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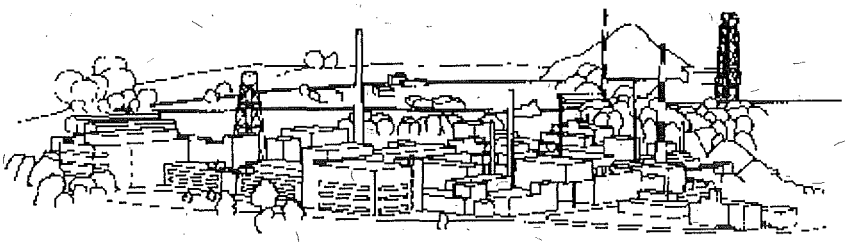
Babcock & Wilcox of Ohio, Inc.



Miamisburg Environmental Management Project

ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1997

September 1998

MOUND
is operated for the
U. S. Department of Energy
under contract No. DE-AC24-97OH20044

Fractions and Multiples of Units

Multiple	Decimal Equivalent	Prefix	Symbol
10^{6}	1,000,000	mega	M
10^{3}	1,000	kilo	k
10^{2}	100	hecto	h
10	10	deka	da
10^{-1}	0.1	deci	d
10^{-2}	0.01	centi	c
10^{-3}	0.001	milli	m
10^{-6}	0.000001	micro	μ
10^{-9}	0.000000001	nano	n
10^{-12}	0.000000000001	pico	p
10^{-15}	0.000000000000001	femto	f
10^{-18}	0.000000000000000001	atto	a

Conversion Table

Multiply	by	to Obtain	Multiply	by	to Obtain
in	2.54	cm	cm	0.394	in
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
qt (U.S.)	0.946	L	L	1.057	qt (U.S.)
ft^2	0.093	m^2	m^2	10.764	ft^2
ft^3	0.028	m^3	m^3	35.31	ft^3
L	1×10^{-3}	m^3	m^3	1000	L
Ci	3.7×10^{10}	Bq	Bq	2.7×10^{-11}	Ci
rad	0.01	Gy	Gy	100	rad
mrem	0.01	mSv	mSv	100	mrem

Ci = Curie, Bq = Becquerel = 1 disintegration/second, rad = radiation absorbed dose, mrem = millirem (radiation dose equivalent), 1 Gray = 100 Rad, 1 Sv = 100 rem

Miamisburg Environmental Management Project
Annual Site Environmental Report for Calendar Year 1997

September 1998

Prepared by the
Environmental Safeguards & Compliance Department
Babcock & Wilcox of Ohio
P.O. Box 3030
Miamisburg, OH 45343-3030

for the
U.S. Department of Energy
under Contract
No. DE-AC24-97OH20044

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LIST OF ACRONYMS

AIP	Agreement-In-Principle
ALARA	As Low As Reasonably Achievable
APG	Analytical Products Group, Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
ATD	Authorization to Discharge
BOD	Biochemical Oxygen Demand
BVA	Buried Valley Aquifer
CAA	Clean Air Act
CBOD	Carbonaceous Biochemical Oxygen Demand
CEDE	Committed Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CRD-LV	Characterization Research Division, Las Vegas
CWA	Clean Water Act
DCF	Dose Conversion Factor
DCG	Derived Concentration Guide
DF&O	Director's Findings and Order
DOE	U. S. Department of Energy
EDE	Effective Dose Equivalent
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ERS	Effluent Recovery System
ESA	Endangered Species Act
ESC	Environmental Safeguards and Compliance
FESOP	Federally Enforceable State Operating Permit
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FFCAct	Federal Facility Compliance Act
FWPCA	Federal Water Pollution Control Act
HEPA	High Efficiency Particulate Air
HSWA	Hazardous and Solid Waste Amendments
HT	Tritium, elemental
HTO	Tritium, oxide
ICRP	International Commission on Radiological Protection
LDL	Lower Detection Limit
LSA	Low Specific Activity
MCL	Maximum Contaminant Level
MEMP	Miamisburg Environmental Management Project
MGD	Million Gallons per Day

LIST OF ACRONYMS (continued)

MMCIC	Miamisburg Mound Community Improvement Corporation
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTS	Nevada Test Site
NVO	Nevada Operations Office of the U. S. DOE
OAC	Ohio Administrative Code
Ohio EPA	Ohio Environmental Protection Agency
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PRS	Potential Release Site
QA	Quality Assurance
RAPCA	Regional Air Pollution Control Agency
RCRA	Resource Conservation and Recovery Act
RMMA	Radioactive Material Management Area
RQ	Reportable Quantity
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
STP	Site Treatment Plan
SU	Standard Units (for pH measurements)
TSCA	Toxic Substances Control Act
TU	Toxicity Units
U. S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WM/PP	Waste Minimization/Pollution Prevention

CONTRIBUTORS

This report was prepared by S. A. Mackey, B.M. Farmer, L. R. Bauer, R.P. Paulick, and J. D. Guenther of the Environmental Safeguards & Compliance Department of Babcock & Wilcox of Ohio. The authors note with appreciation the support of the following personnel:

C. R. Anderson
N. R. Bonekowski
R. J. Brewer
M. C. Becker
M. B. England
A. Gibson
N. M. Grice
T. J. Hamilton
D. D. Hess
L. C. Hopkins
S. L. Howard
M. P. Isper
J. Price
J. K. Puckett
D. A. Rakel
R. A. Shudel
M. P. Shade
E. M. Warmoth
Printing Services Staff

EXECUTIVE SUMMARY

The purpose of this report is to characterize the environmental management performance of the Miamisburg Environmental Management Project (MEMP) in calendar year 1997. The MEMP is a government-owned site operated by Babcock & Wilcox of Ohio (BWO) for the U. S. Department of Energy (DOE). (BWO was awarded the operating contract on October 1, 1997.) The site's historical mission included production, development, and research in support of DOE's weapon and energy related programs. The defense mission is being phased out. Current MEMP objectives include environmental restoration and the transition of the site to the community for reuse as a commercial facility. As a result of economic development activities by the Miamisburg Mound Community Improvement Corporation (MMCIC), over 30 private businesses are operating at the site.

MEMP is comprised of nearly 100 buildings on 124 hectares (306 acres) of land in Miamisburg, Ohio, approximately 16 km (10 mi) southwest of Dayton. The Great Miami River, which flows through the city of Miamisburg, dominates the landscape of the five-county region surrounding MEMP. The river valley is highly industrialized. The rest of the region is predominately farmland dotted with residential areas, small communities and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and six of the city's 17 parks are located within one mile of the site. The climate is moderate. The geologic record preserved in the rocks underlying the site indicates that the area has been relatively stable since the beginning of the Paleozoic Era more than 500 million years ago. The southwestern portion of the site is located over the Buried Valley Aquifer which has been designated as a sole source aquifer by the U.S. Environmental Protection Agency (U. S. EPA).

ES.1 Perspective on Radiation

Radionuclides, radioactive species of atoms, emit ionizing radiation. Ionizing radiation is radiation possessing enough energy to remove electrons from the substances through which it passes. Most consequences to humans from exposure to radionuclides arise from the interactions of ionizing radiation with human tissue. These interactions are measured based on the amount of energy deposited in the tissue. This value is the absorbed dose. Since different types of ionizing radiation cause different degrees of biological harm, it is necessary to weight the doses to account for those differences. The unit used to make this comparison possible is the dose equivalent. The units used to report dose equivalents are the rem and the Sievert (Sv). Because doses associated with environmental exposures are typically only fractions of a rem or Sievert, it is common to report doses in terms of millirem (mrem) or millisievert (mSv). There are 1000 mrem per rem; 1000 mSv per Sv.

Our bodies are exposed to ionizing radiation each day. Most of this radiation comes from natural sources. The average dose to a resident of the United States from natural sources is about 300 mrem (3 mSv) per year. The primary contributors to this background dose are radon, cosmic and terrestrial sources, and medical sources such as x-rays or diagnostic exposures. A summary of the principles of radiation can be found in Appendix F of this Report.

ES.2 Radionuclide Releases from MEMP

Table ES-1 lists the quantities of radionuclides released by MEMP into the air and water during 1997. The unit used to report these quantities is the curie (Ci), a unit of radioactivity equal to 3.7×10^{10} disintegrations per second. The quantities, or activities, shown in Table ES-1 were measured at the point of release.

Table ES-1. Radiological Effluent Data for 1997

Radionuclide	Released to	Activity, Ci	DOE Range[b], Ci
Tritium	Air	802[a]	0 - 190,864
	Water	2.4	0 - 11,556
Plutonium-238	Air	0.000045	0 - 0.002
	Water	0.00045	0 - 0.01
Plutonium-239,240	Air	0.0000001	0 - 0.12
	Water	0.0000024	0 - 0.001
Radon-222	Air	1.36	Not typically measured
Uranium-233,234	Air	0.000000008	0 - 0.00005
	Water	0.00039	0 - 0.1
Uranium-238	Air	0.000000004	0 - 0.00006

[a] Tritium released to air consists of: Tritium oxide, 597 Ci
Elemental tritium, 205 Ci

[b] A range of annual release values reported by various DOE sites.

ES.3 Dose Limits

Dose limits, or more precisely, dose equivalent limits, for members of the public are presented in Table ES-2. These limits are expressed in terms of a committed effective dose equivalent (CEDE) and an effective dose equivalent (EDE) for the DOE and U. S. Environmental Protection Agency (EPA), respectively. Values shown in Table ES-2 represent annual limits on dose equivalents established by the DOE and EPA.

Table ES-2. Radiation Dose Limits for Protection of the Public from all Routine DOE Operations

Pathway	Regulatory Standard or Driver	Effective Dose Equivalent[a] mrem	mSv
All exposure media	DOE Order 5400.5	100	1
Air	40 CFR 61 (EPA)	10	0.1
Drinking water	40 CFR 141 (EPA)	4	0.04

[a] Annual Dose Limits

ES.4 Doses from MEMP Operations

In calculating the maximum dose received by a member of the public from MEMP activities, a committed effective dose equivalent is used. The CEDEs are the doses received by a hypothetical adult individual who remained at the site boundary 24 hours per day throughout 1997. This individual was assumed to have:

- breathed exclusively air with radionuclide concentrations corresponding to the location of the maximum offsite dose,
- drawn all of his drinking water from the Miamisburg water supply,
- consumed produce exhibiting the maximum average radionuclide concentrations in samples collected from the Miamisburg area.

The CEDEs from all of these pathways are added to obtain an estimate of the maximum CEDE received by this hypothetical individual. Table ES-3 shows the results for MEMP in 1997. The results are reported for tritium, plutonium-238, plutonium-239, 240, thorium-228, thorium-230, and thorium-232. The absence of a radionuclide, or an exposure pathway indicates that the concentrations were below background levels or were too small to affect the overall doses.

Table ES-3. Maximum Committed Effective Dose Equivalents to a Hypothetical Individual in 1997

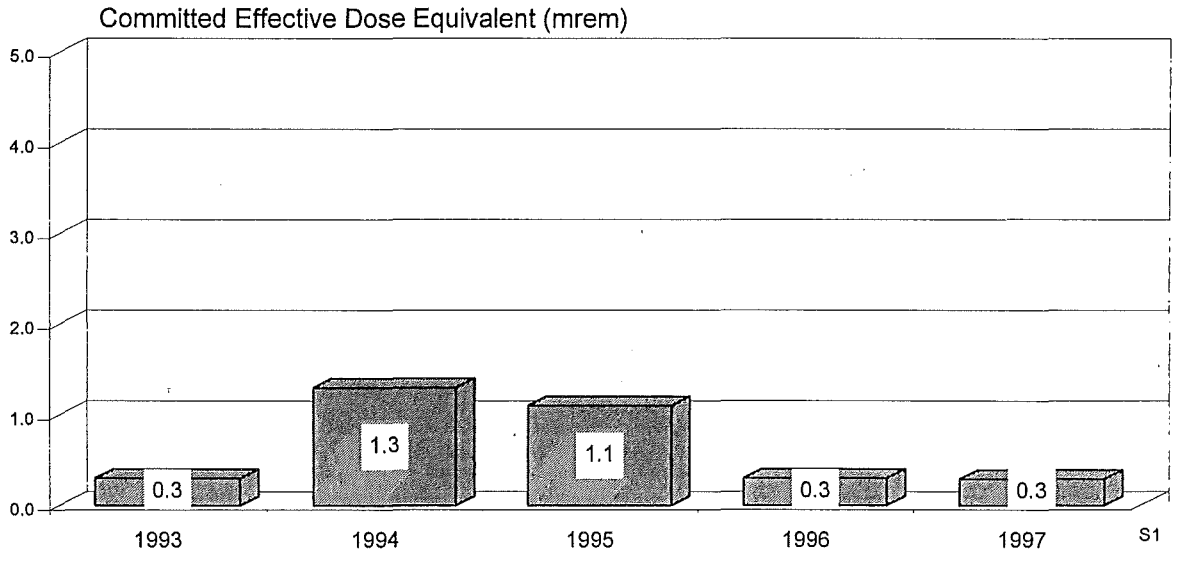
Radionuclide	Pathway	mrem	mSv
Tritium	Air	0.005	0.00005
	Drinking water	0.009	0.00009
	Foodstuffs	0.006	0.00006
	Total	0.02	0.0002
Plutonium-238	Air	0.184	0.00184
	Drinking water	ND	ND
	Foodstuffs	ND	ND
	Total	0.184	0.00184
Plutonium-239,240	Air	ND	ND
	Drinking water	ND	ND
	Foodstuffs	ND	ND
	Total	ND	ND
Thorium-228	Air	0.011	0.00011
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.011	0.00011
Thorium-230	Air	0.017	0.00017
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.017	0.00017
Thorium-232	Air	0.055	0.00055
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.055	0.00055
Total		0.290	0.0029

ND indicates that concentrations were not detectable above the environmental level.
NA = not applicable (not measured).

The data presented in Table ES-3 were calculated using environmental monitoring data measured at and near the site. MEMP also evaluates doses using the EPA's computer code CAP88-PC. CAP88-PC uses air effluent data as input to transport, dispersion, and dosimetry codes. By executing these codes, one generates an estimate of a maximum offsite dose from airborne releases. For 1997, the CAP88-PC-estimated maximum offsite dose was 0.05 mrem. As reported in Table ES-2, the EPA's annual dose limit for airborne releases is 10 mrem. Therefore, MEMP releases in 1997 represented 0.5% of the dose limit set by the EPA.

Figure ES-1 shows the five year trend in CEDEs. The increase in CEDE values during 1994 and 1995 was attributable to the decontamination and decommissioning (D&D) of SM Building. This project was completed in 1995. The dose from MEMP activities in 1997 was a small fraction of the 100 mrem DOE dose limit for members of the public.

Figure ES-1. Calculated CEDEs from MEMP Activities, 1993 - 1997



Population doses. CAP88-PC also has the capability of estimating regional population doses from airborne releases. The population, approximately 3,035,000 persons, within a radius of 80 km (50 mi) of MEMP received an estimated 2.39 person-rem from site activities in 1997. CAP88-PC arrived at that value by calculating doses at specific distances and in specific compass sectors relative to MEMP. The computer code then multiplied the average dose in a given area by the number of people living there. For example, an average dose of 0.001 rem x 10,000 persons in the area yields a 10 person-rem collective dose for that region. CAP88-PC then sums the collective doses for the 80-km radium region and reports a single value. Additional dose components from drinking water and radon emissions are added to obtain this result.

MEMP's dose contribution of 2.39 person-rem can be put in perspective by comparison with background doses. The average dose from background sources is 300 mrem (0.3 rem) per individual per year. A background collective dose can be estimated for the 80-km population by multiplying 0.3 rem x 3.035 million persons. The result, about one million person-rem, represents an estimate of the collective dose from all background sources of ionizing radiation. MEMP's contribution, 2.39 person-rem, is approximately 0.00024% of that value.

ES.5 Environmental Monitoring Program Results

Besides setting limits on the CEDE to any member of the public, DOE has established Derived Concentration Guides (DCGs) for individual radionuclides. The DCG is defined as the concentration of a radionuclide in air or water that will result in a CEDE of 100 mrem (1 mSv) following continuous exposure for one year. The concentrations of radionuclides resulting from MEMP's 1997 releases were small fractions of the corresponding DCGs.

Radiological Monitoring of the Atmosphere

Ambient air is sampled for tritium and plutonium by an onsite network of seven perimeter stations and by an offsite network of 15 stations. Twelve of the offsite samplers are located in the Miamisburg area. One sampler is located far enough away to receive virtually no impact from MEMP activities. This sampler serves as a reference location to establish background or environmental levels of tritium, plutonium, and thorium. The amount by which a sample exceeds the background or environmental level is reported as an incremental concentration.

Incremental concentrations measured at the onsite samplers were less than 0.01% and 0.19%, respectively, of the DOE DCGs for tritium and plutonium-238. Average incremental concentrations at the offsite samplers for tritium and plutonium-238 were less than 0.009% and 0.22%, respectively, of the DOE DCGs. Most incremental plutonium-239,240 concentrations were not detectable above environmental levels. Incremental thorium-228, thorium-230, and thorium-232 concentrations averaged less than 0.01%, 0.02%, and 0.06%, respectively of the DOE DCGs.

Radiological Monitoring of Water

Water samples were collected from locations along the Great Miami River and were analyzed for tritium, plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. Other surface water locations were sampled for tritium and plutonium. Additionally, both river and pond sediment samples were analyzed for isotopes of plutonium and thorium.

River water. Average incremental tritium concentrations in the river were less than 0.02% of the DOE DCG for tritium in water. The average incremental concentrations of plutonium-238 and plutonium-239,240 in water from the Great Miami River were 0.05% and 0.005% of the DOE DCGs, respectively. The average incremental concentrations of uranium-233,234 and uranium-238 were below the environmental level. Thorium-228, thorium-230, and thorium-232 concentrations were 4.0%, 9.3%, and 42.0%, respectively, of the DOE DCGs.

Pond Water. Samples from local ponds are sampled annually for tritium, plutonium-238, and plutonium-239,240. Average incremental tritium concentrations in pond water were 0.01% of the DOE DCG. Most incremental plutonium concentrations were not detectable above environmental levels.

Sediment. Plutonium and thorium results for river and pond sediments are listed in Appendix B, Tables B-14 through B-19. Maximum and average concentrations for 1997 are comparable to concentrations observed in previous years. Since isotopes of plutonium and thorium tend to accumulate in sediment, concentrations are affected by the movement of silt. This accounts for the variability in plutonium concentrations at the various river and pond locations.

Radiological Monitoring of Foodstuffs

Locally-grown produce was collected from the surrounding area. These samples were then analyzed for tritium and/or plutonium as appropriate. Concentrations of radionuclides in produce were at or very near environmental levels.

Nonradiological Monitoring of Air

Particulate loadings are measured at all of the onsite and offsite air sampling locations. Particulate concentrations appeared to be independent of distance. This result suggests that MEMP exerts little or no influence on the levels of airborne particulates in the ambient environment.

Nonradiological Monitoring of Water

MEMP's nonradiological liquid discharges are regulated by an National Pollutant Discharge Elimination System (NPDES) permit and Authorization to Discharge (ATD). In 1997, over 1,550 samples were collected to demonstrate compliance with these permits. Of these, eleven samples exceeded permit limitations for one of the following parameters: carbonaceous oxygen demand, total suspended solids, pH, or residual chlorine. Additional information about NPDES and ATD results for 1997 can be found in Chapter 5.

ES.6 Groundwater Monitoring Program

MEMP maintains an extensive network of onsite and offsite monitoring wells. In addition, a number of onsite and offsite production wells and community water supplies are routinely sampled. Drinking water from the Miamisburg area is analyzed for tritium and isotopes of plutonium and uranium. Other regional water supplies are sampled for tritium. Samples from monitoring and production wells are analyzed for various constituents including volatile organic compounds, metals, and inorganic cations and anions. As in previous years, monitoring data collected in 1997 indicated that volatile organic compounds and tritium, respectively, are the primary nonradiological and radiological contaminants of concern. Information about groundwater monitoring results for 1997 can be found in Chapter 6.

ES.7 Environmental Restoration

MEMP was designated a Superfund site, i.e., placed on the National Priorities List, in November of 1989. A Federal Facilities Agreement (FFA) between the DOE and the U. S. EPA followed in October of 1990. The FFA was expanded to a tri-party agreement in 1993 when the Ohio EPA became a signatory. The purpose of the FFA remains unchanged; it defines the responsibilities of each party for the completion of Superfund-related (CERCLA-related) activities. Highlights of the CERCLA program during 1997 are described in Chapter 3 of this report.

ES.8 Quality Assurance for Environmental Data

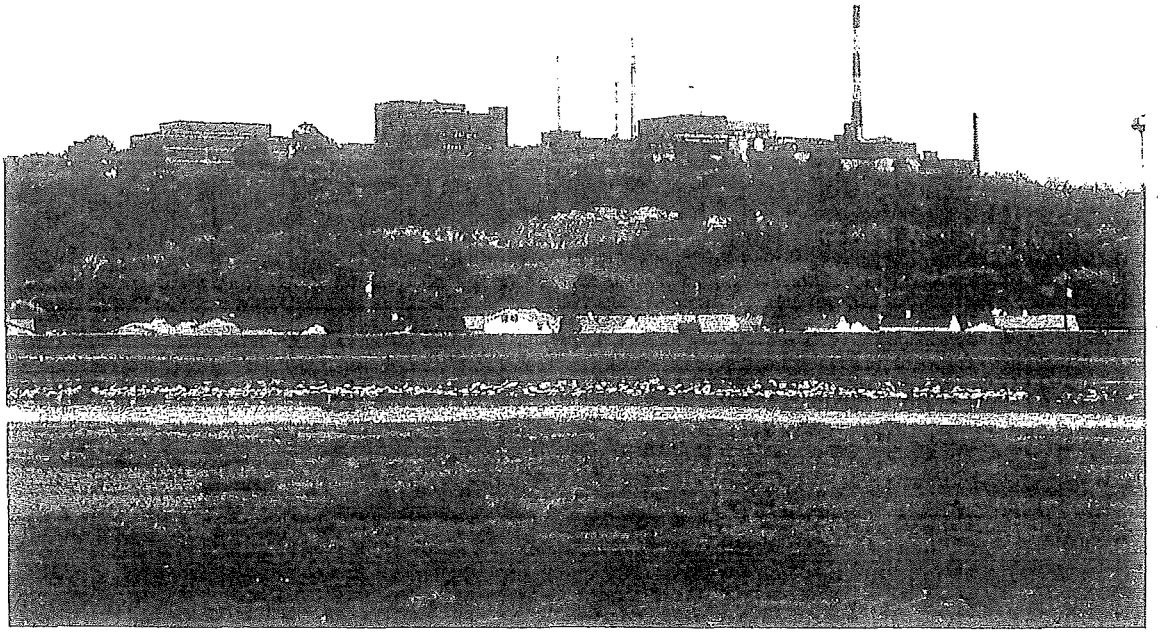
To ensure the reliability of environmental data, MEMP maintains an internal quality assurance (QA) program that consists of running blanks, internal standards, and replicate samples. MEMP also participates in comparison exercises with external laboratories to validate further MEMP's environmental results. Comparisons of MEMP's performance with that of other laboratories are shown in Chapter 7 of this report. The close agreement between MEMP and the external labs provides confidence that MEMP's Environmental Monitoring Program generates reliable data.

1.0 INTRODUCTION

1.1 Description of Miamisburg Environmental Management Project

Location

The Miamisburg Environmental Management Project (MEMP) is comprised of nearly 100 buildings on 124 hectares (306 acres) of land in Miamisburg, Ohio, approximately 16 km (10 mi) southwest of Dayton (Figure 1-1). The Great Miami River flows southwest through the City of Miamisburg and dominates the geography of the region surrounding MEMP (Figure 1-2). The river valley is highly industrialized. The rest of the region is predominately farmland dotted with residential areas, small communities and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and six of the city's 17 parks are located within one mile of the site.



View of MEMP Looking East Across the Great Miami River

Figure 1-1. Locations of Miamisburg and Surrounding Communities

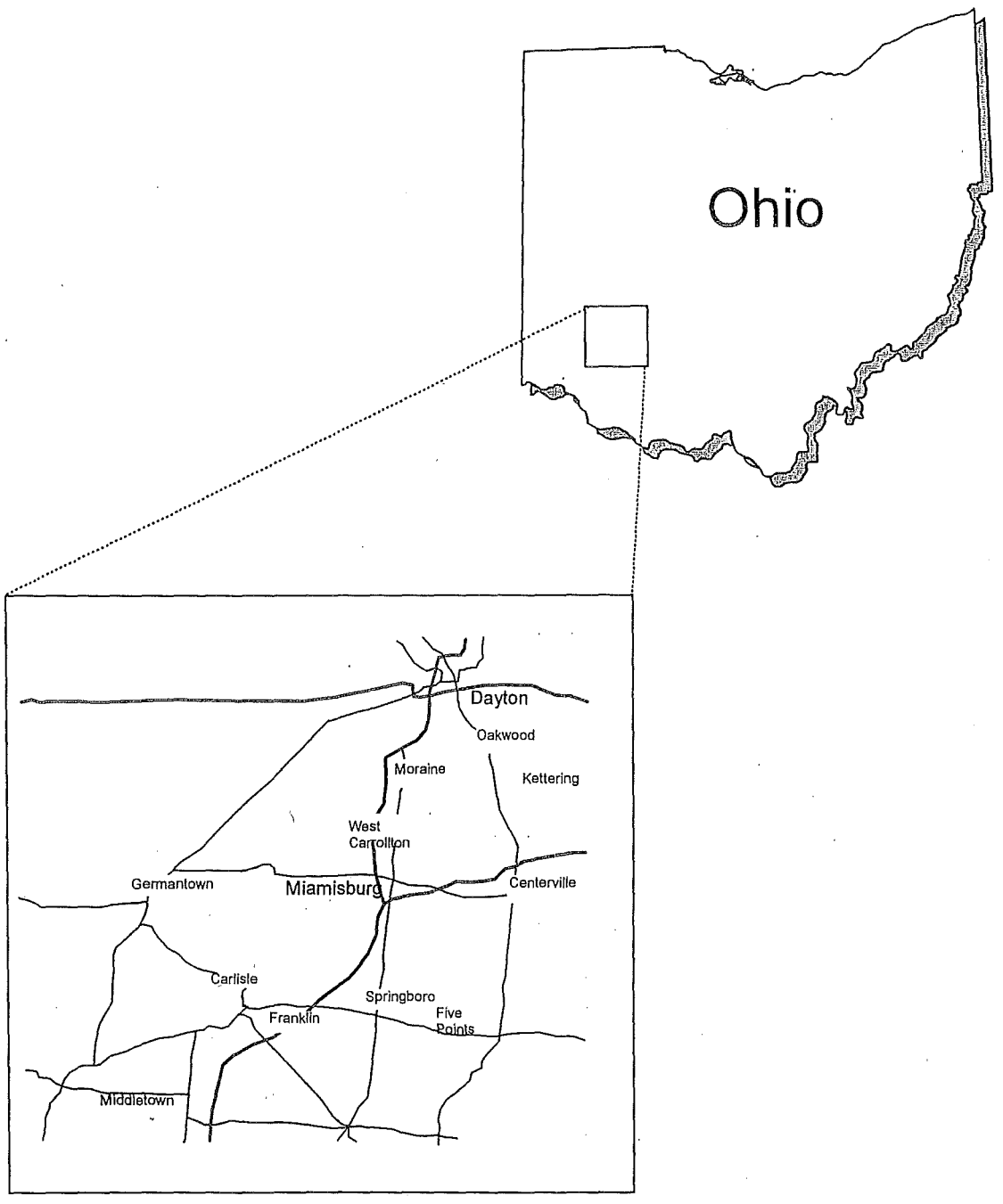
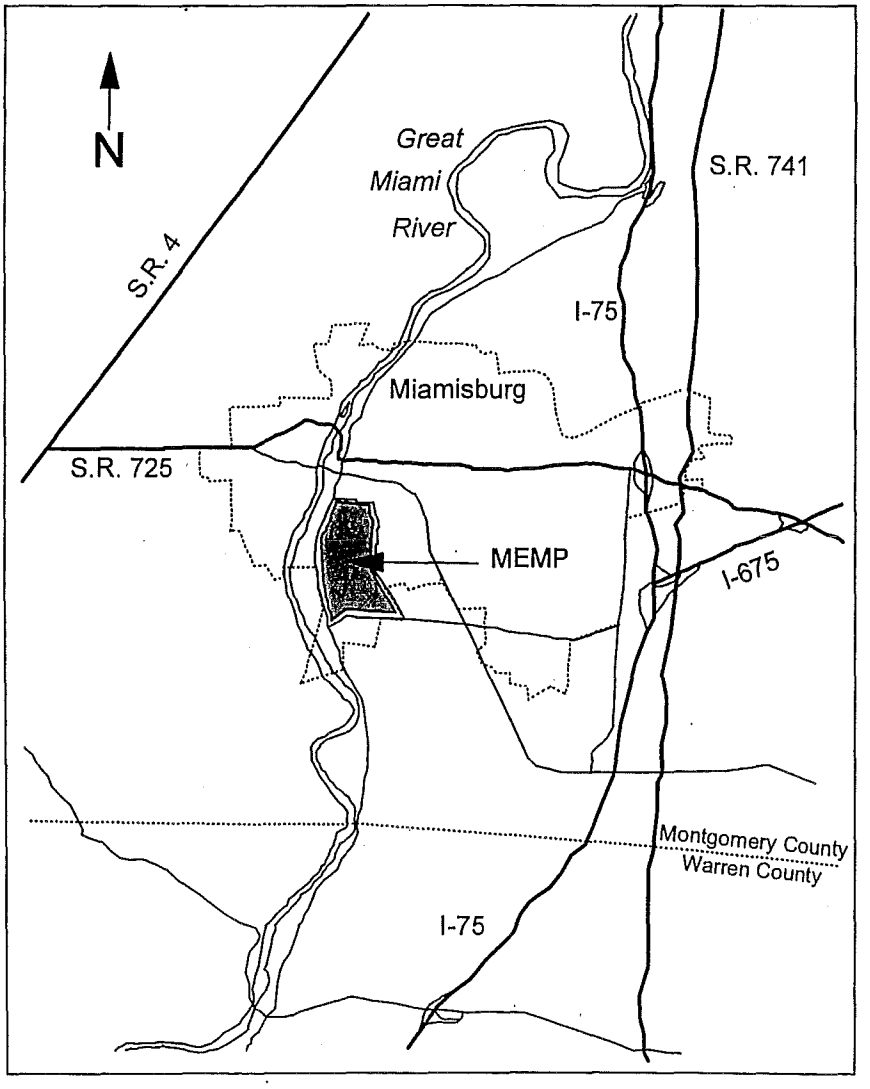


Figure 1-2. Location of MEMP



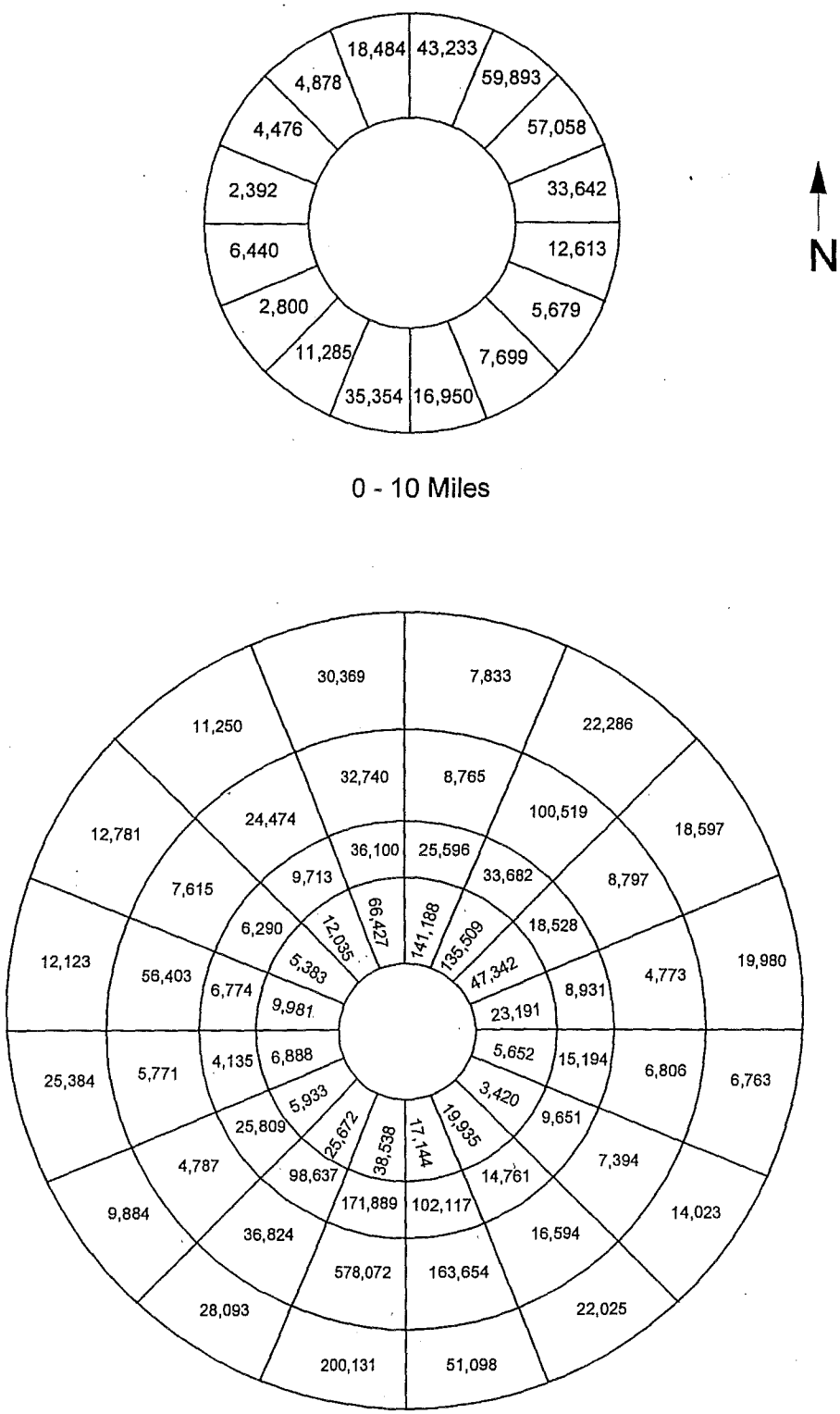
Population and Land Use

Figure 1-3 shows the population distribution within 50 miles (80 km) of the site. The population information was extracted from 1990 Census data by the Ohio Department of Development. The estimated number of individuals residing within the 50-mile radius is 3,034,679 (Table 1-1). The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10% of the agricultural land is devoted to pasturing livestock.

Table 1-1. Population Totals from the 1990 Census

Radius, miles	Total
0-10	322,876
0-20	887,114
0-30	1,477,621
0-40	2,541,609
0-50	3,034,679

Figure 1-3. Distribution of Population within 50 mi (80 km) of MEMP



Geology

The geologic record preserved in the rocks underlying the site indicates that the area has been relatively stable since the beginning of the Paleozoic era more than 500 million years ago. There is no evidence indicating subsurface structural folding, significant stratigraphic thinning, or subsurface faulting. Limestone strata, which are interbedded with protective shale layers at the site, show no evidence of solution activity. No evidence of solution cavities or cavern development has been observed in any borings or outcrops in the Miamisburg area.

Hydrogeology

The aquifer system of the site consists of two different hydrogeologic environments: groundwater flow through the bedrock beneath the hills and groundwater flow within the unconsolidated glacial deposits and alluvium associated with the Buried Valley Aquifer (BVA) in the Great Miami River valley. The bedrock flow system is dominated by fracture flow and is not considered a productive aquifer. The BVA is dominated by porous flow with interbedded gravel deposits providing the major pathway for water movement. The unconsolidated deposits are Quaternary Age sediments consisting of both glacial and fluvial deposits. The BVA is a highly productive aquifer capable of yielding a significant quantity of water. The BVA is considered a sole source aquifer.

Climate

The climate is moderate. The average annual precipitation rate is on the order of 91 cm (36 in) per year. As shown in Figure 1-4, the total precipitation measured at the site in 1997 was 82 cm (32 in). During 1997, winds were predominately out of the southwest (Figure 1-5). The annual average wind speed measured at MEMP for 1997 was 5.1 m/s (11.4 mi/hr) (Table 1-2).

Topography

The site topography is shown in Insert 1-1 (see 11 in x 17 in foldout at the end of this Chapter). MEMP site elevations vary from 216 m to 268 m (700 ft to 900 ft) above sea level; most of the site is above 244 m (800 ft). No building in which radioactive material is processed is located below an elevation of 241 m (790 ft). The typical nonflood stage of the Great Miami River is 208 m (682 ft). The highest flood-water levels that can be reasonably postulated for the Great Miami River basin (100-year storm event) would result in flooding to 216 m (710 ft). A narrow area along the southwest border of the site lies at 216 m (700 ft), the lowest site elevation.

Figure 1-4. Monthly Precipitation Measured at MEMP in 1997

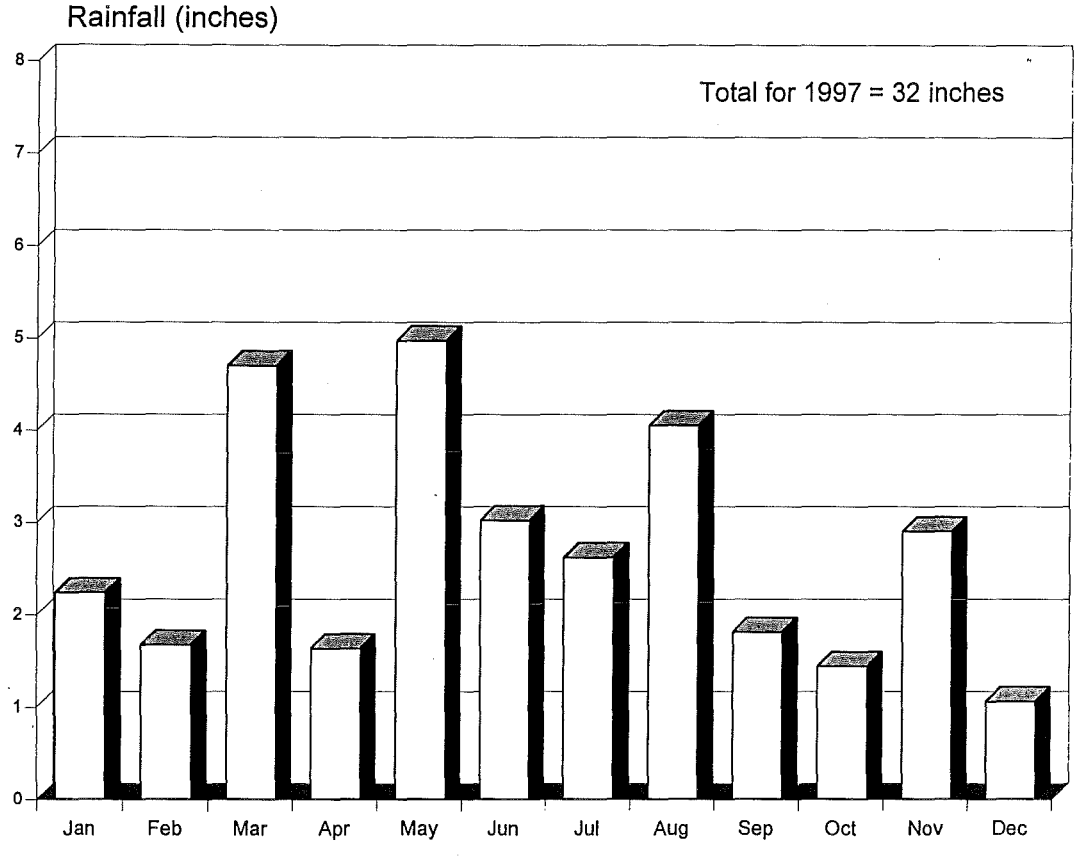
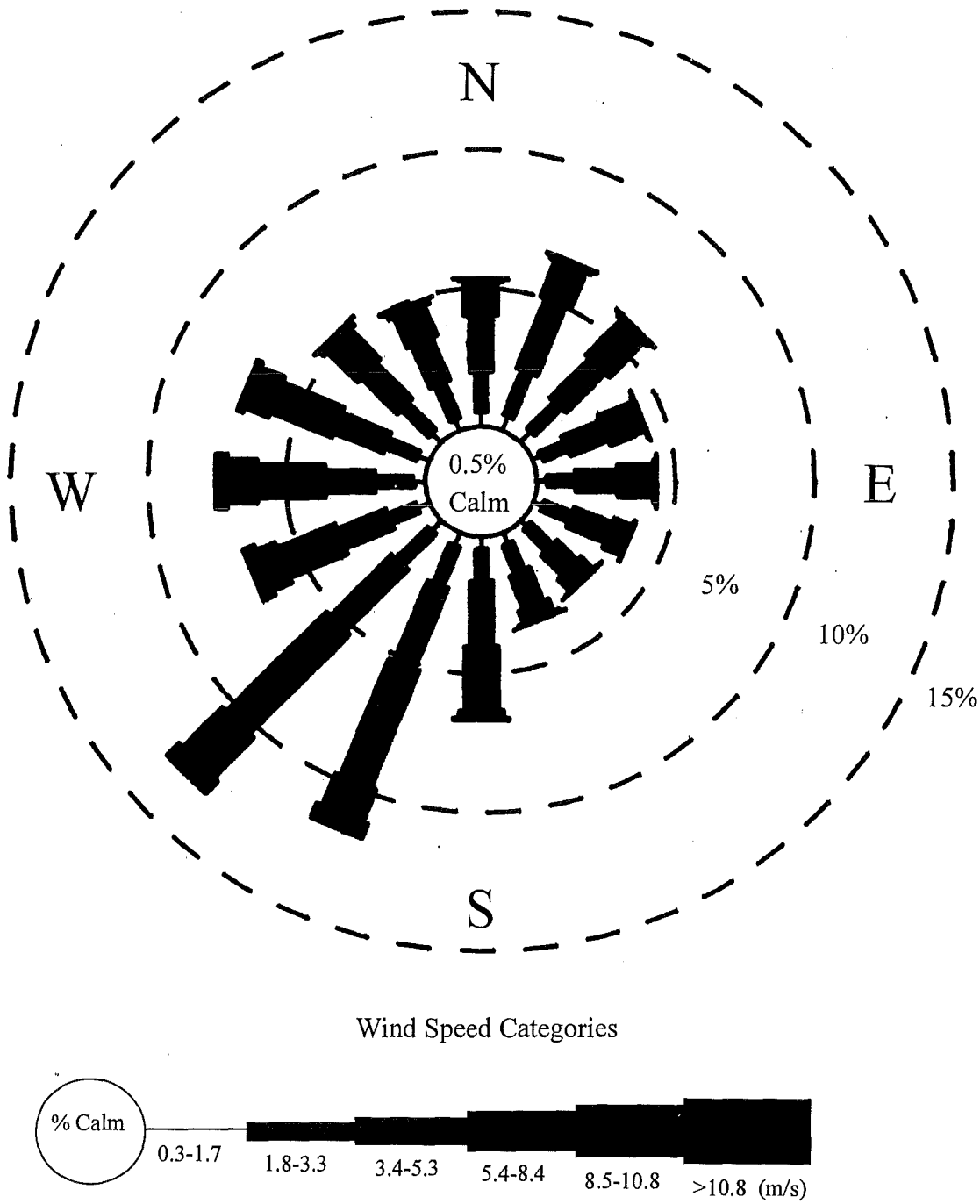


Figure 1-5. 1997 Wind Rose for MEMP



(Figure indicates frequency of winds blowing *from* a given compass sector.)

Table 1-2. Percent Frequency of Wind Direction and Wind Speed from MEMP 50-m Meteorological Tower for 1997

Direction	Percent of Time Winds From	Average Speed (m/s)[a]
N	5.33	4.1
NNE	6.58	4.2
NE	5.84	4.5
ENE	4.20	4.5
E	4.30	4.5
ESE	3.69	3.9
SE	3.11	3.9
SSE	3.44	3.8
S	6.65	4.9
SSW	11.58	5.9
SW	13.03	6.2
WSW	6.85	5.8
W	7.53	5.9
WNW	7.06	5.6
NW	5.44	4.5
NNW	4.85	4.4
		Average 5.1

[a] 1 m/s = 2.24 mi/hr.

Total relative frequency of calms distributed above is 0.48%.

Mission and Operations

In the past, MEMP served as an integrated research, development, and production facility in support of DOE weapon and nonweapon programs, especially in the areas of chemical explosives and nuclear technology. The principal mission of MEMP was research, development, and manufacture of non-nuclear explosive components for nuclear weapons that were assembled at another DOE site. Other major operations at MEMP included:

- Manufacture of stable (nonradioactive) nuclides for medical, industrial, and general research.
- Development and manufacture of small chemical heat sources for the national defense program.
- Recovery and purification of tritium from scrap materials generated by MEMP and other DOE sites.
- Development and fabrication of radioisotopic heat sources fueled with plutonium-238 to provide power sources for such projects as lunar experiments, satellites, and spacecraft.
- Surveillance of explosive and radioactive weapons components received from other DOE sites.

As a result of the November 22, 1993, DOE decision to phase out the defense mission at MEMP, activities are currently underway to transfer MEMP's defense-related programs to other sites within the DOE complex. Current MEMP objectives include continuing the nuclear energy program mission, environmental restoration, and the transition of the site to the community for reuse as a commercial facility. As a result of recent economic development activities by MMCIC, over 30 private businesses are operating at the site.

1.2 Perspective on Radiation

This section puts into perspective the potential consequences of the radionuclide releases described in subsequent sections of this report. Additional background information on radiation can be found in Appendix F, *Principles of Radiation.*

Most consequences to humans from radionuclides are caused by interactions between radiation emitted by the nuclides and human tissue. These interactions involve the transfer of energy from the radiation to the tissue, a process that may damage the tissue. The radiation may come from radionuclides located outside the body (i.e., in or on environmental media and man-made objects) and from radionuclides deposited inside the body via inhalation, ingestion, or absorption through the skin. Exposure to radiation from nuclides located outside the body is called external exposure and will last only as long as the exposed person is near the external source. Exposure to radiation from radionuclides deposited inside the body is called internal exposure and will last as long as the radionuclides remain in the body.

A number of specialized units are used to characterize exposure to ionizing radiation. Because the damage associated with such exposures is due primarily to the deposition of radiant energy in tissue, these units are described in terms of the amount of energy absorbed by the tissue and the biological consequences of the absorbed energy. Some of the key units are defined below:

- **Absorbed dose** indicates the amount of energy absorbed by a material (e.g., human tissue), divided by the mass of the material. The unit of absorbed dose is the gray (Gy) or the rad (100 rads = 1 Gy).

- **Dose equivalent** indicates the biological effect of an absorbed dose on a particular organ or tissue. It equals the absorbed dose multiplied by factors that relate the absorbed dose to biological effects on that particular organ. The unit of dose equivalent is the sievert (Sv) or the rem (100 rem = 1 Sv).

- **Effective dose equivalent** indicates an individual's cancer risk from an exposure to ionizing radiation. It is calculated from the weighted sum of the dose equivalents from the irradiated organs. It is also expressed in rem or Sieverts.

- **Committed effective dose equivalent** indicates the total dose over the individual's projected remaining lifetime (assumed to be 50 years) that results from an intake during one year. The committed effective dose equivalent (CEDE) expresses the dose of internal radiation received when an individual has ingested or inhaled a radionuclide that will remain inside the body for months or years. It is also expressed in rem, mrem (1000 mrem = 1 rem), or Sieverts.

- **Collective committed effective dose equivalent** indicates the sum of the committed effective dose equivalents to the individuals in a population. It gives an estimate of the expected health risk to the population from a dose of radiation. It can be used to calculate probable risks that might be too small to predict on the basis of a single individual. It is expressed in person-rem or person-Sieverts.

Sources of Radiation

Every day our bodies absorb ionizing radiation. Most of it comes from natural sources. Consumer products and medical procedures that use radiation are other common sources of ionizing radiation.

Natural Sources. Natural radiation comes from two sources, cosmic and terrestrial. Cosmic radiation results when energetic particles from outer space, traveling at nearly the speed of light, collide with nuclei in our atmosphere, creating showers of radioactive particles that fall to earth. The average annual dose equivalent received from cosmic radiation is 26 mrem (0.26 mSv) for an individual living at sea level. Because cosmic radiation dissipates as it travels through the atmosphere, individuals living at lower altitudes receive less dose from this source than those living at higher altitudes.

Terrestrial radiation results when radionuclides that are a natural part of the earth's rocks and soils emit ionizing radiation. Because the concentrations of these radionuclides vary

geographically, an individual's exposure depends on his location. The average annual dose equivalent from terrestrial radiation for an individual living in the U. S. is 28 mrem (0.28 mSv).

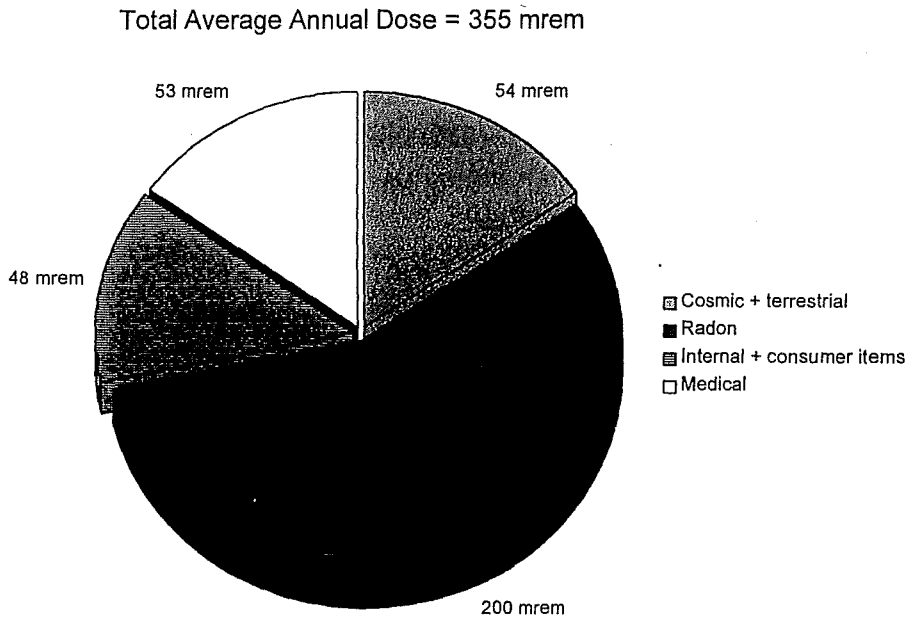
Besides absorbing radiation from external radionuclides, we can also absorb radiation internally when we ingest radionuclides along with the water, milk, and food we eat or along with the air we inhale. Once in our bodies, radionuclides follow the same metabolic paths as nonradioactive forms of the same elements. The length of time a particular radionuclide remains in the body and emits radiation depends on whether the body eliminates it quickly or stores it for a long period, and on how long it takes for the radionuclide to decay into a nonradioactive form. The principal source of internal exposure in the U. S. is believed to be radon. Inhalation of radon contributes about 200 mrem (2.0 mSv) to the average annual dose equivalent from internal radiation. Other radionuclides present in the body contribute approximately 39 mrem (0.39 mSv).

Consumer Products. Many familiar consumer products emit ionizing radiation. Some must emit radiation to perform their functions, e. g., smoke detectors and airport x-ray baggage inspection systems. Other products, e.g., TV sets, emit radiation only incidentally to performing their functions. The average annual effective dose equivalent to an individual from consumer products ranges from 6 to 12 mrem (0.06 to 0.12 mSv).

Medical Uses. Radiation is a tool for diagnosing and treating disease. The average annual dose equivalent for an individual in the U. S. from diagnostic radiation is 53 mrem (0.53 mSv). Individuals undergoing radiation therapeutic procedures may receive much higher doses.

Summary. The contributions to an average individual's annual radiation dose are shown in Figure 1-6. MEMP's maximum contribution for 1997, 0.29 mrem, is too small to be seen in the figure.

Figure 1-6. Average Annual Radiation Dose in the U.S. (NCRP, 1987)



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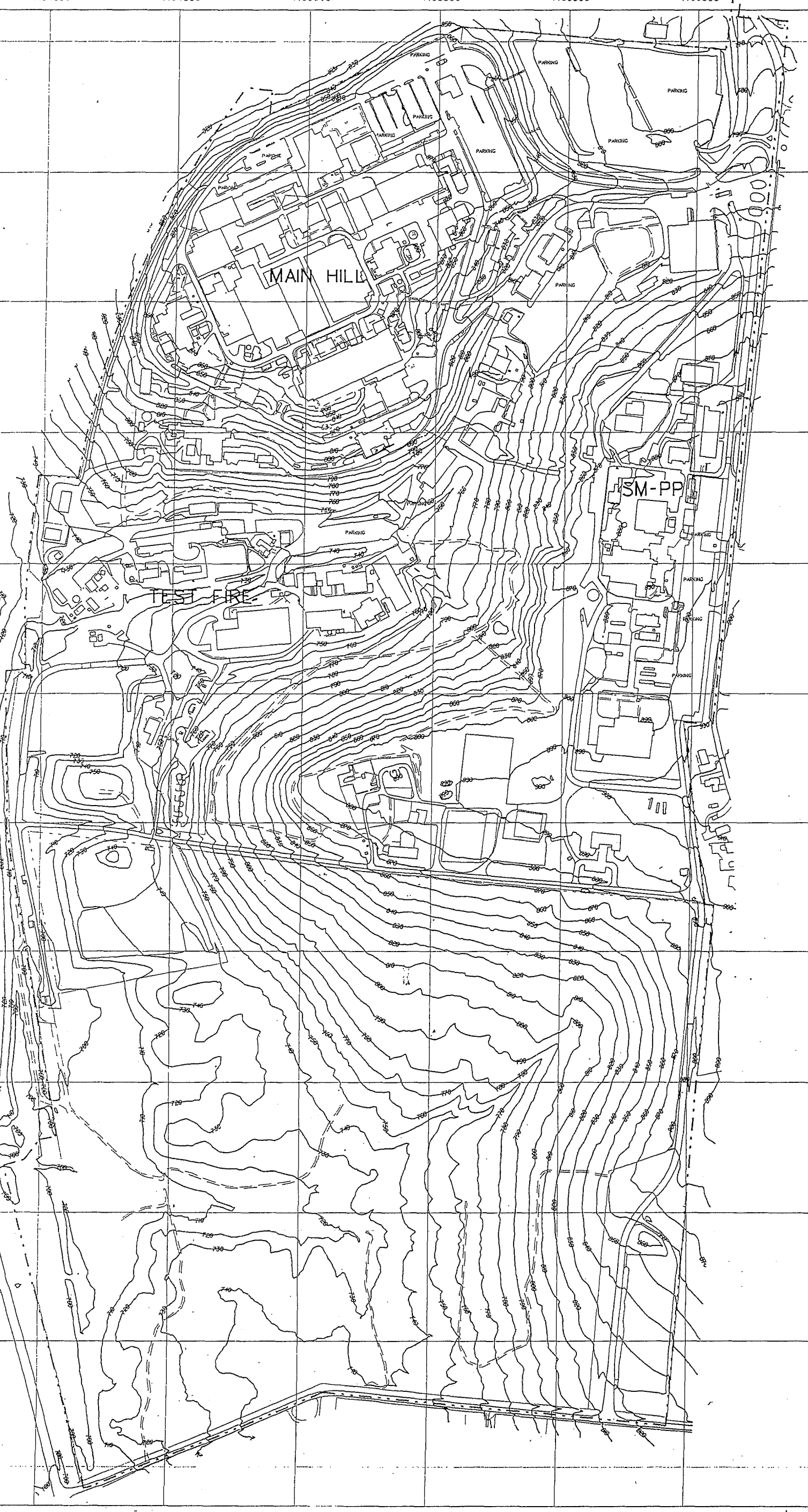

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DRAWING NUMBER

2.0 COMPLIANCE SUMMARY

BWO operates in compliance with environmental requirements established by federal, state, and local statutes and regulations. Additional requirements have been imposed by Executive Orders, DOE Orders, and various compliance agreements. As a result of recent economic development activities, private businesses are operating on the site. These businesses are responsible for obtaining their air permits and operating within the limits of the site's National Pollutant Discharge Elimination System permit. The site's status with respect to environmental requirements is summarized below.

2.1 Major Environmental Statutes, Regulations and Orders

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Federal Facilities Agreement (FFA)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, also known as Superfund, is the federal government's primary environmental restoration legislation. Through CERCLA, the U. S. EPA identifies sites where hazardous substance contamination may present a risk to human health and/or the environment. Those sites presenting a human health or environmental risk are then placed on the National Priorities List (NPL) and a four-stage remediation process begins.

MEMP was added to the NPL in November of 1989 because of volatile organic compound (VOC) contamination in groundwater. A Federal Facilities Agreement (FFA) between the DOE and the U.S. EPA followed in October of 1990. The FFA defines the responsibilities of each party for the completion of CERCLA-related activities.

The FFA became a tri-party agreement on July 15, 1993, when the Ohio EPA became a signatory. The addition of the Ohio EPA did not change the purpose of the agreement, but rather provided a mechanism for the full participation of the Ohio EPA in the CERCLA process.

Preliminary CERCLA assessment of contamination at the site identified approximately 125 locations of actual or suspected releases. These locations were grouped into "Operable Units" (OUs) based on waste type and/or geographical proximity. Originally, nine OUs were established. As CERCLA activities progressed, changes to the number and composition of the OUs were warranted. In 1995, the CERCLA program was reorganized to increase the efficiency of the environmental restoration effort. The initiative, termed "MOUND 2000," has accelerated cleanup of the site so that the land can be released for economic development much sooner than originally planned. The MOUND 2000 process addresses buildings and potential release sites (PRSs) individually. Approximately 400 PRS have been identified. A core team, comprised of U.S. EPA, Ohio EPA, and DOE representatives, reviews the status of each building and PRS based upon an information package that serves as the basis for decision-making. The core team

reaches a consensus decision to categorize each PRS in one of the following ways: (1) *no further assessment* is required, i.e., the site is protective of human health and the environment, (2) a *response action* is warranted, or (3) there is insufficient information to make a determination (*further assessment* is needed). If there is consensus that the site is protective of human health and the environment, no further action is taken. If it is determined that further assessment is needed, the additional data necessary to make a decision are collected and presented to the core team. If it is cost-prohibitive to obtain the necessary data, a decision to initiate a response action may be made. A response action is a clean-up action tailored to the PRS of interest. Core team decisions to initiate a response action or that no further assessment is required are presented to stakeholders. The MOUND 2000 process accelerates clean-up of the site by focusing on discrete areas and streamlining decision making. The end result is a multi-year and multi-million dollar savings that will allow DOE to exit the site without leaving behind environmental concerns. A brief description of CERCLA activities for 1997 can be found in Chapter 3.

In 1997, the Agency for Toxic Substances and Disease Registry (ATSDR) continued its evaluation of the site. It is a requirement of CERCLA that the ATSDR evaluate each site listed on the NPL. The Agency examines health data to seek out abnormal rates or types of illnesses. If any such problems are suspected, the Agency attempts to determine if a correlation exists between the illness and the site.

Initial ATSDR findings for the site were published in October of 1993 as an ATSDR "Health Consultation." The consultation report indicated that plutonium-238 levels in the local environment are not a public health hazard. For other constituents of concern, insufficient data were available to draw public health conclusions. Therefore, a key recommendation of the report was the pursuit of additional testing. ATSDR performed soil and air sampling during 1994. None of the measurements indicated that a public health hazard exists. In 1996, the ATSDR published a public health assessment. This document was made available for public review in December 1996. The assessment concluded that under current conditions the site poses no apparent public health hazard to offsite populations. In 1997, ATSDR worked to develop responses to comments on the report.

In addition to the activities described above, the Superfund Act established a list of CERCLA-regulated materials. Release of these materials to the environment is subject to certain reporting requirements. No releases of reportable quantities of CERCLA-regulated materials occurred in 1997.

Clean Air Act (CAA)

Nonradiological emissions. The Clean Air Act (CAA) of 1970, as amended in 1977, gave the U. S. EPA authority to regulate two groups of airborne pollutants: criteria pollutants and hazardous air pollutants. The CAA was again amended in 1990. The major impact of the amendments was the requirement that major emitters of pollutants obtain comprehensive (Title V) air permits. To ensure that site emissions remain below the Title V permitting threshold, MEMP applied for and received Federally Enforceable State Operating Permits (FESOPs). The FESOPs place limits on annual usage and thus limit potential air emissions.

MEMP is also subject to state air pollution regulations (OAC 3745-31,-35,-15). Compliance with State of Ohio regulations requires that applicable MEMP activities be permitted or otherwise registered. The Ohio Environmental Protection Agency (Ohio EPA) has issued MEMP eighteen air permits. Ten other sources are registered with the Regional Air Pollution Control Agency (RAPCA). In order for a source to be considered for registration status, (1) the source owner must demonstrate compliance with all applicable laws including employment of best available technology, (2) maximum emissions of particulate matter, sulfur dioxide, nitrogen oxides, and organic compounds cannot exceed five tons per year, and (3) the source cannot be subject to U.S EPA new source performance standards or the National Emission Standards for Hazardous Air Pollutants (NESHAPs).

To ensure compliance with all state and local reporting requirements, chemical air emission data are collected. This information is maintained in a data base that is updated each calendar year. In addition to providing information on release levels for materials regulated by the CAA, the database is used to meet the reporting requirements of other statutes such as the Emergency Planning and Community Right-to-Know Act. All emissions were within required limits and no enforcement actions were initiated in 1997.

Radiological emissions. Nine stacks and eight building vents at the site discharge radioactive effluents to the atmosphere. These releases are subject to NESHAPs for radionuclides. These "radionuclide NESHAPs" regulations (40 CFR 61, Subpart H) are components of the Clean Air Act (CAA) and are enforced by the U. S. EPA.

The primary standard against which compliance with 40 CFR 61, Subpart H is measured is an annual effective dose equivalent (EDE). The regulations require that radionuclide air emissions from a given site do not exceed those amounts that would cause a member of the public to receive an annual EDE of 10 mrem (0.10 mSv). The regulations also state that each facility must determine this "maximum offsite dose" using an approved approach; the preferred approach is to use a computer code such as CAP88-PC.

Based on CAP88-PC calculations performed for MEMP emissions in 1997, the maximum EDE received by a member of the public was 0.05 mrem. This value represents 0.5% of the dose limit and demonstrates that MEMP releases for 1997 were well below allowable release levels.

The NESHAPs also define sampling and monitoring techniques which apply to stacks and vents that release radioactive materials. In July 1992, MEMP submitted to the U. S. EPA, Region 5, a proposed compliance schedule to bring MEMP's effluent sampling and monitoring practices into full compliance with the requirements of 40 CFR 61, Subpart H. Discussions between the U.S. EPA and DOE subsequently led to a Federal Facility Compliance Agreement (FFCA). The FFCA was signed July 7, 1994, between U. S. EPA Region 5 and DOE. The FFCA stipulates specific actions and deadlines for achieving compliance with NESHAPs requirements. Stack monitoring upgrades bringing MEMP into compliance with NESHAPs requirements were completed December 31, 1997, as agreed in the FFCA.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (FWPCA) of 1972 was established to limit the types and rates of liquid effluents that may be discharged to the nation's waters. These limits are set for a specific site by the U. S. and/or state EPA using a National Pollutant Discharge Elimination System (NPDES) permit. An NPDES permit is also used to maintain compliance with more recent legislation, the Clean Water Act (CWA) of 1987.

Ohio EPA renewed the site's NPDES permit on November 1, 1997. The permit defines discharge limits and monitoring frequencies for the site's water effluents. NPDES permit limitations were exceeded eleven times during 1997. Exceedances were reported to the Ohio EPA and prompt corrective actions were taken following each incident. A violation notice was issued by OEPA for two copper exceedances reported in January 1997. Violation notices were also issued for exceedances reported in October and December 1996. No enforcement actions were initiated in 1997.

In July 1997, the Ohio EPA issued an Authorization to Discharge (ATD) for the CERCLA OU 1 groundwater remediation process. One element of this process involves the continuous pumping of groundwater from a series of extraction wells to prevent migration of volatile organic compounds (VOCs) into the aquifer. The ATD serves as an NPDES permit for wastewater discharged as a result of this CERCLA action, specifying discharge limits and monitoring frequencies. During 1997, no exceedances of ATD discharge limitations occurred.

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (SDWA) of 1974 required the U. S. EPA to establish a program to protect drinking water sources. To meet this goal, the EPA developed National Primary and Secondary Drinking Water Standards. These standards are applied to drinking water supplies "at the tap." Since the site withdraws well water for use as drinking water, MEMP is subject to the requirements of the Act.

In Ohio, the SDWA is administered by the Ohio EPA. In accordance with Ohio EPA requirements, the site's drinking water system is routinely tested for various compounds. These analyses must be performed by a state-certified laboratory. In 1997, National Environmental Testing, Inc. (NET) performed the following analyses: total coliform, lead, copper, nitrate, synthetic and volatile organic chemicals, radium, gross alpha and beta, and tritium. Except for copper and lead, there were no exceedances for these compounds. The action levels for copper and lead were exceeded during semi-annual sampling. Consequently, MEMP has implemented a corrosion control program designed to reduce copper and lead levels in drinking water.

Under the Ohio EPA's SDWA authority, MEMP is also required to maintain a minimum chlorination level of 0.2 mg/L free chlorine (or 1.0 mg/L combined chlorine) in the site's potable water system. This standard applies throughout the distribution system.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, established a "cradle to grave" tracking system for hazardous wastes. The Acts led to the implementation of registration and/or permit requirements for all facilities that transport, generate, treat, store, and/or dispose of hazardous wastes. The Ohio EPA administers this program for the State of Ohio.

BWO operates two hazardous waste storage units; one is used for hazardous wastes and the other is used for mixed wastes, i.e., radioactive wastes that are also regulated by RCRA. The storage units are operated in accordance with a RCRA Part B permit issued by the Ohio EPA in October 1996. Six energetic materials storage/treatment units, collectively known as the "burn area," are no longer essential for MEMP's mission and are undergoing the final stages of RCRA closure.

Hazardous wastes stored onsite are managed pursuant to RCRA requirements with respect to waste characterization, labeling, storage container integrity, facility performance criteria, and emergency response preparedness. These wastes are shipped offsite for approved treatment and/or disposal.

In 1997, 85,010 pounds of hazardous and other regulated wastes were shipped offsite. Of that amount, 18,756 pounds were RCRA-regulated wastes, 18,899 pounds were asbestos and PCB wastes, and 47,355 pounds were other wastes not suitable for sanitary landfilling.

It is the policy of DOE that hazardous wastes originating in Radioactive Material Management Areas (RMMAs) be treated as "suspect" mixed wastes, (i.e., suspected of being radioactively contaminated). This precaution is necessary to ensure that hazardous waste management facilities do not receive radioactive wastes unless they are equipped and licensed to do so. As a result of this policy, BWO has implemented procedures that assure waste sent to commercial treatment/storage/disposal facilities is not radioactively contaminated.

Nonhazardous solid wastes generated by BWO are disposed of in a licensed, permitted sanitary landfill. The volume of materials requiring landfill disposal has been reduced as a result of recycling programs for paper, glass, and scrap metal.

Federal Facility Compliance Act (FFCAct)

The Federal Facility Compliance Act (FFCAct) was signed into law on October 6, 1992. The FFCAct requires that all DOE facilities prepare an inventory of mixed wastes and mixed waste treatment capabilities. In accordance with the Act, a Conceptual Site Treatment Plan was submitted to the Ohio EPA in October of 1993. Following discussions with the Ohio EPA and public stakeholders, the Conceptual Site Treatment Plan was revised and a *Draft Site Treatment Plan* was submitted to the Ohio EPA in August, 1994. The final *Site Treatment Plan* (STP) was submitted to DOE in March, 1995 and a Director's Findings and Orders (DF&O) was signed on October 4, 1995. The DF&O establishes schedules and treatment technologies for DOE's mixed waste. The STP is updated annually at a minimum.

BWO continued to reduce the volume of onsite legacy mixed waste in 1997. Fifty-two drums filled with scintillation cocktail vials and ten drums filled of containerized samples were shipped to a commercial facility for treatment. Lead shapes in drums and welded steel boxes were shipped to a commercial facility for decontamination and disposal. Disposal/treatment options for the following "newly discovered" waste streams are under evaluation: gold cyanide, cotter concentrate, tributyl phosphates, oil-contaminated absorbent material, and scintillation cocktail-contaminated refuse.

Toxic Substances Control Act (TSCA)

The goal of the Toxic Substances Control Act (TSCA) of 1976 is to protect human health and the environment from unreasonable risks associated with toxic chemical substances. The Act gave the U. S. EPA authority to govern the manufacture and use of chemicals deemed to present significant toxicity risks. MEMP activities do not generate TSCA waste streams on a regular basis. However, efforts continue to remove TSCA wastes associated with past practices. The two primary components of this category of waste are polychlorinated biphenyls (PCBs) and asbestos. In 1997, 18,899 pounds of asbestos and PCB wastes were shipped offsite for disposal.

Polychlorinated Biphenyl (PCB)-contaminated materials that are not suspected of being radioactively contaminated are stored onsite pending their shipment to an EPA-approved facility for disposal. "Suspect" PCB wastes (those wastes originating in RMMAs) are retained onsite for waste characterization. Radioactively contaminated PCB wastes are also retained onsite. Disposal options are currently being explored for PCB-contaminated mixed waste.

The use of asbestos in pipes, panels, and as an additive to diallyl phthalate in parts production has been discontinued. Residual asbestos is handled, packaged, and shipped offsite to an approved disposal facility in compliance with TSCA regulations. In 1997, asbestos removal projects associated with building renovation, maintenance, and demolition activities continued. All such projects are carefully monitored by the Industrial Safety & Hygiene Group to ensure compliance with TSCA and BWO's Safety and Hygiene Manual.

Emergency Planning and Community Right-to-Know Act (SARA Title III)

The reauthorization of CERCLA came in 1986 in the form of the Superfund Amendments and Reauthorization Act (SARA). The Emergency Planning and Community Right-to-Know portion of that legislation is found in Title III of the Act. SARA Title III, Section 312, requires that sites handling "extremely hazardous" and "hazardous" substances notify regional emergency planning agencies. In compliance with the Act, MEMP annually reports hazardous chemical inventory data to the State Emergency Response Commission, the Montgomery/Greene County Information Coordinator, and the City of Miamisburg Fire Department. The inventory information is accompanied by maps showing the specific locations of the chemicals. In 1997, BWO used and/or stored two "extremely hazardous" and seven "hazardous" chemicals in excess of reporting thresholds.

SARA Title III, Section 313 mandates the annual submission of a Toxic Chemical Release Inventory report for sites which manufacture, process, or otherwise use toxic chemicals in quantities greater than specified thresholds. In 1997, BWO used quantities of one toxic chemical, ethylene glycol, in excess of the reporting threshold. Ethylene glycol is used in site utility systems.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) of 1969 was established to ensure that consideration is given to the potential environmental impact of federal actions prior to the irretrievable commitment of resources. DOE has formalized its approach to NEPA by enacting regulations (10 CFR 1021). BWO has also formalized its approach by developing internal NEPA guidance documents. In 1997, NEPA documents were prepared for routine maintenance activities.

Endangered Species Act (ESA)

Provisions of the Endangered Species Act (ESA) of 1973, as amended, prohibit federal departments such as the DOE from carrying out projects that would destroy or modify a habitat deemed critical to the survival of an endangered or threatened species.

MEMP has performed a number of surveys for threatened or endangered species. Two potential ESA compliance issues have been noted. First, an endangered plant species, the Inland rush (*Juncus interior*), and an endangered bird species, the Dark-eyed junco (*Junco hyemalis*), have been observed onsite. Both species are listed on the State of Ohio Endangered Species list. Because only one individual of inland rush was located, it is not considered a viable breeding population at the site. The dark-eyed junco, despite being a common winter visitor to Ohio, is not known to breed in southwestern Ohio. Secondly, it has been determined that the site is in the habitat range of the federally endangered species of Indiana Bat (*Myotis sodalis*). Consultations with the U.S. Fish and Wildlife Service and the Dayton Museum of Natural History, indicate that the site does not provide a suitable habitat for the Indiana bat and no Indiana bats have been observed onsite.

Neither the solitary sitings of the rush and the junco, nor the potential habitat for the Indiana bat, are expected to affect ongoing or future activities at the site.

National Historic Preservation Act (NHPA)

The National Historic Preservation Act (NHPA) of 1966, as amended, made the preservation of historic, architectural, and archeological resources a national policy. Consistent with this policy, the federal government requires that programs it funds or licenses in the State of Ohio be reviewed by the State Historic Preservation Office to determine what effects, if any, the activities will have upon such resources. Two studies were conducted to evaluate non-building archeological resources on the MEMP site. These studies concluded that no significant archeological resources are located on the site. The Ohio Historical Society concurred with these conclusions. An evaluation of buildings and structures for architectural and cultural significance is in progress.

Executive Order 11988, "Floodplain Management"

A narrow area along the southwestern border of the site lies within the 100-year floodplain. This area is primarily located within the undeveloped portion of the site and does not significantly affect project activities.

Executive Order 11990, "Protection of Wetlands"

CERCLA ecological assessments have identified small wetland regions within and around the site. MEMP activities are planned to limit adverse impacts to these regions. During 1997, an isolated wetland was backfilled to allow for construction of a waste consolidation facility. The affected wetland was less than 0.04 acres in size. The activity was performed under Nationwide General Permit Number 26 and the corresponding Ohio EPA Section 401 Water Quality Certification.

Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements"

Executive Order 12856 mandates compliance with EPCRA (SARA Title III) reporting requirements for all federal facilities. In 1997, MEMP submitted SARA Title III Section 312 and 313 reports for chemicals used and/or stored during calendar year 1996. Data for 1997 will be reported in 1998 as specified by EPCRA.

The pollution prevention and waste minimization focus has shifted from routine operations to environmental restoration. Accomplishments in 1997 include the transfer of new, unused chemicals to local educational facilities, collection of ferrous and non-ferrous metals for recycling, and recycling of white recyclable paper and toner cartridges.

2.2 Other Key Environmental Compliance Issues

Major External Environmental Audits in 1997

Ohio EPA RCRA inspection. The annual unannounced RCRA inspection by the Ohio EPA was conducted in March of 1997. The inspection focused on RCRA compliance issues. No noncompliances were identified.

DOE/NVO audit. In March of 1997, a Nevada Operations Office (DOE/NVO) audit team performed a table-top audit of waste streams destined for disposal at the Nevada Test Site. The audit resulted in the site receiving continued approval to ship low-level radioactive waste.

Ohio EPA NPDES permit compliance inspection. The Ohio EPA conducted an NPDES permit compliance evaluation on July 18, 1997. All areas rated were judged to be satisfactory.

Ohio EPA Safe Drinking Water Act inspection. In May of 1997, the Ohio EPA conducted its tri-annual potable water survey of the site. The inspection focused on site drinking water quality control and monitoring programs. The inspection report include positive observations about employee education initiatives. Physical improvements to the water towers and reporting clarifications were recommended.

Continuing Litigation

A class action lawsuit was filed against the Monsanto Research Corporation (MRC) and EG&G Mound Applied Technologies (EG&G) on December 5, 1991. The lawsuit asserts that MRC and EG&G, former site operators, "engaged in a continuous course of negligent...and unlawful conduct resulting in...repeated discharges of both radioactive and nonradioactive hazardous substances...into the environment surrounding the facility." The lawsuit further asserts that these actions were "concealed from the plaintiffs." EG&G and Monsanto continue to vigorously defend the litigation.

Release data for the site have been published each year in publicly distributed documents such as this report. The release data demonstrate the efforts taken by MEMP to ensure that all activities are conducted within applicable regulatory requirements and guidelines. Any individual who desires more information about operations at the site is encouraged to contact DOE's Public Relations Office.

2.3 Summary of Permits

BWO operates in compliance with eighteen state air permits. Ten additional sources of air emissions are on registration status with the State of Ohio. Water releases from the site are governed by an NPDES permit and an Authorization to Discharge. Hazardous waste activities are governed by a RCRA Part B permit.

3.0 ENVIRONMENTAL PROGRAM INFORMATION

The principal objective of MEMP environmental monitoring programs is to ensure that any threat to human health or the environment is promptly detected and mitigated. It is MEMP policy that meeting this goal be viewed as a minimum standard of practice; better performance should always be pursued. The philosophy is evident in the extent and scope of MEMP's effluent and environmental monitoring programs. It is also supported by MEMP's commitment to successful programs in the areas of:

- ALARA (As Low As Reasonably Achievable),
- Regulatory compliance,
- Waste minimization and pollution prevention,
- Environmental restoration.

3.1 Environmental Monitoring Program

The MEMP environmental monitoring program (EG&G, 1997) generates data on surface water, groundwater, sediment, foodstuffs, and air. These media are pathways for migration of hazardous materials from the site to the public. The monitoring program includes effluent monitoring, environmental surveillance, and meteorological monitoring. Effluent monitoring focuses on releases from the site, i.e., stack and wastewater discharges. The environmental surveillance program focuses on environmental conditions in the area surrounding the site and in local communities.

3.2 Effluent Monitoring

Air Emissions

Stacks through which radioactive materials are released are sampled continuously for tritium and/or particulate radionuclides. These samples are collected to demonstrate compliance with radionuclide NESHAPs regulations and to provide early warning of abnormal emissions so that timely corrective actions can be undertaken. An outline of the routine stack radionuclide sampling program is shown in Table 3-1. The stacks are also equipped with real-time monitors that operate continuously. Samples may be collected at any time if one of the real-time monitors should alarm. MEMP also releases very small quantities of nonradiological constituents into the atmosphere. Annual nonradiological emission rates are calculated using a material balance approach. The releases are governed by State of Ohio EPA permits and regulations.

Table 3-1. Effluent Monitoring at MEMP

	Parameter Measured[a]	No. of Sampling Locations	Collection Frequency
Air Emissions			
	HT, HTO	9	Weekly
	^{238}Pu, $^{239,240}Pu$	7	Weekly
	$^{233,234}U$, ^{238}U	4	Weekly
Water Effluents			
	Flow rate	5	Daily
		1	When well is pumped
	HTO	4	Daily
	^{238}Pu, $^{239,240}Pu$	4	Daily
	$^{233,234}U$, ^{238}U	4	Daily
	^{228}Th, ^{230}Th, ^{232}Th	4	Daily
	pH	1	Daily
		3	Weekly
		1	1/2 Weeks
		1	When well is pumped
	Chlorine	1	Daily
	Dissolved oxygen	1	Weekly
	Dissolved solids	1	1/2 Weeks
	Suspended solids	1	2/Week
		2	Weekly
		1	1/2 Weeks
	COD	1	Weekly
	$CBOD_5$	1	2/Week
		1	Monthly
	Fecal coliform	1	Weekly
	Ammonia	1	1/2 Weeks
	Oil and grease	1	Monthly
		1	Quarterly

[a] HTO = Tritium oxide
HT = Elemental tritium
Pu = Plutonium
U = Uranium
Th = Thorium
$CBOD_5$ = Five day carbonaceous biochemical oxygen demand
COD = Chemical oxygen demand

Table 3-1. (continued)

	Parameter Measured[a]	No. of Sampling Locations	Collection Frequency
Water Effluents			
	Free cyanide	1	Monthly
	Cadmium	2	Monthly
	Chromium	1	Weekly
		2	Monthly
	Copper	1	Weekly
		2	Monthly
	Lead	1	1/2 Weeks
		2	Monthly
	Mercury	1	Weekly
	Nickel	1	1/2 Weeks
		2	Monthly
	Selenium	1	Monthly
	Silver	1	Monthly
	Zinc	1	1/2 Weeks
		2	Monthly
	VOCs	1	Monthly
		1	Quarterly
		1	When well is pumped
	Toxicity testing		
	Ceriodaphnia duaia		
	acute	1	1/2 months
	chronic	1	1/2 months
	Pimephales promelas		
	acute	1	1/2 months
	chronic	1	1/2 months

[a] VOC = Volatile organic compound

Water Releases

Water released from the site is also sampled continuously at the discharge points. Effluents include process wastewater, sewage water, and storm water. The focus for monitoring of water releases is on nonradiological parameters. Extensive sampling and analysis is required to demonstrate compliance with the site's National Pollutant Discharge Elimination System (NPDES) permit and the Operable Unit 1 Authorization to Discharge (ATD). An outline of the effluent water sampling program is also shown in Table 3-1.

3.3 Environmental Surveillance

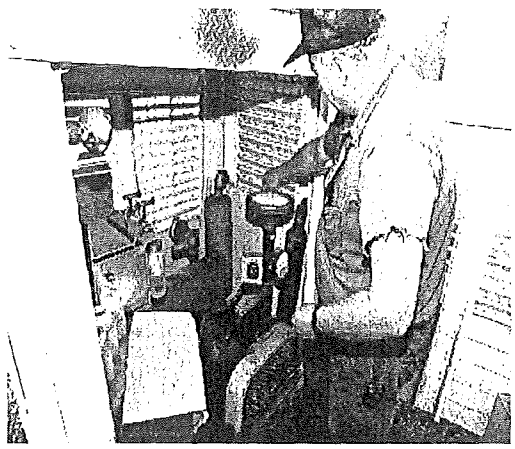
MEMP maintains an extensive environmental surveillance program designed to evaluate potential impacts from the site on human health and the environment. The environmental surveillance program involves sample collection and analysis of ambient air, regional water supplies, sediments, onsite and offsite groundwater, and foodstuffs. This program complements the effluent monitoring program which focuses on releases from the site, i.e., stack and water discharges. An outline of the environmental surveillance program is shown in Table 3-2.

Radionuclides of Concern

The principal radionuclides of concern at MEMP are tritium and plutonium-238; no other radionuclides contribute significantly to the dose estimates for the site (see Appendix E). Small quantities of other radionuclides, however, have been used at the site. Where there is a strong probability of detecting such radionuclides in the environment, they have been added to the appropriate sampling schedule. The primary example is uranium. Because U-233,234 is a decay product of Pu-238, U-233,234 is a part of MEMP's routine environmental monitoring program. MEMP analyzes drinking water and river water samples to monitor the ingrowth of U-233,234. No significant concentrations have been encountered. Radioisotopes of thorium were also used historically in MEMP operations. To ensure that no significant dose impact from thorium is occurring, periodic monitoring is performed. These data show that thorium concentrations are at or very near environmental levels.

Ambient Air

MEMP maintains a network of ambient air surveillance stations to monitor the impact of airborne radiological emissions on the local and regional environments. The network includes both onsite and offsite stations. The number and placement of offsite stations is based on the population distribution and the prevailing winds.



Collection of Ambient Air Samples

Surface Water and Sediment

The Great Miami River and other regional surface water locations are sampled routinely for radionuclides. Since plutonium and thorium in river water tends to accumulate in sediments, sediment samples are collected from these locations and analyzed for isotopes of these radionuclides.

Table 3-2. Environmental Surveillance at MEMP

Environmental Medium	Parameter Measured[a]	No. of Sampling Locations[b]	Collection Frequency
Onsite			
Ambient air	HTO	7	Weekly
	^{238}Pu, $^{239,240}Pu$	7	Weekly
	^{228}Th, ^{230}Th, ^{232}Th	4	Weekly
	Particulates	7	Weekly
Drinking water	HTO	3	Weekly
	^{238}Pu, $^{239,240}Pu$	3	Monthly
	$^{233,234}U$, ^{238}U	3	Monthly
	^{228}Th, ^{230}Th, ^{232}Th	3	Quarterly
	Radium	5	Annually
	Gross Alpha	5	Annually
	Gross Beta	5	Annually
	VOCs	5	Quarterly
	Nitrate	5	Annually
	Lead and Copper	20	Semi-annually
	Total coliform	2	Monthly
Groundwater	HTO	34	c
	^{238}Pu, $^{239,240}Pu$	6	c
	$^{233,234}U$, ^{238}U	6	c
	^{228}Th, ^{230}Th, ^{232}Th	6	c
	VOCs	35	c
	Inorganics	12	c

[a] HTO = Tritium oxide
Pu = Plutonium
U = Uranium
Th = Thorium
VOC = Volatile organic compound
[b] Includes background location when applicable
[c] Sample collection frequency varies

Table 3-2. (continued)

Environmental Medium	Parameter Measured[a]	No. of Sampling Locations[b]	Collection Frequency
Offsite			
Ambient air	HTO	15	Weekly
	^{238}Pu, $^{239,240}Pu$	15	Weekly
	^{228}Th, ^{230}Th, ^{232}Th	2	Weekly
	Particulates	15	Weekly
River/stream water	HTO	7	Monthly
	^{238}Pu, $^{239,240}Pu$	6	Monthly
	$^{233,234}U$, ^{238}U	6	Monthly
	^{228}Th, ^{230}Th, ^{232}Th	6	Annually
River/stream sediment	^{238}Pu, $^{239,240}Pu$	7	Quarterly
	^{228}Th, ^{230}Th, ^{232}Th	7	Quarterly
Pond water	HTO	7	Annually
	^{238}Pu, $^{239,240}Pu$	7	Annually
Pond sediment	^{238}Pu, $^{239,240}Pu$	7	Annually
	^{228}Th, ^{230}Th, ^{232}Th	7	Annually
Drinking water	HTO	8	Monthly
	^{238}Pu, $^{239,240}Pu$	2	Monthly
	$^{233,234}U$, ^{238}U	2	Monthly
Groundwater	HTO	13	c
	^{238}Pu, $^{239,240}Pu$	6	c
	$^{233,234}U$, ^{238}U	6	c
	^{228}Th, ^{230}Th, ^{232}Th	6	c
	VOCs	11	c
	Inorganics	11	c
Foodstuffs	HTO	11	Annually
	^{238}Pu, $^{239,240}Pu$	5	Annually

[a] HTO = Tritium oxide
Pu = Plutonium
U = Uranium
Th = Thorium
VOC = volatile organic compound
[b] Includes background location when applicable
[c] Sample collection frequency varies

Foodstuffs

Various locally-grown vegetables are collected and analyzed to determine whether radionuclides of MEMP origin are contributing a dose via the ingestion exposure pathway. Root crops such as potatoes are analyzed since the roots may come into long-term contact with subsurface plutonium. Tomato samples, conversely, are of use due to their high water content making them excellent indicators of tritium uptake. Although aquatic biota are no longer part of MEMP's routine environmental surveillance program, one fish sampling event was conducted in 1997 in a joint exercise with the Ohio EPA.

Groundwater

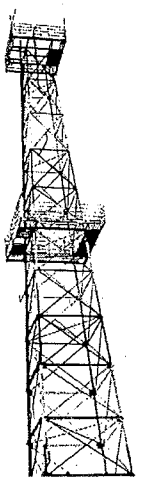
MEMP maintains an extensive groundwater monitoring network designed to provide information on the impact of site activities on local and regional groundwater. Groundwater samples are collected from onsite and offsite monitoring wells, onsite and offsite production wells, private wells, and regional community water supplies. Samples are analyzed for radionuclides, volatile organic compounds (VOCs), and inorganic parameters.

Environmental Levels

To evaluate MEMP's impact on the environment, it is necessary to establish background or baseline levels of contaminants in a variety of media. MEMP accomplishes this task by collecting samples at locations where the impact from site discharges is not observable. These locations are usually in a direction upwind and at a distance too great to be impacted by the site. Concentrations measured at these reference locations are referred to as "environmental levels" in this Report.

3.4 Meteorological Monitoring

Meteorological monitoring provides information on weather conditions that can be used to forecast atmospheric dispersion following planned or unplanned releases of airborne material. Atmospheric dispersion is a function of wind speed, wind direction and atmospheric stability. Atmospheric stability determinations are made by estimating the amount of atmospheric turbulence in the lateral wind direction using a bi-directional wind vane. The parameters which characterize dispersion (wind speed, wind direction and atmospheric stability) are closely monitored at the site with the aid of two meteorological towers.



50-meter meteorological tower

3.5 Effluent Treatment and Waste Management

Effluent Treatment

Air. High efficiency particulate air (HEPA) filters remove particulate radionuclides from process air emissions. Air effluents are filtered first at their point of origin (e.g., a glove box), and again just before reaching the release point (i.e., the stack or vent). The filtering system in place at each stack is composed of two banks of HEPA filters connected in series. Each filter bank has a nominal collection efficiency of 99.95% for 0.2-micron particles.

Tritium is not trapped by HEPA filters. A chemical process is used to recover tritium from waste gas streams.

Water. An onsite sanitary waste treatment plant manages all domestic wastewater generated at the site. Treatment is provided via an activated sludge process operated in the extended aeration mode. A continuous backwash sandfilter serves as tertiary treatment. The influent and effluent at the sewage treatment plant are monitored to ensure that radionuclides are not inadvertently discharged to the environment. All wastewater, after appropriate treatment and monitoring, is discharged to the Great Miami River. Digested sludge from the sanitary treatment plant is managed as Low Specific Activity (LSA) waste.

Waste Management

The waste management focus has shifted from support of routine operations to environmental restoration and disposition of legacy wastes. In 1997, 85,010 pounds of hazardous and other regulated wastes were shipped offsite. Of that amount, 18,756 pounds were RCRA-regulated wastes, 18,899 pounds were asbestos and PCB wastes, and 47,355 pounds were other wastes not suitable for sanitary landfilling.

Hazardous wastes. BWO operates two hazardous waste storage units; one is used for hazardous wastes and the other is used for mixed wastes, i.e., radioactive wastes that are also regulated by RCRA. The storage units are operated in accordance with a RCRA Part B permit issued by the Ohio EPA in October 1996. Six energetic materials storage/treatment units, collectively known as the "burn area," are no longer essential for MEMP's mission and are undergoing the final stages of RCRA closure.

Radioactive Wastes. MEMP currently has two disposal options for low-level radioactive wastes. The waste can be shipped to the Nevada Test Site (NTS) or to Envirocare, a commercial disposal facility. In 1997, 25 truck shipments (33,428 ft^3) of low-level waste were shipped to NTS and 612 railroad shipments (1,200,120 ft^3) of low-level waste were shipped to Envirocare. Much of the volume of waste shipped via rail to Envirocare was soil removed during restoration of the Miami-Erie Canal.

Mixed wastes. Hazardous wastes that are radioactively-contaminated are referred to as mixed wastes. These wastes are stored in a RCRA-permitted facility until treatment/disposal options have been evaluated. In 1997, BWO continued to reduce the volume of onsite legacy mixed waste. Containers of laboratory waste and lead shapes were shipped to commercial facilities for treatment and/or disposal and the evaluation of disposal/treatment options for "newly discovered" waste streams continued.

Nonhazardous solid wastes. Nonhazardous, nonradioactive solid wastes generated by BWO are disposed of in a licensed, permitted sanitary landfill.. The volume of materials requiring landfill disposal has been reduced as a result of recycling programs for paper, glass, and scrap metal.

3.6 Environmental Permits

MEMP activities are routinely measured against the compliance requirements of state air and state water permits. Additionally, the hazardous waste program operates pursuant to a RCRA Part B permit. Table 3-3 lists permits applicable to MEMP and BWO activities.

3.7 Waste Minimization and Pollution Prevention

BWO has established programs to reduce the volume and toxicity of hazardous, radioactive, mixed, and solid waste streams. These goals are accomplished by preventing waste generation, recycling, and reclamation. Programs include recycling of expended vehicle batteries, scrap metals, white recyclable paper, and toner cartridges. Recycling bins are also provided for aluminum cans which are accumulated and recycled by employees. In 1997, MEMP recycled over 40 tons of white paper, 390 toner cartridges, 2.6 tons of lead-acid batteries, and 88 tons of scrap metal. In addition, over 350 containers of new, unused chemicals were donated to local educational facilities and military bases.

3.8 Environmental Restoration

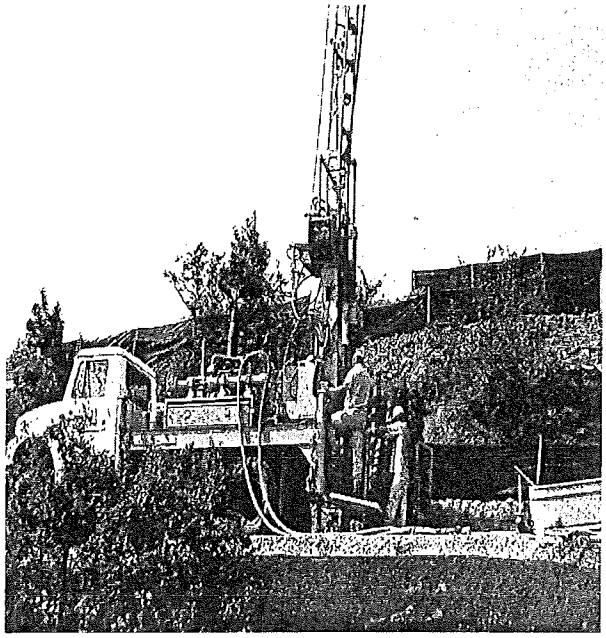
MEMP was added to the National Priorities List (NPL) in 1989. A Federal Facilities Agreement (FFA) between DOE and the U. S. EPA was signed in October of 1990. The FFA defines the responsibilities of each party for the completion of CERCLA-related activities. The FFA became a tri-party agreement on July 15, 1993, when Ohio EPA became a signatory.

Preliminary CERCLA (Superfund) assessments of contamination at the site identified approximately 125 locations of actual or suspected releases. These locations were grouped into nine "Operable Units", or OUs, based on waste type and/or geographical proximity. In 1995, the CERCLA process was reorganized to increase the efficiency of the environmental restoration effort. Key changes include the creation of a core team for decision-making, focused assessments of buildings and potential release sites (approximately 400 potential release sites have been identified), and reliance on removal actions to address environmental concerns. Highlights of the CERCLA program in 1997 are discussed in the following sections.

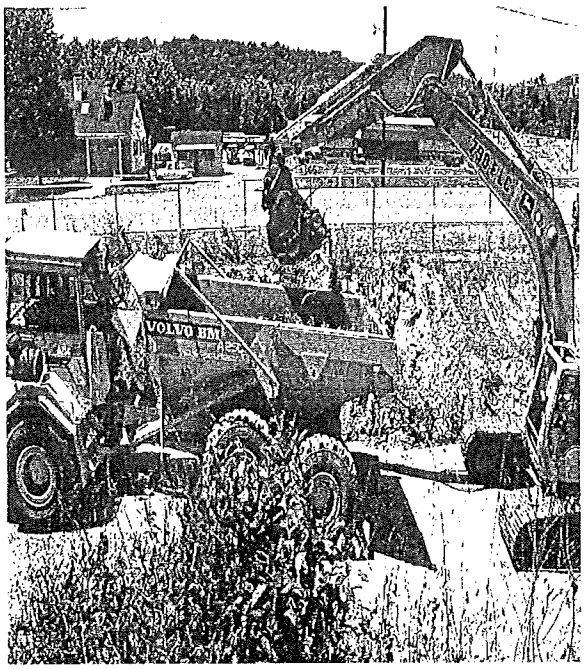
Table 3-3. Environmental Permits

Operation	Permit Type	Permit No.	Valid Through	Issuing Agency
10 Standby Power Diesel Generators	air	B009 - B018	12/28/98	Ohio EPA
SW/R Fumehoods	air	P012, P014, P015, P028 (registration)	permanent	Ohio EPA
WDA Stack	air	P029	8/25/98	Ohio EPA
Paint Spray Booth	air	K001	11/26/98	Ohio EPA
Wastewater Discharge (NPDES)	water	1IO00005*GD	3/31/02	Ohio EPA
Wastewater Discharge (OU1 ATD)	water	1IN90010*AD	permanent	Ohio EPA
E-Building	air	P008	10/22/99	Ohio EPA
Clay Extrusion System	air	P009	2/11/00	Ohio EPA
Clay Extrusion System (diesel generator)	air	B007	3/25/00	Ohio EPA
Roadways and Parking Lots	air	F001 (registration)	permanent	Ohio EPA
Underground Line Removal (diesel generator)	air	B008 (registration)	permanent	Ohio EPA
Gas Dispensing Facility	air	G001 (registration)	permanent	Ohio EPA
Open Burning (fire training)	air	Letter permit (registration)	permanent	Ohio EPA
Powerhouse Boiler 1 and Boiler 2	air	B001 B006 (registration)	permanent	Ohio EPA
Aggregate Storage Pile	air	F002	2/17/01	Ohio EPA
Fuel Oil Storage	air	T005	2/17/01	Ohio EPA
R/SW HEFS Stack	air	P030	1/24/00	Ohio EPA
Hazardous Waste Storage	RCRA operation	05-57-0677	10/18/01	Ohio EPA

OU 1 Treatment Systems. OU1 addresses volatile organic chemicals in the groundwater near the site's former solid waste landfill. A groundwater pump and treat system is utilized to prevent migration of VOCs into the aquifer. Groundwater is continuously pumped from a series of extraction wells and passed through an air stripper to reduce VOC concentrations before being discharged. Water discharges are governed by an ATD issued by the Ohio EPA in July 1997. In 1997, the system treated 43,456,236 gallons of water. An air sparge/soil vapor extraction system will be used to accelerate the removal of VOCs from the soil and groundwater. This system will inject air (air sparge) into the aquifer, then extract the soil vapor. Construction of the system was completed and testing began in December 1997. The system will be operational in 1998.



Operable Unit 1 Well Installation



Restoration of the Miami-Erie Canal

Miami-Erie Canal Project. The Miami-Erie Canal Project addresses contamination of the Miami-Erie Canal bed in Miamisburg. Plutonium contamination was introduced into the canal from a broken waste line and historic stormwater runoff. Tritium is also present in the canal from past MEMP operations. The tritium and plutonium have been monitored since the 1970s and have been found to present no imminent danger to human health or the environment. Sampling to confirm radionuclide concentrations and assess chemical contamination was completed in February 1993. In January 1994, a decision was made to perform a removal action. Cleanup of the canal was nearly complete by the end of 1997. Restoration of the landscape in and around the canal will be completed by May 1998.

CERCLA Groundwater Project. The FFA requires a study of the possible offsite environmental effects of any contamination attributable to MEMP. Results of these investigations are available in the CERCLA Public Reading Room. Routine monitoring of groundwater both onsite and offsite will continue while environmental restoration activities are in progress on the site.

Building 21. Building 21 became operational in 1996 for bulk storage of thorium sludge. During 1997, Building 21 was demolished and contaminated soil surrounding the building was excavated. Radioactive waste was packaged and shipped to Envirocare for disposal.

ATSDR Participation

It is a requirement of CERCLA that the ATSDR evaluate each site listed on the NPL. The Agency examines health data to seek out abnormal rates or types of illnesses. If any such problems are suspected, the Agency attempts to determine if a correlation exists between the illness and the site. Initial ATSDR findings for the site were published in October of 1993 as an ATSDR "Health Consultation." The consultation report indicated that plutonium-238 levels in the environment are not a public health hazard. For other constituents of concern, insufficient data were available to draw conclusions. Therefore, a key recommendation of the report was additional testing. ATSDR performed soil and air sampling during 1994. None of the measurements indicated that a public health hazard exists. In 1996, the ATSDR published a public health assessment. The assessment concluded that under current site conditions the site poses no apparent public health hazard to offsite populations. ATSDR will continue to monitor CERCLA-related activities at MEMP. ATSDR staff are frequent guest speakers at CERCLA public meetings. They may also be contacted directly at their Atlanta, Georgia offices.

3.9 Agreement-In-Principle

The Agreement-In-Principle, or AIP, represents an added dimension to the environmental monitoring programs in place at DOE facilities in the State of Ohio. The AIP was signed by the U. S. Department of Energy and the State of Ohio in 1993. The Agreement establishes the framework under which the State will provide oversight and monitoring activities at MEMP and the Fernald Environmental Management Project.

Under the AIP, various state agencies review DOE environmental monitoring (Ohio EPA and Ohio Department of Health) and emergency management (Ohio Emergency Management Agency) programs and perform independent monitoring and data collection. The Ohio EPA's primary mission is to ensure that cleanup activities at these sites adequately protect human health and the environment. Additional oversight by the Ohio EPA is applied to emergency response and public information programs in place at each site.

4.0 RADIOLOGICAL ENVIRONMENTAL PROGRAM INFORMATION

MEMP activities result in the discharge of radioactive effluents to the air and the Great Miami River. Release limits on these discharges have been established by DOE and the U. S. EPA. Releases are monitored using a network of stack and water sample collection devices. In addition, MEMP maintains an extensive environmental surveillance program to evaluate the impacts from site effluents on the environment. The environmental surveillance program involves the collection and analysis of air, water, sediment, groundwater, and foodstuff samples from locations onsite and in local communities. Data generated from those programs are presented in this Chapter.

4.1 Radionuclide Releases from MEMP

1997 Data

Table 4-1 lists the quantities of radionuclides released by MEMP into the air and water during 1997. The unit used to report these quantities is the curie (Ci), a unit of radioactivity equal to 3.7×10^{10} disintegrations per second. The quantities, or activities, shown in Table 4-1 were measured at the point of release. Information on effluent monitoring systems used to estimate release levels appears in Section 4.2 of this Chapter.

Table 4-1. Radiological Effluent Data for 1997

Radionuclide	Released to	Activity, Ci	DOE Range[b], Ci
Tritium	Air	802[a]	0 - 190,864
	Water	2.4	0 - 11,556
Plutonium-238	Air	0.000045	0 - 0.002
	Water	0.00045	0 - 0.01
Plutonium-239,240	Air	0.0000001	0 - 0.12
	Water	0.0000024	0 - 0.001
Radon-222	Air	1.36	Not typically measured
Uranium-233,234	Air	0.000000008	0 - 0.00005
	Water	0.00039	0 - 0.1
Uranium-238	Air	0.000000004	0 - 0.00006

[a] Tritium released to air consists of: Tritium oxide, 597 Ci
Elemental tritium, 205 Ci

[b] A range of annual release values reported by various DOE sites.

4.2 Effluent Monitoring Program

Effluent monitoring focuses on releases from the site, i.e., stack and water discharges. It is MEMP policy and philosophy that all releases of effluents from the site are ALARA, that is, As Low As Reasonably Achievable. Release trends are monitored and unexpected increases trigger internal investigations. Effluent air and water sampling locations are shown in Figure 4-1.

Applicable Standards

Guidelines for concentrations of radionuclides in air are provided in DOE Order 5400.5 (DOE, 1993a). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The guides for radionuclide concentrations are referred to as Derived Concentration Guides, or DCGs. The DCG for a radionuclide is defined as the concentration of that radionuclide in air or water which will result in a 50-year committed effective dose equivalent of 100 mrem (1 mSv) if taken into the body by inhalation or ingestion during one year of exposure. DCGs are included in Appendix A. In addition, the National Emission Standards for Hazardous Air Pollutants (NESHAPs) radionuclide regulations (40 CFR 61, Subpart H) limit offsite doses from airborne releases from DOE sites (excluding radon) to 10 mrem effective dose equivalent (EDE) per year.

Air Emissions

Stacks through which radionuclides are released are sampled continuously. MEMP monitors eleven stacks and roof vents for tritium and isotopes of plutonium and/or uranium. The average annual concentration of radionuclide air emission are shown in Appendix A, Table A-2. Figure 4-2 illustrates 5-year trends in releases of the radionuclides of primary interest, tritium and plutonium-238.

Tritium. In operational areas where a release potential exists, room air and exhaust stacks are continuously monitored for tritium using strategically placed ionization chambers. These monitoring systems incorporate alarms and have been placed to help to locate the source if a release should occur. In most situations, an effluent removal and containment system can be relied upon to prevent or reduce the release of tritium to the atmosphere.

Plutonium and Uranium. In operational areas where a release potential exists, ventilation air passes through a minimum of two HEPA filters before being discharged to the atmosphere. Fixed continuous air samplers and continuous air monitors with alarm systems are used throughout the operational areas to detect airborne plutonium and/or uranium. These monitoring systems have been designed to ensure that prompt corrective action can be taken to reduce the magnitude of releases to the atmosphere.

Radon. Though emission levels are negligible in comparison with natural radon emanation rates, a radon-222 release rate has been included in the 1997 effluent data (Table 4-1) in the interest of completeness. Radon-222 from natural sources, and from past operations involving radium-226, is continually released to the atmosphere via a small roof vent. The estimated dose contribution from radon, as predicted by CAP88-PC, was 0.002 mrem for 1997.

Figure 4-1. Effluent Air and Water Sampling Locations

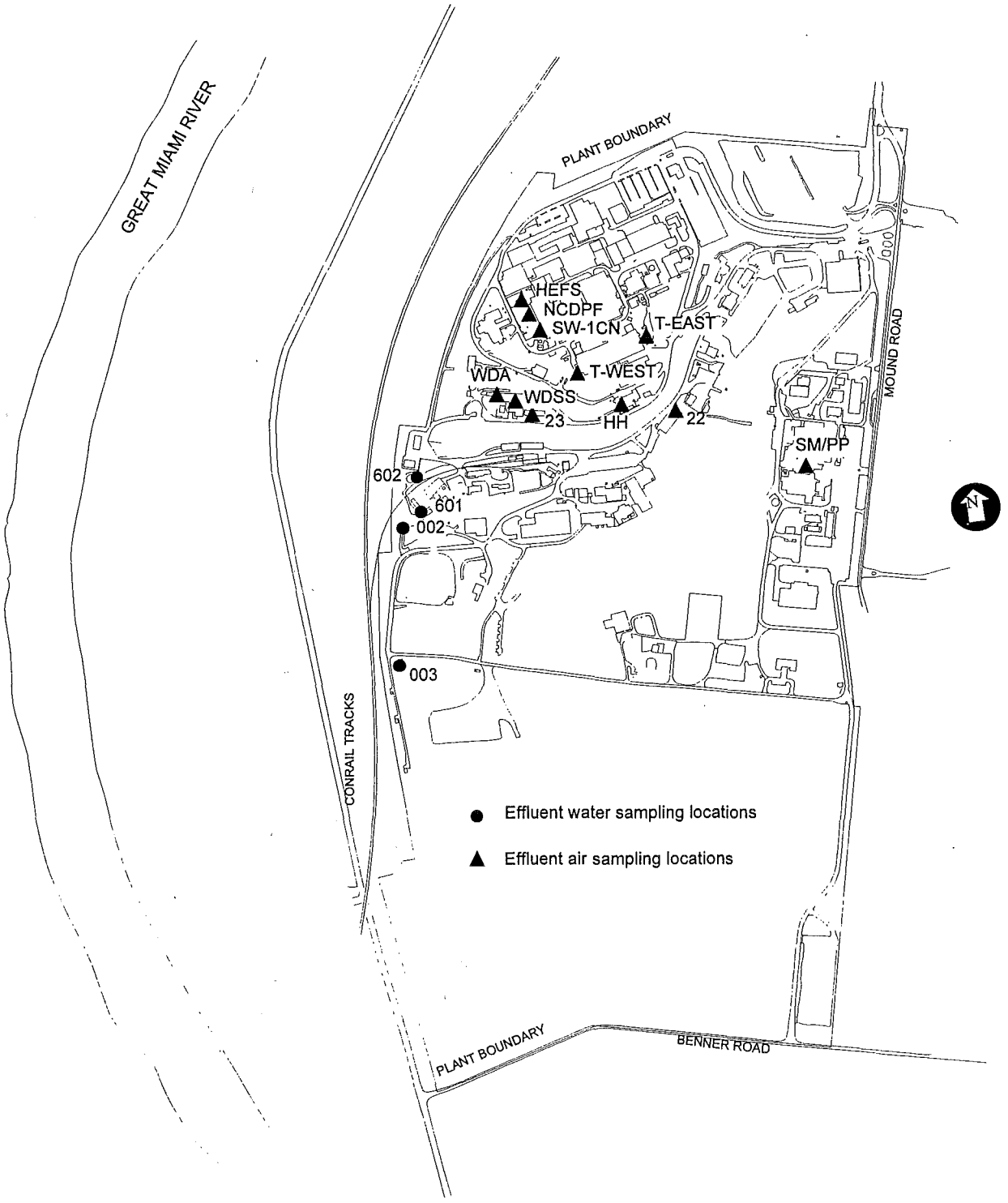
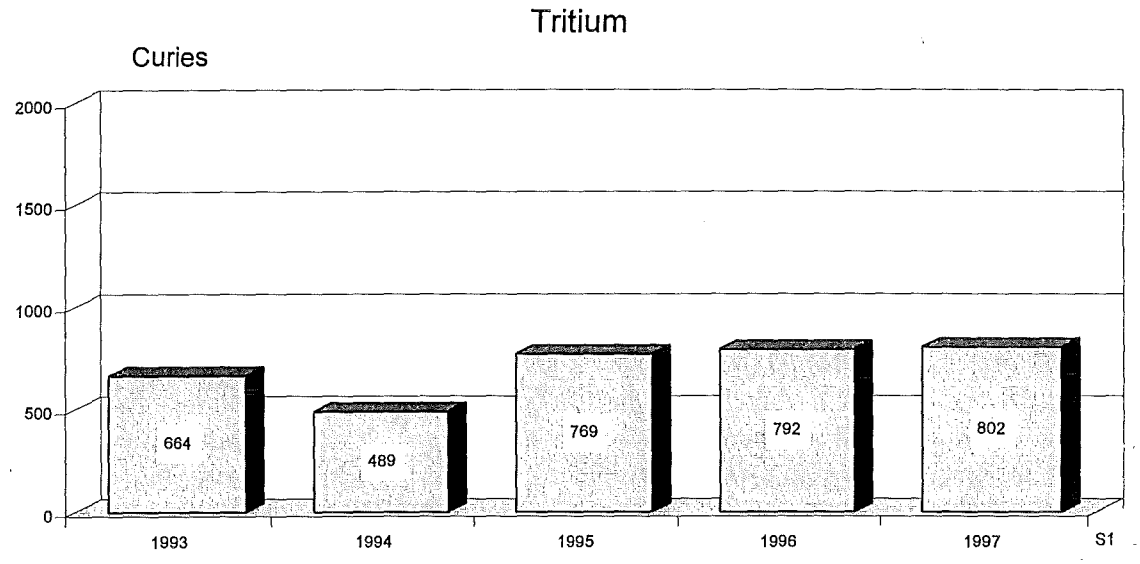
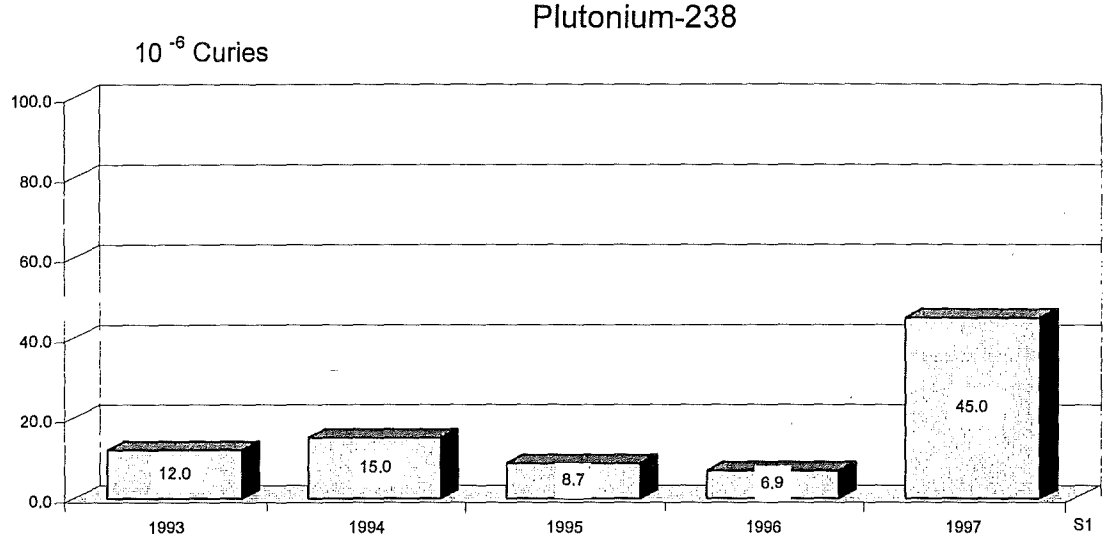


Figure 4-2. Tritium and Plutonium-238 Releases from MEMP to the Atmosphere, 1993 - 1997





Results for 1997

In 1997, the estimated maximum offsite dose from airborne releases of radionuclides was 0.05 mrem. This value represents 0.5% of the dose limit established by the EPA. Airborne emissions of plutonium-238 were elevated in 1997 relative to previous years. The increase was associated with construction activities at the SM/PP stack. Modifications were made to the monitoring system for this stack pursuant to a Federal Facility Compliance Agreement. Though release levels were higher, emissions remained well below regulatory thresholds and have since returned to nominal levels.

Water Releases

Sampling for radionuclides is not required by the NPDES permit; however flow-proportional samples collected from outfalls 601, 602, 002, and 003 (Figure 4-1) are analyzed for tritium and isotopes of plutonium, uranium, and thorium. Samples are collected daily during the work week. Three 24-hour samples are collected on Tuesdays, Wednesdays, and Thursdays. One 96-hour sample is collected each Monday. Samples are analyzed four times a week for tritium. Two-week composite samples are analyzed for isotopes of plutonium and uranium. The two-week composite samples are also analyzed quarterly for isotopes of thorium. Average concentrations of radionuclides in effluent waters are shown in Appendix A, Table A-3, Figure 4-3 illustrates 5-year trends in releases of the radionuclides of primary interest, tritium and plutonium-238 to the Great Miami River.

Figure 4-3. Tritium and Plutonium-238 Releases from MEMP to the Great Miami River, 1993 - 1997

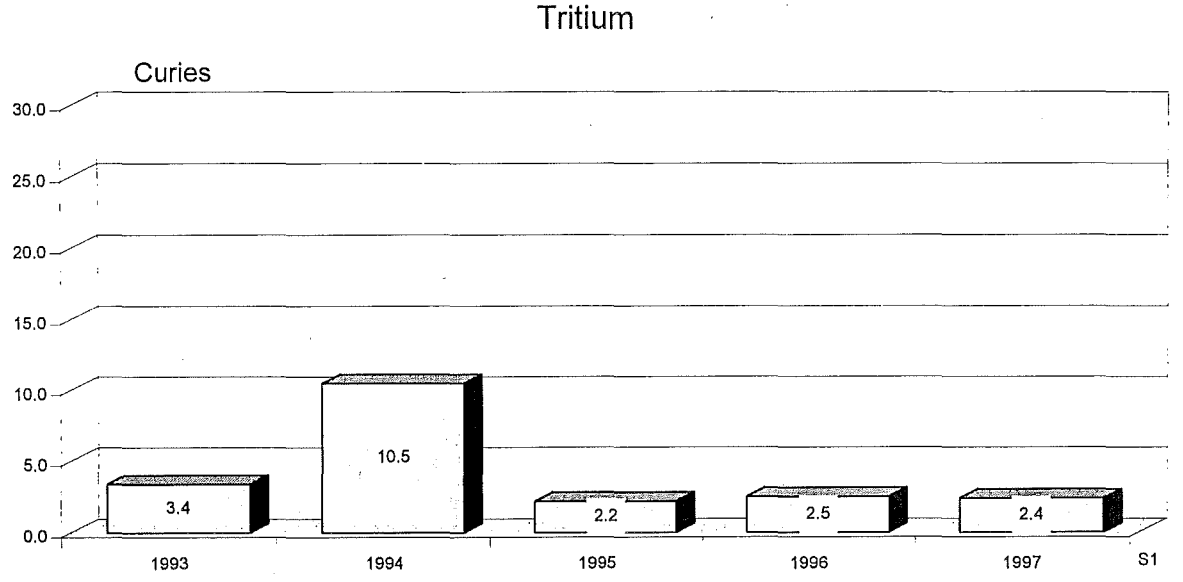
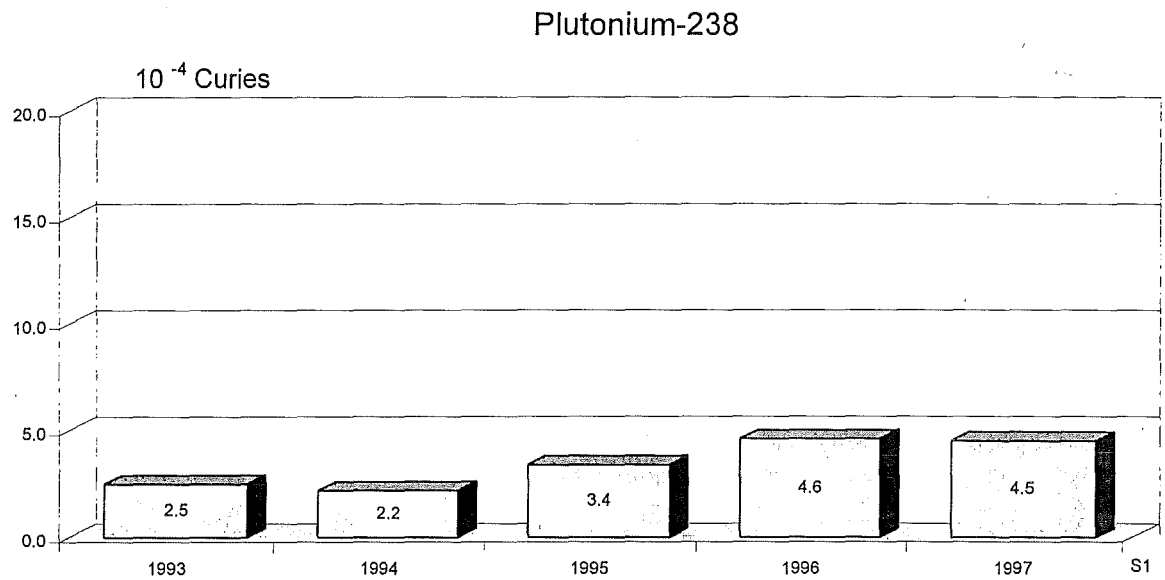


Figure 4-3. (continued)



Results for 1997

Radionuclide releases to water in 1997 were consistent with previous years. Concentrations of tritium averaged less than 0.17% of the DOE DCG. Plutonium and thorium releases remained less than 2.0% of the respective DCGs.

4.3 Environmental Occurrences

Under CERCLA, reportable quantity (RQ) levels have been established for radionuclides and other designated hazardous substances. If a spill or other inadvertent release to the environment exceeds the RQ, immediate notification of the appropriate federal agencies (e.g., National Response Center, EPA, or Coast Guard) is required. No such releases occurred at MEMP during 1997.

4.4 Environmental Surveillance

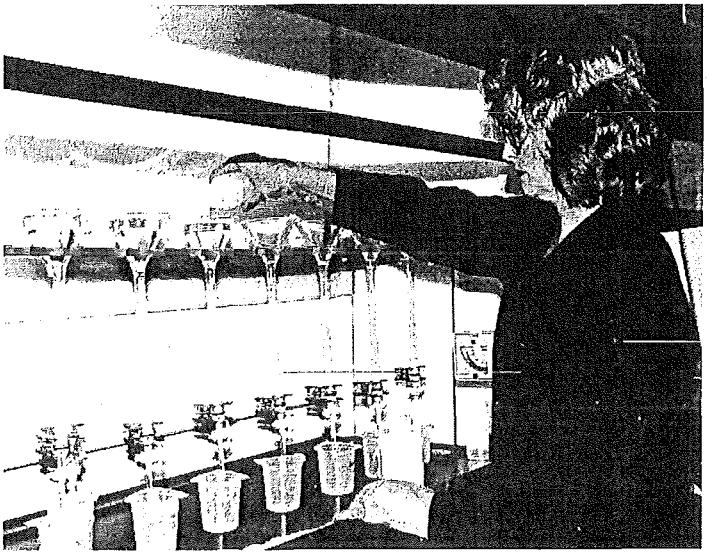
In the sections that follow, results of the Environmental Surveillance Program are summarized. The environmental surveillance program focuses on environmental conditions in the area surrounding the site and in local communities. Tables of monitoring results are presented in Appendix B.

Applicable Standards

Guidelines for concentrations of radionuclides in air and water are provided in DOE Order 5400.5 (DOE, 1993a). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The guides for radionuclide concentrations are referred to as Derived Concentration Guides, or DCGs. The DCG for a radionuclide is defined as the concentration of that radionuclide in air or water which will result in a 50-year committed effective dose equivalent of 100 mrem (1 mSv) if taken into the body by inhalation or ingestion following continuous exposure for one year. DCGs are included in Appendix B.

Environmental Concentrations

In a number of the tables, results are presented as "incremental concentrations." The designation indicates that an average background concentration, or "environmental" concentration, has been subtracted from those values. Therefore, incremental concentrations represent estimates of MEMP's contribution to the radionuclide content of an environmental sample.



Chemist analyzing samples for radionuclides

Environmental or reference locations were positioned at sites where virtually no impact from the site could be measured. The sites are in the least prevalent wind direction and/or are at substantial distances relative to the site. Environmental levels for radionuclides in different environment media are shown in Appendix B, Table B-1.

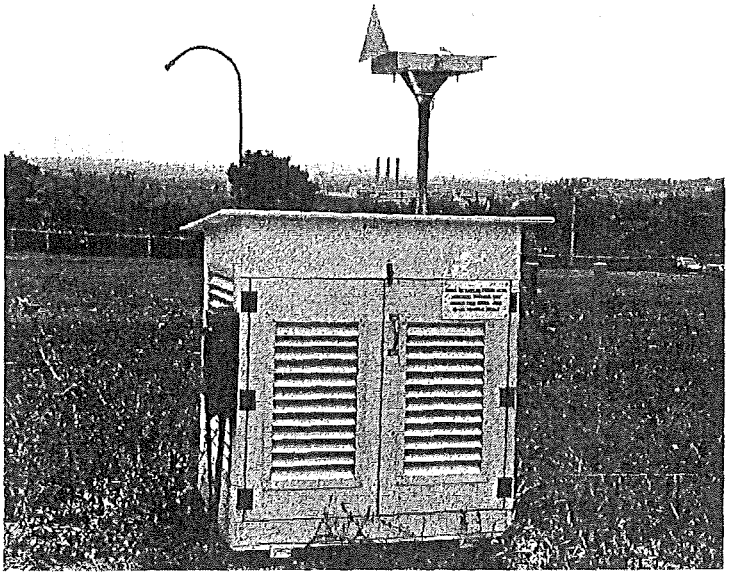
With decreasing release rates of radionuclides, it has become increasingly difficult to observe MEMP's contribution to radionuclide concentrations in the environment. For this reason, many of the tables in Appendix B report data as "below environmental levels." In those cases, it is not possible to observe an incremental concentration. In other words, the radionuclide concentration in the sample was equal to or less than the background sample.

Lower Detection Limit

All concentrations of radionuclides are determined by subtracting the instrument background and/or reagent blank from the sample count. The lower detection limit (LDL) is shown for each set of data in this Chapter. The LDL is the value at which the presence of a contaminant can be inferred at the 95% confidence level. An LDL is calculated from the instrument background or reagent blank results. Much of the radionuclide data in this report show concentrations that are below the LDL. Most of these data are incremental concentrations, i.e., the average environmental concentration has been subtracted from the result. Most of these data lie between true zero and the LDL level and are included for comparative purposes[1].

4.5 Ambient Air Sampling Program

Two types of air samples are collected at each sampling location. A particulate air sample is analyzed for plutonium-238 and plutonium-239,240. Samples from selected locations are also analyzed for thorium-228, thorium-230, and thorium-232. A second air sample, collected in a bubbler apparatus, is analyzed for tritium oxide. MEMP operates a network of 22 stations: seven onsite and 15 offsite. The locations of the stations are shown in Figures 4-4 and 4-5, respectively. Two stations were removed in 1997 (108 and 110). These stations were located in Dayton and Centerville and were removed because they were no longer needed.



Air Sampling Station

[1] The measured concentration may have exceeded the LDL, but when the environmental concentration was subtracted, it fell below the LDL. Data are reported if the concentration is below the LDL but exceeds the reagent blank or the instrument background level.

Figure 4-4. Onsite Ambient Air Sampling Locations

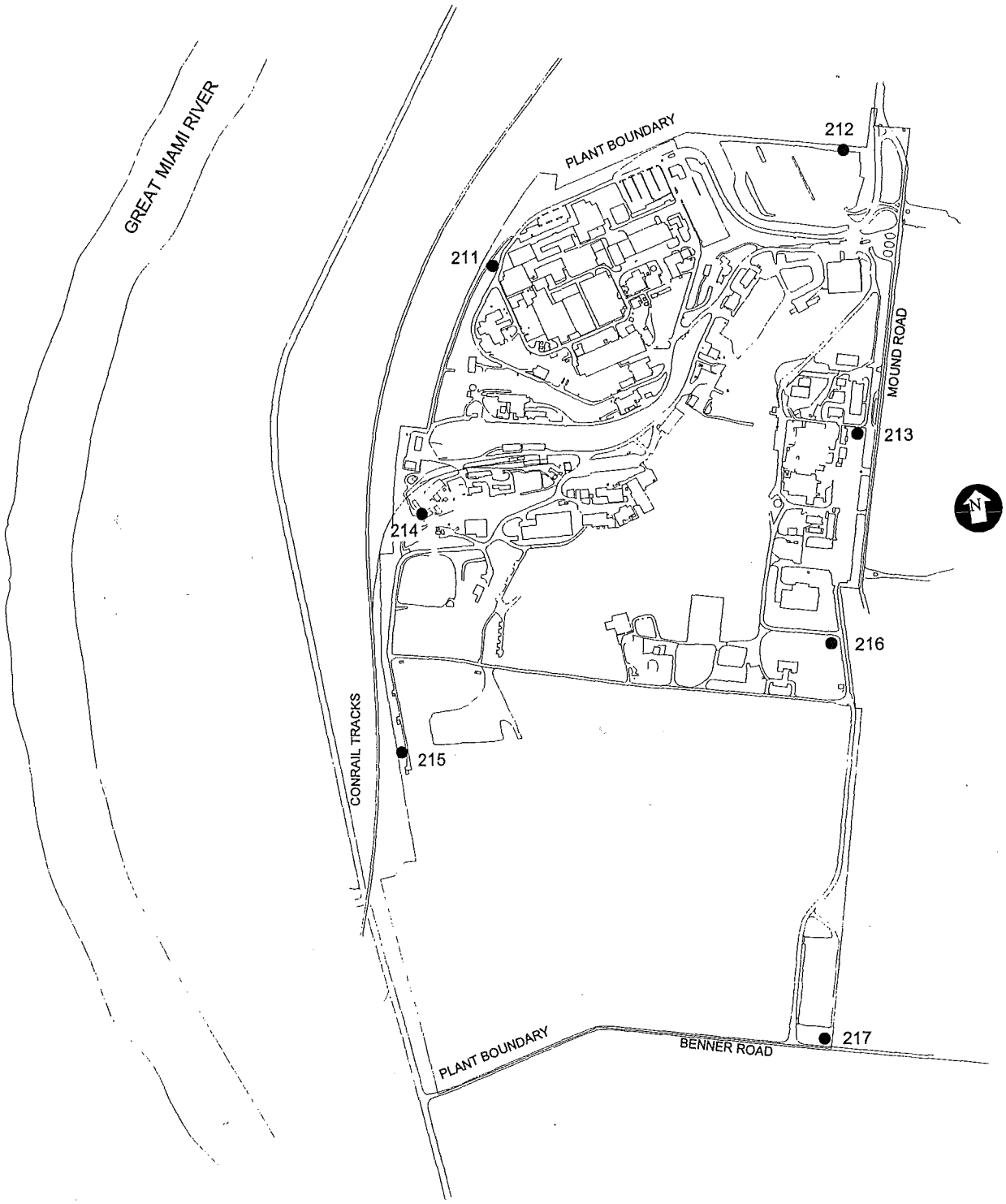
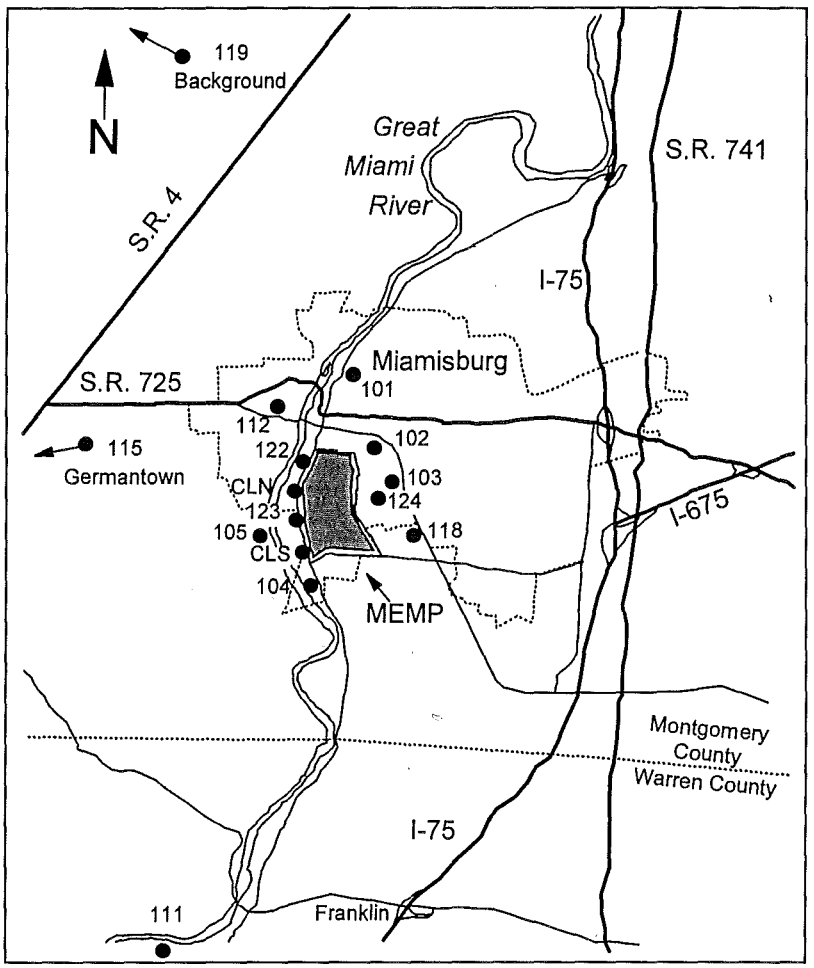


Figure 4-5. Offsite Ambient Air Sampling Locations



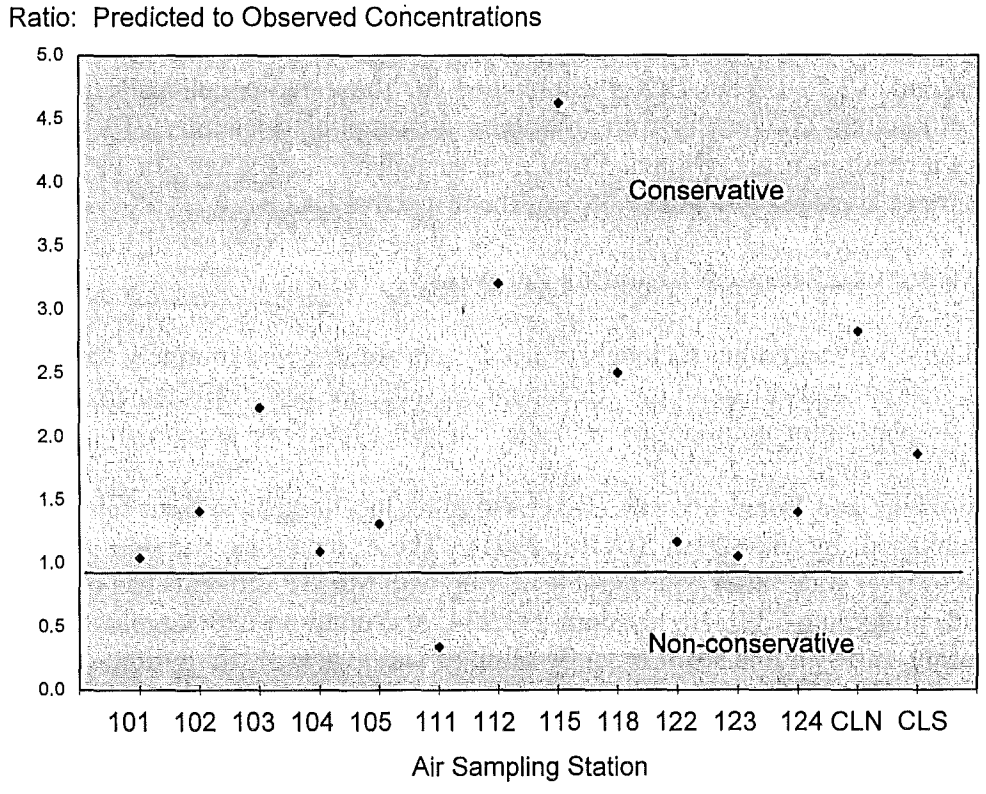
Tritium. Air samples for tritium analyses are collected on a continuous basis. Air is bubbled through 200 mL of ethylene glycol at a flow rate of approximately 1000 cm^3/min. Ethylene glycol is used as a trapping solution because it is not subject to loss by evaporation and will not freeze when exposed to winter sampling conditions. The glycol solutions are changed weekly and represent a sample volume of approximately 10 m^3 of air. An aliquot of each glycol solution is then analyzed weekly in a liquid scintillation counter.

With this technique, tritium oxide rather than elemental tritium is collected. This approach is appropriate because tritium oxide is the more radiotoxic form of tritium. The dose that would result from a given release of tritium oxide would be 25,000 times greater than the dose from the same number of curies of elemental tritium.

Comparisons of Predicted and Measured Tritium Concentrations

For 1997, tritium air concentrations predicted from modeling stack emissions with the EPA CAP88-PC dispersion model were compared to air concentrations observed during routine monitoring. Since essentially all of the impact from plutonium has been observed to be from resuspension of soil, and essentially all the impact from tritium has been observed to be from stack emissions, the air concentration comparison was performed for tritium only. The predicted average concentration at offsite air sampling locations was compared with the observed incremental average concentration for 1997. Figure 4-6 shows the results of the comparison. With one exception, the predicted concentrations were higher than the observed concentrations. This illustrates conservatism in MEMP's approach to estimating the potential dose impact from radiological operations. A non-conservative comparison was observed at sampling location 111. This is an outlying sampling location. At this location, the average tritium concentration was below the detection limit and the results have been included solely for completeness.

Figure 4-6. Predicted and Observed Concentrations of Airborne Tritium in 1997



Plutonium. The particulate sample for isotopic plutonium analysis is collected on a 200-mm diameter fiberglass disc by a continuously operating high-volume air sampler. The air is sampled at an average rate of 1.3 x 10^6 cm^3/min (45 ft^3/min). The disc is changed weekly and represents a sample volume of approximately 13,000 m^3 of air. Each sampler is equipped with a flow meter so location-specific flow rates can be calculated.

Plutonium analysis is performed on monthly composite samples for each onsite location and for the six offsite stations closest to the site. The remaining samples are composited for quarterly analysis. The analytical process for plutonium includes the following basic steps: use of an internal tracer, chemical treatment, separation of plutonium with anion exchange resin, and alpha spectroscopy.

Thorium. Particulate samples from selected air sampling locations are also analyzed for thorium. The release of thorium from ground surfaces (resuspension) is possible due to remediation activities at the site. The analytical process for thorium follows the same principles as the plutonium analysis.

Uranium. As seen in Table 4-1, MEMP includes isotopes of uranium in the release data for air. However, because the stack emissions of uranium-233,234 and uranium-238 are so low and their dose contributions are negligible, air monitoring for uranium is not performed in the environment.

Results for 1997

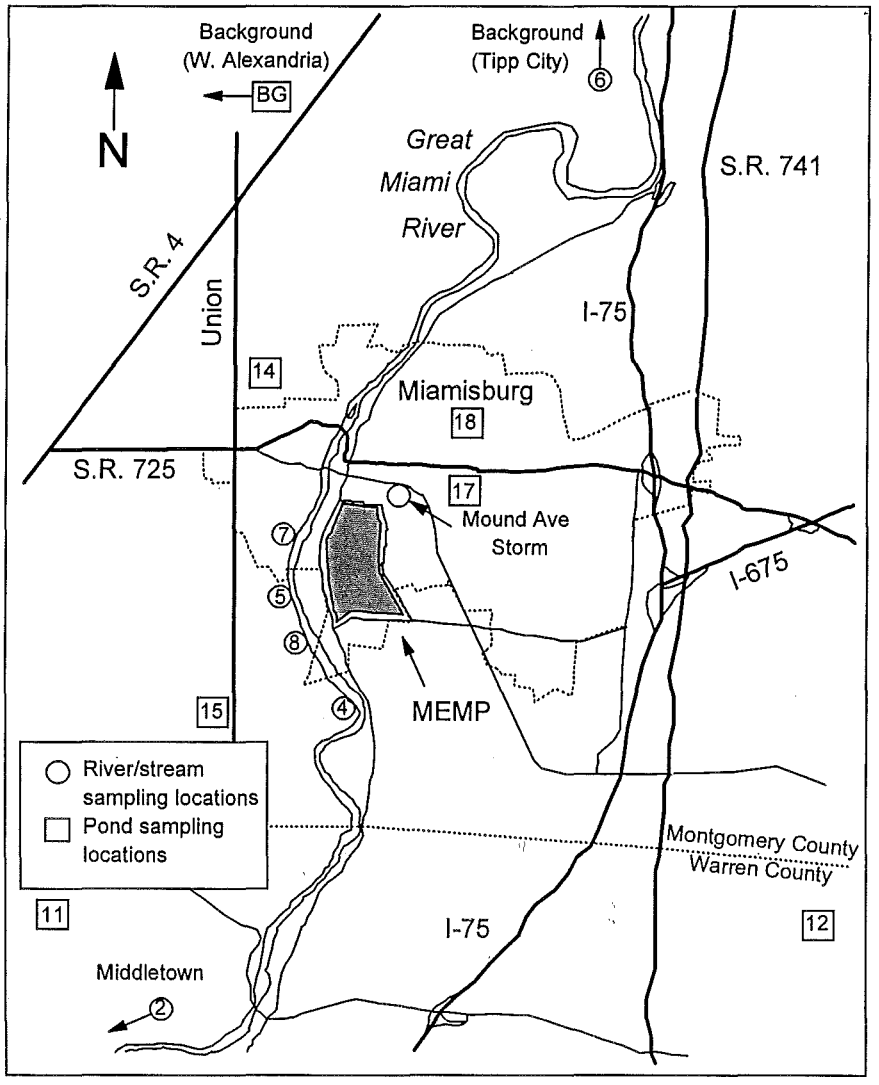
Radionuclide concentrations measured at environmental air sampling stations in 1997 are shown in Appendix B, Tables B-2 through B-5. The results are also presented in terms of the percentage DCG they represent. The tables show that air concentrations of tritium and plutonium consistently averaged less than 0.22% of the DCGs established for those radionuclides. In 1997, localized increases in plutonium-238 results were observed at sampling locations 213 and 215. These increases were a result of nearby Miami-Erie Canal remediation activities. In 1997, concentrations of thorium isotopes averaged less than 0.06% of the respective DCGs.

4.6 Surface Water and Sediment Sampling Program

The Great Miami River and other regional surface waters are sampled routinely for tritium, isotopes of plutonium, and isotopes of uranium. Sediment samples are also collected from these locations and analyzed for plutonium and thorium isotopes. Sampling locations are shown in Figure 4-7.

Great Miami River and Local Stream. River sampling locations have been selected according to guidelines published by the DOE (DOE, 1991). These locations provide samples that are representative of river water after considerable mixing with MEMP effluents has occurred. Tritium, plutonium-238, plutonium-239,240, uranium-233,234, and uranium-238 samples are collected and analyzed monthly. In 1997, one set of monthly samples was analyzed for thorium-228, thorium-230, and thorium-232. A local stream just northeast of the site is also sampled monthly for tritium.

Figure 4-7. Sampling Locations for the Great Miami River, Stream, Ponds, and Sediment



Local surface waters. Ponds in various compass sectors relative to MEMP are sampled annually. These samples are analyzed for tritium, plutonium-238, and plutonium-239,240.

River and pond sediments. Many plutonium and thorium solutions, including those used at MEMP, are relatively insoluble in water. For this reason, they are more likely to be found in sediment than in surface water. Additionally, because of the relatively long half-lives of these isotopes, they may accumulate in sediments. Therefore, MEMP samples river and stream sediments on a quarterly basis and pond sediments on an annual basis. These samples are then analyzed for plutonium-238, plutonium-239, 240, thorium-228, thorium-230, and thorium-232.

Collection of Surface Water Samples

Results for 1997

River and local stream water. Tritium, plutonium, uranium, and thorium concentrations in the Great Miami River are shown in Appendix B, Tables B-6 through B-10. Many measurements were below their respective environmental levels. Tritium concentrations were less than 0.2% of the DOE DCG. Average concentrations of plutonium and uranium isotopes were less than 0.05% of the respective DCG values. One set of monthly river samples was also analyzed for isotopes of thorium. Maximum thorium-228, thorium-230, and thorium-232 concentrations were 4.0%, 9.3%, and 42.0%, respectively, of the DOE DCGs. The thorium-232 concentration was higher than other radionuclide concentrations relative to the DCG values. This is not considered an environmental or safety hazard as no one is reasonably expected to consume 2 liters/day of untreated river water continuously for one year. However, increased monitoring of the Great Miami River for thorium will be conducted in 1998.

Pond water. Radionuclide concentrations measured in pond water are shown in Appendix B, Tables B-11 through B-13. As observed for the river samples, many of the pond results were below environmental levels. Concentrations averaged less than 0.04% of the DCG values.

Sediment. Plutonium and thorium results for river and pond sediments are listed in Appendix B, Tables B-14 through B-19. Maximum and average measurements for 1997 are comparable to those observed in previous years. Since isotopes of plutonium and thorium accumulate in sediment, concentrations are affected by the movement of silt in water bodies. This accounts for the variability in plutonium concentrations at the various river and pond locations.

4.7 Foodstuffs

Various locally grown produce samples and vegetation are collected during the growing season. The objective of this aspect of the Environmental Monitoring Program is to determine whether significant concentrations of radionuclides are present in plant and animal life. In 1997, samples of root crops, tomatoes, and grass samples were collected from a number of regional communities. In addition, a fish sample was analyzed in 1997 as a result of a joint sampling activity with the Ohio EPA.

Plutonium concentrations were determined by ashing the samples, then analyzing the sample using chemical treatment, separation with anion exchange resin, and alpha spectroscopy. Tritium concentrations are determined by removing and distilling the water from the sample, then analyzing the distillate using liquid scintillation spectrometry.

Results for 1997

The results for foodstuff analyses are shown in Appendix B, Tables B-20 through B-22. Most of the samples were below their respective environmental levels. The results demonstrate that exposure to MEMP's effluents via these food-related pathways is negligible.

4.8 Offsite Dose Impacts

Dose Estimates Based on Measured Concentrations

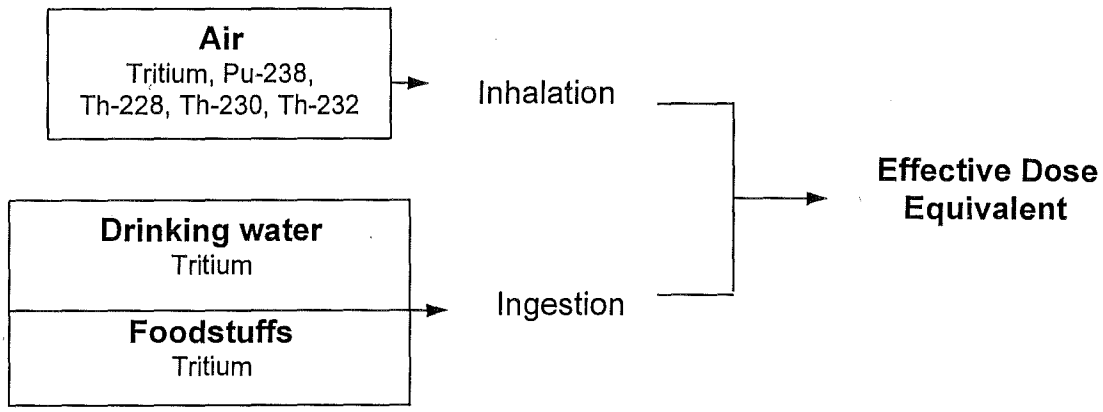
MEMP used the data presented in this report to estimate maximum doses to an offsite individual. The figure-of-merit used to calculate those doses was the committed effective dose equivalent (CEDE). CEDE calculations are required of DOE facilities. These calculations are also useful in evaluating the success of ALARA (As Low As Reasonable Achievable) policies. It is the philosophy of DOE to ensure that all doses from radiation exposure remain ALARA.

To provide an extra degree of conservatism, dose estimates are often calculated based on maximum exposure conditions. This "maximum individual", as defined for purposes of calculating CEDEs, is a hypothetical person who remained at the site boundary 24 hours per day throughout 1997. This individual was assumed to have:

- breathed exclusively air with radionuclide concentrations corresponding to the location of the maximum offsite dose,
- drawn all of his drinking water from the Miamisburg water supply, and
- consumed produce exhibiting the maximum average radionuclide concentrations in samples collected from the Miamisburg area.

The radionuclides and the exposure pathways which contributed to the maximum individual's CEDEs in 1997 are shown in Figure 4-8. Values for the CEDEs are shown in Table 4-2. More detailed information on the CEDE calculations, including the concentration values used, is presented in Appendix E.

Figure 4-8. Exposure Pathways for Dose Calculations Based on Measured Data for 1997



Dose Estimates for NESHAPs Compliance

NESHAPs radionuclide regulations limit offsite doses from airborne releases from DOE sites (excluding radon) to 10 mrem EDE per year. As specified by the EPA, the preferred technique for demonstrating compliance with this dose standard is a modeled approach.

Maximum individual. MEMP uses the EPA's computer code CAP88-PC to evaluate doses for NESHAPs compliance. The 1997 input data for the CAP88-PC calculations are listed in Appendix E. Based on the CAP88-PC output, the maximum EDE from all airborne releases was 0.05 mrem. This estimate represents 0.5% of the dose standard.

Table 4-2. Maximum Committed Effective Dose Equivalents to a Hypothetical Individual in 1997

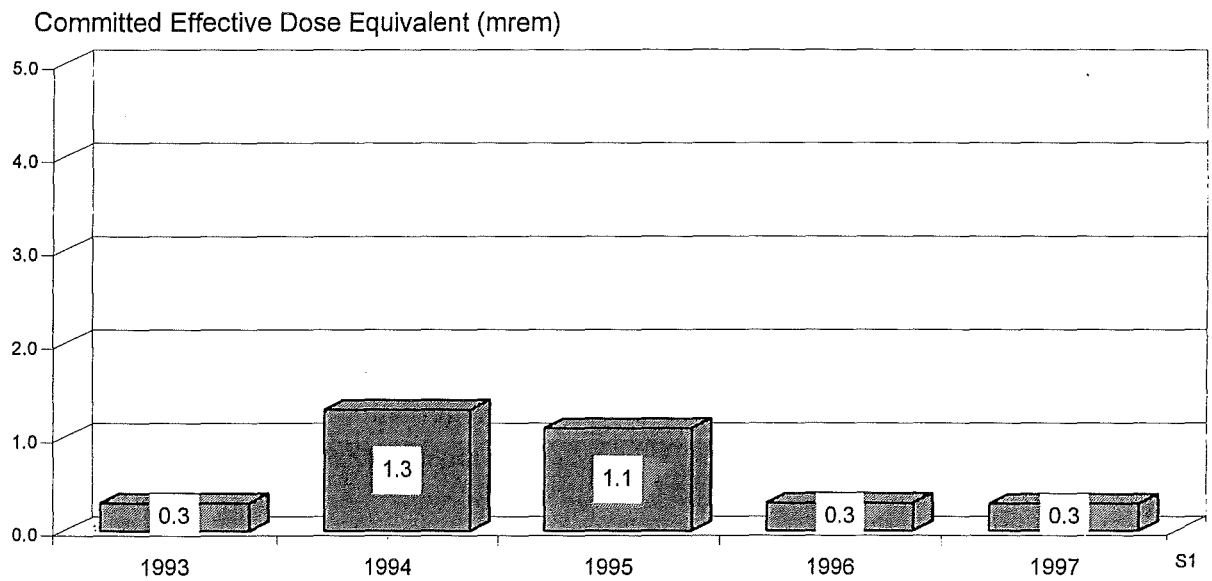
Radionuclide	Pathway	mrem	mSv
Tritium	Air	0.005	0.00005
	Drinking water	0.009	0.00009
	Foodstuffs	0.006	0.00006
	Total	0.02	0.0002
Plutonium-238	Air	0.184	0.00184
	Drinking water	ND	ND
	Foodstuffs	ND	ND
	Total	0.184	0.00184
Plutonium-239;240	Air	ND	ND
	Drinking water	ND	ND
	Foodstuffs	ND	ND
	Total	ND	ND
Thorium-228	Air	0.011	0.00011
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.011	0.00011
Thorium-230	Air	0.017	0.00017
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.017	0.00017
Thorium-232	Air	0.055	0.00055
	Drinking water	NA	NA
	Foodstuffs	NA	NA
	Total	0.055	0.00055
Total		0.290	0.0029

ND indicates that concentrations were not detectable above the environmental level.
NA = not applicable (not measured).

Five-Year Trend in Committed Effective Dose Equivalents to a Hypothetical Individual

Figure 4-9 presents a plot showing the 5-year trend in committed effective dose equivalent to a hypothetical individual. As seen from the figure, a conservative ceiling on the highest annual dose received by an individual during this period is 1.3 mrem.

Figure 4-9. Committed Effective Dose Equivalents to a Hypothetical Individual, 1993 - 1997



Population doses. CAP88-PC also has the capability of estimating regional population doses from airborne releases. The population, approximately 3,035,000 persons, within a radius of 80 km (50 mi) of MEMP received an estimated 2.39 person-rem from site activities in 1997. CAP88-PC arrived at that value by calculating doses at specific distances and in specific compass sectors relative to MEMP. The computer code then multiplied the average dose in a given area by the number of people living there. For example, an average dose of 0.001 rem x 10,000 persons in the area yields a 10 person-rem collective dose for that region. CAP88-PC then sums the collective doses for the 80-km radium region and reports a single value. Additional dose components from drinking water and radon emissions are added to obtain this result.

MEMP's dose contribution of 2.39 person-rem can be put in perspective by comparison with background doses. The average dose from background sources is 300 mrem (0.3 rem) per individual per year. A background collective dose can be estimated for the 80-km population by multiplying 0.3 rem x 3.035 million persons. The result, about one million person-rem, represents an estimate of the collective dose from all background sources of ionizing radiation. MEMP's contribution, 2.39 person-rem, is approximately 0.00024% of that value.

5.0 NONRADIOLOGICAL ENVIRONMENTAL PROGRAM INFORMATION

MEMP releases minor quantities of nonradiological constituents to the environment. These releases are governed by State of Ohio permits. MEMP monitors the impact of nonradiological airborne releases by measuring airborne particulates at seven onsite and 15 offsite locations. Nonradiological releases to water are also subject to extensive sampling protocols. In 1997, MEMP collected over 1,550 water samples to demonstrate compliance with the site's National Pollutant Discharge Elimination System (NPDES) permit and Authorization to Discharge (ATD).

5.1 Air Monitoring Program

Airborne Effluent

The primary source of nonradiological airborne emissions at MEMP is the steam power plant. The plant is normally fueled with natural gas but under certain circumstances fuel oil is used. Fuel oil with a 0.1% sulfur content is burned during unusually cold weather or if the natural gas supply to the site is interrupted. Approximately 3,950 liters (1,043 gallons) of fuel oil and 7,480,745 m^3 (264,180,000 ft^3) of natural gas were burned during 1997. Powerhouse emissions are comprised primarily of sulfur oxides, nitrogen oxides, VOCs, carbon monoxide, lead, and particulates. Airborne effluent rates are calculated using a mass balance approach or AP-42 (EPA, 1985) emission factors. Annual emission rates are presented in Appendix C, Table C-1.

Ambient Air Monitoring

MEMP evaluates particulate concentrations at seven onsite and 15 offsite locations. Sampling locations are shown in Figures 4-4 and 4-5. High-volume particulate air samples are collected weekly by flowing air through a 200-mm diameter fiberglass filter. The system operates at about 1.3 x 10^6 cm^3/min which represents a sample volume of 13,000 m^3 of air per week. By weighing the filter paper before and after use, it is possible to determine the mass of particulates retained by the filter. The mass loading and known air volume can then be used to generate concentration values. Results for 1997 are presented in Appendix C, Table C-2.

Results for 1997

Nonradioactive air emissions from MEMP in 1997 did not significantly affect ambient air quality. All regulated releases were below permit limits, and comparisons of particulate concentrations measured onsite versus offsite suggest little or no influence by MEMP. Particulate measurements for several sampling locations exhibited periodic increases due to construction activities. These elevated air loadings were of short duration and did not significantly affect average values for 1997. The Ohio ambient air quality standard (50 $\mu g/m^3$) is provided as a reference value for particulate measurements. This value is the state goal for average ambient air quality over a three-year period. In 1997, the arithmetic average of particulate concentrations at one sampling location, Station 215, exceeded this reference value. The atypical particulate concentrations in this area were localized and principally attributable to the adjacent Miami-Erie Canal remediation activities.

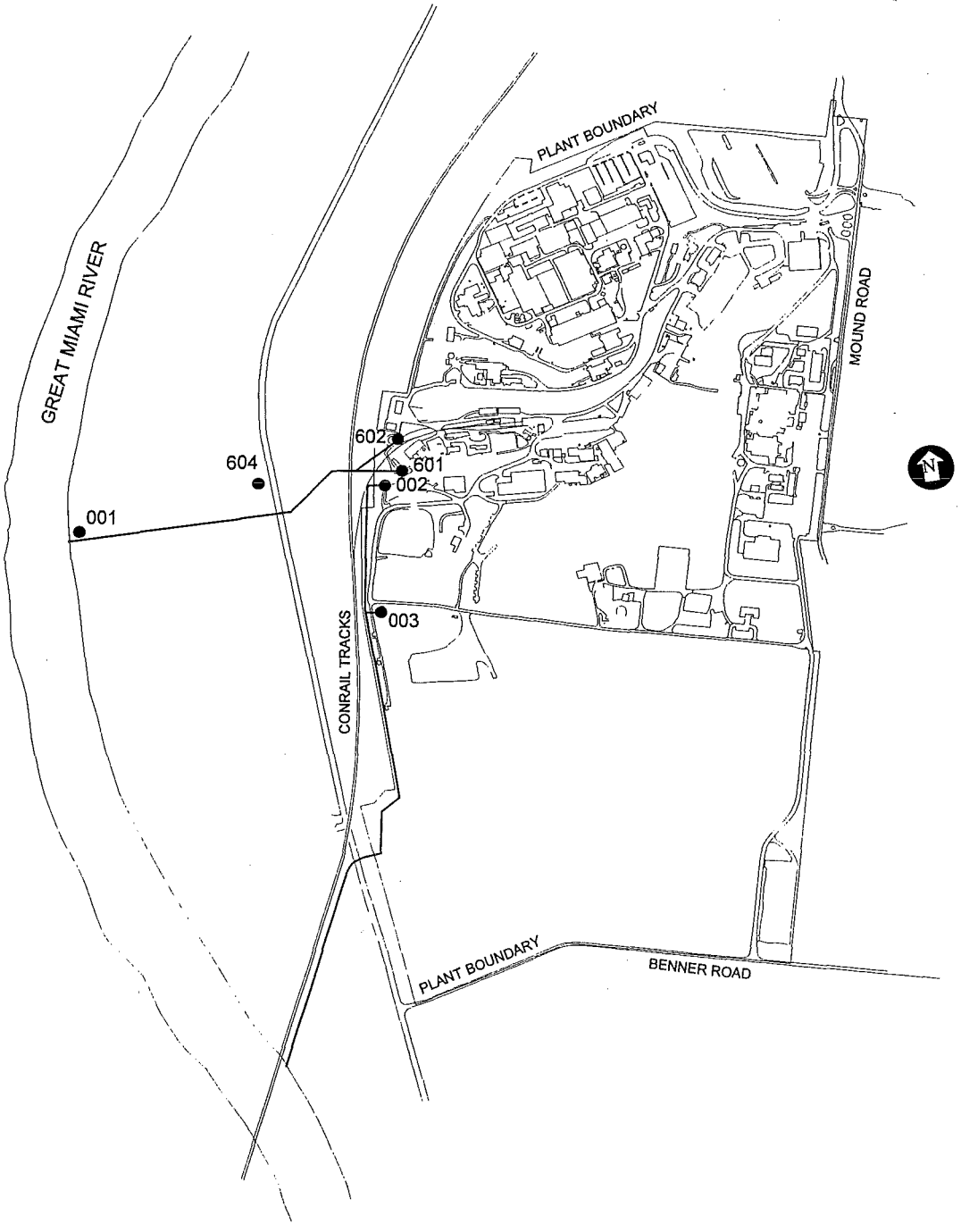
5.2 Water Monitoring Program

MEMP releases wastewater to offsite surface waters via three discharge systems. In 1997, MEMP discharged an average of 0.68 million gallons (2.57 million liters) of water per day to the Great Miami River. U. S. Geological Survey data indicate that the 1997 flow rate in the river averaged 2,137 million gallons per day (MGD), with minimum and maximum flow rates of 315 MGD and 19,454 MGD, respectively. The average magnitude of the river flow rate is significantly greater than that of MEMP's effluents. Therefore, releases from the site can be expected to have a minimal effect on river water quality outside of the mixing zone.

The site's wastewater discharges are regulated by the NPDES permit and ATD. The NPDES permit was renewed by the Ohio EPA on November 1, 1997 and is effective until March 2002. The ATD governs discharges from the CERCLA Operable Unit 1 groundwater pump and treat system. The ATD was issued July 11, 1997 and will remain in effect for the duration of the project. The NPDES permit and ATD define discharge limits and monitoring frequencies for the site's water effluents.

The site's NPDES permit requires scheduled collection and analysis of site effluents at three onsite locations (Outfalls 601, 602, and 002). Flow-weighted effluent limitations are further imposed for the combined discharges from Outfalls 601 and 602 (calculated Outfall 001). Additional samples are required for one offsite outfall (604) when operating. The ATD specifies monitoring requirements for the OU1 pump and treat system. This sampling location is designated Outfall 003. NPDES permit and ATD sampling locations are shown in Figure 5-1. A brief description of each outfall follows Figure 5-1.

Figure 5-1. NPDES Permit and ATD Sampling Locations



Outfall 601. Outfall 601 contains the effluent from the sanitary waste treatment plant. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. Monitoring requirements for this location focus on conventional pollutants and heavy metals. The effluent is also sampled quarterly for ten specific volatile organic compounds.

Outfall 602. Outfall 602 includes stormwater runoff, single-pass cooling water, cooling tower blowdown, zeolite softener backwash, and effluent from the radioactive waste disposal facility. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. Monitoring requirements for this location include chemical oxygen demand, suspended solids, and oil and grease.

Outfall 002. Outfall 002 contains softener backwash, single-pass cooling water, and most of the site's stormwater runoff. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. Monitoring requirements for this location focus on pH and suspended solids.

Outfall 001. Outfall 001 represents the combined effluents of 601 and 602. These discharges are combined and released to the Great Miami River via a closed pipe. Since sampling is not practical, additional limits for this outfall are imposed based on flow-weighted calculations. The concentrations of materials present in Outfalls 601 and 602 are used, along with their respective flow rates, to estimate concentrations in the effluent discharged through the pipe.

Outfall 604. Outfall 604 is a groundwater well, also known as Miamisburg Well 2, located west of the site. In the past, the well was purged to reduce tritium concentrations. The purged water was then directed through a closed pipe to the Great Miami River. When this activity is performed, monitoring of flow rate, pH, and VOCs is required. The well was most recently pumped in 1991.

Outfall 003. Outfall 003 is the discharge from the CERCLA Operable Unit 1 groundwater pump and treat system. Time-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. Monitoring requirements for this location focus on VOCs and heavy metals. Biotoxicity tests are also performed six times each year at this outfall.

Results for 1997

More than 1,550 samples were analyzed for NPDES and ATD parameters in 1997. Key results are summarized in Appendix C, Table C-3. Analytical procedures were consistent with the methods specified in regulations of the Clean Water Act, 40 CFR 136. Sampling and analytical services were provided by BWO's Environmental Monitoring laboratory and by outside contractors. All such procedures meet EPA and BWO standards for quality assurance and quality control.

A review of NPDES and ATD performance over the past five years is shown in Figure 5-2. In 1997, eleven NPDES permit exceedances were recorded. Sampling locations and results associated with the exceedances are shown in Table 5-1. In all cases, prompt corrective action was taken and Ohio EPA was notified. No ATD exceedances occurred in 1997.

Figure 5-2. NPDES and ATD Sampling Profile, 1993 - 1997

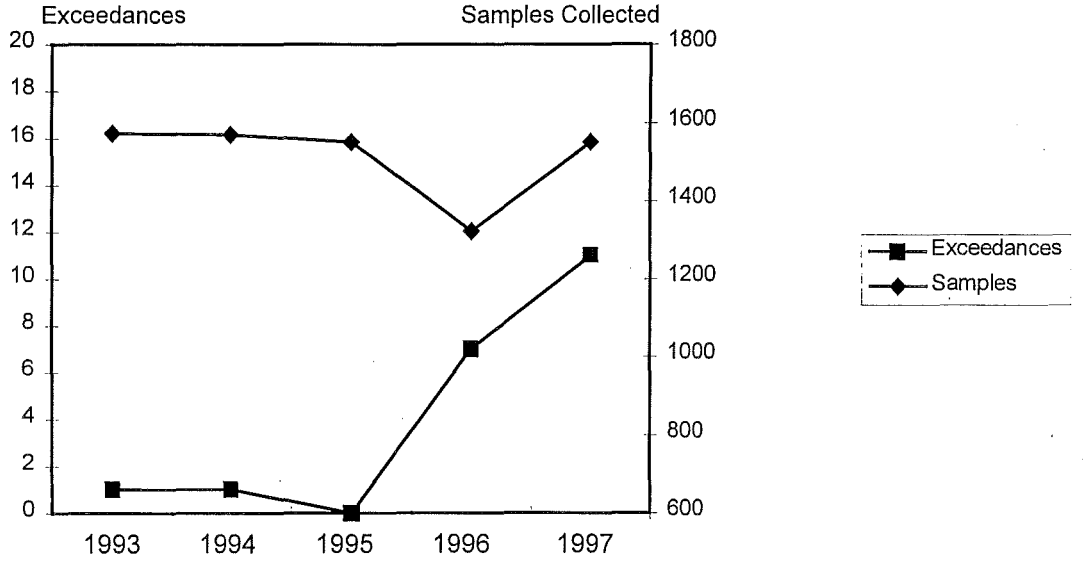


Table 5-1. NPDES Exceedances Recorded in 1997

Outfall	Parameter	Month	Result	NPDES Permit Limit
001	Copper	January	123 µg/L	120 µg/L
001	Copper	January	160 µg/L	120 µg/L
601	$CBOD_5$	February	88 mg/L	15 mg/L
001	Copper	April	131 µg/L	120µg/L
002	Total suspended solids	July	92.8 mg/L	45 mg/L
601	pH	October	5.6 s.u.	6.5-9.0 s.u.
001	Residual chlorine	October	0.080 mg/L	0.038 mg/L
001	Residual chlorine	October	0.220 mg/L	0.038 mg/L
001	Residual chlorine	October	0.090 mg/L	0.038 mg/L
001	Copper	October	130 µg/L	120 µg/L
001	Copper	October	190 µg/L	120 µg/L

5.3 Submissions Under SARA Title III

Title III of the Superfund Amendments and Reauthorization Act (SARA) addresses the emergency planning and community right-to-know responsibilities of facilities handling hazardous substances. Sections 311 and 312 of Title III specify reporting requirements for the use and/or storage of "extremely hazardous" and "hazardous" substances. For facilities subject to Section 311 and 312, chemical usage, storage, and location information must be submitted to regional emergency response agencies before March 1 each year. In 1997, BWO used and/or stored two extremely hazardous substances and seven hazardous substances in excess of reporting thresholds. This information, along with site maps showing usage and storage locations, is reported to the State Emergency Response Commission, the Miami Valley Regional Planning Commission, and the City of Miamisburg Fire Department each year. The nine regulated substances handled by BWO are listed in Table 5-2.

Table 5-2. 1997 SARA Title III Emergency and Hazardous Chemical Data

Hazardous Substances

Diesel fuel	Nitrogen	Ethylene glycol
No. 2 fuel oil	Motor oil	Argon
Gasoline, unleaded		

Extremely Hazardous Substances

Sulfuric acid	Nitric acid

Section 313 of Title III specifies reporting requirements associated with the release of toxic chemicals. For facilities that exceed the reporting threshold, toxic chemical release data must be submitted to the U. S. EPA before July 1 each year. In 1997, BWO used more than the threshold amount of ethylene glycol. A Toxic Chemical Release Inventory (TRI) Report containing information about ethylene glycol use will be submitted in 1998.

5.4 Environmental Occurrences

Under CERCLA and the Clean Water Act, reportable quantity (RQ) levels have been established for designated hazardous substances. If a spill or other inadvertent release to the environment exceeds the RQ, immediate notification of the appropriate federal agencies (e.g., National Response Center, EPA, or Coast Guard) is required. No such releases occurred at MEMP during 1997.

6.0 GROUNDWATER MONITORING PROGRAM

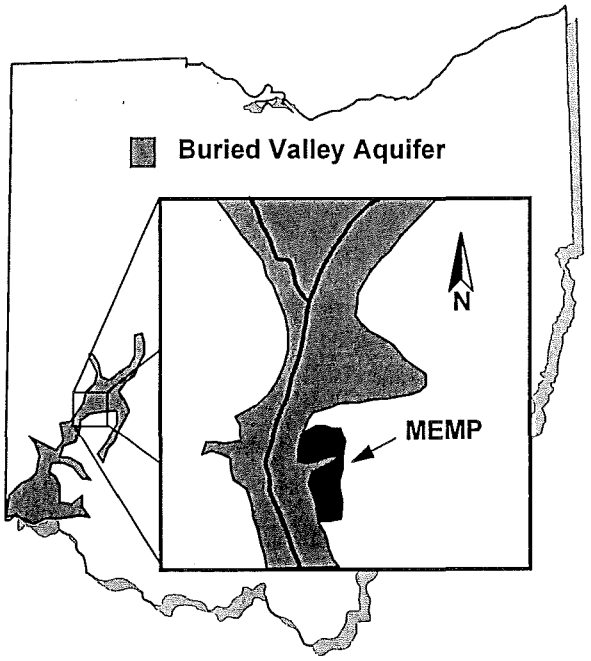
The MEMP site lies atop the largest of Ohio's sole-source aquifers, the Buried Valley Aquifer (BVA). The City of Miamisburg and a number of other communities in the area draw drinking water from the BVA. MEMP also relies on the BVA for drinking and process water.

MEMP maintains approximately 175 active groundwater monitoring sites onsite and offsite to characterize the impact operations may have on the BVA. Included in these sites are three onsite production wells, 117 monitoring wells, 38 piezometers, five capture pits, and 13 community water supplies and private wells. The groundwater monitoring program has been developed to meet Safe Drinking Water Act (SDWA) monitoring requirements, CERCLA program objectives, and DOE-mandated practices.

6.1 Regional Hydrogeology

The BVA was designated a sole-source aquifer by the U.S. EPA in May 1988. This distinction indicates that the aquifer supplies all of the drinking water to the communities above it. The approximate aerial extent of the BVA is shown in Figure 6-1.

Figure 6-1. Location and Extent of the Buried Valley Aquifer



The aquifer has a north-south orientation and reaches a maximum thickness of about 46 m (150 ft) near the Great Miami River channel. Groundwater in the area generally flows south, following the downstream course of the River. Limited recharge by induced stream infiltration occurs due to the extensive layers of clayish till in the region which impede infiltration. The BVA west of the site is estimated to have calculated transmissivity values ranging from 200,000 to 430,000 gallons per day per foot. The transmissivity values are based upon hydraulic characterization data obtained from a May 1993 aquifer pump test.

The BVA is somewhat overdrawn between the cities of West Carrollton and Dayton. Practices involving relocation of well fields and artificial recharge via infiltration lagoons are in use to reduce the magnitude of the reversal. There is no evidence that the gradient reversal affects regions south of West Carrollton such as Miamisburg. In Miamisburg, pumping does not influence the natural groundwater gradient except in the immediate vicinity of the well fields.

Uses of Groundwater in the Vicinity

There are seven municipal water supplies and numerous industrial users within an 8 km (5 mi) radius of the site. The locations of public and private water supply and monitoring wells are shown in Figure 6-2. The only industrial user within 8 km (5 mi) downgradient is the O. H. Hutchings Power Generation Station. Industrial groundwater users located north (upgradient) of the site are isolated from MEMP by hydraulic barriers.

The communities of Franklin and Carlisle are the first downgradient water supplies. Monitoring efforts are concentrated in the Miamisburg area, however, due to the relatively slow movement of groundwater. The City of Miamisburg operates four production to the west of the Great Miami River. These wells are upgradient and are not expected to be impacted by MEMP. All community production wells in use are separated from the site by a minimum straight-line distance of 0.8 km (0.5 mi).

In 1992, a residential well and cistern study (DOE, 1993b) was conducted. A total of 216 residential wells and 14 cisterns were identified within a two-mile radius of the site. Results of this study are in the CERCLA Public Reading Room.

6.2 Hydrology

As seen in Figure 6-1, a "tongue" of the BVA underlies the site. Within the limits of the property, the maximum known thickness of the aquifer is about 21 m (70 ft) at the extreme southwest corner of the site. Present usage of the BVA by MEMP ranges from 19 to 32 liters per second (300 to 500 gallons per minute). Recharge to the portion of the BVA underlying the site primarily arises from infiltration of river water, precipitation, and leakage from valley walls. These sources of recharge provide sufficient volumes of water to balance MEMP's withdrawals.

Typical groundwater elevations are shown on groundwater contour maps (Figures 6-3 and 6-4). The contour maps reflect the two sources of groundwater that are of concern to MEMP, perched water in the bedrock and the BVA. Groundwater levels vary from elevations near 204 m (670 ft) to approximately 267 m (875 ft). Onsite groundwater levels generally increase with increasing ground surface elevations. (Ground surface elevations are shown on Insert 1-1.) At the lowest site elevations overlying the BVA, groundwater is typically present at depths between 20 ft (6 m) and 25 ft (7 m) below the surface. The maximum groundwater level for the perched water in the bedrock beneath the main hill is approximately 255 m (835 ft). The ground surface elevation for the main hill is approximately 268 m (880 ft).

Bedrock permeability. As a result of the dramatic changes in elevations associated with site topography, the site has a variety of groundwater regimes. Virtually impermeable bedrock underlies all but the first few feet of the hilltop and hillside areas. Although the rock itself is, for practical purposes, impermeable, small quantities of groundwater seep through joints and cracks. The upper 6 m (20 ft) of bedrock, where chemical weathering leads to enlargement of the cracks, is the most permeable. Permeability of the upper 6 m (20 ft) of bedrock is estimated to range from 40 to 400 L/day/m^2 (1 to 10 gal/day/ft^2). Below this depth, bedrock permeability generally ranges from 0 to 8 L/day/m^2.

Glacial till and outwash permeability. Hydraulic properties of the glacial tills that form a veneer over the site vary depending on the proportions of fine and course-grained materials at a given location. Values of permeability normally range from 0.0041 to 0.041 L/day/m^2 (0.0001 to 0.001 gal/day/ft^2), although values up to 2.8 L/day/m^2 (0.007 gal/day ft^2) have been measured in upper weathered zones. Below the glacial till in the lower valley is a zone of glacial outwash composed of sand and gravel. The permeability of this zone is estimated to range from 40,700 to 81,000 L/day/m^2 (1,000 to 2,000 gal/day /ft^2).

Seeps

At points along the north hillside, bedrock is exposed and seep lines exist. A generalized cutaway depicting this phenomenon is shown in Figure 6-5. Seeps serve as escape routes for groundwater in the upper elevations of the groundwater regime.

Surface Water Features

There are no perennial streams on the site. A natural drainage area exists in the deep valley separating the two main hills, but water in this area generally has a short residence time. The basin is relatively small and the slopes are relatively steep. Therefore, runoff through site drainage features is rapid.

Figure 6-2. Production and Monitoring Well Locations

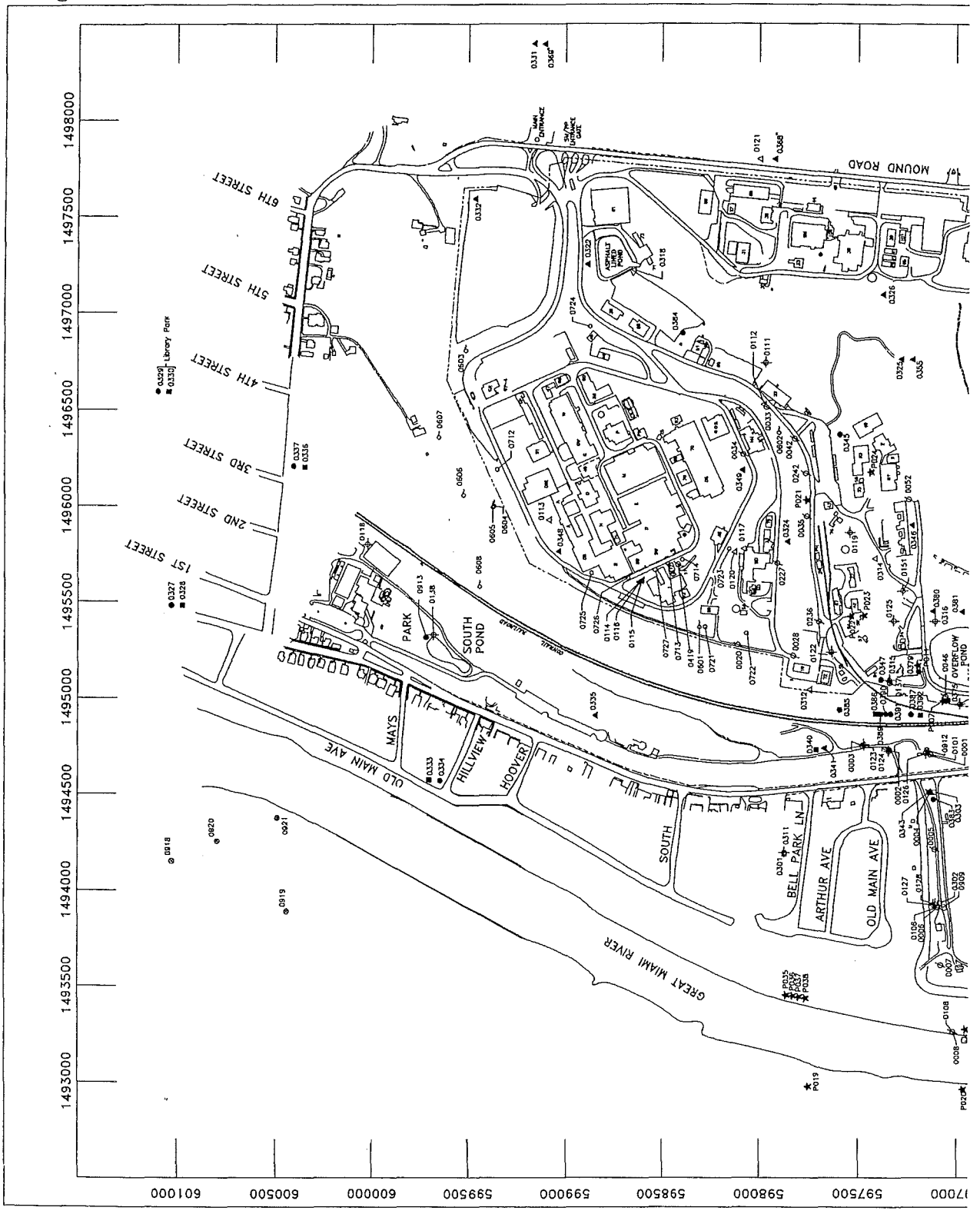


Figure 6-2. Production and Monitoring Well Locations

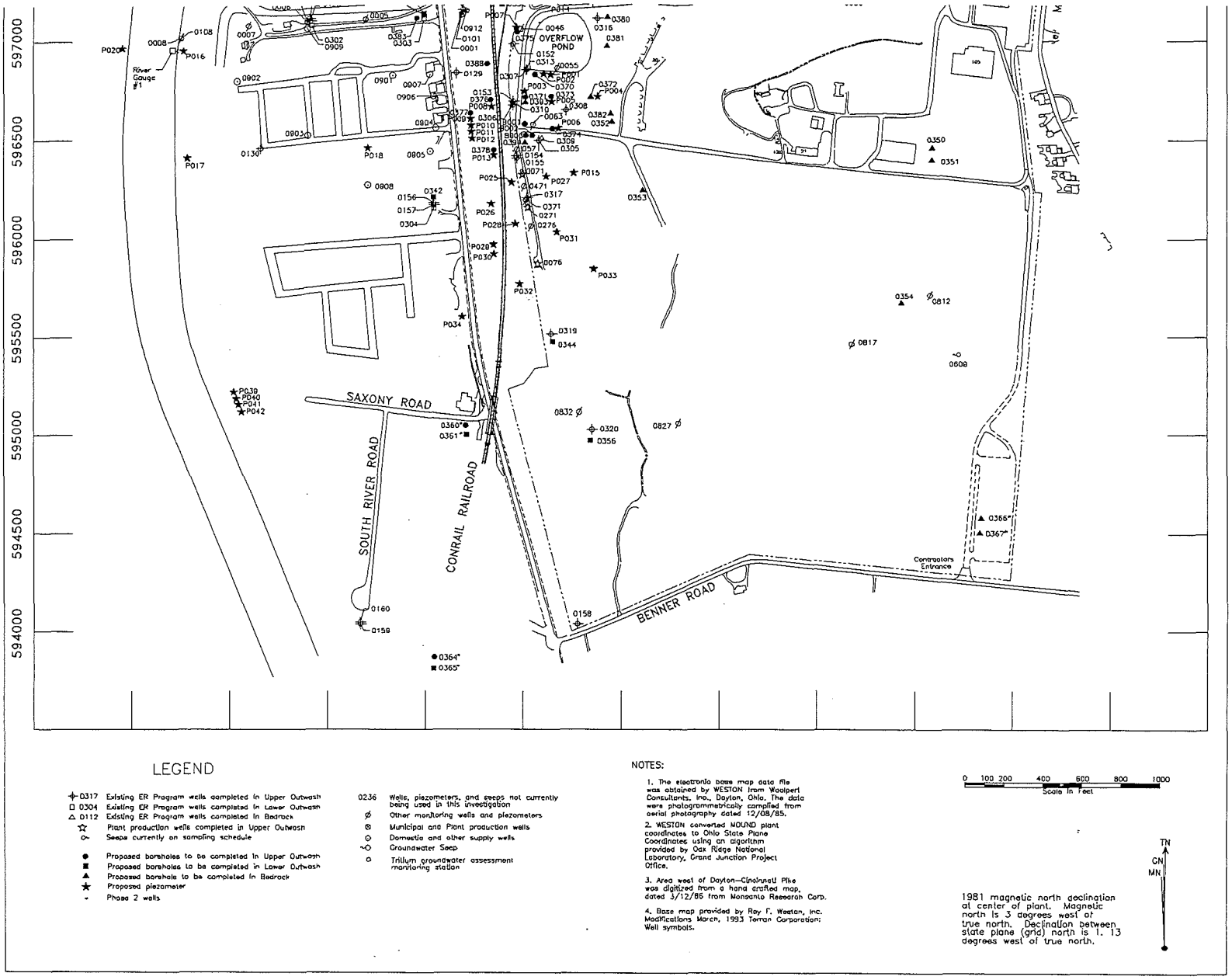


Figure 6-3. Groundwater Elevations for Perched Water in the Bedrock

Figure 6-4. Groundwater Elevations for the Buried Valley Aquifer

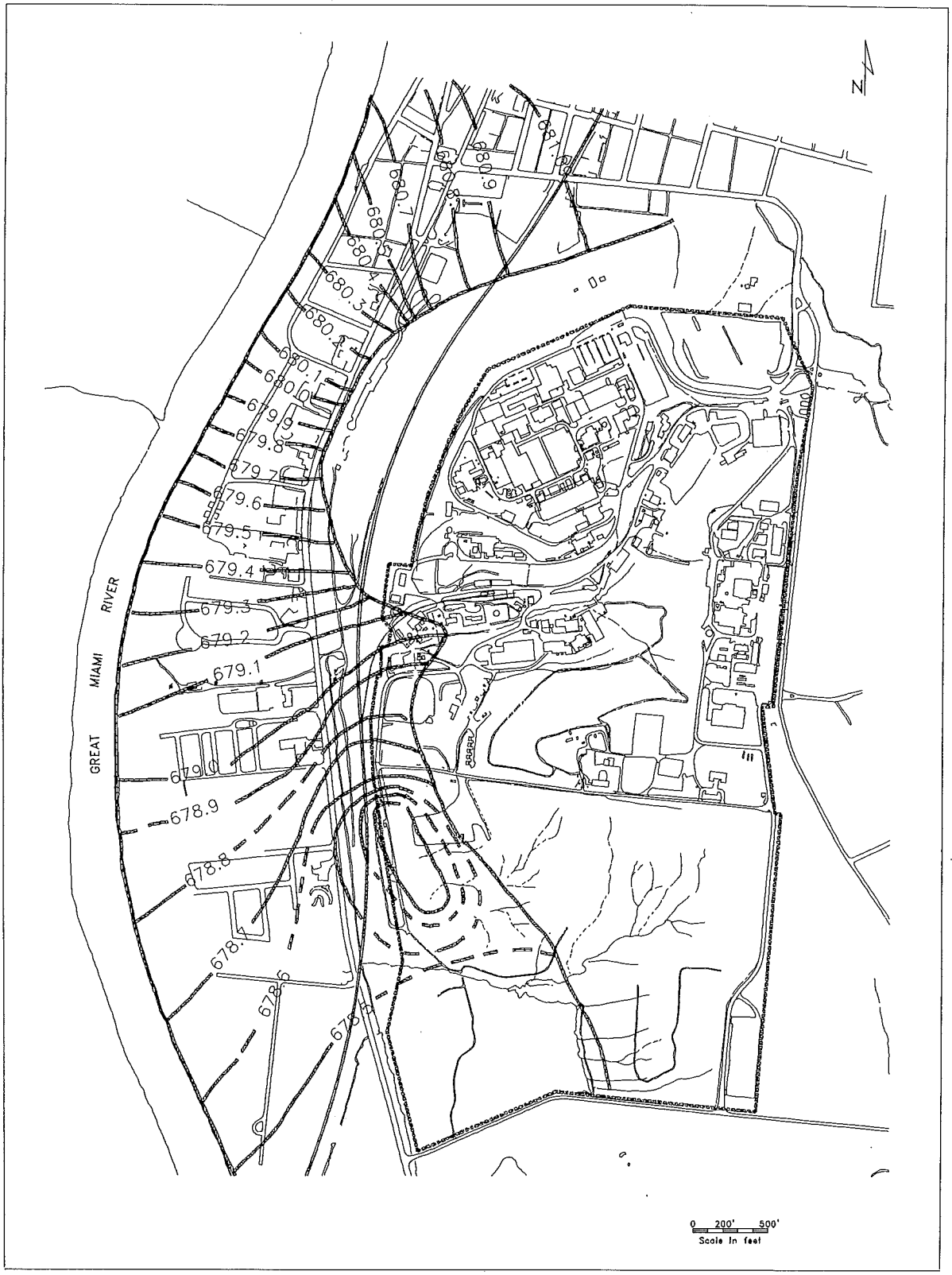
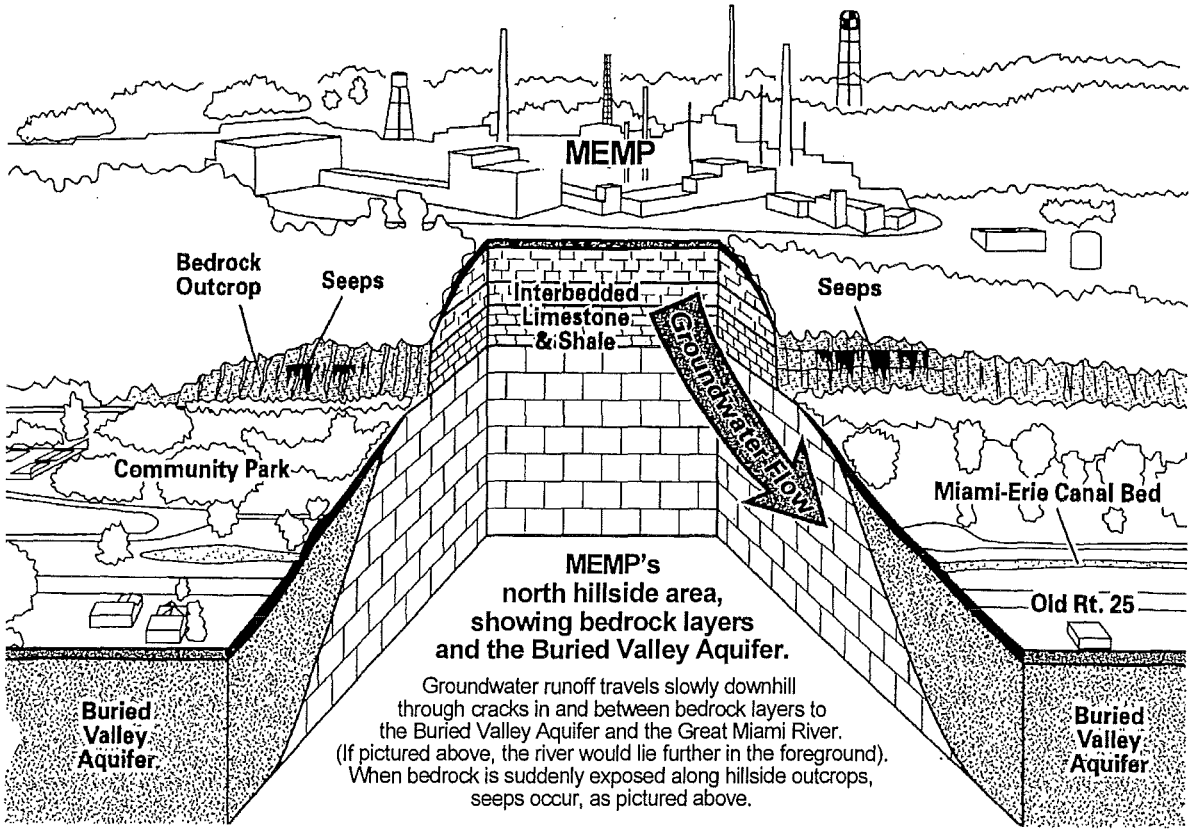


Figure 6-5. Geologic Cutaway



6.3 Applicable Standards

Guidelines for concentrations of radionuclides in drinking water are provided in DOE Order 5400.5 (DOE, 1993). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The guides for radionuclide concentrations are referred to as Derived Concentration Guides, or DCGs. The DCG for a radionuclide is defined as the concentration of that radionuclide which will result in a 50-year committed effective dose equivalent of 100 mrem (1 mSv) following continuous exposure for one year. EPA has also established a drinking water dose standard of 4 mrem/year for specific combinations of radionuclides and concentration standards, or maximum contaminant levels (MCLs), for tritium, radium, and gross alpha.

The National Primary and Secondary Drinking Water Standards also provide MCLs for nonradiological parameters. Primary MCLs have been established for a variety of parameters, including volatile organic compounds (VOCs) and inorganic substances such as metals. Primary MCLs are the maximum concentrations allowed under the SDWA. Secondary MCLs are guidelines for maximum advisable concentrations of listed contaminants. Maximum concentrations of lead and copper are expressed as "action levels". DCGs, MCLs, and action levels are included with the groundwater results presented in Appendix D.

6.4 Environmental Concentrations

Each year, samples are collected from a community water supply that is not affected by MEMP operations. These samples represent background, or "environmental," levels for radionuclides. For drinking water, the environmental reference location is Tipp City, approximately 32 km (20 mi) north of MEMP. Environmental concentrations for 1997 can be found in Appendix D, Table D-1.

6.5 Offsite Groundwater Monitoring Program

The offsite groundwater monitoring program consists of the collection and analysis of samples from production wells, private wells, regional drinking water supplies, and BVA monitoring wells. Samples are analyzed for radionuclides, inorganic substances, and VOCs. A description of the analytical procedures used to generate these results can be found in the Environmental Monitoring Plan (EG&G, 1997) and the Groundwater Protection Management Program Plan (DOE, 1997).

Community Water Supplies and Private Wells

Tritium is the most mobile of the radionuclides released from the site. Therefore, private wells immediately downgradient of MEMP and regional groundwater supplies are closely monitored for tritium. Monthly samples are collected from seven community water supplies and six private wells. Results for 1997 are shown in Appendix D, Table D-2. Average tritium concentrations ranged from 0.05 nCi/L to 2.60 nCi/L, or 0.3% to 13.0% of the MCL, respectively. The results reflect the pattern of tritium concentrations one would expect: higher averages near the site (e.g., Miamisburg) and lower averages at greater distances (e.g., Middletown).

The Miamisburg community water supply is also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, and uranium-238 monthly. Results for 1997 are shown in Appendix D, Tables D-3 and D-4. Many results for 1997 were comparable to background levels for these radionuclides; average concentrations were less than 3.1% of the respective DCG values.

Offsite Monitoring Wells

Radionuclides. To provide additional information on the extent of offsite tritium migration, MEMP also collects groundwater samples from offsite monitoring wells. The results for 1997 are shown in Appendix D, Table D-5. Average tritium concentrations ranged from 0.16 nCi/L to 13.64 nCi/L, or 0.8% to 68.2% of the MCL, respectively.

Monitoring wells along the western boundary of the site are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. The results are shown in Appendix D, Tables D-6 through D-8. Average concentrations ranged from non-detectable to 6.5% of the respective DCG values.

VOCs and Inorganics. Offsite monitoring wells are used to evaluate concentrations of VOCs in the BVA. Samples are analyzed for over 50 organic compounds. The results are presented in Appendix D, Table D-9. In 1997, one trichloroethene result exceeding the MCL was observed. 1,1,1-trichloroethane was detected most frequently in offsite monitoring wells.

Samples from offsite monitoring wells are also analyzed for inorganic substances. The metals and other inorganics of interest are those regulated under the SDWA. The results are presented in Appendix D, Table D-10. In 1997, concentrations above primary MCLs were observed for chromium and nickel. Secondary MCLs were exceeded for aluminum, iron, and manganese. The action level was exceeded for lead.

It should be noted that MCLs and action levels have been established to protect drinking water supplies. Since BVA monitoring wells do not serve as production wells these standards are provided for reference only.

6.6 Onsite Groundwater Monitoring Program

The onsite groundwater monitoring program consists of routine collection and analysis of samples from production wells and BVA monitoring wells. Samples are analyzed for radionuclides, inorganic substances, and VOCs. A description of the analytical procedures used to generate these results can be found in the Environmental Monitoring Plan (EG&G, 1997) and the Groundwater Protection Management Program Plan (DOE, 1997).

MEMP Production Wells

Three onsite production wells provide drinking and process water for the site. Samples from the production wells are analyzed for tritium, plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. Tritium samples are collected and analyzed weekly, plutonium and uranium samples monthly, and thorium quarterly. Results for 1997 are summarized in Appendix D, Tables D-11 through D-14. Average tritium concentrations observed in 1997 were less than 1.0 nCi/L. This value represents 5.0% of the MCL. Average concentrations of other radionuclides measured in 1997 represented less than 1.3% of the applicable DCGs.

MEMP's production wells are also analyzed for over 50 organic compounds quarterly each year. The five halogenated solvents typically present in trace concentrations are 1,1,1-trichloroethane, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, and chloroform. Results for 1997 are shown Appendix D, Table D-15. The data confirm that the production wells are consistently below MCLs for organic compounds.

Onsite Monitoring Wells

Radionuclides. MEMP maintains an extensive network of onsite BVA monitoring wells (Figure 6-2). Samples from these wells are analyzed for tritium. The results for 1997 are shown in Appendix D, Table D-16. Average concentrations observed in 1997 were less than 7.22 nCi/L. This value represents 36.1% of the MCL.

Samples from onsite monitoring wells are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. Results for 1997 are shown in Appendix D, Tables D-17 through D-19. In 1997, average values ranged from non-detectable to 9.8% of the respective DCG values.

VOCs and Inorganics. Onsite monitoring wells in the upper and lower units of the BVA have been sampled since 1988. Results confirm the presence of VOC contamination in the aquifer. The contamination appears to be greatest in the upper unit of the BVA along the western boundary, immediately southwest of the Main Hill. Generally, within the site boundaries, contamination tends to decrease from west to east and from north to south.

The CERCLA Operable Unit 1 project addresses VOC contamination in groundwater near the site's former solid waste landfill. The project is comprised of two elements: a groundwater pump and treat system designed to prevent the migration of VOCs into the aquifer and an air sparge/soil vapor extraction system to accelerate the removal of VOCs from the soil.

Onsite monitoring wells are sampled for over 50 organic compounds. Many of the wells are sampled to evaluate containment of the plume and the effectiveness of the Operable Unit 1 treatment process. A declining trend in VOC concentrations has been observed. Results for 1997 are presented in Appendix D, Table D-20. In 1997, cis-1,2-dichloroethene, trichloroethene, and tetrachlorethene exceeded drinking water MCLs.

Inorganic substances in onsite monitoring wells are also evaluated. The metals and other inorganics of interest are those regulated under the SDWA. The results are presented in Appendix D, Table D-21. In 1997, concentrations above primary MCLs were observed for antimony, arsenic, chromium, and nickel. Secondary MCLs were exceeded for aluminum, iron, and manganese.

As indicated above, MCLs have been established to protect drinking water supplies. Since BVA monitoring wells do not serve as sources of drinking water, these standards are provided for reference only.

SDWA Compliance Summary

Results in this Chapter have been summarized in terms of average concentrations for the year. SDWA compliance for drinking water supplies, however, is evaluated by comparing individual sample results with applicable MCL values. Because the three onsite production wells serve as a drinking water source for the site, SDWA compliance is determined by an annual running average. Table 6-1 shows the maximum concentrations of parameters measured in the production wells during 1997. In 1997, no MCL exceedances were observed in the production wells.

Table 6-1. SDWA Compliance Summary

Parameter	Maximum Concentration	MCL
Tritium	2.5 nCi/L	20 nCi/L
1,1,1-Trichloroethane	3.2 µg/L	200 µg/L
cis-1,2-Dichloroethene	1.5 µg/L	70 µg/L
Trichloroethene	3.9 µg/L	5 µg/L
Tetrachloroethene	2.2 µg/L	5 µg/L
Chloroform	4.1 µg/L	100 µg/L

MCL = Maximum Contaminant Level (based on EPA Drinking Water Standards)

The SDWA does not limit the concentrations of most radionuclides individually (tritium is an exception). Instead, the dose from specific combinations of radionuclides is limited to 4 mrem/year. In 1997, the dose from plutonium, uranium, and thorium measured in the onsite production wells was 0.13 mrem. This represents 3.3% of the dose standard.

To demonstrate compliance with the SDWA, samples are collected from the distribution system. These samples are analyzed for total coliform, lead, copper, nitrate, radium, gross alpha and beta. The action levels for copper and lead were exceeded during semi-annual sampling. As a result, MEMP has initiated a corrosion control program to reduce corrosion of distribution system piping, a significant contributor to copper and lead levels in drinking water. No other exceedances were observed in 1997.

6.7 Seeps and Capture Pits

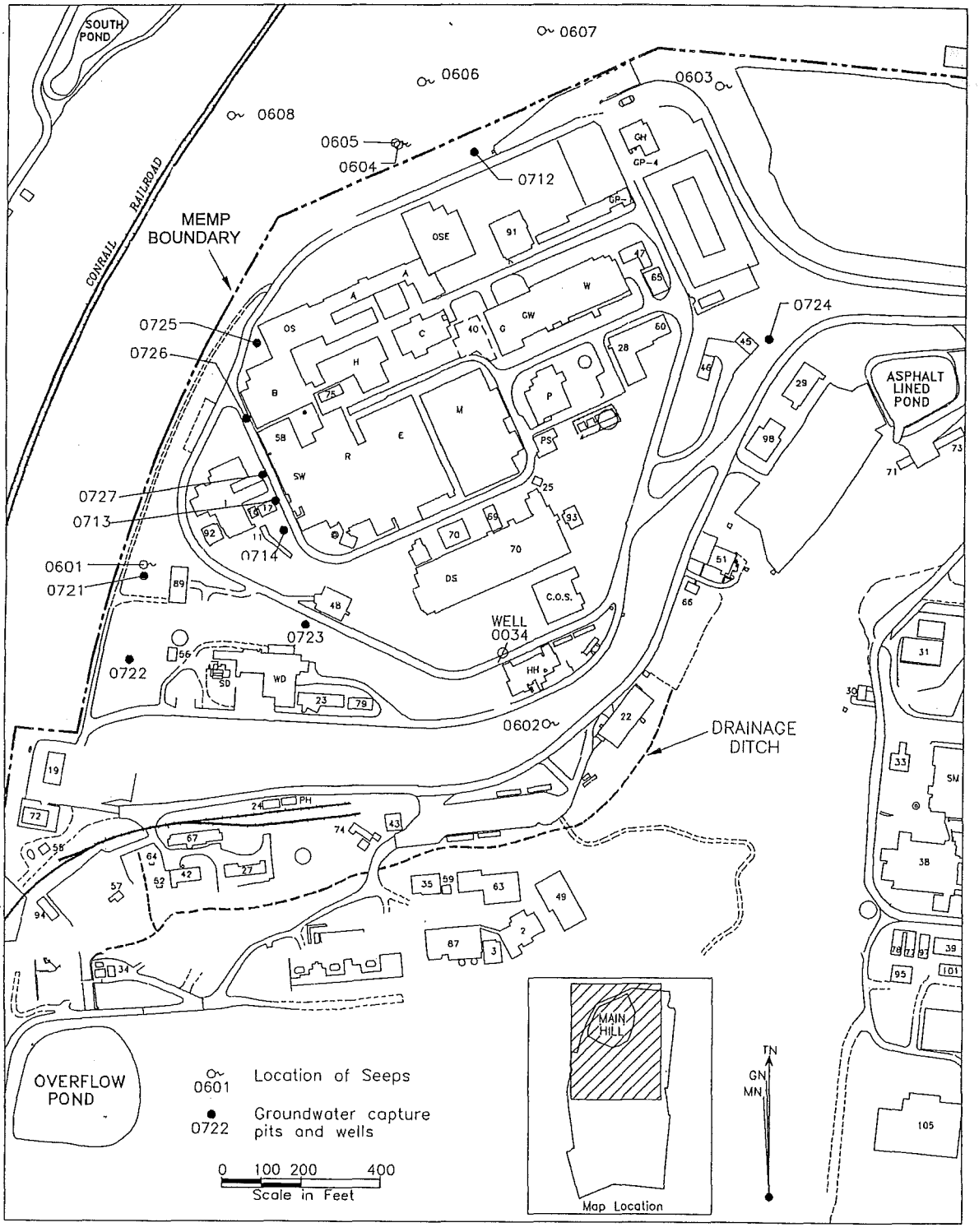
Seeps. Tritium has been recognized as a contaminant in the seeps located along the northwest border of the site since 1986. Since then, tritium has been the focus of extensive sampling activities in that area. Appendix D, Table D-22 shows concentrations of tritium in seep samples in 1997. In 1997, the highest tritium concentrations were associated with Seep 601, consistent with observations in previous years. The sampling locations are shown on Figure 6-6.

Samples collected in 1988 first confirmed the presence of VOCs in Seeps 0601, 0602, 0605, and 0607 (EG&G, 1991). VOC monitoring results for the seeps in 1997 are presented in Appendix D, Table D-23. In 1997, trichloroethene and tetrachloroethene were observed at concentrations greater than the drinking water MCL.

Capture Pits. A number of groundwater collection devices, or "capture pits", are used on the Main Hill to isolate and monitor contamination in perched groundwater. These devices have been designed to collect pockets of shallow groundwater which may have been contaminated as a result of past operational practices. In 1997, samples were collected from the capture pits and analyzed for tritium. The results are shown in Appendix D, Table D-24. The sampling locations are shown on Figure 6-6.

Monitoring in previous years has indicated that the VOC contamination exists in the capture pits. The results are shown in Appendix D, Table D-25. In 1997, trichloroethene was the only compound to exceed the MCL value.

Figure 6-6. Seep and Capture Pit Locations



6.8 Five-Year Trends for Wells of Interest

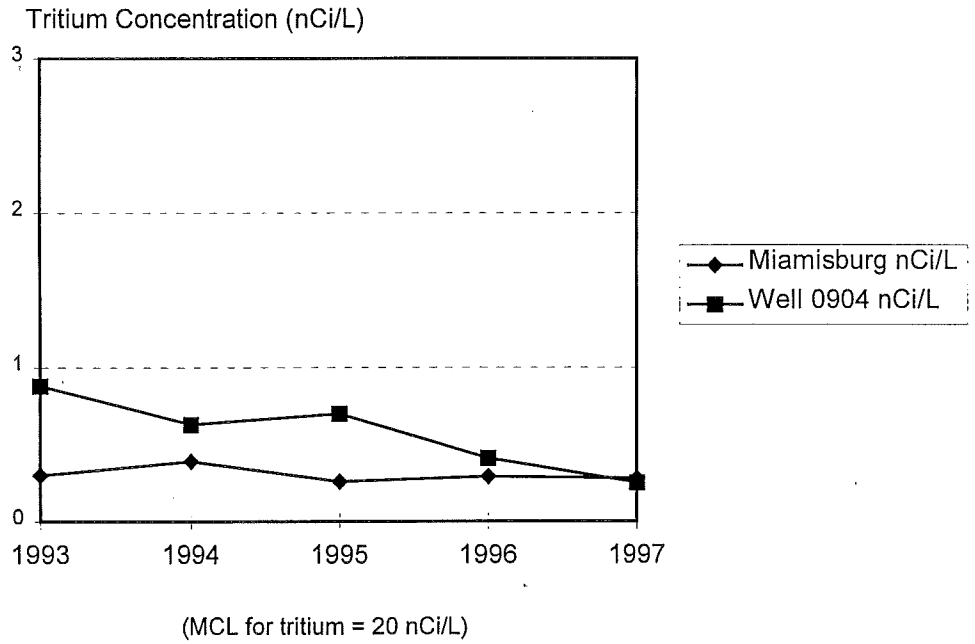
As seen in the preceding sections of this Chapter, a large volume of groundwater monitoring data is generated each year. It is important that the data be reviewed for evidence of long-term trends, especially in cases where there is some history of elevated concentrations of contaminants. In this section, five-year trends are presented for certain indicator parameters measured in wells of interest.

Trend Data for Offsite Drinking Water

A primary consideration of the MEMP environmental monitoring program is to ensure that area drinking water supplies are not adversely affected by activities at the site. The most mobile of the constituents released to groundwater is tritium. For this reason, tritium is an excellent indicator of offsite migration. Two drinking water sources can be considered key receptor wells. First, the drinking water supply of the City of Miamisburg is of interest due to the proximity of the City's well fields. And second, Well 0904, a private well, is useful as an indicator because it reflects potential impact to small drinking water systems.

Five-year trends for tritium concentrations in the two wells described above are shown in Figure 6-7. As seen in the figure, tritium levels in the wells have exhibited little change over the past five years. All of the values are significantly below the MCL for tritium of 20 nCi/L.

Figure 6-7. Annual Average Tritium Concentrations in Offsite Drinking Water, 1993 - 1997



Trend Data for Onsite Production Wells and Seeps

As previously described in this chapter, tritium and certain VOCs have been observed in groundwater underlying the site. The five halogenated solvents typically present in trace concentrations are trichloroethene, tetrachloroethene, cis-1,2-dichloroethene, 1,1,1-trichloroethane, and chloroform. Trichloroethene has been the most prevalent contaminant and, therefore, serves as an "indicator" VOC.

An appropriate onsite indicator well is Production Well 0076 (also referred to as Well 3) because it serves as the primary source of drinking water for the site. Other important monitoring points for the evaluation of groundwater conditions are the seeps. Data suggest that Seep 0601 is an appropriate location for the observation of long-term trends.

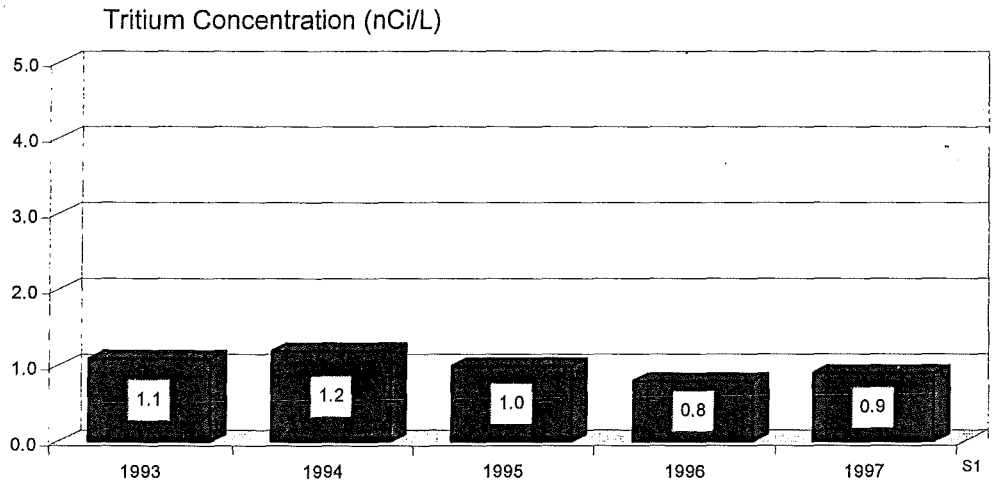
Five-year trend data for Production Well 0076 are shown in Figures 6-8 and 6-9 for tritium and trichloroethene, respectively. Similarly, Figures 6-10 and 6-11 present five-year trend data for tritium and trichloroethene at Seep 0601.

Figure 6-8 indicates that tritium levels in Well 0076 have consistently averaged near 1 nCi/L. This value is well below the applicable MCL (20 nCi/L). Trace concentrations of trichloroethene have also been observed in Well 0076 (Figure 6-9). However, measured concentrations have remained well below the applicable MCL (5 μg/L).

Figure 6-10 presents tritium concentration data for Seep 0601. Data for the period 1993-1997 show the yearly average for tritium concentrations ranging from approximately 75 nCi/L to 350 nCi/L. It can be noted that average concentrations have varied over the five-year period shown; tritium values in 1997 represent a five-year low. Seep 0601 is also characterized by elevated levels of trichloroethene. Additionally, though not shown in the figure, tetrachloroethene has also emerged as a contributor to VOC contamination in this seep.

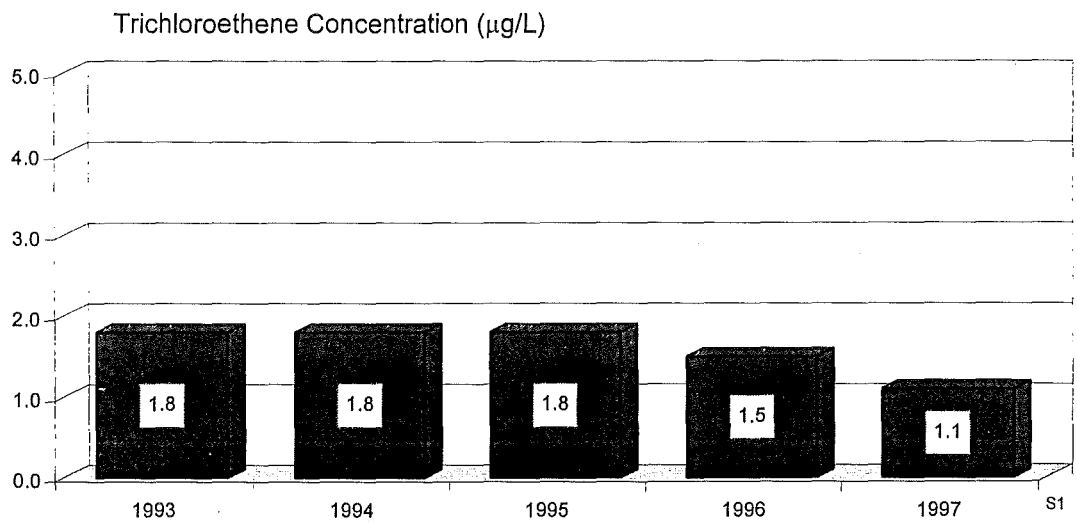
The risks associated with contamination in the seeps and will be evaluated under CERCLA and appropriate remediation actions taken if indicated.

Figure 6-8. Annual Average Tritium Concentration in Production Well 0076, 1993 - 1997



(MCL for tritium = 20 nCi/L)

Figure 6-9. Annual Average Indicator VOC Concentration in Production Well 0076, 1993 - 1997



(MCL for trichloroethene = 5 µg/L)

Figure 6-10. Annual Average Tritium Concentration for Seep 0601, 1993 - 1997

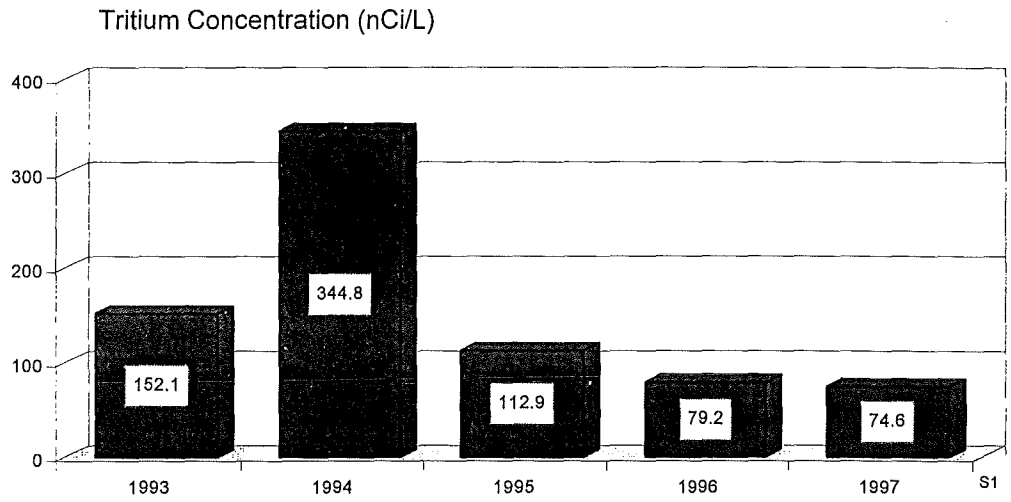
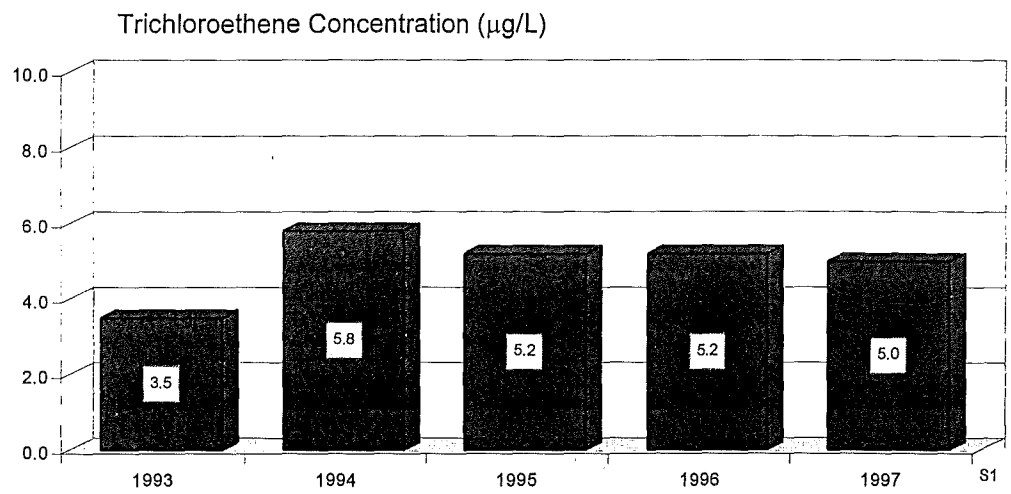


Figure 6-11. Annual Average Indicator VOC Concentration for Seep 0601, 1993 - 1997



7.0 QUALITY ASSURANCE PROGRAMS FOR ENVIRONMENTAL DATA

MEMP participates in quality assurance (QA) exercises sponsored and/or recognized by the DOE and the EPA. Such exercises provide objective evaluations of the validity of the environmental data generated by MEMP. In this Chapter, QA programs involving radiological and nonradiological analyses of a variety of environmental media are described. In addition to these external QA programs, MEMP performs internal QA studies that make use of reagent blanks, internal standards, and replicate samples.

Internal QA Program

MEMP employs a quality-based approach to environmental data. Such an approach is imperative because many sample results are at or below the lower detection limit. QA samples, including blanks, standards, and replicates, are routinely analyzed to evaluate analytical bias and precision. Blank samples are analyzed to verify the absence of excessive instrument contamination or background levels. The standard deviation of the blanks is used to calculate the lower limit of detection. Standards and replicates are used to evaluate analytical bias and precision, respectively. QA parameters are closely monitored and tracked. Deviations from expected values result in a review of analytical protocol.

External QA Activities

Twice each year MEMP participates in DOE's Office of Environmental Management, Quality Assessment Program conducted by Environmental Measurements Laboratory (EML). EML supplies samples containing specific quantities of radionuclides to each participating lab for radiological analysis. The radionuclides are present as contaminants on air filters, soil, vegetation, or water. The radionuclide activity present in the sample is not disclosed to the participating laboratory. A laboratory's performance is evaluated by comparing their results with the EML reference values.

The results reported by MEMP for the March and September 1997 studies are shown in Table 7-1. EML reference values are also shown. A useful method of evaluating MEMP's performance is to examine the ratio of MEMP's result to the EML reference concentration for each environmental medium. This comparison is shown in Figure 7-1.

In the 1997 EML Performance Evaluation, four environmental media were analyzed. As evidenced by Table 7-1 and Figure 7-1, MEMP's results compared favorably with DOE (EML) reference values with an overall average ratio of 1.09.

The U. S. EPA Analytical Sciences Branch, Characterization Research Division, Las Vegas (CRD-LV) distributed samples containing known radioactive constituents in water for analysis as part of their Performance Evaluation Studies Program. MEMP's performance is evaluated by comparing MEMP's results with CRD-LV reference values.

The concentrations reported by MEMP are shown in Table 7-2. The reference values established by CRD-LV are also shown in the table along with the ratio of MEMP's results to the CRD-LV reference value. Figure 7-2 shows a plot of the ratio of MEMP's results to the CRD-LV reference value. MEMP's results compared favorably with CRD-LV results with an overall average ratio of 1.02.

Table 7-1. DOE Quality Assessment Program Results for 1997: Radionuclides in Environmental Samples

Sample Type	Date	Radionuclide	MEMP Result	EML[a] Reference	Ratio MEMP/EML
Air filters, pCi/filter	March	Pu-238	2.97	2.70	1.10
		Pu-239	3.51	3.22	1.09
		U-234	2.70	2.78	0.97
		U-238	2.97	2.84	1.05
	September	Pu-238	6.22	5.68	1.10
		U-234	1.62	1.35	1.20
		U-238	1.62	1.35	1.20
Vegetation, pCi/kg	March	Pu-239	60.82	52.49	1.16
	September	Pu-239	161.64	148.12	1.09
Soil, pCi/kg	March	Pu-238	18.92	14.33	1.32
		Pu-239	3573.91	3647.16	0.98
		U-234	1075.79	1015.52	1.06
		U-238	1132.02	1146.88	0.99
	September	Pu-239	297.87	274.62	1.08
		U-234	909.56	1004.16	0.91
		U-238	938.48	943.35	0.99
Water, pCi/L	March	Tritium	6527.20	6765.61	0.96
		Pu-238	38.11	34.90	1.09
		Pu-239	25.14	22.98	1.09
		U-234	17.03	14.60	1.17
		U-238	16.22	14.87	1.09
	September	Tritium	3518.50	3108.45	1.13
		Pu-238	20.54	19.46	1.06
		Pu-239	21.89	20.27	1.08
		U-234	7.30	6.22	1.17
		U-238	7.30	6.49	1.13

[a] DOE Environmental Measurements Laboratory.

Figure 7-1. MEMP Performance in the DOE Quality Assessment Program in 1997

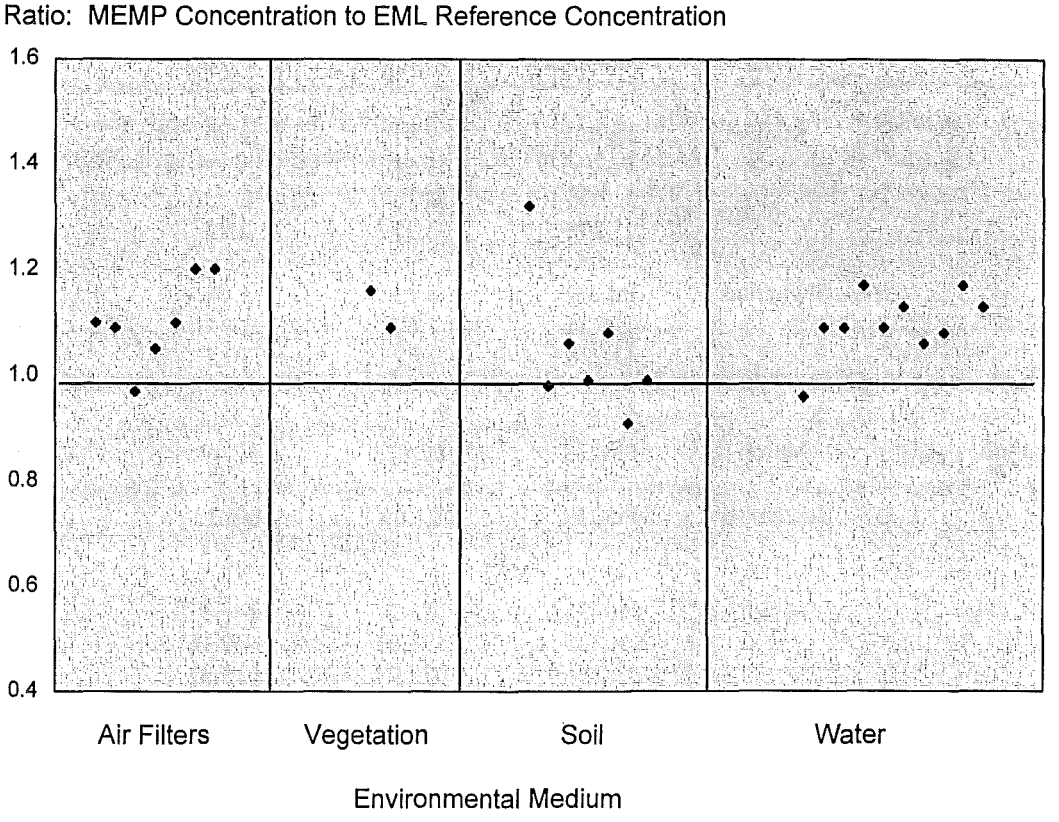
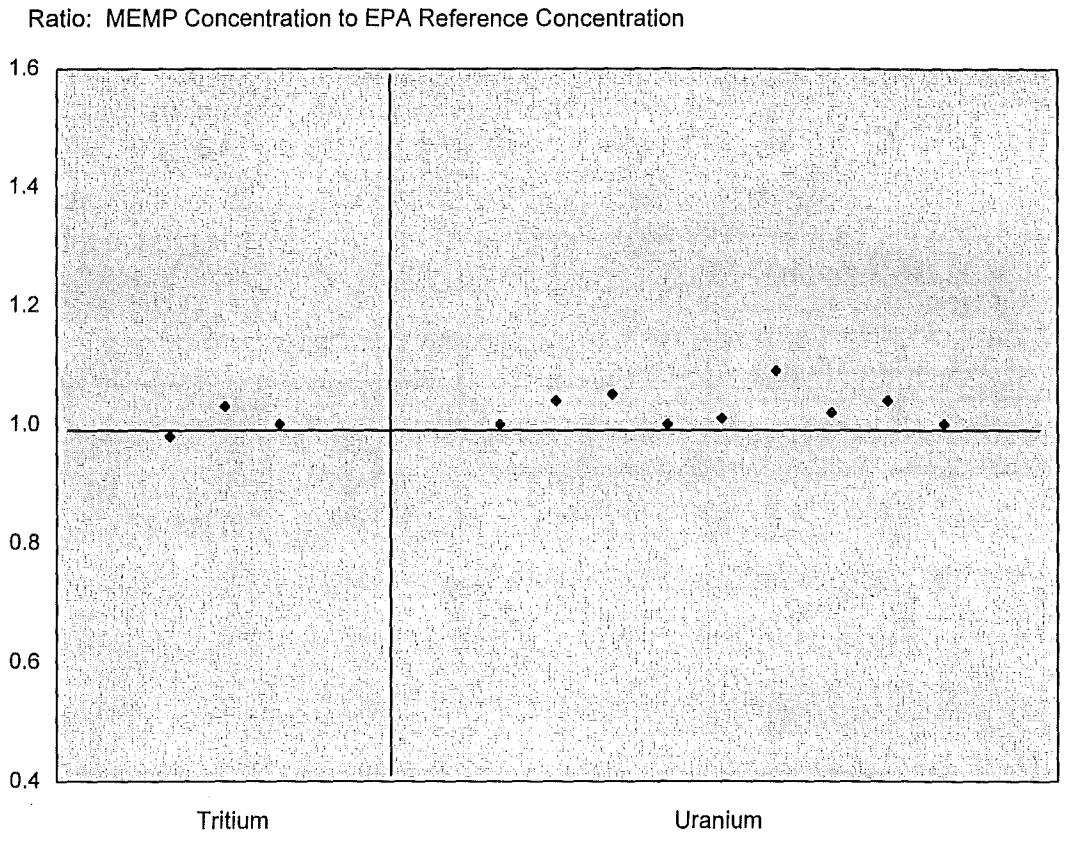


Table 7-2. U.S. EPA Quality Assessment Program Results for 1997: Radionuclides in Water Samples

Radionuclide (pCi/L)	Date	MEMP Result	CRD-LV[a] Reference Concentration	Ratio MEMP/EPA
Tritium	March	7753	7900	0.98
		8120	7900	1.03
		7906	7900	1.00
Uranium (natural)	February	27.1	27.0	1.00
		28.2	27.0	1.04
		28.3	27.0	1.05
	June	40.5	40.3	1.00
		40.9	40.3	1.01
		44.0	40.3	1.09
	September	5.2	5.1	1.02
		5.3	5.1	1.04
		5.1	5.1	1.00

[a] U. S. EPA Analytical Sciences Branch, Characterization Research Division, Las Vegas.

Figure 7-2. MEMP Performance in the U.S. EPA Quality Assessment Program in 1997



NPDES QA Program

National Pollutant Discharge Elimination System (NPDES) permits are used by the EPA to regulate discharges of water effluents. The permits limit the concentrations of certain wastewater constituents to protect the receiving body of water. To ensure that effluent limits are not exceeded, NPDES permits impose strict requirements for effluent characterization. EPA requires that laboratories performing analyses for NPDES parameters participate in QA exercises. These exercises ensure EPA that the laboratories are producing reliable and accurate data.

Discharge Monitoring Report (DMR) Quality Assessment Program. In 1997, as in previous years, MEMP participated in the NPDES QA exercise. In this program, a contract laboratory, ManTech Environmental Technology, Inc., supplies water samples containing specific unknown quantities of analytes to participating laboratories. Laboratories analyze these samples and submit the results to the contractor. The contractor evaluates the data based on limits for acceptability. MEMP's performance in the NPDES QA exercise in 1997 is shown in Table 7-3. One of the 14 parameters evaluated was rated not acceptable. The source of error was traced to a deficiency in instrument maintenance and the lack of benchmark standards during batch analyses. Prompt corrective action was completed to prevent recurrence.

APG Quality Assessment Program. As a companion to the DMR QA program, MEMP voluntarily participates in second QA exercise for NPDES parameters. In this study, water samples prepared by Analytical Products Group, Inc. (APG) are analyzed by participating laboratories. For each parameter of interest, APG determines the average value reported by all participants. The figure-of-merit used to evaluate a laboratory is the standard deviation of a result from the average for that parameter. In this fashion, a laboratory's performance is rated relative to the performance of all other laboratories.

APG has established "warning" and "not acceptable" limits of acceptability for these studies. These limits have been set at 1.96 and 2.58 standard deviations from the average, respectively.

MEMP participated in two APG studies in 1997. The results are shown in Table 7-4 and Figure 7-3. While the results for 1997 were not as successful as desired, the exercise worked as intended by identifying programmatic weaknesses. Improvements involving the use of instrument ledgers, maintenance logs, and benchmark standards have been implemented and subsequent performance has been much improved.

Table 7-3. NPDES DMR Quality Assessment Program Results for 1997

Parameter	MEMP Value	DMR QA[a] Reference Value	Acceptance Range	MEMP Performance Evaluation
Trace Metals, µg/L				
Cadmium	74.0	69.0	58.5-78.6	Acceptable
Chromium	403.0	420.0	371.0-473.0	Acceptable
Copper	264.0	277.0	252.0-305.0	Acceptable
Mercury[b]	3.9	3.9	2.9-4.3	Acceptable
Nickel	189.0	188.0	168.0-213.0	Acceptable
Lead	440.0	430.0	379.0-480.0	Acceptable
Zinc	1466.0	1551.0	1360.0-1760.0	Acceptable
Miscellaneous, mg/L				
Total residual chlorine	1.50	1.39	1.14-1.73	Acceptable
Total suspended solids	35.2	46.0	33.3-48.0	Acceptable
Oil and grease	11.1	12.2	4.4-18.2	Acceptable
Demand, mg/L				
Chemical oxygen demand	84.0	81.0	59.4-95.7	Acceptable
Carbonaceous biochemical oxygen demand	46.0	43.0	18.1-68.6	Acceptable
Nutrients, mg/L				
Ammonia as N	1.95	2.80	2.16-3.47	Unacceptable
pH, standard units				
pH	6.61	6.58	6.44-6.74	Acceptable

[a] EPA Discharge Monitoring Report Quality Assurance Program.
[b] Mercury analysis performed by a contract laboratory.

Table 7-4. NPDES APG Quality Assessment Program Results for 1997

Parameter	Date	MEMP Value	APG[a] Reference Value	Acceptance Range	MEMP Performance Evaluation
Trace Metals, µg/L					
Cadmium	April	39.0	33.5	26.6-40.2	Warning
Cadmium		128.0	119.5	104.2-136.4	Acceptable
Chromium		279.0	278.3	236.0-317.8	Acceptable
Chromium		619.0	612.2	547.3-675.6	Acceptable
Copper		397.0	396.8	355.6-437.3	Acceptable
Copper		776.0	777.6	715.8-840.9	Acceptable
Lead		461.0	478.9	410.2-539.2	Acceptable
Lead		525.0	532.1	490.3-579.8	Acceptable
Nickel		82.0	79.0	60.6-93.5	Acceptable
Nickel		593.0	607.4	528.2-677.8	Acceptable
Zinc		39.0	40.2	30.6-54.1	Acceptable
Zinc		419.0	457.9	406.2-511.4	Acceptable
Cadmium	October	76.0	77.7	67.8-86.3	Acceptable
Cadmium		106.0	119.5	97.9-139.1	Acceptable
Chromium		419.0	390.2	330.2-440.9	Acceptable
Chromium		875.0	822.2	699.1-928.9	Acceptable
Copper		242.0	243.0	213.9-265.1	Acceptable
Copper		531.0	534.6	479.8-577.9	Acceptable
Lead		419.0	212.8	175.5-251.8	Unacceptable
Lead		875.0	995.3	825.5-1147.3	Acceptable
Mercury[b]		1.5	1.6	1.2-2.3	Acceptable
Mercury[b]		7.0	9.2	7.7-11.5	Unacceptable
Nickel		471.0	427.8	391.0-486.0	Acceptable
Nickel		711.0	653.6	597.7-738.0	Acceptable
Selenium		34.0	37.2	31.5-43.7	Acceptable
Selenium		132.0	144.3	121.6-162.6	Acceptable
Silver		87.0	94.7	80.5-108.9	Acceptable
Silver		114.0	115.7	100.4-131.8	Acceptable
Zinc		60.0	60.0	44.4-77.4	Acceptable
Zinc		255.0	260.1	220.2-299.2	Acceptable

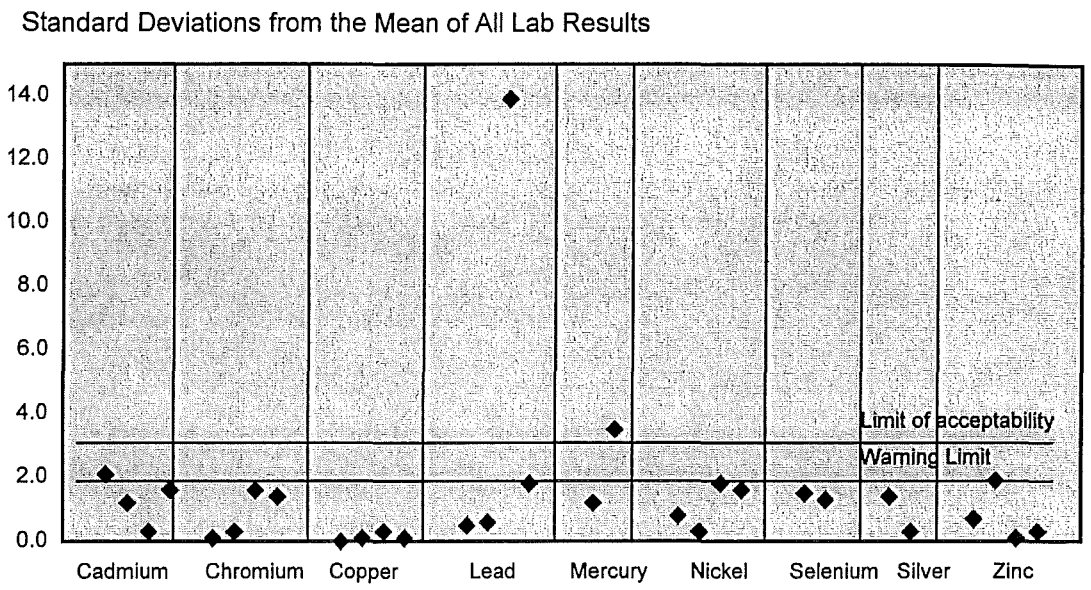
[a] Analytical Products Group, Inc.
[b] Mercury analysis performed by a contract laboratory.

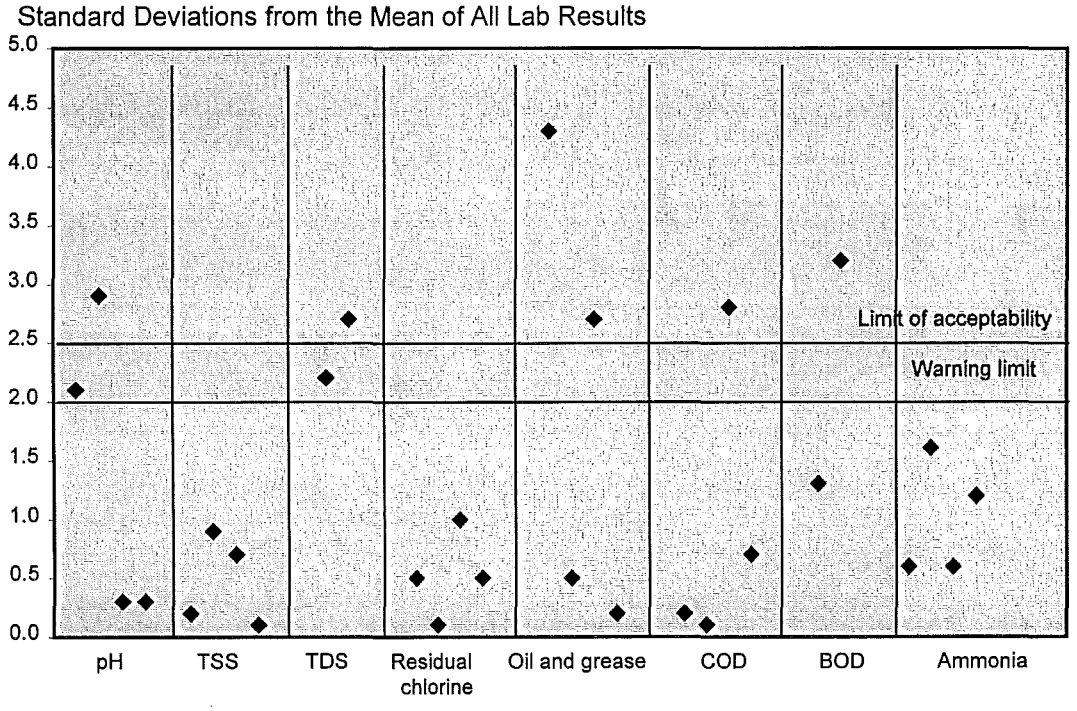
Table 7-4. (continued)

Parameter	Date	MEMP Value	APG[a] Reference Value	Acceptance Range	MEMP Performance Evaluation
Miscellaneous, mg/L					
Residual chlorine	April	0.85	0.81	0.60-1.01	Acceptable
Residual chlorine		2.60	2.61	2.02-3.14	Acceptable
Total suspended solids		27.6	29.1	21.8-32.6	Acceptable
Total suspended solids		388.3	382.8	323.9-418.2	Acceptable
Oil and grease		9.20	33.38	17.78-43.05	Unacceptable
Oil and grease		58.90	68.39	47.08-76.96	Acceptable
Residual chlorine	October	0.50	0.44	0.29-0.60	Acceptable
Residual chlorine		1.39	1.32	1.03-1.63	Acceptable
Total suspended solids		47.3	52.8	41.8-56.7	Acceptable
Total suspended solids		265.0	277.6	224.4-308.8	Acceptable
Total dissolved solids		307.0	338.4	301.7-383.1	Warning
Total dissolved solids		801.0	857.7	803.4-915.1	Unacceptable
Oil and grease		6.79	19.53	7.41-28.52	Unacceptable
Oil and grease		55.30	58.56	39.33-68.70	Acceptable
Demand, mg/L					
Chemical oxygen demand	April	333.0	345.6	276.2-399.3	Acceptable
Chemical oxygen demand		120.0	127.6	87.3-155.6	Acceptable
Biochemical oxygen demand	October	118.0	158.5	83.0-221.9	Acceptable
Biochemical oxygen demand		24.1	66.7	31.1-93.7	Unacceptable
Chemical oxygen demand		295.0	255.1	202.8-290.8	Unacceptable
Chemical oxygen demand		110.0	107.4	74.9-130.0	Acceptable
Nutrients, mg/L					
Ammonia as N	April	2.85	3.01	2.39-3.57	Acceptable
Ammonia as N		6.26	6.99	5.49-8.34	Acceptable
Ammonia as N	October	2.57	2.76	1.96-3.56	Acceptable
Ammonia as N		10.28	12.09	9.29-14.78	Acceptable
pH, standard units					
pH	April	4.67	5.11	4.57-5.67	Warning
pH		5.22	5.77	5.28-6.32	Unacceptable
pH	October	7.51	7.62	6.75-8.10	Acceptable
pH		9.40	9.45	8.40-10.20	Acceptable

[a] Analytical Products Group, Inc.

Figure 7-3. MEMP Performance in the APG Quality Assessment Program for 1997





TSS = Total suspended solids	COD = Chemical oxygen demand
TDS = Total dissolved solids	BOD = Biochemical oxygen demand

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OAC 3750-30. *Hazardous Chemical Reporting.*

OAC 3745-31. *Permits to Install New Sources of Pollution.*

OAC 3745-33. *Ohio National Pollutant Discharge Elimination System Program.*

OAC 3745-35. *Air Permits to Install and Variances.*

OAC 3745-81. *Primary Drinking Water Rules.*

OAC 3745-77. *Title V Permits.*

OAC 3745-82. *Secondary Maximum Contaminant Levels.*

OAC-3745-83. *Operational Requirements.*

OAC 3745-84. *Public Water System Licenses.*

OAC 3745-95. *Backflow Prevention and Cross-Connection Control.*

OAC 3745-100. *Toxic Chemical Release Reporting.*

APPENDIX A

RADIOLOGICAL RELEASE RESULTS

Effluent monitoring focuses on releases from the site, i.e., stack and liquid (wastewater) discharges. Tables summarizing monitoring results from 1997 are presented in this Appendix. The tables show the average concentration and a comparison to a DOE standard. It should be noted that DOE Derived Concentration Guide (DCG) values are not directly applicable to airborne (stack) releases as it is not credible for a receptor to be present at the point of release. For such releases, DCG values are provided for comparative purposes.

Table A-1. Radiological Effluent Data for 1997

Radionuclide	Released to	Activity, Ci	DOE Range[b], Ci
Tritium	Air	802[a]	0 - 190,864
	Water	2.4	0 - 11,556
Plutonium-238	Air	0.000045	0 - 0.002
	Water	0.00045	0 - 0.01
Plutonium-239,240	Air	0.0000001	0 - 0.12
	Water	0.0000024	0 - 0.001
Radon-222	Air	1.36	Not typically measured
Uranium-233,234	Air	0.000000008	0 - 0.00005
	Water	0.00039	0 - 0.1
Uranium-238	Air	0.000000004	0 - 0.00006

[a] Tritium released to air consists of: Tritium oxide, 597 Ci
Elemental tritium, 205 Ci

[b] A range of annual release values reported by various DOE sites.

Table A-2. Average Annual Concentration of Radionuclide Air Emissions in 1997

Stack*	Radionuclide	Average Concentration (μCi/mL)	Average as a Percent of DOE DCG[a]
HH	Tritium	1.86×10^{-7}	185.9
NCDPF	Tritium	1.62×10^{-7}	162.2
SM/PP	Pu-238	9.36×10^{-14}	312.1
	Pu-239,240	2.35×10^{-16}	1.2
SW-1CN	Tritium	5.06×10^{-8}	50.6
	Pu-238	3.24×10^{-18}	0.01
	Pu-239,240	9.83×10^{-19}	0.01
	U-233,234	9.03×10^{-18}	0.01
	U-238	7.18×10^{-19}	0.001
T-West	Tritium	1.18×10^{-7}	117.6
	Pu-238	7.37×10^{-18}	0.03
	Pu-239,240	5.13×10^{-19}	0.003
	U-233,234	2.00×10^{-18}	0.002
	U-238	1.69×10^{-18}	0.002
T-East	Tritium	2.13×10^{-10}	0.20
HEFS	Tritium	4.97×10^{-7}	496.5
	Pu-238	1.04×10^{-17}	0.04
	Pu-239,240	1.11×10^{-18}	0.01
	U-233,234	2.54×10^{-18}	0.003
	U-238	7.83×10^{-19}	0.001
WDA	Tritium	5.27×10^{-9}	5.3
	Pu-238	5.75×10^{-16}	1.9
	Pu-239,240	1.07×10^{-18}	0.01
WDSS	Pu-238	6.05×10^{-18}	0.02
	Pu-239,240	1.10×10^{-18}	0.01
Building 22	Tritium	1.23×10^{-8}	12.3
Building 23	Tritium	1.92×10^{-7}	192.3
	Pu-238	2.41×10^{-16}	0.8
	Pu-239	2.48×10^{-18}	0.01

[a] DOE DCG values in air:
Tritium = 1.0×10^{-7} μCi/mL.
Pu-238 = 3.0×10^{-14} μCi/mL.
Pu-239,240 = 2.0×10^{-14} μCi/mL.
U-233,234 = 9.0×10^{-14} μCi/mL.
U-238 = 1.0×10^{-13} μCi/mL.

Note: DOE DCG values are not directly applicable to airborne (stack) releases as it is not credible for a receptor to be present at the point of release. DCG values are provided for comparative purposes only.

* Sampling locations shown on Figure 4-1.

Table A-3. Average Annual Concentration of Radionuclides in Water Effluents in 1997

Outfall*	Radionuclide	Average Concentration (μCi/mL)	Average as a Percent of DOE DCG[a]
602	Tritium	3.03×10^{-6}	0.15
	Pu-238	7.80×10^{-11}	0.20
	Pu-239,240	1.81×10^{-12}	0.006
	U-233,234	4.53×10^{-10}	0.09
	Th-228	2.80×10^{-12}	0.001
	Th-230	8.60×10^{-12}	0.003
	Th-232	1.20×10^{-12}	0.002
002	Tritium	2.42×10^{-6}	0.12
	Pu-238	8.16×10^{-10}	2.04
	Pu-239,240	3.28×10^{-12}	0.01
	U-233,234	4.54×10^{-10}	0.09
	Th-228	6.90×10^{-11}	0.017
	Th-230	3.80×10^{-11}	0.013
	Th-232	2.50×10^{-11}	0.050
601	Tritium	2.30×10^{-6}	0.12
	Pu-238	1.29×10^{-10}	0.32
	Pu-239,240	1.74×10^{-12}	0.006
	U-233,234	4.55×10^{-10}	0.09
	Th-228	5.50×10^{-12}	0.001
	Th-230	1.70×10^{-12}	0.001
	Th-232	ND	ND
003	Tritium	3.40×10^{-6}	0.17
	Pu-238	6.33×10^{-12}	0.02
	Pu-239,240	1.65×10^{-12}	0.006
	U-233,234	3.67×10^{-10}	0.07
	Th-228	ND	ND
	Th-230	ND	ND
	Th-232	7.60×10^{-12}	0.015

[a] DOE DCG values in water:
Tritium = 2×10^{-3} μCi/mL
Pu-238 = 4×10^{-8} μCi/mL
Pu-239,240 = 3×10^{-8} μCi/mL
U-233,234 = 5×10^{-7} μCi/mL
Th-228 = 4×10^{-7} μCi/mL
Th-230 = 3×10^{-7} μCi/mL
Th-232 = 5×10^{-8} μCi/mL

ND = average results not detected above reagent blanks.

* Sampling locations shown on Figure 4-1.

APPENDIX B

ENVIRONMENTAL SURVEILLANCE PROGRAM RESULTS

The environmental surveillance program focuses on environmental conditions in the area surrounding the site and in local communities. Tables summarizing monitoring results from 1997 are presented in this Appendix. In a number of the tables, results are presented as "incremental concentrations." The designation indicates that an average background concentration, or "environmental" concentration, has been subtracted from those values. Therefore, incremental concentrations represent estimates of MEMP's contribution to the radionuclide content of an environmental sample. Environmental concentrations are shown in Table B-1. Environmental sampling results are organized into tables showing:

- number of samples analyzed during the year,
- minimum concentration measured,
- maximum concentration measured,
- average value with error limits, and, when appropriate,
- a comparison to a DOE or EPA standard.

Table B-1. Environmental Concentrations of Radionuclides in Sample Media in 1997

Radionuclide	Number of Samples	Average Concentration[a]	Unit of Measure
Ambient air[b]			
Tritium oxide	51	5.74 ± 2.17	10^{-12} µCi/mL
Plutonium-238	4	0.06 ± 0.2	10^{-18} µCi/mL
Plutonium-239,240	4	0.43 ± 0.55	10^{-18} µCi/mL
Thorium-238	4	7.37 ± 5.83	10^{-18} µCi/mL
Thorium-230	4	8.3 ± 7.34	10^{-18} µCi/mL
Thorium-232	4	6.57 ± 6.52	10^{-18} µCi/mL
River water[c]			
Tritium	12	0.02 ± 0.06	10^{-6} µCi/mL
Plutonium-238	12	1.91 ± 4.91	10^{-12} µCi/mL
Plutonium-239,240	12	ND	10^{-12} µCi/mL
Uranium-233,234	12	0.78 ± 0.1	10^{-9} µCi/mL
Uranium-238	12	0.69 ± 0.10	10^{-9} µCi/mL
Thorium-228	1	28.0 ± 15.3	10^{-12} µCi/mL
Thorium-230	1	6.0 ± 5.3	10^{-12} µCi/mL
Thorium-232	1	ND	10^{-12} µCi/mL
Pond water[d]			
Tritium	1	ND	10^{-6} µCi/mL
Plutonium-238	1	5.0 ± 2.37	10^{-12} µCi/mL
Plutonium-239,240	1	2.5 ± 4.1	10^{-12} µCi/mL
Sediment			
Plutonium-238 in river sediment[c]	4	2.88 ± 3.51	10^{-9} µCi/g
Plutonium-238 in pond sediment[d]	1	1.1 ± 0.37	10^{-9} µCi/g
Plutonium-239,240 in river sediment[c]	4	1.59 ± 0.98	10^{-9} µCi/g
Plutonium-239,240 in pond sediment[d]	1	0.27 ± 0.18	10^{-9} µCi/g
Thorium-228 in river sediment[c]	4	409.9 ± 207.0	10^{-9} µCi/g
Thorium-228 in pond sediment[d]	1	248.0 ± 19.3	10^{-9} µCi/g
Thorium-230 in river sediment[c]	4	806.8 ± 361.9	10^{-9} µCi/g
Thorium-230 in pond sediment[d]	1	489.0 ± 33.3	10^{-9} µCi/g
Thorium-232 in river sediment[c]	4	456.9 ± 63.3	10^{-9} µCi/g
Thorium-232 in pond sediment[d]	1	227.0 ± 18.7	10^{-9} µCi/g
Foodstuffs[e]			
Tritium in grass	1	0.12 ± 0.13	10^{-6} µCi/g
Tritium in tomatoes	1	0.03 ± 0.06	10^{-6} µCi/g
Plutonium-238 in root crops	1	0.0007 ± 0.0002	10^{-9} µCi/g
Plutonium-239,240 in root crops	1	0.0004 ± 0.0001	10^{-9} µCi/g
Plutonium-238 in fish	1	0.02 ± 0.02	10^{-9} µCi/g
Plutonium-239, 240 in fish	1	0.01 ± 0.02	10^{-9} µCi/g

[a] Error limits are estimates of the standard error or estimated error at 95% confidence level.
[b] Measured 28 mi (45 km) northwest of MEMP.
[c] Measured 25 mi (40 km) upstream of MEMP on the Great Miami River.
[d] Measured 25 mi (40 km) northwest of MEMP.
[e] Measured 30 mi (48 km) north of MEMP.
ND indicates that concentration was not detectable above the average reagent blanks..

Table B-2. Incremental Concentrations[a] of Tritium Oxide in Air in 1997

Location*	Number of Samples	Tritium Oxide 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
Offsite					
101	51	e	40.64	3.08 ± 3.29	0.003
102	52	e	51.14	6.51 ± 3.86	0.007
103	52	e	59.79	4.93 ± 3.85	0.005
104	52	e	26.96	2.93 ± 3.1	0.003
105	49	e	43.57	3.44 ± 3.53	0.003
111	51	e	37.57	2.04 ± 3.38	0.002
112	52	e	24.08	1.03 ± 2.82	0.001
115	49	e	22.99	0.13 ± 2.94	0.0001
118	52	e	39.67	1.92 ± 3.14	0.002
122	51	e	30.73	4.03 ± 3.49	0.004
123	51	e	41.64	6.11 ± 4.16	0.006
124	50	e	41.56	8.58 ± 3.52	0.009
CLN	52	e	27.25	2.02 ± 2.94	0.002
CLS	50	e	31.15	3.65 ± 3.39	0.004
Onsite					
211	49	e	27.08	9.04 ± 3.01	0.009
212	53	e	80.13	11.8 ± 4.50	0.01
213	53	e	39.75	9.91 ± 3.66	0.01
214	53	e	35.32	7.19 ± 3.72	0.007
215	32	e	26.76	6.3 ± 3.58	0.006
216	53	e	18.24	5.77 ± 2.9	0.006
217	49	e	18.92	1.97 ± 2.77	0.002

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for tritium offsite in air is 22 x 10^{-12} µCi/mL. The LDL for tritium in onsite air is 31 x 10^{-12} µCi/mL. The LDL for sample 211 is 35 x 10^{-12} µCi/mL. These differences are due to different calculational methods and propagation of standard deviations due to the number of bubblers in series.

[d] DOE DCG for tritium oxide in air is 100,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Onsite sampling locations shown on Figure 4-4. Offsite sampling locations shown on Figure 4-5.

Table B-3. Incremental Concentrations[a] of Plutonium-238 in Air in 1997

Location*	Number of Samples	Plutonium-238 10^{-18} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
Offsite					
101	4	0.26	0.6	0. 44 ± 0.3	0.001
102	4	1.0	6.69	3.26 ± 3.93	0.01
103	4	0.76	2.26	1.38 ± 1.11	0.005
104	12	0.09	2.27	0.75 ± 0.48	0.003
105	4	0.27	0.83	0.45 ± 0.46	0.002
111	4	e	0.18	0.5 ± 0.26	0.0002
112	4	0.22	0.51	0 .37 ± 0.3	0.001
115	4	e	0.84	0.15 ± 0.76	0.0005
118	4	0.12	0.44	0.27 ± 0.32	0.0009
122	12	e	19.58	4.33 ± 3.46	0.01
123	12	6.37	318.17	65.59 ± 59.85	0.22
124	12	1.02	9.33	3.98 ± 1.68	0.01
CLN	12	0.66	44.34	14.26 ± 8.63	0.05
CLS	12	1.65	28.3	11.92 ± 5.19	0.04
Onsite					
211	12	2.17	33.5	9.31 ± 5.66	0.03
212	12	1.25	5.19	3.02 ± 0.96	0.01
213	12	2.89	141.76	33.35 ± 26.15	0.11
214	12	5.85	56.08	31.89 ± 8.31	0.11
215	9	22.54	81.56	44.66 ± 15.61	0.15
215T	9	41.38	98.76	57.7 ± 14.82	0.19
216	12	1.58	9.87	3.54 ± 1.62	0.01
217	12	0.12	1.93	0.8 ± 0.38	0.003

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for monthly values is 0.5 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.2 x 10^{-18} µCi/mL.

[d] DOE DCG for plutonium-238 in air is 30,000 x 10^{-18} µCi/mL.

[e] Below environmental level.

T = Supplemental sampling height (2m).

* Offsite sampling locations shown on Figure 4-4. Onsite sampling locations shown on Figure 4-5.

Table B-4. Incremental Concentrations[a] of Plutonium-239,240 in Air in 1997

Location*	Number of Samples	Plutonium-239,240 10^{-18} µCi/mL			Average as a percent of DOE DCG[d]
		Minimum	Maximum	Average[b,c]	
Offsite					
101	4	e	e	e	e
102	4	e	1.31	e	e
103	4	e	e	e	e
104	4	e	0.09	e	e
105	4	e	0.45	0.14 ± 0.71	0.0007
111	4	e	1.27	0.06 ± 1.4	0.0003
112	4	e	e	e	e
115	4	e	e	e	e
118	4	e	0.79	e	e
122	12	e	1.67	e	e
123	12	e	0.65	e	e
124	12	e	0.09	e	e
CLN	12	e	0.58	e	e
CLS	12	e	0.22	e	e
Onsite					
211	12	e	0.2	e	e
212	12	e	e	e	e
213	12	e	0.85	e	e
214	12	e	0.1	e	e
215	9	e	0.33	e	e
215T	8	e	0.25	e	e
216	12	e	e	e	e
217	12	e	0.31	e	e

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for monthly values is 0.3 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.1 x 10^{-18} µCi/mL.

[d] DOE DCG for plutonium-239,240 in air is 20,000 x 10^{-18} µCi/mL.

[e] Below environmental level.

T = Supplemental sampling height (2m).

* Onsite sampling locations shown on Figure 4-4. Offsite sampling locations shown on Figure 4-5.

Table B-5. Incremental Concentrations[a] of Thorium-228, Thorium-230, and Thorium-232 in Air in 1997

Location*	Number of Samples	Thorium-228 10^{-18} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[f]
Offsite					
124	12	e	10.63	1.53 ± 6.55	0.004
Onsite					
213	12	e	8.25	1.61 ± 6.22	0.004
215T	9	1.12	11.57	4.38 ± 6.47	0.010
216	12	e	4.8	e	e

Location*	Number of Samples	Thorium-230 10^{-18} µCi/mL Minimum	Maximum	Average[b,d]	Average as a percent of DOE DCG[f]
Offsite					
124	12	g	14.18	2.37 ± 6.97	0.006
Onsite					
213	12	g	13.56	2.77 ± 6.62	0.007
215T	9	g	17.51	6.17 ± 7.90	0.020
216	12	g	7.87	g	g

Location*	Number of Samples	Thorium-232 10^{-18} µCi/mL Minimum	Maximum	Average[b,e]	Average as a percent of DOE DCG[f]
Offsite					
124	12	g	10.35	0.45 ± 6.62	0.006
Onsite					
213	12	g	5.1	0.21 ± 6.15	0.003
215T	9	g	10.04	4.07 ± 6.58	0.060
216	12	g	5.68	g	g

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for monthly values is 0.7 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.2 x 10^{-18} µCi/mL.

[d] LDL for monthly values is 1.1 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.2 x 10^{-18} µCi/mL.

[e] LDL for monthly values is 0.6 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.1 x 10^{-18} µCi/mL.

[f] DOE DCG for thorium-228 and thorium-230 in air is 40,000 x 10^{-18} µCi/mL. The DOE DGC for thorium-232 in air is 7,000 x 10^{-18} µCi/mL.

[g] Below environmental level.

T = Supplemental sampling height (2m).

* Offsite sampling locations shown on Figure 4-4. Onsite sampling locations shown on Figure 4-5.

Table B-6. Incremental Concentrations[a] of Tritium in the Great Miami River and Stream in 1997

Location*	Samples	Minimum	Maximum	Average[b,c]	DOE DCG[d]
2	12	e	0.17	e	e
4	12	e	0.14	e	e
5	12	e	0.19	e	e
7	12	e	1.57	0.48 ± 0.38	0.02
8	12	e	0.89	0.16 ± 0.23	0.008
Mound Ave Storm	11	0.09	0.57	0.31 ± 0.12	0.020

[a] Average environmental level shown in Table B-1 subtracted from the data.
[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.
[c] LDL for tritium in water is 0.77×10^{-6} µCi/mL.
[d] DOE DCG for tritium in water is $2{,}000 \times 10^{-6}$ µCi/mL.
[e] Below environmental level.
* Sampling locations shown on Figure 4-7.

Table B-7. Incremental Concentrations[a] of Plutonium-238 in the Great Miami River in 1997

Location*	Number of Samples	Plutonium-238 10^{-12} µCi/mL			Average as a percent of DOE DCG[d]
		Minimum	Maximum	Average[b,c]	
2	12	e	7.99	e	e
4	12	e	95.09	12.48 ± 18.32	0.03
5	12	e	100.09	5.82 ± 20.09	0.01
7	12	e	58.09	8.47 ± 12.34	0.02
8	12	e	192.99	21.88 ± 34.96	0.05

[a] Average environmental level shown in Table B-1 subtracted from the data.
[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.
[c] LDL for plutonium-238 in river water (including suspended sediment) is 36.0×10^{-12} µCi/mL.
[d] DOE DCG for plutonium-238 in water is $40{,}000 \times 10^{-12}$ µCi/mL.
[e] Below environmental level.
* Sampling locations shown on Figure 4-7.

Table B-8. Concentrations[a] of Plutonium-239,240 in the Great Miami River in 1997

Location*	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL			Average as a percent of DOE DCG[d]
		Minimum	Maximum	Average[b,c]	
2	12	e	15.0	3.94 ± 4.01	0.01
4	12	e	12.3	1.39 ± 2.78	0.005
5	12	e	16.0	0.69 ± 3.66	0.002
7	12	e	10.1	0.73 ± 2.26	0.002
8	12	e	8.0	0.42 ± 2.12	0.001

[a] Average environmental level below reagent blanks.

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

[c] LDL for plutonium-239,240 in river water (including suspended sediment) is 23.1 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-239,240 in water is 30,000 x 10^{-12} µCi/mL.

[e] Below reagent blanks.

* Sampling locations shown on Figure 4-7.

Table B-9. Incremental Concentrations[a] of Uranium-233,234 and Uranium-238 in the Great Miami River in 1997

Location*	Number of Samples	Uranium-233,234 10^{-9} µCi/mL			Average as a percent of DOE DCG[d]
		Minimum	Maximum	Average[b,c]	
2	12	e	0.18	e	e
4	12	e	0.12	e	e
5	12	e	0.16	e	e
7	12	e	0.15	e	e
8	12	e	0.28	e	e

Location*	Number of Samples	Uranium-238 10^{-9} µCi/mL			Average as a percent of DOE DCG[d]
		Minimum	Maximum	Average[b,c]	
2	12	e	0.16	e	e
4	12	e	0.06	e	e
5	12	e	0.1	e	e
7	12	e	0.21	e	e
8	12	e	0.11	e	e

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. The LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[c] DOE DCG for uranium-233,234 in water is 500 x 10^{-9} µCi/mL. The DOE DCG for uranium-238 in water is 600 x 10^{-9} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-10. Incremental Concentrations[a] of Thorium-228, Thorium-230, and Thorium-232 in the Great Miami River in 1997

Location*	Number of Samples	Thorium-228 Value[b,c] 10^{-9} µCi/mL	Value as a percent of DOE DCG[d]
2	1	e	e
4	1	e	e
5	1	e	e
7	1	16.0 ± 22.7	4.0
8	1	7.0 ± 22.2	1.8

Location*	Number of Samples	Thorium-230 Value[a, b.c] 10^{-9} µCi/mL	Value as a percent of DOE DCG[d]
2	1	1.0 ± 7.4	0.3
4	1	28.0 ± 9.6	9.3
5	1	18.0 ± 10.2	6.0
7	1	16.0 ± 8.5	5.3
8	1	e	e

Location*	Number of Samples	Thorium-232 Value[b,c,e] 10^{-9} µCi/mL	Value as a percent of DOE DCG[d]
2	1	3.0 ± 5.1	6.0
4	1	11.0 ± 6.3	22.0
5	1	21.0 ± 8.7	42.0
7	1	9.0 ± 5.9	18.0
8	1	f	f

[a] Average environmental level shown in Table B-1 subtracted from the data.

[b] Estimated error at the 95% confidence level.

[c] LDL for thorium-228 in river water is 154.4 x 10^{-9} µCi/mL. The LDL for thorium-230 in river water is 55.1 x 10^{-9} µCi/mL. The LDL for thorium-232 in river water is 83.5 x 10^{-9} µCi/mL.

[d] DOE DCG for thorium-228 in water is 400 x 10^{-9} µCi/mL. DOE DCG for thorium-230 in water is 300 x 10^{-9} µCi/mL. DOE DC thorium-232 in water is 50 x 10^{-9} µCi/mL.

[e] Below environmental level.

[f] Average environmental level below reagent blanks.

* Sampling locations shown on Figure 4-7.

Table B-11. Concentrations[a] of Tritium in Pond Water in 1997

Location*	Number of Samples	Tritium Value[b,c] 10^{-6} µCi/mL	Value as a percent of DOE DCG[d]
11	1	0.11 ± 0.02	0.006
12	1	0.07 ± 0.02	0.004
14	1	0.04 ± 0.02	0.002
15	1	0.13 ± 0.02	0.007
17	1	0.21 ± 0.02	0.01
18	1	0.24 ± 0.02	0.01

[a] Average environmental level below reagent blanks.

[b] Error limits represent counting error only.

[c] LDL for tritium in pond water is 0.5 x 10^{-6} µCi/mL.

[d] DOE DCG for tritium in water is 2,000 x 10^{-6} µCi/mL.

* Sampling locations shown on Figure 4-7.

Table B-12. Incremental Concentrations[a] of Plutonium-238 in Pond Water in 1997

Location*	Number of Samples	Plutonium-238 Value[b,c] 10^{-12} µCi/mL	Value as a percent of DOE DCG[d]
11	1	e	e
12	1	e	e
14	1	e	e
15	1	1.8 ± 4.12	0.005
17	1	14.0 ± 5.53	0.04
18	1	e	e

[a] Average environmental level shown in Table B-1 subtracted from the data.

[b] Error limits represent counting error only.

[c] LDL for plutonium-238 in pond water is 43.8 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-238 in water is 40,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-13. Concentrations[a] of Plutonium-239,240 in Pond Water in 1997

Location*	Number of Samples	Plutonium-239,240 Value[b,c] 10^{-12} µCi/mL	Value as a percent of DOE DCG[d]
11	1	e	e
12	1	1.9 ± 5.92	0.006
14	1	e	e
15	1	e	e
17	1	e	e
18	1	e	e

[a] Average environmental level below reagent blanks.

[b] Error limits represent counting error only.

[c] LDL for plutonium-239,240 in pond water is 15.7 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-239,240 in water is 30,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-14. Incremental Concentrations[a] of Plutonium-238 in River and Stream Sediments in 1997

Location*	Number of Samples	Plutonium-238 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
2	4	0.53	8.13	3.78 ± 7.01
4	4	170.13	315.83	214.6 ± 108.66
5	4	14.23	27.13	19.45 ± 9.91
7	4	81.83	754.83	404.63 ± 487.12
8	4	29.43	1461.73	680.45 ± 1134.52
Mound Ave Storm	4	60.83	220.23	112.48 ± 116.43

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for plutonium-238 in river sediment is 4.4 x 10^{-9} µCi/g.

* Sampling locations shown on Figure 4-7.

Table B-15. Incremental Concentrations[a] of Plutonium-238 in Pond Sediments in 1997

Location*	Number of Samples	Plutonium-238 Value[b,c] 10^{-9} µCi/g
11	1	0.4 ± 0.61
12	1	1.0 ± 0.59
14	1	1.9 ± 0.7
15	1	7.9 ± 1.13
17	1	67.3 ± 4.48
18	1	3.8 ± 0.88

[a] Average environmental level shown in Table B-1 subtracted from the data.

[b] Error limits represent counting error only.

[c] LDL for plutonium-238 in pond sediment is 4.4 x 10^{-9} µCi/g.

* Sampling locations shown on Figure 4-7.

Table B-16. Incremental Concentrations[a] of Plutonium-239,240 in River and Stream Sediments in 1997

Location*	Number of Samples	Plutonium-239,240 10^{-9} µCi/g		
		Minimum	Maximum	Average[b,c]
2	4	d	d	d
4	4	0.61	4.52	2.57 ± 3.04
5	4	d	3.12	1.42 ± 3.33
7	4	0.52	1.92	1.22 ± 1.49
8	4	d	4.92	2.57 ± 3.92
Mound Ave Storm	4	d	2.72	1.04 ± 2.23

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for plutonium-239,240 in river sediment is 1.6 x 10^{-9} µCi/g.

[d] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-17. Incremental Concentrations[a] of Plutonium-239,240 in Pond Sediments in 1997

Location*	Number of Samples	Plutonium-239,240 Value[b,c] 10^{-9} µCi/g
11	1	2.53 ± 0.6
12	1	4.93 ± 0.76
14	1	1.03 ± 0.49
15	1	4.43 ± 0.76
17	1	1.03 ± 0.46
18	1	0.25 ± 0.39

[a] Average environmental level shown in Table B-1 subtracted from the data.

[b] Error limits represent counting error only.

[c] LDL for plutonium-239,240 in pond sediment is 1.6 x 10^{-9} µCi/g.

* Sampling locations shown on Figure 4-7.

Table B-18. Incremental Concentrations[a] of Thorium-228, Thorium-230, and Thorium-232 in River and Stream Sediments in 1997

Location*	Number of Samples	Thorium-228 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
2	4	d	493.6	50.5 ± 573.1
4	4	d	168.1	48.3 ± 327.8
5	4	d	210.1	60.0 ± 284.2
7	4	12.6	159.1	72.5 ± 231.0
8	4	d	296.1	177.5 ± 302.9
Mound Ave Storm	4	98.1	263.1	170.6 ± 233.9

Location*	Number of Samples	Thorium-230 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
2	4	d	812.3	d
4	4	d	214.3	d
5	4	26.3	161.3	83.3 ± 377.5
7	4	d	218.3	76.0 ± 444.1
8	4	d	331.3	153.1 ± 488.0
Mound Ave Storm	4	d	d	d

Location*	Number of Samples	Thorium-232 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
2	4	d	372.1	d
4	4	d	399.1	48.5 ± 398.0
5	4	d	175.1	50.5 ± 152.3
7	4	d	98.1	37.9 ± 131.7
8	4	d	166.1	93.9 ± 168.6
Mound Ave Storm	4	48.1	274.1	127.6 ± 176.9

[a] Average environmental level shown in Table B-1 subtracted from the data.

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

[c] LDL for thorium-228 in river sediment is 123.5 x 10^{-9} µCi/g. The LDL for thorium-230 in river sediment is 44.1 x 10^{-9} µCi/g. The LDL for thorium-232 in river sediment is 66.8 x 10^{-9} µCi/g.

[d] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-19. Incremental Concentrations[a] of Thorium-228, Thorium-230, and Thorium-232 Pond Sediments in 1997

Location*	Number of Samples	Thorium-228 Value[b,c] 10^{-9} µCi/g
11	1	605.0 ± 58.6
12	1	623.0 ± 67.5
14	1	399.0 ± 54.2
15	1	742.0 ± 78.4
17	1	87.0 ± 36.8
18	1	251.0 ± 45.0

Location*	Number of Samples	Thorium-230 Value[b,c] 10^{-9} µCi/g
11	1	843.0 ± 89.8
12	1	621.0 ± 86.7
14	1	111.0 ± 57.9
15	1	549.0 ± 86.1
17	1	d
18	1	185.0 ± 61.8

Location*	Number of Samples	Thorium-232 Value[b,c] 10^{-9} µCi/g
11	1	626.0 ± 58.4
12	1	701.0 ± 71.2
14	1	373.0 ± 54.0
15	1	633.0 ± 69.9
17	1	281.0 ± 46.6
18	1	224.0 ± 41.7

[a] Average environmental level shown in Table B-1 subtracted from the data.

[b] Estimated error at the 95% confidence level.

[c] LDL for thorium-228 in pond sediment is 155.1 x 10^{-9} µCi/g. The LDL for thorium-230 in pond sediment is 55.8 x 10^{-9} µCi/g. The LDL for thorium-232 in pond sediment is 84.3 x 10^{-9} µCi/g.

[d] Below environmental level.

* Sampling locations shown on Figure 4-7.

Table B-20. Incremental Concentrations[a] of Tritium in Foodstuffs in 1997

Location*	Type of Sample	Number of Samples	Tritium 10^{-6} µCi/g			
			Value[e]	Minimum	Maximum	Average[b,c]
Centerville	Tomatoes	2		d	0.05	0.01 ± 0.08
Springboro	Tomatoes	1	d			
Germantown	Tomatoes	2		d	d	d
Miamisburg	Tomatoes	2		0.01	0.13	0.07 ± 0.08
Camden	Tomatoes	1	d			
102	Grass	1	0.65 ± 0.22			
103	Grass	1	0.26 ± 0.20			
112	Grass	1	d			
123	Grass	1	0.18 ± 0.19			
124	Grass	1	d			
212	Grass	1	0.53 ± 0.20			

[a] The average environmental level shown in Table B-1 subtracted from the data.

[b] Error limits are counting error at the 95% confidence level.

[c] LDL for tritium in tomatoes is 0.4 x 10^{-6} µCi/g. LDL for tritium in grass is 0.1 x 10^{-6} µCi/g.

[d] Below environmental level.

[e] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

* Grass sampling locations are coincident with air sampling locations. Air sampling locations are shown on Figures 4-4 and 4-5.

Table B-21. Incremental Concentrations[a] of Plutonium-238 in Foodstuffs in 1997

Location	Type of Sample	Number of Samples	Plutonium-238 10^{-9} µCi/g Value[e]	Minimum	Maximum	Average[b,c]
Centerville	Root crops	1	d			
Germantown	Root crops	2		d	d	d
Miamisburg	Root crops	1	d			
Overflow Creek	Fish	1	0.23 ± 0.06			

[a] Environmental level shown in Table B-1 subtracted from the data.

[b] Error limit is the counting error at the 99% confidence level.

[c] The LDL for plutonium-238 in root crops is 0.4 x 10^{-9} µCi/g. The LDL for plutonium-238 in fish is 0.4 x 10^{-9} µCi/g.

[d] Below environmental level.

[e] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

Table B-22. Incremental Concentrations[a] of Plutonium-239,240 in Foodstuffs in 1997

Location	Type of Sample	Number of Samples	Plutonium-239,240 10^{-9} µCi/g Value[e]	Minimum	Maximum	Average[b,c]
Centerville	Root crops	1	d			
Germantown	Root crops	2		d	d	d
Miamisburg	Root crops	1	d			
Overflow Creek	Fish	1	0.009 ± 0.03			

[a] Environmental level shown in Table B-1 subtracted from the data.

[b] Error limit is the counting error at the 99% confidence level.

[c] The LDL for plutonium-239,240 in root crops is 0.1 x 10^{-9} µCi/g. The LDL for plutonium-239, 240 in fish is 0.1 x 10 x 10^{-9} µCi/g.

[d] Below environmental level.

[e] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

APPENDIX C

NONRADIOLOGICAL MONITORING RESULTS

Effluent and environmental samples are analyzed for nonradiological parameters. Tables summarizing monitoring results from 1997 are presented in this Appendix. Nonradiological airborne effluent rates are calculated using a mass balance approach and the annual emission rate is reported as a percent of the applicable EPA standard. The remainder of the tables show:

- number of samples analyzed during the year,
- minimum concentration measured,
- maximum concentration measured,
- average value, and, when appropriate,
- a comparison to a DOE or EPA standard.

Table C-1. Nonradiological Air Emissions Data for 1997

Pollutant	Emission Rate (tons/yr) [b]	Emission Threshold Limit (tons/yr) [a]	% of Standard
Total suspended particulates	9.9	100	9.9
Sulfur oxides	2.9	250	1.1
Nitrogen oxides	19.6	100	19.6
VOCs	1.0	100	1.0
Carbon monoxide	5.4	250	2.1
Lead	0.001	0.6	1.6

[a] Threshold limits defined in 40 CFR Part 70 and Ohio Administrative Code 3745-77, Title V Permits
[b] Emission rates are calculated using a material balance approach or AP-42 (EPA, 1985) emission factors.

Table C-2. 1997 Particulate Air Concentrations

Sampling Location*	Number of Samples	Particulate Concentration ($\mu g/m^3$) Minimum	Particulate Concentration ($\mu g/m^3$) Maximum	Arithmetic Average[a, b] ($\mu g/m^3$)
Offsite				
101	52	19	51	35 ± 2
102	52	17	58	31 ± 3
103	51	14	48	24 ± 2
104	52	16	47	27 ± 2
105	50	13	41	25 ± 2
111	51	16	65	32 ± 3
112	52	14	36	25 ± 1
115	50	14	40	25 ± 2
118	50	14	43	25 ± 2
119[c]	50	9	68	26 ± 3
122	52	16	38	26 ± 2
123	51	17	58	32 ± 2
124	50	17	74	33 ± 4
CLN	50	21	52	35 ± 2
CLS	50	21	50	32 ± 2
Onsite				
211	53	15	60	28 ± 2
212	53	12	40	25 ± 2
213	46	14	64	33 ± 3
214	53	14	60	32 ± 3
215	35	13	87	42 ± 7
215T	35	16	100	53 ± 8
216	53	14	45	28 ± 2
217	50	14	45	27 ± 2

[a] Values are weekly averages. Error limits are estimates of the standard error of the estimated mean at the
[b] Ohio ambient air quality standard is 50 $\mu g/m^3$ (3-year average).
[c] Background location.
* Sampling locations shown on Figures 4-4 and 4-5 for onsite and offsite sampling stations, respectively.

Table C-3. NPDES Permit and ATD Data for 1997

Sampling Location *	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limit	
						Daily	Monthly Average
Outfall 601 Parameters							
Flow rate, MGD	f	0.02	0.104	0.046	0.059	n/a	n/a
pH, s.u.	198	5.6	8.7	7.6	8.1	6.5-9.0	n/a
Chlorine: total[a], mg/L	102	<0.01	0.22	<0.01	0.02	0.5	n/a
Suspended Solids[b], mg/L	100	<1	14.5	3.4	7.7	30	15
Fecal coliform[a], n/100mL	26	1	240	13	18	2000	1000
Ammonia, mg/L as N	24	<0.09	6.8	0.56	4.01	n/a	n/a
$CBOD_5$, mg/L	103	<1.0	88	3.3	15.0	15	10
Oil and grease[c], mg/L	4	<1	<1	<1	<1	n/a	n/a
Cadmium, µg/L	46	<10	10	<10	<10	n/a	n/a
Chromium, µg/L	46	<15	50	<15	35	n/a	n/a
Copper, µg/L	48	35	415	141	287	n/a	n/a
Nickel, µg/L	46	<15	50	19	50	n/a	n/a
Lead, µg/L	46	<15	91	<15	58	n/a	n/a
Zinc, µg/L	46	<15	169	49	103	n/a	n/a
Mercury[d], µg/L	1	<0.2	<0.2	<0.2	<0.2	n/a	n/a
VOCs[c,e]	4	ND	4.1	1.45	4.1	n/a	n/a
Outfall 602 Parameters							
Flow rate, MGD	f	0.0	0.260	0.119	0.137	n/a	n/a
pH, s.u.	50	7.1	8.7	8.2	8.5	6.5-9.0	n/a
Suspended solids[b], mg/L	48	<1	34.9	3.2	14.3	45	30
Chemical oxygen demand, mg/L	50	2	719	137	247	n/a	n/a
Oil and grease, mg/L	12	<1	6.5	2.2	6.5	10	n/a

[a] Summer months only (May 1 through October 31).

[b] Limit n/a if > 0.25 inches of rainfall 3 days during the week.

[c] Quarterly samples collected in Mar., Jun., Aug., Dec.

[d] Semi-annual samples collected in June and December.

[e] Chloroform results reported (no other compounds detected).

[f] Continuous.

n/a = not applicable, no permit limits.

MGD = million gallons per day.

* Sampling locations shown on Figure 5-1.

Note: New NPDES permit parameters went into effect

Table C-3. (continued)

Sampling Location*	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limit	
						Daily	Monthly Average
Outfall 002 Parameters							
Flow rate, MGD	f	0.0	2.320	0.376	0.530	n/a	n/a
pH, s.u.	52	7.2	8.9	8.0	8.4	6.5-9.0	n/a
Suspended solids[b], mg/L	49	<1	92.8	11.9	26.8	45	30
Outfall 001 Parameters							
Flow rate, MGD	f	0.041	0.307	0.165	0.187	n/a	n/a
pH, s.u.	27	7.2	8.6	8.0	8.3	6.5-9.0	n/a
Residual chlorine[a], mg/L	32	<0.01	0.22	<0.01	0.04	0.038	n/a
Cyanide, µg/L	12	<5	<5	<5	<5	0.083	0.023
Pentachlorophenol, µg/L	10	<10	<10	<10	<10	n/a	n/a
Bis (2-ethylhexyl) phthalate, µg/L	10	<5	5.8	<5	5.8	n/a	n/a
Cadmium, µg/L	44	<10	26	<10	26	43	n/a
Chromium, µg/L	44	<15	34	<15	19	878	546
Copper, µg/L	44	27	190	69	105	120	n/a
Nickel, µg/L	44	<15	173	36	173	1261	760
Lead, µg/L	44	<15	44	<15	15	305	191
Zinc, µg/L	44	<15	111	39	69	n/a	n/a

[a] Summer months only (May 1 through October 31).

[b] Limit n/a if > 0.25 inches of rainfall 3 days during the week.

f Continuous.

n/a = not applicable, no permit limits.

MGD = million gallons per day.

* Sampling locations shown on Figure 5-1.

Note: New NPDES permit parameters went into effect November 1, 1997.

Table C-3. (continued)

Sampling Location*	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	ATD Limit Daily	ATD Limit Monthly Average
Outfall 003 Parameters							
Flow rate, MGD	c	0.0	0.205	0.138	0.154	n/a	n/a
pH, s.u.	47	7.0	8.2	7.7	8.0	6.5-9.0	n/a
Dissolved oxygen, mg/L	22	10.1	13.3	10.9	11.9	n/a	n/a
Dissolved solids, mg/L	10	594	743	667	731	n/a	n/a
Suspended solids, mg/L	10	<1	2.1	<1	1.1	45	30
$CBOD_5$, mg/L	9	<1	1.7	<1	1.7	n/a	n/a
Mercury, µg/L	44	<0.2	1.1	<0.2	0.3	2.2	0.023
Selenium, µg/L	6	<100	140	<100	<100	n/a	n/a
Silver, µg/L	6	<40	<40	<40	<40	n/a	n/a
Chromium, µg/L	45	<15	28	<15	<15	9800	1100
Copper, µg/L	45	<15	<15	<15	<15	120	65
Nickel, µg/L	22	<15	83	21	56	n/a	n/a
Lead, µg/L	22	<15	99	23	52	n/a	n/a
Zinc, µg/L	22	<15	22	<15	<15	n/a	n/a
VOCs, µg/L	<1	<1	<1	<1	<1	10	5
Bis (2-ethylhexyl) phthalate [a], µg/L	2	<5	<5	<5	<5	n/a	n/a
Ceriodaphnia dubia [b]							
acute, TU	4	ND	ND	ND	ND	1.0	n/a
chronic, TU	4	ND	1.4	1.0	1.4	2.8	n/a
Pimephales promelas [b]							
acute, TU	4	ND	ND	ND	ND	1.0	n/a
chronic, TU	4	ND	ND	ND	ND	2.8	n/a

[a] Quarterly samples collected in Mar., Jun., Aug., Dec.

[b] Toxicity samples collected bimonthly.

[c] Continuous.

TU = toxicity units.

* Sampling locations shown on Figure 5-1.

ND = below minimum detection limit.

n/a = not applicable, no permit limits.

MGD = million gallons per day.

APPENDIX D

GROUNDWATER MONITORING RESULTS

Groundwater samples are collected from onsite and offsite drinking water supplies, monitoring wells, and seeps. These samples are analyzed for radionuclides, volatile organic compounds (VOCs), and inorganic substances. Results of groundwater monitoring activities in 1997 are presented in this Appendix. DOE or EPA standards for drinking water are also provided for comparison. Such standards are established to protect drinking water supplies. It should be noted that for monitoring wells, these standards are provided for reference only as these wells do not serve as sources of drinking water.

Radionuclide results tables show the number of samples analyzed during the year, minimum and maximum concentrations measured, and the average value with error limits. Because of the large volume of nonradiological data for onsite monitoring wells, VOC and inorganic results have been summarized. Data for onsite monitoring wells have only been included in the tables if detectable levels of VOCs or inorganics were observed during one of the sampling events (all VOCs are included; inorganic parameters which have been assigned an MCL are included).

Table D-1. Environmental Concentrations of Radionuclides in Groundwater in 1997

Radionuclide	Number of Samples	Average Concentration [a, b]	Unit of Measure
Tritium	12	0.09 ± 0.08	nCi/L
Plutonium-238	12	0.0013 ± 0.0047	10^{-9} µCi/mL
Plutonium-239,240	12	0.0025 ± 0.0039	10^{-9} µCi/mL
Uranium-233,234	12	0.54 ± 0.08	10^{-9} µCi/mL
Uranium-238	12	0.42 ± 0.07	10^{-9} µCi/mL

[a] Measured 25 mi (40 km) north of MEMP in Tipp City.

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

[c] Not measured.

Table D-2. Tritium Concentrations in Offsite Drinking Water and Private Wells in 1997

Sampling Location*	Historic Designation	Number of Samples	Tritium nCi/L			Average as a % of the EPA Standard [c]
			Minimum	Maximum	Average [a,b]	
0904	J-1	9	0.06	0.43	0.25 ± 0.10	1.3
0905	Tr-1	7	d	0.29	0.17 ± 0.10	0.9
0906	B-R	4	1.10	1.66	1.34 ± 0.37	6.7
0907	B-H	6	0.57	0.88	0.69 ± 0.11	3.5
0909[e]	MCD	11	d	0.24	0.13 ± 0.06	0.7
0912	MSBG2	7	0.75	4.54	2.60 ± 1.28	13.0
Franklin[e]		12	d	0.25	0.10 ± 0.08	0.5
Germantown[e]		12	d	0.25	0.06 ± 0.07	0.3
Miamisburg[e]		12	0.08	0.38	0.28 ± 0.06	1.4
Middletown[e]		12	d	0.20	0.05 ± 0.08	0.3
Springboro[e]		12	0.04	0.39	0.17 ± 0.07	0.9
W. Carrollton[e]		12	d	0.17	0.05 ± 0.05	0.3

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

[b] LDL for tritium in private well water is 0.8 nCi/L. LDL for tritium in community drinking water is 0.5 nCi/L.

[c] The EPA standard for tritium in drinking water is 20 nCi/L.

[d] Below the blank value.

[e] Drinking water supply.

* Well locations shown on Figure 6-2.

Table D-3. Plutonium Concentrations in Offsite Drinking Water in 1997

Sampling Location*	Number of Samples	Plutonium-238 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
Miamisburg	12	d	0.0095	d	d

Sampling Location*	Number of Samples	Plutonium-239,240 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
Miamisburg	12	d	0.0082	0.0010 ± 0.0029	0.08

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

[b] LDL for plutonium-238 in well water is 0.028 x 10^{-9} µCi/mL. LDL for plutonium-239,240 in well water is 0.018 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238, and plutonium-239,240 are 1.6 x 10^{-9} µCi/mL and 1.2 x 10^{-9} µCi/mL, respectively.

[d] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-4. Uranium Concentrations in Offsite Drinking Water in 1997

Sampling Location*	Number of Samples	Uranium-233,244 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x the DOE DCG [c]
Miamisburg	12	0.516	0.682	0.608 ± 0.037	3.1

Sampling Location*	Number of Samples	Uranium-238 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x the DOE DCG [c]
Miamisburg	12	0.440	0.702	0.511 ± 0.044	2.1

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

[b] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA drinking water dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

* Well locations shown on Figure 6-2.

Table D-5. Tritium Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Tritium nCi/L				Average as a % of the EPA Standard [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0123	1	0.49				2.5
0127	4		e	0.66	0.17 ± 0.33	0.9
0128	3		0.13	1.29	0.67 ± 0.59	3.4
0129	4		0.43	1.61	1.08 ± 0.50	5.4
0302	2		2.87	3.67	3.27 ± 0.57	16.4
0303	4		8.98	9.91	9.32 ± 0.42	46.6
0343	2		8.93	16.05	12.49 ± 5.04	62.5
0376	4		0.85	1.98	1.62 ± 0.53	8.1
0377	4		0.23	1.25	0.77 ± 0.42	3.9
0378	2		0.39	1.17	0.78 ± 0.55	3.9
0383	1	0.16				0.8
0389	1	4.88				24.4
0392	1	13.64				68.2

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] LDL for tritium in monitoring wells is 0.5 nCi/L.

[d] The EPA standard for tritium in drinking water is 20 nCi/L.

[e] Below the blank value.

* Well locations shown on Figure 6-2.

Table D-6. Plutonium Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Plutonium-238 10^{-9} µCi/mL				Average as a % of 0.04 x the DOE DCG [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0129	2		0.004	0.018	0.011 ± 0.010	0.7
0303	2		0.003	0.006	0.004 ± 0.002	0.3
0343	1	0.104				6.5
0376	2		0.003	0.022	0.013 ± 0.013	0.8
0377	2		0.002	0.074	0.038 ± 0.051	2.4
0383	1	0.008				0.5

Well I.D.*	Number of Samples	Plutonium-239,240 10^{-9} µCi/mL				Average as a % of 0.04 x the DOE DCG [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0129	2		0.001	0.008	0.005 ± 0.005	0.4
0303	2		e	0.001	e	e
0343	1	0.003				0.3
0376	2		0.003	0.006	0.004 ± 0.002	0.3
0377	2		0.003	0.003	0.003	0.2
0383	1	0.003				0.3

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] LDL for plutonium-238 in well water is 0.028 x 10^{-9} µCi/mL. LDL for plutonium-239,240 in well water is 0.018 x 10^{-9} µCi/mL.

[d] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238, and plutonium-239,240 are 1.6 x 10^{-9} µCi/mL and 1.2 x 10^{-9} µCi/mL, respectively.

[e] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-7. Uranium Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Uranium-233,234 10^{-9} µCi/mL Value[a]	Minimum	Maximum	Average [b,c]	Average as a % of 0.04 x the DOE DCG[d]
0129	2		0.205	0.213	0.209 ± 0.006	1.0
0303	2		0.046	0.083	0.065 ± 0.026	0.3
0343	1	0.073				0.4
0376	2		0.293	0.300	0.297 ± 0.005	1.5
0377	2		0.110	0.368	0.239 ± 0.182	1.2
0383	1	0.178				0.9

Well I.D.*	Number of Samples	Uranium-238 10^{-9} µCi/mL Value[a]	Minimum	Maximum	Average [b,c]	Average as a % of 0.04 x the DOE DCG [d]
0129	2		0.154	0.160	0.157 ± 0.004	0.7
0303	2		0.025	0.075	0.050 ± 0.035	0.2
0343	1	0.045				0.2
0376	2		0.189	0.270	0.230 ± 0.051	1.0
0377	2		0.124	0.287	0.206 ± 0.115	0.9
0383	1	0.124				0.5

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[d] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA drinking water dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

* Well locations shown on Figure 6-2.

Table D-8. Thorium Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Thorium-228 10^{-9} µCi/mL				Average as a % of 0.04 x DOE DCG [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0129	2		e	0.033	e	e
0303	2		e	0.028	e	e
0343	1	0.205				1.3
0376	2		e	0.140	0.058 ± 0.116	0.4
0377	2		e	0.875	0.364 ± 0.723	2.3
0387	1	0.122				0.8

Well I.D.*	Number of Samples	Thorium-230 10^{-9} µCi/mL				Average as a % of 0.04 x DOE DCG [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0129	2		e	e	e	e
0303	2		e	0.031	0.006 ± 0.035	0.05
0343	1	0.018				0.2
0376	2		0.010	0.012	0.011 ± 0.001	0.1
0377	2		e	0.073	0.031 ± 0.060	0.3
0383	1	0.005				0.04

Well I.D.*	Number of Samples	Thorium-232 10^{-9} µCi/mL				Average as a % of 0.04 x DOE DCG [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0129	2		0.003	0.015	0.009 ± 0.009	0.4
0303	2		e	0.080	0.035 ± 0.063	1.8
0343	1	0.034				1.7
0376	2		e	0.022	0.002 ± 0.028	0.1
0377	2		e	0.116	0.045 ± 0.101	2.2
0383	1	0.016				0.8

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.
[b] Error limits are one standard deviation of the estimated mean.
[c] LDL for thorium-228 is 0.154 x 10^{-9} µCi/mL. LDL for thorium-230 is 0.055 x 10^{-9} µCi/mL. LDL for thorium-232 is 0.084 x 10^{-9} µCi/mL.
[d] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCGs for thorium-228, thorium-230, and thorium-232 are 16 x 10^{-9} µCi/mL, 12 x 10^{-9} µCi/mL, and 2 x 10^{-9} µCi/mL respectively.
[e] Below reagent blank.
* Well locations shown on Figure 6-2.

Table D-9. VOC Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL
0123		NS	a	
0129	1,1,1-Trichloroethane	0.66	0.61	200
0302		a	a	
0303		a	a	
0343		a	a	
0376	1,1,1-Trichloroethane	0.48	0.45	200
0377	1,1,1-Trichloroethane	20.50	20.25	200
0378	1,1,1-Trichloroethane	14.00	4.70	200
0383	Chloroform	NS	0.88	100
0389	Trichloroethene	NS	5.50	5
	Tetrachloroethene	NS	0.51	5
0392	Trichloroethene	NS	1.20	5
	Tetrachloroethene	NS	0.31	5

[a] Results below the method detection limit.

MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).

NS = Not sampled.

* Well locations shown on Figure 6-2.

Table D-10. Inorganic Concentrations in Offsite Monitoring Wells in 1997

Well I.D.*	Compound	µg/L		
		2nd Quarter	4th Quarter	MCL
0123	Manganese	NS	372	50 [b]
0129	Aluminum	1681	28.9	50-200 [c]
	Chromium	246	30	100 [a]
	Iron	e	465	300 [b]
	Lead	67	2	15 [d]
	Manganese	67	15	50 [b]
	Nickel	275	39	100 [a]
0302	Aluminum	1681	362	50-200 [c]
	Iron	3952	2350	300 [b]
	Lead	10	2	15 [d]
	Manganese	323	57	50 [b]
0303	Aluminum	35	1752	50-200 [c]
	Iron	4660	7330	300 [b]
	Lead	4	2	15 [d]
	Manganese	323	417	50 [b]
0343	Aluminum	107	54	50-200 [c]
	Iron	3905	4070	300 [b]
	Lead	14	e	15 [d]
	Manganese	402	402	50 [b]
0376	Aluminum	20	7	50-200 [c]
	Chromium	246	6	100 [a]
	Iron	5090	255	300 [b]
	Manganese	67	e	50 [b]
	Nickel	275	251	100 [a]
0377	Aluminum	26	7	50-200 [c]
	Chromium	3530	1	100 [a]
	Iron	50600	24	300 [b]
	Manganese	506	3	50 [b]
	Nickel	989	83	100 [a]

[a] Primary Maximum Contaminant Level.

[b] Secondary Maximum Contaminant Level.

[c] The secondary MCL for aluminum is a range; final MCL values have not been established.

[d] Action level.

[e] Results below the method detection limit.

MCL = Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).

NS = Not sampled.

* Well locations shown on Figure 6-2.

Table D-10. (continued)

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL
0378	Aluminum	47	11	50-200 [c]
	Chromium	292	143	100 [a]
	Iron	6230	3080	300 [b]
	Manganese	61	55	50 [b]
	Nickel	243	234	100 [a]
0383	Iron	NS	128	300 [b]
	Nickel	NS	63	100 [a]
0389	Aluminum	NS	25	50-200 [c]
0392	Aluminum	NS	326	50-200 [c]
	Chromium	NS	119	100 [a]
	Iron	NS	1270	300 [b]
	Manganese	NS	41	50 [b]
	Nickel	NS	90	100 [a]

[a] Primary Maximum Contaminant Level.

[b] Secondary Maximum Contaminant Level.

[c] The secondary MCL for aluminum is a range; final MCL values have not been established.

MCL = Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).

NS = Not sampled.

* Well locations shown on Figure 6-2.

Table D-11. Tritium Concentrations in Onsite Production Wells in 1997

Well I.D.*	Historic Designation	Number of Samples	Tritium nCi/L			Average as a % of EPA Standard [c]
			Minimum	Maximum	Average [a,b]	
0071	1	47	0.3	2.0	0.9 ± 0.1	4.5
0271	2	47	0.4	1.6	1.0 ± 0.1	5.0
0076	3	43	0.1	2.5	0.9 ± 0.2	4.5

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

[b] LDL for tritium in onsite well water is 0.9 nCi/L.

[c] The EPA standard for tritium in drinking water is 20 nCi/L.

* Well locations shown on Figure 6-2.

Table D-12. Plutonium Concentrations in Onsite Production Wells in 1997

Well I.D.*	Historic Designation	Number of Samples	Plutonium-238 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
			Minimum	Maximum	Average [a,b]	
0071	1	17	d	0.0073	d	d
0271	2	17	d	0.0141	0.0021 ± 0.0031	0.1
0076	3	22	d	0.0583	0.0039 ± 0.0063	0.2

Well I.D.*	Historic Designation	Number of Samples	Plutonium-239,240 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
			Minimum	Maximum	Average [a,b]	
0071	1	17	d	0.0061	0.0013 ± 0.0012	0.1
0271	2	17	d	0.0092	0.0012 ± 0.0016	0.1
0076	3	22	d	0.0161	0.0011 ± 0.0021	0.1

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

[b] LDL for plutonium-238 in drinking water is 0.028 x 10^{-9} µCi/mL. LDL for plutonium-239,240 in well water is 0.018 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238, and plutonium-239,240 are 1.6 x 10^{-9} µCi/mL and 1.2 x 10^{-9} µCi/mL, respectively.

[d] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-13. Uranium Concentrations in Onsite Production Wells in 1997

Well I.D.*	Historic Designation	Number of Samples	Uranium-233,234 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
			Minimum	Maximum	Average [a,b]	
0071	1	12	0.179	0.293	0.231 ± 0.023	1.2
0271	2	12	0.144	0.272	0.199 ± 0.025	1.0
0076	3	11	0.173	0.340	0.251 ± 0.031	1.3

Well I.D.*	Historic Designation	Number of Samples	Uranium-238 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
			Minimum	Maximum	Average [a,b]	
0071	1	12	0.149	0.244	0.188 ± 0.018	0.8
0271	2	12	0.151	0.270	0.194 ± 0.027	0.8
0076	3	11	0.160	0.291	0.205 ± 0.024	0.9

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

[b] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA drinking water dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

* Well locations shown on Figure 6-2.

Table D-14. Thorium Concentrations in Onsite Production Wells in 1997

Well I.D.*	Historic Designation	Number of Samples	Thorium-228 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x DOE DCG [c]
0071	1	4	d	0.036	d	d
0271	2	4	d	0.039	d	d
0076	3	4	d	0.216	0.041 ± 0.199	0.3

Well I.D.*	Historic Designation	Number of Samples	Thorium-230 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x DOE DCG [c]
0071	1	4	d	0.018	d	d
0271	2	4	d	d	d	d
0076	3	4	d	0.083	0.025 ± 0.074	0.2

Well I.D.*	Historic Designation	Number of Samples	Thorium-232 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x DOE DCG [c]
0071	1	4	d	0.010	d	d
0271	2	4	d	0.022	0.0001 ± 0.027	0.007
0076	3	4	d	0.034	0.007 ± 0.048	0.4

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

[b] LDL for thorium-228 in drinking water is 0.154 x 10^{-9} µCi/mL. LDL for thorium-230 in well water is 0.055 x 10^{-9} µCi/mL. LDL for thorium-232 in drinking water is 0.084 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for thorium-228, thorium-230, and thorium-232 are 16 x 10^{-9} µCi/mL, 12 x 10^{-9}, and 2 x 10^{-9} µCi/mL, respectively.

[d] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-15. VOC Concentrations in Onsite Production Wells in 1997

Well I.D.*	Historic Designation	Compound	Number of Samples	µg/L			
				Minimum	Maximum	Average [a]	MCL
0071	1	1,1,1-Trichloroethane	6	b	1.5	0.8 ± 0.7	200
		cis-1,2-Dichloroethene	6	b	1.5	0.6 ± 0.7	70
		Trichloroethene	6	1.1	3.8	2.2 ± 1.2	5
		Tetrachloroethene	6	b	1.8	0.9 ± 1.0	5
0271	2	1,1,1-Trichloroethane	7	1.8	3.2	2.3 ± 0.6	200
		cis-1,2-Dichloroethene	7	b	1.4	0.7 ± 0.7	70
		Trichloroethene	7	b	3.9	2.5 ± 1.6	5
		Tetrachloroethene	7	b	2.2	1.3 ± 1.0	5
0076	3	1,1,1-Trichloroethane	7	b	0.6	0.2 ± 0.3	200
		Chloroform	7	b	4.1	0.6 ± 1.5	100
		Trichloroethene	7	0.8	1.2	1.1 ± 0.1	5

[a] Error limits are one standard deviation of the estimated mean.

[b] Results below the method detection limit.

MCL = Maximum Contaminant Level (based on EPA Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-16. Tritium Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Tritium nCi/L				Average as a % of the EPA Standard [d]
		Value[a]	Minimum	Maximum	Average [b,c]	
0111	2		0.96	1.20	1.08 ± 0.17	5.4
0119	2		1.39	2.09	1.74 ± 0.50	8.7
0125	2		1.22	1.33	1.28 ± 0.08	6.4
0158	1	0.66				3.3
0305	3		1.00	1.57	1.38 ± 0.33	6.9
0313	3		2.74	6.82	4.22 ± 2.26	21.1
0314	2		1.41	2.98	2.20 ± 1.11	11.0
0317	3		1.40	1.51	1.44 ± 0.06	7.2
0345	2		0.10	0.91	0.51 ± 0.57	2.5
0346	2		4.02	4.16	4.09 ± 0.10	20.5
0353	2		1.14	13.3	7.22 ± 8.60	36.1
0370	3		0.51	4.38	2.84 ± 2.05	14.2
0373	3		1.00	4.30	3.00 ± 1.76	15.0
0379	2		3.81	5.14	4.48 ± 0.95	22.4
0382	1	0.38				1.9
0397	1	1.10				5.5
0410	1	0.74				3.7
0415	1	0.51				2.6
0416	1	0.81				4.1
0417	1	0.81				4.1
0418	1	0.34				1.7
0419	1	0.68				3.4
0421	1	1.88				9.4
0422	1	5.52				27.6
0423	1	1.19				6.0
0424	1	0.85				4.3
0425	1	0.55				2.8
P015	1	2.98				14.9
P027	1	0.64				3.2
P031	1	0.29				1.5
P043	1	4.13				20.7
P044	1	0.82				4.1
P045	1	0.66				3.3
P046	1	1.91				9.6

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] LDL for tritium in monitoring wells is 0.5 nCi/L.

[d] The EPA standard for tritium in drinking water is 20 nCi/L.

* Well locations shown on Figure 6-2.

Table D-17. Plutonium Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Plutonium-238 10^{-9} µCi/mL			Average as a % of 0.04 x DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
0111	2	0.003	0.014	0.008 ± 0.008	0.5
0119	2	d	0.010	0.005 ± 0.008	0.3
0125	2	0.003	0.008	0.006 ± 0.004	0.4
0314	2	0.012	0.015	0.014 ± 0.002	0.8
0345	2	0.007	0.008	0.008 ± 0.001	0.5
0346	2	0.002	0.005	0.004 ± 0.002	0.2

Well I.D.*	Number of Samples	Plutonium-239,240 10^{-9} µCi/mL			Average as a % of 0.04 x DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
0111	2	d	d	d	d
0119	2	0.002	0.005	0.003 ± 0.002	0.3
0125	2	d	0.004	0.002 ± 0.004	0.1
0314	2	d	0.004	d	d
0345	2	d	0.001	d	d
0346	2	d	0.005	0.002 ± 0.003	0.2

[a] Error limits are one standard deviation of the estimated mean.

[b] LDL for plutonium-238 in drinking water is 0.028 x 10^{-9} µCi/mL. LDL for plutonium-239,240 in well water is 0.018 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238, and plutonium-239,240 are 1.6 x 10^{-9} µCi/mL and 1.2 x 10^{-9} µCi/mL, respectively.

[d] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-18. Uranium Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Uranium-233,234 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
0111	2	0.273	0.276	0.275 ± 0.002	1.4
0119	2	0.352	0.419	0.386 ± 0.047	1.9
0125	2	1.758	1.856	1.807 ± 0.069	9.0
0314	2	0.603	0.682	0.643 ± 0.056	3.2
0345	2	0.156	0.189	0.173 ± 0.023	0.9
0346	2	0.356	0.408	0.382 ± 0.037	1.9

Well I.D.*	Number of Samples	Uranium-238 10^{-9} µCi/mL			Average as a % of 0.04 x the DOE DCG [c]
		Minimum	Maximum	Average [a,b]	
0111	2	0.199	0.227	0.213 ± 0.020	0.9
0119	2	0.269	0.283	0.276 ± 0.100	1.2
0125	2	1.364	1.424	1.394 ± 0.042	5.8
0314	2	0.448	0.636	0.542 ± 0.133	2.3
0345	2	0.132	0.141	0.137 ± 0.006	0.6
0346	2	0.265	0.265	0.265	1.1

[a] Error limits are one standard deviation of the estimated mean.

[b] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA drinking water dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

* Well locations shown on Figure 6-2.

Table D-19. Thorium Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Number of Samples	Thorium-228 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x the DOE DCG [c]
0111	2	d	0.090	0.041 ± 0.069	0.3
0119	2	d	d	d	d
0125	2	d	0.185	0.087 ± 0.139	0.5
0314	2	0.222	1.075	0.649 ± 0.603	4.1
0345	2	d	0.133	0.056 ± 0.108	0.4
0346	2	0.013	0.107	0.060 ± 0.066	0.4

Well I.D.*	Number of Samples	Thorium-230 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x the DOE DCG [c]
0111	2	0.005	0.220	0.014 ± 0.012	0.1
0119	2	d	0.006	0.002 ± 0.006	0.01
0125	2	0.002	0.065	0.034 ± 0.044	0.3
0314	2	0.149	0.408	0.279 ± 0.183	2.3
0345	2	d	0.004	d	d
0346	2	d	0.013	0.007 ± 0.009	0.1

Well I.D.*	Number of Samples	Thorium-232 10^{-9} µCi/mL Minimum	Maximum	Average [a,b]	Average as a % of 0.04 x the DOE DCG [c]
0111	2	d	0.021	0.004 ± 0.025	0.2
0119	2	d	0.009	0.004 ± 0.006	0.2
0125	2	0.005	0.041	0.023 ± 0.026	1.1
0314	2	0.096	0.294	0.195 ± 0.140	9.8
0345	2	0.017	0.022	0.020 ± 0.004	1.0
0346	2	d	0.015	d	d

[a] Error limits are one standard deviation of the estimated mean.

[b] LDL for thorium-228 in drinking water is 0.154×10^{-9} µCi/mL. LDL for thorium-230 in well water is 0.055×10^{-9} µCi/mL. LDL for thorium-232 in drinking water is 0.084×10^{-9} µCi/mL.

[c] DOE DCGs correspond to doses of 100 mrem/year. Since the EPA dose standard is 4 mrem/year, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for thorium-228, thorium-230, and thorium-232 are 16×10^{-9} µCi/mL, 12×10^{-9} µCi/mL, and 2×10^{-9} µCi/mL, respectively.

[d] Below reagent blank.

* Well locations shown on Figure 6-2.

Table D-20. VOC Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Compound	Number of Samples	µg/L Minimum	µg/L Maximum	µg/L Average[a]	MCL
0111	Chloroform	2	2.55	2.65	2.60 ± 0.07	100
0305	cis-1,2-Dichloroethene	4	1.40	35.5	10.74 ± 16.57	70
	Trichloroethene	4	9.60	22.00	15.66 ± 6.76	5
	Tetrachloroethene	4	7.70	17.50	12.15 ± 5.09	5
	Carbon Tetrachloride	4	b	1.25	0.31 ± 0.63	5
	Chloroform	4	b	3.45	1.11 ± 1.63	100
	1,1,1-Trichloroethane	4	b	1.95	0.93 ± 0.80	200
0313	cis-1,2-Dichloroethene	4	b	1.95	0.49 ± 0.98	70
	Trichloroethene	4	1.85	7.55	4.21 ± 2.50	5
	Tetrachloroethene	4	6.35	11.00	8.61 ± 2.26	5
	Carbon Tetrachloride	4	b	1.25	0.31 ± 0.63	5
0370	cis-1,2-Dichloroethene	3	27.50	130.0	76.17 ± 51.44	70
	Trichloroethene	3	30.50	90.00	59.33 ± 29.79	5
	Tetrachloroethene	3	60.00	120.0	93.50 ± 30.61	5
	Carbon Tetrachloride	3	b	3.60	1.90 ± 1.81	5
	Chloroform	3	3.50	38.50	15.80 ± 19.68	100
	Freon-113	3	b	4.10	1.37 ± 2.37	c
	Freon-11	3	b	8.55	2.85 ± 4.94	c
0373	cis-1,2-Dichloroethene	2	6.00	11.50	8.75 ± 3.89	70
	Trichloroethene	2	15.50	24.00	19.75 ± 6.01	5
	Tetrachloroethene	2	23.00	37.50	30.25 ± 10.25	5
	Carbon Tetrachloride	2	2.40	3.85	3.13 ± 1.03	5
	Chloroform	2	1.90	7.75	4.83 ± 4.14	100
	Freon-113	2	b	2.25	1.13 ± 1.59	c
	Freon-11	2	b	1.70	0.85 ± 1.20	c
0379	Tetrachloroethene	2	1.00	1.50	1.25 ± 0.36	5
	Carbon Tetrachloride	2	1.55	3.40	2.48 ± 1.31	5

[a] Error limits are one standard deviation of the estimated mean.

[b] Results below the method detection limit.

[c] No MCL assigned.

MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-20. (continued)

Well I.D.*	Compound	Number of Samples	µg/L Value[d]	µg/L MCL
0397	Trichloroethene	1	5.05	5
	Tetrachloroethene	1	9.00	5
0410	cis-1,2-Dichloroethene	1	6.55	70
	Trichloroethene	1	26.50	5
	Tetrachloroethene	1	6.00	5
	Chloroform	1	1.05	100
0415	Trichloroethene	1	1.40	5
	Tetrachloroethene	1	1.50	5
0416	1,1,1-Trichloroethane	1	0.70	200
0417	1,1,1-Trichloroethane	1	1.60	200
	Trichloroethene	1	1.55	5
	Tetrachloroethene	1	1.21	5
0418	1,1,1-Trichloroethane	1	1.50	200
	Trichloroethene	1	12.50	5
	Tetrachloroethene	1	9.05	5
0419	cis-1,2-Dichloroethene	1	14.00	70
	Trichloroethene	1	29.00	5
	Tetrachloroethene	1	13.50	5
	Chloroform	1	1.55	100
0420	Trichloroethene	1	2.05	5
	Tetrachloroethene	1	5.75	5
0421	Tetrachloroethene	1	0.75	5
0422	Trichloroethene	1	7.60	5
	Tetrachloroethene	1	5.35	5

[d] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-20. (continued)

Well I.D.*	Compound	Number of Samples	µg/L Value[d]	µg/L MCL
0423	Tetrachloroethene	1	2.05	5
0424	1,1,1-Trichloroethane	1	3.70	200
	Trichloroethene	1	1.35	5
	Tetrachloroethene	1	0.63	5
0425	1,1,1-Trichloroethane	1	5.30	200
	Tetrachloroethene	1	0.59	5
P015	cis-1,2-Dichloroethene	1	46.00	70
	Trichloroethene	1	32.00	5
	Tetrachloroethene	1	8.50	5
	Chloroform	1	2.85	100
P027	1,1,1-Trichloroethane	1	3.00	200
	Trichloroethene	1	1.70	5
	Tetrachloroethene	1	1.65	5
P031	1,1,1-Trichloroethane	1	0.97	200
	Trichloroethene	1	2.45	5
	Tetrachloroethene	1	1.24	5
	Chloroform	1	2.85	100
P044	1,1,1-Trichloroethane	1	2.85	200
P046	Trichloroethene	1	2.10	5
	Tetrachloroethene	1	0.74	5

[d] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-21. Inorganic Concentrations in Onsite Monitoring Wells in 1997

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	µg/L MCL
0111	Chromium	e	58	100 [a]
	Iron	e	313	300 [b]
0119	Aluminum	118	45	50-200 [c]
	Iron	1740	1230	300 [b]
	Lead	13.4	e	15 [d]
	Manganese	46.6	44.8	50 [b]
0125	Aluminum	156	778	50-200 [c]
	Chromium	e	10	100 [a]
	Iron	297	1500	300 [b]
	Lead	3	3	15 [d]
	Manganese	e	31	50 [b]
0158	Lead	3	e	15 [d]
0305	Aluminum	255	NS	50-200 [c]
	Chromium	2000	NS	100 [a]
	Iron	18200	NS	300 [b]
	Lead	4	NS	15 [d]
	Manganese	144	NS	50 [b]
	Nickel	434	NS	100 [a]
0313	Aluminum	26	NS	50-200 [c]
	Chromium	92	NS	100 [a]
	Iron	1070	NS	300 [b]
	Lead	3	NS	15 [d]
	Mercury	0.4	NS	2 [a]
	Nickel	88	NS	100 [a]

[a] Primary Maximum Contaminant Level.

[b] Secondary Maximum Contaminant Level.

[c] The secondary MCL for aluminum is a range; final MCL values have not been established.

[d] Action level.

[e] Results below the method detection limit.

MCL = Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).

NS = Well not sampled.

* Well locations shown on Figure 6-2.

Table D-21. (continued)

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL
0314	Aluminum	3120	8260	50-200 [c]
	Antimony	e	11	6 [a]
	Arsenic	87	250	50 [a]
	Chromium	11	158	100 [a]
	Iron	20900	47700	300 [b]
	Lead	13	15	15 [d]
	Manganese	126	262	50 [b]
	Nickel	e	56	100 [a]
0345	Aluminum	e	48	50-200 [c]
	Chromium	24	e	100 [a]
	Iron	545	150	300 [b]
	Lead	11	e	15 [d]
	Manganese	33	30	50 [b]
	Nickel	63	e	100 [a]
0346	Iron	1180	1100	300 [b]
	Manganese	41	38	50 [b]
0353	Aluminum	1345	498	50-200 [c]
	Chromium	40	63	100 [a]
	Iron	3180	1560	300 [b]
	Manganese	127	198	50 [b]
	Nickel	40	344	100 [a]

[a] Primary Maximum Contaminant Level.

[b] Secondary Maximum Contaminant Level.

[c] The secondary MCL for aluminum is a range; final MCL values have not been established.

[d] Action level.

[e] Results below method detection limit.

MCL = Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-21. (continued)

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL
0379	Aluminum	21	e	50-200 [c]
	Chromium	620	773	100 [a]
	Iron	9047	14800	300 [b]
	Lead	11	e	15 [d]
	Manganese	30	28	50 [b]
	Nickel	216	255	100 [a]
0382	Aluminum	71	175	50-200 [c]
	Chromium	e	17	100 [a]
	Iron	184	390	300 [b]
	Manganese	18	25	50 [b]

[a] Primary Maximum Contaminant Level.

[b] Secondary Maximum Contaminant Level.

[c] The secondary MCL for aluminum is a range; final MCL values have not been established.

[d] Action level.

[e] Results below method detection limit.

MCL = Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).

* Well locations shown on Figure 6-2.

Table D-22. Tritium Concentrations in Seeps in 1997

Seep I.D.*	Historic Designation	Number of Samples	Tritium nCi/L			
			Value[a]	Minimum	Maximum	Average [b,c]
0601	S001	360		32.27	107.19	74.59 ± 15.72
0602	S002	2		8.94	23.02	15.98 ± 9.96
0603	S003	1	0.40			
0605	S005	3		20.95	31.93	27.98 ± 6.11
0606	S006	1	17.88			
0607	S007	275		6.90	45.87	20.89 ± 5.78
0608	S008	3		13.59	16.39	14.55 ± 1.59
0609	S009	2		0.22	0.83	0.53 ± 0.43

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] LDL for tritium in seep water is 0.5 nCi/L.

* Seep locations are shown on Figure 6-6.

Table D-23. VOC Concentrations in Seeps in 1997

Seep I.D.*	Compound	Number of Samples	µg/L Value[a]	Minmum	Maximum	Average[b]	MCL
0601	Trichloroethene	3		4.0	5.80	5.00 ± 0.90	5
	Tetrachloroethene	3		c	12.5	4.17 ± 7.22	5
0602	cis-1,2-Dichloroethene	3		c	2.2	0.72 ± 1.24	70
	Trichloroethene	3		1.85	3.10	2.52 ± 0.63	5
0605	cis-1,2-Dichloroethene	3		c	1.35	0.45 ± 0.78	70
	Trichloroethene	3		4.60	8.10	5.83 ± 2.00	5
0606	Trichloroethene	1	5.40				5
	Chloroform	1	0.89				100
0607	Trichloroethene	3		1.85	3.40	2.82 ± 0.84	5
0608	Freon-113	3		c	0.97	0.32 ± 0.56	d
0609	Chloroform	1	0.73				100

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] Results below the method detection limit.

[d] No MCL assigned.

MCL = Maximum Contaminant Level (based on EPA Drinking Water Standard).

* Seep locations are shown on Figure 6-6.

Table D-24. Tritium Concentrations in the Capture Pits in 1997

Capture Pit I.D.*	Historic Designation	Number of Samples	Tritium nCi/L		
			Minimum	Maximum	Average [a,b]
0712	P012	46	0.55	3.12	1.77 ± 0.59
0714	P014	37	61.53	281.84	133.70 ± 46.24
0725	W005	46	c	6.14	2.56 ± 0.96
0726	W006	47	1.31	329.85	92.07 ± 101.08
0727	W007	38	109.83	392.00	248.77 ± 70.87

[a] Error limits are one standard deviation of the estimated mean.

[b] LDL for tritium in capture pit water is 0.5 nCi/L.

[c] Results below the method detection limit.

* Capture pit locations are shown on Figure 6-6.

Table D-25. VOC Concentrations in the Capture Pits in 1997

Seep I.D.*	Compound	Number of Samples	µg/L Value[a]	Minmum	Maximum	Average[b]	MCL
0712	cis-1,2-Dichloroethene	2		1.25	2.55	1.90 ± 0.92	70
	Trichloroethene	2		2.20	2.53	2.36 ± 0.23	5
	Freon-113	2		c	2.68	1.34 ± 1.89	d
0713	Tetrachloroethene	2		0.70	1.35	1.03 ± 0.46	5
0714	Trichloroethene	2		c	1.25	0.63 ± 0.88	5
	Tetrachloroethene	2		c	0.58	0.29 ± 0.41	5
0726	cis-1,2-Dichloroethene	2		3.45	4.58	4.01 ± 0.80	70
	trans-1,2-Dichloroethene	2		1.30	3.45	2.38 ± 1.52	100
	Trichloroethene	2		33.0	36.8	34.9 ± 2.65	5
	Tetrachloroethene	2		0.70	0.86	0.78 ± 0.11	5
	Chloroform	2		c	7.70	3.85 ± 5.45	100
0727	Tetrachloroethene	1	0.83				5

[a] In cases where only one sample was collected, minimum, maximum, and average values do not apply.

[b] Error limits are one standard deviation of the estimated mean.

[c] Results below the method detection limit.

[d] No MCL assigned.

MCL = Maximum Contaminant Level (based on EPA Drinking Water Standard).

* Seep locations are shown on Figure 6-6.

APPENDIX E

DOSE ASSESSMENT METHODOLOGY

E.1 Exposure Routes

Members of the public receive radiation doses via various exposure pathways. For radionuclides discharged to the atmosphere, a person may inhale or be immersed in airborne radionuclides. Other routes of airborne exposure include ground deposition of radionuclides and consumption of food products that were contaminated by airborne releases. For radionuclides released to water, a person may consume contaminated water or fish. The other potential water-based exposure pathways (e.g., swimming and boating) generally do not add significantly to the dose.

E.2 Dose Calculations Based on Measured Data

For DOE reporting requirements, doses are presented as 50-year committed effective dose equivalents (CEDEs). The CEDE is the total dose equivalent that will be received by an individual over a 50-year time period as a result of one year of exposure to ionizing radiation. The total CEDE reported for MEMP is the sum of the CEDEs from the air, drinking water, and foodstuff pathways.

CEDEs for tritium, plutonium-238, plutonium-239,240, thorium-228, thorium-230, and thorium-232 were calculated for 1997. (Concentrations of other radionuclides were below background levels or were too small to affect the overall dose.) The CEDEs are evaluated using environmental monitoring data measured on and near the site. A CEDE for a given radionuclide is calculated as shown below. Specific input values for 1997 are shown in Table E-1. The CEDEs for all radionuclides are then summed to provide a single value for reporting purposes.

$$CEDE = \sum_{1}^{p} C_r \bullet I_a \bullet DCF$$

where CEDE = total committed effective dose equivalent, mrem.

$\sum_{1}^{p}$ = summation over the exposure pathways 1 through p.

C_r = maximum average concentration of the radionuclide.

I_a = annual intake of the environmental medium.

DCF = dose conversion factor for the radionuclide and intake type.

Table E-1. Factors Used to Calculate 1997 CEDEs

Radionuclide	Concentration[a]	Location*	Dose Conversion Factor, mrem/μCi
Tritium			
Air	6.3×10^{-12} μCi/mL	215	6.3×10^{-2} (a)
Drinking water	0.19×10^{-6} μCi/mL	Miamisburg	6.3×10^{-2}
Foodstuffs	0.37×10^{-6} μCi/mL	Miamisburg	6.3×10^{-2}
Plutonium-238			
Air	57.7×10^{-18} μCi/mL	215T	3.8×10^{5} (b)
Drinking water	ND	Miamisburg	ND
Foodstuffs	ND	Miamisburg	ND
Plutonium-239,240			
Air	ND	215T	ND
Drinking water	ND	Miamisburg	ND
Foodstuffs	ND	Miamisburg	ND
Thorium-228			
Air	4.38×10^{-18} μCi/mL	215T	3.1×10^{5}
Drinking Water	NA		
Foodstuffs	NA		
Thorium-230			
Air	6.17×10^{-18} μCi/mL	215T	3.2×10^{5}
Drinking Water	NA		
Foodstuffs	NA		
Thorium-232			
Air	4.07×10^{-18} μCi/mL	215T	1.6×10^{6}
Drinking Water	NA		
Foodstuffs	NA		

[a] Represents the average radionuclide concentrations in air corresponding to the location of the maximum offsite dose, average incremental radionuclide concentrations from the Miamisburg water supply, and average produce concentrations from the Miamisburg area.

ND indicates that concentrations were not detectable above the environmental level.

NA = not applicable (not measured).

* Air sampling locations shown on Figure 4-4.

Annual Intake Rates	
Air	8400 m^3
Drinking water	730 L
Foodstuffs	260 kg

(a) To calculate the CEDE, the dose factor shown in the table is multiplied by 1.5 to include absorption of tritium through the skin.

(b) Plutonium releases from MEMP are believed to be insoluble (Class Y). However, to provide a reasonable degree of conservatism in the dose estimates, the Pu-238 and Pu-239 dose factors are averages of Class W and Class Y values.

E-3. Dose Calculations for NESHAPs Compliance

To demonstrate compliance with the requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAPs, 40 CFR 61, Subpart H), MEMP performs additional dose calculations each year for all airborne releases. As approved by the EPA, the computer code CAP88-PC is used to calculate those doses.

The CAP88-PC computer model is a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to air. CAP88-PC was developed by the U.S. EPA to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) or radionuclides under 40 CFR Part 61, Subpart H.

Whenever available, MEMP uses site-specific data as input to the code. Meteorological data measured onsite are used to evaluate transport and dispersion. Stack specific release rates are used as shown below (Table E-2). Table E-2 also lists the relevant stack information used for the 1997 CAP88-PC runs.

Table E-2. 1997 CAP88-PC Input Data

Stack ID	Stack Height (meters)	Stack Diameter (meters)	Exit Velocity (meters/sec)	Radionuclide(s)	1997 Release Rate (Ci/yr)
HH	34	1.7	1.3	Tritium	1.7×10^{1}
NCDPF	41	0.6	26.6	Tritium	3.8×10^{1}
SM/PP	60	1.8	6.0	Pu-238	4.5×10^{-5}
				Pu-239,240	1.1×10^{-7}
SW-1CN	46	0.9	11.7	Tritium	1.2×10^{1}
				Pu-238	7.6×10^{-10}
				Pu-239,240	2.3×10^{-10}
				U-233,234	2.1×10^{-9}
				U-238	1.7×10^{-10}
T-West	60	2.4	9.7	Tritium	1.6×10^{2}
				Pu-238	1.0×10^{-8}
				Pu-239,240	7.1×10^{-10}
				U-233,234	2.8×10^{-9}
				U-238	2.3×10^{-9}
T-East	60	1.8	8.2	Tritium	1.4×10^{-1}
HEFS	46	1.9	12.6	Tritium	5.6×10^{2}
				Pu-238	1.2×10^{-8}
				Pu-239,240	1.3×10^{-9}
				U-233,234	2.9×10^{-9}
				U-238	8.9×10^{-10}
WDSS	16	0.3	11.8	Pu-238	1.6×10^{-10}
				Pu-239,240	2.9×10^{-11}
WDA	9	1.0	8.7	Tritium	1.1×10^{0}
				Pu-238	1.2×10^{-7}
				Pu-239,240	2.3×10^{-10}
Building 22	7	0.9	0[a]	Tritium	1.4×10^{0}
Building 23	2	0.3	0[a]	Tritium	8.2×10^{0}
				Pu-238	1.0×10^{-8}
				Pu-239,240	1.1×10^{-10}

[a] No credit taken for exit velocity due to horizontal orientation of the building vent.

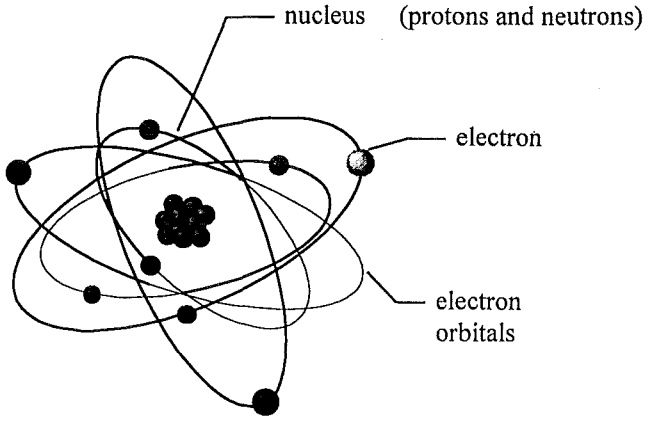
APPENDIX F

PRINCIPLES OF RADIATION

The Atom

All substances are composed of atoms. Atoms are exceedingly small with an average diameter of only about 0.000,000,001 inch. To put this in perspective, approximately 100,000 atoms lying side by side in a straight line touching one another would span the thickness of a sheet of thin paper. Atoms are composed of three basic parts:

- electrons,
- protons , and
- neutrons



Atom Model

Protons and neutrons compose the part of an atom called the nucleus. The protons have a positive electrical charge while the neutrons have no electrical charge. Protons and neutrons are similar in mass and are considerably more massive than electrons (approximately 1,800 times as massive). Therefore the nucleus contains nearly all of the mass of the atom. The electrons, which carry a negative electrical charge, orbit the nucleus. Typically, the number of protons (positive charges) in the nucleus is equivalent to the number of electrons (negative charges) in the orbits, thus creating an atom that is electrically neutral (no net charge).

The atomic number is an identifying characteristic of an element and equals the number of protons in the atomic nucleus of an atom. Each element has an associated atomic number that serves as an identifier. For example, hydrogen has an atomic number of one corresponding to one proton in the nucleus (the hydrogen atom also has an electron that orbits the nucleus thus keeping the atom electrically neutral). Plutonium, a much more massive atom, has an atomic number of 94 corresponding to 94 protons in the nucleus and 94 electrons orbiting the nucleus to maintain electrical neutrality.

The sum of the protons and neutrons in an atom's nucleus is called the mass number. Although the number of protons in the nucleus will always be the same for any given element, the number of neutrons in the nucleus can vary. For example, most hydrogen atoms have a nucleus composed of a single proton with no neutrons giving it a mass number of 1. Hydrogen atoms

with mass number two are known as deuterium and have both a proton and a neutron in the nucleus. Tritium, a form of hydrogen important to past MEMP operations, has a nucleus composed of one proton and two neutrons. As can be seen from this example, all three forms of hydrogen have exactly one proton in the nucleus, but have differing numbers of neutrons. Chemically, these three forms of hydrogen all behave in a similar manner. These forms of hydrogen all having the same atomic number but different mass numbers are known as isotopes.

The radionuclides that are of concern at MEMP are:

Radionuclide	Mass Number	Half-Life (years)
plutonium-238	(94 protons + 144 neutrons = mass number 238)	86
plutonium-239	(94 protons + 145 neutrons = mass number 239)	24,400
plutonium-240	(94 protons + 146 neutrons = mass number 240)	6,580
uranium-233	(92 protons + 141 neutrons = mass number 233)	1.6×10^5
uranium-234	(92 protons + 142 neutrons = mass number 234)	2.5×10^5
uranium-235	(92 protons + 143 neutrons = mass number 235)	7.1×10^8
uranium-238	(92 protons + 146 neutrons = mass number 238)	4.5×10^9
thorium-228	(90 protons + 138 neutrons = mass number 228)	1.9
thorium-230	(90 protons + 140 neutrons = mass number 230)	8.4×10^4
thorium-232	(90 protons + 142 neutrons = mass number 232)	1.4×10^{10}
hydrogen-3 (tritium)	(one proton + two neutrons = mass number 3)	12.3

Radioactivity and Radiation

The atomic nucleus is held together by exceedingly strong forces of attraction which act indiscriminately between its protons and neutrons, protons and protons, neutrons and neutrons. Certain isotopes, because of their own physical makeup, are unstable. This instability is due to an unbalanced ratio between the number of protons and the number of neutrons. This instability in the nucleus causes the atom to change spontaneously to a more stable, less energetic state. This spontaneous change is called radioactivity and the atom is said to decay or disintegrate. Radiation is the energy associated with the radioactivity. Radiation is generally one of the following three types:

- alpha
- beta
- gamma

When a radioactive atom decays, its nucleus changes and the resultant atom may no longer be the same kind of atom; it can transform into an element of different atomic number. As noted above, the radioactive decay is brought about by instability in the nucleus and therefore, by the process of radioactive decay, the atom strives to achieve a more stable configuration. The ultimate stable configuration is generally not reached in decay transformation. In fact, the new element, called a "daughter" resulting from the radioactive decay may be more unstable than the "parent." Ultimately the original radionuclide will be transformed into a stable element through a series of transformations. The decay sequence from radioactive parent to radioactive daughter is called a radioactive decay chain. The time required for one-half of all the atoms of a radionuclide to decay is called its "half-life." The half-life is an average value for any very large number of atoms. It does not accurately apply to a small number of atoms.

Each atom essentially takes its own time to decay and there is no predicting when its instability will cause it to do so. Radionuclides with short half-lifes such as iodine-131 (used in medical radiotherapy) decay away rapidly and may not pose as much of an environmental concern as a long lived (long half-life) radionuclide like plutonium-239 which may remain in the environment for many thousands of years.

As noted above there are three primary types of radiation:

- alpha
- beta
- gamma

Alpha particles result when the unstable nucleus of a radionuclide ejects a particle consisting of two protons and two neutrons. The resulting particle has a net positive charge and will therefore react with any atoms that are nearby (i.e. with the negative electronic charges of the orbital electrons or the positive electronic charge of the protons in the nucleus). These interactions cause the alpha particle to give up some of the original energy it contained when ejected from the nucleus. In fact there are enough atoms within the thickness of an ordinary sheet of paper to react with and bring to rest most alpha particles. The alpha particle will therefore not penetrate solid material to any significant depth. If, however, an alpha particle is released inside the human body (by means such as inhaling radioactive particles) the emitted alpha particle will be brought to rest rapidly within a small volume of human tissue. Thus all of the energy of the alpha particle is released within a small volume of tissue and cellular damage can occur. Isotopes of plutonium and uranium are examples of radionuclides used by MEMP that decay by emitting alpha particles.

Beta particles result when the unstable nucleus of a radionuclide ejects a particle consisting of a negatively charged electron. As with alpha particles, the charged beta particle interacts with any atoms that are nearby thus losing some of its initial energy. However because beta particles have only half the charge of an alpha particle and are ejected from the nucleus with a much greater velocity, most can penetrate solids more readily than alpha particles. When compared to an alpha particle, beta particles give up their initial energy over a longer distance. This results in less

localized damage to tissue that may interact with a beta particle. Tritium is an example of a radionuclide used by MEMP that decays by emitting a beta particle.

Gamma rays, unlike alpha and beta particles, are not discrete physical particles. Instead a gamma ray is a package of energy that behaves as though it were a particle. Gamma rays are exactly the same in nature as visible light, heat waves, radio waves, radar rays and x-rays. They have very short wavelengths like those of most x-rays and are in fact indistinguishable from such x-rays. The penetrating power of x-rays is well known and since gamma radiation is very much like the radiation of x-rays the penetrating power of gamma radiation is also very high. Gamma rays can pass through the human body giving up small amounts of energy along the way. Many radionuclides emit both alpha and gamma or beta and gamma radiation upon decay. Isotopes of plutonium are examples of radionuclides used by MEMP that decay by emitting both alpha and gamma radiation.

Units of Measurement

Radiation intensity is typically measured in terms of "activity." Activity corresponds to the number of atomic nuclei of any particular radionuclide that decay over a specified time interval. A "curie" (Ci) is a unit typically used to define activity. One curie is equal to the amount of radioactive material that decays at a rate of 37 billion atoms per second. This disintegration rate is almost exactly the rate at which one gram of radium-226 decays. As noted earlier, each radioactive isotope follows its own specific decay schedule in accordance with its half-life. As a result, for a given quantity of material (e.g. one gram), different radionuclides will vary in the quantity of nuclei that will disintegrate over a given time period. Therefore equal masses of different radionuclides have varying activity levels that are dependent on each radionuclide's half-life. As an example, one gram of radium-226 (radium-226 has a half-life of 1,622 years) is equivalent to one curie of activity. It would take about 1.5 million grams of uranium-238 (half-life 4.5 billion years) to have an activity of one curie. In other words it would take 1.5 million grams of uranium-238 to yield 37 billion disintegrations per second. As can be seen from the example, radionuclides that decay rapidly (short half-lives) have relatively high activity levels compared to radionuclides that have very long half-lives.

It should be noted that a curie is only related to the number of disintegrations that occur in a given time frame and does not indicate the biological damage that the radionuclide could cause if it comes into contact with a person. That is to say that one curie of tritium is not equivalent to one curie of plutonium-238 in terms of the biological effect on living tissue. The activity levels of radionuclides in the environment due to MEMP activities operations are typically very small fractions of a curie. A convenient way to express these very small curie fractions is introducing two additional units; the microcurie (μCi) one millionth of a curie, and the picocurie (pCi) one trillionth of a curie. These units are used throughout this Report.

Radiation Dose

Radiation exposure to humans is described in terms of a "dose." Dose is a measure of the amount of radiation delivered to the body. As noted in the previous section, for a given activity level, different radionuclides will vary in their ability to cause biological damage (e.g., at a given activity level, alpha radiation is more damaging than beta). A "dose equivalent" is a means of comparing the dose resulting from exposure to various radionuclides. The Roentgen Equivalent Man (rem) is the unit used to express the dose equivalent. A rem is defined as the dose, measured in terms of a specific amount of energy, which produces the biological equivalent to that produced by the same amount of x-ray energy. The rem allows for a direct comparison of the potential damage that may be caused by exposure to various radionuclides. The higher the rem value, the greater the potential for biological damage.

Dose can be viewed in several different ways and is typically reported with respect to either a specific organ, an effective dose, a committed effective dose, or a whole body dose. Each dose measure will be discussed below.

The ***organ dose*** is the estimated dose received by a specific organ due to exposure to radiation. Certain radionuclides may tend to accumulate within specific organs of the body. Critical organs can be identified based on the chemistry of the radionuclide, the amount of radiation, the sensitivity of the organ to radiation, and the importance of the organ to the body.

The ***effective dose*** estimates the health risk that a radiation dose poses to an individual. The effective dose is calculated by summing the weighted organ dose for each organ. The weighted organ dose is simply the original calculated organ dose multiplied by an importance factor that takes into account the relative risk to the exposed organ.

Some radionuclides assimilated into the body can remain in the body for long periods of time. When particulate material, (e.g. dust) contaminated with plutonium is breathed, the plutonium is deposited in the lung tissue. The plutonium will remain in the body indefinitely (the original quantity will be reduced over time due to radioactive decay and biological factors). The plutonium is continually emitting alpha and gamma radiation while in the lungs. The individual is therefore exposed to this radiation for the remainder of their life.

The ***committed effective dose equivalent*** indicates the total dose over the individual's projected remaining lifetime (assumed to be 50 years) that results from an intake during one year. The committed effective dose equivalent (CEDE) expresses the dose of internal radiation received when an individual has ingested or inhaled a radionuclide that will remain inside the body for months or years. It is also expressed in rem, mrem (1000 mrem = 1 rem), or Sieverts.

Dose Due to Exposure to Background Radiation Sources

Every day our bodies absorb ionizing radiation. Most of it comes from natural sources. Consumer products and medical procedures that use radiation are other common sources of ionizing radiation.

Natural Sources. Natural radiation comes from two sources: cosmic and terrestrial. Cosmic radiation results when energetic particles from outer space, traveling at nearly the speed of light, collide with nuclei in our atmosphere, creating showers of radioactive particles that fall to earth. The average annual dose equivalent received from cosmic radiation is 26 mrem for an individual living at sea level. Because cosmic radiation dissipates as it travels through the atmosphere, individuals living at lower altitudes receive less dose from this source than those living at higher altitudes.

Terrestrial radiation results when radionuclides that are a natural part of the earth's rocks and soils emit ionizing radiation. Because the concentrations of these radionuclides vary geographically, an individual's exposure depends on his location. The average annual dose equivalent from terrestrial radiation for an individual living in the U. S. is 28 mrem.

Besides absorbing radiation from external radionuclides, we can also absorb radiation internally when we ingest radionuclides along with the food, milk, and water we ingest or along with the air we inhale. Once in our bodies, radionuclides follow the same metabolic paths as nonradioactive forms of the same elements. The length of time a particular radionuclide remains and emits radiation depends on whether the body eliminates it quickly or stores it for a long period, and on how long it takes for the radionuclide to decay into a nonradioactive form. The principal source of internal exposure in the U. S. is believed to be radon. Inhalation of radon contributes about 200 mrem to the average annual dose equivalent from internal radiation. Other radionuclides present in the body contribute approximately 39 mrem.

Consumer Products. Many familiar consumer products emit ionizing radiation. Some must emit radiation to perform their functions, e. g., smoke detectors and airport x-ray baggage inspection systems. Other products, e.g., TV sets, emit radiation only incidentally to performing their functions. The average annual effective dose equivalent to an individual from consumer products ranges from 6 to 12 mrem.

Medical Uses. Radiation is a tool for diagnosing and treating disease. The average annual dose equivalent for an individual in the U. S. from diagnostic radiation is 53 mrem. Individuals undergoing radiation therapeutic procedures may receive much higher doses.

Radiation Environment at MEMP

On average the annual radiation dose due to background radiation to a person living in the United States is about 300 millirem. The total contribution to this dose due to MEMP activities in 1997 was 0.29 mrem, or a very small fraction of the dose received from background.

MEMP's dose contribution for 1997 was well within all applicable guidelines, limits, and regulatory standards. These guidelines, limits and standards are levels which present very low risk to individuals near the site. MEMP, like all DOE sites, strives to keep worker and public doses as low as reasonably achievable.

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Jim Barrett
WHIO Radio

Chris Collins
WMMX Radio

Kim Faris
WING Radio

Danni Coates
WONE/WTUE Radio

Bill Nance
WFCJ Radio

Rica Duffuss
WROU Radio

Steve Sandlin
Miamisburg News

Jim Hannah
Associated Press

Dale Dempsey
Dayton Daily News

John Bennett
Dayton Business Reporter

Kathy Nolte
The Business News

Michelle Tedford
Dayton Voice

Stakeholders

Kathy Adams

John Appelgate
Fernald Citizen's Task Force

Dan Brouwer
Brouwer Enterprises Inc.

India Clarke
Sierra Club

Sharon Cowdrey
Miamisburg Environment, Safety and Health

Jeff Fisher
Hydro-Log

Lee Flowers

Roland Foster

David Frizzell

Debbie Gill

Rick Heaberlin

Marlin Heist

Jodi Lally
Boston University School of Public Health

James Lucas
Dayton Citizens for Global Security

Jerry Mason

Mike McManus

Gary Nolly, President
Oil, Chemical and Atomic Worker's Union

John O'Gorman

Fred Robinson

Robert Schiffer

Velma Shearer
Neighbors in Need

James Stepp

Peter Townsend
Hydro-Log

Jerry Vaughn

Joseph Walker
Citizen's Association for the Economy

Charles Williams, President
United Plant Guard Workers of America

Ralph Wilson

Gary Woodward

Sandy Woodward

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S. Baker
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M. C. Becker (80)
N. R. Bonekowski
D. C. Bradley
R. J. Brewer
V. Catania
M. B. England
B. M. Farmer (30)
J. P. Fontaine
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