 (U-235 Processing Facility) to the Columbus municipal sewerage system is performed on a monthly basis. (See Figure 7.) This discharge consists of the liquid wastes from the building sanitary drain systems. The sanitary discharge samples are normally analyzed for gross alpha and gross beta activities. Any sample exceeding 4×10^{-7} µci/ml* receives a gamma isotopic (GeLi) analysis and/or an alpha spectrometric analysis as necessary.

Sample analyses are performed monthly on the sanitary discharge samples. The concentrations of gross alpha and gross beta activity are summarized in Table 14. The average concentration of the mixture was less than 1.7% of the RCG. For averaging purposes, samples below the minimum detection limit are assumed to be the value of the limit.

Total releases of radioactivity during CY 1978 from the West Jefferson and King Avenue sites are summarized in Table 15.

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* RCG value for unidentified radionuclides in unknown concentrations released to a public sanitary sewerage system, DOE Appendix 0524.

TABLE 5. NONRADIOLOGICAL SAMPLING FOR WEST JEFFERSON SITE

January 1, 1978, to December 31, 1978

	North Sanitary System Sewer(e)				JN-4 Storm Sewer(f)			Permit Requirements(g) Discharge Limitations			
				Kg/Day				Loading(h) Kg/Day		Concentration Other Units	
	Avg.	Max.	Min.	Avg.	Avg.	Max.	Min.	30 Day	Daily	30 Day	Daily
Flow Rate (gal/day)	(a)	(a)	(a)	(d)	4,840	10,440	120			(d)	(d)
Residual Chlorine (mg/l)	(a)	(a)	(a)		(c)	(c)	(c)			(d)	0.5
pH Value (S.U.)	(a)	(a)	(a)	(d)	7.98	8.74	7.12			6.0 to	9.0
Fecal Coliform (#/100 ml)	(a)	(a)	(a)	(d)	(c)	(c)	(c)			200	400
Total Suspended Solids (mg/l)	(a)	(a)	(a)	(d)	(c)	(c)	(c)	0.49	0.99	10	20
Temperature (°F)	(c)	(c)	(c)		59.75	72.00	51.00				90
B.O.D. (5 day)(mg/l)	(a)	(a)	(a)	(d)	(c)	(c)	(c)	0.49	0.99	10	20

(a) Sample not taken, insignificant flow from outfall.
(b) Below detectable limits.
(c) Sample analysis for this parameter was not required by our NPDES Permit.
(d) No restrictions for flow under our NPDES Permit.
(e) Sampling site location No. 010.
(f) Sampling site location No. 011.
(g) Permit requirement discharge limitations based on NPDES Permit #N404-CD.
(h) Flow rate 0.013 mgd.

FIGURE 5. MAP OF GRASS, FOODCROP AND SOIL SAMPLING LOCATIONS

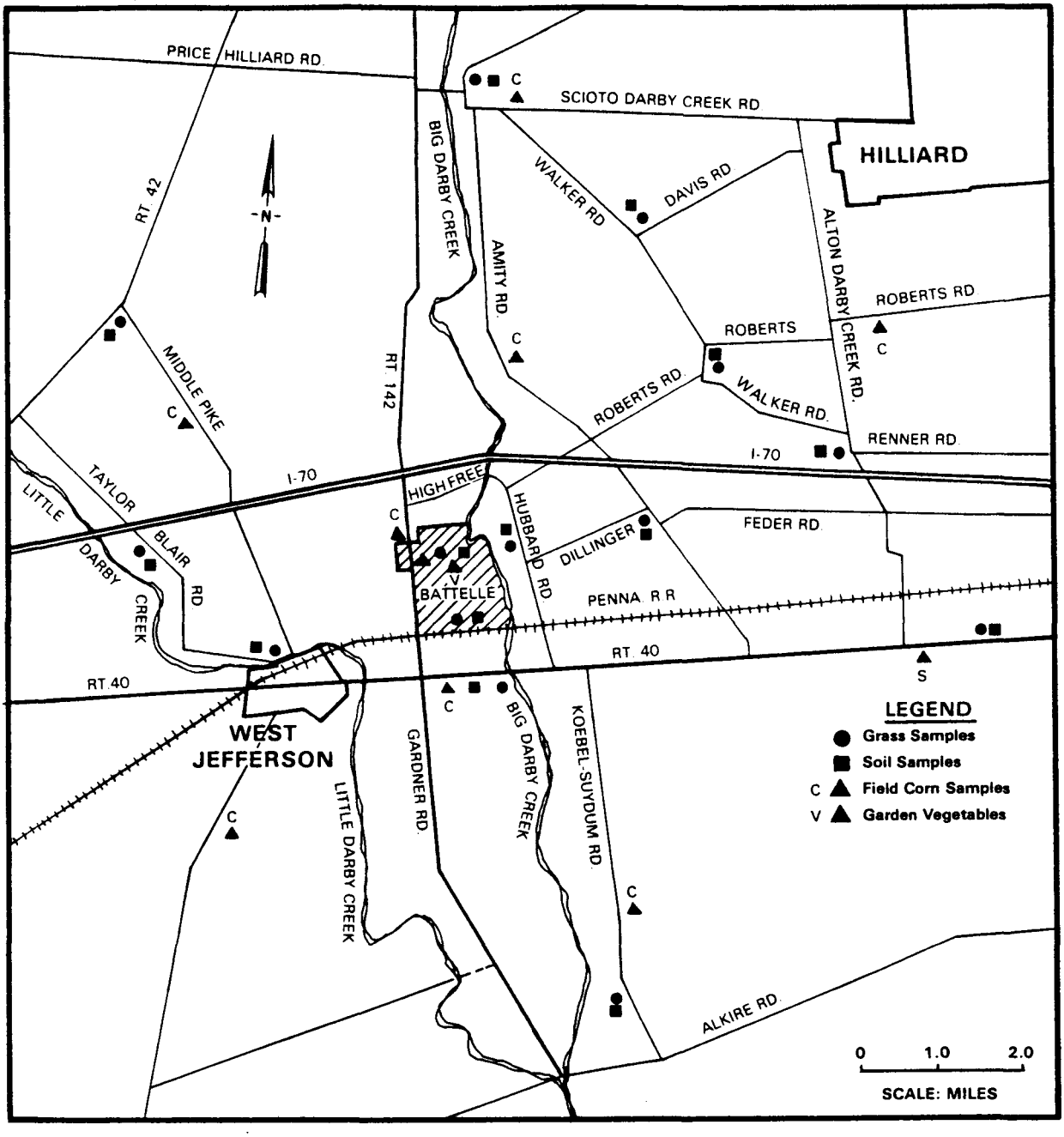

TABLE 6. SUMMARY OF GRASS ANALYSES

CY-1978

Location[a] (Direction and Distance from Nuclear Sciences Area)		Number of Samples	pCi/g dry[b]		
			^{90}Sr	^{238}Pu	^{239}Pu
North	8.0 km (5.0 miles)	2	0.71 ± 0.28	<0.02	<0.02
East	3.2 km (2.0 miles)	2	0.70 ± 0.32	<0.02	<0.02
	6.4 km (4.0 miles)	2	0.66 ± 0.33	<0.02	<0.02
	8.0 km (5.0 miles)	2	<0.54	<0.02	<0.02
South	3.1 km (1.9 miles)	2	<0.86	<0.02	<0.02
West	6.4 km (4.0 miles)	2	<0.40	<0.02	<0.02
On Site	----------	2	0.83 ± 0.33	<0.02	<0.02

Note: No standards for radionuclides in grass have been established.

(a) Locations are shown in Figure 5.

(b) Minimum Detection Limit for ^{90}Sr in grass is 0.40 pCi/g dry.
Minimum Detection Limit for ^{238}Pu and ^{239}Pu in grass is 0.02 pCi/g dry.

TABLE 7. SUMMARY OF FOOD CROP ANALYSES

CY-1978

Type of Samples	Location[a] (Direction and Distance from Nuclear Sciences Area)		Number of Composite Samples	pCi/g dry[b]		
				^{90}Sr	^{238}Pu	^{239}Pu
Field Corn	North	4.0 km (2.5 miles)	1	0.10 ± 0.05	<0.01	<0.01
	West	0.74 km (2400 feet)	1	0.18 ± 0.08	<0.01	<0.01
	North-west	6.4 km (4.0 miles)	1	<0.05	<0.01	<0.01
	South	8.0 km (5.0 miles)	1	0.07 ± 0.06	<0.01	<0.01
	North east	8.0 km (5.0 miles)	1	<0.05	<0.01	<0.01
	North	8.0 km (5.0 miles)	1	<0.05	<0.01	<0.01
	South west	6.4 km (4.0 miles)	1	0.07 ± 0.06	<0.01	<0.01
	South	2.4 km (1.5 miles)	1	0.13 ± 0.07	<0.01	<0.01
Vegetables Composite[c]	South	0.43 km (1400 feet)	1	<0.05	<0.01	<0.01

Note: No standards for radionuclides in food crops have been established.

(a) Locations are shown in Figure 5.

(b) Minimum Detection Limit for ^{90}Sr in food crops is 0.05 pCi/g dry.
Minimum Detection Limit for ^{238}Pu and ^{239}Pu in food crops is 0.01 pCi/g dry.

(c) Composite sample of various vegetables (sweet corn, beans, tomatoes, and carrots).

TABLE 8. SUMMARY OF SILT ANALYSES

CY-1978

Location[b] Figure	Number of Samples	pCi/g dry[a] ^{90}Sr	^{238}Pu	^{239}Pu
A (20 yd above outfall)	2	<0.05	<0.02	<0.02
B (20 yd below outfall)	2	<0.05	<0.02	<0.02

Note: No standards for radionuclides in silt have been established.

(a) Minimum Detection Limit for ^{90}Sr in silt is 0.05 pCi/g dry. Minimum Detection Limit for ^{238}Pu and ^{239}Pu in silt is 0.02 pCi/g dry.

(b) The collection of silt samples at these locations, where silt deposition and accumulation should be at a maximum, was based on observations of the average flow pattern of Big Darby Creek in the vicinity of the outfall.

TABLE 9. SUMMARY OF SOIL CORE ANALYSES

CY-1978

Location[a] (Direction and Distance from the Nuclear Sciences Area)		Number of Composite Samples	pCi/g dry[b]		
			^{238}Pu	^{239}Pu	^{90}Sr
North	8.0 km (5.0 miles)	1	<0.05	<0.05	0.14 ± 0.02
East	3.2 km (2.0 miles)	2	<0.05	<0.05	0.20 ± 0.03
	6.4 km (4.0 miles)	2	<0.05	<0.05	0.17 ± 0.02
	8.0 km (5.0 miles)	2	<0.05	<0.05	0.13 ± 0.02
South	0.8 km (0.5 mile)	1	<0.05	<0.05	0.15 ± 0.03
	3.1 km (1.9 miles)	1	<0.05	<0.05	0.13 ± 0.02
West	4.8 km (3.0 miles)	2	<0.05	<0.05	0.14 ± 0.02
	8.0 km (5.0 miles)	1	<0.05	<0.05	0.13 ± 0.02
On Site	----------	2	<0.05	<0.05	0.18 ± 0.03

Note: No standards for radionuclides in soil have been established. The Environmental Protection Agency's proposed federal radiation protection guidance for exposures to transuranium elements in the environment has recommended a reference level of 0.2 $\mu Ci/m^2$ for soil contamination.

(a) Locations are shown in Figure 5.

(b) Minimum Detection Limit for ^{238}Pu and ^{239}Pu in soil is 0.05 pCi/g dry. Minimum Detection Limit for ^{90}Sr in soil is 0.05 pCi/g dry.

TABLE 10. SUMMARY OF GAMMA ISOTOPIC ANALYSIS OF SOIL CORE SAMPLES

CY-1978

Location (Direction and Distance from the Nuclear Sciences Area)[a]

	North 8.0 km (5.0 miles)	East 3.2 km (2.0 miles)	East 6.4 km (4.0 miles)	East 8.0 km (5.0 miles)
Number of Composite Samples	3	6	6	6
Nuclide	Average Concentration pCi/g (dry)[b]			
^{134}Cs	0.80 ± 0.10	0.55 ± 0.10	0.80 ± 0.20	0.55 ± 0.10
^{208}Tl	<0.18	<0.18	<0.18	<0.18
^{214}Pb	<0.32	<0.32	<0.32	<0.32
^{214}Bi	<0.69	<0.69	<0.69	<0.69
^{212}Pb	<0.25	<0.25	<0.25	<0.25
^{137}Cs	<0.08	<0.08	<0.08	<0.08
^{228}Ac	<0.60	<0.60	<0.60	<0.60

TABLE 10. (Continued)

	Location (Direction and Distance from the Nuclear Sciences Area[a]				
	South 0.8 km (0.5 miles)	South 3.1 km (1.9 miles)	West 4.8 km (3.0 miles)	West 8.0 km (5.0 miles)	On Site
Number of Composite Samples	3	3	3	3	6
Nuclide	Average Concentration pCi/g (dry)[b]				
^{134}Cs	0.40 ± 0.10	0.70 ± 0.20	0.40 ± 0.10	0.76 ± 0.11	0.90 ± 0.20
^{208}Tl	<0.18	<0.18	<0.18	<0.18	<0.18
^{214}Pb	<0.32	<0.32	<0.32	<0.32	<0.32
^{214}Bi	<0.69	<0.69	<0.69	<0.69	<0.69
^{212}Pb	<0.25	<0.25	<0.25	<0.25	<0.25
^{137}Cs	<0.08	<0.08	<0.08	<0.08	<0.08
^{228}Ac	<0.60	<0.60	<0.60	<0.60	<0.60

Note: No standards for radionuclides in soil have been established.

(a) Locations are shown in Figure 5.

(b) Minimum Detection Limit for nuclides (in pCi/g dry wt.) are as follows: ^{134}Cs 0.10, ^{208}Tl 0.18, ^{214}Pb 0.32, ^{214}Bi 0.69, ^{212}Pb 0.25, ^{137}Cs 0.08, ^{228}Ac 0.60.

(c) No detectable activity.

TABLE 11. SUMMARY OF FISH ANALYSES

CY-1978

Location[a]	Period of Collection	Number of Composite Samples	pCi/g dry[b]		
			^{238}Pu	^{239}Pu	^{90}Sr
Darby Creek	1st qtr.	1	0.00 ± 0.01	0.00 ± 0.01	0.58 ± 0.11
Battelle Lake	1st qtr.	1	0.00 ± 0.01	0.00 ± 0.01	0.28 ± 0.09
Darby Creek	2nd qtr.	1	0.00 ± 0.01	0.00 ± 0.01	0.58 ± 0.11
Battelle Lake	2nd qtr.	1	0.00 ± 0.01	0.00 ± 0.01	0.28 ± 0.09
Darby Creek	3rd qtr.		(c)		
Battelle Lake	3rd qtr.	-	(c)		
Darby Creek	4th qtr.		(c)		
Battelle Lake	4th qtr.		(c)		

Note: No standards for radionuclides in fish have been established.

(a) Locations are shown in Figure 6.

(b) Minimum Detection Limit for ^{90}Sr in fish was 0.09 pCi/g dry weight for composite samples and 0.01 pCi/g dry weight for ^{238}Pu and ^{239}Pu.

(c) No fish samples collected during third and fourth quarters of CY 1978.

FIGURE 6. MAP OF SITE BOUNDARY AIR SAMPLING LOCATIONS AND BATTELLE LAKE AND DARBY CREEK WATER SAMPLING LOCATIONS

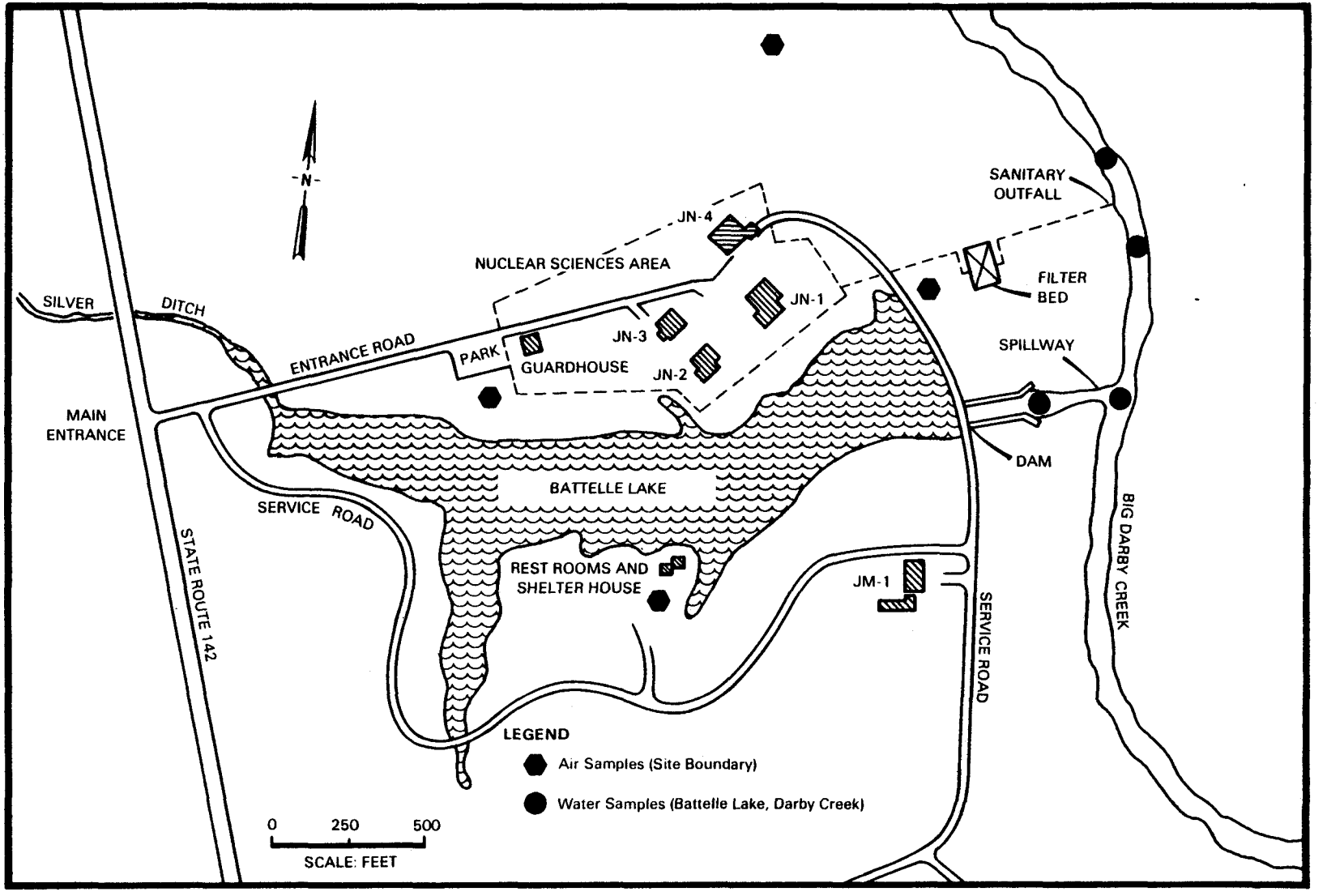

FIGURE 7. BATTELLE'S COLUMBUS LABORATORIES
KING AVENUE SITE

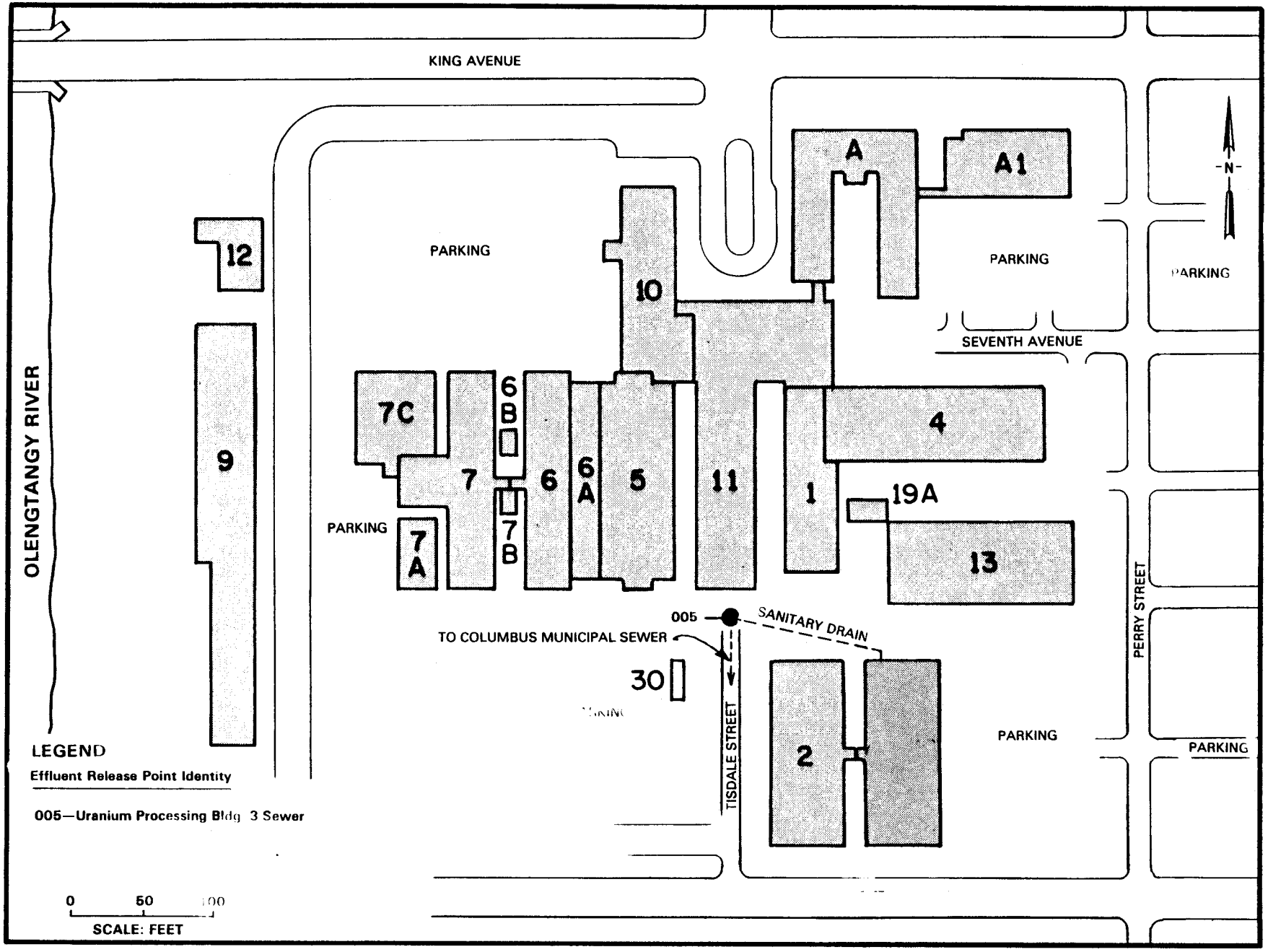

TABLE 12. EXTERNAL BACKGROUND RADIATION LEVELS WITHIN 3/4-MILE RADIUS - WEST JEFFERSON SITE

Location and Distance[a]	Exposure to TLD in Rem				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total for Year
Southwest					
400 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
2400 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
4050 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
West					
500 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
2070 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
Southeast					
1200 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
3300 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
South					
1350 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
1800 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
3600 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
East					
1380 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
Northeast					
1200 ft.	<0.030	<0.030	<0.030	<0.030	<0.120
Northwest					
1320 ft.	<0.030	<0.030	0.030	0.030	0.120
North					
1500 ft.	<0.030	<0.030	<0.030	<0.030	<0.120

(a) Refer Figure 8.

TABLE 13. EXTERNAL BACKGROUND RADIATION LEVELS AT PERIMETER SECURITY FENCE - WEST JEFFERSON SITE

Location and Distance[a]	Exposure to TLD in Rem				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total for Year
Southwest					
100 ft. JN-3	<0.030	<0.030	<0.030	<0.030	<0.120
150 ft. JN-2	<0.030	<0.030	<0.030	<0.030	<0.120
175 ft. JN-1	<0.030	<0.030	<0.030	<0.030	<0.120
West					
75 ft. JN-2	<0.030	<0.030	<0.030	<0.030	<0.120
150 ft. JN-3	<0.030	<0.030	<0.030	<0.030	<0.120
Southeast					
150 ft. JN-4	0.050	0.050	<0.030	<0.030	<0.140
200 ft. JN-1	<0.030	<0.030	<0.030	<0.030	<0.120
240 ft. JN-1	<0.030	<0.030	<0.030	<0.030	<0.120
250 ft. JN-1	<0.030	<0.030	0.030	<0.030	<0.120
South					
150 ft. JN-2	<0.030	<0.030	<0.030	<0.030	<0.120
160 ft. JN-1	<0.030	<0.030	<0.030	<0.030	<0.120
190 ft. JN-1	0.030	0.050	0.040	<0.030	<0.150
East					
150 ft. JN-4	0.030	<0.030	0.030	0.020	<0.120
230 ft. JN-1	0.030	<0.030	0.040	0.080	<0.180
240 ft. JN-1	0.040	<0.030	0.040	0.120	<0.230
Northeast					
150 ft. JN-4	<0.030	<0.030	<0.030	<0.030	<0.120
225 ft. JN-4	<0.030	<0.030	<0.030	<0.030	<0.120
250 ft. JN-1	0.030	<0.030	0.030	0.060	<0.150
260 ft. JN-1	0.030	<0.030	0.030	0.100	<0.190
275 ft. JN-3	<0.030	<0.030	<0.030	<0.030	<0.120
Northwest					
200 ft. JN-4	<0.030	<0.030	<0.030	<0.030	<0.120
250 ft. JN-3	<0.030	<0.030	<0.030	<0.030	<0.120
North					
150 ft. JN-4	<0.030	<0.030	<0.030	<0.030	<0.120
200 ft. JN-4	<0.030	<0.030	<0.030	<0.030	<0.120
300 ft. JN-3	<0.030	<0.030	<0.030	<0.030	<0.120

(a) Refer Figure 9.

TABLE 14. CONCENTRATION OF RADIOACTIVITY IN LIQUID DISCHARGES TO COLUMBUS MUNICIPAL SANITARY SEWERAGE SYSTEM

CY-1978

Nuclide	Location Figure 7	Number of Samples	Activity, μCi/yr	Concentration Range,[a] 10^{-9} μCi/ml	Concentration Average, 10^{-9} μCi/ml	Percent of RCG[b]
Gross α	005	11	211.2	<MDL-41.6	1.6	1.7
Gross β	005	11	686.4	<MDL-9.9	5.2	

(a) Minimum Detection Limit (MDL) for: gross alpha: 0.9×10^{-9} μCi/ml; gross beta: 2.0×10^{-9} μCi/ml.

(b) RCG - Mixture of alpha and beta activity: 400×10^{-9} μCi/ml.

FIGURE 8. MAP OF TLD LOCATIONS WITHIN ¾ MILE RADIUS OF THE NUCLEAR SCIENCES AREA

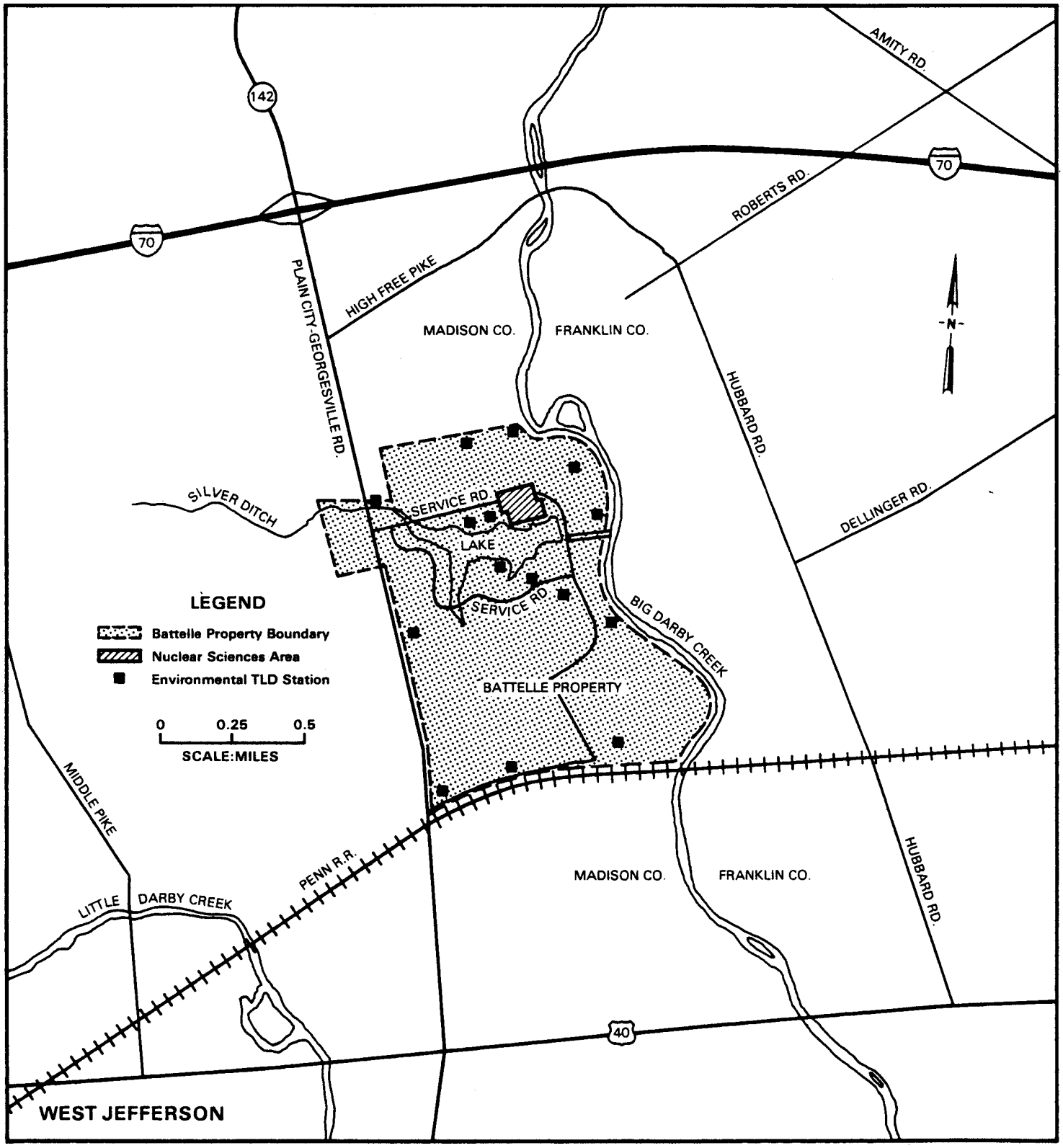

FIGURE 9. MAP OF TLD LOCATIONS AT THE PERIMETER SECURITY FENCE

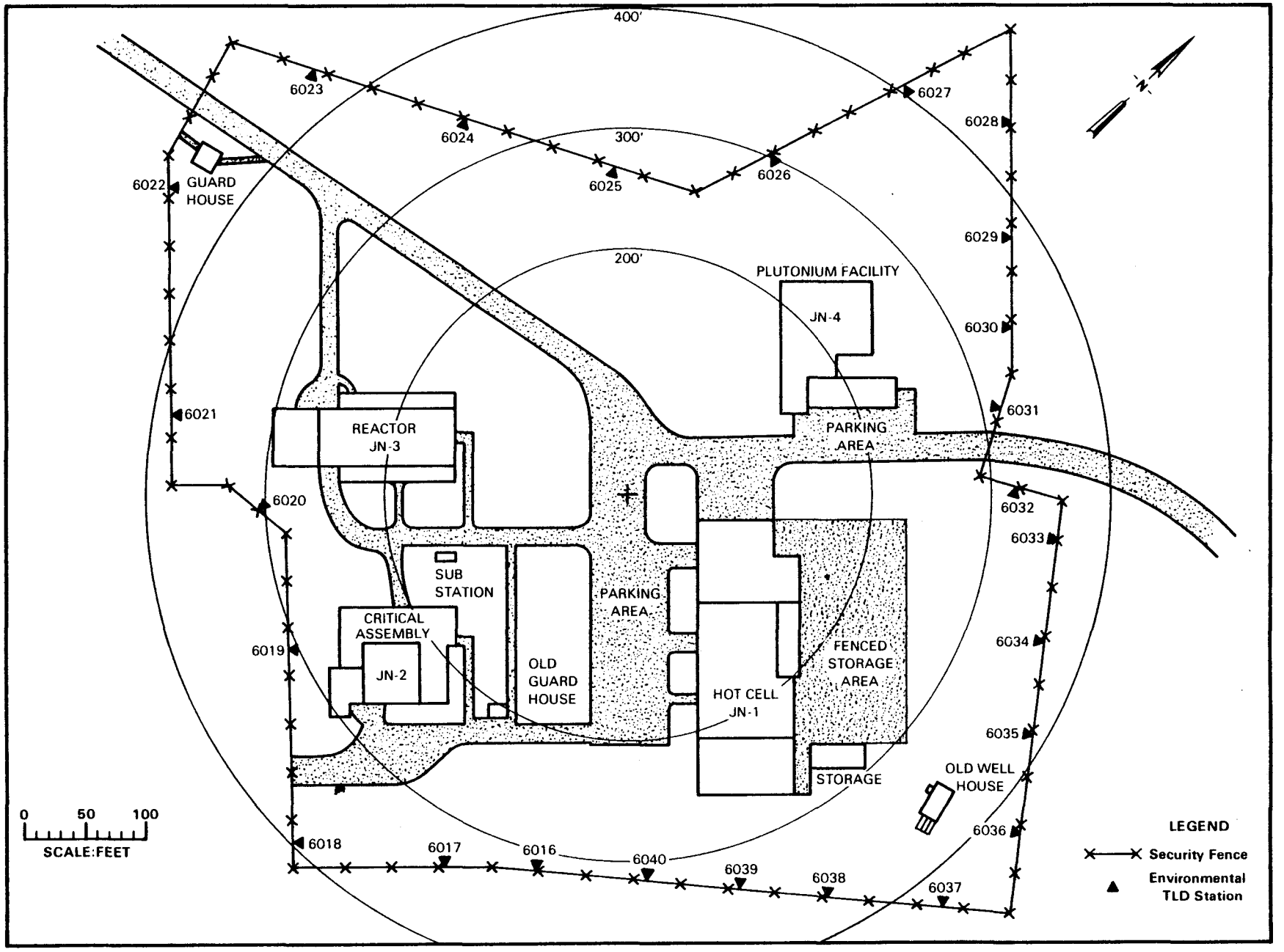

FIGURE 10. MAP OF COLUMBUS AND VICINITY SHOWING OFF SITE AIR SAMPLING LOCATIONS

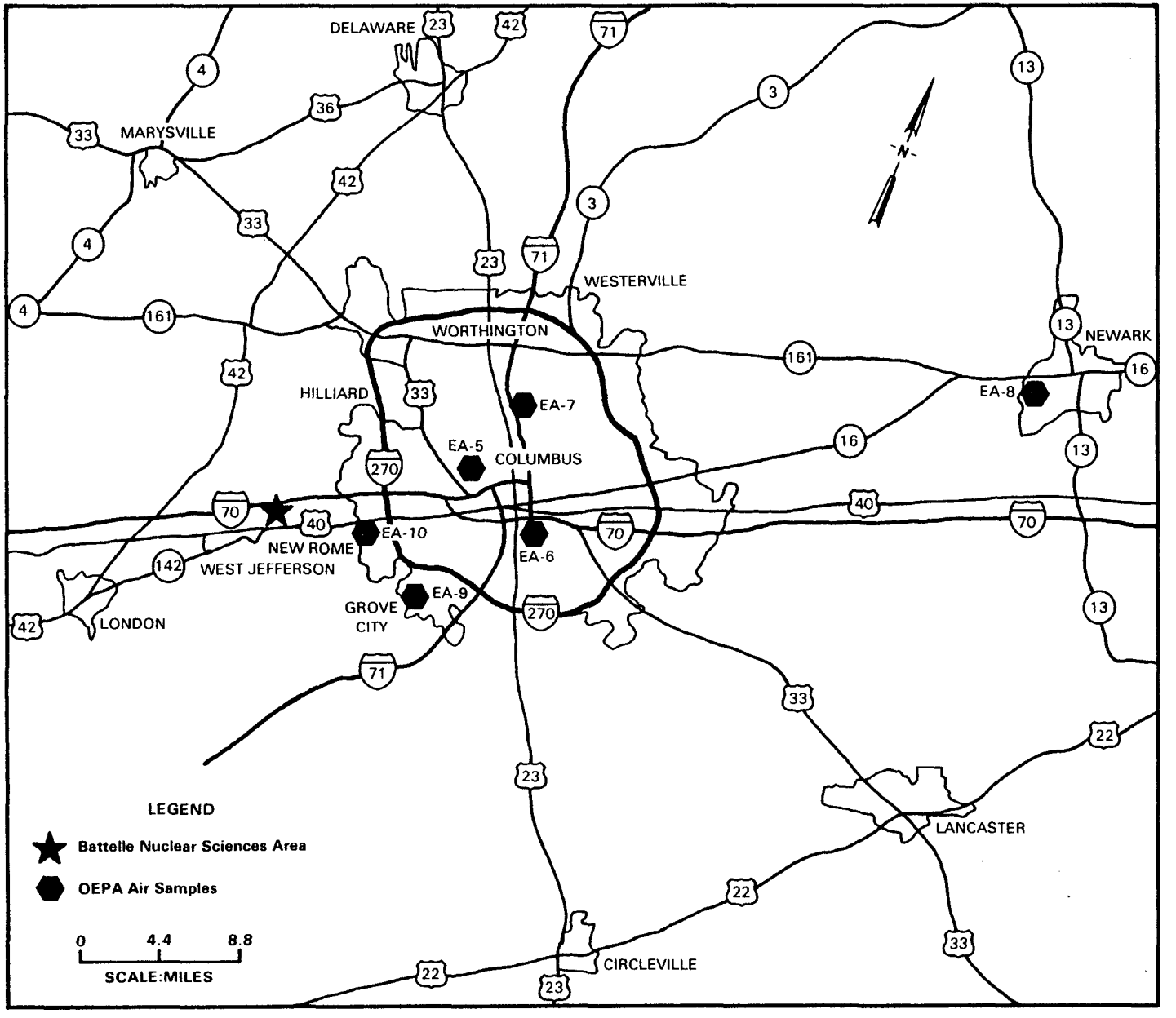

FIGURE 11. 1978 WIND ROSE PATTERN FOR WEST JEFFERSON SITE

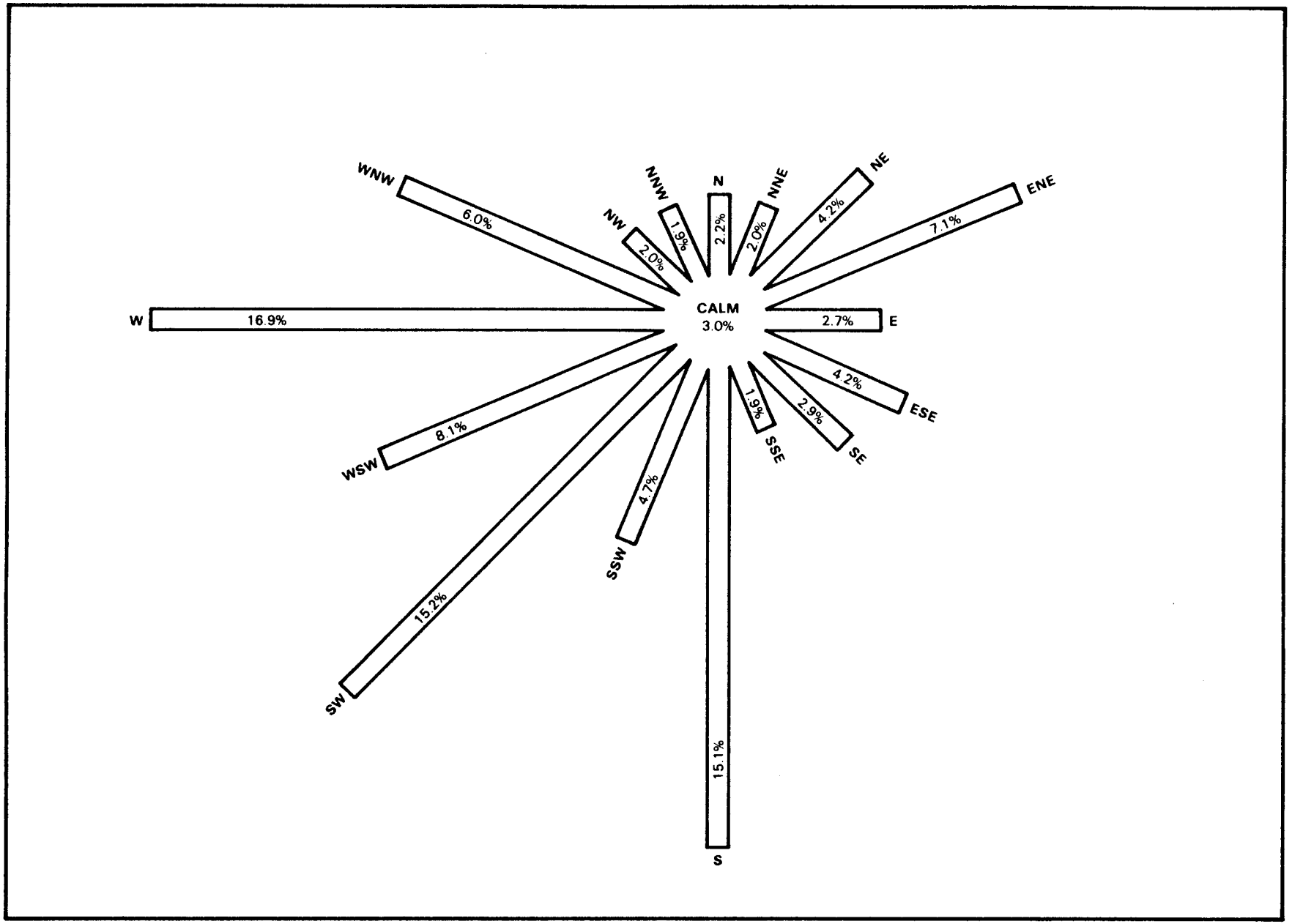

TABLE 15. TOTAL RELEASES OF RADIOACTIVITY

CY-1978

West Jefferson Site

Air	Activity (μCi)
Gross Alpha	0.03
Gross Beta	0.76
Plutonium-239	1.14
Cobalt-60	26.77
Cobalt-57	2.13
Thallium-208	2.71
Cesium-137	4.41
Lead-210	0.30
Cesium-134	0.25
Lead-212	0.88
Lead-214	0.52
Chromium-51	1.91
Tin-113	0.13
Zirconium-95	0.61
Krypton-85m	0.02
Bismuth-214	37.59
Cerium-144	0.07
Antimony-125	9.64
Terbium-160	0.10
Krypton-85	1859.70
Rhodium-103m	0.65
Ruthenium-103	1.02
Actinium-228	0.20
Bismuth-207	0.12
Zenon-138	0.04
Mercury-203	1.05
Water	
Gross Alpha	0.03
Gross Beta	0.14
Iodine-129	0.048
Cesium-137	0.17
Strontium-90	0.073
Plutonium-238	0.0006
Plutonium-239	0.0004
Radium-226	0.002
Radium-228	0.001

TABLE 15. (Continued)

King Avenue Site	
Water	Activity (μCi)
Gross Alpha	211.2
Gross Beta	686.4

EVALUATION OF DOSE TO THE PUBLIC

Estimated Radiation Doses to the Public from Emissions from the Battelle West Jefferson Site During CY 1978

The following information is presented to report and evaluate the possible radiation dose to the public resulting from DOE contract operations at Battelle's nuclear facilities at West Jefferson, Ohio. The procedures used to estimate radiation doses utilize standard methods as recommended by ICRP[4] or specified by DOE[5]. Details concerning the calculational methodology can be found in our report for CY 1972.

Radioactive Emissions from the West Jefferson Site for 1978

Atmospheric Discharges

Measured releases and ground level annual average concentrations at the site boundary during 1978 for the West Jefferson Site are summarized in Table 2. The site boundary, which determines the perimeter for uncontrolled exposure, is considered coincident with the downwind position from the facility where the annual ground level concentrations will be highest. This point is on BCL property but outside the security fence. Analyses of the data in Tables 2 and 3 show that the total mixed fission product (MFP) beta releases for 1978 amounted to 89.4 μCi with a total average concentration at the site boundary of 1.1×10^{-15} μCi/ml. Based on isotopic analyses of the stack effluents from the JN-1 facility, the principal radionuclides were determined to be cobalt-60, cobalt-57, cesium-137, lead-212, zirconium-95, lead-210, cerium-144, bismuth-207, mercury-203, tin-113, antimony-125, actinium-228, cesium-134, niobium-95, rhodium-103, and terbium-160. An average composition of the effluents containing these radionuclides emitted from the five stacks of the JN-1 facility was calculated from the isotopic concentrations given in Table 3, and this was used in evaluating the dose from the MFP beta releases. The total krypton-85 emission was 1.78 mCi with a corresponding average concentration at the site boundary of 2.3×10^{-14} μCi/ml. The total alpha activity emissions were 1.17 μCi and review of facility operation for 1978 indicates that most of this was due to plutonium-239. Therefore, all the alpha emissions should be considered to be plutonium-239 only with an annual average concentration at the site boundary of 2.9×10^{-18} μCi/ml.

Liquid Discharges

Measured aqueous releases and effluent concentrations during 1978 for the West Jefferson Site are summarized in Table 4. The concentration values apply to the water discharged into Big Darby Creek after passage through a conventional leaching bed. Based on knowledge gained from an isotopic

inventory of radionuclide concentrations in the leaching bed, emissions should be due to very limited elution from the leach bed of contaminants that were delivered to the bed in past years. Therefore, the alpha activity is considered to be primarily uranium-238 and the gross beta activity should contain only relatively long-lived radionuclides.

Estimated Radiation Dose to the Public from Atmospheric Discharges

Calculation of Atmospheric Dispersion Parameters

In all cases Columbus Meteorological data[6] were used as input to compute the annual average dispersion parameters for the site. The air quality Display Model computer program[7], modified for localized applications, was used to generate the required X/Q data. Thus, annual average X/Q values were developed for a series of concentric rings extending from the site boundary out to a distance of 50 miles. (Refer to Figure 1.) The annular rings were broken down into sixteen sectors corresponding to the normal wind rose pattern. (Refer to Figure 11.)

Calculation of Individual and Population Group Doses

The annual radiation dose to persons from gaseous or particulate radionuclides discharged into the atmosphere was calculated for a person continuously immersed in an infinite hemispherical cloud containing the radionuclides. Table 2 lists cloud concentrations at the site boundary which were estimated from the X/Q data noted in the above paragraph. The estimated composition for the MFP source was used to specify individual nuclide concentraitons, and critical organ doses were calculated assuming the more sensitive biological form (soluble or insoluble) was present. Doses arising from the alpha activity emissions were based on plutonium-239, liberated entirely as the insoluble oxide form. The maximum dose estimate obtained for an individual and for the nearest population group are summarized in Table 16.

The estimated off site doses listed in the table are very low compared to the maximum permissible exposures (MPE) which have been recommended by the ICRP[4] and other groups for the general public. The MPE values recommended for an individual are: bone - 3 rem/yr, GI tract - 1.5 rem/yr, whole body - 0.5 rem/yr, skin - 3 rem/yr, throid - 3 rem/yr, lung - 1.5 rem/yr, and kidney - 1.5 rem/yr. The recommended values for a population group are one-third of these values. Therefore, from Table 16 it may be seen that the largest fraction of MPE occurs to the kidney and is 0.002% of the recommended limits at the site boundary. In addition, exposure of persons to natural background radiation in the area would be less than 0.16 rem/yr as measured by TLD stations. Therefore, atmospheric emissions from the site (Table 2) led to estimated radiation doses which are a small fraction of that expected from natural background.

TABLE 16. SUMMARY OF MAXIMUM RADIATION DOSE TO AN INDIVIDUAL AND THE NEAREST POPULATION GROUP (WITHIN TWO MILES OF SITE) FROM ATMOSPHERIC EMISSIONS

CY 1978

Source	Critical Organ	Estimated Doses at Site Boundary: Individual Dose, rem/yr	Estimated Doses at a Radius of Two Miles from Site[a]: Individual Dose, rem/yr	Estimated Doses at a Radius of Two Miles from Site[a]: Population Group Dose, person-rem/yr
MFP	Lung	4.5×10^{-6}	2.7×10^{-9}	1.2×10^{-5}
MFP	Kidney	1.1×10^{-5}	6.5×10^{-9}	2.9×10^{-5}
MFP	GI Tract	3.9×10^{-12}	2.3×10^{-15}	1.0×10^{-11}
^{85}Kr	Total Body	3.8×10^{-8}	2.2×10^{-11}	1.0×10^{-7}
^{85}Kr	Skin	2.3×10^{-7}	1.3×10^{-10}	6.0×10^{-7}
^{239}Pu	Lung	4.4×10^{-6}	2.6×10^{-9}	1.2×10^{-5}

(a) Two miles from site, population of 4500 and atmospheric dilution factor from site boundary of 1700.

Calcualtion of the 50-Mile Integrated Population Annual Dose

The cummulative population dose is the product of the individual radiation dose and the figures from the 1970 census[1] for the population in the various annuli around the site out to a 50-mile radius. Using the release data given on page 13, under Atmospheric Discharges, as input the integrated population dose calculation produced the estimated 50-mile annual person-rem doses listed in Table 17. The values given in this table may be compared against the integrated person-rem/yr dose that would be expected for the population group due to natural background. Since the level of natural background radiation would be essentially constant over the whole area, the corresponding person-rem/yr value is simply the product of the total population and the natural background radiation value. Using a natural background of 0.16 rem/yr and a total population figure of 623,400 produces an integrated population dose from natural background of 9.97×10^4 person-rem/yr. The dose caused by emissions from Battelle's West Jefferson Site is insignificant by comparison.

Table 17. ESTIMATED INTEGRATED 50-MILE POPULATION DOSES

CY-1978

Source	Critical Organ	Integrated 50-Mile Population Dose, person-rem/yr
MFP	Lung	3.1×10^{-4}
MFP	GI Tract	2.7×10^{-10}
MFP	Kidney	7.7×10^{-4}
^{85}Kr	Total Body	2.6×10^{-6}
^{85}Kr	Skin	1.6×10^{-5}
^{239}Pu	Lung	3.1×10^{-4}

Estimated Radiation Dose to the Public from Liquid Discharges

Radiation Dose from Swimming (External Whole Body)

It is not known if any of the area below the outfall on Big Darby Creek is used for swimming purposes; however, such use could be possible.

Swimmers are assumed to receive an external radiation dose from being submerged in water containing radionuclides which are anticipated to be present in the liquid effluent. The measured emissions at the outfall were summarized in Table 4. Only the beta releases were used in calculating the external radiation dose to potential swimmers, since the less penetrating alpha emissions do not make a significant contribution to the total body dose. Using standard decay energy values, the estimated doses for a swimmer who might spend 8 hours in the water each week from June to September 30 were obtained as shown in Table 18. Results are given for two cases: one where the swimmer stays in water near the outfall (dilution factor of 10) and the other where the swimmer remains well downstream such that the discharged activities are completely mixed with the annual average stream flow of Big Darby Creek.

TABLE 18. ESTIMATED RADIATION DOSE TO A SWIMMER (EXTERNAL WHOLE BODY DOSE)

CY-1978

Water Body	Radiation Dose, rem/yr
Outfall Effluent	2.8×10^{-7}
Downstream	1.5×10^{-13}

Radiation Dose Due to Boating and Water Skiing

Big Darby Creek is too small to allow boating and other water recreation sports. Thus, there will be no dose from these activities.

Radiation Dose from Drinking Water

Water from Big Darby Creek below the outfall is not used for drinking prior to its confluence with the Scioto River according to the U.S. Geological Survey; therefore, there will be negligible dose contribution from this source.

Radiation Dose from Eating Fish

There may be limited fishing activity along Big Darby Creek but no estimate of the extent of this activity is available. Radiation dose to man can occur from eating fish which have resided in water which contains radionuclides from the liquid effluent. The concentration of an individual radionuclide in the fish (μCi/g) is assumed to be directly related to the concentration of the radionuclide in the water in which the fish reside multiplied by a bioaccumulation factor.[8] In calculating the radiation dose to a human it was assumed the person consumes an average of 4.8 kg of fish per year, taken from Big Darby Creek either a short distance below the outfall (water dilution factor of 10) or well downstream where the effluent has become completely mixed with the annual average stream flow. Internal radiation doses were estimated on the basis of the discharge data given on pages 22 and 45, under Liquid Discharges, and the composition assumptions noted there.

The doses from eating fish caught in Big Darby Creek are also representative of doses from eating fish caught in Battelle Lake because the overflow from the lake drains into Big Darby Creek and is monitored, at the point of outfall to the creek, to determine the concentrations of radionuclides in the water.

Comparison of the data in Tables 18 and 19 show that fish consumption is expected to be the dominant exposure pathway for persons from liquid emissions at the Battelle West Jefferson Site. However, individuals in this area would routinely be exposed to natural background radiation at levels of about 0.16 rem/yr. Therefore, maximum doses resulting from liquid emissions from the site should have been a small fraction of that produced by natural background.

TABLE 19. ESTIMATED RADIATION DOSES FROM EATING FISH CAUGHT IN BIG DARBY CREEK NEAR THE BATTELLE WEST JEFFERSON SITE

CY-1978

Nuclide	Critical Organ	Radiation Dose, rem/yr (a)					
		Fish Taken Near Outfall			Fish Taken Downstream		
		Adult	Teen	Child	Adult	Teen	Child
^{137}Cs	Total Body	1.5×10^{-3}	8.0×10^{-4}	3.0×10^{-4}	6.5×10^{-9}	3.6×10^{-9}	1.3×10^{-9}
^{90}Sr	Bone	9.9×10^{-4}	8.2×10^{-4}	7.1×10^{-4}	4.4×10^{-9}	3.6×10^{-9}	3.2×10^{-9}

(a) Calculation of rem dose per yr was based on guidelines set forth in U. S. NRC Regulatory Guide 1.109 (8).

REFERENCES

(1) U.S. Census, 1970 Population Data, Dayton, Ohio, Standard Metropolitan Statistical Area.

(2) U.S. Energy Research and Development Administration, Manual Chapter 0524, "Standards for Radiation Protection".

(3) Scioto River Basin Waste Load Allocation Report for the 303 (e) Continuing Planning Process for Water Quality Management.

(4) ICRP Publication 2, "Recommendations of the International Commission on Radiological Protection, Report of Committee II on Permissible Dose for Internal Radiation". Pergamon Press, 1959.

(5) U.S. Energy Research and Development Administration, Manual Chapter 0513, "Effluent and Environmental Monitoring and Reporting".

(6) U.S. Weather Bureau, Weather Information for Columbus, Ohio Decennial Census of United States Climate (1951-1960) Washington, D.C. (1963).

(7) TRW Systems Group, "Air Quality Display Model", Report PB-189194 (Contract PH 22-68-60), November, 1969.

(8) U.S. NRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for Purpose of Evaluating Compliance With 10CFR Part 50, Appendix 1".

APPENDIX

ADDITIVE LEVELS DUE TO RADIONUCLIDE MIXTURE

The "Standards for Radiation Protection" (DOE Manual Chapter 0524) states that a radionuclide may be considered as not present in a mixture if the ratio of its concentration to its RCG is not greater than one-tenth. Furthermore, the sum of all such excluded ratios cannot exceed one-fourth. The sum of the ratios of the concentrations of radionuclides to their respective RCG's are listed below. The sum is presented for maximum levels at the site boundary in both air and water.

West Jefferson Site

Radionuclide	Radionuclide Concentration / RCG
	Air
Plutonium-239	8.98×10^{-2}
Krypton-85	4.59×10^{-5}
Cobalt-60	4.69×10^{-4}
Cobalt-57	2.63×10^{-6}
Cesium-134	1.70×10^{-5}
Lead-212	7.71×10^{-6}
Cesium-137	4.63×10^{-5}
Actinium-228	1.81×10^{-5}
Ruthenium-103	1.85×10^{-5}
Mercury-203	3.89×10^{-6}
Zirconium-95	3.32×10^{-5}
Lead-210	3.21×10^{-4}
Rhodium-103M	1.77×10^{-8}
Cerium-144	9.51×10^{-6}
Antimony-125	7.93×10^{-6}
Terbium-160	8.57×10^{-7}
Tin-113	5.57×10^{-7}
Krypton-85M	1.71×10^{-9}
Bismuth-207	2.06×10^{-6}
Chromium-51	1.30×10^{-6}
	Sum 9.08×10^{-2}

West Jefferson Site

Radionuclide	Radionuclide Concentration RCG Water
Radium-228	1.92×10^{-3}
Radium-226	7.60×10^{-3}
Cesium-137	7.40×10^{-4}
Strontium-90	2.08×10^{-2}
Iodine-129	6.80×10^{-2}
Plutonium-238	1.00×10^{-5}
Plutonium-239	6.66×10^{-6}
	Sum 9.91×10^{-2}

The data indicate that, according to the criteria of DOE Manual Chapter 0524, the sum of the above radios does not exceed one-fourth; therefore, these nuclides are not considered as part of the mixture.

APPLICABLE STANDARDS

Radioactive Standards

In conformance with Federal Radiation Council (FRC) guidelines and DOE Manual Chapter 0524, "Standards for Radiation Protection", site boundary Concentrations are compared with RCG's established for uncontrolled areas.

Uncontrolled Area (Site Boundary)

Air	Concentration, µCi/ml
Plutonium-239	6×10^{-14}
Krypton-85	3×10^{-7}
Cobalt-60	3×10^{-10}
Cobalt-57	6×10^{-9}
Cesium-137	5×10^{-10}
Cesium-134	4×10^{-10}
Lead-210	8×10^{-12}
Lead-212	6×10^{-10}
Actinium-228	6×10^{-10}
Tin-113	2×10^{-9}
Cerium-144	2×10^{-10}

Uncontrolled (Site Boundary)

Air	Concentration, μCi/ml
Chromium-51	8×10^{-8}
Ruthenium-103	3×10^{-9}
Rhodium-103m	2×10^{-6}
Zirconium-95	1×10^{-9}
Krypton-85m	1×10^{-7}
Bismuth-207	5×10^{-10}
Antimony-125	9×10^{-9}
Terbium-160	1×10^{-9}
Mercury-203	2×10^{-9}
Water	
Cesium-137	2×10^{-5}
Iodine-129	6×10^{-8}
Radium-226	3×10^{-8}
Radium-228	3×10^{-8}
Plutonium-238	5×10^{-6}
Plutonium-239	5×10^{-6}
Strontium-90	3×10^{-7}

Mixture

DOE Manual Chapter 0524, "Standards for Radiation Protection", provides for the calculation of guide values in any case where there is a mixture of radionuclides in air or water. The ratio between the concentration of each radionuclide present in the mixture and its respective RCG must first be determined. The sum of these ratios for all the radionuclides in the mixture should not exceed unity. A radionuclide may be considered as not present in the mixture unless the ratio of the concentration of the radionuclide to its RCG is greater than one-tenth, provided that the sum of such excluded ratios does not exceed one-fourth.

Grass and Food Crops

There are no guidelines established for radionuclides in grass and food crops.

Soil and Sediment

There are no guidelines established for radionuclides in soil and sediment. The Environmental Protection Agency's radiation protection requirement for exposures to transuranium elements in the environment necessitates doses to the critical fraction of the unrestricted population be less than 1 mRad/yr to the pulmonary lung and 3 mRad/yr to the bone.

Fish

There are no guidelines established for radionuclides in fish.

Nonradioactive Standards (Water)

Concentrations of nonradioactive species in water are subject to the restrictions of the (NPDES) Permit as were determined by the Ohio EPA following a study of the Scioto River Basin.

External Radiation - General Public

The permissable level of radiation in an uncontrolled area is that which will cause any individual to receive a dose, to the whole body, not exceeding 0.5 rem in any period of one calendar year.

EXTERNAL DISTRIBUTION LIST

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