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FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL MONITORING ANNUAL REPORT FOR 1971

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FEED MATERIALS PRODUCTION CENTER

ENVIRONMENTAL MONITORING ANNUAL REPORT

FOR 1971

Prepared by

HEALTH AND SAFETY DIVISION

NATIONAL LEAD COMPANY OF OHIO
P. O. Box 39158
Cincinnati, Ohio 45239

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UNITED STATES ATOMIC ENERGY COMMISSION
CINCINNATI AREA

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INTRODUCTION

This report summarizes environmental monitoring data collected at the Feed Materials Production Center (FMPC) during 1971. Data are presented for both radioactive and non-radioactive contaminants in environmental samples. These data show that the average offsite concentrations of radioactive contaminants produced by FMPC operations were not greater than 2% of the guide levels published in AEC Manual Chapter 0524. The resulting offsite radiation exposures would, therefore, be a small fraction (<1%) of the standards for uncontrolled areas. In addition, no ambient standard for non-radioactive contaminants was exceeded by airborne or liquid effluents.

The FMPC is an industrial facility owned by the Atomic Energy Commission and operated by the National Lead Company of Ohio. It is located on a 1050-acre site about 20 miles northwest of Cincinnati, Ohio. Several small rural communities are 1-3 miles away. See Figure 1 for a map of the area.

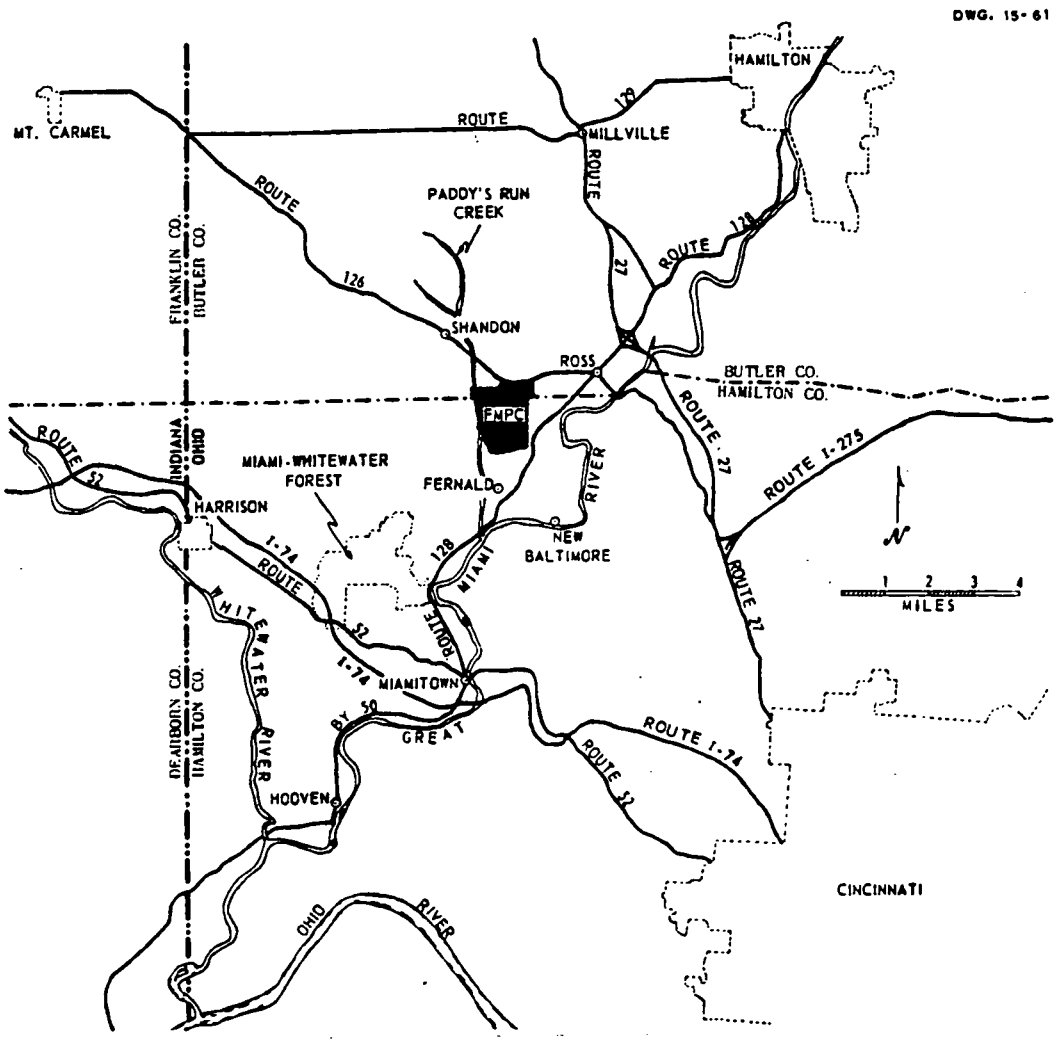


FIGURE 1 Area Map of Relative Locations

The primary work at the FMPC is the production of purified uranium metal and compounds for use at other AEC sites. A small amount of thorium is also processed.

Uranium production may begin with ore concentrates, recycled uranium from spent reactor fuel, or with various compounds from other AEC sites. Impure starting material is dissolved in nitric acid and the uranium is extracted into an organic liquid and then back-extracted into dilute nitric acid to yield a solution of uranyl nitrate hexahydrate.

Evaporation and heating convert the nitrate solution to uranium trioxide (UO_3) powder. This compound is reduced to uranium dioxide (UO_2) with hydrogen and then converted to uranium tetrafluoride (UF_4) by reaction with anhydrous hydrogen fluoride. Uranium metal is produced by reacting UF_4 and magnesium metal in a refractory-lined reduction vessel. This primary uranium metal is then remelted with scrap uranium metal to yield a purified uranium ingot which is rolled or extruded to form rods or tubes. Sections are then cut and machined to final dimensions. These machined cores are then shipped to other AEC sites for canning and final assembly into reactor fuel elements.

Thorium production steps, in general, are similar to those followed in uranium production. Final products may be purified thorium nitrate solution, solid thorium compounds, or metal.

STANDARDS

There are several sets of standards which can be applied to environmental samples collected in in connection with FMPC operations. These standards have been set by the AEC, State of Ohio, and the U. S. Environmental Protection Agency (EPA).

AIR. The AEC has specified limits for radionuclides in air and water which must be followed by contract operators such as the National Lead Company of Ohio.[1] These criteria, published in AEC Manual Chapter 0524, specify maximum concentrations in work areas and in offsite areas which are beyond AEC control.

For environmental monitoring purposes, the criteria for air and water in uncontrolled areas are used as standards. At the FMPC, criteria for offsite air are applied to samples collected at the plant boundary.

Criteria used for non-radioactive contaminants in ambient air are those established by the EPA.[2] However, not all EPA criteria apply to the FMPC. Current production operations do exhaust particulates and oxides of nitrogen in sufficient quantity to warrant occasional boundary sampling of ambient air. In the near future, boundary air samples will be collected for sulfur dioxide analyses to determine the importance of emissions from the project's coal-fired boiler plant.

WATER. As previously noted, standards for radionuclides in water have been specified by the AEC for use by the Commission's contract operators. Criteria for offsite water are applied to

river samples collected downstream from the point where the plant effluent reaches the river, but upstream from any known use of the water as a drinking water supply.

Water quality criteria adopted by the State of Ohio are mainly concerned with non-radioactive contaminants, but several radioactivity limits are included.[3] The criteria are applied to samples collected downstream from the FMPC effluent discharge point.

In addition to the criteria which are now part of regulations adopted by the Ohio Water Pollution Control Board, the National Lead Company of Ohio uses additional criteria recommended by the State Department of Health. These criteria are for chloride,[4] nitrate,[4] and filterable solids.[5] The criteria for chloride and nitrate are similar to those recommended by the Public Health Service for potable water supplies[6] and are applied to the river downstream from the plant effluent line. The limit for filterable solids was set by agreement with the State and it is applied to the effluent before mixing in the river.

SAMPLE COLLECTION AND ANALYSES

AIR. Conversion of impure uranium and thorium compounds to reactor-grade feed materials involves operations which generate radioactive dust, nuisance dusts, and corrosive mists or reaction products. Ventilation and air cleaning systems are used to confine this air and remove airborne contaminants, including valuable material which is returned to the production processes. The filtered or scrubbed air is exhausted to the atmosphere. Sampling of these stack exhausts is maintained on a continuous schedule to determine the operating condition of the air cleaning systems.

To determine the concentration of material which might reach the offsite air, samples were collected continuously at four locations around the production area and at the Sewage Treatment Plant (STP). See Figure 2. At each location a metered quantity of air was drawn through a filter which was changed weekly. Each filter and its collection of dust was dissolved and the solution analyzed for uranium and alpha and beta radioactivity. After these analyses, the remaining solutions were saved and composited for thorium analysis. Frequent analyses for thorium are not considered necessary because of the small amount of thorium processed.

During 1971, the only routine analysis made for non-radioactive contaminants was the determination of particulate matter. Filters used at the five sampling locations mentioned above plus one test sampler at location (E) were weighed before use and then reweighed after changing to obtain the weight of collected dust. All locations are indicated in Figure 2.

A new air sampling schedule was started in January, 1972, and includes occasional boundary sampling for oxides of nitrogen and sulfur dioxide. Occasional grab sampling for nitrogen oxide near the production area has shown that the concentration of this chemical is well within EPA limits but the boundary sampling will be carried out to provide documentation.

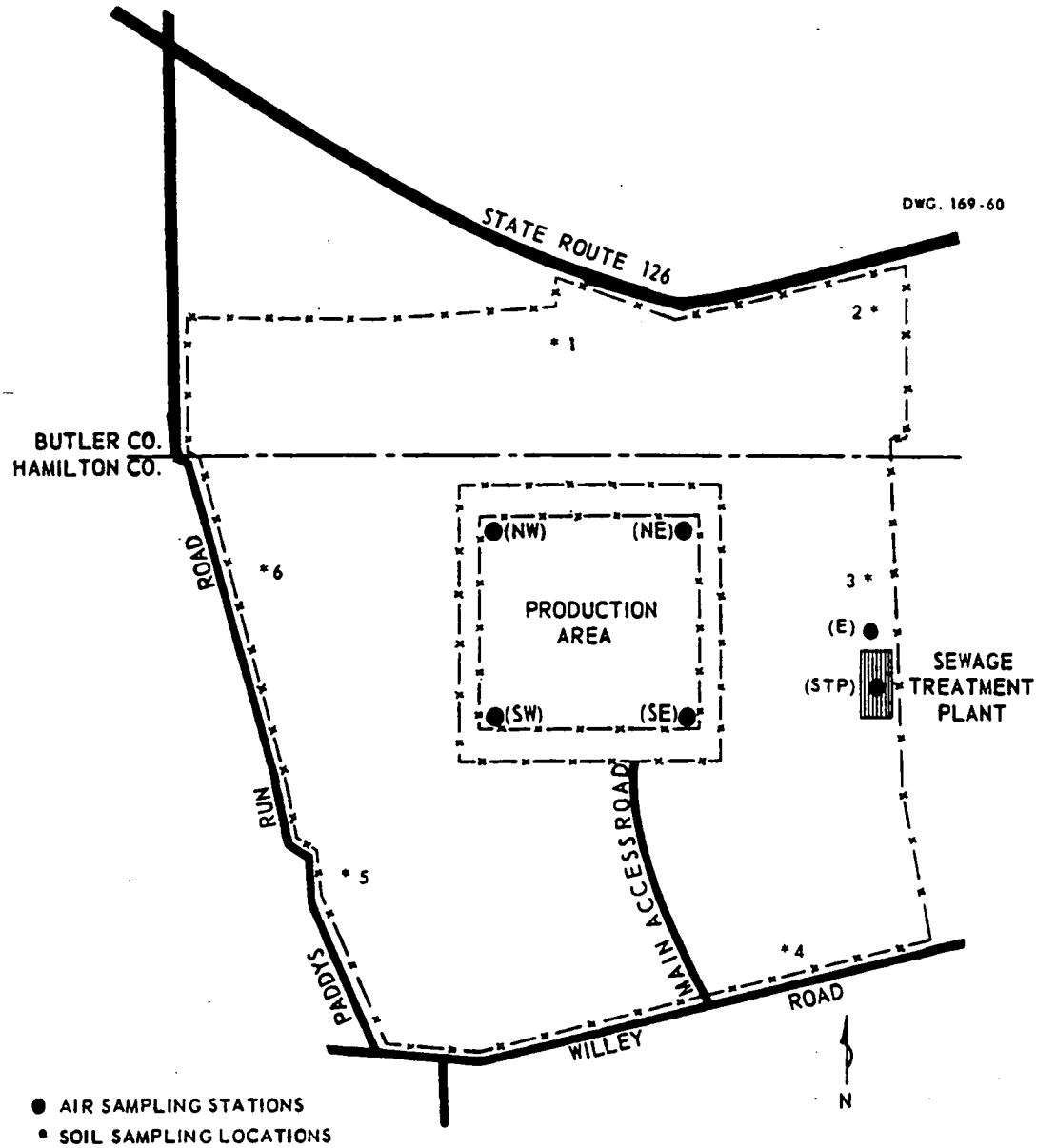
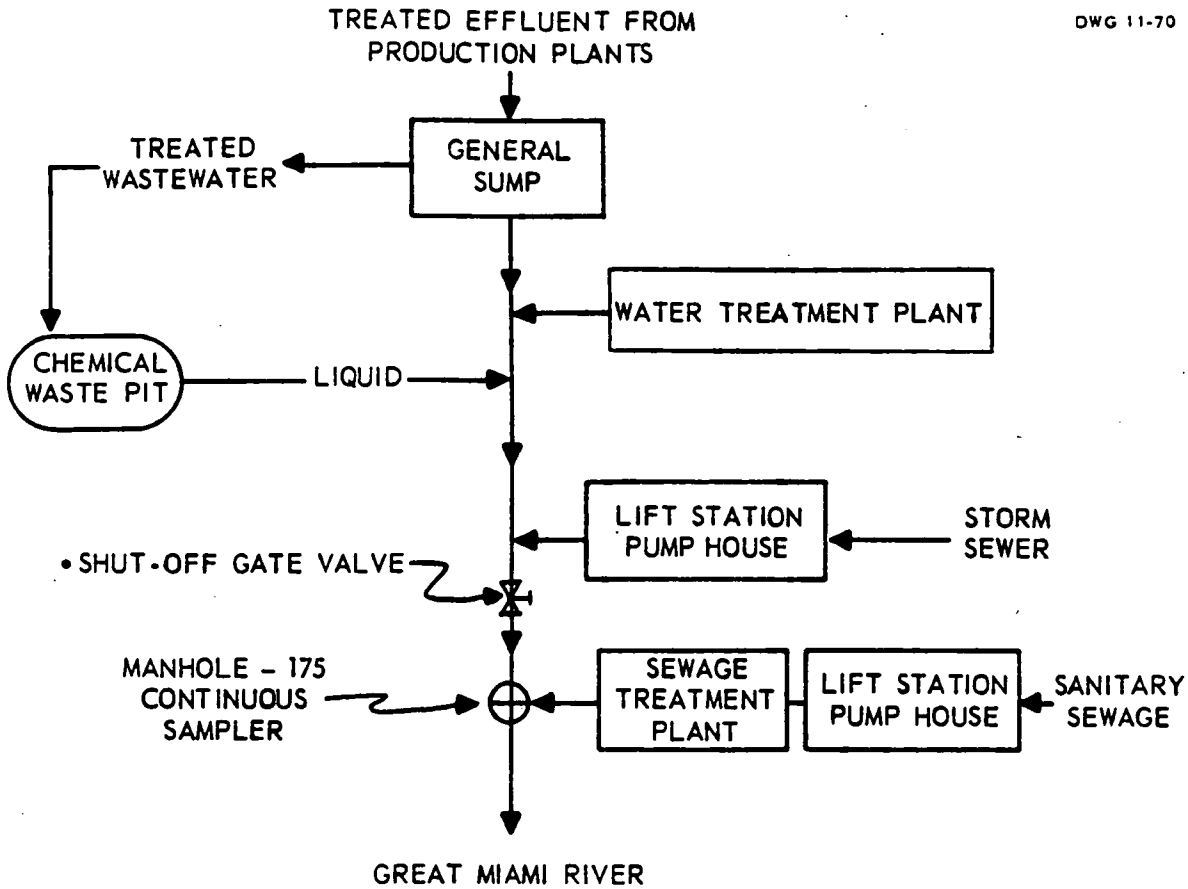


FIGURE 2 Soil and Air Sampling Locations

WATER. Each of the individual production plants on the project has collection sumps and treatment equipment for the initial treatment of process waste water. Uranium and thorium may be recovered as part of the treatment. Effluents from the plants are collected at a central facility, called the General Sump, for additional treatment. The treated wastes are then discharged into a large pit where the solids settle to the bottom. Clear effluent from the pit is combined with the other water streams and discharged to the Great Miami River. See Figure 3 for a diagram of the process.



* *Storm sewer water can be diverted to the Chemical Waste Pit or the General Sump by first halting the pumping from both locations and then closing the shut-off gate valve in the process waste line.*

FIGURE 3 Flow Diagram of Chemical Waste and Disposal Process

Water samples are collected at several points to determine the effect of the effluent upon the river. Locations are shown in Figure 4. At point W1, upstream from the effluent discharge, a weekly river water spot sample is taken for background analysis. At the final access point on the waste liquid line, a Parshal Flume type water sampler collects continuously a sample which is proportional to the total flow. This sample is collected and analyzed on a daily basis. Results of this analysis, combined with daily river flow measurements, are used to calculate contaminant concentrations added to the river at point W2. At point W3, downstream on the river from the discharge point, 24-hour samples are collected by a continuous sampler. At least one sample is analyzed each week.

Samples from all collection points are analyzed for uranium, alpha, and beta radioactivity, radium-226, radium-228, chloride, fluoride, nitrate, filterable solids, and pH. Results of this monitoring have been reported to the Ohio Department of Health on a monthly basis since 1954.

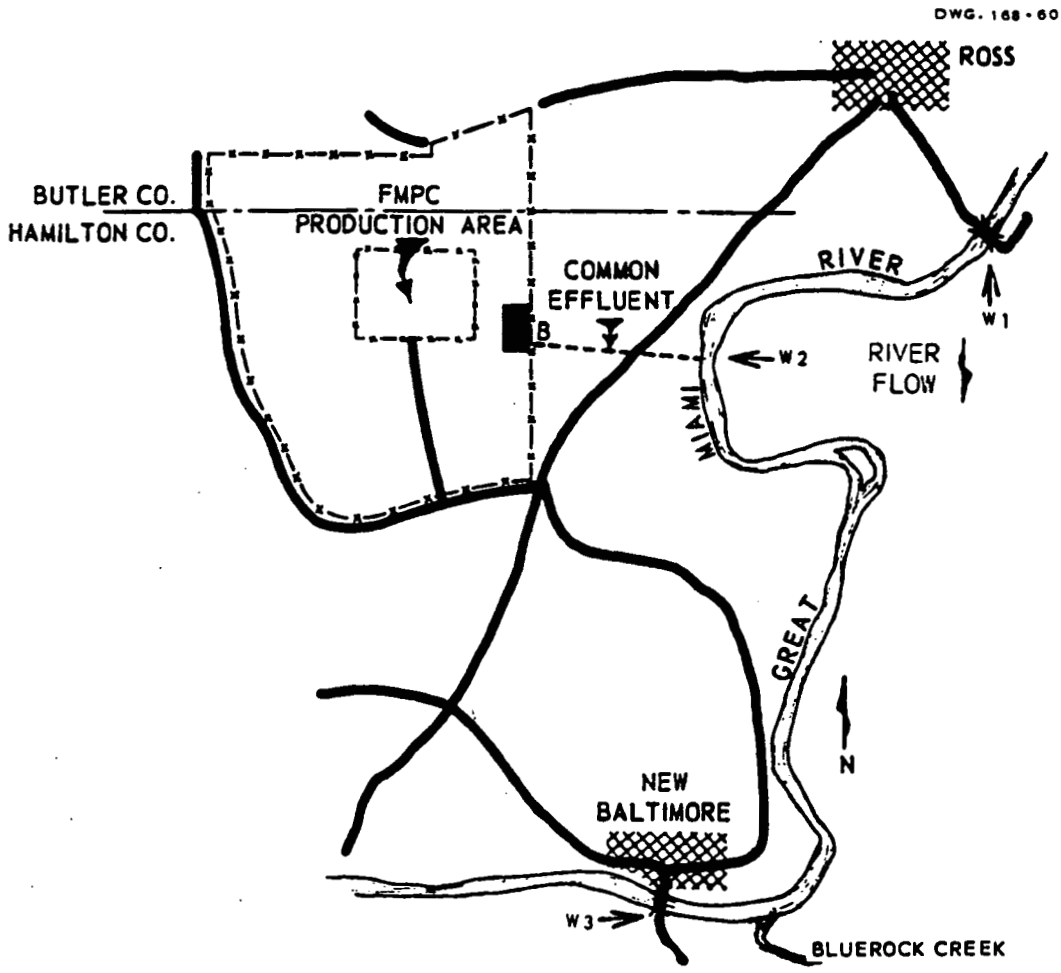


FIGURE 4 Water Sampling Locations

Individual samples may be analyzed for other contaminants or they may be composited for varying periods and analyzed for lesser contaminants such as thorium.

SOIL. At least once each year, soil samples are collected at six locations inside the project boundary. See Figure 2. Each sample consists of six cores, 2 cm diameter and 10 cm deep. The cores are taken about 1.5 meters apart. These samples are analyzed for uranium to observe the possible contribution from stack effluents.

MONITORING DATA

Environmental data collected during 1971 are given in Tables 1 – 5. Where appropriate, comparisons are made with the applicable standard for each contaminant.

TABLE 1 Radioactive Contaminants in Air

Contaminant	Sampling Point (1)	Number of Samples	Max. Conc. Found		Min. Conc. Found		Average Condentration Found				Detection Level	Standard(2)
			μCi/ml	μg/m³	μCi/ml	μg/m³	μCi/ml	μg/m³	% of Standard	95% Confidence Limit		
Uranium	SW	50	0.37×10^{-12}	1.11	$< 0.01 \times 10^{-12}$	< 0.03	0.04×10^{-12}	0.12	2.0	$\pm 0.5 \times 10^{-14}$ μCi/ml	0.01×10^{-12} μCi/ml	2.00×10^{-12} μCi/ml
	NW	48	0.13×10^{-12}	0.39			0.03×10^{-12}	0.09	1.5			
	NE	52	0.11×10^{-12}	0.33			0.03×10^{-12}	0.09	1.5			
	SE	49	0.20×10^{-12}	0.60			0.03×10^{-12}	0.09	1.5			
	STP	43	0.11×10^{-12}	0.33			0.02×10^{-12}	0.06	1.0			
Thorium	SW	6(3)	0.58×10^{-15}	0.0046	0.18×10^{-15}	0.0014	0.39×10^{-15}	0.0031	0.04	$\pm 0.5 \times 10^{-15}$ μCi/ml	4.5×10^{-17} μCi/ml	1000×10^{-15} μCi/ml
	NW	6	0.65×10^{-15}	0.0052	0.10×10^{-15}	0.0008	0.25×10^{-15}	0.0020	0.02			
	NE	6	0.66×10^{-15}	0.0053	0.12×10^{-15}	0.0010	0.30×10^{-15}	0.0026	0.03			
	SE	6	0.39×10^{-15}	0.0031	0.08×10^{-15}	0.0006	0.25×10^{-15}	0.0020	0.02			
Gross Alpha Radioactivity	SW	50	0.28×10^{-12}	NA(4)	$< 0.01 \times 10^{-12}$	NA	0.04×10^{-12}	NA	2.0	$\pm 0.8 \times 10^{-14}$ μCi/ml	0.01×10^{-12} μCi/ml	2.00×10^{-12} μCi/ml
	NW	48	0.14×10^{-12}	NA			0.03×10^{-12}	NA	1.5			
	NE	52	0.08×10^{-12}	NA			0.03×10^{-12}	NA	1.5			
	SE	49	0.15×10^{-12}	NA			0.03×10^{-12}	NA	1.5			
	STP	43	0.15×10^{-12}	NA			0.02×10^{-12}	NA	1.0			
Gross Beta Radioactivity	SW	50	0.43×10^{-12}	NA	0.04×10^{-12}	NA	0.16×10^{-12}	NA	0.02	$\pm 0.7 \times 10^{-13}$ μCi/ml	0.01×10^{-12} μCi/ml	1000×10^{-12} μCi/ml
	NW	48	0.52×10^{-12}	NA	0.02×10^{-12}	NA	0.16×10^{-12}	NA	0.02			
	NE	52	0.55×10^{-12}	NA	0.03×10^{-12}	NA	0.15×10^{-12}	NA	0.02			
	SE	49	0.40×10^{-12}	NA	0.02×10^{-12}	NA	0.14×10^{-12}	NA	0.01			
	STP	43	0.60×10^{-12}	NA	0.04×10^{-12}	NA	0.15×10^{-12}	NA	0.02			

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) See reference 1.

(3) Each sampled covered 1 – 2 months and was a composite of daily samples.

(4) Not applicable.

Data in Table 1 show that the average radionuclide concentrations in air, at the onsite sampling stations, were no greater than 2% of their respective standards for offsite areas. It is concluded from these data that any offsite radiation exposure resulting from FMPC airborne contaminants would be a small fraction (<1%) of the standards given in reference (1).

TABLE 2 Particulate Matter in Air

Sampling Point (1)	Number of Samples	Maximum Conc. Found µg/m³	Minimum Conc. Found µg/m³	Average Concentration Found			Detection Level	Standard (2)
				µg/m³	% of Standard	95% Confidence Limit		
SW	7	57	28	46	61	±5%	1 µg/m³	75 µg/m³
NW	5	70	37	57	76			
NE	6	77	46	64	85			
SE	4	64	38	55	73			
STP	4	89	32	55	73			
E	8	76	33	54	72			

Footnotes:
(1) See sampling locations shown in Figure 2.
(2) See reference 2.

The average concentrations of airborne particulate matter, given in Table 2, are below the EPA standard. The highest average, at point NE, may have been due to the contribution from the nearby boiler plant.

Table 3 contains information on radionuclides in water. As shown, the average concentrations of uranium, thorium, and radium added to the river was <1% of the AEC Radiation Protection Standards. The average upstream concentrations of radium-226 and radium-228 were 3.0% and 1.5% of the standard for uncontrolled areas. Although both radionuclides were present in the plant effluent, the average downstream concentrations were no higher than those found upstream.

As shown in Table 3, the State criteria for gross beta and dissolved alpha radioactivity were not exceeded in the river. The calculated addition of gross dissolved alpha did average 12.3% of the State criteria. However, this alpha activity was due principally to uranium, for which the AEC limit is substantially higher. The more limiting State standard is intended to provide control over all alpha emitters, including radium-226 which must be kept at a concentration much lower than other less important radionuclides.

Operations at the FMPC did not cause any State standard for non-radioactive contaminants to be exceeded in the river. The contaminants listed in Table 4 were selected for analysis and reporting because of the possibility of adding to the river contaminant concentrations which were >1% of the applicable State standards.

TABLE 3 Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number of Samples	Max. Conc. Found		Min. Conc. Found		Average Concentration Found				Detection Level	Standard
			µCi/ml	mg/l	µCi/ml	mg/l	µCi/ml	mg/l	% of Standard	95% Confidence Limit		
Uranium(2)	W1	55	0.20×10^{-7}	0.055	$< 0.01 \times 10^{-7}$	< 0.003	0.03×10^{-7}	0.009	0.015	$\pm 0.5 \times 10^{-9}$	1.0×10^{-10}	2×10^{-5} µCi/ml(5)
	W2	365	1.82×10^{-7}	0.560			0.02×10^{-7}	0.006	0.01	NA	NA	
	W3	56	0.06×10^{-7}	0.018			0.02×10^{-7}	0.006	0.01	$\pm 0.5 \times 10^{-9}$	1.0×10^{-10}	
Thorium(2)	W2	12(3)	9.00×10^{-12}	8×10^{-5}	0.9×10^{-12}	8×10^{-6}	1.12×10^{-12}	1×10^{-5}	< 0.001	NA(4)	NA	1×10^{-6} µCi/ml(5)
Radium-226	W1	6	9.08×10^{-10}	NA	$< 4.45 \times 10^{-10}$	NA	4.45×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	3×10^{-8} µCi/ml(5)
	W2	15	1.39×10^{-10}	NA	0.04×10^{-10}	NA	0.62×10^{-10}	NA	0.2	NA	NA	
	W3	6	9.08×10^{-10}	NA	$< 4.45 \times 10^{-10}$	NA	4.45×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	
Radium-228	W1	12	9.08×10^{-10}	NA	$< 4.45 \times 10^{-10}$	NA	4.45×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	3×10^{-8} µCi/ml(5)
	W2	24	0.58×10^{-10}	NA	$< 0.02 \times 10^{-10}$	NA	0.15×10^{-10}	NA	< 0.1	NA	NA	
	W3	12	9.08×10^{-10}	NA	$< 4.45 \times 10^{-10}$	NA	4.45×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	
Dissolved Alpha	W2	60	1.52×10^{-9}	NA	1.61×10^{-10}	NA	3.68×10^{-10}	NA	12.3	NA	NA	3×10^{-9} µCi/ml(6)
Gross Beta	W1	55	0.54×10^{-7}	NA	0.04×10^{-7}	NA	0.20×10^{-7}	NA	2.0	$\pm 0.9 \times 10^{-8}$	6×10^{-9}	1×10^{-6} µCi/ml(6)
	W2	365	9.21×10^{-7}	NA	$< 0.01 \times 10^{-7}$	NA	0.38×10^{-7}	NA	3.8	NA	NA	
	W3	56	0.45×10^{-7}	NA	0.09×10^{-7}	NA	0.18×10^{-7}	NA	1.8	$\pm 0.9 \times 10^{-8}$	6×10^{-9}	

Footnotes:

(1) See sampling locations shown in Figure 4. W1 – Miami River, upstream at Ross, Ohio; W2 – Calculated addition to the river based on effluent analyses and river flow; W3 – Miami River, downstream at New Baltimore, Ohio.

(2) In accordance with AEC Manual Chapter 0524 a curie of natural uranium means a total of 7.49×10^{10} dis/sec, and a curie of natural thorium means a total of 7.4×10^{10} dis/sec.

(3) Each sample covers a one-month period.

(4) Not applicable.

(5) See reference 1.

(6) See reference 3.

TABLE 4 Non-Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc. Found mg/l	Minimum Conc. Found mg/l	Average Concentration Found mg/l	Average Concentration Found % of Standard	Average Concentration Found 95% Confidence Limit	Detection Limit	Standard
Chloride	W1	55	78.0	23.0	50.0	25.0	±10%	1 mg/l	250 mg/l(2)
	W2	365	2.1	0.1	0.3	0.1			
	W3	56	75.0	16.0	50.0	25.0			
Filterable Solids	W1	51	437	4	51	NA(3)	±20%	4 mg/l	100 mg/l(4)
	W2	365	746	2	71	71			
	W3	56	800	8	52	NA			
Fluoride	W1	55	0.87	0.23	0.56	46.7	±15%	0.2 mg/l	1.0 mg/l(5)
	W2	365	0.20	<0.01	0.02	2.0			
	W3	56	0.92	0.25	0.58	48.3			
Nitrate	W1	55	37.8	5.2	13.9	31.6	±10%	0.3 mg/l	44 mg/l(2)
	W3	365	17.7	0.02	3.7	8.5			
	W3	56	38.2	10.3	19.6	44.4			

Footnotes:

(1) See Figure 4.

(2) See reference 4.

(3) Not applicable.

(4) Agreement with the Ohio Department of Health for average concentration in the effluent.

(5) See reference 3.

TABLE 5 Uranium in Soil – Onsite Locations

Sampling Point (1)	Number of Samples	Uranium Concentration (2) µCi/g	Uranium Concentration (2) µg/g	Uranium Concentration (2) 95% Confidence Limit	Detection Level
1	1	2.2×10^{-6}	10.1	±25%	0.5 µg/g
2	1	4.4×10^{-6}	19.9		
3	2	21.3×10^{-6}	95.8		
4	1	2.0×10^{-6}	8.9		
5	1	3.8×10^{-6}	17.0		
6	1	4.0×10^{-6}	18.2		

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) Results on dry basis.

There are no standards for comparison with the results for uranium in soil listed in Table 5. The higher result for point (E) is due to the localized contribution from the small onsite incinerator. Although the normal values for uranium in local soil is 1-4 µg/g, there are no hazards associated with the elevated soil uranium produced by FMPC operations. External radiation from uranium is slight and the exposure contribution from these onsite concentrations would be considerably less than 1% of the Radiation Protection Standard for people in uncontrolled areas.

REFERENCES

(1) U. S. Atomic Energy Commission, AEC Manual Chapter 0524, Standards for Radiation Protection. February 4, 1969.

(2) Environmental Protection Agency. "Code of Federal Regulations, Title 42, Part 410, National Primary and Secondary Ambient Air Quality Standards," Federal Register, 36: No. 84. April 30, 1971.

(3) Ohio Department of Health, Water Pollution Control Board. "Resolution Establishing Amended Criteria of Stream-Water Quality for Various Uses Adopted by the Board on April 14, 1970."

(4) Ohio Department of Health. "Report of Water Pollution Study of Miami River." 1951.

(5) Agreement between the Ohio Department of Health and the National Lead Company of Ohio.

(6) U. S. Public Health Service. 1962. Public Health Service Drinking Water Standards, 1962. PHS Pub. No. 956, Washington, D. C.

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