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REPORT OF FMPC GROUND CONTAMINATION STUDY COMMITTEE

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REPORT OF
FMPC GROUND CONTAMINATION STUDY COMMITTEE

By

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of

NATIONAL LEAD COMPANY OF OHIO

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NATIONAL LEAD COMPANY OF OHIO
Cincinnati, Ohio
Contract No. AT(30-1)-1156

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I. INTRODUCTION

Prior to and during the start-up of construction of the FMPC, the AEC requested the United States Geological Survey (USGS) to conduct a study of "Conditions Governing the Occurrence of Ground Water in the Fernald Area, Ohio, with Reference to the Possibilities of Contamination by Disposal of Chemical Wastes." This study was conducted during May, August and September, 1951 by G. D. Dove and S. E. Norris of the USGS. From this action it is apparent that there was an awareness of the possibility of contaminating the ground water* in the vicinity with the wastes resulting from the FMPC operations. The site for the FMPC was chosen by the AEC after consideration of a total of 63 possible locations in 7 states. One of the major factors affecting their decision was the large underground water supply in the area, which at that time was being virtually unused.

Dove and Norris in their report[2] state, **"In view of the potential hazards it is not considered advisable to allow harmful wastes to enter the surface drainage or to be discharged onto the ground where it may infiltrate to water bearing gravels and eventually reach surface streams by underground flow."**

Consideration was given for the proper storage of materials in the original design of the FMPC, but it was assumed that the run-off from the FMPC, both via the storm sewer and open ditches which eventually discharge into Paddy's Run, would be virtually non-contaminated. This assumption was proven to be invalid soon after the start of operations inasmuch as chemical and radioactive contamination**, both liquid and solid, has been found repeatedly in Paddy's Run since the start of FMPC operations. A storm sewer detention sump was provided by the architect-engineer in the vicinity of the main storm sewer outfall for the purpose of catching the initial run-off of rain water. No means of emptying this sump was provided, therefore, it was very seldom used.

The storage space originally provided throughout the process area was inadequate in that the pad area was too small, and a number of the pads that were provided had no curbs, thus they drained onto the ground and eventually into the storm sewers or the water soaked into the ground.

The above conditions have resulted in contaminants in Paddy's Run frequently exceeding desirable concentrations as well as causing concern that the FMPC operations might contaminate the ground water.[2,8,15 & 16]

Since the start-up of plant operations, approximately $1,000,000 have been spent on projects which deal with correcting these faulty conditions (see Appendix I). In a large part these changes have followed the recommendations made by various consultants and NLO groups assigned the task of studying various phases of the problem of ground contamination.

These included, in addition to the Dove and Norris[2] study, studies by: Ross, Williams and Barry in 1954,[7] Theis in 1955,[8] Cuthbert, DeFazio, Quigley, and Stewart in 1957,[10] Hartsock in 1960,[15] Eye in 1960 and 1961,[16,23, & 24] and Starkey, Watson, Coates, and Riestenberg in 1961.[17] In all of these reports

* *Ground water is defined as all water below the ground surface.*

** *Contaminants being considered in this report are: uranium, fluorides, nitrates, chlorides, radioactivity, oil and total suspended solids.*

specific conclusions were reached pertaining to ground water contamination and/or stream pollution. In each case, recommendations were made for minimizing the possibility and magnitude of ground contamination.

In general, statements have been made to the effect that the potential contamination of the ground water from the operations at the FMPC exists; although in no case was an estimate made as to just when this might occur. Theis[8] attempted some calculations concerning the rate of flow of the ground water in this area; however, he stated "Because of the small size of the controlled area it seems impossible to predict future movements of the ground water and possible movements of contaminated ground water out of the area if other industrial wells should be constructed nearby." Since the time of this report, the Southwest Ohio Water Company has constructed a second well on the west side of Miami River less than one mile from the FMPC. They now have a total pumping capacity of 30 million gallons a day (mgd); however, at this time they are pumping approximately 20 mgd.

Recently the City of Cincinnati announced tentative plans for developing wells near Ross, Ohio, capable of supplying 40 mgd. Objections to this proposal are being raised by the cities of Fairfield and Hamilton, Ohio, as well as the Southwestern Ohio Water Company. Wells were constructed and pumping tests were conducted by the Ohio Water Resources Division to attempt to determine the effect of the proposed well on the present water levels. Following these tests the City of Cincinnati announced plans to proceed with their original proposal. Land was purchased for this purpose approximately 5 miles northeast of the FMPC on the east side of the Miami River.

Dove and Norris,[2] Theis,[8] Hartsock,[15] and Eye,[16] were primarily concerned with contamination of the ground water by the storage or disposal of chemical wastes at the FMPC. In each report, a statement is made to the effect that the possibility of contaminating the ground water by the FMPC operations is increased by the quantity of water being withdrawn from the deep aquifer.

In addition Hartsock[15] stated:
"A long-term possibility exists that downward-seeping ground water may pick up contamination from the surface in the production area and ultimately carry this to the deep, high-yield aquifer. If radioactive or chemical contamination of adequate proportions should reach the aquifer, a serious problem would then exist since the FMPC derives its water supply from deep wells. Furthermore, numerous deep wells in other parts of the valley would face the possibility of contamination."

Other groups: Ross, Williams and Barry,[7] Eye,[24] Cuthbert, Quigley, DeFazio and Stewart,[10] and Starkey, Watson, Coates and Riestenberg[17] were primarily concerned with stream pollution.

Within the past 2 years extensive study has been put into both aspects of the over-all problem, potential ground water contamination and stream pollution.

In June 1960, J. D. Eye, Associate Professor of Sanitary Engineering, University of Cincinnati, was retained by NLO as a sanitary engineering consultant. He has conducted three studies. The first was concerned solely with the potential contamination of the ground water by the activities carried out at the FMPC,[16] the second involved a study of direction of flow of the ground water in the vicinity of the FMPC[23] and the third with Paddy's Run contamination.[24]

In January 1961, J. H. Noyes requested that a committee be organized to study the problem of ground contamination at the FMPC. A committee consisting of R. H. Starkey of the Health & Safety Division, C. Watson of the Procurement Division, R. C. Coates of the Production Division, and E. B. Riestenberg of the Engineering Division, was formed to make this study. This group's study was limited to the FMPC's contribution of uranium to Paddy's Run resulting from ground contamination. This committee's findings, including recommendations, are included in Reference No. 17.

On March 21, 1961, a meeting was held in the Plant Manager's office to discuss Eye's report[16] on the ground water pollution potential of the FMPC activities. The CAO Deputy Area Manager, as well as the appropriate NLO Division Directors, attended this meeting. At this meeting assignments were made[21] to implement the specific recommendations listed in Eye's report.

Following the completion of Eye's third study, a meeting was held in the Plant Manager's office for the purpose of determining what future action should be taken and it was decided to re-establish the Starkey, Watson, Coates and Riestenberg committee. Because some questions raised at this meeting pertained to sampling and analytical procedures, J. W. Robinson of the Technical Division was made a member of the committee.

The committee, following the outline as proposed by the Plant Manager,[25] expanded the study to include a review of previous studies made of stream pollution and ground water contamination. The three reports of J. D. Eye and the previous report of this committee were reviewed and are largely the basis for the conclusions and recommendations which follow. Included are specific recommendations for the reduction or elimination of the potential sources of contamination in the ground water, the Miami River and Paddy's Run.

Following the issuance of a preliminary report by this committee, meetings were held in the NLO Plant Manager's office on August 7 and 9, 1962 to discuss the report. At that time definite plans for making the necessary revisions of equipment and operating procedures were formulated and assignments made for follow-up. Reference 26 lists the findings, recommendations and assignments resulting from this meeting.

Capital and operating cost estimates are included herein for accomplishing each of the recommendations.

II. FINDINGS AND CONCLUSIONS

A. STREAM POLLUTION

1. For the past 3½ years the FMPC effluent to the Miami River has been within concentrations desired by the State of Ohio Department of Health with but two exceptions. These exceptions are total suspended solids (TSS) and oil, for which the State's objectives are "substantially complete removal."

2. Paddy's Run is exceeding the desired maximum concentrations for both radioactive and chemical contaminants, and has been since shortly after the start-up of the FMPC operations. These concentrations are above those desired to be "caused in the waters of the State," which Paddy's Run becomes once it leaves government property.

   Annual average concentrations of contaminants found in Paddy's Run have exceeded the desired concentrations. Appendix II is a summary of the monthly and yearly average concentrations, starting with May 1959, found at the Willey Road bridge where Paddy's Run leaves government property. "Total radioactivity"* is the contaminant most frequently found to be exceeding limits. The highest concentrations of all contaminants are found during a light rain following an extended dry period.

   There are three sources of contamination of Paddy's Run. They are:
   a. Overflow from the storm sewer system during heavy rains.
   b. Drainage of the western side of the project, including a portion of the production area from "A" Street to the inner security fence.
   c. Seepage through the walls of the pits.

B. GROUND WATER CONTAMINATION

1. There is a definite potential that the FMPC activities might contaminate the aquifer from which the FMPC and some Millcreek Valley industries secure their water. This is a major consideration inasmuch as ground water is a vital natural resource and if it were to become contaminated, serious legal and public relations problems would be created.

   This possibility was realized, even before the start-up of the FMPC and was so pointed out in the Dove and Norris report of 1951.[2] Since that time five additional and separate studies have been made of the geology and hydrology of the area in the immediate vicinity of the FMPC. Each of these included statements to the effect that materials should be kept off of the ground so as to eliminate the possibility of their entering the ground water.

   Nitrates and chlorides offer the greatest potentials for contaminating the ground water as they are quite soluble and are or have been used in large quantities at the FMPC. The possibility that the desired concentrations for these or other contaminants will ever be exceeded in the aquifer is small. However, any significant increase of contaminants would be prohibitive from a public relations standpoint and is likely to result in additional costs to NLO and other water treatment facilities.

* *"Total radioactivity" is the sum of alpha and beta activity.*

C. GENERAL

1. Although responsibility for the prevention of ground contamination has been clearly defined as being that of the operating departments, the responsibility for evaluating ground control measures and for following up on suspected improper actions leading to ground contamination are not clearly defined.

2. Ground contamination requirements have not always been given adequate consideration when capital and/or operational changes have been proposed.

3. This Committee concludes that the specific recommendations included in the three reports of J. D. Eye and the previous report of this committee are adequately covered in the Discussion section of this report. Also the committee's recommendations pertaining to the above conclusions are listed, along with cost estimates, in the following section of this report.

4. It is concluded by this committee that when the studies have been completed, capital improvements made, and the recommended training program has been carried out that:
   a. The solids and oil being released to the Miami River will not be a major problem.
   b. Contamination of Paddy's Run as a result of FMPC activities will not be a major problem.
   c. The possibility that ground contamination at the FMPC would result in the contamination of the ground water will be minimized.

III. RECOMMENDATIONS

A. The philosophy concerning ground contamination and plant cleanliness must be firmly restated and enforced throughout the project. At least the following specifics should be developed:

1. This philosophy should include a statement of priority and a procedure for instituting necessary measures within each Division. It should also be an integral part of all Standard Operating Procedures and Construction Proposals.

2. A training program should be set up for all supervisory and pertinent hourly personnel for the purpose of periodically emphasizing and explaining the need for controlling ground contamination.
   a. This committee will develop the training program for which a preliminary outline has been prepared (Appendix III). It is expected that four, ½ hour sessions will be required to complete the course.

3. Organizational responsibility for the control of ground contamination should be defined.

4. The Internal Auditor's (Accounting Division) work assignment should include a management appraisal audit of the effectiveness of compliance with the ground contamination program.

B. The specific capital improvements recommended by this committee and an estimate of their respective costs are as follows:

1. To eliminate the sources of contamination of the ground water supply the following should be accomplished:
   a. Provide pads and curbs for storage of process materials.
      (1) Plant 6 . . . . $ 5,400
   b. Dry up and cover pits No. 1 and No. 2 10,000

C. The present methods of evaluating or monitoring for ground water contamination should be continued to determine the presence or extent, if any, of any contamination originating from the pit area.

D. The Plant 1 Storage Pad should have all leaking drums re-drummed as soon as possible. In addition, manpower should be furnished for the continued upkeep of all drums in storage. It is estimated that the initial re-drumming operation will cost approximately $20,000 and an additional $5,000 to $10,000 a year will be needed to maintain this area in an acceptable condition.

E. An extensive study should be conducted to determine which radioisotopes are the major contributors of radioactivity to the FMPC effluents to Paddy's Run and the Miami River. The concentrations of these contaminants should then be compared with the maximum permissible concentrations (MPC's) as listed in National Bureau of Standards Handbook #69 to determine if further corrective action is required.

F. When sufficient evidence has been accumulated with respect to the determination of practical concentrations of the various contaminants, if deemed necessary, the State Board of Health should be appraised of these, self-imposed limits.

G. The sump areas, such as the K-65 area and the concrete trench leading to it, should continue to be inspected frequently and any liquids accumulating therein should be pumped to Pit No. 3. Also, the three concrete storage tanks should continue to be routinely inspected and any necessary repairs made immediately.

H. The oil burning investigations and recommendations presently being carried out should be expedited in an attempt to dispose of all oil as soon as possible after generation.

I. The manholes south of the Pilot Plant should be connected into the storm sewer system. $14,000

J. Efficiency tests should be conducted on the Plant 8 wet scrubbers to determine if additional or larger scrubbers would provide adequate collection efficiency for eliminating this source of ground contamination originating from this plant. If adequate efficiency cannot be attained by this method, then the proposed installation of electrostatic precipitators should again be considered.

K. The possibility of processing all FMPC liquid wastes so as to reduce the quantity of chlorides and nitrates being pumped to Pit No. 3 should be thoroughly investigated.

IV. DISCUSSION

The need for control of ground contamination has been realized since the very early days of operation of the FMPC. Although relatively little capital equipment was provided for this purpose in the original design of the FMPC, considerable time, effort, and money have been spent since that time. Approximately $1,000,000 (see Appendix I) has been spent on capital improvements which were all, or in part for the better control of contamination in the way of storage pits, pads, sumps, etc. In addition, much emphasis has been placed on the control of ground contamination over the years. Periodically, renewed effort is made, as is pointed out in References No. 11, 12, 18, 19, 20 and 21, wherein various directives have reflected the Company's attitude toward problems of ground contamination. Following each letter some improvement has been realized. Each time the improvement diminished as time elapsed until conditions warranted a new letter and new emphasis.

During the past two years, NLO management has taken an even greater interest in the problem and has followed the progress quite closely. During this period J. D. Eye has been requested to conduct three different studies and this committee is now conducting its second study. In addition, copies of the Health & Safety monthly reports showing ground contamination status have been thoroughly reviewed by all levels of NLO management. Bi-weekly surveys have been conducted to detect ground contamination incidents in the production area. Time and effort have been spent in removing contamination from soil, gravel, roadways and pads, and new pads have been constructed where operations warranted. Operating procedures have been revised so as to minimize the possibility of spills and spread of contamination. References No. 17, 18, 19 and 20 point out in detail special precautions prescribed to prevent ground contamination. A definite improvement in the ground contamination conditions has been realized, however, continuing effort by all concerned must be maintained.

It is therefore concluded by this committee that the recommended capital improvements, along with increased awareness of the problem and efforts by all concerned, will eliminate or minimize undersirable contamination in Paddy's Run, the ground water and the Miami River.

The AEC was requested to furnish a geologist to review the capital improvements being recommended in this report and to give expert opinions as to their merit. On January 3 and 4, 1962, R. M. Richardson, a geologist from the USGS on loan to the AEC at Oak Ridge, and R. L. Hervin, a health physicist with OROO-AEC, visited the FMPC for this purpose. This committee spent the two days with these men and E. L. Giebel of the CAO-AEC in reviewing the problems and their proposed solutions. Pertinent supporting information was subsequently forwarded to Mr. Richardson for his review. After a rather complete review of the data, Mr. Richardson suggested that S. E. Norris of the USGS Ground Water Branch, Columbus, Ohio, be contacted and his assistance requested. This was done, and it was agreed that Mr. Norris would perform a survey of the hydrology in the vicinity of the FMPC. The survey was conducted during July and August, 1962 and the findings and recommendations reported in Reference 27.

A definite improvement in ground contamination conditions has been realized as is evidenced by the great reduction in the losses of material from the FMPC dust collectors. In 1955, a stack sampling program was instituted and a steady reduction in the quantity of material lost via this route has been realized each year. (From [illegible] lbs. of uranium in 1956 to 2,300 lbs. in 1961.) The major portion of the material lost from dust collector exhaust stacks falls within the production area and is either carried away into the storm sewers or soaks into the ground. However, even with this significant reduction in the material reaching the ground and subsequently the storm sewers, the losses of uranium via the storm sewer system have increased from 1,800 lbs. of uranium in 1956 to 11,800 lbs. in 1961.

This committee has attempted to study the many aspects of ground contamination including the problems and potential problems which might result from it. The known contaminants (uranium, F^-, Cl^-, NO_3^-, radioactivity, oil and TSS) have been considered and all aspects of each have been covered. Reports of all previous studies were reviewed and pertinent portions of these reports are either abstracted or quoted throughout the following discussion.

A. MIAMI RIVER

The Miami River rises in Logan County, Ohio, and flows in a general southwesterly direction for approximately 172 river miles to the confluence with the Ohio River near the Ohio-Indiana State Line. The Miami River and its major tributaries; the Stillwater, Whitewater and Mad Rivers constitute one of the larger water-sheds embodied in the drainage area of the Ohio River (5385 square miles).[1]

Upstream from the FMPC are a number of facilities known to handle radioactive materials which from time to time might contribute significant quantities of radioactive materials to the Miami River. Known facilities include two reactors, one at Piqua, Ohio, and one at Wright-Patterson Air Force Base just outside of Dayton, Ohio; and one AEC facility, the Mound Laboratory, Miamisburg, Ohio.

Flows in the Miami River, based upon the 20 year Miami Conservancy District reports are:

January through March – 8,000 to 14,000 cfs (Avg. ~10,000 cfs)
March to September – 600 to 4,000 cfs (Avg. ~2,000 cfs)
September to December – 100 to 6,000 cfs (Avg. ~5,000 cfs)

The following extremes of flow have been reported in a 37 year study:

Maximum: 352,000 cfs (March 26, 1913)
Minimum: 100 cfs (September 26, 1941)

The Miami River is not used for any municipal water supplies between the FMPC and the Ohio River. One industrial plant, the Gulf Refining Company at Hooven, Ohio, does obtain well water from a point near the Miami River, but the wells do not receive infiltration from the river.

The Miami River below the FMPC outfall is, at the present time, and has been since April 1958, well within the State of Ohio Department of Health specifications for all contaminants except oil and TSS. The concentrations of the various contaminants are calculated daily and are measured weekly by river sampling. Over the years the correlation between the concentrations determined by the two methods has been extremely good (see Appendix IV).

Normal process waste from the production area is collected in the General Sump, monitored, pumped to Pit No. 3 where most of the solids settle, and the clear waste is pumped to the outfall line which discharges into the Miami River at a point directly east of the project. The point of discharge is [illegible] river miles above New Baltimore, the downstream sampling point. There is no known municipal or individual usage of water from the river between these points.

The two contaminants that are exceeding the maximum levels desired by the State are total suspended solids (TSS) and oil. The desired concentration for TSS in the FMPC effluent is 25 ppm.[13] This concentration is exceeded daily, with the yearly average being 65 ppm in 1960 and 85 ppm in 1961. (See Appendix V.) The two primary contributors of solids to the effluent are Pit No. 3 and the storm sewer system. The 25 ppm TSS MAC is not considered to be realistic in the opinion of this committee. During 1960, oil occurred in measurable quantities (1 ppm or greater) in the FMPC effluent approximately 60% of the time and during 1961, approximately 55% of the time. The State requirements for oil is "substantially complete removal,"[1] and this means "no" oil to them. The rupturing of oil drums on the Plant 1 Storage Pad is a major contributor of oil to the FMPC effluent. The solids content in the FMPC effluent has consistently been in excess of the 25 ppm; however, to date no word has been received from the state that this is not acceptable. The solids content found in the FMPC effluent for the period of 1957 - 1961 is shown in Appendix V. This seems to bear out the general opinion that as long as the radioactivity is kept well below the MAC, that the solids do not seem to be of great concern to the State. This opinion was derived from the fact that a monthly report is issued to the State which includes the FMPC effluent solids content, and no comments have been received since the establishment of the 25 ppm limit.

The installation of Pit No. 3 did much for controlling the quantity of contaminants being discharged to the Miami River. Since May 20, 1959, when this pit was put into operation, all process wastes have been discharged here from the General Sump. This alleviates the problems encountered previously when the raffinate calciner became inoperative, and large quantities of radioactive solids had to be released to the river. It was during this period that State representatives noticed an appreciable increase in the radioactivity being found below the FMPC outfall in the Miami River and suggested the meeting mentioned above pertaining to TSS.

B. PADDY'S RUN

Surface drainage at the FMPC flows from the north, east and south sides of the project by means of three, principal well-defined ditches discharging into Paddy's Run, which is located at the extreme west side of the project. Paddy's Run, in turn, flows from north to south and joins the Miami River at a point 2 miles south of the project area and 1½ miles downstream of New Baltimore, Ohio. At no point on the north, south or east sides of the site does drainage leave the project.

A flow in Paddy's Run exists during the period of January to May. This flow ranges from 0.2 to 4.0 cfs. The balance of the year it may be considered as a dry bed stream with occasional flash flows of a few hours duration due to storms. Because of a long dry season, Paddy's Run is not a usable supply of water for any purpose. As far as can be determined, there is no use whatsoever made of this stream other than as a ditch for plant effluent drainage. Two chemical plants near Fernald, and south of the FMPC, use this stream to discharge their industrial wastes, however, no other known use of the stream is made.

During 1961, it became necessary to relocate this stream in the vicinity of the FMPC scrap pits, because at one location the stream was approaching Pit No. 3, and it was feared that eventually the walls of the pit might collapse into the stream. This would result in gross contamination of the stream and adjoining farmland all the way to the Miami River.

The storm sewer system, consisting of numerous catch basins, manholes and approximately 9 miles of sewer lines, was designed to flow by gravity to Paddy's Run. It was originally designed to handle all of the storm waters within the fenced area (approximately 136 acres). A detention sump had been provided to contain the initial run-off from rains, which it was assumed would contain virtually all contamination that would be washed into the system by rain. However, no means of emptying this sump was furnished; therefore, it was never used in the manner intended. All rain water was discharged into a ditch which, in turn, discharged into Paddy's Run.

It had been assumed in the original design that very little contamination would be carried by the storm sewer system; however, this assumption was found to be incorrect as high concentrations of contaminants were measured even after extended periods of rainfall. The same assumption was made with respect to the drainage from the west side of the project from which it was also assumed that the run-off would be non-contaminated.

As a result of a study by Ross, Williams and Barry in 1954,[7] it was realized that the storm sewers were contaminated, and that Paddy's Run was also being contaminated above acceptable levels from this source. This group recommended that a lift station be installed at manhole no. 34 for the purpose of pumping dry weather flow from the storm sewer into the process waste lines and on to the Miami River. This was installed in August,1955 at a cost of $39,500.

Water in the storm sewer presently exceeds the capacity of the lift station on the average of six times a month at which times the overflow enters Paddy's Run causing it to exceed levels desired in "a water of the State."

Whenever the flow is sufficient for doing so, daily grab samples are taken in Paddy's Run at the Willey Road bridge. Samples for three consecutive days are composited into one sample which is analyzed for all contaminants which might be originating from the FMPC operations. Average concentrations for uranium and radioactivity in excess of the desired concentrations are repeatedly measured in these samples. In addition, monthly average fluoride concentrations exceed permissible levels approximately 35% of the time. The highest concentrations in this stream are usually found after a brief rain during the dry season. This occurs because the capacity of the lift station is exceeded and since the dilution in Paddy's Run itself is quite small, the contaminant concentrations are therefore relatively high. Table 1 shows the maximum and average concentrations for various contaminants for the years of 1959, 1960 and 1961, found in Paddy's Run at the Willey Road bridge. This is the location where this stream leaves the government property.

TABLE 1 Paddy's Run Contaminant Concentration (Willey Road Bridge)

Year	Uranium ppm		Alpha Dis/min/ml		Beta Dis/min/ml		Nitrates ppm		Fluorides ppm	
	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1959	15.7	1.3	55.0	4.5	11.4	1.2	73.0	16.0	36.0	4.1
1960	8.9	2.3	11.9	5.8	13.0	2.2	460.0	43.0	8.8	1.0
1961	11.0	2.0	24.3	2.7	3.0	0.6	71.0	13.0	7.5	1.0
MPC	.35		.22 Total				44		1.2	

Losses of uranium via the storm sewer system have steadily increased. The losses via this route were relatively small until 1958 when the losses were approximately doubled over those in 1957. In 1959 the losses stayed about the same as in 1958; however, in 1960 a large increase in the loss occurred. A smaller increase occurred in 1961 but the trend was still upward. Yearly losses of uranium via the storm sewer system for the years 1956 through 1961 are shown in Table 2. Losses from this system to Paddy's Run are available only for the years of 1959, 1960 and 1961. These are included below.

TABLE 2 Storm Sewer Losses (Uranium)

1956 – 1,800 pounds of uranium
1957 – 2,600 pounds of uranium
1958 – 5,400 pounds of uranium
1959 – 6,300 pounds of uranium – 1400 pounds via Paddy's Run
1960 – 11,200 pounds of uranium – 2000 pounds via Paddy's Run
1961 – 11,800 pounds of uranium – 2600 pounds via Paddy's Run

The problem of Paddy's Run contamination could be solved by purchasing the right of way to Paddy's Run to the Miami river. This committee considered the advisability of doing so, but it was agreed that to purchase this stream at this time would raise a question as to what had been occurring in this stream for the past 10 years and undoubtedly would result in some unfavorable publicity. In addition, it is doubtful that purchase of this stream would be any cheaper than isolating it. Isolation of the stream also eliminates it as a potential source of ground water contamination which might result from the FMPC operations.

C. GROUND WATER CONTAMINATION

The physical characteristics of the sand and gravel deposits in the Miami Valley in the Ross, Ohio, area have given rise to ground water resources which are of tremendous potential economic value. At the present time, only limited use is being made of the ground water in the [illegible] FMPC but increased industrial and [illegible] probably be experienced in the future.

Test borings for foundation design, well drilling, and waste pit excavations within the confines of the FMPC have demonstrated the existence of many ground water systems. Some of these are quite localized; however there are two major water bearing formations, or aquifers, under the FMPC site. The upper aquifer is approximately 60 to 70 feet below the ground surface and is approximately 50 feet thick. The deeper, and much more important aquifer, is approximately 140 feet below the surface and in excess of 70 feet thick. When wells are drilled into a water bearing formation and water is withdrawn by pumping, the direction of flow in the vicinity of the wells is more or less radial and is governed to a large extent by the elevation of the free water surface in the well or wells being pumped. Thus, while the undisturbed or normal flow pattern is in a given direction, this pattern can change drastically by the introduction of wells, even miles away. This could very well be the case with the direction of flow of the water underlying the FMPC. In the Dove and Norris report[2] it is stated, "**There is, therefore, a ground water divide which corresponds roughly to the topographic divide marked approximately by the 600-foot contour at the eastern side of the new plant site. West of the divide the shallow ground water flows to Paddy's Run and east of the divide it flows to the Miami River.**"

The above condition was not found to be the case at the time of Eye's study of January 23, 1961.[16] He states in that report, "In the FMPC plant site, the water in the shallow formation appears to be flowing in a south-easterly direction toward the Miami River."

After the above statement was questioned in a letter from C. L. Karl to J. H. Noyes,[22] a further, more comprehensive study was conducted by J. D. Eye, the results of which are reported in Reference No. 23. In this report he states, "**Irrespective of the findings and assumptions made in 1951 with respect to the movement of ground water in the FMPC area, it must be recognized that the conditions noted resulted from natural causes and were not influenced by the withdrawal of ground water from the basin for industrial and domestic use. When water is withdrawn from an aquifer by pumping, the hydraulic gradient in the area will change in response to the free water surface in the well or wells. Thus, while under natural conditions, the ground water in the plant site may have been moving toward Paddy's Run, the influence of the wells of the Southwestern Ohio Water Company and those of the FMPC project easily could cause a complete reversal in the direction of flow. Likewise the present pattern of ground water movement can be changed significantly if large amounts are withdrawn at points other than those now in use.**"

Theis states in his report[8]: "**The movement of ground water in the permeable sands and gravels is dependent in large part upon the pumping at the plant site and at the collectors for the Southwestern Ohio Water Company. To determine with assurance the exact pattern of movement would require a close study of water levels in wells in the area between the Miami River and Paddy's Run and probably some pumping tests. However, some approximations and probabilities of movement can be suggested at this time.**

Because of the proximity of the water collectors of the Southwestern Ohio Water Company to the Miami River nearly all the water pumped from these is doubtless taken from the river within a few thousand feet of the collectors and there is probably little movement to these collectors from as far west as the Fernald Plant site. The pattern of movement within the plant site, although probably somewhat complex, is more or less toward the producing wells of the plant. Because of the small size of the Fernald area – about 1.7 square miles – and of the location of the producing wells at the approximate center of the area, any pit would be roughly about ½ mile from the wells. While the velocity along various streamlines to the wells must vary, an order of magnitude of the time involved in transit can be derived from considering the movement of the ground water within the Fernald area toward the wells as radial. The time involved in passage of the ground water from any particular point to the wells would be, in this case, the time necessary to remove the intervening water. If the thickness of the aquifer is taken on an average is 200 feet, and the porosity is about 25%, a cylinder of water with a radius of ½ mile would contain about 24,000 acre feet. If the rate of pumpage of the wells is 2,000,000 gallons a day in the near future, about 2,000 acre feet of water will be removed per year by the wells. Thus, the time involved for any waste to move from a distance of ½ mile would be of the order of 12 years or something less than 2 half lives of radium 228.

To the writer the particular danger in any ground disposal of waste at the Fernald site lies in the small size of the area. Although, presumably, an intensive investigation of the hydraulic and hydrologic features of the site and of the adsorption characteristics of the underlying sediments with respect to the particular waste involved might determine the on-site risk involved, the movements of water would be entirely changed if large wells were drilled for industrial or other purposes close to the site and perhaps close to a waste disposal pit. Because of the small size of the area, it does not seem possible to assume that at no time in the future could waste moving in the ground water outside the area be assured to be well below tolerance levels."

The heterogeneity of the earth underlying the FMPC makes a prediction as to the possibility of ground water contamination as a result of the FMPC activities virtually impossible. Test borings on the site reveal that the sand, gravel and clay are deposited in a very irregular manner, sometimes appearing as small lenses of a single material and at other places as mixtures of two or more of the constituents. As Dove and Norris[2] state: "Although the upper 20 or 30 feet of the glacial and alluvial materials underlying the proposed plant site are of low permeability, the fact that dug wells are developed in these materials indicate that wastes discharged on the ground would very probably infiltrate to the water table. Depending upon its relationship to the ground water divide, the contaminant either would flow westward to Paddy's Run, eastward to the Miami River, or it might percolate through the upper and less permeable material to the more permeable sands and gravels of the lower aquifer. . . . . In view of the potential hazards it is not considered advisable to allow harmful wastes to enter the surface drainage or to be discharged onto the ground where it may infiltrate to water-bearing gravels and eventually reach surface streams by underground flow."

At this writing there is conclusive evidence that the FMPC operations have affected the ground waters underlying the site. Appendix VI lists the concentrations of the chlorides and nitrates measured in Test Well No. 1. The concentrations of these two contaminants showed an increase during November 1961. Shortly after these increases were detected, it was thought advisable to deepen Test Well No. 1 and to install a larger pump. This was accomplished, and extensive pumping of this well was started on April 23, 1962. At that time the Cl^- concentration was approximately 2500 ppm and the NO_3^- concentration was approximately 1900 ppm. The concentrations of both contaminants decreased steadily until approximately

[redacted]

June 15, 1962, and are presently remaining at approximately 700 ppm Cl^- and approximately [illegible] Due to the [illegible] it is being pumped only once every two weeks for the purpose of determining if the contaminant concentrations are remaining stable.

The water is drawn from the upper water bearing aquifer (approximately 80' deep) however according to the reports of both Dove and Norris[2] and Eye[16] there is a good possibility that the shallow and deep aquifers are connected. The Dove and Norris report states: **"East of the divide water levels in shallow wells as measured or reported seem to correspond with those in deep wells, leading to the conclusion that the shallow and deep deposits form a single aquifer."**

Eye in his report of January 23, 1961[16] states, **"The static water level in the production wells and in the well at the Old Administration Building are approximately the same thereby indicating that the deep and shallow aquifers are interconnected. Chemical analyses of water samples from both deep and shallow wells indicate that the deep and shallow ground water are of the same general composition, a further indication of direct interchange between the two systems. It is quite possible that the layer of blue clay separating the two water bearing formations is in places discontinuous, thereby permitting water to flow from one aquifer to the other. Since the two aquifers are undoubtedly interconnected, any accumulation of pollutants in the shallow ground water can in turn contaminate the plant water supply."**

More recently Norris and Spieker[27] conclusively proved that the FMPC scrap storage operations are contaminating the ground water underlying the FMPC. They did state, however, that the first wells to be effected would be the FMPC production wells. They state that this could occur in from 2 to 5 years and that, in their opinion, there was ample time to prevent this from occurring if prompt remedial steps are taken.

At the time the FMPC was originally planned there were no major quantities of water being withdrawn from the deep aquifer which underlies the FMPC. In June, 1952, the Southwestern Ohio Water Company started pumping from their Ranney Collector on the east side of the Miami, approximately one mile from the FMPC. In May, 1952, NLO started pumping from their three production wells and as of today are pumping approximately 1.2 million gallons per day (mgd) from the three wells. In 1954 the Southwestern Ohio Water Company constructed a Ranney Type Collector on the west side of the Miami River also only approximately one mile from the FMPC. From these two wells they are pumping approximately 20 mgd, from rated capacity of 30 mgd. In the fall of 1961 the City of Cincinnati, which supplies water throughout Hamilton County, announced a plan to develop a well field near Ross, Ohio. Spokesmen for the City of Cincinnati state that a well capable of 40 mgd is desired to serve the northwest portion of Hamilton County. They further state that it would only be used as a temporary alternate supply so that the city would not have to speculate on an immediate investment to serve this area of Hamilton County, with which the city has a 30-year contract to supply water. The spokesman added that a water source north of the city would enable it to serve the area, delaying an investment in large-sized trunk lines from the Ohio River until such time as the needs of the area were better established. The well would also serve as an emergency supply in the event the Ohio River were to become contaminated as a result of an industrial accident or by radioactive materials. Daily pumping rates are to be only 10 mgd with the possibility that 40 mgd would be needed during the dry weather when the water table already is at its lowest point.

The cities of Hamilton and Fairfield, Ohio, along with the Southwestern Ohio Water Company are raising strong objections to these proposed wells and a public hearing was scheduled for January, 1962 for them to voice their objections. At the last minute, the meeting was canceled and to date no new date set. This has not deterred the City of Cincinnati who announced their plans to dig test wells as soon as weather permitted in the Spring of 1962. These wells were used to attempt to determine the draw-down of the water table in the vicinity of the wells. The Southwestern Ohio Water Company estimates that the proposed wells will effect a 25% draw-down in their two wells. Recently the City of Cincinnati purchased 172 acres of land in Butler County approximately 5 miles northeast of the FMPC and announced plans to proceed with their planned well construction. Norris and Spieker[27] state quite conclusively that if the City of Cincinnati wells are constructed on the recently procurred land that there is no danger of the FMPC operations affecting the water from these wells. It is further stated that the Cincinnati wells will not affect the FMPC production wells from a productivity or draw-down standpoint.

There was considerable concern during the early days of operation of the FMPC that the activities would contaminate the Southwestern Ohio Water Company wells. So much so that a meeting was held with representatives of NYOO-AEC, Procter and Gamble, NLO, and the Southwestern Ohio Water Company on August 4, 1952. Reference No. 4 is a report on that meeting. It was pointed out that Procter and Gamble had been testing well water samples for radioactivity since the start-up of the first well of the Southwestern Ohio Water Company. They had detected some radioactivity in this water in early June of 1952 but subsequent to that had not detected any. Although no conclusions were reached at this meeting it was agreed that routine samples would be collected by NLO and these would be analyzed in four different laboratories; (1) NYOO-AEC, (2) Procter and Gamble, (3) NLO-Tech. Div. and (4) NLO H & S Div. This procedure whereby all four laboratories were analyzing the samples has since been discontinued, however, routine samples from the wells are taken by the Southwestern Ohio Water Company and these are analyzed by the Kettering Laboratory of the University of Cincinnati. Since that original sample, no known occurrence of radioactivity has been detected in the wells.

There are three potential sources of possible ground water contamination arising from the operations carried out at the FMPC. These are:

a. The four pits through which contaminated liquids will always seep to some degree, and more so if a leak develops in any of them. It is generally agreed that this is the largest single source of potential ground water contamination. High concentrations of all contaminants are maintained in these pits but they become diluted to acceptable levels when discharged into the river; however the same would not be true in the ground water where any significant increase of any contaminant is intolerable. This has been borne out in the recent pumping tests mentioned above.

b. Paddy's Run is a definite potential source of ground water contamination. The porous bottom of this stream, which in some locations has completely collapsed, permits water to pass through it and subsequently into the upper aquifer. Water from the plant site enters Paddy's Run by three paths: (1) Run-off from the entire area bordered by "A" Street on the east and Paddy's Run on the west. This emcompasses the four pits, the four concrete storage tanks, the roadway connecting these areas with the production area, and a portion of the storage areas of Plant 1, Experimental Machine Shop and the Pilot Plant, (2) from the storm sewer system when the flow exceeds the capacity of the pumps in the lift station and (3) the pits from any leakage that may occur in the sides above the normal ground level.

c. Material handling difficulties can contribute to ground water contamination by three avenues. (1) Material spilled on the ground which passes through the soil and into the upper aquifer. (2) Material which is washed into the storm sewer system when heavy rains cause an overflow into Paddy's Run and then into the ground water. (3) Spills on the area described in (b.- 1) above which are washed into Paddy's Run and then into the ground water.

Probable Results of Pollution of the Ground Water:

1. If pollution of the ground water by chemicals from the plant should occur, the cost and difficulty of treating the water to make it suitable for use will be increased even though the degree of pollution may be small.

2. If the concentration of contaminants should become excessive it is possible that the water from the production wells could not be treated to render it suitable for plant use.

3. Wells other than those owned by the Government could be rendered unfit for use, thereby creating serious legal and public relations problems.

4. The ground water in the entire area could be rendered unusable for a very long period of time because the contaminants can only be eliminated by removing the source and then removing all of the polluted water from the aquifers. This would be a gigantic task if pollution accumulated for a long period of time before it is discovered. Norris and Spieker[27] explain that this could only occur if a "catastrophic break" were to occur in the lining of the disposal pits.

It is obvious that constant vigil should be maintained in order that any contamination in the ground water can be detected before any of the serious consequences listed above occur. Test Well No. 1 has been deepened and a 200 gpm pump installed in it to permit routine pumping from this well. As was expected, a contamination, appeared in Test Well No. 1. As yet no contamination has been detected in the NLO production wells, however, Norris and Spieker[27] stated that this will probably occur within 2 to 5 years. Test Well No. 1, along with five other wells, were constructed around the scrap pit area as a result of a recommendation by Theis in 1955 who stated: "Construct some shallow auger holes in the vicinity of the 'clay-lined' pit from which samples could be taken for monitoring to determine if there is seepage of fluoride or radioactive components into the ground water."

Spieker and Norris[27] recommended that additional test wells be constructed at various places throughout the FMPC. These would be pumped routinely to determine the extent and degree of contamination resulting from the storage pits and to minimize the chances of even greater contamination in the future.

It should be remembered that Theis' visit preceded the construction of Pits No. 2, 3 and 4, and that only residues being stored in pits at that time were trailer cake (largely MgF_2) and contaminated graphite.

D. NEGOTIATIONS WITH THE STATE

The State does not publish a list of MAC's for contaminants in public waters. The limits under which the FMPC operates were established by: (1) letters of agreement, (2) verbal agreement, (3) formal negotiation, (4) unilateral proposals and (5) suggestions listed in Reference No. 1. See Appendix VIII for details. For example, Reference No. 1 states: **"Adequate protection will probably be provided the waters of the Miami River and its tributaries if, after initial dilution at times of critical flow, the following values are maintained."**

For oils, Reference No. 1 states: **"Substantially complete removal."**

In verbal conversations with State people, it is evident that they interpret this to mean that "no" oil should be released to the river.

The preceding statement concerning oil is just an example of the difficulty encountered in trying to obtain firm numbers from the State pertaining to the concentration of various contaminants acceptable in "waters of the State." The State representatives have always been extremely cooperative, and helpful, however, they have never seen fit to publish an official list of MAC's for public waters. They prefer to handle such matters on an individual basis and this is the way that virtually all of the FMPC's limits have been established.

A case in point is the establishment of an acceptable concentration for "total suspended solids" in the FMPC effluent. In a meeting held with representatives of the Ohio Department of Health on November 1, 1957, a general discussion of the problem of settleable solids was held. At that time, it was explained to them that the FMPC effluent generally ran from 100 to 200 ppm of settleable solids. State representatives, thought that this concentration was fairly high so in an attempt to get a specific number from them, 50 ppm was suggested. They said, "You ought to be able to do better than that." They then recommended further testing on the FMPC effluents to determine the degree of solids removable with the aid of coagulants. The State agreed to send an engineer to the FMPC to work with NLO personnel in evaluating the NLO effluent. This was done, and a report was issued by the Health and Safety Division Analytical Laboratory[13] on February 10, 1958. This report suggested that 25 ppm would be a suitable standard for total suspended solids in the FMPC wastes being discharged to the Miami River. Copies of this report were forwarded to the State and unofficially it is understood that NLO proposal was accepted. No written confirmation has ever been received, even to the effect that the report was received in their office; however, it is understood that they are satisfied with this figure.

In a number of conversations with the State people they remarked that, "oh, but your solids are radioactive," when solid content in the FMPC effluent was being discussed. This was true prior to April 1958, at which time raffinate neutralization and storage in Pit No. 2 was begun. From that time until the present, all solids from the General Sump have been sent to Pit No. 3 for settling and the liquor pumped to the River via Manhole No. 175.

Over the years, similar meetings have been held with State people, however, agreements which have been confirmed in writing by the State representatives have been reached for only three contaminants. The first agreement was concerning uranium, which was reached between F. H. Waring, then Chief Sanitary Engineer of the Ohio State Department of Health, and M. Eisenbud, then Director of the Health and Safety Division of the NYOO-AEC. A letter from F. H. Waring to M. Eisenbud, dated December 11, 1951[3] approved a MAC of .35 ppm for uranium in the river below the FMPC outfall. The State had proposed a figure 1/10 th of this or .035 ppm, however Mr. Eisenbud presented information and data which influenced agreement with the higher figure.

The second agreement concerned the concentration of fluorides which would be permitted in the Miami River below the [illegible] outfall.

Originally a letter, F. H. Waring to J. A. Quigley, M. D., dated August 20, 1952[5] approved addition of fluorides to the river so as not to exceed 1.0 ppm in the river. However, later during a meeting at Columbus on January 26, 1955, between Mr. Waring and J. D. Yoder of the NLO Health and Safety Division, Mr. Waring agreed to a higher figure of 1.2 ppm. This higher figure, however, was never confirmed in writing.

The MAC for total radioactivity of 10^{-7} μc/ml (or .22d/m/ml alpha + beta) is the one listed in the NBS Handbook 69[14] for water in the neighborhood of an Atomic Energy plant where Ra^{226} and Ra^{228} are not present. At the time of start up of the FMPC, NBS Handbook 52[6] was in effect and the 10^{-7} μc/ml level was for water containing unknown mixtures of radioisotopes beyond the areas that are under the control of the installation responsible for the contamination.

Although nothing written has ever been received from the State which stated the levels of radioactivity which would be acceptable in the Miami River below the FMPC outfall, the 10^{-7} μc/ml level has been stated by Mr. Waring a number of times, the last during a meeting held with J. A. Quigley, M. D. and R. C. Heatherton of the NLO Health and Safety Division on February 5, 1957. At that time, Mr. Waring stated that an agreement among the Ohio Department of Health, the U. S. Public Health Service and the AEC Division of Reactor Development on the 10^{-7} μc/ml limit had been reached for streams such as the Miami River which empty into the Ohio River.

From the above, it is apparent that it isn't definite just what is required to satisfy the conditions of the permit which authorizes "the discharging of industrial wastes and sanitary sewage in Waters of the State, Miami River." Since 1954, NLO has requested and received an annual permit to do so under authority of the Ohio Water Pollution Control Act, Sections 6111.01 to 6111.08 of the Revised Code of Ohio.

Each application for a permit, filed annually, in accordance with AEC policy, is accompanied with a copy of a letter, Karl to Dwork, dated March 22, 1956.[9] This letter states in part: "as was explained to Mr. Waring at the meeting, however, the AEC feels it necessary that the Board clearly understands that NLO's obtaining and/or renewing the permit in question shall in no wise be construed as an acknowledgment of the applicability of the State's Water Pollution Control Law, or of regulations promulgated and issued pursuant thereto to the Government's operations at Fernald. It is our position in accordance with well-defined legal principles that Federal activities at Fernald, whether performed by the AEC direct or through its contractors, are not subject to regulation and control by State and local agencies where this would impede, burden or otherwise interfere with the discharge of the AEC's functions and responsibilities under the Atomic Energy Act of 1954. However, where conformity with State and local laws and regulations appears to be of mutual advantage to the AEC and to the agencies concerned and where such conformity can be achieved without burden on Federal funds or activities, we are agreeable to voluntary conformance as a matter of comity. It should be clearly understood that we do not agree to be bound as a matter of legal right, by any recommendations or suggestions resulting from inspections by the Board, but we shall where we deem advisable endeavor to follow them."

To date there have been no instances wherein the above mentioned authority has been exercised so as to permit the release of excessive quantities of contaminants to the river. All dealings with the State have been very amiable. Monthly reports containing the results of all samples pertaining to the Miami River are sent to the Division of Sanitary Engineering of the Ohio State Department of Health. This includes calculated concentrations in the river as well as actual samples taken upstream and downstream of the FMPC outfall.

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[17]R. H. Starkey, C. Watson, R. C. Coates and E. B. Riestenberg. Personal Communication to J. A. Quigley, M.D. FMPC Ground Contamination. February 1, 1961.

[18]W. A. Smith, Jr. Personal Communication to C. R. Chapman. Ground Contamination. February 9, 1961.

[19]C. R. Chapman. Personal Communication to J. H. Noyes. Storm Sewer Losses. February 10, 1961.

[20]C. R. Chapman. Personal Communication to Production Division Superintendents. Ground Contamination. February 10, 1961.

[21]M. S. Nelson. Personal Communication to J. H. Noyes. Ground Water Control. March 23, 1961.

[22]C. L. Karl. Personal Communication to J. H. Noyes. Report on Ground Water Pollution Potential by J. D. Eye, dated January 23, 1961. April 14, 1961.

[23]J. D. Eye. Special Report on the Occurrence and Movement of Ground Water in the FMPC Area. June 18, 1961.

[24]J. D. Eye. Contamination of Paddy's Run by Process Chemicals Used in the Feed Materials Production Center. August 28, 1961.

[25]J. H. Noyes. Personal Communication to J. A. Quigley, M.D. FMPC Ground Contamination Study Committee. October 17, 1961.

[26]M. S. Nelson. Personal Communication to J. H. Noyes. Ground Contamination Control. August 14, 1962.

[27]A. M. Spieker and S. E. Norris. Ground-Water Movement and Contamination in the Vicinity of the U. S. Atomic Energy Commission Feed Materials Production Center Located Near Fernald, Ohio. September, 1962.

APPENDIX I

Control of Ground Contamination

CP No.	Description	Year	Cost
	General Plant Expansion Program (Control of Ground Contamination Portion Only)	1954-55	$ 115,723
54-71	Storm Sewer Lift Station	1955	39,437
54-77	Enlargement and Acid Proofing of Pad in Combined Raffinate Area	1955	875
54-79	Materials Handling at Scrap Pit	1955	7,633
54-80	Sewer Sampler	1955	12,024
54-129	Motorized Street Sweeper	1955	8,408
54-134	Outside Sump Hold Tanks — Plant 9	1955	11,751
55-16	Concrete Pads for Dempster Dumpsters	1955	2,182
55-35	Storage Pad for Used Equipment and Scrap Metal	1956	64,280
55-37	"In Process" Storage Pad — Plant 9	1956	5,140
55-85	Repair of K-65 Access Road and Scrap Pit Pad	1956	8,540
55-96	Decontamination Building	1957	239,956
56-24	New Scrap Pit	1957	25,572
56-40	New Process Piping — Plant 6	1957	31,898
56-41	Installation of Large Baler	1956	26,277
59-7	Portable Dust Collector — Health and Safety	1958	5,411
57-3	Enriched Storage Pad Enlargement	1957	10,478
57-38	Expansion of Pad at Incinerator	1958	4,607
57-40	Additional Storage Pads — Plant 9	1958	11,440
57-48	Acid Proof Pad at Pilot Plant HNO_3 Tanks	1958	6,112
57-71	General Sump Decant System	1956	3,074
58-21	Sludge Line from General Sump	1958	4,269
58-32	Additional Storage Pad — Plant 8	1959	6,366
58-40	Scrap Pit No. 3	1959	163,299
59-83	Sampling Wells at Scrap Pits	1959	4,037
59-86	Additional Dry Residue Pit	1960	37,582
59-105	Storage Pad Drainage Improvements	1960	12,515
59-106	Storm Drainage Revisions — Digestion Area Storage Pad	1960	17,245
60-51	Enlargement of Denitration Pad — Plant 3	1960	3,537
60-58	Off-Site Feed Preparation Pad — Plant 8	1960	2,163
60-61	Thorium Storage Pad	1960	16,690
60-63	Storage Pad — Plant 5	1960	12,842
60-101	In Process Storage Pad — Pilot Plant	1961	9,137
60-104	Replacement of Contaminated Sump — Pilot Plant	1962	7,400
61-19	Storage Pad — Plant 5	1961	18,000
61-21	Storage Pad — Plant 9	1961	22,500
61-35	Replacement of South Sump — Pilot Plant	1962	6,700
61-36	Additional Pad Area — Plant 8	1961	12,000
61-46	Sewer Sampler Replacement at Manhole 175	1962	9,000
	TOTAL		$1,016,100

APPENDIX II

Paddy's Run (Willey Road Bridge) Contaminant Concentrations

	Uranium ppm		Nitrates ppm		Fluorides ppm		Alpha d/m/ml		Beta d/m/ml	
	High	Average	High	Average	High	Average	High	Average	High	Average
1959										
May	.59	.22	12	6	1.7	.8	1.76	.69	NA	NA
June	.39	.20	1	1	4.9	.9	.92	.49	.13	.06
July	2.19	1.16	73	41	3.2	2.1	4.80	2.51	1.05	.43
August	15.68	5.57	73	43.5	13.1	7.8	55.12	16.46	11.38	3.97
September	2.42	.99	11	7	2.9	1.4	6.87	2.88	1.33	.82
October	4.37	3.57	14	12	36.0	14.5	9.29	7.95	3.09	1.88
November	6.56	2.56	16	9.6	3.4	2.0	8.56	4.16	3.23	1.22
December	.54	.35	12	7.8	15.9	3.6	.72	.50	.85	.38
1959 Average		1.83		16		4.1		4.46		1.25
1960										
January	.46	.14	16	8.0	1.0	.03	.8	.25	.6	.20
February	.24	.12	10.0	8.0	1.6	.4	.63	.25	.63	.19
March	.20	.07	11.0	7.1	.2	.03	.33	.15	.49	.15
April					No Flow					
May					No Flow					
June *	8.6	8.6	15.0	15.0	1.7	1.7	11.9	11.9	5.7	5.7
July	1.9	.9	15.	8.	4.4	1.2	2.75	1.1	.40	.16
August*	8.9	8.9	288.	288.	4.5	4.5	37.	37.	13.0	13.0
September	.9	.23	6.0	2.2	1.1	.2	1.2	.52	.38	.12
October	.19	.05	460.	59.	8.8	1.1	.16	.11	.59	.27
November	.12	.06	113.	17.	1.4	.2	.31	.15	.33	.12
December*	4.2	4.2	22.	22.	1.2	1.2	6.34	6.34	1.77	1.77
1960 Average		2.33		43.4		1.06		5.78		2.17
1961										
January	1.20	.08	11.0	10.0	15.3	2.4	1.71	1.28	.46	.15
February	1.90	.53	58.0	16.0	.7	.3	3.30	.84	.84	.28
March	1.40	.38	13.0	8.8	.3	.2	1.77	.55	1.47	.29
April	.70	.25	12.0	8.0	.6	.3	1.22	.41	.67	.19
May	1.10	.26	47.0	12.	.6	.3	1.83	.61	.59	.18
June	11.00	6.12	71.0	30.	2.2	1.0	24.33	11.19	2.99	1.58
July	4.00	1.20	26.0	15.5	.5	.3	6.44	2.06	1.91	.53
August	.30	.21	14.0	7.3	.3	.3	.51	.32	2.01	.72
September	3.90	2.23	26.0	14.7	7.5	2.7	3.59	2.51	1.24	.54
October*	9.5	9.5	6	6	3.0	3.0	9.5	9.5	1.16	1.16
November	6.80	2.81	43	20	1.0	.7	7.22	3.08	1.99	.92
December	.39	.22	27	9	1.0	.6	.99	.45	.44	.23
1961 Average		1.98		13.1		1.01		2.73		.56

* Only one sample possible during entire month because of low stream flow.

APPENDIX III

GROUND CONTAMINATION TRAINING PROGRAM:

Four, ½ hour classes will be given to supervision to acquaint them with the problem and to give them the proper philosophy in prevention and control. Following the supervisory training a shorter training program will be given to those hourly employees whose performance could cause ground contamination. The cost of such a program would be negligible from an "out-of-pocket" standpoint.

THE SUPERVISORY PROGRAM

First Class: <u>The Problems</u>

- Miami River
- Paddy's Run
- Ground Water

Second Class: <u>Our Storm Sewer System</u>

- Purpose
- Construction
- Proper Use
- Maintenance

Third Class: <u>Pads and Sumps</u>

- Their Purpose
- Proper Use
- Mis-Use Examples

Fourth Class: <u>Ground Contamination Priority</u>

- SOP Considerations
- New Installations
- Unusual Operations
- Reporting Incidents
- Summary

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APPENDIX IV

Miami River Contaminant Concentrations

Year	Alpha d/min/ml		Beta d/min/ml		Nitrates ppm		Chlorides ppm		Uranium ppm		Fluoride ppm	
	Meas.*	Calc.**	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.
1955	.060	–	NA	–	2.2	–	NA	–	.008	–	.23	–
1956	.002	–	NA	–	5.8	–	NA	–	.040	–	.30	–
1957	(.090)	.060	(.8)	1.220	2.0	3.23	NA	NA	.013	.003	(.12)	.08
1958	(.076)	.012	(.029)	.108	1.7	1.96	NA	NA	.001	.002	(.09)	.03
1959	.090	.006	.00	.006	.9	1.64	2.90	4.60	.009	.003	(.02)	.04
1960	.019	.016	.040	.003	1.66	5.89	5.02	4.55	.007	.009	.006	.10
1961	.008	.016	.001	.004	1.40	6.36	2.00	5.22	.001	.009	.07	.08

*Measured – Samples taken upstream and downstream from FMPC outfall. Figures shown above are FMPC contributions to the river. This is determined by subtracting the upstream concentrations from the downstream concentrations.

**Calculated – Samples taken of the FMPC effluent. Figures shown above are calculated by assuming full dilution in the river.

NA – Not Analyzed.

( ) – Upstream concentrations greater than downstream concentrations.

APPENDIX V

Solids Content (ppm) FMPC Effluent

	1957	1958	1959	1960	1961
January	1011	140	141	79	110
February	744	145	105	74	106
March	431	98	63	93	72
April	492	183	66	55	55
May	404	181	167	58	83
June	230	167	138	45	64
July	288	192	93	72	65
August	450	320	51	58	50
September	112	76	57	44	57
October	288	59	60	54	63
November	230	152	91	60	139
December	175	188	72	98	153
Average	405	158	92	65	85

APPENDIX VI

Test Well No. 1

Nitrate and Chloride Concentrations

	Chlorides (ppm)	Nitrates (ppm)
Aug. – Sept., 1959	19	7
7/60	23	.2
5/61	80	12
11/10/61	91	107
11/11/61	95	102
11/15/61	89	119
12/5/61	60	13
2/8/62	24	13
2/9/62	36	14
2/15/62	51	28
2/16/62	53	27
4/23/62	2500	1900
4/24/62	2200	1600
4/30/62	1700	1400
5/7/62	1300	1000
5/13/62	1000	900
5/20/62	850	900
5/27/62	700	750
6/11/62	700	850
6/25/62	800	800
7/9/62	750	800
7/23/62	700	900
8/6/62	700	900
8/20/62	700	1000
8/31/62	700	1000
9/16/62	800	1350

APPENDIX VII

Production Wells – Chloride and Nitrate Concentrations (ppm)

Year	Well No. 1		Well No. 2		Well No. 3	
	Chlorides	Nitrates	Chlorides	Nitrates	Chlorides	Nitrates
1952	28	2	18	<1	11	Trace
1953	29	2	18	<1	11	Trace
1954	30	3	18	1	11	Trace
1955	31	3	18	1	11	<1
1956	32	4	18	1	11	<1
1957	34	4	19	2	12	<1
1958	34	4	19	2	12	<1
1959	35	5	19	2	12	<1
1960	35	5	19	2	12	1
1961	36	6	20	2	13	1
1962	36	6	20	3	13	1

APPENDIX VIII

Standards for Liquid Effluents

Material	Maximum Desired Concentration	Authority for Use
Uranium	.35 ppm in the river	Letter, F. H. Waring to Eisenbud, 12/11/54.[3]
Fluorides	1.2 ppm as F^- in a stream	Verbal communication from Waring to Yoder. Trip report of visit to Department of Health, Columbus, Ohio, 1/26/55. Letter, F. H. Waring to J. A. Quigley, M. D., 8/20/52 authorizes 1.0 ppm as F^- in the river.
Nitrates	44.0 ppm as NO_3^- in a stream	Report of the Water Pollution Study of Miami River, Ohio Department of Health, 1951.[1]
Chlorides	250 ppm as Cl^- in a stream	Same as above.
Free Acid	None	Same as above.
pH	Between 6.3 and 9.0 as measured in the effluent	Same as above.
Oil	Substantially complete removal	Same as above.
Settleable Solids	25 ppm measured in the effluent	Report, M. W. Boback and R. Heatherton, 2/10/58, "Laboratory Tests for Flocculation and Removal of Suspended Solids in Process Wastes."[13]
Total Activity ($\alpha + \beta$)	10^{-7} μc/ml(.22d/m/ml)	Agreement among the USPHS, AEC, and State of Ohio.
Radium	10^{-8} μc/ml in the river	National Bureau of Standards Handbook No. 69.[14]
Color and odor	To be non-offensive	Report of the Water Pollution Study of Miami River, Ohio Department of Health, 1951.[1]
Other toxic wastes, deleterious substances and high temperature liquids	None alone or in combination with other substances in sufficient amounts to impair water usage	Same as above.