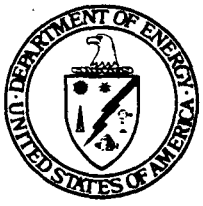
MLM-2700

Annual Environmental Monitoring Report: Calendar Year 1979

Billy M. Farmer and Daniel G. Carfagno

April 25, 1980



Monsanto

MOUND FACILITY
Miamisburg, Ohio 45342

operated by
MONSANTO RESEARCH CORPORATION
a subsidiary of Monsanto Company

for the
U. S. DEPARTMENT OF ENERGY

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ERRATA

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p. 14, 5th line, left column should read

"10^{-11} μCi/ml."

p. 15, 8th line, left column, should read

"10^{-17} μCi/ml"

p. 15, 6th line, right column, should read

"10^{-11} μCi/ml"

MLM-2700
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Foreword

This report was prepared by the Environmental Assessment and Planning Section of the Administrative Services Department at Mound Facility. Sample analyses and data reduction were performed by the Environmental Laboratory Group of the Environmental Assessment and Planning Section. Particulate samples offsite were collected by the Air Pollution Control Section of the Montgomery County Combined General Health District which acts as the Regional Air Pollution Control Agency in this area for the Ohio Environmental Protection Agency.

Contents

Introduction

Mound Facility is situated on 180 acres of land in Miamisburg, Ohio. This location is approximately 16 km (10 mi) southwest of Dayton. The predominant geographical feature in the five-county region surrounding the Facility is the Great Miami River which flows from northeast to 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. Figure 2 shows the population distribution around Mound Facility. Drinking water for the area is obtained from a buried valley aquifer which generally follows the Great Miami River. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10% of the land area in

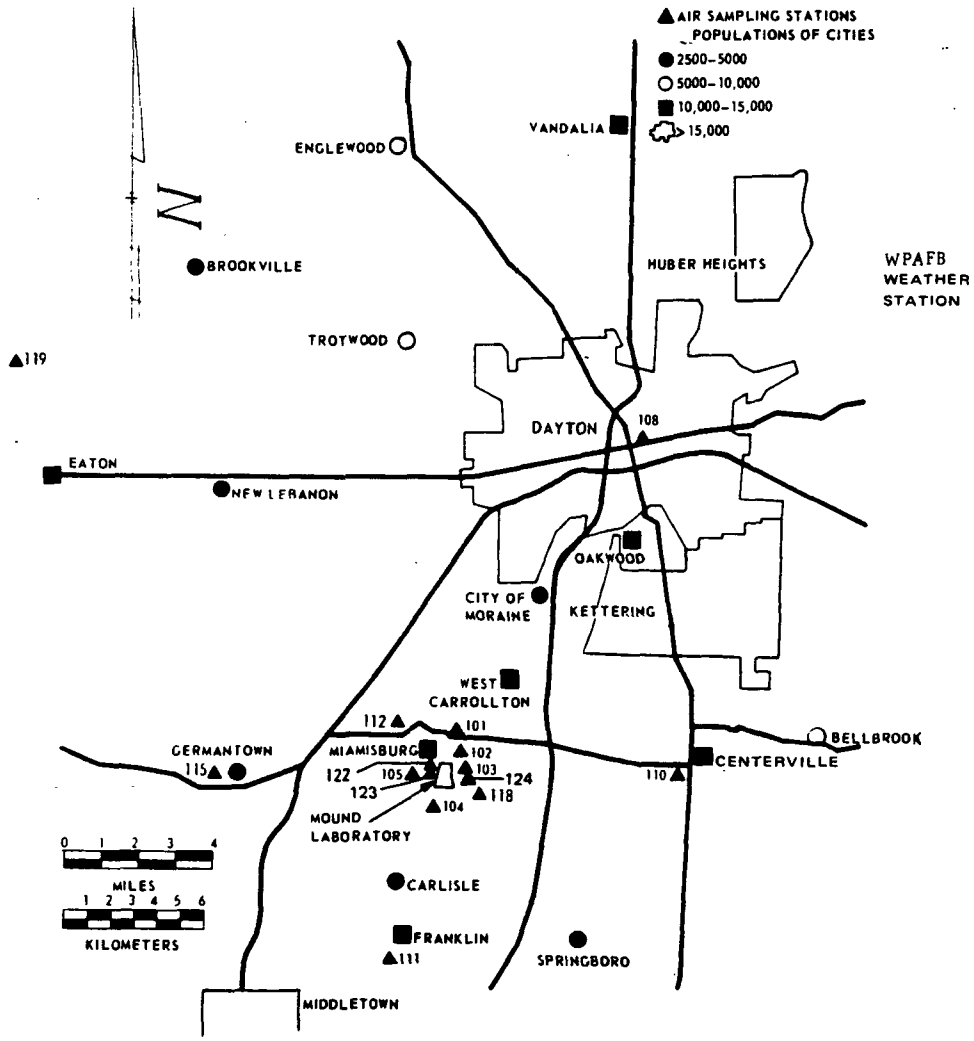
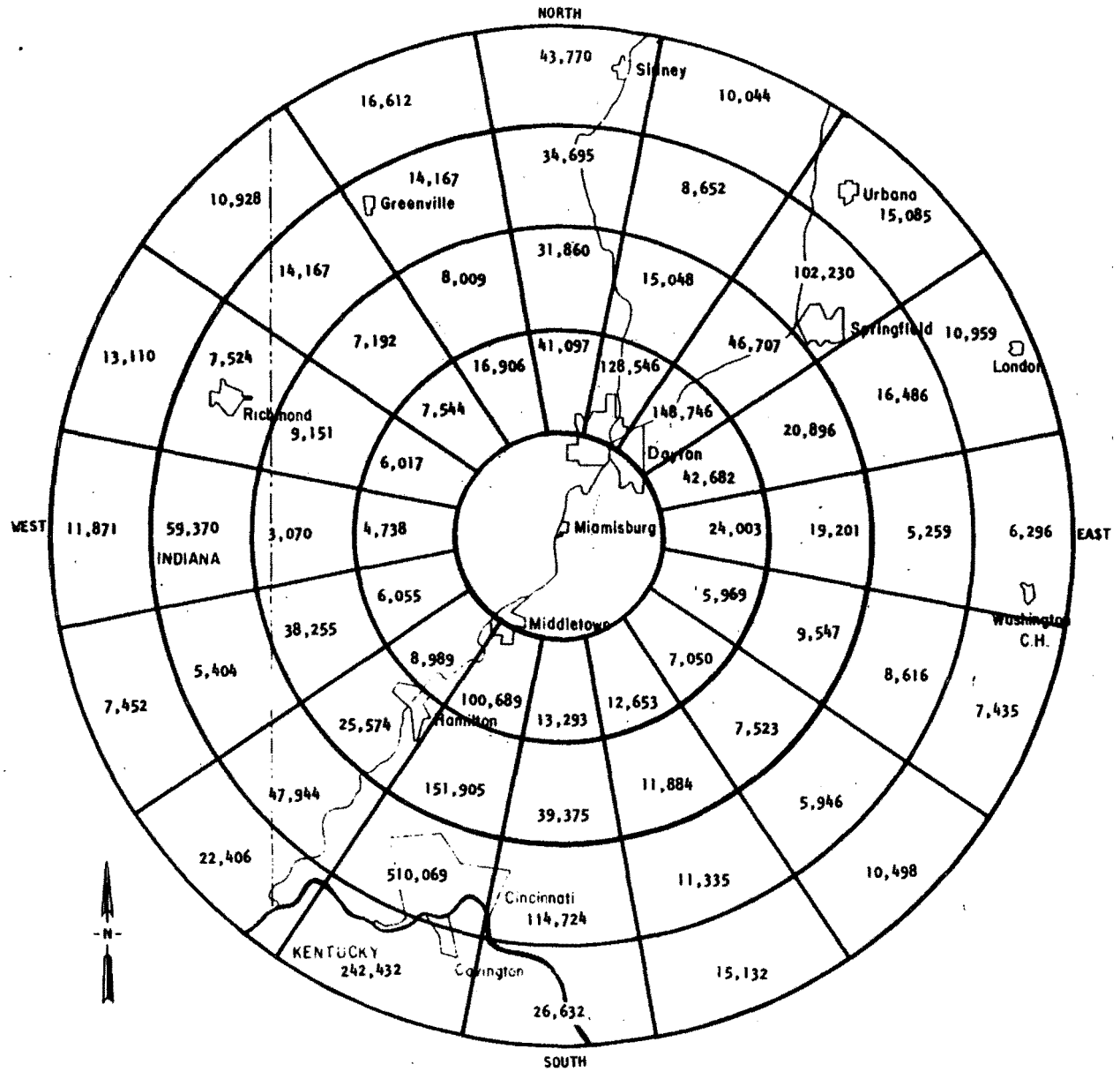


FIGURE 1 - Offsite air sampling locations.



Cumulative Population Totals
Present Population 0 - 50 Miles

0-20	895,941
0-30	1,341,138
0-40	2,307,726
0-50	2,778,388

FIGURE 2 - 1970 population within 50 miles of Mound Facility.

agricultural use is devoted to pasturing livestock [1].

Weather conditions in the area are moderate. The average annual precipitation is approximately 91 cm (36 in.) and is evenly distributed throughout the year. Winds are predominantly from the south or west except during the summer months when a higher frequency is recorded from out of the southwest. The wind speed averages about 16 km/hr (10 mi/hr) annually [2]. Figure 3 shows the wind rose compiled at Wright Patterson AFB which is located approximately 13 mi northeast from Mound. This wind rose approximates average wind conditions at Mound.

Mound Facility began operations in 1949. Its mission currently includes research, development, engineering, production, and surveillance of components for the Department of Energy (DOE) weapon programs; separation, purification, and sale of stable isotopes of the noble gases; and other DOE programs including solar energy, fossil fuels, nuclear safeguards and waste management, and fusion fuel systems. The radionuclides of primary concern resulting from Mound's current or past operations include plutonium-238 and tritium.

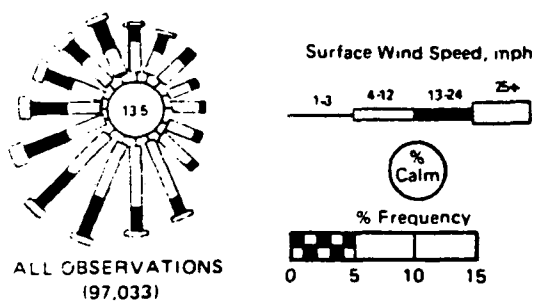


FIGURE 3 - The relative frequency and strength of winds from different directions for Wright-Patterson Air Force Base.

Radionuclides in particulate form are removed from process air effluents from nuclear operations facilities by high efficiency particulate air (HEPA) filters. The air effluents are filtered first at the points of origin, i.e., gloveboxes, and just prior to the release point, i.e., the stack. The filtering system at the stack consists of two banks of HEPA filters in series, each bank with a collection efficiency of 99.95%. Radionuclides are removed from liquid effluents such as process wastes by chemical processing. Solid radioactive wastes are packaged and shipped offsite for burial at approved burial sites. Wastes generated in the processing of explosive materials are collected and disposed of according to the Army Materiel Command Regulation 385-100.

An onsite sanitary waste treatment plant provides secondary treatment in accordance with U. S. Environmental Protection Agency (EPA) requirements [3] using an activated sludge process operating in the extended aeration mode. All domestic sewage generated onsite is treated in this facility. The influent and effluent at the sewage treatment plant are also monitored for radioactivity to ensure no undetected release can occur to the environment via the sanitary sewage plant. The digested sludge from the sewage plant is shipped offsite for burial at an approved burial site. Nonradioactive solid wastes are

disposed of according to a recycling and reclamation program where possible. White paper, scrap metal, and wood are sold for reclamation. General refuse was transported during 1979 to two sanitary landfill sites approved by both the state and county. Waste solvents and chemicals are removed offsite by a commmercial industrial-waste-disposal firm.

Conformance to regulations prescribed by DOE pertaining to the safety of employes and the public has been demonstrated during the history of Mound Facility. The fundamental objective of the Mound Facility Environmental Control Program, which has been in existence throughout the history of the Facility, is the containment of radioactive effluents to levels well within the existing standards. As part of this function, effluents are monitored and controlled at each operating step resulting in no more than low-level releases of airborne or liquid wastes to the environment. Because of early detection, control techniques can be implemented, thus ensuring that concentrations are well within existing standards and are as low as practicable.

As part of the Mound Environmental Program monitoring functions, air, water, vegetation, foodstuff, and sediment samples are collected from the environment at distances up to 45 km (28 mi) from the Facility boundaries. These samples are analyzed for the specific radionuclides handled at the Facility.

The results of the environmental analyses for CY-1979 are provided in this report.

The primary purpose of this report is to demonstrate what impact, if any, Mound Facility has on the adjacent environment from annual operations. To meet this purpose, there are several calculational techniques which should be described. These techniques have been used throughout the report. The concentrations of various radionuclides found in this report which result from Mound Facility's operations are termed "incremental." The term "incremental" denotes that concentration value that exceeds normal environmental levels of the same radionuclide. The environmental level is the level found in the environment where Mound would have no impact. These environmental levels are shown in Table 1.

In addition, a new approach was used during 1979 in order to provide a better estimate of actual concentrations of radionuclides in the environment. The instrument background was subtracted from the sample count, and this value was then used in averages, as opposed to using the lower detection limit (LDL) as had been the practice in past years.

For comparative purposes and for single sample evaluation, however, the lower detection limit (LDL) is shown for each set of data in this report. The LDL is composed of the average (estimated mean) of the blank results plus the standard error of the estimated mean at the 95% confidence level.

The error estimates shown with each set of data are estimates of the standard error of the estimated mean at the 95%

Table 1 - ENVIRONMENTAL CONCENTRATIONS OF RADIONUCLIDES IN VARIOUS MEDIA

Plutonium-238 in air[a]	=	0.05	±	0.05	x	10^{-17}	µCi/ml
Tritium oxide in air[a]	=	0.06	±	0.04	x	10^{-11}	µCi/ml
Plutonium-238 in river water[b]	=	0.03	±	0.03	x	10^{-10}	µCi/ml
Tritium in river water[b]	=	1.1	±	0.18	x	10^{-6}	µCi/ml
Plutonium-238 in surface water[c]	=	0.013	±	0.007	x	10^{-10}	µCi/ml
Tritium in surface water[c]	=	0.85	±	0.38	x	10^{-6}	µCi/ml
Plutonium-238 in well water[d]	=	0.013	±	0.007	x	10^{-10}	µCi/ml
Tritium in well water[c]	=	0.81	±	0.27	x	10^{-6}	µCi/ml
Uranium-233,234 in river water[b]	=	7.7	±	4.2	x	10^{-10}	µCi/ml
Uranium-238 in river water[b]	=	7.6	±	2.7	x	10^{-10}	µCi/ml
Plutonium-238 in river silt[b]	=	0.0005	±	0.0002	x	10^{-6}	µCi/g
Plutonium-238 in surface water silt[c]	=	0.0011	±	0.0006	x	10^{-6}	µCi/g
Tritium in grass[e]	=	0.14	±	0.05	x	10^{-6}	µCi/g
Tritium in tomatoes[e]	=	0.24	±	0.03	x	10^{-6}	µCi/g
Plutonium in grass[e]	=	0.0009	±	0.0008	x	10^{-6}	µCi/g
Plutonium in potatoes[e]	=	0.0007	±	0.0007	x	10^{-6}	µCi/g
Plutonium in fish[e]	=	0.0003	±	0.0001	x	10^{-6}	µCi/g

[a]Measured at offsite sampler 119.

[b]Measured 20 mi upstream on Great Miami River.

[c]Measured 28 mi northwest of Mound Facility.

[d]Used concentrations found for surface water.

[e]Measured 30 mi west of Mound Facility.

confidence level. These values include all sources of variability including sampling, analyses, counting statistics, and the propagated error involved when subtracting the environmental levels from the actual data.

Introduction

Summary

The local environment surrounding Mound Facility was monitored primarily for tritium and plutonium-238. The results are reported for CY-1979. The environmental parameters analyzed included air, water, vegetation, foodstuffs, and sediment. The average concentrations of plutonium-238 and tritium were within the applicable standards (adopted by the U. S. DOE) for radioactive species.

Mound Facility initiated a program in 1975 to bring Mound water wells and eight offsite wells into compliance with a proposed new EPA standard for tritium in public drinking water. The new regulations reduced the federal standard for tritium by a factor of 50. Final standards were eventually promulgated for various parameters and made effective June 24, 1977. Mound's program has involved an extensive study of the local area water source, the Buried Valley Aquifer, and high volume pumping of water from the aquifer, with replacement by induced infiltration of dilution water from the Great Miami River. The overall effectiveness of the program has been significant. All wells have been brought into compliance: Mound's three wells in September 1977; five offsite public wells in April 1978; and three offsite private wells in December 1979.

Data concerning nonradioactive species in air and water are also presented and compared to federal, state, and local standards where applicable. The average incremental concentrations of plutonium-238 and tritium oxide in air measured at all offsite locations during CY-1979 were 0.53×10^{-17} µCi/ml and 0.44×10^{-11} µCi/ml, respectively. These correspond to 0.03% and 0.006% of their respective Radioactivity Concentration Guides (RCG). Details of the applicable standards are given in the Appendix.

The average incremental concentration of plutonium-238 measured at all locations in the Great Miami River during CY-1979 was 0.04×10^{-10} µCi/ml which is 0.0002% of the RCG. The average concentration of tritium measured at all locations in the Great Miami River during CY-1979 was at the environmental level shown in Table 1.

Radionuclide effluent data for CY-1979 are summarized in Table 2.

The average incremental concentrations of plutonium-238 found during CY-1979 in surface and area drinking water were also a fraction of the DOE RCG. In addition, the average incremental concentration of tritium in surface water and the average concentration in area and municipal drinking water were a fraction of each respective DOE RCG and EPA standard.

Although there are no specific standards (RCG) for plutonium-238 and tritium in foodstuffs, the concentrations found, if compared to the water standard, are also a small fraction of the RCG. No offsite soil sampling was conducted in CY-1979 since a soil inventory was completed and reported for CY-1977. Sediment was sampled at several water sampling locations, however. Radionuclide levels found in these sediment samples are not detrimental to the environment.

Table 2 - EFFLUENT DATA FOR CY-1979

Radionuclide	Media	Quantity	
Tritium	air	3831	Ci
Tritium	water	33.9	Ci
Plutonium-238	air	0.012	mCi
Plutonium-238	water	3.2	mCi
Uranium-233, 234	water	1.2	mCi

Mound Facility has been granted a National Pollutant Discharge Elimination System Permit. Effluent stream analyses during 1979 indicated that the suspended solids limitation for one of the two discharge points was exceeded for a short period. All other parameters were within permit limitations. All results indicate that Mound effluent streams have no significant effect on the Great Miami River and certainly do not cause Ohio stream standards to be exceeded.

The dose commitment estimates indicate that, in all cases, the levels are below 1% of the DOE standard. The person-rem calculated to 80 km for the total population as a result of Mound operations during 1979 was 13 person-rem. Natural radiation would result in approximately 320,000 person-rem for the area.

The data contained in this summary demonstrate the status of compliance with various current regulatory agency standards and demonstrate Mound's emphasis on the as-low-as-practicable (ALAP) concept.

Summary

Environmental surveillance

Quality assurance

A quality assurance 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 analyses for each group of samples. The blank values have been consistently small in comparison with sample values, indicating good control and no contamination problems during analytical procedures. These blank values are the basis for detection limits as discussed later in the report.

The external portion involves Mound participation in DOE's Quality Assessment Program. This program is conducted by the Department of Energy's Environmental Measurements Laboratory (EML) which prepares "reference" samples for analysis by DOE laboratories throughout the country. The "air" samples are simulated, consisting of filter papers spiked with known amounts of plutonium, uranium, and other radionuclides. Results of significance to the environmental monitoring program at Mound are summarized in Table 3. Concentrations for air samples are given in pCi/filter, and the units for water concentrations are in pCi/ml.

Mound values can be compared with the EML reference values and with the mean values of all the laboratories participating in the program, by referring to the concentration ratios given in the last two columns of Table 3. If Mound's experimental errors and EML's errors are taken into consideration, then a "Mound-to-EML" concentration ratio between 0.8 and 1.2 is completely acceptable. In four cases, this ratio was less than 0.8. For uranium-234 in "air" (7904) the 0.71 ratio is low and has not been completely explained. The "Mound-to-Mean" ratio of 0.85, however, indicates the possibility that EML's uranium-234 finding was high. The other three low "Mound-to-EML" ratios are for plutonium in water (samples dated 7901 and 7904). For two of these three, Mound plutonium in water concentrations are essentially equivalent to the mean of all the laboratories. It is believed that since the EML water samples are preserved only in 0.1 M hydrochloric acid, some plutonium hydrolysis occurs resulting in the plutonium concentrations determined by participating laboratories being lower then EML's concentrations.

The reliability of the data generated in the routine environmental monitoring program is illustrated by the good agreement of Mound data with reference data in this Quality Assurance Program.

Air - Radioactive

The offsite air-sampling network used during CY-1979 consisted of 15 continuously operating air-sampling stations that are used for sampling both tritium oxide and plutonium. Ten sampling stations are located within a 1.6 km (1 mi) radius of the Facility, and four samplers are located in or near population centers. The remaining sampler (#119) is approximately 44.8 km (28 mi) from the Facility in the least

Table 3 - MOUND FACILITY QUALITY ASSESSMENT PROGRAM RESULTS (FIRST THROUGH FOURTH QUARTER, 1979)

Sample Type	Sample No.	Isotope Determined	Concentration*		Concentration Ratio	
			Mound	EML[a]	Mound to EML	Mound to Mean[b]
Air	7901	Pu-239	0.53	0.53	1.00	0.88
Air	7904	U-234	0.87	1.23	0.71	0.85
		U-238	0.85	0.98	0.87	0.80
Air	7907	U-234	1.75	1.70	1.03	0.88
		U-238	1.71	1.75	0.98	0.90
Air	7910	Pu-239	0.52	0.60	0.87	0.81
			0.51	0.60	0.85	0.80
		U-234 &	1.38	1.58	0.87	0.78
		U-238	1.37	1.58	0.87	0.77
Water	7901	H-3	11.3	12.4	0.91	0.88
			12.7	12.4	1.02	0.99
			10.2[c]	12.4	0.82	0.80
Water	7904	H-3	23.5	24.5	0.96	0.94
			27.0	24.5	1.10	1.08
Water	7907	H-3	30.7	30.4	1.01	0.92
Water	7910	H-3	13.8	13.4	1.03	0.96
			14.3	13.4	1.07	0.99
			13.0[c]	13.4	0.97	0.90
Water	7901	Pu-239	0.0018	0.0023	0.78	0.79
Water	7904	Pu-238	0.0067	0.0090	0.74	1.06
		Pu-239	0.0065	0.0090	0.72	1.00
Water	7907	Pu-238	0.0079	0.0090	0.88	0.93
		Pu-239	0.0073	0.0081	0.90	0.85
Water	7910	Pu-238	0.0092	0.0104	0.88	1.08
Water	7901	U-234	0.0097	0.0099	0.98	0.99
		U-238	0.0097	0.0099	0.98	1.07
Water	7904	U-234	0.0207	0.0219	0.95	1.18
		U-238				
Water	7907	U-234	0.0100	0.0113	0.88	0.86
		U-238	0.0102	0.0113	0.90	0.90
Water	7910	U-234	1.38	1.58	0.87	0.78
		U-238	1.37	1.58	0.87	0.77

*Air values - pCi/filter
*Water values - pCi/ml

[a]Environmental Measurements Laboratory.

[b]The mean of all concentrations determined by all participating laboratories.

[c]These H-3 values were determined by the Mound Nuclear Measurement Group.

Quality Assurance

prevailing wind direction. This sampler receives no measurable contribution from Mound operations and serves as a baseline sample for computing environmental levels. The levels from sampler #119 are subtracted from other locations. The samplers currently in operation are located at critical distances and directions based on a diffusion model developed for Mound Facility. The locations of the sampling stations are shown in Figure 1.

Two types of samples are collected at each sampling station. One is a particulate air sample for plutonium-238 analysis, and the other is a bubbler type sampler for tritium oxide analysis. The particulate sample is collected on a 200-mm diameter Microsorban disk by a continuously operating (24 hr/day, 7 days/week) high-volume air sampler. The air is sampled at an average rate of 1.3×10^6 cm^3/min ($\sim$45 ft^3/min). The Microsorban disk is changed weekly, and represents a sample of approximately 13,000 m^3 of air. Plutonium-238 analyses were performed on a monthly composite for three sampling locations, #122, #123, and #124, and on quarterly composites for the other offsite locations.

The analytical scheme for plutonium-238 incorporates the following basic steps: addition of a known amount of plutonium-242 tracer, ignition to 600°C, leaching with nitric acid, separation of plutonium with anion exchange resin, electrodeposition of plutonium, and finally alpha spectrometry.

The average incremental offsite plutonium-238 air concentration for all locations was 0.53×10^{-17} µCi/ml which is 0.03% of the DOE 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 human body is unknown. The analytical results are summarized in Table 4.

Table 5 shows concentrations of plutonium-239, plutonium-240, and plutonium-238, including environmental levels, so that a ratio comparison between these radionuclides can be made. Ratios greater than that observed at location #119 ($\sim$0.1) result from a concentration of plutonium-238 in excess of that from atmospheric fallout and are indicative of the influence of Mound operations.

The gas bubbler sample is also collected on a continuous basis by bubbling air at approximately 3×10^3 cm^3/min through 200 ml of ethylene glycol. Ethylene glycol is used because this material eliminates evaporation and freezing problems associated with sample collection [4]. Any tritium (oxide) in the air is collected in the solution. Tritium oxide rather than elemental tritium is sampled and analyzed because the RCG for the oxide is 200 times more restrictive than it is for elemental tritium [5]. A sample representing $\sim$30 m^3 of air is collected, and an aliquot representing 1.5 m^3 is counted in a liquid scintillation spectrometer. The average

Table 4 - INCREMENTAL CONCENTRATIONS OF PLUTONIUM-238 IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1979

Location	Number of Samples	Range[d] (10^{-17} µCi/ml)	Average[a,c,d,e] (10^{-17} µCi/ml)	Percent of RCG[b]
101	4	0.06 - 0.7	0.29 ± 0.54	0.01
102	4	0.46 - 0.87	0.62 ± 0.34	0.03
103	4	0.13 - 0.61	0.36 ± 0.37	0.02
104	4	0.07 - 0.56	0.35 ± 0.47	0.02
105	4	0.01 - 0.17	0.09 ± 0.13	0.005
108	4	0.02 - 0.11	0.06 ± 0.09	0.003
110	4	E.L. - 0.12	0.05 ± 0.11	0.003
111	4	0.008 - 0.22	0.11 ± 0.17	0.006
112	4	0.02 - 0.07	0.04 ± 0.07	0.002
115	4	E.L. - 0.04	0.003 ± 0.07	0.0002
118	4	0.07 - 0.94	0.35 ± 0.74	0.02
122	12	0.14 - 0.88	0.37 ± 0.17	0.02
123	12	0.34 - 11	3.5 ± 2.2	0.18
124	12	0.31 - 2.9	1.2 ± 0.64	0.06

[a] Lower Detection Limit (LDL) for ^{238}Pu in air for quarterly samples is 0.05 X 10^{-17} µCi/ml. This is 0.003% of the RCG.

[b] Radioactivity Concentration Guide (RCG) = 2000 X 10^{-17} µCi/ml for the soluble form of ^{238}Pu for the general population.

[c] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d] Average environmental level (E.L.) subtracted from data.

[e] Lower Detection Limit (LDL) for ^{238}Pu in air for monthly samples is 0.15 X 10^{-17} µCi/ml. This is 0.008% of the RCG.

incremental concentration of tritium oxide measured during 1979 for all offsite locations, not including the environmental level found at sampler #119, was 0.44 x 10^{-11} Ci/ml. This concentration is 0.006% of the RCG. The RCG used for comparison is the most restrictive RCG for tritium for the general population. The results are summarized in Table 6. Table 1 shows environmental levels for plutonium-238 and tritium in air as measured at sampler #119.

An onsite perimeter network consisting of five continuous, high-volume air samplers is used to further assess the effectiveness of stack emission control systems. The onsite sampling locations are shown

Table 5 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL LEVELS IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1979

Location	Number of Samples	$^{239,240}Pu$ Range (10^{-17} µCi/ml)	$^{239,240}Pu$ Average[a,b] (10^{-17} µCi/ml)	^{238}Pu Average[a,b] (10^{-17} µCi/ml)	$^{238}Pu/^{239,240}Pu$
101	4	0.39 - 1.7	0.87 ± 1.1	0.34 ± 0.54	0.39
102	4	0.28 - 1.6	0.87 ± 1.0	0.67 ± 0.34	0.77
103	4	0.29 - 1.7	0.85 ± 1.1	0.42 ± 0.36	0.49
104	4	0.34 - 1.9	1.0 ± 1.2	0.40 ± 0.47	0.40
105	4	0.29 - 1.9	0.91 ± 1.3	0.14 ± 0.12	0.15
108	4	0.42 - 2.0	1.1 ± 1.3	0.11 ± 0.07	0.10
110	4	0.28 - 1.9	0.95 ± 1.2	0.10 ± 0.10	0.11
111	4	0.34 - 2.0	0.95 ± 1.3	0.16 ± 0.17	0.17
112	4	0.27 - 1.6	0.88 ± 0.97	0.09 ± 0.04	0.10
115	4	0.30 - 1.8	0.92 ± 1.1	0.06 ± 0.05	0.07
118	4	0.28 - 1.9	0.99 ± 1.2	0.41 ± 0.74	0.41
119	4	0.21 - 1.5	0.78 ± 0.96	0.05 ± 0.05	0.06
122	12	0.22 - 1.2	0.74 ± 0.27	0.42 ± 0.16	0.57
123	12	0.21 - 2.1	0.96 ± 0.36	3.6 ± 2.2	3.8
124	12	0.26 - 2.0	0.98 ± 0.40	1.3 ± 0.64	1.3

[a] Lower Detection Limit (LDL) for $^{239,240}Pu$ in air for samplers 101 through 119 is 0.04 X 10^{-17} µCi/ml, and the LDL for samplers 122 through 124 is 0.08 X 10^{-17} µCi/ml. The LDL for ^{238}Pu is 0.05 X 10^{-17} µCi/ml for samplers 101 through 119 and 0.15 X 10^{-17} µCi/ml for samplers 122 through 124.

[b] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

in Figure 4. Particulate samples and tritium samples are collected by the onsite samplers at approximately the same flow rate as the offsite samplers and are analyzed in the same manner.

The average incremental plutonium-238 concentration measured for all locations onsite is 4.9 x 10^{-17} Ci/ml which is 0.07% of the RCG. The results are summarized in Table 7. Table 8 presents onsite concentrations of plutonium-239, plutonium-240, and plutonium-238, including environmental levels, so that a ratio comparison between these radionuclides can be made.

The average incremental onsite tritium oxide concentration for all locations was 0.95 x 10^{-11} Ci/ml which is 0.005% of the RCG. The results are summarized in Table 9.

The RCGs used for onsite comparisons are those applicable for exposed individuals

Table 6 - INCREMENTAL CONCENTRATIONS OF TRITIUM OXIDE IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1979

Location	Number of Samples	Tritium Oxide Range[d] (10^{-11} µCi/ml)	Tritium Oxide Average[a,c,d] (10^{-11} µCi/ml)	Percent of RCG[b]
101	52	E.L. - 2.83	0.53 ± 0.13	0.008
102	52	E.L. - 2.74	1.04 ± 0.41	0.015
103	52	0.04 - 4.74	0.65 ± 0.21	0.009
104	52	E.L. - 2.82	0.39 ± 0.13	0.006
105	52	E.L. - 1.68	0.28 ± 0.11	0.004
108	52	E.L. - 1.81	0.10 ± 0.09	0.001
110	52	E.L. - 0.42	0.06 ± 0.06	0.0009
111	52	E.L. - 0.46	0.05 ± 0.06	0.0007
112	52	E.L. - 1.28	0.22 ± 0.08	0.003
115	52	E.L. - 0.75	0.03 ± 0.06	0.0004
118	52	E.L. - 1.91	0.29 ± 0.11	0.004
122	52	E.L. - 2.97	0.62 ± 0.08	0.009
123	52	E.L. - 4.18	0.76 ± 0.12	0.011
124	52	0.06 - 6.03	1.1 ± 0.16	0.016

[a] Lower Detection Limit (LDL) for tritium oxide in air is 0.03 X 10^{-11} µCi/ml which is 0.0004% of the RCG.

[b] Radioactivity Concentration Guide (RCG) = 7000 X 10^{-11} µCi/ml for the general population and for soluble form of tritium.

[c] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d] Average environmental level (E.L.) subtracted from data.

in the population. The total amounts of plutonium-238 and tritium discharged to the atmosphere were 0.012 mCi and 3831 Ci, respectively.

Air - Nonradioactive

The Mound steam power plant is normally fueled with natural gas but has the capability to burn fuel oil. During unusually cold weather, natural gas supply to Mound is interrupted, and fuel oil with <1% sulfur content is burned. The average sulfur content of the fuel oil burned in 1979 was approximately 0.5%. Approximately 37,000 gal of No. 2 fuel oil were burned during 1979.

Additional sources of airborne emissions are as follows. A water-wash, paint spray booth is operated intermittently in the Mound paint shop. Wastes from operations

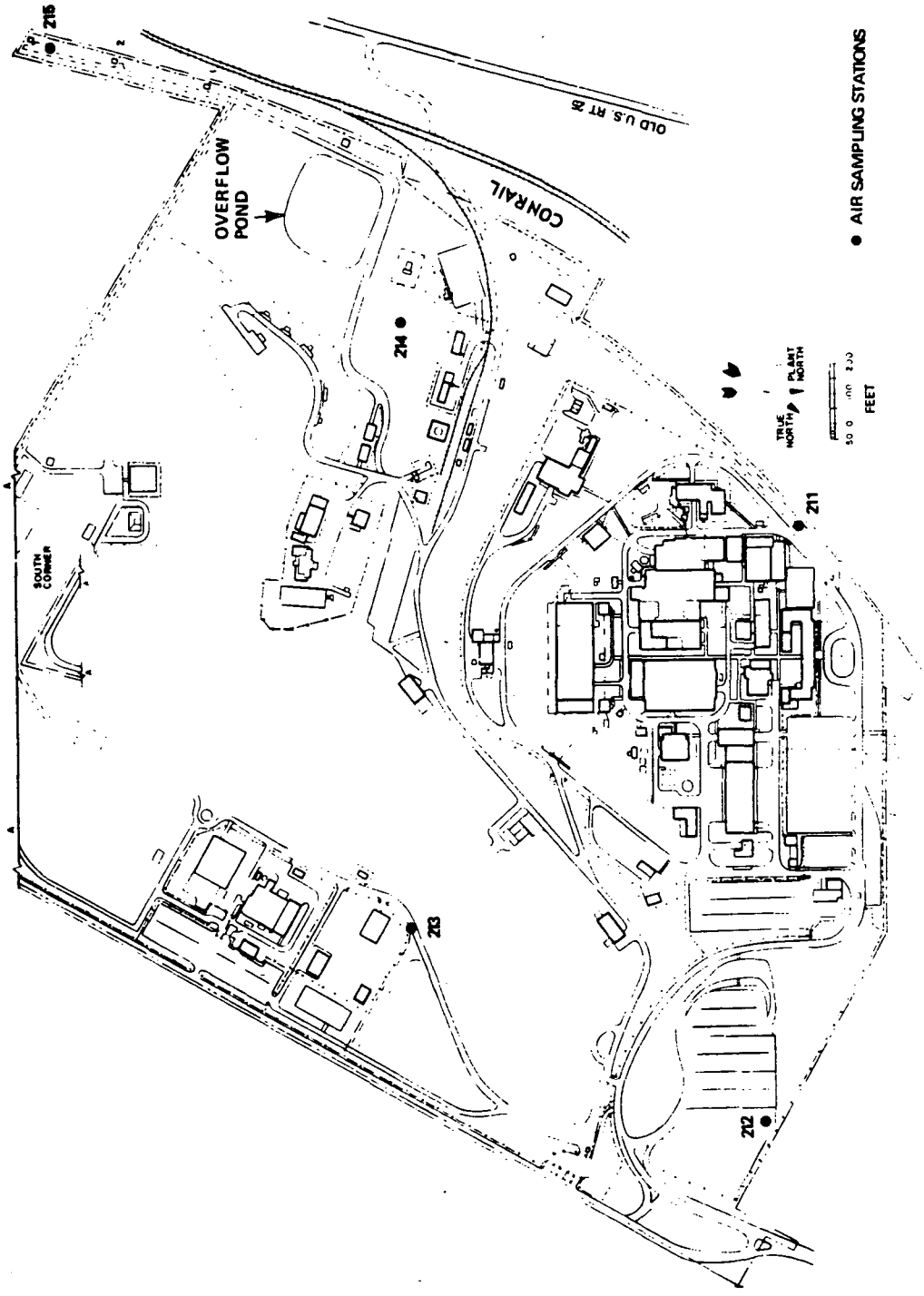


FIGURE 4 - Onsite air sampling locations.

Table 7 - INCREMENTAL CONCENTRATION OF ^{238}Pu IN AIR AT ONSITE SAMPLING LOCATIONS IN 1979

Location	Number of Samples	Range[d] (10^{-17} µCi/ml)	Average[a,c,d] (10^{-17} µCi/ml)	Percent of RCG[b]
211	12	0.54 - 3.3	2.1 ± 0.47	0.03
212	12	0.4 - 3.7	1.6 ± 0.71	0.02
213	12	1.9 - 88	19 ± 15	0.27
214	12	0.51 - 3.9	1.3 ± 0.64	0.02
215	12	0.23 - 1.8	0.63 ± 0.30	0.009

[a]Lower Detection Limit (LDL) for ^{238}Pu in air is 0.15 X 10^{-17} µCi/ml which is 0.002% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = 7000 X 10^{-17} µCi/ml for the soluble form of plutonium-238 for individuals in the population.

[c]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d]Average environmental level (E.L.) subtracted from data.

Table 8 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL LEVELS IN AIR AT ONSITE SAMPLING LOCATIONS IN 1979

		$^{239,240}Pu$		^{238}Pu	
Location	Number of Samples	Range (10^{-17} µCi/ml)	Average[a,b] (10^{-17} µCi/ml)	Average[a,b] (10^{-17} µCi/ml)	Ratio $^{238}Pu/^{239,240}Pu$
211	12	0.24 - 1.6	0.84 ± 0.31	2.2 ± 0.46	2.6
212	12	0.28 - 1.2	0.83 ± 0.30	1.7 ± 0.71	2.0
213	12	0.25 - 2.1	1.1 ± 0.47	19 ± 15	17
214	12	0.28 - 1.4	0.81 ± 0.29	1.4 ± 0.64	1.7
215	12	0.18 - 1.5	0.79 ± 0.32	0.68 ± 0.30	0.86

[a]Lower Detection Limit (LDL) for $^{239,240}Pu$ in air is 0.08 X 10^{-17} µCi/ml. The LDL for ^{238}Pu is 0.15 X 10^{-17} µCi/ml.

[b]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

Table 9 - INCREMENTAL CONCENTRATION OF TRITIUM OXIDE IN AIR AT ONSITE SAMPLING LOCATIONS IN 1979

Location	Number of Samples	Tritium Oxide Range[d] (10^{-11} µCi/ml)	Tritium Oxide Average[a,c,d] (10^{-11} µCi/ml)	Percent of RCG[b]
211	52	E.L. - 2.48	0.83 ± 0.17	0.004
212	51	0.041 - 2.62	0.95 ± 0.17	0.005
213	52	0.012 - 3.74	1.35 ± 0.24	0.007
214	52	E.L. - 4.09	0.86 ± 0.21	0.004
215	51	E.L. - 3.71	0.74 ± 0.21	0.004

[a]Lower Detection Limit (LDL) for tritium oxide in air is 0.03 X 10^{-11} µCi/ml which is 0.00015% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = 20,000 X 10^{-11} µCi/ml for individuals in the population and soluble form of tritium.

[c]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d]Average environmental level (E.L.) subtracted from data.

involving explosives are disposed of by open burning under a permit issued by the Regional Air Polution Control Agency (RAPCA). A fire-test facility for qualifying containers for shipping radioactive wastes was used only once during 1979. A maintenance grinding operation and a carpenter shop also operated on an intermittent basis. Fire-fighter training exercises are held at an open outdoor facility under a burning permit issued by RAPCA.

Emissions from sources registered with the Regional Air Pollution Control Agency (RAPCA) and the Ohio EPA which have applicable emission standards are summarized in Table 10. The emissions were estimated from emission factors established by the USEPA or from material balances [6]. The emission from the shipping-container fire-test facility is controlled with a forced air supply and water spray nozzles at the fuel-flame interface to an average equivalent opacity of <20%. The particulates from the grinding and carpenter shop operations are captured by cyclone air cleaners rated at 95% efficiency. Nonradioactive airborne emissions at Mound Facility were all within applicable standards and had minimal impact on ambient air quality. This is further demonstrated by the particulate concentration data summarized in Tables 11 and 12. The data presented are weekly particulate concentrations measured at Mound's offsite and onsite air-sampling sites. The particulate concentration at onsite locations is somewhat lower than at offsite locations. The particulate concentration also appears to be independent of

Table 10 - NONRADIOACTIVE AIRBORNE EMISSIONS 1979

Emission Source	Pollutant	Emission	Emission Standard[a]	% of Standard
Power House	Particulates	0.01 lb/10^6 Btu Input	0.20 lb/10^6 Btu Input	6
Power House	Sulfur Oxides	0.01 lb/10^6 Btu Input	1.6 lb/10^6 Btu Input	0.6
Paint Shop	Organics	0.29 lb/day	40 lb/day	0.7
Explosives Burning	Particulates	∿5 lb	NA	NA
Fire Fighter Training	Particulates	370 lb	NA	NA

[a]Ohio EPA Air Pollution Regulations 3745-17-01 through 3745-17-13 and 3745-21-01 through 3745-21-08.

NA - not applicable.

distance from Mound. This would suggest no influence from Mound operations. For comparison purposes, the State of Ohio - Ambient Quality Standard for airborne particulates is also given in Table 11.

Water - Radioactive

Water sampling locations along the bank of the Great Miami River were selected according to guidelines recommended by the U. S. EPA [7]. The locations, shown in Figure 5, provide samples which are representative of river water after suitable mixing of the effluent from Mound has occurred. Water samples are normally collected and filtered in the field at these locations five days per week and are subjected to specific analyses for plutonium-238 and tritium.

The plutonium-238 river water analyses have been improved by a procedure developed at Mound Facility to maximize the sensitivity of detection of plutonium-238 in water. Large-volume water samples are analyzed by compositing daily samples for a quarterly analysis. The average incremental concentration of plutonium-238 measured for all locations in the Great Miami River was 0.04 x 10^{-10} µCi/ml which is 0.0002% of the RCG for the general population, the most restrictive standard for plutonium-238. These results are summarized in Table 13.

Weekly composites of daily samples are analyzed for tritium. The average incremental concentration of tritium measured at all locations in the Great Miami River was at the environmental level shown in

Table 11 - 1979 WEEKLY PARTICULATE CONCENTRATION DATA OFFSITE[a]

Location	Number of Samples	Range ($\mu g/m^3$)	Average ($\mu g/m^3$)[b]
101	52	18 - 285	117 ± 14
102	49	23 - 290	93 ± 13
103	52	27 - 147	73 ± 7
104	52	45 - 287	112 ± 14
105	52	27 - 143	77 ± 7
108	50	68 - 183	129 ± 8
110	52	17 - 154	76 ± 7
111	51	13 - 354	126 ± 16
112	52	32 - 155	86 ± 7
115	52	35 - 149	82 ± 7
118	52	31 - 258	94 ± 11
119	52	9 - 103	57 ± 6
122	51	22 - 117	63 ± 5
123	52	58 - 183	100 ± 9
124	51	39 - 303	89 ± 12

[a]Ohio Ambient Air Quality Standard = 60 $\mu g/m^3$.

[b]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

These data are obtained by the Mound air monitoring program and are indicative only of the particulate air loading the Dayton metropolitan area. Mound particulate discharges presented in Table 10 make a negligible contriubtion to the surrounding area. In addition, Table 12 presents onsite particulate data.

Table 12 - 1979 WEEKLY PARTICULATE CONCENTRATION DATA ONSITE

Location	Number of Samples	Range ($\mu g/m^3$)	Average ($\mu g/m^3$)[a]
211	52	44 - 217	86 ± 8
212	51	39 - 148	82 ± 7
213	49	53 - 265	108 ± 13
214	51	17 - 127	66 ± 6
215	51	4 - 140	64 ± 6

[a]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

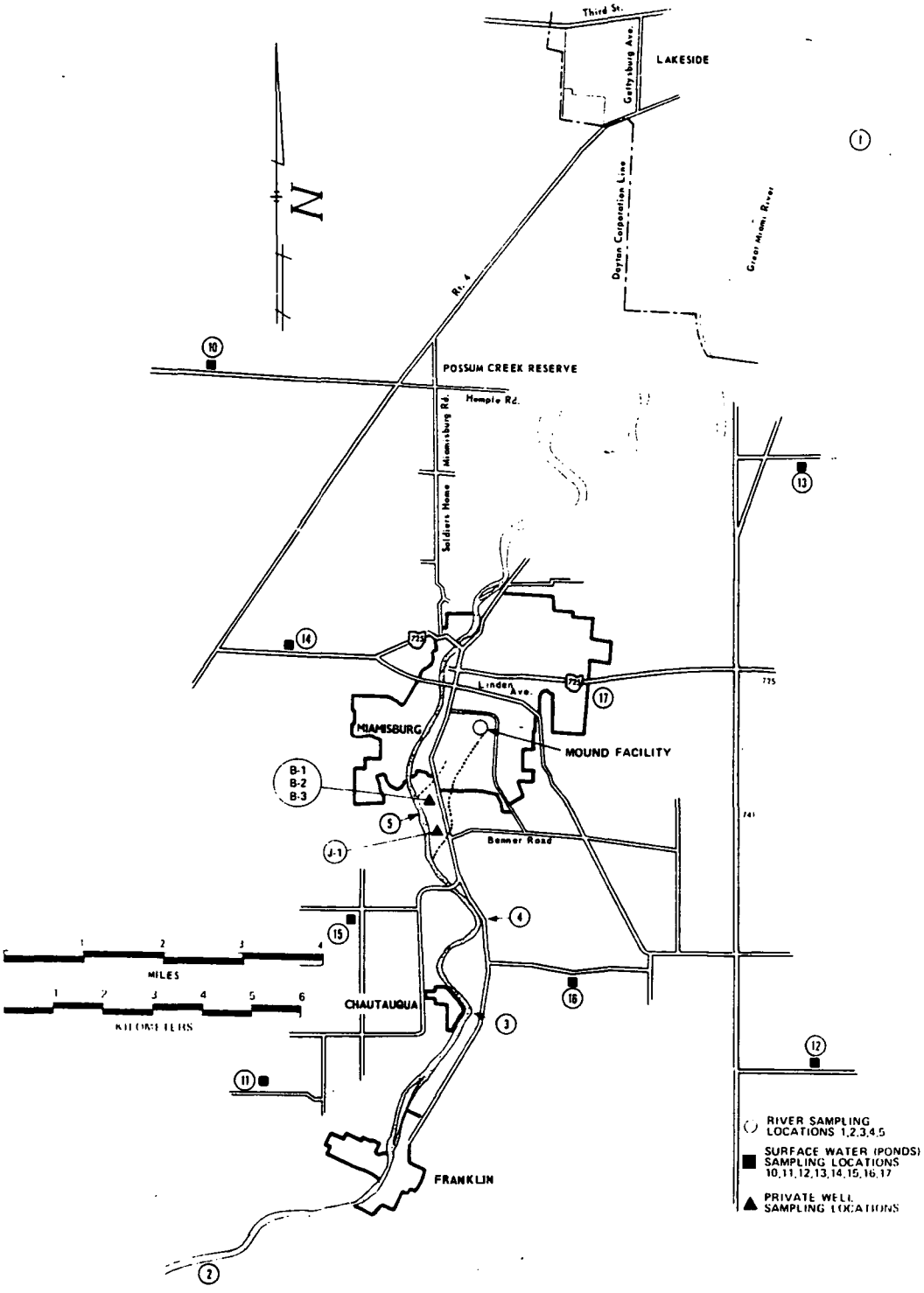


FIGURE 5 - Offsite water sampling locations.

Table 13 - INCREMENTAL CONCENTRATION OF ^{238}Pu IN THE GREAT MIAMI RIVER IN 1979

Location	Number of Samples[a]	^{238}Pu Range[d] (10^{-10} µCi/ml)	^{238}Pu Average[b,d,e] (10^{-10} µCi/ml)	Percent of RCG[c]
1	4	0.004 - 0.06	0.02 ± 0.05	0.0001
2	4	E.L. - 0.03	0.01 ± 0.04	0.00005
3	4	0.01 - 0.06	0.04 ± 0.05	0.0002
4	4	E.L. - 0.15	0.07 ± 0.10	0.00035
5	4	0.01 - 0.14	0.07 ± 0.10	0.00035

[a]Composite large volume water samples for each location from water collected during CY-1979.

[b]Lower Detection Limit (LDL) for ^{238}Pu in water is 0.009×10^{-10} µCi/ml which is 0.000045% of the RCG.

[c]Radioactivity Concentration Guide (RCG) = $20,000 \times 10^{-10}$ µCi/ml for the general population and the soluble form of plutonium-238.

[d]Average environmental level (E.L.) subtracted from data.

[e]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

Table 1. These results are summarized in Table 14.

The total amounts of plutonium-238, tritium, and uranium-233, 234 discharged to the Great Miami River were 3.2 mCi, 33.9 Ci, and 1.2 mCi, respectively. These concentrations were o.06%, 1.1%, and 0.004% of the most restrictive RCG for individuals in the population. It should be noted that a drainage control system consisting of retention basins and an overflow pond was placed in operation during 1979 in order to reduce plutonium levels in plant effluents. The system has resulted in approximately 35% less plutonium-238 discharged than in 1978.

Uranium-233, 234, and 238 were also monitored at the river water sampling locations during CY-1979. The average incremental concentrations of uranium-233, 234 and uranium-238 were 0.0002% and 0.00002%, respectively, of the RCG. In addition, as shown in Table 15, the ratio of uranium-233, 234 to uranium-238 is slightly greater than unity, which is in range of background ratios reported [8]. This is expected as a result of secular equilibrium.

Eight additional surface water locations, such as ponds, in all quadrants surrounding Mound Facility as shown in Figure 5 are sampled quarterly. These samples, used for plutonium-238 determination, are

Table 14 - INCREMENTAL CONCENTRATION OF TRITIUM IN THE GREAT MIAMI RIVER IN 1979

Location	Number of Samples	Tritium Range[d] (10^{-6} µCi/ml)	Tritium Average[a,c,d] (10^{-6} µCi/ml)	Percent of RCG[b]
1	42	E.L. - 0.9	E.L.	-
2	43	E.L. - 1.7	E.L.	-
3	43	E.L. - 1.1	E.L.	-
4	43	E.L. - 0.8	E.L	-
5	43	E.L. - 1.6	E.L.	-

[a]Lower Detection Limit (LDL) for tritium in water is 0.30 x 10^{-6} µCi/ml which is 0.03% of the RCG.

[b]DOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000 x 10^{-6} µCi/ml for the general population and the soluble form of tritium.

[c]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d]Average environmental level (E.L.) subtracted from data.

also large volume water samples. The large volume of sample increases the sensitivity of the analysis for plutonium. A smaller aliquot (10 ml) was taken which was adequate for the tritium analysis. The average concentrations of plutonium-238 and tritium for all locations were 0.02 x 10^{-10} µCi/ml and 0.1 x 10^{-6} µCi/ml, respectively, which are 0.0001% and 0.01% of the respective RCG for the general population. The results of the surface water samples are summarized in Tables 16 and 17. Environmental levels (Table 1) have been subtracted from the concentration of plutonium and tritium in water.

During 1979, Mound continued a previously reported program of reducing the concentration of tritium in the local area of the Buried Valley Aquifer adjacent to the Facility site in order to achieve compliance of this water source with new EPA Interim Primary Drinking Water Regulations which became effective in June 1977 for public water systems. The background level of tritium in the aquifer had been increased by past tritium operations at Mound. In response to this situation, releasing tritium process liquid effluents to the environment discontinued a number of years ago. The reduction of tritium in the aquifer has since been achieved by forced water turnover involving high-volume pumping of two high-capacity wells and induced infiltration of water from the Great Miami River.

The EPA drinking water regulations, promulgated in July 1976, reduced the federal standard for tritium by a factor of 50.

Table 15 - INCREMENTAL CONCENTRATION OF $^{233,234}U$ AND ^{238}U IN THE GREAT MIAMI RIVER IN 1979

Location	Number of Samples[a]	$^{233,234}U$ Range[e] (10^{-10} µCi/ml)	$^{233,234}U$ Average[a,b,c,e] (10^{-10} µCi/ml)	$^{233,234}U$ Percent of RCG[f,g]	^{238}U Range (10^{-10} µCi/ml)	^{238}U Average[a,b,c,e] (10^{-10} µCi/ml)	^{238}U Percent of RCG[f,g]	Ratio[d] $^{233,234}U/^{238}U$
1	4	E.L. - 2.1	1.0 ± 4.6	0.001	E.L. - 1.8	0.3 ± 3.4	0.00008	1.1
2	4	E.L. - 1.2	E.L.	-	E.L. - 0.3	E.L.	-	1.1
3	4	E.L. - 0.7	E.L.	-	E.L. - 0.2	E.L.	-	1.1
4	4	E.L. - 1.8	0.1 ± 4.6	0.0001	E.L. - 0.8	E.L.	-	1.1
5	4	E.L. - 1.3	E.L.	-	E.L. - 0.6	E.L.	-	1.1

[a] Composite large volume water samples for each location.

[b] Lower Detection Limit (LDL) for $^{233,234}U$ and ^{238}U in water is 0.14×10^{-10} µCi/ml and 0.09×10^{-10} µCi/ml, respectively.

[c] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d] A ratio slightly greater than unity indicates naturally occurring uranium [10]. Does not have environmental levels subtracted.

[e] Average environmental level (E.L.) subtracted from data.

[f] DOE Concentration Guide (RCG) for $^{233,234}U = 100,000 \times 10^{-10}$ µCi/ml for the general population.

[g] DOE Concentration Guide (RCG) for $^{238}U = 400,000 \times 10^{-10}$ µCi/ml for the general population.

Table 16 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN SURFACE WATER IN 1979

Location	Number of Samples[a]	^{238}Pu Range (10^{-10} µCi/ml)[d]	^{238}Pu Average[b,d,e] (10^{-10} µCi/ml)	Percent of RCG[c]
10	4	E.L. - 0.04	0.02 ± 0.03	0.0001
11	4	0.01 - 0.03	0.02 ± 0.02	0.0001
12	4	0.02 - 0.03	0.02 ± 0.01	0.0001
13	4	0.002 - 0.06	0.02 ± 0.04	0.0001
14	3	0.01 - 0.03	0.02 ± 0.03	0.0001
15	4	0.004 - 0.02	0.01 ± 0.02	0.00005
16	3	0.006 - 0.01	0.01 ± 0.01	0.00005
17	4	0.03 - 0.06	0.04 ± 0.02	0.0002

[a]Composite large volume water samples were used for each location.

[b]Lower Detection Limit (LDL) for ^{238}Pu in water is 0.009 x 10^{-10} µCi/ml which is 0.000045% of the RCG.

[c]Radioactivity Concentration Guide (RCG) for ^{238}Pu in water = 20,000 x 10^{-10} µCi/ml for the general population and soluble form of plutonium-238.

[d]Average environmental level (E.L.) subtracted from data.

[e]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

This drastic reduction resulted in Mound's three wells and eight offsite wells being out of compliance. Mound's pumping program to remove the tritiated water from the aquifer brought Mound's three wells into compliance with the new tritium standard in September 1977 and five of the affected offsite public wells in April 1978. Although private wells were technically not regulated by the new EPA standard, Mound continued its tritium reduction program and by December 1979 achieved the new standard for three private wells that had also been affected. The average concentration of tritium in all eight affected offsite wells during 1979 was 12 x 10^{-6} µCi/ml or 40% below the EPA standard. Periodic pumping of the aquifer will be continued to maintain the wells in compliance until continuing studies indicate that the program can be terminated. Additional details concerning this program have been reported by Styron and Meyer [9]. Analysis results on the private wells are summarized in Table 18.

Drinking water from communities in the surrounding area is sampled and analyzed quarterly for tritium. These communities and their relative locations are shown in Figure 1. The average concentration of

Table 17 - INCREMENTAL CONCENTRATION OF TRITIUM IN SURFACE WATER IN 1979

Location	Number of Samples	Tritium Range (10^{-10} µCi/ml)[d]	Tritium Average[a,b,d,e] (10^{-10} µCi/ml)	Percent of RCG[c]
10	4	E.L. - 0.9	0.1 ± 1.0	0.01
11	4	E.L. - 0.7	E.L.	-
12	4	E.L.	E.L.	-
13	4	E.L. - 0.05	0.1 ± 0.6	0.01
14	4	E.L. - 0.7	0.4 ± 0.7	0.04
15	4	E.L. - 0.5	E.L.	-
16	4	E.L. - 0.2	E.L.	-
17	4	E.L. - 1.1	0.3 ± 1.2	0.03

[a]Lower Detection Limit (LDL) for tritium in water is 0.3×10^{-6} µCi/ml which is 0.03% of the RCG.

[b]DOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000×10^{-6} µCi/ml for the general population and soluble form of tritium.

[c]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d]Average environmental level (E.L.) subtracted from data.

Table 18 - TRITIUM IN PRIVATE WELLS IN 1979

Location	Number of Samples	Tritium Range[e] (10^{-6} µCi/ml)	Tritium Average[a,b,d,e] (10^{-6} µCi/ml)	Percent Standard[c]
B-1	34	13.9 - 26.9	19.3 ± 1.3	97
B-2	12	10.3 - 14.9	11.1 ± 2.1	56
B-3	12	10.4 - 13.6	11.8 ± 0.7	59
J-1	12	8.3 - 15.7	12.0 ± 1.4	60

[a]All wells are approaching compliance with the new EPA standard of 20×10^{-6} µCi/ml.

[b]Lower Detection Limit (LDL) for tritium in water is 0.3×10^{-6} µCi/ml which is 1.5% of the EPA Standard.

[c]EPA Standard for tritium in community drinking water systems = 20×10^{-6} µCi/ml. Mound is using the EPA Standard as a guide for the private water supplies.

[d]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[e]Environmental level is included in these data for comparison to the EPA standard.

tritium for all locations was 1.0×10^{-6} µCi/ml which is 5% of the standard adopted by the U. S. EPA in 1977 for community drinking water systems. Data from the analyses of community drinking water samples are summarized in Table 19. The environmental level in Table 1 for tritium in water is not subtracted from these data.

Four private wells and Miamisburg city water were sampled and analyzed quarterly for plutonium-238. These samples were also large volume water samples. The average plutonium-238 concentration for these locations was 0.013×10^{-10} µCi/ml which is 0.00007% of the applicable DOE RCG for the general population. These results are shown in Table 20.

Water - Nonradioactive

Mound Facility has a discharge permit under the National Pollutant Discharge Elimination System (NPDES) issued by Region V of the U. S. EPA. The permit specifies limitations for pollutants in the two effluent streams from Mound that discharge to the Great Miami River. The discharge from outfall number 001 includes the discharge from the sanitary waste treatment plant, radioactive waste disposal facility,

Table 19 - SUMMARY OF TRITIUM LEVELS IN COMMUNITY DRINKING WATER IN 1979

Locations	Number of Samples	Tritium Range[d] (10^{-6} µCi/ml)	Tritium Average[a,c,d] (10^{-6} µCi/ml)	Percent Standard[b]
Bellbrook	4	0.4 - 1.0	0.7 ± 0.5	3.5
Centerville	4	0.2 - 1.2	0.7 ± 0.7	3.5
Dayton	4	0.2 - 1.3	0.7 ± 0.8	3.5
Franklin	4	0.6 - 1.0	0.8 ± 0.3	4.0
Germantown	4	0.5 - 1.6	1.0 ± 0.8	5.0
Kettering	4	0.3 - 1.9	1.0 ± 1.1	5.0
Miamisburg	4	1.5 - 5.1	2.8 ± 2.5	14
Middletown	4	0.5 - 0.8	0.6 ± 0.3	3.0
Moraine	4	0.3 - 1.0	0.6 ± 0.5	3.0
Springboro	4	0.5 - 2.9	1.5 ± 1.7	7.5
Waynesville	4	0.2 - 0.7	0.4 ± 0.3	2.0
West Carrollton	4	1.1 - 1.7	1.4 ± 0.4	7.0

[a] Lower Detection Limit (LDL) for tritium oxide is 0.3×10^{-6} µCi/ml which is 1.5% of the EPA Standard for community drinking water.

[b] EPA Drinking Water Standard for tritium = 20×10^{-6} µCi/ml for community drinking water systems.

[c] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[d] Environmental level is included in these data for comparison to the EPA standard.

Table 20 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN PRIVATE WELLS AND MIAMISBURG MUNICIPAL DRINKING WATER IN 1979

Location	Number of Samples[a]	^{238}Pu Range[e] (10^{-10} µCi/ml)	^{238}Pu Average[b,d,e] (10^{-10} µCi/ml)	Percent of RCG[c]
Miamisburg	4	E.L. - 0.013	0.003 ± 0.013	0.00002
B-1	4	E.L. - 0.009	0.004 ± 0.011	0.00002
B-2	4	E.L. - 0.019	0.007 ± 0.014	0.00004
B-3	4	0.002 - 0.02	0.011 ± 0.013	0.00006
J-1	4	0.002 - 0.14	0.042 ± 0.11	0.002

[a]Composite large volume water samples were analyzed from each location from water collected during CY-1979.

[b]Lower Detection Limit (LDL) for ^{238}Pu is 0.009 x 10^{-10} µCi/ml which is 0.000045% of the RCG.

[c]Applicable DOE Radioactivity Concentration Guide (RCG) for ^{238}Pu in water = 20,000 x 10^{-10} µCi/ml for the general population and soluble form of ^{238}Pu.

[d]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[e]Average environmental levels (E.L.) subtracted from data.

single-pass cooling water, zeolite softener backwash, boiler-plant blowdown, and some storm water runoff. The discharge from outfall number 002 consists of single-pass cooling water, cooling-tower blowdown, zeolite softener backwash, and most of the stormwater runoff. A 24-hr composite sample of each effluent stream is collected automatically. The volume of samples collected is proportional to the flow in the stream. The composite effluent water samples are analyzed for water quality parameters according to standard methods [10]. The results of effluent stream analyses for 1979 are summarized in Tables 21 and 22.

The suspended solids limitation for discharge 001 was exceeded during the months of September and October. The exceptions were the result of an unusual perturbation at the sewage treatment plant caused by the introduction of boiler cleaning solutions during unanticipated high flows. The unanticipated high flows prevented the planned slow introduction of the boiler cleaning solutions into the sewage treatment plant influent. The boiler cleaning solutions contained high concentrations of precipitated ferric hydroxide that were not adequately removed by the biological treatment process. A sample of the suspended solids from discharge 001 during this period was analyzed for iron; over 80% of the suspended solid matter consisted of iron oxide or rust. Although the iron oxide did not represent a significant pollutant to the environment, more frequent

Table 21 - 1979 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT DATA FOR STATION 001

Parameter		No. Samples	Minimum	Maximum	Average
Flow, MGD[a]	Reported	Cont.	0.06	0.45	0.18
	Permit			0.92	0.53
BOD_5	Reported	92	0.7	9.4	3.9
	Permit			15	10
Suspended Solids	Reported	113(89)[c]	0.3	120(16)[c]	10.9(7.0)[c]
	Permit			15	10
Dissolved Oxygen	Reported	177	7.6	12.8	10.1
	Permit				>5
Residual Chlorine	Reported	104	ND[b]	0.4	0.14
	Permit			0.5	
Oil and Grease	Reported	96	0.14	4.6	1.3
	Permit			10	
pH	Reported	250	6.9	9.0	
	Permit		6.0	9.0	
Organic[d] Carbon	Reported	43	ND	25	6.1

[a]MGD - million gallons per day. All other values are in milligrams per liter.

[b]ND - none detectable.

[c]September and October data omitted.

[d]March through September, instrument down.

Table 22 - 1979 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT DATA FOR STATION 002

Parameter		No. Samples	Minimum	Maximum	Average
Flow, MGD[a]	Reported	Cont.	0.14	1.4	0.42
	Permit				0.53
Suspended Solids	Reported	26	0.7	18.5	10.7
	Permit			20.0	15
Dissolved Oxygen	Reported	215	7.0	14.0	10.4
	Permit				>5.0
Residual Chlorine	Reported	25	ND[b]	0.02	ND
	Permit			0.05	
Oil and Grease	Reported	60	0.1	3.6	1.2
	Permit			10.0	
pH	Reported	235	7.7	8.8	
	Permit		6.0	9.0	
Dissolved Solids	Reported	40	576	1784	1090
	Permit			2000	1500

[a]MGD - million gallons per day. All other values are in milligrams per liter, except pH.

[b]ND - none detectable.

removal of sludge from the system and pumping of sludge from the sludge digestor into drying beds was implemented to expedite the return of the plant to more normal operating conditions. The plant returned to normal operating conditions within five weeks. No other permit limitations were exceeded during this period. These data show that Mound releases to the Miami River did not cause the Ohio Stream Standards to be exceeded.

Foodstuffs and vegetation - Radioactive

Various locally grown foodstuffs and vegetation samples are collected from the surrounding area. The intent of this portion of the Environmental Monitoring Program is to determine whether there is any significant uptake and concentration of radionuclides by plant or animal life. The sampling sites were changed during 1979. Samples were collected in Miamisburg, Centerville, and Bellbrook. Centerville and Bellbrook are in the prevailing wind direction from Mound at a distance of 5 mi and 10 mi respectively. These communities are shown in Figure 1. Fish were collected in the Great Miami River downstream of Mound's outfall into the Great Miami River. The area where the fish were taken can be seen in Figure 5. The plutonium-238 content of the foodstuff and vegetation samples is determined by ashing the samples and then proceeding with the same techniques used for plutonium-238 analyses of air samples (see section on Air - Radioactive). The tritium content of the foodstuff and vegetation samples is determined by distilling the water from the sample and then analyzing the distillate for tritium. The results of the foodstuff, vegetation, and fish analyses are summarized in Tables 23 and 24. The concentration is given in terms of the sample weight (net weight) before ashing or distilling. The samples of aquatic life analyzed included only the edible fleshy portions of fish. These analyses indicate no evidence that there is any significant uptake or concentration by plant or animal life of the radionuclides handled at Mound Facility. Environmental levels for foodstuffs and vegetation have been subtracted from the data (Table 1).

Silt - Radioactive

Silt samples were collected from the surface water sample locations shown in Figure 5.

The results of the silt sample analyses are found in Tables 25 and 26. No offsite soil sampling was conducted in CY-1979 since the soil inventory was completed and reported for CY-1977, and there is no evidence of other than minimal uptake of plutonium-238 by plants from soil [11].

Table 23 - INCREMENTAL PLUTONIUM-238 IN FOODSTUFFS AND VEGETATION IN 1979

Location	Type of Sample	Number of Samples	Plutonium-238 Range[a,d] (10^{-6} µCi/g)	Plutonium-238 Average[a,b,c,d] (10^{-6} µCi/g)
Miamisburg	Grass	8	E.L. - 0.0008	0.00003 ± 0.0009
	Potatoes	4	E.L.	E.L.
Centerville	Grass	8	E.L. - 0.003	0.00007 ± 0.0013
	Potatoes	4	E.L.	E.L.
Bellbrook	Grass	8	E.L. - 0.0004	E.L.
	Potatoes	4	E.L. - 0.0003	E.L.
Mound Facility (outfall to river)	Fish	8	0.0001 - 0.0007	0.0004 ± 0.0002

[a]Average environmental level (E.L.) subtracted from data.

[b]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[c]Lower detection limit (LDL) for plutonium-238 in these samples is 0.0009 x 10^{-6} µCi/g.

[d]Many of these results were at the LDL level; however, the actual values were used in the averages as explained earlier in this report.

Table 24 - INCREMENTAL CONCENTRATION OF TRITIUM IN VEGETATION IN 1979

Location	Type of Sample	Number of Samples	Tritium Range[c] (10^{-6} µCi/g)	Tritium Average[a,b,c,d] (10^{-6} µCi/g)
Miamisburg	Grass	8	0.92 - 2.0	1.32 ± 0.4
	Tomatoes	4	0.47 - 0.69	0.59 ± 0.14
Centerville	Grass	8	0.54 - 1.1	0.88 ± 0.24
	Tomatoes	4	0.16 - 0.23	0.20 ± 0.04
Bellbrook	Grass	8	0.27 - 1.0	0.53 ± 0.24
	Tomatoes	4	0.48 - 0.53	0.51 ± 0.04

[a]LDL for tritium in grass is 0.03 x 10^{-6} µCi/g.

[b]LDL for tritium in tomatoes is 0.02 x 10^{-6} µCi/g.

[c]Average environmental levels have been subtracted from data.

[d]Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

Table 25 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN SILT FROM RIVER MONITORING LOCATIONS IN 1979

Location	Number of Samples	^{238}Pu [a,b,c] (10^{-6} µCi/g)
1	1	0.0006
2	1	0.01
3	1	0.81
4	1	0.42
5	1	0.07

[a] Lower Detection Limit (LDL) for ^{238}Pu in silt is 0.0009×10^{-6} µCi/g.

[b] No error limits as only one sample was collected.

[c] Average environmental level (E.L.) subtracted from data.

Table 26 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN SILT FROM SURFACE WATER MONITORING LOCATIONS IN 1979

Location	Number of Samples	^{238}Pu Range[c] (10^{-6} µCi/g)	^{238}Pu Average[a,b,c] (10^{-6} µCi/g)
10	4	E.L. - 0.0005	0.0002 ± 0.0009
11	3	E.L. - 0.003	0.0008 ± 0.0057
12	4	0.0003 - 0.003	0.0011 ± 0.0023
13	1	-	0.0013
14	3	E.L. - 0.0001	E.L.
15	3	0.001 - 0.004	0.0019 ± 0.0036
16	4	E.L. - 0.003	0.0008 ± 0.0028
17	1	-	0.0612

[a] Lower Detection Limit (LDL) for ^{238}Pu is 0.0009×10^{-6} µCi/g.

[b] Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

[c] Average environmental levels (E.L.) have been subtracted from data.

Evaluation of dose commitment to the public

A dose assessment was performed for radionuclides in the environment from Mound Facility operations. These radionuclides are plutonium-238 and tritium. Tritium (oxide) is the only radionuclide at Mound Facility for which the critical organ is the whole body. The critical organs for plutonium-238 are assumed to be the lung for insoluble material and the bone for soluble material. The solubility of plutonium-238 in the receptor is unknown; therefore each dose evaluation for both lung and bone were based on total incremental concentration of plutonium-238 found in the environment. This approach gives a very conservative or over estimate of the dose commitment.

The term "dose commitment" as used in this report is that cumulative dose for a period of 50 yr from 1 yr of exposure to a given radionuclide.

Plutonium-238 assumptions and methodology

The dose commitment estimates for plutonium-238 were based on environmental monitoring data for CY-1979. The estimates for maximum dose commitment to the lung at the site boundary and maximum dose commitment to the lung in individuals were based on the maximum onsite incremental average concentration of plutonium-238 in air from onsite samplers (sampler 213, Table 7) since the samplers are in close proximity to the site boundary. The maximum dose commitment to the lung in population group(s) was based on the maximum offsite average incremental concentration of plutonium-238 in air (sampler 123, Table 4).

The estimates for maximum dose commitment to the bone at the site boundary and in individuals were also based on the maximum onsite average incremental concentration of plutonium-238 in air and the maximum offsite average concentration of plutonium-238 in drinking water (J-1, Table 20). The maximum dose commitment to the bone for individuals in population group(s) was based on the maximum offsite average incremental concentration of plutonium-238 in water (Miamisburg drinking water, Table 20). The total dose commitment for bone was obtained by the addition of the dose commitment of plutonium in air and the dose commitment of plutonium in water.

The terms "maximum dose commitment at the site boundary" and "maximum dose commitment to individuals" refer to the maximum dose commitment possible for individuals to receive assuming they remain at the site boundary 24 hr/day and 365 days/yr. The term "maximum dose commitment for individuals in population group(s)" refers to those individuals who reside in a location adjacent to Mound Facility who receive the maximum dose commitment values found in the offsite environment.

The calculational methods can be found in the Appendix. The results of the dose commitment estimate calculations are shown in Table 27.

Table 27 - DOSE COMMITMENT ESTIMATES

	Plutonium-238 (mrem/50 yr)				Tritium Oxide (mrem/50 yr)	
	Lung	% of Applicable DOE Standard	Bone	% of Applicable DOE Standard	Whole Body	% of Applicable DOE Standard
Maximum dose equivalent at the site boundary	1.21	-	8.06	-	1.32	-
Maximum dose equivalent to an individual	1.21	0.08%	8.06	0.5%	1.32	0.3%
Maximum dose equivalent to an individual in the population group(s)	0.22	0.04%	1.49	0.3%	0.21	0.1%

The data indicate that in all cases of dose commitment comparisons, the dose commitments are well within 1% of the DOE standard. In addition, to provide a relative comparison of these dose commitment values, the maximum dose to the lung of an individual around Mound Facility is 1.21 mrem/50 yr. This would be equivalent to the additional dose to an individual smoking 1.8 cigarettes /yr [12] or visiting a friend who lives in a brick house for 1.4 days [13] (as compared to living in a wooden house).

Tritium (oxide) assumptions and methodology

The dose commitment estimates for tritium (oxide) were also based on environmental monitoring data for CY-1979. The concentrations used for dose commitment estimates for tritium (oxide) were arrived at by the same method as that used for plutonium. The maximum average onsite air incremental concentration was measured at sampler 213 (Table 9), and the maximum drinking water incremental concentration was the average of B-1, B-2, and B-3 (Table 18). The maximum average offsite air incremental concentration was measured at sampler 124 (Table 6), and the maximum incremental concentration of drinking water for individuals in a population group was Miamisburg drinking water. The total dose commitment for the whole body was obtained by addition of the dose commitment of tritium (oxide) in air and the dose commitment of tritium (oxide) in water. The calculational methods can be found in the Appendix. The results of the dose commitment estimate calculations are shown in Table 27.

The tritium data also indicate dose commitment levels well within 1% of the DOE standards. For example, the maximum

whole body dose commitment to an individual around Mound Facility from tritium is 1.32 mrem. This value is equivalent to the additional dose to an individual from Ohio taking a 4.4 day vacation in Colorado [14].

Environmental data indicate that Mound's influence does not reach 32 km (20 mi); however, 32 km (20 mi) will be the assumed limit for Mound's impact. This, coupled with the assumption of 360° atmospheric diffusion to 32 km (20 mi), provides a high degree of conservatism or over estimation of Mound's impact.

The person-rem dose commitment estimate calculations were based on average tritium (oxide) data from environmental air sampling stations and average tritium (oxide) data in community drinking water.

The average concentration of tritium (oxide) in air was obtained by averaging all offsite tritium air samplers less the concentration found at sampler #119. From this average concentration a dose commitment was determined and multiplied by the number of people from 0 to 32 km (20 mi).

The person-rem from tritium (oxide) in community water was based upon average concentrations of tritium (oxide) in various community water supplies, less appropriate environmental levels, and weighting these concentrations with respective populations.

The calculations for the air and water dose commitment estimates are shown in the Appendix.

It is estimated that the total population from 0 to 32 km (20 mi) is receiving 13 person-rem from Mound's emissions. The remaining population from 32 km to 80 km (20 to 50 mi) is not receiving any dose commitment from tritium (oxide) emissions.

For comparison, the person-rem values from natural radiation, including cosmic rays and terrestrial radiation, would be approximately 320,000 person-rem for the 0 to 80 km (50 mi) range [15]. The dose commitment from natural background tritium alone is 80 person-rem for the 0 to 80 km range.

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Appendix

Applicable standards

RADIOACTIVE STANDARDS

In conformance with DOE 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 three.

Onsite sample results are compared with the uncontrolled area RCG's which are applicable for individuals in the population.

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.

Plutonium-238 (Soluble Form)

Air

General Population	2×10^{-14}	μCi/ml
Uncontrolled Area (Individuals in the Population)	7×10^{-14}	μCi/ml

Water

General Population	2×10^{-6}	μCi/ml
Uncontrolled Area (Individuals in the Population)	5×10^{-6}	μCi/ml

Tritium (Soluble Form)

Air

General Population	7×10^{-8}	μCi/ml
Uncontrolled Area (Individuals in the Population)	2×10^{-7}	μCi/ml

Water (DOE RCG is compared to water not used for drinking purposes)

General Population	1×10^{-3}	μCi/ml
Uncontrolled Area (Individuals in the Population)	3×10^{-3}	μCi/ml

As of June 24, 1977, community drinking water quality is regulated by the EPA National Interim Primary Drinking Water Regulations for Radionuclides. The new standard = 20×10^{-6} μCi/ml (20,000 pCi/l).

Foodstuffs There are no RCG values specified for foodstuffs.

Soil There are no guidelines established for radioactive species in soil. (The U. S. EPA has guidelines under consideration.)

NONRADIOACTIVE STANDARDS

Water Region V of the USEPA has issued a discharge permit under NPDES regulations covering both Mound Facility liquid effluent streams. The discharge limitations for each effluent stream are as follows:

Outfall Number 001	Daily Average	Daily Maximum
Flow (10^6 gal/day)	0.53	0.92
BOD_5 (mg/liter)	10	15
Suspended Solids (mg/liter)	10	15
Dissolved Oxygen (mg/liter)	5	-
Residual Chlorine (mg/liter)	-	0.5
Oil and Grease (mg/liter)	-	10
pH	6-9	-

Outfall Number 002	Daily Average	Daily Maximum
Flow (10^6 gal/day)	0.53	-
Suspended Solids (mg/liter)	15	20
Dissolved Oxygen (mg/liter		
October-April	8	-
May-September	5	-
Residual Chlorine (mg/liter)	-	0.05
Oil and Grease (mg/liter)	-	10
Dissolved Solids (mg/liter)	1500	2000
pH	6-9	-

The Ohio EPA has established Water Quality Standards (3745-1-01-3745-1-09). The standards listed below are excerpted from these regulations. 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/liter)
Dissolved Oxygen	5.0
pH	6-9
Fecal Coliform	200 per 100 ml

Constituent	Average Concentration (mg/liter)
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 and Grease	5
Phenols	0.01
Selenium	0.005
Silver	0.001
Copper	0.005 - 0.075*
Zinc	0.075 - 0.5*

*Dependent on $CaCo_3$ hardness.

Dose commitment calculations

PLUTONIUM-238 CALCULATIONAL METHODS

The dose commitment to the lung resulting from inhalation of airborne plutonium-238 was calculated by:

$$D(t) = \frac{51.1 C I_a t_1 f_a f_r \Sigma EF(RBE)_n}{\lambda m} (1-e^{-\lambda t_2})$$

where

D(t) = 50-yr dose commitment delivered to the lung in 365 days of continuous exposure to plutonium-238 in air, rem/50 yr

C = average airborne concentration, μCi/ml

Appendix

I_a = average air intake = 2×10^7 ml/day [1]

t_1 = time exposed, 365 days

t_2 = duration of dose, 50 yr

f_a = fraction of inhaled material reaching organ of interest = 0.7 (max.) for the pulmonary region [2]

f_r = fraction of pulmonary deposition undergoing long-term retention = 0.6 for actinide (class Y) [2]

$\Sigma EF(RBE)\eta$ = effective energy deposition per disintegration = 57 [1]

λ = effective decay rate, 0.0014 day^{-1} for actinides (class Y) from the pulmonary region [3]

m = lung mass, 1000 g [1]

The dose commitment to bone resulting from inhalation of airborne plutonium-238 was calculated by:

$$D(t) = \frac{51.1CI_a f_a t_1 \Sigma EF(RBE)\eta}{\lambda m}(1-e^{-\lambda t_2})$$

where

f_a = 0.2 [1]

$\Sigma EF(RBE)\eta$ = 284 [1]

m = 7×10^3 g [1]

= 3×10^{-5} day^{-1} [1]

The dose commitment to bone resulting from ingestion of plutonium-238 in water was calculated by:

$$D(t) = \frac{51.1CI_w f_a t_1 \Sigma EF(RBE)}{\lambda m}(1-e^{-\lambda t_2})$$

where

I_w = average quantity of water intake, 2200 cm^3 [1]

f_a = 2.4×10^{-5} [1]

TRITIUM OXIDE CALCULATIONAL METHODS

The dose commitment to the whole body resulting from exposures to tritium (oxide) in air was calculated by:

$$D(t)a = \frac{\bar{C}a}{Ra} \times S$$

where

D(t)a = dose commitment, mrem/50 yr

$\bar{C}a$ = average concentration of tritium (oxide) in air

Ra = RCG for tritium (oxide) in air [4]

S = Radiation protection standard in mrem/50 yr [4]

The dose commitment to the whole body resulting from uptake of tritium (oxide) in water was calculated by:

$$D(t)w = \frac{\bar{C}w}{Rw} \times S$$

where

D(t)w = dose equivalent in mrem/50 yr

$\bar{C}w$ = average concentration

Rw = RCG for tritium (oxide) in water [4]

S = radiation protection standard in mrem/50 yr [4]

These dose commitment values were divided by 1.7 in order to reflect the quality factor of one as recommended by the

Appendix

International Commission on Radiological Protection [5] and the National Council on Radiation Protection Measurements [6].

PERSON-REM CALCULATIONS

The equations used for this calculation were:

$$\bar{D}(t)a = \frac{\bar{C}a}{Ra} \times S$$

where

$\bar{D}(t)a$ = dose commitment from tritium (oxide) in air

$\bar{C}a$ = average tritium (oxide) concentration in air

Ra = RCG for tritium (oxide) in air [4]

S = radiation protection standard for tritium (oxide) in air in mrem/50 yr [4]

$$\bar{D}(t)w = \frac{\bar{C}w}{Rw} \times S$$

where

$\bar{D}(t)w$ = dose commitment from tritium (oxide) in water

$\bar{C}w$ = average tritium (oxide) concentration in water

Rw = RCG for tritium (oxide) in water [4]

S = radiation protection standard for tritium (oxide) in water, mrem/50 yr [4]

These dose commitment values were divided by 1.7 in order to reflect the quality factor of one as recommended by the International Commission on Radiological Protection [5] and the National Council on Radiation Protection and Measurements [6].

The total person-rem from 0 to 32 km is obtained by:

$$\sum_0^{32} R = \left(\left(\bar{D}(t)a \sum_0^{32} P\right) + \sum_0^{32}\left(\bar{D}(t)wP\right)\right)$$

where

$\sum_0^{32} R$ = person-rem within 32 km

$\bar{D}(t)a \sum_0^{32} P$ = average dose commitment x population from 0-32 km (895,941)

$\sum_0^{32}\left(\bar{D}(t)wP\right)$ = summation of dose commitments x respective population from 0-32 km

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Appendix

Distribution

EXTERNAL

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