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Annual Environmental Monitoring Report: Calendar Year 1974

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FOREWORD

This report was prepared by the Environmental Control Section of the Personnel Safety, Waste Management, and Environmental Control Function in the Administrative Services Department at Mound Laboratory. Sample analyses and data reduction were performed by the Analytical and Development group of the Environmental Control Section. Particulate samples and data were also received from the Air Pollution Control Section of the Montgomery County Combined General Health District which acts as the Regional Air Pollution Control Agency in this region for the Ohio Environmental Protection Agency.

INTRODUCTION

Mound Laboratory is situated on 180 acres of land in Miamisburg, Ohio. This location is approximately 16 km (10 miles) southwest of Dayton. The predominant geographical feature in the five-county region surrounding the Laboratory is the Great Miami River which flows from the northeast to the southwest through Miamisburg. This river valley area is generally highly industrialized. The remainder of the region is predominantly agricultural with some light industry and scattered residential communities. The location and population of these communities are shown in Figure 1. 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 livestock.[1]

Weather conditions in the area are described as moderate. The average annual precipitation is approximately 91 cm (36 in.) and is evenly distributed throughout the year. Winds predominate out of the south or west except during the summer months when a higher frequency is observed out of the southwest. The wind speed averages about 16 km (10 miles) per hour annually.[2]

Mound Laboratory began operation in 1949. Its mission currently includes research, development, engineering, and production of components for the ERDA weapons program; research, development, and production of explosive materials; separation, purification, and sale of stable isotopes of the noble gases; and development, design, and fabrication of radioisotopic heat sources for medical application and space exploration. The chief radionuclides currently being handled include plutonium-238 and tritium.

Interest in the health and safety of employes and the public is manifested by an environmental control program which has been in existence continuously during the Laboratory's history. Fundamental objectives of the environmental control program are the containment of radioactive waste and control of nonradioactive effluents to levels well within existing or proposed standards. As part of this control function, all effluents containing polluting materials are controlled at each operating step. As a result of this control, any releases of low-level airborne and liquid wastes to the environment are carefully controlled and dispersed to ensure that concentrations are well within recommended standards.

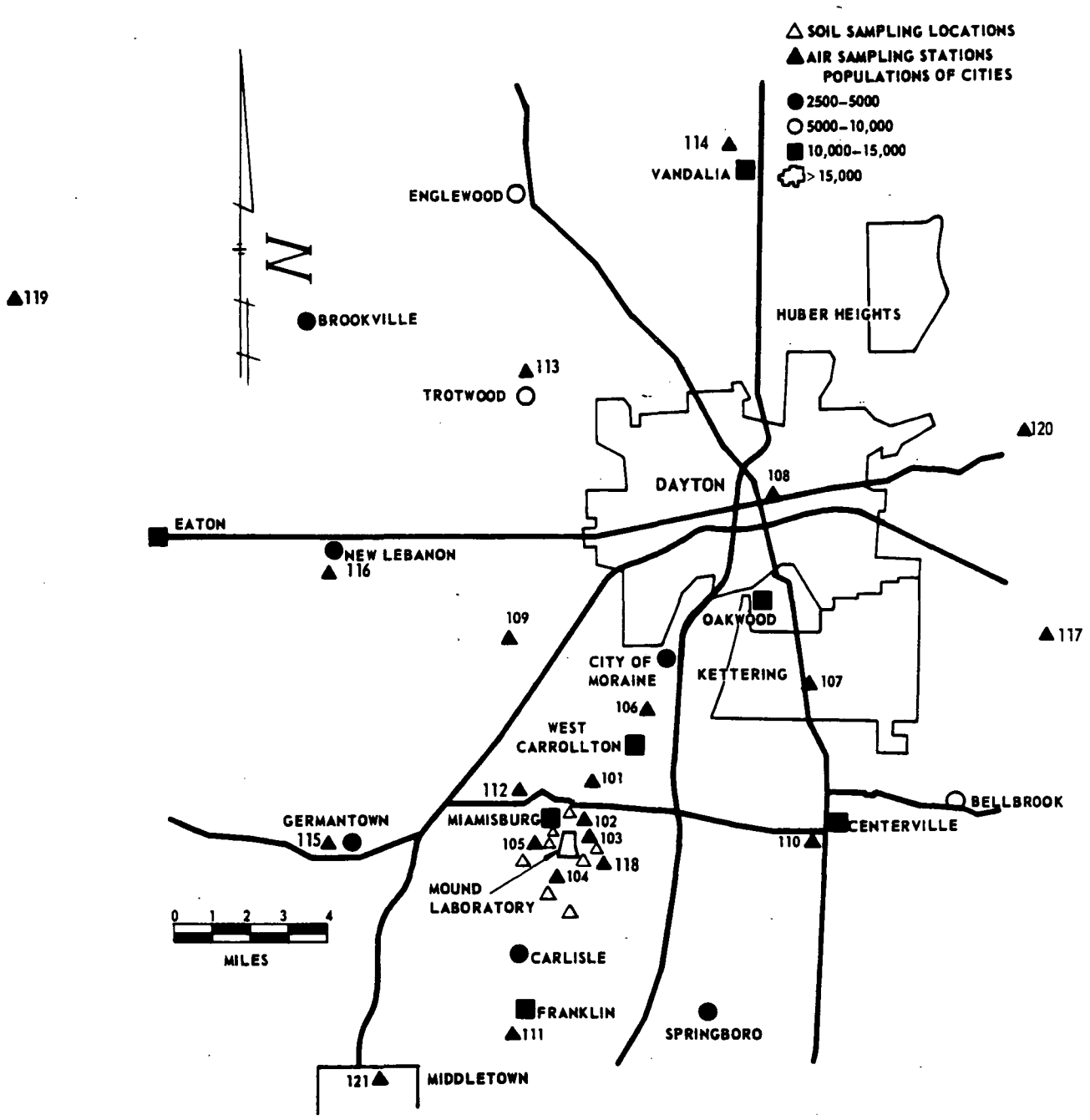

FIGURE 1 - Offsite air and soil sampling locations.

Radionuclides in particulate form are removed from air effluents by the use of high-efficiency particulate air (HEPA) filters. The air effluents are filtered first at the points of origin, i.e., glove boxes, and finally at the release point, i.e., the stack, by two banks of HEPA filters in series. Radionuclides are removed from liquid effluent by chemical processing. Solid radioactive wastes are packaged and shipped offsite for burial at ERDA-approved burial sites. Airborne and liquid wastes generated in the processing of explosive materials are collected and disposed of according to the Army Material Command Regulation 385-100.

A sanitary sewage treatment plant, which provides secondary treatment, is operated in accordance with State of Ohio regulations and handles all domestic sewage generated on site. Solid wastes are disposed of according to a recycling and reclamation program implemented during the first quarter of 1974. White paper, scrap metal, and wood are sold for reclamation. General refuse is transported to the Franklin Reclamation Center, Franklin, Ohio for processing and eventual use in recycled products. Waste solvents and chemicals are removed offsite by a commercial industrial waste disposal firm. As a result, onsite incineration has been discontinued and airborne pollutants resulting from that method of waste disposal have been eliminated.

As part of the Program's monitoring functions, air, water, foodstuff and soil samples are collected from the environment at distances up to 45 km (28 miles) from the Laboratory boundaries. These samples are analyzed for the specific radionuclides handled at the Laboratory as well as non-radioactive pollutants. The sampling techniques, analyses and counting methods are those best suited for the determination of the radionuclides of interest.

A quality control program for environmental analytical procedures has been in effect for several years. There are two parts to the program: internal and external. The internal portion consists of blank and duplicate analyses for each group of samples. The blank results have been consistently small and insignificant in comparison with sample results. The blank results are normally subtracted from the sample results. If a blank result is high, the sample analysis is performed again. The duplicate results for 1974 were also satisfactory. During the Mound Plutonium Study, an intensive quality control program was carried out on the plutonium analysis of silt. The results were satisfactory and indicated that the analytical work was under control throughout the program. The external part of the program consists of sending duplicate samples to an independent laboratory. These results for 1974 were also satisfactory. Three independent laboratories also performed duplicate analyses during the Mound Plutonium Study. Agreement was generally good at all concentration levels.

The results of the analyses for calendar year 1974 are provided in this report. Error limits, when given, reflect the uncertainties in the data at the 95% confidence level due to counting statistics.

SUMMARY

The environment surrounding Mound Laboratory was monitored and results reported for calendar year 1974. Samples analyzed included air, water, foodstuffs, soil, and silt. For radioactive species, the average concentrations of polonium-210, plutonium-238, and tritium detected were well within the stringent standards adopted by the Energy Research and Development Administration and the Environmental Protection Agency. Data concerning nonradioactive species in air and water are also presented.

The average concentrations of polonium-210, plutonium-238 and tritium measured in air during this period were less than 0.07%, 0.5% and 0.2% of their respective Radioactivity Concentration Guides (RCG's).

Water monitoring in the Great Miami River for radioactive species found the average concentrations of plutonium-238 and tritium measured at the water sampling locations during this period to be less than 0.07% and 0.3% of their respective RCG's.

Additionally, data concerning radioactive species in surface water, community drinking water, foodstuffs, and silt are presented. No significant uptake of radioactive species from air or water by plant or animal life has been observed. No significant reentrainment of radioactive species from soil or silt is indicated at this time. Soil core sample analyses will continue to establish a plutonium-238 soil inventory as part of the total program to assess the impact of the Laboratory's operations on the environment.

Water monitoring for nonradioactive species was conducted. These results indicate that Mound's effluent streams have no significant effect on the Great Miami River and most likely do not cause Ohio Stream Standards to be exceeded.

These data reflect the effectiveness of Mound Laboratory's Environmental Control Program. They indicate that the operation of the Laboratory does not have a measurable effect on the environment and that effluents are well within emission standards.

ENVIRONMENTAL MONITORING

Air - Radioactive

An offsite air sampling network consisting of 21 continuously operating air sampling stations is utilized to assess the effectiveness of systems controlling airborne emissions. Seven sampling stations are located within a 1.6-km (1-mile) radius of the Laboratory. This array of seven samplers surrounding the Laboratory ensure detection of any inadvertent release of radioactive materials and prompt assessment of the environmental impact, if any. Thirteen of the remaining samplers are located in or near population centers ranging from Vandalia, which is 33.6 km (21 miles) to the north, to Middletown, which is 16 km (10 miles) to the south. The remaining sampler (#119) is located at a distance approximately 44.8 km (28 miles) from the Laboratory in the least prevailing wind direction. This site should receive no measurable contribution from Mound Laboratory operations and serves as a background sample for comparison purposes. The sampling sites are shown in Figure 1.

Two types of samples are collected at each sampling station: a particulate air sample for plutonium-238 and polonium-210 analysis, and a gas bubbler sample for tritium oxide analysis. The particulate sample is collected on a 200mm diameter Microsoban disk by means of a continuously operating (24 hours, 7 days per week) high volume air sampler. The air is sampled at the rate of 1×10^6 cc/min (40 ft^3/min). The Microsorban disk is changed weekly, which represents a sample of approximately 10,000 m^3 of air. Polonium-210 analyses are performed on a weekly basis while the plutonium-238 analyses are performed on a monthly composite sample.

The analytical scheme for plutonium-238 incorporates the following basic steps: addition of a known amount of plutonium-242 tracer, ignition to 600° C., dissolution with nitric acid, separation of plutonium with anion exchange resin, electrodeposition of plutonium and finally alpha spectrometry. The use of plutonium-242 as an internal standard allows a correction to be made for chemical recovery. All plutonium analyses of environmental samples use this basic scheme after proper pre-treatment of the samples. The results reported represent total concentrations of the analyzed radionuclides including contribution from natural sources and atmospheric fallout.

Since commercial sales of polonium-210 from Mound Laboratory have ceased, and the concentration of polonium-210 measured in the atmosphere has significantly decreased, samples collected at only two offsite locations were analyzed weekly for polonium-210 during 1974. If a significant increase in the concentration of polonium-210 is observed at these locations, additional analyses at other locations will be performed to assure that control of emissions is still effective; i.e., well within stringent ERDA standards. The results of the polonium-210 analyses are summarized in Table 1. Average concentrations measured were only 0.07% or less of the Radioactivity Concentration Guide (RCG). As a result, no further analyses were performed. It should be noted that the more

restrictive RCG for the insoluble form of polonium was used for this comparison. (A listing and discussion of RCG's are located in the appendix of this report.)

The average plutonium-238 concentrations measured were all less than 0.5% of the RCG. The RCG used for comparison is the guide for the soluble form of the isotope and for the general population. This is the most restrictive RCG for plutonium-238 and is applied since the solubility of the measured particles in the potential receptor, i.e., the human body, is unknown at this time. The results are summarized in Table 2. Included in Table 2 are plutonium-239 concentrations and the ratio of plutonium-238 to plutonium-239 measured at these same locations. The relatively good agreement of the average ^{239}Pu concentrations from location to location is a good indicator of the reliability of the plutonium analyses. The range of ^{239}Pu values which made up the averages were 0.4 to 13 x 10^{-17} microcuries/ml. These ^{239}Pu values are well within the values of 0.8 to 28.3 x 10^{-17} microcuries/ml reported by HASL for the first part of 1974.[4] The ratio of ^{238}Pu to ^{239}Pu is approximately 0.2 for atmospheric fallout. A ratio significantly greater than 0.2 would indicate a concentration of ^{238}Pu greater than that due to atmospheric fallout and most likely due to Mound Laboratory operations.

The gas bubbler sample is also collected on a continuous basis by bubbling air at approximately 3 x 10^3cc/min through 500 ml of water. Any tritium oxide present in the air is collected in the solution. The sampling and analysis is directed to tritium oxide rather than elemental tritium since the RCG for the oxide is two hundred times more restrictive. A sample representing 30 m^3 of air is collected and an aliquot of this counted in a liquid scintillation spectrometer. The average concentrations of tritium oxide measured during 1974 were all less than 0.2% of the RCG. These results are summarized in Table 3. For averaging purposes, samples less than the minimum detection limit are assumed to be the value of the limit and the average is expressed as less than (<) the computed value.

TABLE 1

CONCENTRATION OF ^{210}Po IN AIR AT OFFSITE SAMPLING LOCATIONS
CY-1974

Location*	Number of Samples	Range (10^{-15}µCi/ml)	Average** (10^{-15}µCi/ml)	Percent of RCG***
101	52	0.59 - 3.0	1.2 ± 0.07	0.06
108	47	0.43 - 2.4	1.3 ± 0.08	0.07

* Samples from only two locations analyzed because of significant decrease in concentrations measured in atmosphere. See page 8.

** Minimum detection limit (MDL) for ^{210}Po in air is 0.02 x 10^{-15}µCi/ml, which is 0.0003% of the RCG.

*** RCG - Radioactivity Concentration Guide = 2000 x 10^{-15}µCi/ml.

TABLE 2

CONCENTRATION OF Pu IN AIR AT OFFSITE SAMPLING LOCATIONS
1974

Location	Number of Samples	^{238}Pu Range (10^{-17} μCi/ml)	^{238}Pu Average* (10^{-17} μCi/ml)	Percent of RCG**	^{239}Pu Average (10^{-17} μCi/ml)	$^{238}Pu/^{239}Pu$
101	52	2.3 - 31.6	10.0 ± 0.4	0.5	3.1 ± 0.2	3.2
102	53	0.96 - 29.3	6.0 ± 0.3	0.3	2.8 ± 0.2	2.1
103	53	1.8 - 33.5	6.4 ± 0.3	0.3	3.2 ± 0.2	2.0
104	53	0.38 - 3.4	1.3 ± 0.2	0.07	3.3 ± 0.2	0.39
105	35	0.33 - 3.6	1.2 ± 0.1	0.06	3.4 ± 0.3	0.35
106	22	0.21 - 2.1	0.63 ± 0.11	0.03	3.5 ± 0.3	0.18
107	30	0.06 - 3.7	0.60 ± 0.11	0.03	3.4 ± 0.3	0.18
108	47	0.60 - 8.4	3.2 ± 0.2	0.2	3.4 ± 0.3	0.94
109	53	0.12 - 1.6	0.56 ± 0.10	0.03	3.7 ± 0.3	0.15
110	18	0.19 - 4.3	1.3 ± 0.2	0.06	1.3 ± 0.2***	1.0
111	53	0.09 - 3.2	0.78 ± 0.12	0.04	3.0 ± 0.2	0.26
112	53	0.28 - 7.9	2.0 ± 0.2	0.1	2.7 ± 0.2	0.74
113	53	0.08 - 2.3	0.56 ± 0.10	0.03	2.9 ± 0.2	0.19
114	53	0.17 - 1.5	0.63 ± 0.11	0.03	2.8 ± 0.2	0.23
115	50	0.03 - 7.1	1.0 ± 0.1	0.05	3.4 ± 0.3	0.29
116	47	0.07 - 3.5	0.56 ± 0.10	0.03	2.9 ± 0.2	0.19
117	48	0.07 - 3.2	0.73 ± 0.12	0.04	3.0 ± 0.2	0.24
118	53	0.40 - 3.2	1.4 ± 0.2	0.07	3.0 ± 0.2	0.47
119	48	0.11 - 0.54	0.19 ± 0.06	0.01	2.9 ± 0.2	0.07
120	53	0.16 - 1.9	0.43 ± 0.09	0.02	3.6 ± 0.3	0.12
121	53	0.05 - 2.8	0.55 ± 0.10	0.03	3.2 ± 0.2	0.17

* Minimum Detection Limit (MDL) for ^{238}Pu is air is 0.036×10^{-17} μCi/ml which is 0.002% of of the RCG.

** RCG - Radioactivity Concentration Guide = 2000×10^{-17} μCi/ml.

*** Samples were collected only during the fall season at this location when ^{239}Pu concentrations are typically lower.

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TABLE 3

CONCENTRATIONS OF TRITIUM OXIDE IN AIR AT OFFSITE SAMPLING LOCATIONS
1974

Location	Number of Samples	Range (10^{-11} µCi/ml)	Average* (10^{-11} µCi/ml)	Percent of RCG **
101	53	<0.2 - 90	<11.0 ± 1.0	<0.2
102	53	<0.2 - 170	<14.0 ± 1.1	<0.2
103	53	<0.2 - 249	<14.8 ± 1.1	<0.2
104	53	<0.2 - 52	< 4.9 ± 0.7	<0.07
105	53	<0.2 - 51	< 5.4 ± 0.8	<0.08
106	53	<0.2 - 23	< 2.9 ± 0.7	<0.04
107	52	<0.2 - 26	< 2.1 ± 0.6	<0.03
108	52	<0.2 - 14	< 1.6 ± 0.6	<0.02
109	53	<0.2 - 13	< 1.5 ± 0.6	<0.02
110	52	<0.2 - 9	< 1.7 ± 0.6	<0.03
111	52	<0.2 - 6	< 1.1 ± 0.5	<0.02
112	53	<0.2 - 53	< 4.0 ± 0.7	<0.06
113	53	<0.2 - 5	< 0.9 ± 0.5	<0.01
114	53	<0.2 - 6	< 0.8 ± 0.5	<0.01
115	53	<0.2 - 16	< 1.2 ± 0.6	<0.02
116	53	<0.2 - 10	< 1.0 ± 0.5	<0.01
117	53	<0.2 - 4	< 0.7 ± 0.5	<0.01
118	53	<0.2 - 180	< 8.7 ± 0.9	<0.1
119	52	<0.2 - 4	< 0.7 ± 0.5	<0.01
120	53	<0.2 - 3	< 0.6 ± 0.5	<0.01
121	53	<0.2 - 3	< 0.8 ± 0.5	<0.01

* Minimum Detection Limit (MDL) for tritium oxide in air is 0.2×10^{-11} µCi/ml, which is 0.004% of the RCG.

** RCG - Radioactivity Concentration Guide = 7000×10^{-11} µCi/ml.

An onsite perimeter network consisting of five continuous, high volume air samplers is used to further assess the effectiveness of control systems. The onsite sampling locations are shown in Figure 2. Particulate and gas samples are collected by the onsite samplers at the same flow rate as the offsite samplers, i.e., 1×10^6 cm^3/min and 3×10^3 cm^3/min, respectively. The samples are also analyzed in the same manner as the offsite samples with the exception that all onsite samples are also analyzed for polonium-210. The results of the onsite polonium-210 analyses are summarized in Table 4. The average concentrations of polonium-210, measured during 1974 at the onsite sampling stations, were all 0.02% or less of the RCG. The RCG used for comparison for these onsite samples as well as plutonium and tritium oxide samples is the guide for an uncontrolled area as listed in the appendix.

The average plutonium-238 concentrations measured onsite were all less than 1.2% of the RCG and are summarized in Table 5.

The results of the onsite tritium oxide analyses are summarized in Table 6. The average concentrations measured were all less than 0.2% of the RCG.

The total amounts of polonium-210, plutonium-238, and tritium discharged to the atmosphere during 1974 were 0.7 μCi, 28 μCi, and 10,000 Ci, respectively.

TABLE 4

CONCENTRATIONS OF ^{210}Po IN AIR AT ONSITE SAMPLING LOCATIONS 1974

Location	Number of Samples	Range (10^{-15}μCi/ml)	Average* (10^{-15}μCi/ml)	Percent of RCG**
211	52	0.31 - 2.8	1.1 ± 0.07	0.02
212	50	0.42 - 2.2	1.2 ± 0.07	0.02
213	53	0.60 - 2.5	1.1 ± 0.07	0.02
214	53	0.63 - 2.5	1.1 ± 0.07	0.02
215	52	0.46 - 2.4	1.1 ± 0.07	0.02

* Minimum Detection Limit (MDL) for ^{210}Po in air is 0.02×10^{-15}μCi/ml, which is 0.0001% of the RCG.

** RCG - Radioactivity Concentration Guide = 7000×10^{-15}μCi/ml.

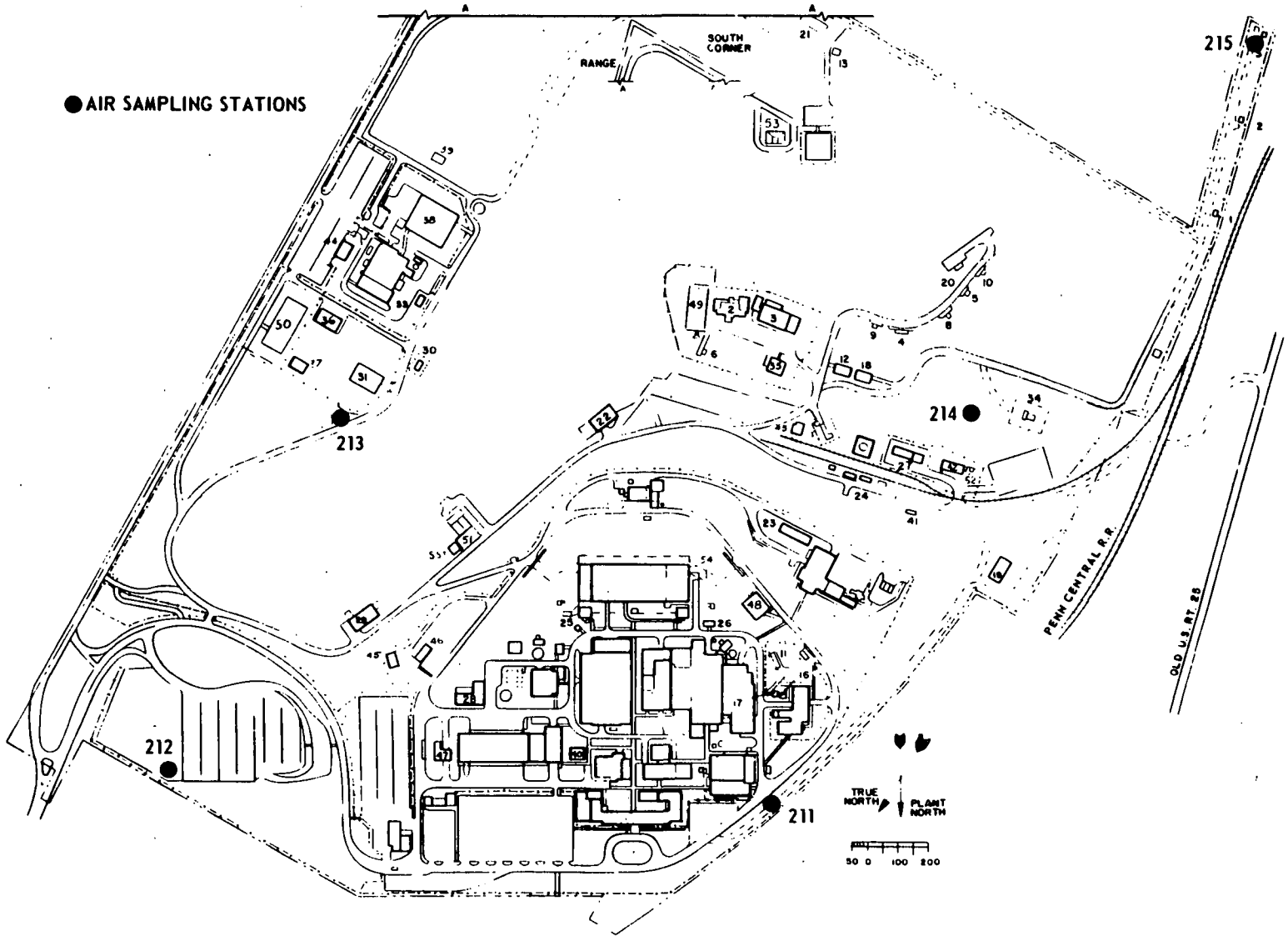

FIGURE 2 - Onsite air sampling locations.

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TABLE 5

CONCENTRATION OF ^{238}Pu IN AIR AT ONSITE SAMPLING LOCATIONS
1974

Location	Number of Samples	Range ($10^{-17}\mu Ci/ml$)	Average* ($10^{-17}\mu Ci/ml$)	Percent of RCG**
211	52	5.1 - 392	81 ± 1.2	1.2
212	50	6.0 - 53	19 ± 0.6	0.3
213	53	20 - 190	57 ± 1.1	0.8
214	53	6.7 - 46	17 ± 0.6	0.3
215	52	2.3 - 19	8.2 ± 0.4	0.1

* Minimum Detection Limit (MDL) for ^{238}Pu in air is $0.036 \times 10^{-17}\mu Ci/ml$, which is 0.0007% of the RCG.

** RCG - Radioactivity Concentration Guide = $7000 \times 10^{-17}\mu Ci/ml$.

TABLE 6

CONCENTRATION OF TRITIUM OXIDE IN AIR AT ONSITE SAMPLING LOCATIONS
1974

Location	Number of Samples	Range ($10^{-11}\mu Ci/ml$)	Average ($10^{-11}\mu Ci/ml$)	Percent of RCG**
211	53	<0.3 - 55	< 8.6 ± 1.3	<0.04
212	50	<0.3 - 122	<11 ± 1.4	<0.05
213	53	2 - 333	32 ± 2.1	0.2
214	53	<0.3 - 144	<17 ± 1.6	<0.09
215	53	<0.3 - 175	<16 ± 1.5	<0.08

* Minimum Detection Limit (MDL) for tritium oxide in air in 0.3×10^{-11} $\mu Ci/ml$, which is 0.002% of the RCG.

** RCG - Radioactivity Concentration Guide = $20,000 \times 10^{-11}\mu Ci/ml$.

Air - Nonradioactive

Mound's steam power supply has been converted from fuel oil to natural gas on an interruptable basis. During unusually cold weather, natural gas supply to Mound is interrupted and fuel oil with much less than 1% sulfur content is burned. Except for these occasions, virtually all sulfur dioxide emissions have been eliminated. None of the operations presently carried on at Mound Laboratory involve amounts of material which would lead to significant particulate, carbon monoxide, photochemical oxidant or hydrocarbon emissions from stationary sources. Therefore, no sampling for these nonradioactive pollutants is carried on at this time.

Water - Radioactive

Water sampling locations along the bank of the Great Miami River were selected according to guidelines proposed by the Federal EPA. The locations, shown in Figure 3, provide samples which are representative of river water after suitable mixing of Mound's effluent has occurred. Water samples are collected at these locations five days per week and are subjected to specific analyses for plutonium-238 and tritium oxide. River samples are no longer analyzed for polonium-210 for the same reasons that air samples for polonium-210 have been reduced. Effluent streams leaving Mound are analyzed for polonium-210 as well as plutonium-238 and tritium. If a significant increase in these streams is detected, river samples are then analyzed for polonium-210. No significant increases were detected during 1974.

The plutonium-238 analyses are performed on a monthly composite of the daily samples. The concentrations of plutonium-238 measured in the Great Miami River are summarized in Table 7. The average concentrations were 0.07% or less of the RCG.

Tritium oxide analyses are performed on a weekly composite of the daily samples collected. The average concentrations of tritium oxide measured in the Great Miami River were all less than 0.3% of the RCG. These results are summarized in Table 8.

Results of plutonium-238 and tritium analyses for three sampling locations on the abandoned Miami-Erie canal and adjacent ponds are reported in Tables 9 and 10, respectively. These results represent levels in the site drainage ditch which discharges into the canal-pond system prior to mixing with the Great Miami River. These results, as expected, are higher than those concentrations found in the Great Miami River where mixing and dilution occur.

The total amounts of polonium-210, plutonium-238, and tritium discharged to the Great Miami River were 0.6 millicuries, 20 millicuries, and 105 curies, respectively.

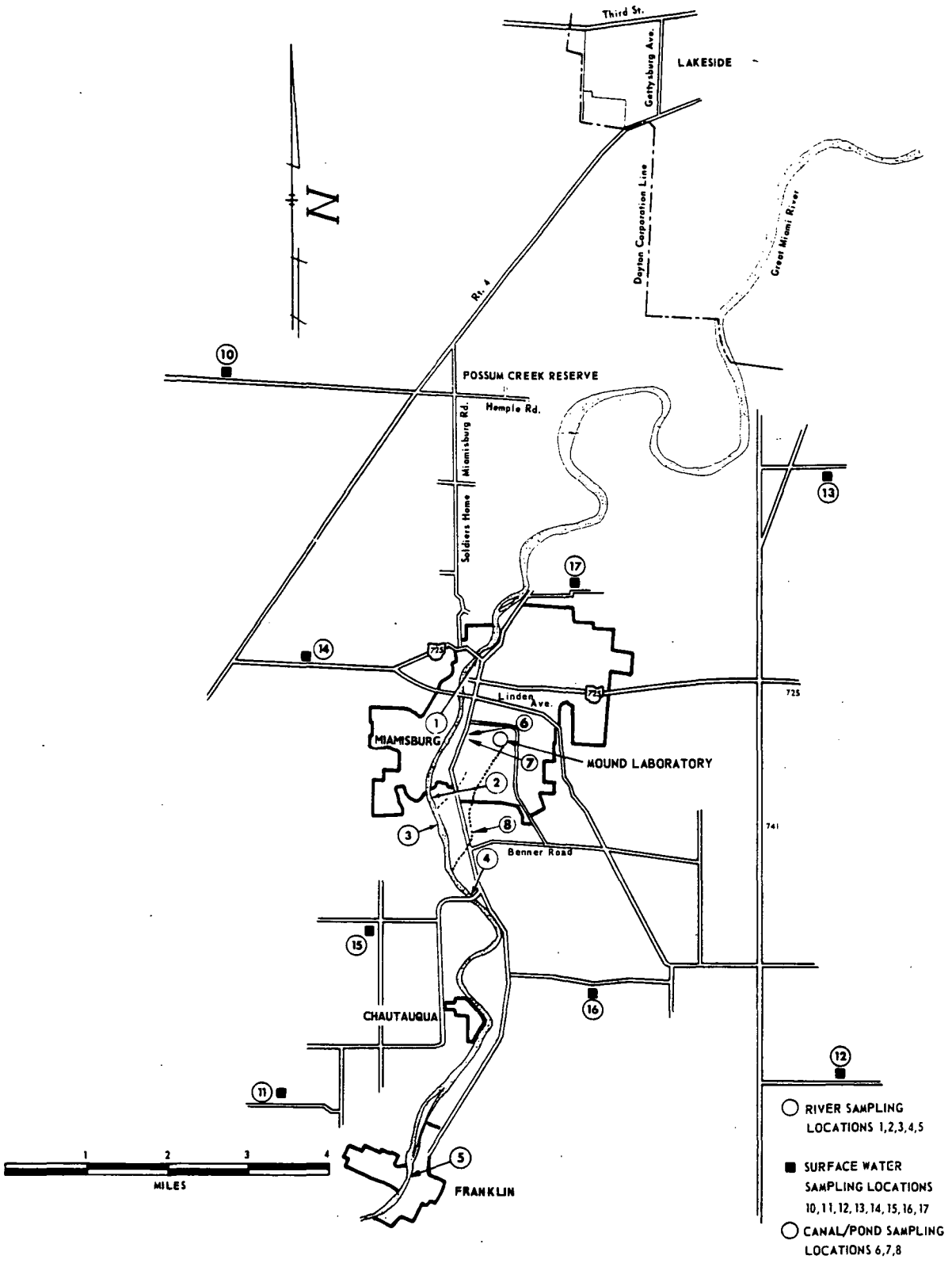

FIGURE 3 - Offsite water sampling locations.

TABLE 7

CONCENTRATION OF ^{238}Pu IN THE GREAT MIAMI RIVER
1974

Location	Number of Samples	Range ($10^{-8}\mu Ci/ml$)	Average* ($10^{-8}\mu Ci/ml$)	Percent of RCG**
1	249	<0.04 - 0.3	<0.06 ± 0.02	<0.03
2	249	<0.04 - 0.8	<0.14 ± 0.02	<0.07
3	249	<0.04 - 0.5	<0.08 ± 0.02	<0.04
4	249	<0.04 - 0.4	<0.05 ± 0.01	<0.03
5	249	<0.04 - 0.7	<0.08 ± 0.02	<0.04

* Minimum Detection Limit (MDL) for ^{238}Pu in water is $0.04 \times 10^{-8}\mu Ci/ml$, which is 0.02% of the RCG.

** RCG - Radioactivity Concentration Guide = $200 \times 10^{-8}\mu Ci/ml$.

TABLE 8

CONCENTRATION OF TRITIUM IN THE GREAT MIAMI RIVER
1974

Location	Number of Samples	Range ($10^{-6}\mu Ci/ml$)	Average* ($10^{-6}\mu Ci/ml$)	Percent of RCG**
1	249	<0.2 - 5.2	<1.0 ± 0.3	<0.1
2	249	<0.2 - 28	<2.8 ± 0.3	<0.3
3	249	<0.2 - 8.1	<2.9 ± 0.3	<0.3
4	249	<0.2 - 7.6	<2.0 ± 0.3	<0.2
5	249	<0.2 - 23	<1.4 ± 0.3	<0.1

* Minimum Detection Limit (MDL) for tritium in water is $0.2 \times 10^{-6}\mu Ci/ml$, which is 0.02% of the RCG.

** RCG - Radioactivity Concentration Guide = $1000 \times 10^{-6}\mu Ci/ml$.

TABLE 9

CONCENTRATION OF ^{238}Pu IN CANAL/POND AREA
1974

Location*	Number of Samples	Range ($10^{-8}\mu Ci/ml$)	Average** ($10^{-8}\mu Ci/ml$)	Percent of RCG***
6 (North Pond)	249	<0.04 - 1.2	<0.2 ± 0.03	<0.1
7 (North Canal)	249	0.05 - 1.2	0.5 ± 0.04	0.3
8 (South Canal)	249	0.2 - 4.6	1.9 ± 0.09	0.9

* Locations shown in Figure 3.

** Minimum Detection Limit (MDL) for ^{238}Pu in water is $0.04 \times 10^{-8}\mu Ci/ml$, which is 0.02% of the RCG.

*** RCG - Radioactivity Concentration Guide = $200 \times 10^{-8}\mu Ci/ml$.

TABLE 10

CONCENTRATION OF TRITIUM IN CANAL/POND AREA
1974

Location*	Number of Samples	Range ($10^{-6}\mu Ci/ml$)	Average** ($10^{-6}\mu Ci/ml$)	Percent of RCG***
6 (North Pond)	249	12 - 72	48 ± 0.8	4.8
7 (North Canal)	249	18 - 77	55 ± 0.8	5.5
8 (South Canal)	249	20 - 92	52 ± 0.8	5.2

* Locations are shown in Figure 3.

** Minimum Detection Limit (MDL) for tritium in water is $0.2 \times 10^{-6}\mu Ci/ml$, which is 0.02% of the RCG.

*** RCG - Radioactivity Concentration Guide = $1000 \times 10^{-6}\mu Ci/ml$.

Eight additional surface water locations such as ponds and streams are sampled quarterly. These locations are shown in Figure 3. A sample of approximately four liters is collected at each location and analyzed for plutonium-238, and tritium oxide. The average concentrations of plutonium-238 measured at these locations during 1974 were 0.05% or less of the RCG. The average concentrations of tritium oxide measured at these locations were 0.3% or less of the RCG. The results of the surface water monitoring program are summarized in Tables 11 and 12.

In the routine environmental monitoring program, data obtained for plutonium-238 in water overestimates actual concentrations. Water samples of 500 cm^3 and counting times of 16 hr have been used in the routine program and have been more than adequate to demonstrate compliance with guidelines. Larger volume samples of water and longer counting times would be required to obtain results comparable to background concentrations. As discussed in the preceding paragraphs, the plutonium-238 concentration in various environmental waters has been estimated as only a fraction of one percent of the RCG, which indicates that the impact on the environment has been minor.

Drinking water from communities in the surrounding area is sampled quarterly and analyzed for tritium oxide. These communities are shown in Figure 1. The concentrations of tritium oxide were found to be less than 1.4% of the RCG. The results of the community drinking water sampling program are summarized in Table 13. Several private wells in the vicinity of Mound Laboratory were also sampled and analyzed for tritium oxide during 1974. The results ranged from 32 to 101 x 10^{-6} μCi/ml which represent 3.2 to 10.1% of the RCG, respectively.

Water - Nonradioactive

It is difficult to measure the levels of nonradioactive pollutants in the Great Miami River resulting from Mound Laboratory's water effluent because of the relatively high level of these pollutants already present in the river upstream from the outfalls. Instead, a composite sample of both water effluent streams leaving the Laboratory is automatically collected and analyzed for various water quality parameters as reported below. The sample volume is proportionate to the flow in the stream. The composite effluent water samples are analyzed for the listed water quality parameters according to standard techniques[4] for waste water analysis accepted by the office of Water Programs of the Environmental Protection Agency. The effluent standards which EPA proposed in late 1974 for nine toxic pollutants have been withdrawn until the EPA can collect additional data. The results of the effluent stream analyses are summarized in Table 14. These results indicate that Mound's effluent streams have no significant effect on the Great Miami River and most likely do not cause Ohio Stream Standards to be exceeded.

TABLE 11

SUMMARY OF SURFACE WATER MONITORING FOR ^{238}Pu
1974

Location	Number of Samples	Range ($10^{-10}\mu Ci/ml$)	Average* ($10^{-10}\mu Ci/ml$)	Percent of RCG**
10	4	<3 - 15	<4.5 ± 1.4	<0.02
11	4	<3 - 9.1	<3.8 ± 1.3	<0.02
12	4	<3 - 4.0	<3.1 ± 1.2	<0.02
13	4	<3 - 3.7	<3.1 ± 3	<0.01
14	3	<3	<3 ± 3	<0.01
15	4	<3 - 11	<6.1 ± 1.6	<0.03
16	4	<3 - 24	<9.4 ± 2.0	<0.05
17	4	<3 - 9.6	<3.3 ± 1.2	<0.02

* Minimum Detection Limit (MDL) for ^{238}Pu is water is $3 \times 10^{-10}\mu Ci/ml$. The MDL = 0.01% of the RCG.

** RCG - Radioactivity Concentration Guide for ^{238}Pu in water = $20,000 \times 10^{-10}\mu Ci/ml$.

TABLE 12

SUMMARY OF SURFACE WATER MONITORING FOR TRITIUM
1974

Location	Number of Samples	Range ($10^{-6}\mu Ci/ml$)	Average ($10^{-6}\mu Ci/ml$)	Percent of RCG**
10	4	<0.2 - 4	<1.4 ± 0.3	<0.1
11	4	<0.2 - 2	<0.8 ± 0.3	<0.08
12	4	<0.2 - 2	<0.9 ± 0.3	<0.09
13	4	<0.2 - 4	<1.4 ± 0.3	<0.1
14	4	<0.2 - 5	<2.1 ± 0.3	<0.2
15	4	<0.2 - 6	<2.8 ± 0.3	<0.3
16	4	<0.2 - 2	<0.9 ± 0.3	<0.09
17	4	<0.2 - 6	<3.5 ± 0.3	<0.3

* Minimum Detection Limit (MDL) for tritium in water is $0.2 \times 10^{-6}\mu Ci/ml$. The MDL is 0.02% of the RCG.

** RCG - Radioactivity Concentration Guide for tritium oxide in water = $1000 \times 10^{-6}\mu Ci/ml$.

TABLE 13

SUMMARY OF TRITIUM OXIDE LEVELS IN COMMUNITY DRINKING WATER
1974

Location	Number of Samples	Range (10^{-6} μCi/ml)	Average* (10^{-6} μCi/ml)	Percent of RCG**
Bellbrook	4	<0.3 - 1.9	<0.8 ± 0.3	<0.08
Centerville	4	<0.3 - 1.5	<0.9 ± 0.3	<0.09
Dayton	4	<0.3 - 0.8	<0.4 ± 0.3	<0.04
Franklin	4	<0.3 - 0.9	<0.5 ± 0.3	<0.05
Germantown	4	<0.3 - 1.9	<0.9 ± 0.3	<0.09
Kettering	4	<0.3 - 0.6	<0.4 ± 0.3	<0.04
Miamisburg	4	9 - 24	13.3 ± 0.5	1.33
Middletown	4	<0.3 - 1.5	<0.8 ± 0.3	<0.08
Moraine	4	<0.3 - 1.3	<0.5 ± 0.3	<0.05
South Lebanon	4	<0.3 - 0.9	<1.2 ± 0.3	<0.12
Springboro	4	<0.3 - 7.9	<2.9 ± 0.3	<0.29
Waynesville	4	<0.3 - 0.9	<0.5 ± 0.3	<0.05
West Carrollton	4	<0.3 - 1.8	<1.1 ± 0.3	<0.11

* Minimum Detection Limit (MDL) for tritium oxide is 0.3 x 10^{-6} μCi/ml. The MDL is 0.03% of the RCG.

** RCG - Radioactivity Concentration Guide for tritium oxide in water = 1000 x 10^{-6} μCi/ml.

TABLE 14

SUMMARY OF EFFLUENT WATER MONITORING FOR NONRADIOACTIVE CONSTITUENTS
1974

Constituent	Average Value (mg/l)
Heavy Metals	
Antimony	<0.0005
Arsenic	<0.01
Barium	0.007
Beryllium	<0.0001
Bismuth	0.02
Boron	0.09
Cadmium	0.002
Chromium, Hexavalent	0.007
Cobalt	0.02
Copper	0.08
Iron	0.39
Lead	0.006
Manganese	0.02
Mercury	0.0008
Molybdenum	0.01
Nickel	0.01
Selenium	<0.001
Silver	0.002
Zinc	0.11
Other Inorganics	
Chloride	826
Cyanide	<0.003
Sulfate	102
Nitrate	4.2
pH	7.6 - 8.9
Total Dissolved Solids	1090
Dissolved Oxygen	7.2
Phosphate	4.9
Fluoride	0.2
Organic	
Oil & Grease	1.5
Physical Properties	
Suspended Solids	20

Foodstuffs and Vegetation - Radioactive

Various locally grown foodstuffs and vegetation samples are collected from the surrounding area. The intent of this portion of the Envrionmental Monitoring Program is to determine if there is any uptake and concentration of radionuclides by plant or animal life. Where possible, sampling sites are chosen at maximum deposition locations predicted on the basis of the diffusion model developed for Mound Laboratory. Field crops, fruit, and vegetables are collected on the basis of this diffusion model. Milk is collected from individual farms closest to the Laboratory. Aquatic life is trapped from the Miami River generally downstream of Miamisburg and adjacent waterways, dependent upon availability of fish. Grass samples are collected in the vicinity of the surface water locations listed in Tables 11 and 12. As mentioned previously, commercial sales of polonium-210 from Mound Laboratory have ceased. Since air and water are monitored for polonium-210, and no significant increases have been observed, foodstuff samples are not analyzed for polonium-210. The plutonium-238 content of the foodstuff and vegetation samples is determined by slowly evaporating the samples to dryness and then proceeding with the same techniques used for plutonium-238 analyses of air samples. Milk samples are analyzed for tritium oxide by distilling the water fraction from an aliquot of the entire sample. The distillate is then analyzed for tritium by liquid scintillation spectrometry in the same manner as the water samples previously discussed in this report. The remaining foodstuff samples are analyzed for tritium by oxidizing the samples in a controlled air stream and collecting the combustion products. The tritium content of the combustion products is then determined by liquid scintillation spectrometry as discussed above. This technique allows analysis for total tritium in the samples rather than tritium oxide only. The results of the foodstuff and vegetation analyses are summarized in Table 15. The concentration is given in terms of the sample weight before evaporation to dryness. The vegetables analyzed included potatoes and tomatoes. The field crops analyzed were the edible portions of corn and soybeans. The sample of aquatic life analyzed included only the edible fleshy portions of the fish. No evidence has been found, as yet, that there is any significant uptake and concentration by plant or animal life of these radionuclides handled at Mound Laboratory.

Soil and Silt - Radioactive

The soil sampling program has included two aspects of soil monitoring. One aspect, which was reported in MLM-1922 Environmental Monitoring Report, July - December 1971 and 1971 Summary, is the evaluation of the resuspendable amounts of plutonium-238 in soil. For this evaluation, surface scrapings, approximately one-eighth inch deep, of undisturbed soil are collected and analyzed. Review of the pathways to man that plutonium could follow from soil to man, indicate that the most likely pathway is inhalation of resuspended material. Therefore, evaluation of resuspendable plutonium in soil is best accomplished by continuous high volume air sampling, not only because this samples the direct

TABLE 15

SUMMARY OF FOODSTUFFS & VEGETATION ANALYSIS
1974

Type of Sample	Number of Samples	^{238}Pu ($10^{-8}\mu Ci/g$) Range	Average*	Percent RCG**	Tritium ($10^{-6}\mu Ci/g$) Range	Average***	Percent of RCG****
Milk	3	0.3 - 0.4	0.34 ± 0.1	0.2	0.5 - 0.9	0.7 ± 0.5	0.07
Fruits & Vegetables	2	<0.1 - 0.2	<0.17 ± 0.04	<0.09	0.9 - 3.3	1.4 ± 0.5	0.14
Grass	12	<0.1 - 1.7	<0.7 ± 0.02	<0.3	0.7 - 2.3	1.5 ± 0.5	0.15
Field Crops	1	- - -	0.8 ± 0.02	0.4	- - -	- - -	- -
Aquatic Life	3	<0.3 - 0.5	<0.37 ± 0.1	<0.2	<0.1 - 2.8	<1.2 ± 0.5	<0.12

* Minimum Detection Limit (MDL) for ^{238}Pu in foodstuffs ranges from 0.06×10^{-8} to $0.3 \times 10^{-8}\mu Ci/g$. The MDL ranges from 0.03 to 0.1% of the RCG.

** RCG - Radioactivity Concentration Guide for ^{238}Pu in water = $200 \times 10^{-8}\mu Ci/g$.

*** Minimum Detection Limit for tritium in foodstuffs is $0.1 \times 10^{-6}\mu Ci/g$. The MDA is 0.01% of the RCG.

**** RCG - Radioactivity Concentration Guide for ^{3}H oxide in water = $1000 \times 10^{-6}\mu Ci/g$.

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pathway to man, but also because air sampling and analyses are more accurate and reproducible than soil sampling and analyses. If air sampling results indicate a potential problem in this area, surface soil sampling will be resumed.

The second aspect of soil monitoring, which was also reported in MLM-1922 and MLM-2028 (Environmental Monitoring Reports for 1971 and 1972), is soil core sampling. The purpose of this type of soil sampling is the documentation, for historical purposes, of the total accumulation and distribution of plutonium deposited offsite, and for verification of Mound Laboratory's atmospheric diffusion model. Present plans are to complete the initial total inventory during 1975 and to then repeat and refine the inventory over the next five-year interval, i.e., a revised and updated inventory completed by 1980. Soil core samples 3.5 inches in diameter, approximately 12 inches deep, are taken for the inventory determination. Core samples were collected at two locations in each quadrant around the Laboratory during 1974. These locations are shown in Figure 1. Ten cores were collected from a square area 30 ft (9.1m) on a side, at each location and composited to form one core sample.

Soil samples are digested with an acid mixture to extract the plutonium. The solution is then passed over an ion exchange column specific for plutonium and analyzed in the same manner as the particulate air samples previously discussed in this report. This leach method has been compared with a fusion method for soil analysis.[5] Good agreement was obtained between the two methods of analysis. The leach method was chosen for the soil analysis because larger samples, which minimize sampling and aliquoting errors, and increased sensitivity can be handled with this method. The results of the core sampling program for 1974 are summarized in Table 16. As mentioned previously in this report, no standards have been established for radioactive species in soil. Additional sample analyses are necessary before a total inventory can be calculated and these are continuing as part of Mound Laboratory's comprehensive Environmental Control Program.

Preliminary samples collected from offsite sediment in the Miami-Erie Canal area near Mound Laboratory indicated that plutonium-238 concentrations were substantially above baseline levels. As a result, an extensive sampling and analysis program was performed during 1974 to determine the plutonium-238 concentrations as a function of depth and location in a drainage ditch, the canal, two ponds, a run-off hollow, a canal overflow creek and the Great Miami River. The plutonium-238 concentration data was used to estimate the total inventory of plutonium-238 deposited in these waterways, to determine the extent of the contamination, and to evaluate the potential health hazards to the general population of the area.

The detailed hazard analysis of the presence of plutonium in the silt of the canal/ponds indicates that there is no significant radiological impact on the area and no short or long term health hazard.

TABLE 16

SUMMARY OF SOIL CORE ANALYSIS FOR ^{238}Pu
1974

Location * (Direction & Distance)			Pu ($10^{-3}\mu Ci/m^2$)**
15°	760m	(2500 ft.)	5.0 ± 0.6
105°	760m	(2500 ft.)	40 ± 1
115°	60m	(200 ft.)	79 ± 2
180°	1900m	(6300 ft.)	5.6 ± 0.5
205°	1500m	(5000 ft.)	4.4 ± 0.7
270°	150m	(500 ft.)	230 ± 3
270°	460m	(1500 ft.)	0.40 ± 0.20
320°	120m	(400 ft.)	42 ± 2

* Locations are shown in Figure 1. Direction is from approximate center of plant and distances are measured from site boundary.

** Minimum Detection Limit for ^{238}Pu in soil is $0.004 \times 10^{-3}\mu Ci/m^2$.

NOTE: No standards for radioactive species in soil have been established.

EVALUATION OF DOSE TO THE PUBLIC

A dose assessment was done for each radionuclide found in significant quantities in Mound Laboratory's effluent streams. These radionuclides are tritium(oxide) and plutonium-238. Tritium (oxide) is the only radionuclide for which the critical organ is the whole body. The critical organ for plutonium-238 is assumed to be the bone.

The dose estimates were based on environmental monitoring data for 1974. The dose estimates for air were based on perimeter and offsite continuous air sampling data, (minus background), and the waterborne radionuclide dose estimate was based only on tritium in drinking water for the local area. The levels of other radionuclides indicated background or non-detectable levels in drinking water and were thus not factored in. The estimates were arrived by use of the ratio of the observed concentration to the applicable RCG.

The dose estimates obtained for the maximum potential at the site boundary were based on the highest single annual average of the five onsite continuous air samplers located in the proximity of the site boundary.

The maximum dose to an individual was also based on the single highest yearly average of 5 onsite continuous air samplers. The maximum dose to population group(s) was based on the single highest yearly average of 20 offsite continuous air samplers surrounding the Laboratory. These results of dose estimates are given below:

Plutonium-238

As mentioned earlier, bone is the critical organ for plutonium. Therefore, the values indicated below are estimations for maximum potential dose to bone at: (1) the site boundary; (2) of individuals; and (3) of population group(s). The dose listed represents the annual internal dose following a continuous exposure for 50 years to airborne concentrations of plutonium-238 equivalent to those measured in the environment during 1974.

Maximum dose to bone at the site boundary	- 5.8 mrem
Maximum dose to bone in individuals	- 5.8 mrem
Maximum dose to bone in population group(s)	- 0.85 mrem

Tritium (oxide)

The critical organ for tritium (oxide) is the whole body. Therefore, these doses are estimations for whole body dose with the dose from tritium (oxide) in local

drinking water factored in. The other radionuclides apparently have had no effect on local drinking water since the values based on environmental monitoring are background or not detectable. The tritium (oxide) whole body dose estimations are shown below:

Maximum potential dose at site boundary	- 1.8 mrem/yr
Maximum dose to an individual	- 6.5 mrem/yr
Maximum dose to population group(s)	- 1.5 mrem/yr

The 50-mile (80 km) person-rem (whole body) dose estimates were based on average tritium (oxide) data from environmental air sampling stations out to a distance of 20 miles (32 km) from Mound Laboratory. The value from 20 to 50 miles was based on the average levels of tritium at 20 miles, extrapolated out to 50 miles. The dose from tritium (oxide) in the local drinking water was also included in this estimate. The results of the estimate, considering a total of 2,800,000 people in the 50-mile radius, is 56 person-rem.

For comparison the person-rem value from natural radiation, including cosmic rays and terrestrial radiation, would be approximately 320,000 person-rem. The dose commitment due to natural background tritium is 82 person-rem.

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APPENDIX

APPLICABLE STANDARDS

Radioactive Standards

In conformance with Federal Radiation Council (FRC) guidelines and ERDA Manual Chapter 0524, "Standards for Radiation Protection," offsite sample results are compared with RCG's established for the general population. These RCG's are derived by dividing the RCG's for an uncontrolled area by 3.

Onsite sample results are compared with the uncontrolled area RCG's rather than the controlled area RCG's which provides a conservative evaluation by approximately a factor of 10.

The RCG values (in microcuries per milliliter - μCi/ml) used for comparison purposes for the various types of samples in this report are listed below. In all cases, these are the most restrictive RCG's.

General Population

Air

Polonium-210 :	2×10^{-12}	μCi/ml
Plutonium-238:	2×10^{-14}	μCi/ml
Tritium :	7×10^{-8}	μCi/ml

Water

Polonium-210 :	2×10^{-7}	μCi/ml
Plutonium-238:	2×10^{-6}	μCi/ml
Tritium :	1×10^{-3}	μCi/ml

Uncontrolled Area

Air

Polonium-210 :	7×10^{-12}	μCi/ml
Plutonium-238:	7×10^{-14}	μCi/ml
Tritium :	2×10^{-7}	μCi/ml

Mixture

In addition to the RCG values for the individual radionuclides, the Standards for Radiation Protection (ERDA Manual Chapter 0524), indicate that if a mixture of more than one radionuclide occurs in air or water, the following guidelines shall be used. The ratio between the concentration of each radionuclide present in the mixture and its respective RCG

shall be determined. The sum of these ratios for all the radionuclides in the mixtures should not exceed unity. A radionuclide should not be considered part of the mixture if the ratio of the concentration of the radionuclide to its RCG is not greater than 1/10 provided that the sum of all such excluded ratios does not exceed 1/4.

Foodstuffs

There are no RCG values specied for foodstuffs as such since the water content of food was taken into account in the determination of RCG values for water. Consideration of radionuclides in food is necessary only in case of concentration in food during processing or in case it enters the food from other sources. For purposes of providing a reference point, the RCG for water converted to microcuries per gram is used for comparison.

Soil

There are no guidelines established for radioactive species in soil.

Nonradioactive Standards

The Ohio EPA has established Water Quality Standards (EP-1-EP-9) and Air quality Standards (EP-10-EP-19). The standards listed below are excerpted from these regulations.

Air

The standards listed below are State of Ohio Ambient Quality Standards. National Ambient Air Quality Standards are shown in parentheses. As previously stated, none of Mound Laboratory operations involve significant emissions to warrant environmental sampling for these nonradioactive pollutants at this time.

POLLUTANT	CONCENTRATION	REMARKS
Suspended Particulates (a)	60 micrograms/m^3 (75 primary, 60 secondary) (g)	Maximum annual geometric mean at any sampling site.
	150 micrograms/m^3 (260 primary, 150 secondary)	Maximum 24-hour concentration not to be exceeded more than 1 day per year.
Sulfur Dioxide (b)	60 microgram/m^3 (80 micrograms/m^3)	Maximum annual arithmetic mean concentration.
	260 micrograms/m^3 (365 micrograms/m^3)	Maximum 24-hour concentration not to be exceeded more than 1% of the time on annual basis.

POLLUTANT	CONCENTRATION	REMARKS
Carbon Monoxide (c)	10 milligrams/m^3 (10 milligrams/m^3)	Maximum 8-hour arithmetic mean concentration not be be exceeded more than one 8-hour period per year.
Photochemical Oxidants (d)	119 micrograms/m^3	Maximum 1-hour arithmetic mean.
	(160 micrograms/m^3)	
	79 micrograms/m^3	Maximum 4-hour arithmetic mean not to be exceeded more than one consecutive 4-hour period per year.
	40 micrograms/m^3	Maximum 24-hour arithmetic mean not to be exceeded more than one day per year.
NON METHANE Hydrocarbons (e)	126 micrograms/m^3 (160 micrograms)	Maximum 3-hour arithmetic mean concentration between the hours of 6 AM & 9 PM.
	331 micrograms/m^3	Maximum 24-hour arithmetic mean concentration not to be exceeded more than one day per year.
Nitrogen Oxides (f)	100 micrograms/m^3 (100 micrograms)	Annual arithmetic mean.
	250 micrograms/m^3 (250 micrograms)	24-hour concentration not to be exceeded more than one time per year.

(a) Housed high volume sampler.

(b) Hourly concentrations, continuous sampling, utilizing the colorometric analytical method.

Average 24-hour concentration - determined by hourly integrated data obtained as above, or through use of 24-hour bubblers, utilizing the West-Geake analytical procedure.

(c) Continuous sampling, utilizing the non-dispersive infrared principle.

(d) Continuous sampling, utilizing a chemiluminescent method.

(e) Determined as the difference between total hydrocarbon concentrations and methane concentrations, which are determined by the use of continuous sampling, utilizing the flame ionization methods providing a separate measurement of the methane fraction.

(f) Average 24-hour concentration - determined by hourly integrated data obtained as above, or through use of 24-hour bubblers, utilizing the Jacob-Hochheiser or arsenite analytical procedures.

(g) Primary standards: defines levels of air quality which are necessary to adequately protect the public health.

Secondary standard: defines levels of air quality which are necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Water

The standards listed below are Water Quality Standards established by the Ohio EPA. These standards are stream standards and apply to a stream beyond a suitable mixing zone permitted for discharges. They should not be compared with effluent concentrations.

Constituent	Average Concentration (mg/l)
Dissolved Oxygen	5.0
pH	6-9
Fecal Coliform	200 per 100 ml
Dissolved Solids	1500
Ammonia	1.5
Arsenic	0.05
Barium	0.8
Cadmium	0.005
Chloride	250
Chromium (Hexavalent)	0.05
Cyanide (Free)	0.005
Fluoride	1.3
Foaming Agents (MBAS)	0.5
Iron	1
Lead	0.04
Manganese	1
Mercury	0.0005
Oil & Grease	5

Constituent	Average Concentration (mg/l)
Phenols	0.01
Selenium	0.005
Silver	0.001
Copper	0.005 - 0.075*
Zinc	0.075 - 0.5*

* Dependent on $CaCO_3$ hardness.

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