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FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL MONITORING ANNUAL REPORT FOR 1974

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FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL MONITORING ANNUAL REPORT
FOR 1974

Prepared by

HEALTH AND SAFETY DIVISION

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

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UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
CINCINNATI AREA

HS
Env '74

CONTENTS

	Page
INTRODUCTION	1
SUMMARY	3
AREA FEATURES	3
ENVIRONMENTAL STANDARDS	5
SAMPLE COLLECTION AND ANALYSES	7
MONITORING DATA	13
TOTAL RADIONUCLIDES RELEASED	20
RADIATION EXPOSURE ESTIMATIONS FOR 1974	20
OTHER ENVIRONMENTAL CONTROLS	25
REFERENCES	28
DISTRIBUTION LIST	29

FIGURES

		Page
1	AREA MAP	2
2	FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL FEATURES	9
3	WASTE DISPOSAL FLOW DIAGRAM	11
4	FMPC AND SURROUNDING AREA	12

TABLES

		Page
1	RADIOACTIVE CONTAMINANTS IN AIR	14
2	NON-RADIOACTIVE CONTAMINANTS IN AIR	15
3	RADIOACTIVE CONTAMINANTS IN WATER	17
4	NON-RADIOACTIVE CONTAMINANTS IN WATER	19
5	HYDROGEN ION CONCENTRATION	19
6	URANIUM IN SOIL	22
7	URANIUM IN MIAMI RIVER SEDIMENT	22
8	URANIUM IN LOCALLY-GROWN VEGETABLES	26
9	SEWAGE TREATMENT PLANT DATA	26

INTRODUCTION

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Energy Research & Development Administration 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 rural communities are 1-3 miles away. See Figure 1 for a map of the area.

The primary work at the FMPC is the production of purified uranium metal and compounds for use at other ERDA sites. In regard to U^{235} content, the uranium may be depleted, normal, or slightly enriched. The average content is close to normal.

Uranium production may begin with ore concentrates, recycled uranium from spent reactor fuel, or with various compounds from other ERDA 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.

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 extruded to form rods or tubes.

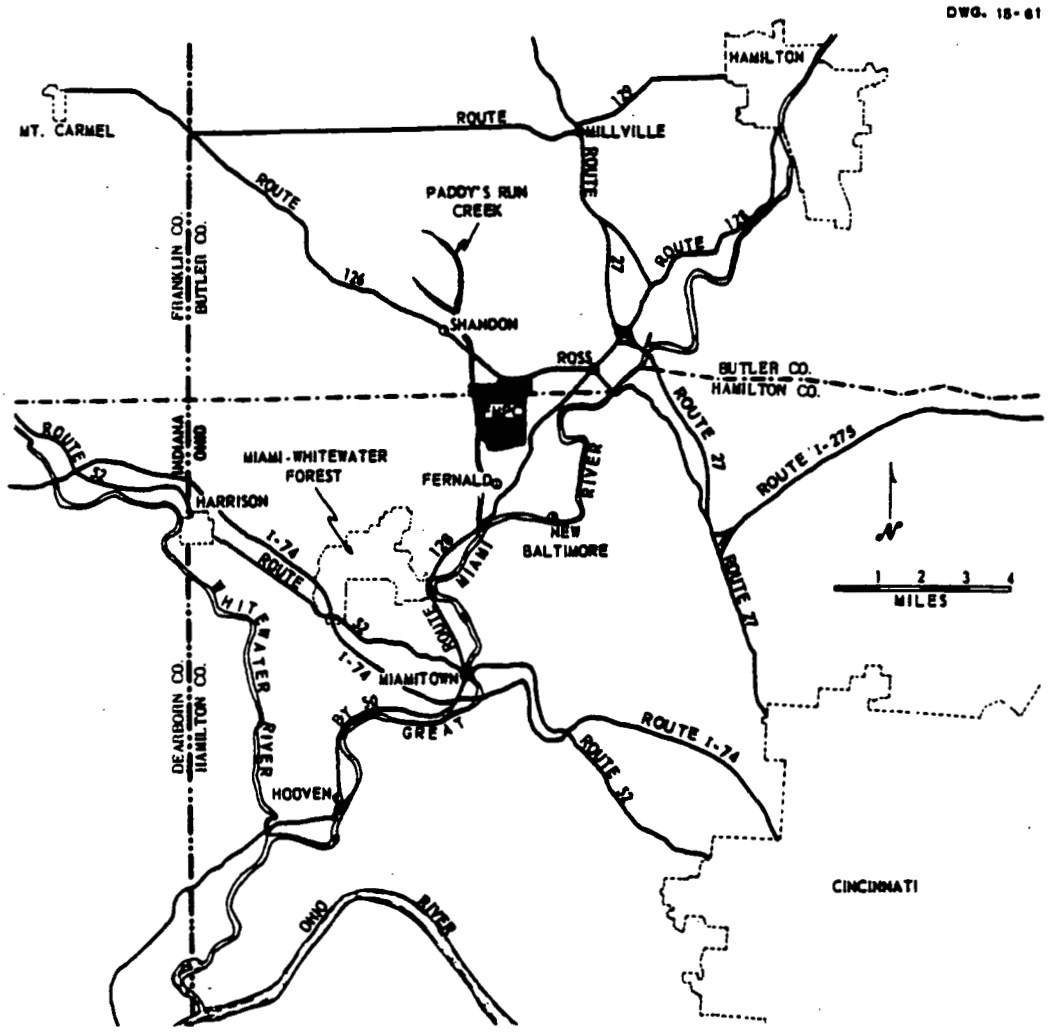


FIGURE 1 Area Map

Sections are then cut and machined to final dimensions. These machined cores are shipped to other ERDA sites for canning and final assembly into reactor fuel elements.

Periodically, small amounts of thorium are processed. 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.

SUMMARY

This report contains environmental monitoring data collected at the FMPC during 1974. Data are given for both radioactive and non-radioactive contaminants in air and water samples. These data show that the average boundary concentrations of radioactive contaminants from FMPC operations were no greater than 0.6% of the guide levels published in ERDA Manual Chapter 0524.[1] The resulting offsite radiation exposures would, therefore, be a small fraction of the standards for uncontrolled areas.

Concentrations of environmentally important non-radioactive contaminants in water and air are also reported. Results show that FMPC operations did not cause state standards for these contaminants to be exceeded.

AREA FEATURES

Glacial action during the time of the Illinoian and Wisconsinan ice sheets gave the area its basic geological

features. In the FMPC area, outwash from retreating glaciers filled in the wide valley of a large ancient river. Through this fill, the Miami River has cut its present course and the river bed is now located about 60 feet below the original level of the glacial deposits. Underlying the FMPC is about 50 feet of a clay-rich till which may be a remnant of a large glacial moraine. Beneath the till is about 150 feet of sand and gravel which fills the buried valley of the pre-glacier river. In the FMPC area, that ancient valley is about three miles wide.

The area east of the FMPC, in the Miami River floor plain, has fertile soil and is reported to contain some of the best farm land in the state. In the gently rolling uplands west of the flood plain, the thin soil mantle over the glacial drift is less fertile.

Although there are several small industries nearby, the major economic activities in this rural area are farming, dairying, and the raising of beef cattle. Farm crops include sweet corn, field corn, soybeans and wheat. Truck crops are widely grown and sold at local produce stands and in nearby urban markets.

The glacial fill and the Miami River have provided two other important area products--ground water and gravel. A company located about one mile from the FMPC pumps out about 20 million gallons of ground water per day, chiefly for industries in and near Cincinnati. Pumping began just before the FMPC was

built. The permeable glacial deposits, called valley-train, house the bountiful deep aquifer from which the water company and the FMPC draw supplies. The Miami River continuously provides part of the aquifer recharge.

Gravel pit operations are a familiar sight in the Miami Valley. Some operations are located along the river, with a sand dike separating gravel washwater from the river. Other operations are within the flood plain, but are several hundred feet from the river.

Upstream from the FMPC, the river receives substantial amounts of industrial and municipal wastes. The cities of Dayton, Middletown, Hamilton, and Fairfield are major contributors. Little recreational use is made of the river. Downstream from the FMPC, the population is sparse and industries are small and scattered. About 18 miles away, the Miami meets the Ohio River.

In 1974, the total precipitation measured at the FMPC was 46 inches. Monthly maximum and minimum values were seven inches during August and one inch during October.

ENVIRONMENTAL STANDARDS

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

ERDA specifies 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 ERDA Manual Chapter 0524, are concentration guides for work areas and for offsite areas which are beyond ERDA control.

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

Criteria used for non-radioactive contaminants in ambient air are those established by the Ohio EPA.[2] Current production operations exhaust particulates and oxides of nitrogen in sufficient quantity to warrant occasional boundary sampling for these contaminants.

As previously noted, federal standards for radionuclides in water have been specified for ERDA contract operators. In regard to FMPC operations, 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 Ohio EPA are mainly concerned with non-radioactive contaminants, but several radioactivity limits are included.[3] State water quality standards apply to the river, beyond a mixing zone permitted for industrial and municipal effluents.

SAMPLE COLLECTION AND ANALYSIS

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.

During 1974, samples of particulate matter in air were continuously collected at six permanent sampling stations located on the project's outer boundary (see Figure 2). At each Boundary Station, air is drawn at a rate of about one cubic meter per minute through 8 inch x 10 inch filter which is changed weekly. Filters are weighed before use and then reweighed after changing to obtain the weight of collected dust. After reweighing, the filter and its collection of dust is dissolved in acid and the solutions are analyzed for uranium and alpha and beta radioactivity. Counting is done about seven days after the end of the collection period. After these analyses are completed the remaining solution is held to provide a long-term composite for thorium analyses. Frequent thorium analyses are not considered necessary because of the small amount of thorium

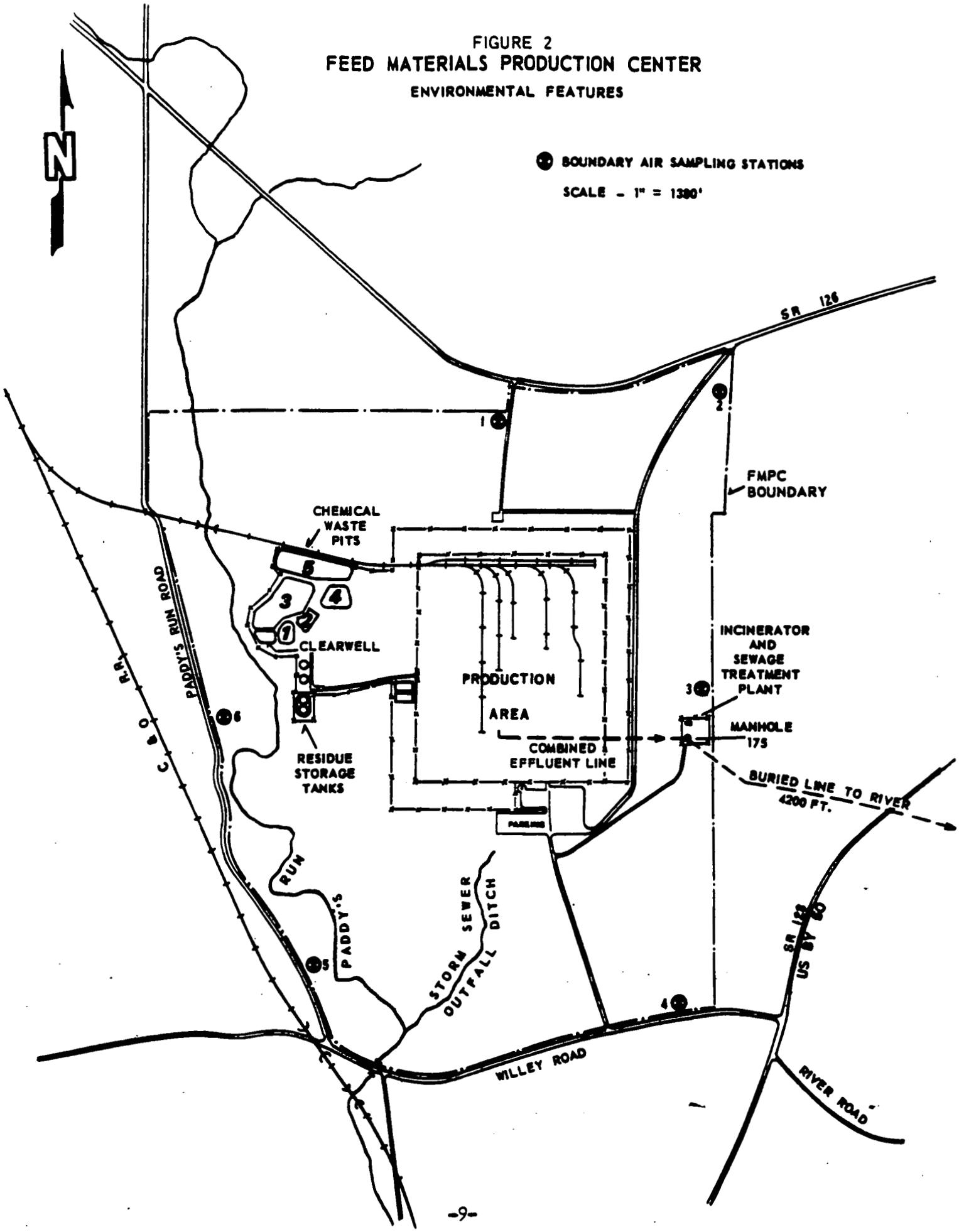
processed and the low concentration of thorium found in the boundary samples. Because of the low concentrations, analysis of annual composites for each station is considered adequate.

During the first three months of 1974, a four-bubbler air sampler belonging to the Southwestern Ohio Air Pollution Control Division operated at Boundary Station 2. Division personnel supplied and analyzed sampling solutions for nitrogen dioxide, sulfur dioxide, total oxidants, and aldehydes. The sampler operated for a 24-hour period every six days. During the remainder of the year, the Health & Safety Division periodically collected air samples which were analyzed for nitrogen dioxide and sulfur dioxide.

Water. Each of the individual production plants on the project has sumps and equipment for the collection and 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.

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,

FIGURE 2
FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL FEATURES

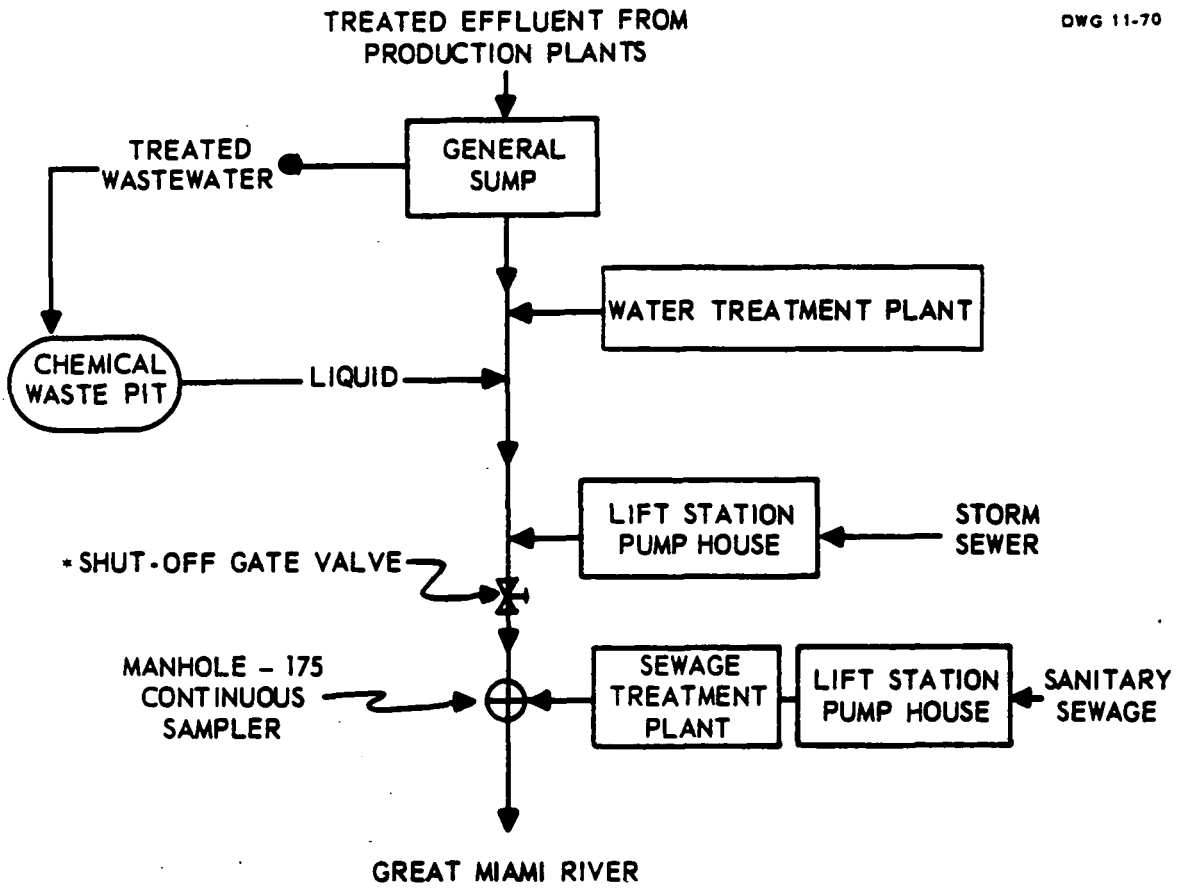


a daily grab sample is collected. At the final access point on the waste line, a Parshal Flume type water sampler collects continuously a sample which is proportional to the total flow. This sample is collected and analyzed on a daily basis. Results of these analyses, combined with river flow measurements, 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.

Daily samples from the final access point are analyzed for uranium, alpha and beta radioactivity, chloride, fluoride, nitrate, non-filterable solids, and pH. The same analyses are made on at least one sample per week from each of the river sampling points (W1 and W3). Results of this monitoring have been reported to the State of Ohio on a monthly basis since 1954.

Each month, single upstream and downstream river samples collected at points W1 and W3 are analyzed for radium^{226} and radium^{228}. Two-week composites from the waste-line final access point are analyzed for radium and one-month composites are analyzed for thorium.

<u>Soil and River Sediment</u>. Once each year, soil samples are collected near the six Boundary Sampling Stations. 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.



** 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

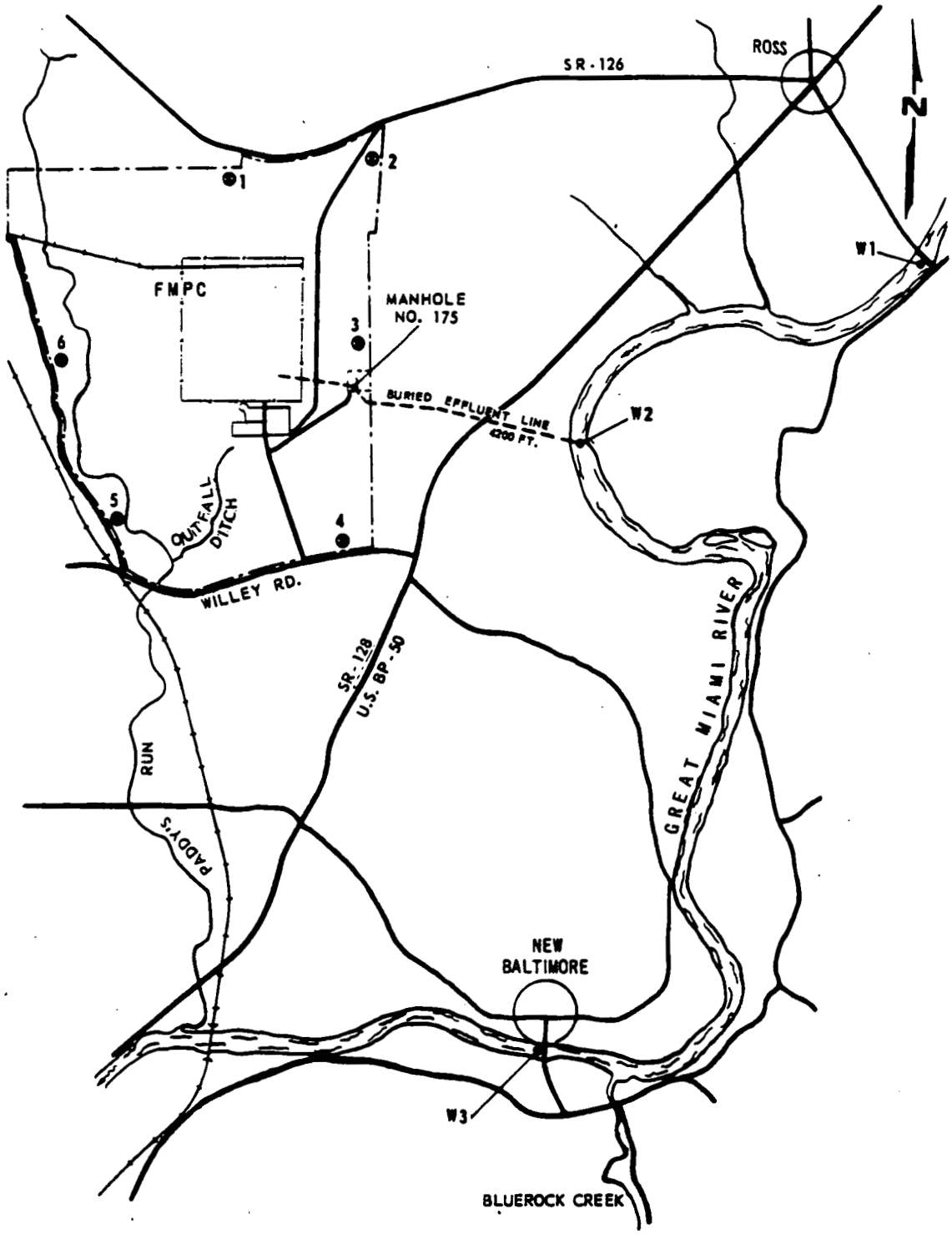


FIGURE 4 FMPC and Surrounding Area

● BOUNDARY AIR SAMPLING STATIONS.
W1 & W3 - WATER SAMPLING LOCATIONS.
W2 - POINT OF PLANT DISCHARGE
SCALE: 1" = 3055'

Sediment samples were collected from the Miami River and analyzed for uranium to determine if material was accumulating below the site outfall. Samples from the river bed were collected by dragging a heavy metal container along the bottom. Sediment from the river bank, near the water line, was collected by scraping up the top one or two inches. Only the portion passing a 50-mesh screen was analyzed.

MONITORING DATA

Environmental data collected during 1974 are given in Tables 1-6. Comparisons are made with the applicable standard for each contaminant. Confidence limits given in the tables are derived from analytical variations or from the statistical error inherent in radioactivity determinations.

Data in Table 1 show that average airborne uranium concentrations at the boundary sampling stations were no greater than 0.6% of the standard for offsite areas. It is concluded from these data that any offsite radiation exposure resulting from FMPC airborne contaminants would be a small fraction of the standards given in reference 1.

The concentrations of particulate matter found at the boundary are given in Table 2. At all locations the average concentration of particulate matter was less than the OEPA limit for the annual arithmetic mean.

During the first quarter of the year, a total of thirteen 24-hour samples were collected with the sampler operated by the

TABLE 1 Radioactive Contaminants in Air

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc. Found		Minimum Conc. Found		Average Concentration				Detection Level	Standard
			μCi/ml	μg/m³	μCi/ml	μg/m³	μCi/ml	μg/m³	% of Standard	95% Confidence Limit		
Uranium	BS1	51	3.42×10^{-14}	0.103	0.04×10^{-14}	0.001	1.09×10^{-14}	0.033	0.5	$\pm 0.14 \times 10^{-14}$ μCi/ml	0.03×10^{-14} μCi/ml	2×10^{-12} μCi/ml (2)
	BS2	52	2.37×10^{-14}	0.071	0.05×10^{-14}	0.002	0.85×10^{-14}	0.026	0.4			
	BS3	52	2.32×10^{-14}	0.070	0.08×10^{-14}	0.002	0.84×10^{-14}	0.025	0.4			
	BS4	52	1.07×10^{-14}	0.032	0.03×10^{-14}	0.001	0.24×10^{-14}	0.007	0.1			
	BS5	52	1.38×10^{-14}	0.041	0.05×10^{-14}	0.002	0.35×10^{-14}	0.010	0.2			
	BS6	51	1.95×10^{-14}	0.058	0.04×10^{-14}	0.001	0.58×10^{-14}	0.017	0.3			
Thorium	BS1	1(3)	NA(5)	NA	NA	NA	0.21×10^{-16}	1.9×10^{-4}	0.002	$\pm 0.01 \times 10^{-15}$ μCi/ml	0.01×10^{-15} μCi/ml	1×10^{-12} μCi/ml (4)
	BS2	1					0.18×10^{-16}	1.6×10^{-4}	0.002			
	BS3	1					0.19×10^{-16}	1.7×10^{-4}	0.002			
	BS4	1					0.10×10^{-16}	0.7×10^{-4}	0.001			
	BS5	1					0.22×10^{-16}	2.0×10^{-4}	0.002			
	BS6	1					0.20×10^{-16}	1.8×10^{-4}	0.002			
Gross Alpha Radioactivity	BS1	51	4.66×10^{-14}	NA	0.08×10^{-14}	NA	1.22×10^{-14}	NA	0.6	$\pm 0.14 \times 10^{-14}$ μCi/ml	0.01×10^{-14} μCi/ml	2×10^{-12} μCi/ml (2)
	BS2	52	2.89×10^{-14}		0.10×10^{-14}		0.93×10^{-14}		0.5			
	BS3	52	2.88×10^{-14}		0.05×10^{-14}		0.92×10^{-14}		0.5			
	BS4	52	1.82×10^{-14}		0.04×10^{-14}		0.28×10^{-14}		0.1			
	BS5	52	1.40×10^{-14}		0.04×10^{-14}		0.36×10^{-14}		0.2			
	BS6	51	2.33×10^{-14}		0.04×10^{-14}		0.65×10^{-14}		0.3			
Gross Beta Radioactivity	BS1	51	15.92×10^{-14}	NA	0.26×10^{-14}	NA	5.87×10^{-14}	NA	0.06	$\pm 0.6 \times 10^{-14}$ μCi/ml	0.05×10^{-15} μCi/ml	1×10^{-10} μCi/ml (6)
	BS2	52	14.32×10^{-14}		2.22×10^{-14}		5.16×10^{-14}		0.05			
	BS3	52	16.56×10^{-14}		2.07×10^{-14}		5.45×10^{-14}		0.05			
	BS4	52	16.01×10^{-14}		2.50×10^{-14}		5.91×10^{-14}		0.06			
	BS5	52	15.75×10^{-14}		2.28×10^{-14}		6.29×10^{-14}		0.06			
	BS6	51	16.10×10^{-14}		2.68×10^{-14}		6.56×10^{-14}		0.06			

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) ERDA Manual Chapter 0524, Annex A, Table II, Concentration Guide for natural uranium.

(3) Each sample is a composite of 51 or 52 weekly samples.

(4) ERDA Manual Chapter 0524, Annex A, Table II, Concentration Guide for natural thorium.

(5) Not applicable.

(6) ERDA Manual Chapter 0524, Annex A, Table II, Concentration Guide for mixtures of unknown beta emitters.

TABLE 2 Non-Radioactive Contaminants in Air

Contaminant	Sampling Point (1)	Number of Samples	Concentration Range		Average Concentration			Detection Level	Standard (2)
			Maximum $\mu g/m^3$	Minimum $\mu g/m^3$	$\mu g/m^3$	% of Standard	95% Confidence Limit		
Particulates	BS1	51	86	31	52	87	±5%	$1\mu g/m^3$	$60\mu g/m^3$
	BS2	52	91	31	53	88			
	BS3	52	74	30	46	77			
	BS4	52	104	36	58	97			
	BS5	52	97	34	54	90			
	BS6	51	86	24	52	87			
Nitrogen Dioxide	BS2	43	76	0.3	22	22	(3)	(3)	$100\mu g/m^3$
Sulfur Dioxide	BS2	20	100	0.3	23	38	(3)	(3)	$60\mu g/m^3$
Total Oxidants	BS2	13	21	10.0	15	38	(3)	(3)	$40\mu g/m^3$
Aldehydes, as Formaldehyde	BS2	13	61	8.0	27	5	(3)	(3)	$331\mu g/m^3$

(1) See sampling locations shown in Figure 2.
(2) Ohio Ambient Air Quality Standards.
(3) Not known.

Southwestern Ohio Air Pollution Control Division. Results are included in Table 2. Also included in Table 2 are additional results of sampling carried out at Boundary Station 2 after the Control Division ended their testing and removed the sampler. The average for NO_2, SO_2, total oxidants, and aldehydes are within OEPA limits.

Table 3 contains information on radionuclides in water. As shown, the average concentration of uranium and thorium added to the river was less than 0.001% of ERDA Radiation Protection Standards for uncontrolled areas. Combined radium^{226} and -228 added to the river was 0.02% of the standards. By comparison, the combined average upstream concentrations of radium^{226} and radium^{228} was 3.0% of the standard.

The calculated addition of gross alpha and gross beta radioactivity averaged 6.1% and 0.4%, respectively, of the state criteria. However, gross alpha upstream and downstream in the river was above the state standard. No effort was made to identify this activity but it appears that all of it may be due to uranium which either occurs naturally or is added by upstream industrial effluents.

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

TABLE 3 Radioactive Contaminants In Water

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc. Found		Minimum Conc. Found		Average Concentration				Detection Level µCi/ml	Standard
			mg/l	µCi/ml	mg/l	µCi/ml	mg/l	µCi/ml	% of Standard	95% Confidence Limit µCi/ml		
Uranium	W1	52	0.055	0.18×10^{-7}	0.001	3.3×10^{-10}	0.007	0.02×10^{-7}	0.01	$\pm 3.4 \times 10^{-10}$	3.3×10^{-10}	2×10^{-5} µCi/ml (3)
	W2	365	9.47×10^{-4}	3.16×10^{-10}	0.45×10^{-4}	0.15×10^{-10}	2.71×10^{-4}	0.90×10^{-10}	4.5×10^{-4}	NA(2)	NA	
	W3	52	0.080	0.27×10^{-7}	<0.001	$<3.3 \times 10^{-10}$	0.005	$<0.02 \times 10^{-7}$	<0.01	$\pm 3.4 \times 10^{-10}$	3.3×10^{-10}	
Thorium	W2	12	15.70×10^{-8}	17.67×10^{-13}	1.14×10^{-8}	1.28×10^{-13}	5.54×10^{-8}	6.24×10^{-13}	6.2×10^{-5} %	NA	NA	1×10^{-8} µCi/ml (3)
Radium - 226	W1	13	NA	9.08×10^{-10}	NA	$<4.54 \times 10^{-10}$	NA	$<4.54 \times 10^{-10}$	<1.5	$\pm 4.54 \times 10^{-10}$	4.54×10^{-10}	3×10^{-8} µCi/ml (3)
	W2	24	NA	7.82×10^{-12}	NA	0.64×10^{-12}	NA	3.28×10^{-12}	0.01	NA	NA	
	W3	13	NA	9.08×10^{-10}	NA	$<4.54 \times 10^{-10}$	NA	$<4.54 \times 10^{-10}$	<1.5	$\pm 4.54 \times 10^{-10}$	4.54×10^{-10}	
Radium - 228	W1		NA	9.08×10^{-10}	NA	9.08×10^{-10}	NA	4.54×10^{-10}	1.5	$\pm 4.5 \times 10^{-10}$	4.54×10^{-10}	3×10^{-8} µCi/ml (3)
	W2	24	NA	8.48×10^{-12}	NA	0.50×10^{-12}	NA	2.57×10^{-12}	0.01	NA	NA	
	W3		NA	9.08×10^{-10}	NA	9.08×10^{-10}	NA	4.54×10^{-10}	1.5	$\pm 4.5 \times 10^{-10}$	4.54×10^{-10}	
Gross Alpha	W1	52	NA	3.68×10^{-8}	NA	$<1 \times 10^{-9}$	NA	$<5.45 \times 10^{-9}$	<182	$\pm 0.05 \times 10^{-7}$	1×10^{-9}	3×10^{-9} µCi/ml (4)
	W2	365	NA	5.75×10^{-10}	NA	0.45×10^{-10}	NA	1.83×10^{-9}	6.1	NA	NA	
	W3	52	NA	2.27×10^{-8}	NA	$<1 \times 10^{-9}$	NA	$<3.90 \times 10^{-9}$	<130	$\pm 0.05 \times 10^{-7}$	1×10^{-9}	
Gross Beta	W1	52	NA	0.86×10^{-7}	NA	0.04×10^{-7}	NA	0.21×10^{-7}	21	$\pm 5 \times 10^{-9}$	4×10^{-9}	1×10^{-7} µCi/ml (4)
	W2	365	NA	8.21×10^{-10}	NA	0.94×10^{-10}	NA	3.74×10^{-10}	0.4	NA	NA	
	W3	52	NA	0.72×10^{-7}	NA	0.04×10^{-7}	NA	0.16×10^{-7}	16	$\pm 5 \times 10^{-9}$	4×10^{-9}	

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) Not applicable.

(3) ERDA Manual Chapter 0524, Annex A, Table II, Concentration Guides for natural uranium, natural thorium, radium - 226, and radium - 228.

(4) Ohio EPA water quality standards for gross alpha and gross beta radioactivity.

state standards. Generally there is no need to calculate the concentration of plant contaminants at point W2 except for the inclusion of such data in this report. In order to avoid the calculation of daily values, the maximum and minimum values given for point W2 in Tables 3 and 4 were calculated from monthly averages of river flow, effluent flow, and contaminant concentrations in the effluent.

There are no standards for comparison with the results for uranium in soil listed in Table 5. Although the normal value 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 boundary concentrations would be considerably less than 1% of the Radiation Protection Standard for people in uncontrolled areas.

The results of sediment sampling given in Table 6 do not indicate any build-up of uranium in the river bed or along the edge of the water where settling might be expected to occur. Most of the uranium present in the site effluent is soluble, probably existing as a carbonate complex, and remains soluble after mixing in the river. Furthermore, periodic flooding, which is severe enough to cause frequent channel changes and bank erosion, scours the river bed and prevents any sediment accumulation.

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 mg/l	Average Concentration % of Standard	Average Concentration 95% Confidence Limit	Detection Limit	Standard
Fluoride	W1	52	1.7	0.2	0.5	38	± 15%	0.2 mg/l	1.3mg/l (2)
	W2	365	0.003	<0.001	0.001	0.07			
	W3	52	1.2	0.3	0.6	46			
Nitrate	W1	52	42	6	13	37	± 10%	0.3 mg/l	35 mg/l (2)
	W2	365	5.0	0.3	2.2	6.3			
	W3	52	42	9	16	46			
Non-Filterable Solids	W1	52	506	<4	72	NA (3)	± 20%	4 mg/l	100 mg/l (4)
	W2	365	60	20	38	38			
	W2	52	942	<4	75	NA			

Footnotes:

(1) See sampling locations shown in Figure 4.

(2) Ohio Water Quality Standard for river water.

(3) Not applicable.

(4) National Lead Company of Ohio Concentration Guide for non-filterable solids in the effluent.

TABLE 5 Hydrogen Ion Concentration

Sampling Point (1)	Number of Samples	pH Range	Standard
W1	52	6.7 – 8.5	6.0 – 9.0 (2)
W2	365	6.5 – 10.7	N.A. (3)
W3	52	6.9 – 8.8	6.0 – 9.0 (2)

Footnotes:

(1) See sampling locations shown in Figure 4.

(2) Ohio Water Quality Standard for river water.

(3) Not applicable.

TOTAL RADIONUCLIDES RELEASED

During 1974, the amount of airborne uranium released through the plant stacks was 0.09 curies. The total uranium released in liquid effluent was 0.64 curies. Other liquid effluent release totals were: natural thorium, 0.002 curies; radium^{226}, 0.008 curies; radium^{228}, 0.006 curies.

RADIATION EXPOSURE ESTIMATIONS FOR 1974

Based on the reasoning outlined below, it is concluded that radiation doses to the public from activities at the FMPC during 1974 did not exceed one percent of ERDA radiation protection standards.(1) Intakes of radionuclides from water, food, and air are considered as the only potential sources of exposure. As discussed below, exposure from FMPC radionuclides in water is not likely. A hypothetical radiation dose from FMPC radionuclides in food is calculated and, even if likely to be received, is small enough to be considered insignificant.

Water. As shown in Table 3, radium was the radionuclide present at the greatest percentage of the limits specified in ERDM-0524. Radium^{226} and radium^{228}, combined, from the FMPC amounted to 0.02% of the permissible intake limit for persons living at the plant boundary. Bone is the critical organ for radium and the radiation protection standard for bone is 0.5 rem/year. Therefore, if a resident used downstream water from the Miami River, the possible radiation dose to bone from the

intake of FMPC radium would have been 1×10^{-4} rem. This is a negligible dose and, in addition, there is no known downstream use of the river as a potable water supply.

Food. It is possible for locally grown vegetables to contain a minute amount of uranium either from FMPC operations or from uranium which occurs naturally in the soil. Results of analyses obtained during 1973 are shown in Table 7. The average concentration of uranium found in vegetables grown near the FMPC was 0.016 micrograms per gram wet weight. If we assume that a boundary resident consumes one pound of such vegetables per day, his uranium intake would be 7 micrograms per day. This amount of uranium is 0.005% of the intake permitted in drinking water. The gastrointestinal tract is the critical organ for ingested uranium and the radiation protection standard for the GI tract is 1.5 rem/year. Therefore, the radiation dose to the GI tract from total ingested uranium (including background) would have been 7.5×10^{-5} rem.

Air. As shown in Table 1, the highest average concentration of uranium in air was at Boundary Sampling Station No. 1. Using the figure obtained from gross alpha radioactivity, the average was 0.6% of the standard for insoluble uranium given in ERDM-0524. The critical organ is the lung and the related permissible radiation protection standard is 1.5 rems/year to a boundary resident. Therefore, the radiation dose to the lung from total inhaled uranium (including background) would have been 9×10^{-3} rem.

TABLE 6 Uranium in Soil

Sampling Point (2)	Uranium Concentration (1)			Detection Level
	μCi/g	μg/g	95% Confidence Level	
BS1	5.0×10^{-6}	15		
BS2	6.0×10^{-6}	18		
BS3	31.4×10^{-6}	94	± 25%	0.5μg/g
BS4	1.5×10^{-6}	4.5		
BS5	4.0×10^{-6}	12		
BS6	4.7×10^{-6}	14		

Footnotes:

(1) Results on dry basis.

(2) See sampling locations shown in Figure 2.

TABLE 7 Uranium in Miami River Sediment

Distance from FMPC Outfall	ppm Uranium(1)	
	Sediment from River Bed	Sediment from River Bank
Upstream		
3 miles	2.1	2.8
1.7 miles	1.9	3.2
Downstream		
50 feet	2.4	3.0
3.4 miles	1.6	1.9
4.5 miles	2.1	2.5

Footnotes:

(1) Results on dry basis.

Maximum Radiation Dose At The Site Boundary. The maximum lung exposure at the site boundary from airborne uranium was calculated by two techniques. As noted in the previous section, a value of 9×10^{-3} rem or 0.6% of the standard was obtained from the Table 1 data. Using the total amount of airborne uranium released (0.09 curies), a diffusion equation calculation gave a value of 3×10^{-3} rem or 0.2% of the standard.

Starting in 1975, periodic measurements will be made of external radiation at the site boundary and the data will be used to calculate a maximum whole body dose.

Maximum Dose To An Individual. Airborne uranium is the only significant source of exposure from FMPC operations. As noted in a preceding section, the highest average uranium concentration was found at Boundary Station No. 1. The nearest residence to this location is about 700 feet away. Assuming an occupancy factor of 80%, the radiation dose at this location due to airborne uranium was 7×10^{-3} rem or about 0.5% of the standard.

Maximum Dose To A Population Group. In addition to providing limits for boundary residents, ERDM-0524 also stipulates that the limits must be reduced by a factor of three when applied to a suitable sample of the exposed population. The community of Ross, Ohio, is located about 2.5 miles from the center of the FMPC production area. If Ross residents qualify as a suitable

sample of the exposed population, their airborne uranium exposure limit should be one-third of the limit used in Table 1 of this report, or 0.7×10^{-2} μCi/mℓ.

Boundary Station No. 2 is the nearest station to Ross. During 1974, the average airborne uranium concentration at this station (based on alpha radioactivity, Table 1) was 0.93×10^{-14} μCi/mℓ. This is 1.3% of 0.7×10^{-12} μCi/mℓ. The actual concentration in Ross would have been much lower since the 2.5 miles between FMPC and Ross is about six times the distance from the production area center to the Boundary Sampling Station. Based on diffusion equation calculations, we conservatively assume a reduction to one-third of the boundary concentration, or 0.4% of 0.7×10^{-12} μCi/mℓ.

The uranium limit of 0.7×10^{-12} μCi/mℓ for Ross residents is equivalent to a dose limit of 0.5 rem for a suitable sample of the exposed population. Therefore, the airborne uranium concentration assumed for Ross is equivalent to 0.4% of 0.5 rem, or 2×10^{-3} rem.

Additional exposure from possible food intake would be negligible compared with the possible exposure from airborne uranium. As noted earlier, the river is not used as a potable water supply. Therefore, there would be no additional exposure from water-borne radionuclides.

OTHER ENVIRONMENTAL CONTROLS

Sewage Plant Effluent. Effluent from the FMPC Sewage Treatment Plant is combined with other effluents at MH-175 (see Figure 3). Prior to discharge from the Sewage Treatment Plant, however, the effluent is carefully monitored and sampled to determine efficiency of operation and compliance with all applicable standards. The comparison in Table 8 shows that FMPC sewage treatment effluent far surpasses the requirements, in all parameters, of the federal EPA secondary treatment regulations (40 CFR 133.102).

Steam Plant Emissions. The steam generation plant at FMPC consists of four boilers with a total design capacity of 300,000 lbs. of steam per hour. State of Ohio EPA Regulation EP-11-10 (AP-3-11), "Restriction on emission of particulate matter from fuel-burning equipment" establishes 0.13 pounds of particulates per million BTU input as the maximum limit on emissions of particulates from a steam generation plant with such capacity. Repeated stack sampling tests have shown that the range of particulate emissions from the steam generation plant stacks is 0.25 - 0.40 lbs. per million BTU input.

Funds have been requested for the installation of electrostatic precipitation equipment on the steam generation plant. If Congress appropriates these funds, upon the completion of the installation it is anticipated that FMPC will be in compliance with the particulate emission limit set by EP-11-10 (AP-3-11).

TABLE 8 Uranium in Locally-Grown Vegetables

Vegetable	Uranium ppm, wet weight
Farm A, sweet corn	0.0026
Farm B, sweet corn	0.0040
Farm C, sweet corn	0.0309
green beans	0.0033
red beets	0.0033
carrots	0.0132
potatoes	0.0946

TABLE 9 Sewage Treatment Plant Data

Parameter	EPA Standard			1974 FMPC Monthly Results
B.O.D. (five-day)	30 days (1)	(mg/l)	30	2 avg.
	7 days (1)	(mg/l)	45	10 max.
	Reduction (2)	(%)	≥85	97
Suspended Solids	30 days	(mg/l)	30	7 avg.
	7 days	(mg/l)	45	17 max.
	Reduction	(%)	≥85	94
Fecal Coliform	30 days	(per 100 ml)	200	4 avg.
	7 days	(per 100 ml)	400	22 max.
pH		(range)	6.0-9.0	7.0-8.2

Footnotes:

(1) Sampling period.

(2) Removal determined from Sewage Treatment Plant influent and effluent samples.

Sulfur dioxide emission limits for stationary facilities in Ohio such as the FMPC steam generation plant are in dispute between the regulatory agencies and therefore at this time it is impossible to state compliance status.

Particulates From Industrial Processes. Maximum rates of emissions of particulates from industrial processes are prescribed in State of Ohio EPA Regulation EP-11-11, "Restriction of emission of particulate matter from industrial processes." Through the use of many dust collectors, scrubbers, electrostatic precipitators, and other types of air cleaning equipment, particulate emissions from FMPC process operations are far below the established limits. No problems are anticipated in remaining in compliance with EP-11-11.

Incinerator Operations. The FMPC incinerator is used for the destruction of combustible trash, paper, wood, etc. It is equipped with a gas-fired afterburner to aid in attaining a goal of +1850°F temperature in the stack gases. The particulate emission limit prescribed by State of Ohio EPA Regulation EP-11-09, "Restriction on emissions from incinerators" is 0.10 pounds of particulate matter per 100 pounds of combustible refuse charged. Inaccessability of the stack and the high temperature of the stack gas combine to make sampling difficult and data as to compliance with EP-11-09 has not been obtained. However, during steady state operations with the 1850°F temperature developed, it is believed the incinerator operation is in compliance. Open burning is prohibited at FMPC in compliance with State of Ohio EPA Regulation AP3-08.

REFERENCES

(1) U. S. Energy Research & Development Administration, ERDA Manual Chapter 0524, Standards For Radiation Protection. February 4, 1969.

(2) Ohio Environmental Protection Agency, Ambient Air Quality Standards.

(3) Ohio Environmental Protection Agency, Regulation EP-1, Water Quality Standards, effective July 27, 1973.

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