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Data Package for the Atomic Vapor Laser Isotope Separation (AVLIS) Plant Environmental Impact Statement

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DEPARTMENT OF ENERGY

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ENERGY DIVISION

DATA PACKAGE FOR THE ATOMIC VAPOR LASER ISOTOPE SEPARATION (AVLIS) PLANT ENVIRONMENTAL IMPACT STATEMENT

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ALARA	as low as reasonably achievable
ATC	Applied Technology Council
AVLIS	Atomic Vapor Laser Isotope Separator
CFR	Code of Federal Regulations
CRK	Clinch River kilometer
CRM	Clinch River mile
CY	calendar year
DCG	Derived Concentration Guideline
DNAP	Division of Natural Areas and Preserves (state of Ohio)
DOE	U.S. Department of Energy
EA	environmental assessment
EDGe	Engineering, Design and Geosciences Group
EIS	environmental impact statement
EPGA	effective peak ground acceleration
ERDA	U.S. Energy Research and Development Administration
ESP	electrostatic precipitator
FEMA	U.S. Federal Emergency Management Agency
FWS	U.S. Fish and Wildlife Service
GCEP	Gas Centrifuge Enrichment Plant
HEPA	high-efficiency particulate air (filter)
ICBO	International Council of Building Officials
I_{mm}	modified Mercalli intensity
KAS-KSNPC	Kentucky Academy of Sciences and Kentucky State Nature Preserves Commission
KPDES	Kentucky Pollutant Discharge Elimination System
LETC	Law Engineering Testing Company
LOS	Level of Service
LWD	Liquid Waste Disposal, Inc.
m_b	body-wave magnitude
MRS	Monitored Retrievable Storage
MSL	mean sea level
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPP	net primary productivity
NRC	Nuclear Regulatory Commission
ODNR	Ohio Division of Natural Resources
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORO	U.S. Department of Energy Oak Ridge Operations
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PCK	Poplar Creek kilometer
PCM	Poplar Creek mile
PGA	peak ground acceleration
PGDP	Paducah Gaseous Diffusion Plant
PMC	Project Management Corporation
PORTS	Portsmouth Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
RK	river kilometer
RM	river mile

RV	recreational vehicle
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SMSA	Standard Metropolitan Statistical Area
SR	state route
TAPCD	Tennessee Air Pollution Control Division
TCE	trichloroethylene
TDHE	Tennessee Department of Health and Environment
TSCA	Toxic Substances Control Act of 1976
TSP	total suspended particulates
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USGS	U.S. Geological Survey
VOC	volatile organic compound
WMU	waste management unit

ABSTRACT

The U.S. Department of Energy (DOE) is investigating the feasibility of constructing and operating the first Atomic Vapor Laser Isotope Separation (AVLIS) plant for uranium enrichment. This document provides environmental data to support the preparation of an environmental impact statement (EIS) for the AVLIS project. It contains background environmental information for the two operating DOE uranium enrichment plants and the one that has been shut down: (1) the Oak Ridge Gaseous Diffusion Plant in Oak Ridge, Tennessee (shut down); (2) the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and (3) the Portsmouth Gaseous Diffusion Plant near Portsmouth, Ohio. These three existing uranium enrichment plants are candidate sites for the AVLIS plant. Environmental information regarding other potential sites will be collected separately, if necessary, during the preparation of the AVLIS EIS.

The data package is organized by environmental topic: air quality/meteorology, geology, seismicity, surface water, groundwater, radiological environment, terrestrial ecology, aquatic ecology, and socioeconomics.

Site environmental information was collected from a variety of sources, including plant site visits, annual plant site environmental reports, information generated for remedial action activities, and surveys of local communities for socioeconomic information. All information is referenced to provide the preparers of the AVLIS EIS with the source material for information given in this data package. This report also serves as a guide to other information that exists in separate environmental documentation.

1. INTRODUCTION

1.1 SCOPE OF DATA PACKAGE

The U.S. Department of Energy (DOE) is investigating the feasibility of constructing and operating the first Atomic Vapor Laser Isotope Separation (AVLIS) plant for uranium enrichment. This document provides environmental data to support the preparation of an environmental impact statement (EIS) for the AVLIS project. It contains background environmental information for the two operating DOE uranium enrichment plants and the one that has been shut down: (1) the Oak Ridge Gaseous Diffusion Plant (ORGDP) in Oak Ridge, Tennessee (shut down); (2) the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky; and (3) the Portsmouth Gaseous Diffusion Plant (PORTS) near Portsmouth, Ohio. These three existing uranium enrichment plants are candidate sites for the AVLIS plant. Environmental information regarding other potential sites will be collected separately, if necessary, during the preparation of the AVLIS EIS.

The data in this report are the result of a reconnaissance survey of available information; they are not part of a field study. As a result, the type and amount of data vary by site and by discipline. In addition, the data collection procedures were based on experience with EIS content and should, therefore, provide an adequate basis for preliminary EIS work. Because of these aspects of the data collection process, this report does not include (1) AVLIS process data (i.e., characterizations of waste streams and detailed descriptions of the AVLIS production facility), (2) information on existing enrichment plant site infrastructures (e.g., utilities), or (3) assessment and comparison of environmental impacts from construction activities or operation of the AVLIS facility at each of the enrichment sites. EIS assessment activities may reveal the need for additional environmental information that must be obtained to complete the EIS.

The data package is organized by environmental topic. These topics are discussed in the following sections of the data package:

- air quality/meteorology, which gives site information on temperature, precipitation, wind speeds, various pollutant emissions, air monitoring practices, and air quality standards;
- geology, which contains data about site topography, physiography, geologic structure, stratigraphy, lithology, soils, and deposits;
- seismicity, which describes regional faults, risk assessments for the facilities, seismic source zones, liquefaction, ground-motion magnification, and potential soil-structure interaction;
- surface water, which contains data on site hydrology, effluents, water withdrawals, area drainage basins and water bodies, water quality, water uses, sediment sampling, and monitoring points;
- groundwater, which provides data regarding aquifer systems and their geologic composition, monitoring programs, groundwater flow, interaquifer flow, groundwater quality, soil permeability, and hydraulic conductivity;
- radiological environment (including both natural and man-made radiation), which gives summary data for the maximally exposed individual;

- terrestrial ecology, which describes land uses and productivity, vegetation/plant communities, wildlife, endangered and threatened species, natural areas in the region, and biological monitoring;
- aquatic ecology, which provides information about biotic communities, relative abundance, pollutant levels and criteria for aquatic biota, wetlands, and threatened and endangered species; and
- socioeconomics, which gives data about area population, housing, land use, public services (education, water, sewage, fire/police protection, medical facilities, recreation, solid and hazardous waste facilities, emergency preparedness, and transportation), traffic counts, regional economics, cultural and historical resources, and social structures.

Site environmental information was collected from a variety of sources, including plant site visits, annual plant site environmental reports, information generated for remedial action activities, and surveys of local communities for socioeconomic information. All information is referenced to provide the preparers of the AVLIS EIS with the source material for information given in this data package. This report also serves as a guide to other information that exists in separate environmental documentation.

1.2 EVOLUTION OF THE AVLIS PROGRAM

DOE began the national AVLIS program in 1975 to identify a technology that could eventually replace the energy-intensive, low-enrichment-efficiency gaseous diffusion process currently used to enrich uranium for the nuclear power industry and nuclear-powered submarines. The plants have been subjected to increasing economic, environmental, and regulatory pressures that are likely to render them noncompetitive in the international market over the next decade.

In 1982, DOE selected the AVLIS process over two other advanced uranium isotope separation processes (Molecular Laser Isotope Separation and Plasma Separation Process) for large-scale research and development (R&D) and subsequent demonstration. An environmental assessment (EA) of these technologies (DOE 1982) concluded that no significant adverse environmental impacts would result from any of the three. A DOE process evaluation board ultimately recommended AVLIS over the other processes on the basis of technical and economic considerations. In 1985, DOE further evaluated the application of AVLIS technology in an enriched uranium production plant, comparing AVLIS technology with the advanced gas centrifuge process. A second EA (DOE 1985) found no significant adverse impacts from either technology, and the AVLIS process was selected for further R&D and potential deployment.

Over the past 4 years, various laboratory and pilot-scale demonstrations have been conducted to test and develop the AVLIS lasers and separators and the uranium processing technologies that would provide feed materials for the lasers and would convert laser-separated enriched uranium metal product to a form suitable for use by fuel fabricators. Laser and separator development has been the focus of DOE-sponsored research at Lawrence Livermore National Laboratory (LLNL) at Livermore, California; and uranium processing technologies have been explored for DOE by Martin Marietta Energy Systems, Inc., in Oak Ridge, Tennessee.

1.3 ENRICHMENT TECHNOLOGIES

In its natural state, uranium (U) is composed of about 0.7% ^{235}U and about 99.3% ^{238}U. For use as the fissionable isotope in nuclear fuel, it must be enriched in order to obtain a greater percentage of ^{235}U. The AVLIS process will be designed to enrich the uranium to less than 5% ^{235}U.

The only commercial production method currently used for enriching the ^{235}U isotope is the gaseous diffusion process. The basis of the process is the molecular diffusion of uranium hexafluoride gas (UF_6), which is both the feed material to the diffusion process and the enriched product used in nuclear fuel fabrication. The gaseous diffusion process separates ^{235}U from ^{238}U by difference in isotopic mass. UF_6 feed material is prepared from uranium ore concentrate, and the enriched UF_6 gaseous product is processed to nuclear fuel uranium dioxide (UO_2) by fuel fabricators under contract to utility companies.

In contrast, the AVLIS process separates the atoms of ^{235}U from ^{238}U by electrostatic extraction of laser-produced ^{235}U ions. In the first step, metallic uranium is melted and vaporized (Fig. 1.3-1). The vapor is then illuminated by precisely tuned laser light that can be absorbed by ^{235}U atoms. The absorption of this energy causes individual ^{235}U atoms to emit an electron. The loss of an electron from the ^{235}U atom creates a charged ^{235}U ion. The ^{238}U atoms, which are unaffected by the laser beams, pass through the product collector to condense on the tails collector. The enriched uranium liquid metal condensate flows out of the separator to the cast and is stored in solid metallic form for eventual conversion to uranium oxide for reactor fuel rods.

1.4 PROJECT DESCRIPTION OF THE AVLIS PRODUCTION PLANT

Current DOE long-range plans are to begin construction of the AVLIS plant in March 1993 and to complete the plant in December 1997. The capacity of the enrichment facility is currently designed to be 10 million separative work units (SWU). This compares with about 11 million and 8 million SWU capacity at PGDP and PORTS respectively. Initial plans call for the AVLIS production plant to operate concurrently with the two gaseous diffusion plants.

The total construction cost of the AVLIS facility in 1994 dollars is expected to be about $1 billion. The peak demand for construction workers would occur during the third year of construction at each site, with a maximum of more than 1500 construction workers. The peak production workforce would be about 1300 individuals.

The conceptual design of the AVLIS facility requires approximately 80 acres of land to site. Plans for each of the three enrichment facility AVLIS production plants integrate existing enrichment facilities and utilities into preliminary designs. Preliminary plans call for ORGDP to construct a stand-alone AVLIS facility (Fig. 1.4-1, in a plastic sleeve after Appendix I). PGDP preliminary plans entail constructing a stand-alone facility or integrating part of the new AVLIS facility into existing Building C-333. Figure 1.4-2, in a plastic sleeve after Appendix I, shows the location of the stand-alone option at PGDP and the location of Building C-333. PORTS preliminary plans call for the use of buildings completed for the Gas Centrifuge Program. The primary buildings at PORTS considered for the AVLIS facility are X-3001, X-3002, and X-7725 (Fig. 1.4-3, also in a plastic sleeve after Appendix I). AVLIS Production Plant plans for all three enrichment sites are in initial conceptual stages and may change as more detailed assessments are completed.

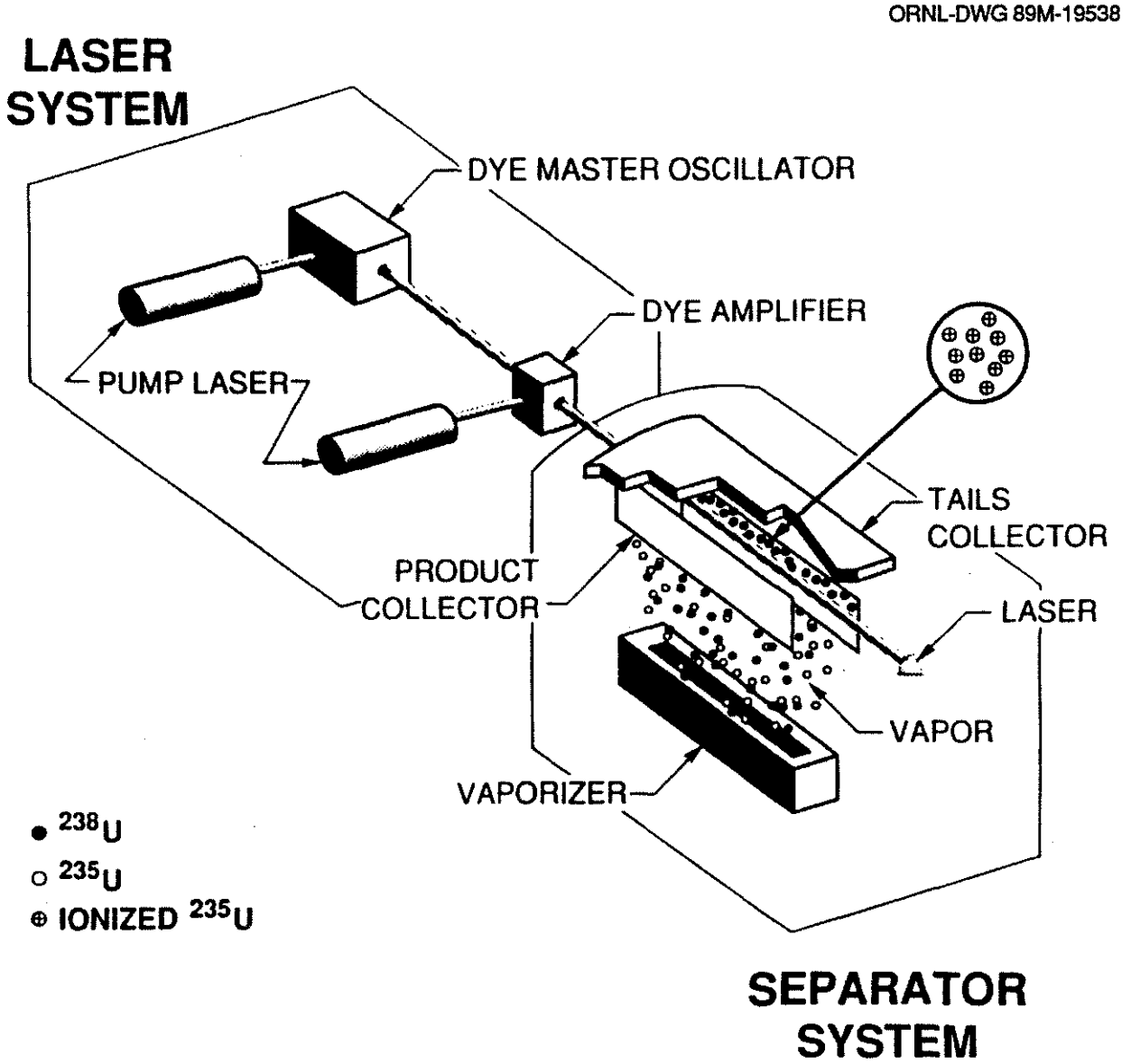


Fig. 1.3-1. The Atomic Vapor Laser Isotope Separation (AVLIS) process.

1.5 GENERAL DESCRIPTION OF DOE GASEOUS DIFFUSION PLANTS

1.5.1 Operations of the Oak Ridge Gaseous Diffusion Plant

ORGDP is located on the DOE Oak Ridge Reservation (ORR), which is within the corporate limits of the city of Oak Ridge in eastern Tennessee. ORR consists of about 14,300 ha (35,000 acres) of federally owned land (Rogers et al. 1989a). Oak Ridge and ORR are shown on the map of Tennessee in Fig. 1.5-1. The ORR site is predominantly to the west and south of the population center of the city. Oak Ridge (population 28,000) lies in a valley between the Cumberland and southern Appalachian mountain ranges and is bordered on one side by the Clinch River. The largest city in the area is Knoxville, with a population of 175,000 people, located 48 km (30 miles) east of ORR. The Cumberland Mountains are about 16 km (10 miles) northwest; the Great Smoky Mountains are about 113 km (70 miles) southeast.

ORR contains three major operating facilities: the Oak Ridge Y-12 Plant (Y-12), the Oak Ridge National Laboratory (ORNL), and ORGDP. The locations of these three facilities are shown on the map of ORR (Fig. 1.5-2).

Until the summer of 1985, the primary mission of ORGDP was enrichment of uranium hexafluoride (UF_6) in the ^{235}U isotope for use as a fuel in nuclear reactors. The gaseous diffusion process was used in the enrichment services. In August 1985, the gaseous diffusion process of ORGDP was placed in a "ready standby" mode because of declining demands for enriched uranium. Since that time, the decision has been made to permanently shut down the gaseous diffusion cascade. Waste management activities at ORGDP are, however, increasing. Although enrichment operations at ORGDP are shut down, some waste streams are being generated, and wastes now in storage will require disposal in the future. Low-level radioactive wastes from other DOE-Oak Ridge Operations (ORO) sites are now being placed in interim storage facilities in ORGDP buildings until the final disposition strategy is devised. Also, polychlorinated biphenyl (PCB) wastes contaminated with uranium began arriving from other DOE-ORO sites in 1987 for future incineration in the new K-1435 Toxic Substances Control Act (TSCA) incinerator.

Other remaining missions at ORGDP include advanced enrichment technology research and development, analytical laboratory service, engineering and computer support, and waste treatment services.

1.5.2 Operations of the Paducah Gaseous Diffusion Plant

PGDP is located on a reservation consisting of about 545 ha (1350 acres) in western McCracken County, Kentucky (Fig. 1.5-3). Lightly populated farmland is in the immediate environs of PGDP. The unincorporated communities of Grahamville and Heath are 2 to 3 km (1.2 to 1.9 miles) east of the plant (Fig. 1.5-4). Portions of 28 counties, 11 of which are in Kentucky, 4 in Missouri, 10 in Illinois, and 3 in Tennessee, are included within an 80-km (50-mile) radius of the plant. The largest cities in the region are Paducah, Kentucky, located approximately 16 km (10 miles) east of the plant, and Cape Girardeau, Missouri, located approximately 64 km (40 miles) east of the plant. The population within the 80-km radius is about 500,000 people, of whom about 50,000 live within 16 km of the plant.

The PGDP uranium enrichment facility consists of a diffusion cascade and extensive support facilities. The cascade is housed in five buildings, covering a total of about 30 ha (75 acres) (Rogers and Jett 1989). The first step in the uranium enrichment process takes

ORNL-DWG 87-7351

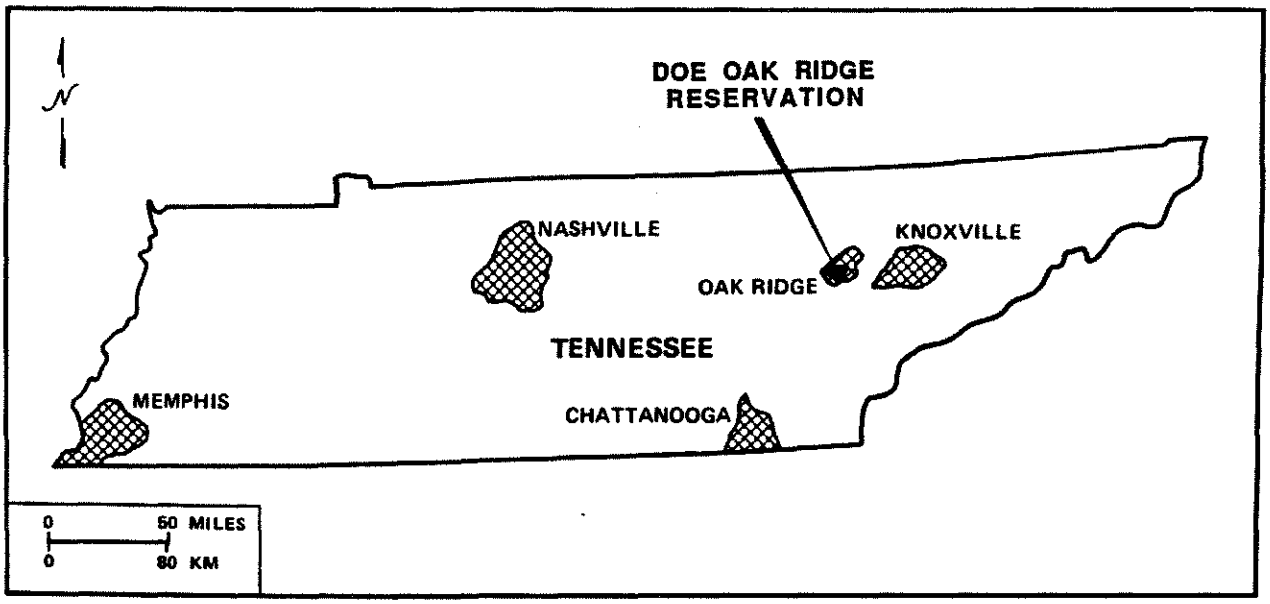


Fig. 1.5-1. Map showing the location of the U.S. Department of Energy Oak Ridge Reservation in the state of Tennessee. *Source:* J. G. Rogers et al., *Oak Ridge Reservation Environmental Report for 1988, Vol. 1, Narrative, Summary, and Conclusions,* ES/ESH-8/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May 1989.

ORNL-DWG 87-7053

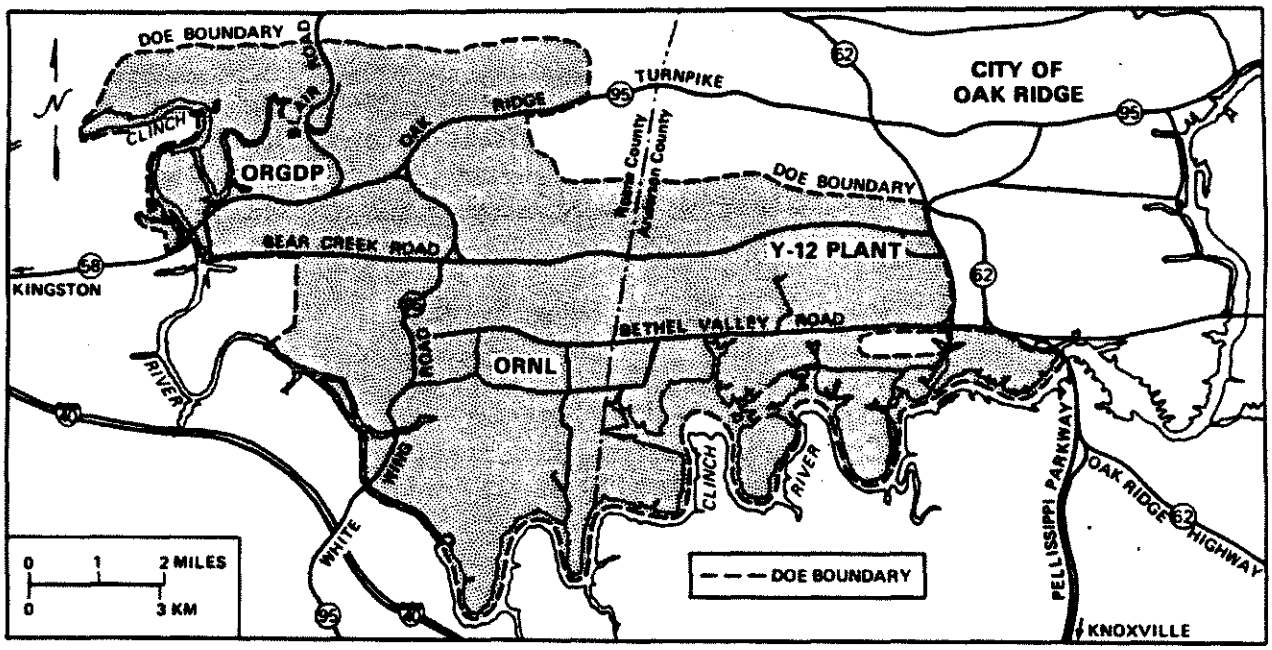


Fig. 1.5-2. Map showing the U.S. Department of Energy Oak Ridge Reservation and the location of the three major installations. *Source:* J. G. Rogers et al., *Oak Ridge Reservation Environmental Report for 1988, Vol. 1, Narrative, Summary, and Conclusions,* ES/ESH-8/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May 1989.

ORNL-DWG 87-7352

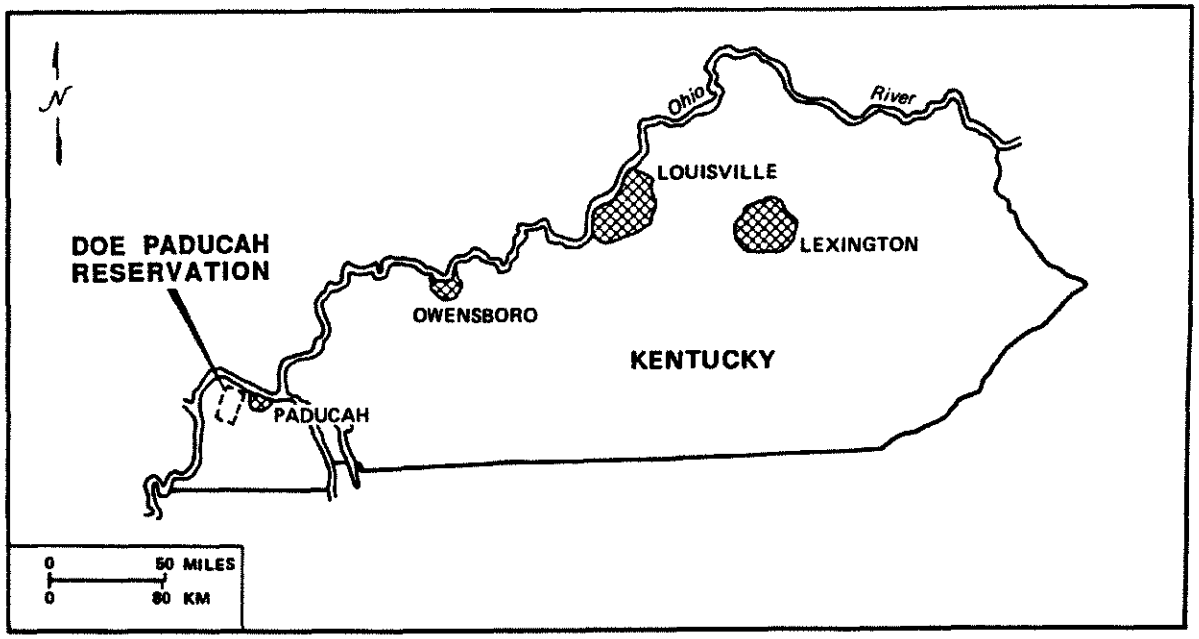


Fig. 1.5-3. Map showing the location of the U.S. Department of Energy Paducah Reservation in the state of Kentucky. *Source:* J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.

ORNL-DWG 87-8430

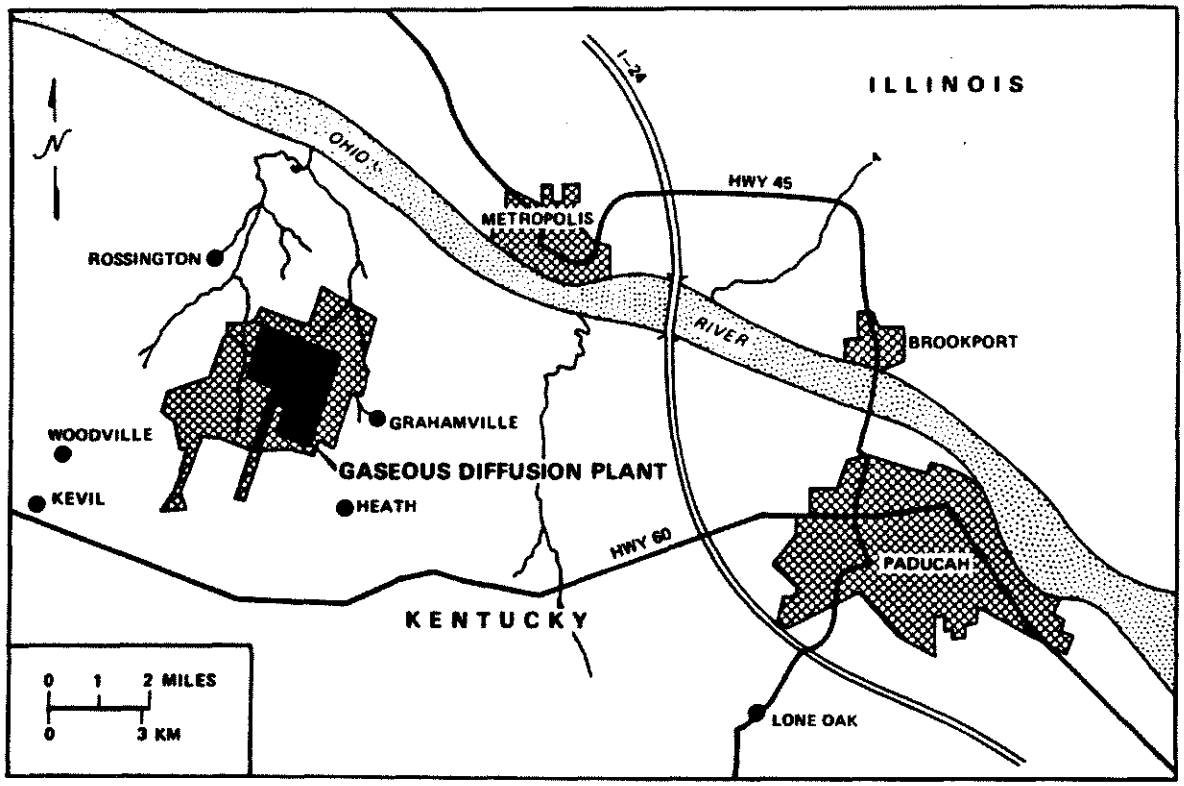


Fig. 1.5-4. Map showing the location of the Paducah Gaseous Diffusion Plant in relationship to the geographic region. *Source:* J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.

place at PGDP, but the product must be further enriched prior to its use as a nuclear fuel. The plant provides an enriched feed stream to PORTS and previously provided a similar feed stream to ORGDP before its shutdown. Hazardous, nonhazardous, and radioactive wastes have been generated and disposed of as a result of plant operations.

Extensive support facilities are required to maintain the diffusion process. Some of the major support facilities include a steam plant, four electrical switchyards, four sets of cooling towers, a recovery and decontamination building, a water treatment plant, a cooling water blowdown treatment facility, maintenance facilities, and two active landfills. Several inactive facilities are also located on the plant site.

1.5.3 Operations of the Portsmouth Gaseous Diffusion Plant

The location of the PORTS site is shown on the map of Ohio in Fig. 1.5-5. The facility is located in sparsely populated, rural Pike County, Ohio, on a 16.2-km^2 (6.3-mile^2) site about 1.6 km (1 mile) east of the Scioto River Valley at an elevation approximately 36.6 m (120 ft) above the Scioto River floodplain (Rogers et al. 1989b). The terrain

ORNL-DWG 87-6713

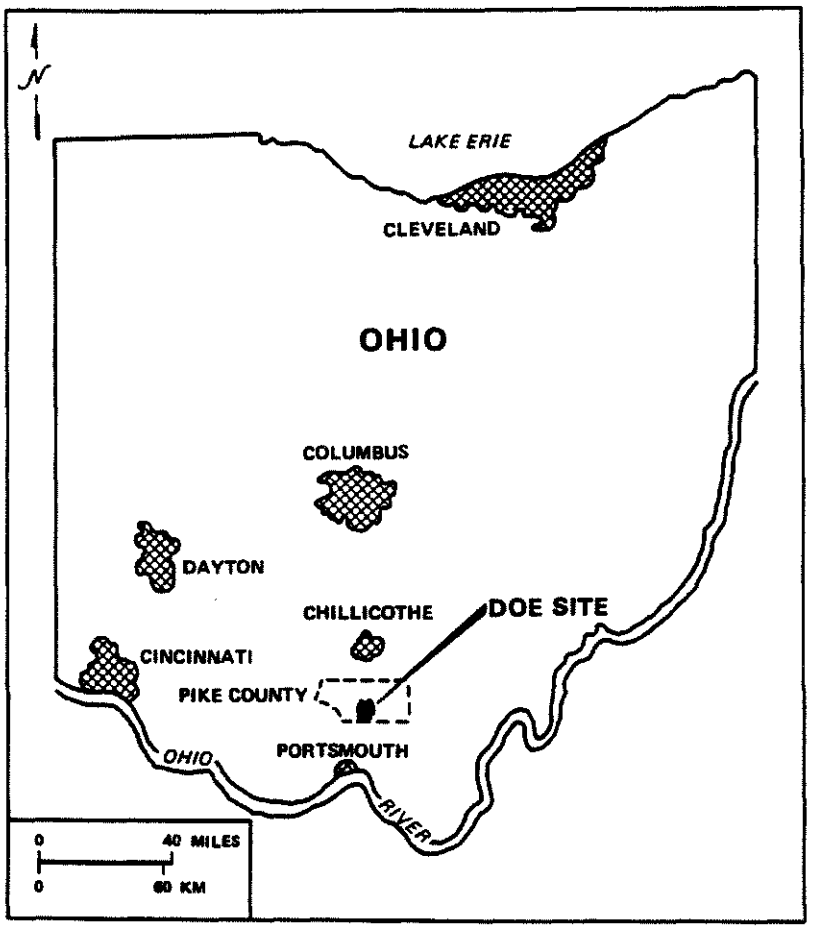


Fig. 1.5-5. Map showing the location of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant in the state of Ohio. *Source:* J. G. Rogers et al., *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.

surrounding the plant, except for the Scioto River floodplain, consists of marginal farmland and densely forested hills. The Scioto River floodplain is farmed extensively; the principal crop is grain.

Figure 1.5-6 shows the plant site and its immediate environs. Pike County has approximately 23,000 residents. Scattered rural development is typical; however, the county contains numerous small villages such as Piketon, Wakefield, and Jasper, which lie within a few kilometers of the plant. The county's largest community, Waverly, is located about 19 km (12 miles) north of the plant site and has a population of approximately 5100 residents. Additional population centers within 80 km (50 miles) of the plant are

ORNL-DWG 87-9139

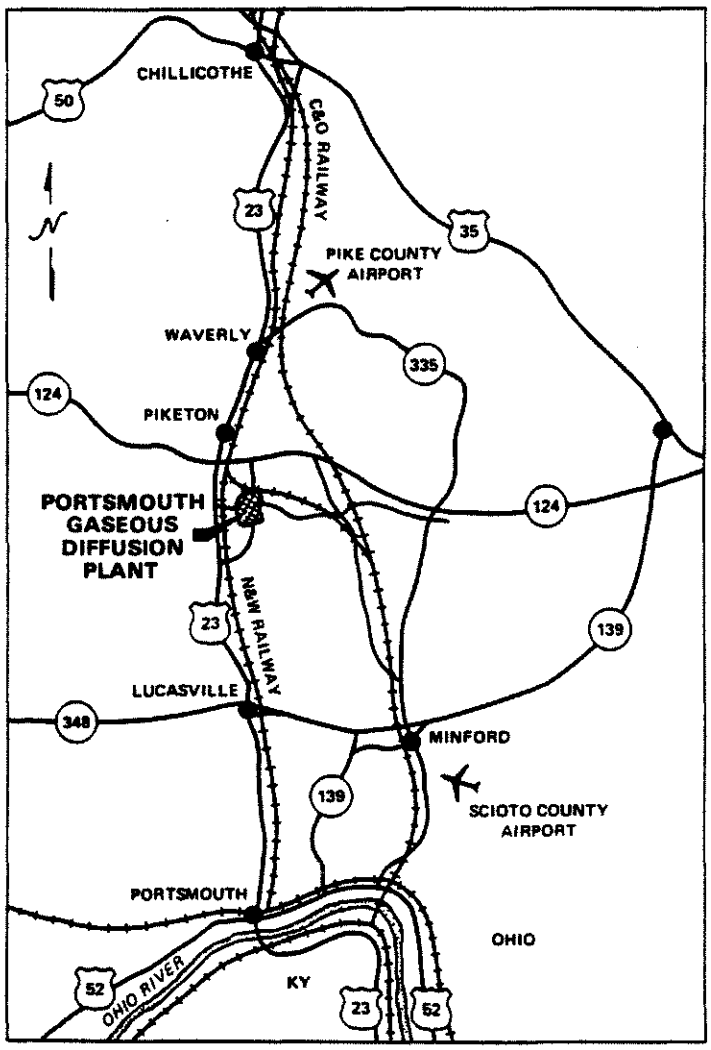


Fig. 1.5-6. Map showing the location of the Portsmouth Gaseous Diffusion Plant site in relation to the geographic region. *Source:* J. G. Rogers et al., *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.

Portsmouth (population 25,500), 43 km (27 miles) south; Chillicothe (population 23,420), 43 km north; and Jackson (population 6,675), 29 km (18 miles) east. The total population of the area lying within an 80-km (50-mile) radius of the plant is approximately 600,000.

The principal site process is the separation of uranium isotopes through the gaseous diffusion process. Support operations include the feed and withdrawal of material from the primary process, treatment of water for both potable and cooling purposes, steam generation for heating purposes, decontamination of equipment removed from the plant for maintenance or replacement, recovery of uranium from various waste materials, and treatment of industrial wastes.

1.6 REFERENCES

DOE (Department of Energy) 1982. *Environmental Assessment, Advanced Isotope Separation Process Selection,* DOE/EA-0174, Pacific Northwest Laboratories.

DOE (Department of Energy) 1985. *Environmental Assessment, Advanced Technologies for Uranium Enrichment Isotope Separation Decision,* DOE/EA-0256.

Rogers, J. G., et al. 1989a. *Oak Ridge Reservation Environmental Report for 1988, Vol. 1, Narrative, Summary, and Conclusions,* ES/ESH-8/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May.

Rogers, J. G., et al. 1989b. *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May.

Rogers, J. G., and Jett, T. G. 1989. *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May.

2. AIR QUALITY/METEOROLOGY

The following subsections include compendiums of recent meteorology data collected on-site (or nearby) for each of the three sites under consideration as well as a summary of existing air quality conditions and air emissions at each location.

2.1 OAK RIDGE

2.1.1 Meteorology

Oak Ridge is located in a broad valley between the Cumberland Mountains, which lie to the northwest of the area, and the Great Smoky Mountains, which lie to the southeast. These mountain ranges are oriented northeast-southwest, and the valley between is corrugated by broken ridges 91 to 152 m (300 to 500 ft) high and is oriented parallel to the main valley. The mountains frequently divert the hot, southeasterly winds that often develop along the southern Atlantic coast. The area has a temperate climate with warm, humid summers and cool winters. No extreme conditions prevail in temperature, precipitation, or winds. Spring and fall are usually long, and the weather is normally sunny with mild temperatures.

Table 2.1-1 presents a summary of monthly and average annual precipitation at Oak Ridge for the period 1959–1988. Total annual precipitation (water equivalent) is 1.36 m (53.5 in.), including approximately 2.5 cm (10 in.) of snowfall, with monthly precipitation peaking in January and February. The winter months are characterized by passing storm fronts and high rainfall. Winter storms are generally of low intensity and long duration. Severe storms such as tornadoes or high-velocity winds are rare.

Another peak in rainfall occurs in July, during which short, heavy rains associated with thunderstorms are common. Typically, in October slow-moving, high-pressure cells suppress rain and, while remaining nearly stationary for many days, provide mild, clear, dry weather. Poor air dilution (and thus the primary air pollution episodes) occurs with the greatest frequency and severity during this period. Humidity values tend to be high, largely because of the numerous local sources of moisture coupled with the limited ventilation of the area.

Temperatures in the Oak Ridge area are moderate throughout the year. Temperatures of 38°C (100°F) or more have occurred during fewer than one-half of the years of the recorded period, and temperatures of –18°C (0°F) or below are rare. Table 2.1-2 presents a monthly and annual average temperature summary for Oak Ridge. Records of the 1951–1980 period indicate that the average first occurrence of a freezing temperature in the fall is October 27 and the average last occurrence in the spring is April 11.

The Oak Ridge area has one of the country's lowest average wind speeds. Local terrain dominates the influences on daily wind patterns and contributes to the low annual wind speeds. Prevailing winds travel up-valley (from the southwest) and down-valley (from the northeast) directions. Thus, providing relief from the summer's humidity through ventilation is difficult. The atmosphere can be considered to be in an inversion status ~36% of the time. The daily up- and down-valley winds, however, provide some diurnal exchange. Wind-direction and wind-speed data for the year 1987 for the 10-m (3.28-ft) and

Table 2.1-1. Precipitation summary (in inches) for Oak Ridge, Tennessee

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1959	5.81	4.39	4.28	4.35	3.24	3.85	3.23	5.63	0.56	4.05	5.78	5.37	50.54
1960	3.75	3.59	5.23	2.09	1.97	7.00	3.76	10.46	4.64	4.55	2.72	4.56	54.32
1961	1.86	7.88	7.33	3.61	4.39	7.16	7.06	4.02	0.41	2.91	4.41	9.86	60.90
1962	5.93	9.01	5.88	3.94	2.64	8.09	4.28	2.87	6.42	3.28	5.44	3.31	61.09
1963	2.83	2.86	9.05	3.70	3.24	3.62	7.51	3.17	1.43	T	4.30	2.99	44.70
1964	4.81	4.33	6.32	7.13	2.84	0.86	3.41	5.05	3.14	2.61	3.82	5.62	49.94
1965	4.17	2.89	9.92	3.86	3.27	5.75	7.54	2.76	3.01	1.08	2.92	0.67	47.84
1966	3.72	5.73	2.29	5.50	3.52	2.65	2.57	4.73	4.20	3.85	4.74	3.72	47.22
1967	3.78	3.77	6.11	2.62	4.77	6.40	19.27	2.22	3.27	3.61	5.01	7.94	68.77
1968	4.47	0.84	5.26	5.21	4.01	3.56	2.80	1.25	3.47	2.23	2.24	4.28	39.62
1969	4.30	4.84	2.24	2.86	2.76	6.07	5.27	4.17	4.08	1.83	2.62	8.54	49.58
1970	2.96	3.74	4.06	9.24	0.80	5.90	1.55	9.10	2.54	6.07	1.78	4.47	52.21
1971	4.88	4.68	4.61	4.73	7.17	2.25	8.22	2.57	3.32	1.75	2.25	6.90	53.33
1972	7.32	4.83	5.99	2.94	5.81	5.56	5.22	1.77	4.28	6.95	5.02	9.20	64.89
1973	4.21	3.42	11.43	5.66	10.43	6.94	5.54	2.25	3.41	3.36	10.78	8.90	76.33
1974	9.62	4.72	7.22	3.78	7.98	2.00	1.99	4.31	4.18	1.78	5.04	4.96	57.58
1975	5.88	5.91	12.24	2.36	4.02	5.60	2.88	2.67	5.79	5.55	3.42	4.36	60.68
1976	5.47	2.60	6.00	0.88	7.24	4.80	4.03	4.89	4.56	5.91	2.27	4.68	53.33
1977	2.52	1.89	5.42	8.50	1.67	6.68	4.11	4.40	8.67	4.97	9.12	4.82	62.77
1978	5.99	1.13	4.69	3.21	4.50	3.97	4.89	5.75	1.70	0.39	5.54	6.65	48.41
1979	7.60	4.30	5.01	5.25	9.32	3.73	12.92	5.49	3.74	1.93	5.77	2.24	67.30
1980	6.24	1.51	9.20	3.89	3.01	0.85	2.39	2.07	3.31	1.08	4.55	2.02	40.12
1981	0.93	4.69	3.59	4.58	2.65	4.50	2.42	3.11	3.90	4.89	3.20	4.12	42.58
1982	6.70	5.42	6.20	2.79	2.88	2.15	7.01	4.61	5.31	1.95	7.81	7.22	60.05
1983	1.75	4.38	2.57	6.40	6.90	2.53	2.41	1.28	2.07	4.58	5.85	6.95	47.67
1984	2.62	3.92	4.81	4.16	10.70	4.70	8.72	1.87	1.87	6.19	4.37	2.59	56.52
1985	2.88	3.73	2.60	2.23	3.83	5.08	6.43	8.50	1.56	3.08	4.49	2.11	46.52
1986	1.16	5.15	2.70	1.73	2.74	1.45	2.84	2.84	4.70	4.51	3.67	5.34	38.83
1987	4.87	5.64	2.82	2.97	2.02	4.26	3.94	1.92	5.64	0.69	2.11	3.43	40.31
1988	5.44	3.43	3.80	3.42	2.65	0.53	7.60	2.39	5.63	1.97	6.56	5.53	48.95
Record Mean	5.10	4.71	5.65	4.13	4.25	3.93	5.37	3.71	3.66	3.01	4.64	5.42	53.59

Table 2.1-2. Temperature summary (°F) for Oak Ridge, Tennessee

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1959	35.9	42.9	44.6	58.0	70.6	72.9	77.2	78.2	72.7	62.1	47.4	41.3	58.7
1960	40.1	37.3	35.9	58.8	63.5	73.0	77.1	77.1	71.9	60.6	47.2	34.6	56.4
1961	33.3	46.5	51.8	53.9	62.7	71.6	73.9	75.1	72.2	57.6	50.8	40.4	57.5
1962	36.0	45.6	46.0	53.9	72.5	73.2	76.1	76.0	68.3	60.8	46.1	34.4	57.4
1963	31.2	32.5	52.3	59.6	65.8	73.4	73.7	75.4	69.4	62.0	47.8	30.5	56.1
1964	36.9	35.4	47.5	60.7	67.6	75.4	74.9	74.3	68.8	55.1	51.3	41.7	57.5
1965	38.5	38.9	45.1	60.7	68.6	71.4	75.5	75.8	71.1	56.1	49.5	41.4	57.7
1966	33.1	39.7	48.8	57.0	64.6	72.5	78.4	75.0	68.5	55.5	47.8	38.3	56.6
1967	40.5	36.3	52.9	61.3	62.7	72.0	72.1	72.8	64.9	57.8	44.3	44.2	56.8
1968	36.8	32.7	48.9	58.2	65.2	73.9	77.3	78.3	68.1	58.7	47.3	36.4	56.8
1969	35.7	38.7	41.2	59.4	67.3	74.6	79.1	74.8	68.5	58.1	44.8	36.5	56.6
1970	29.8	38.0	47.0	60.3	67.7	72.1	76.7	76.5	73.9	61.2	46.9	42.5	57.7
1971	36.8	39.1	44.4	57.6	63.5	75.6	75.0	74.8	72.6	64.0	46.7	47.8	58.2
1972	40.6	37.4	46.5	58.0	63.9	69.8	75.2	75.5	72.1	57.3	47.0	44.2	57.3
1973	37.4	38.2	55.0	55.4	62.0	74.0	76.8	75.3	72.8	62.1	50.9	39.3	58.2
1974	47.1	41.6	53.6	57.7	65.9	67.7	75.4	74.2	65.6	54.1	45.8	39.6	57.4
1975	41.1	43.0	44.6	54.9	68.2	72.0	74.7	76.2	66.0	58.5	48.4	39.4	57.3
1976	32.6	45.7	49.9	56.2	60.5	70.9	73.5	72.3	65.0	52.3	39.7	34.6	54.4
1977	24.8	36.7	50.8	59.2	66.4	72.0	77.3	75.3	70.3	53.6	49.9	36.1	56.0
1978	27.3	31.1	46.1	57.2	64.1	72.5	75.7	75.6	72.8	55.7	51.7	39.7	55.8
1979	31.1	35.3	50.0	57.2	64.4	71.5	73.9	74.9	69.7	56.5	47.9	39.5	56.0
1980	38.8	34.3	44.5	55.4	65.7	72.8	80.6	78.9	73.7	55.4	46.6	38.3	57.1
1981	32.3	39.9	44.1	61.2	62.3	75.4	77.8	74.1	66.8	55.0	46.0	34.3	55.8
1982	31.6	41.2	50.7	52.6	69.3	71.6	77.5	73.8	66.8	57.6	47.4	43.0	57.0
1983	35.4	38.6	47.7	51.2	63.8	71.5	77.9	79.2	69.4	59.4	45.7	34.4	56.2
1984	33.2	41.3	44.9	54.7	60.7	74.0	73.5	75.1	66.5	65.5	43.1	45.8	56.5
1985	28.0	35.3	47.8	57.3	64.2	71.0	74.8	73.1	67.0	61.9	54.5	30.9	55.5
1986	35.2	43.2	48.4	58.3	66.7	75.7	80.3	75.6	72.1	59.9	51.1	37.7	58.7
1987	36.0	40.8	48.3	56.7	71.6	75.0	78.1	78.1	69.7	53.4	50.0	42.8	58.4
1988	32.9	38.5	49.5	58.3	66.5	74.1	77.6	78.7	70.9	51.8	48.2	38.9	57.2
Record Mean	36.5	40.1	47.9	58.0	66.1	73.3	76.7	75.8	69.8	58.4	47.3	39.3	57.4
Max	45.7	50.7	59.5	70.6	78.3	84.9	87.4	86.6	81.0	70.5	58.3	48.7	68.5
Min	27.2	29.5	36.2	45.3	53.8	61.7	66.0	65.0	58.5	46.2	36.2	29.8	46.3

Note: Convert inches to centimeters by multiplying by 2.54. Convert degrees Fahrenheit (°F) to degrees Celsius by subtracting 32 and dividing by 1.8.

Source for Tables 2.2-1 and 2.2-2: National Oceanographic and Atmospheric Administration, *Local Climatological Data, 1988, Annual Summary—Paducah, Kentucky,* National Climate Center, Asheville, N.C.

60-m (18.3-ft) heights at ORGDP Tower "K" are presented graphically in Figs. 2.1-1 and 2.1-2. Tables A.1-1 through A.1-4 summarize wind data frequency distributions collected for 1986 and 1987 at the 10- and 60-m ORGDP tower heights respectively.

2.1.2 Air Quality

The Oak Ridge area is currently an attainment area for all criteria [sulfur dioxide (SO_2), particulate matter <10 μm in diameter (PM_{10}), carbon monoxide (CO), ozone (O_3), nitrogen oxides (NO_x), and lead (Pb)] air pollutants (see Appendix I: Liebsch 1990). Ambient monitoring data collected for SO_2 and total suspended particulates (TSP) in Anderson County (Oak Ridge) in 1988 by the Tennessee Air Pollution Control Division (TAPCD 1989) are summarized in Table A.1-5.

Most of the currently permitted air-pollution sources at ORGDP are inactive because of the shutdown of the gas centrifuge development program and the gaseous diffusion process. Currently, the only major emission source operating is the K-1501 steam plant. The K-1435 Toxic Substances Control Act (TSCA) incinerator, which is scheduled for operation in the 1990–1991 time frame, will be a new source. To reduce opacity excursions, a decision was made in 1985 to use natural gas as K-1501 fuel as much as possible. Because sufficient natural gas capacity is not available under very cold winter conditions, some coal must be burned during peak periods of use.

Table 2.1-3 provides estimates for quantities of pollutants discharged from ORGDP in 1987 from permitted sources. Most of the emissions are from either the K-1501 steam plant or the K-1420 decontamination facility. The estimates for emissions from the steam plant were based on 69 d of coal operation in 1987. Uranium emissions in 1987 resulted from an increase in operational hours in the K-1420 decontamination facility and a test on compressors conducted in building K-1401 (Rogers et al. 1988, p. 29).

ORGDP has five ambient air monitoring stations, which are positioned in the predominant wind directions, as shown in Fig. 2.1-3. These monitors sample ambient air for 24 h every sixth day to be consistent with the Tennessee Department of Health and Environment (TDHE) TSP sampling schedule. The analysis parameters for the ambient air samples are U, Ni, Pb, Cr, and TSP. Table 2.1-4 summarizes data for each parameter checked by the ORGDP ambient air monitoring system. These data indicate that no standards were exceeded. For TSP, no maximum concentration exceeded 50% of the secondary standard. Effective July 31, 1987, the Environmental Protection Agency (EPA) replaced the existing National Ambient Air Quality Standards (NAAQS) for TSP with the PM_{10} standards. The PM_{10} standards, for particulate matter with aerodynamic diameters of 10 μm or less, replaced the TSP standards for all suspended particulate matter because the former group is considered to contain almost all the particulate matter that is most dangerous to human health (inhalable particulate matter). No PM_{10} monitoring data are as yet available for this location. For lead, the percentage of the standard was less than 3%.

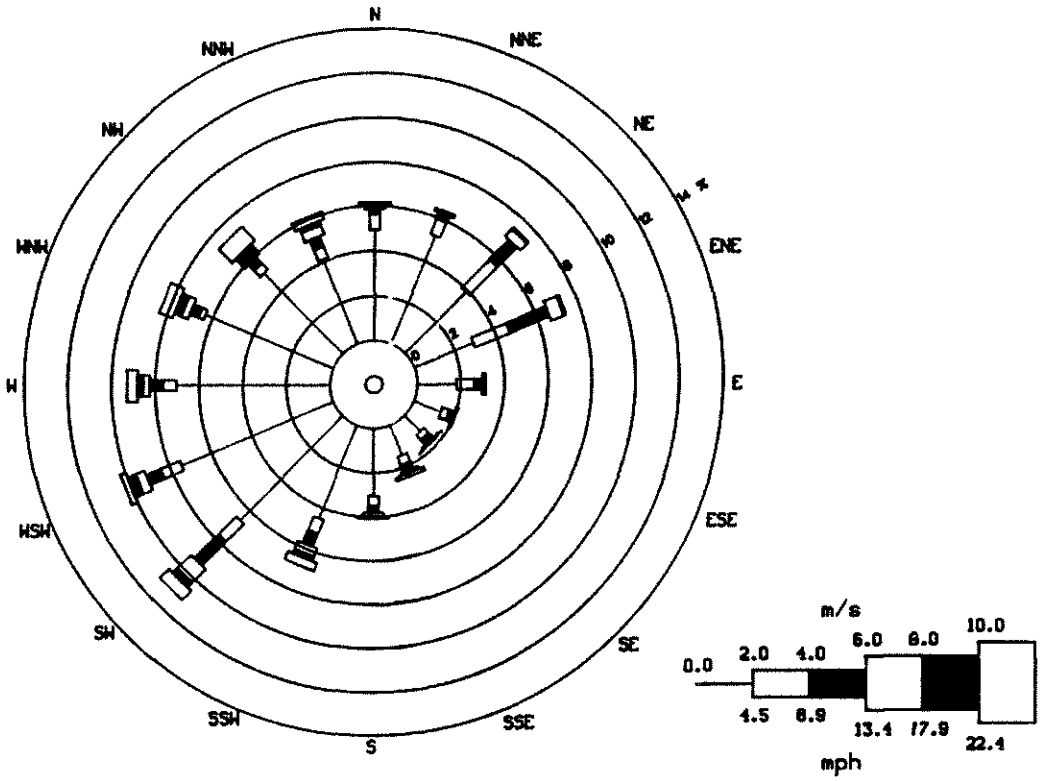


Fig. 2.1-1. Wind rose for Tower K (10 m) for January 1, 1987, through December 31, 1987, with 85.6% of possible data.

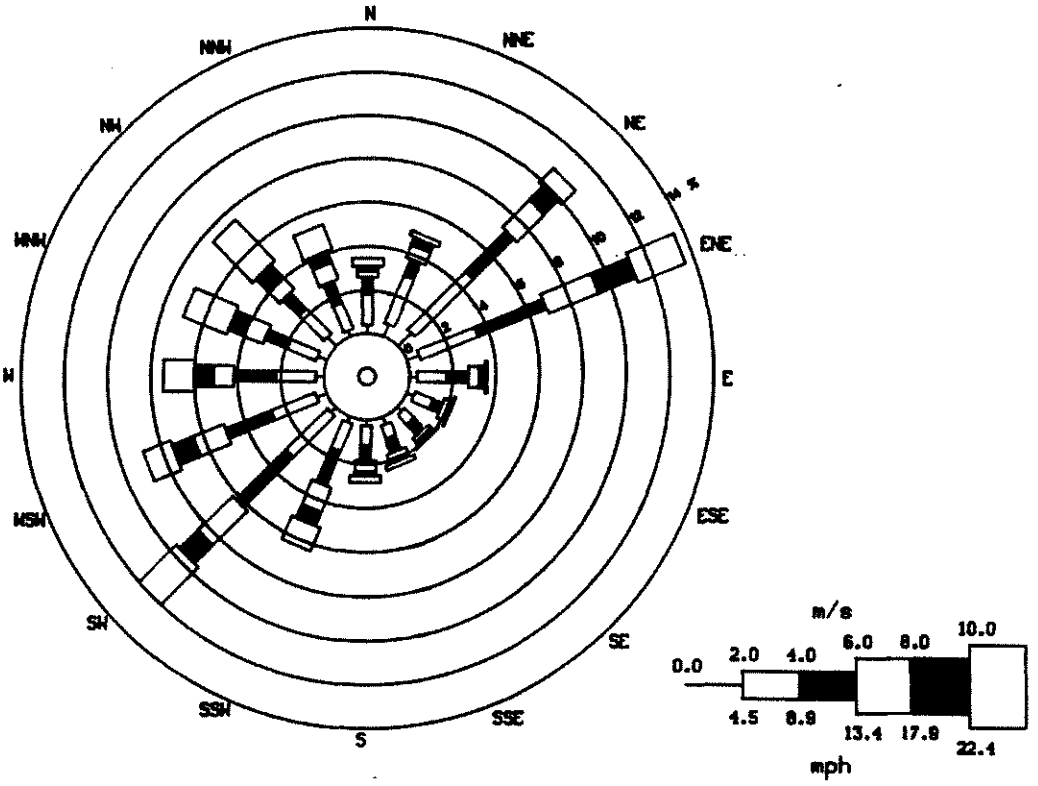


Fig. 2.1-2. Wind rose for Tower K (60 m) for January 1, 1987, through December 31, 1987, with 85.6% of possible data.

Table 2.1-3. Estimated 1987 pollutant emissions for Oak Ridge Gaseous Diffusion Plant

Pollutant	Emissions (tons/year)[a]
SO_2	414.7
NO_x	93.5
Uranium	0.0004 (0.0003 Ci)
CO	13.3
Particulates	8.2
Ammonia	0.6
Fluorides	0.2
VOC[b]	40.6
Other[c]	3.4

[a]To convert tons to kilograms, multiply the given value by 907.185.

[b]The degreaser baths in K-1401 use 1,1,1-trichloroethane, which is not defined by the Tennessee Department of Health and Environment as a volatile organic compound. However, this material is a volatile organic.

[c]The "Other" category consists mainly of several acid vapors from decontamination and parts cleaning processes.

Source: J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987,* ES/ESH-4/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.

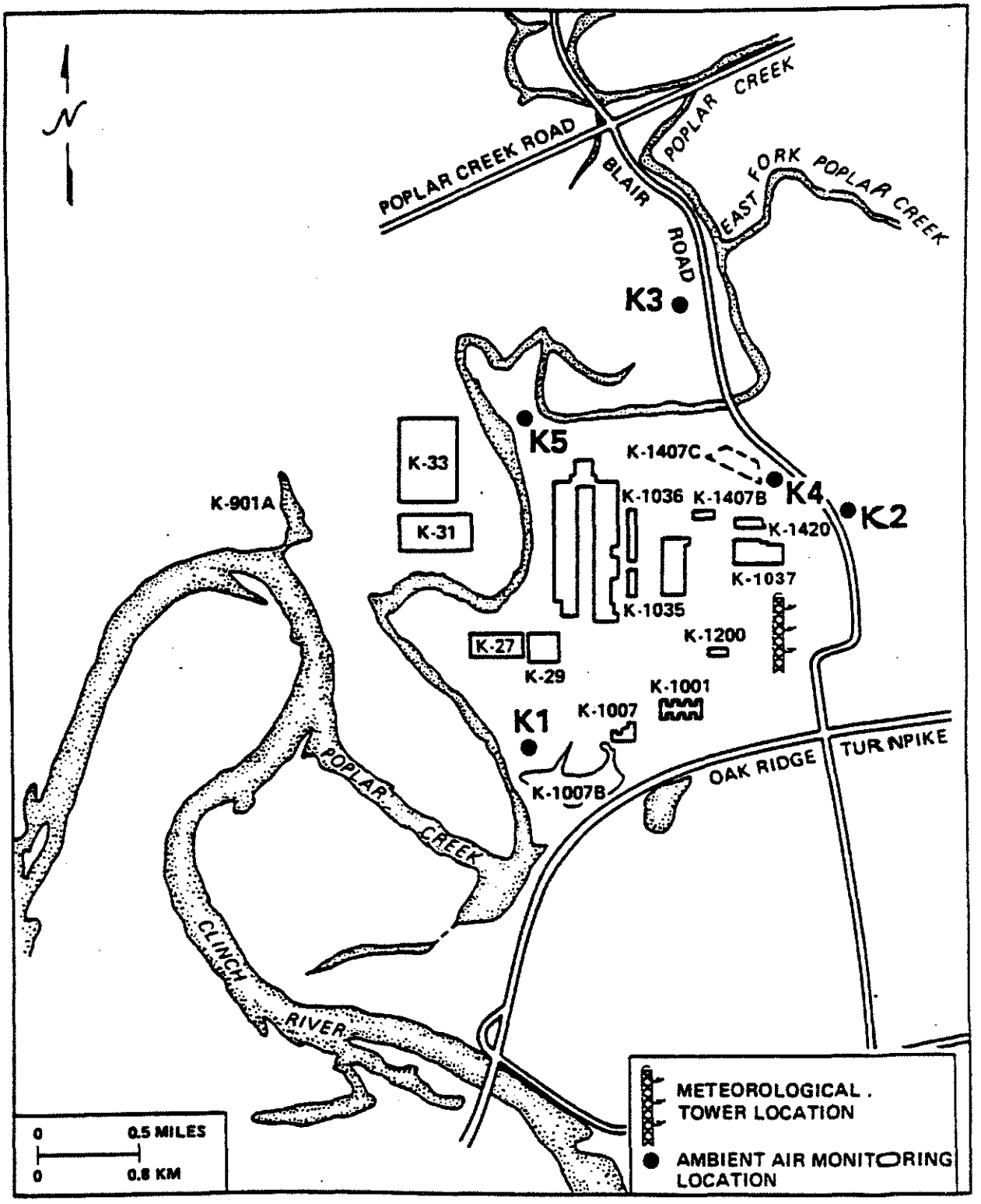


Fig. 2.1-3. Location of the Oak Ridge Gaseous Diffusion Plant ambient air monitors and meteorological tower. *Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 43.

Table 2.1-4. 1987 Oak Ridge Gaseous Diffusion Plant environmental air sampling

Sample point[a]	No. of samples	Concentration ($\mu g/m^3$)			Percentage of standard (based on maximum concentration)	
		Max	Min	Geometric average	Primary standard	Secondary standard
				TSP[b]		
K1	58	67.30	5.58	20.46 ± 4.03	26	45
K2	61	61.17	3.64	20.30 ± 3.56	26	41
K3	61	63.04	4.91	20.38 ± 3.50	24	42
K4	59	66.19	5.69	24.32 ± 4.46	25	44
K5	56	64.97	5.24	21.13 ± 3.98	25	43
				Lead[c]		
K1	58	0.0390	<0.0049	<0.0134 ± 0.0020	3	NA[d]
K2	61	0.0415	<0.0052	<0.0147 ± 0.0022	3	NA
K3	61	0.0375	<0.0049	<0.0151 ± 0.0020	2	NA
K4	59	0.0511	<0.0053	<0.0183 ± 0.0027	3	NA
K5	56	0.0357	<0.0046	<0.0135 ± 0.0021	2	NA
				Chromium[e]		
K1	58	0.0050	<0.0024	<0.0027 ± 0.0001	0	NA
K2	61	0.0049	<0.0024	<0.0027 ± 0.0001	0	NA
K3	61	0.0052	<0.0003	<0.0024 ± 0.0001	0	NA
K4	59	0.0071	<0.0021	<0.0029 ± 0.0002	0	NA
K5	56	0.0045	<0.0023	<0.0025 ± 0.0001	0	NA
				Nickel[e]		
K1	58	0.0139	<0.0024	<0.0038 ± 0.0006	0	NA
K2	61	0.0125	<0.0024	<0.0037 ± 0.0005	0	NA
K3	61	0.0122	<0.0014	<0.0034 ± 0.0006	0	NA
K4	59	0.0133	<0.0022	<0.0042 ± 0.0007	0	NA
K5	56	0.0136	<0.0023	<0.0034 ± 0.0007	0	NA
				Uranium[f]		
K1	58	0.0006	<0.0001	<0.0002 ± 0.0000	0.4	NA
K2	61	0.0018	<0.0001	<0.0002 ± 0.0001	1.15	NA
K3	61	0.0017	<0.0001	<0.0002 ± 0.0001	1.15	NA
K4	59	0.0017	<0.0001	<0.0003 ± 0.0002	1.15	NA
K5	56	0.0016	<0.0001	<0.0002 ± 0.0001	1.15	NA

Source: J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs during 1987, Vol. 1: Narrative, Summary, and Conclusions*, ES/ESH-4/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.

[a] See Fig. A.1-6.

[b] Primary standard for TSP for the state of Tennessee is 260 µg/m3/24 h. Secondary standard for TSP for the state of Tennessee is 150 $\mu g/m^3$/24 h.

[c] The primary standard for lead is 1.5 $\mu g/m^3$.

[d] Not applicable.

[e] 8-h NIOSH exposure limit = 1000 $\mu g/m^3$

[f] Standard for the public for natural uranium is 1 x 10-1 pCi/m^3, which converts to 0.15 $\mu g/m^3$. No TDHE ambient standards exist for uranium.

2.2 PADUCAH

2.2.1 Meteorology

The climate of Paducah, Kentucky, is characteristic of the humid continental zone in which Paducah is located. Precipitation is well distributed throughout the year, with an average of ~119 cm (~47 in.). Table 2.2-1 presents a summary of monthly and average precipitation levels at Paducah during the past 5 years (data were not collected at this location before 1984). Relative humidity is estimated as ~83% at 6 a.m. and 61% at noon.

Winters are characterized by moderately cold days, and summers are warm and humid. July is the hottest month of the year; January is the coldest. Average monthly temperatures are 25.6°C and 1.5°C (78°F and 34.7°F) respectively. The average length of the growing season is 200 d. Table 2.2-2 presents a summary of monthly and annual average temperatures for Paducah. A new meteorological monitoring system, installed at PGDP in 1987, consists of wind and temperature sensors at 10 and 60 m above ground level as well as computerized data display.

The prevailing wind direction at Paducah is south to southwest. Wind-direction and wind-speed data are presented graphically for the 10- and 60-m heights at PGDP in Figs. 2.2-1 and 2.2-2 respectively. Tables A.2-1 and A.2-2 summarize wind data frequency distributions collected at the 10- and 60-m PGDP towers respectively.

Very little off-site fogging and icing have been observed in recent years from operation of the existing PGDP cooling towers. Conservative estimates of fogging and icing are generally below 12.5 and 15 h/year, respectively, at 2400 MW (DOE 1982).

2.2.2 Air Quality

McCraken County is now classified as attainment for CO, O_3, SO_2, and NO_x. TSP has been classified as nonattainment in the *Code of Federal Regulations* (CFR) but is classified as "better than standards" by Kentucky. Ozone monitoring data collected in 1989 may result in eventual reclassification of the county to nonattainment if excessive monitoring levels persist (see Appendix I: Mitckes 1989a). Ambient monitoring data collected in or near Paducah by the Division of the Quality (1989) between April 1988 and March 1989 are summarized in Table A.2-3.

The major air-emission sources in operation at PGDP during 1987 were

- two coal-fired boilers and one gas-fired boiler in the C-600 steam plant,
- the cascade purge vent stack at building C-301,
- the uranium tetrafluoride (UF_4) pulverizer dust collector vent at building C-400, and
- two vapor degreasers in building C-400.

Other air emissions are reported during asbestos removal, boiler startup and shutdown, and fire training exercises. Accidental chemical spills or process leaks also would require air monitoring.

The pollution parameters that must be quantified to demonstrate compliance with permits or the DOE as-low-as-reasonably-achievable (ALARA) policy are TSP, SO_2, NO_x, volatile organic compounds (VOCs), radionuclides, and fluorides. The 1987 cumulative emissions for these pollutants are tabulated by source in Table 2.2-3.

Table 2.2-1. Precipitation summary for Paducah, Kentucky

PRECIPITATION (inches) PADUCAH, KENTUCKY

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1984	1.21	4.74	5.83	8.45	6.50	1.58	5.44	3.96	6.80	5.88	4.75	9.99	65.13
1985	1.82	3.70	3.67	6.85	4.13	4.85	0.85	5.89	9.23	7.26	4.29	1.34	53.88
1986	1.44	3.73	3.16	1.55	8.51	1.50	7.07	4.33	3.69	4.45	3.59	3.11	46.13
1987	0.99	3.93	1.93	2.30	1.43	4.03	2.58	1.31	2.80	1.58	4.29	9.19	36.36
1988	3.50	5.15	4.60	2.13	3.14	0.41	3.08	1.05	3.49	3.81	9.56	3.05	42.97
Record Mean	1.79	4.25	3.84	4.26	4.74	2.47	3.80	3.31	5.20	4.60	5.30	5.34	48.89

Table 2.2-2. Temperature summary for Paducah, Kentucky

AVERAGE TEMPERATURE (deg. F) PADUCAH, KENTUCKY

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1984	29.2	42.1	43.6	56.7	64.6	78.6	76.7	76.9	68.5	63.1	45.0	45.2	57.5
1985	23.9	32.0	51.3	60.9	66.8	73.3	78.4	74.8	68.8	62.4	52.5	31.3	56.4
1986	35.5	40.3	49.7	60.6	68.7	77.4	81.7	73.8	73.8	60.1	45.1	36.9	58.6
1987	33.5	40.9	50.2	57.4	73.0	78.2	79.5	79.8	71.6	53.4	50.9	41.1	59.1
1988	32.2	35.1	47.5	57.4	67.3	75.8	80.4	80.9	70.8	52.8	48.4	38.2	57.2
Record Mean	30.9	38.0	48.5	58.6	68.1	76.6	79.3	77.2	70.7	58.3	48.4	38.5	57.7
Max	39.9	47.5	59.2	70.4	79.6	88.1	90.2	88.6	82.7	69.9	58.2	48.1	68.5
Min	21.8	28.6	37.7	46.8	56.5	65.1	68.4	65.8	58.6	46.7	38.5	28.9	46.9

Note: Convert inches to centimeters by multiplying by 2.54. Convert degrees Fahrenheit to degrees Celsius by subtracting 32 and dividing by 1.8.

Source for Tables 2.2-1 and 2.2-2: National Oceanographic and Atmospheric Administration, *Local Climatological Data, 1988, Annual Summary—Paducah, Kentucky,* National Climate Center, Asheville, N.C.

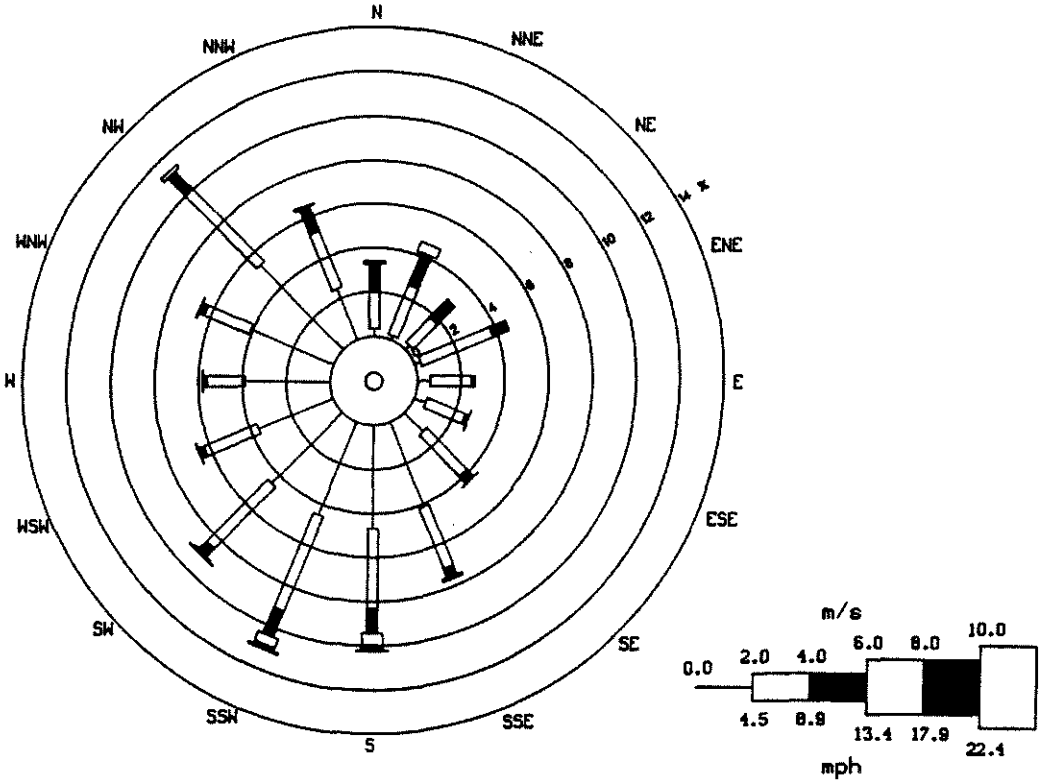


Fig. 2.2-1. Wind rose for Paducah Tower (10 m) for the period from January 1, 1988, through December 31, 1988, with 75.7% of possible data.

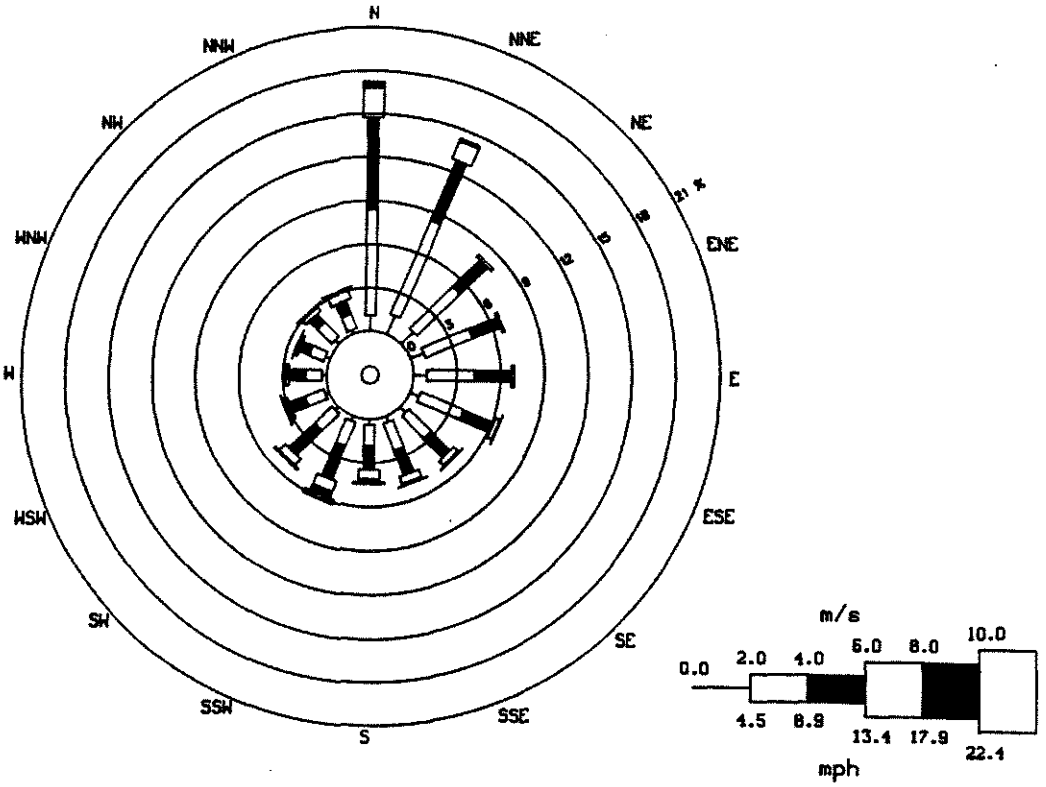


Fig. 2.2-2. Wind rose for Paducah Tower (60 m) for the period from January 1, 1988, through December 31, 1988, with 86.7% of possible data.

Table 2.2-3. 1987 Paducah Gaseous Diffusion Plant stack emissions summary

Stack	Control Equipment	Emission		
		Effluent	kg/year	(Curies)
C-310 cascade vent	Gaseous diffusion stages and chemical traps	^{234}U	2.5×10^{-6}	(1.7×10^{-5})
		^{235}U	3.4×10^{-4}	(0.78×10^{-6})
		^{238}U	3.4×10^{-2}	(1.1×10^{-5})
		^{99}Tc	5.2×10^{-5}	(0.89×10^{-3})
	Gaseous fluorides		7.1×10^{3}	
C-400 UF_4 pulverizer	High-efficiency cartridge filter	^{234}U	8.2×10^{-6}	(5.6×10^{-5})
		^{235}U	1.2×10^{-3}	(2.5×10^{-6})
		^{238}U	0.59	(2.0×10^{-4})
C-600 steam plant	Use of low-sulfur coal	SO_2	165,000	
	Control of excess air	NO_2	223,000	
	Electrostatic precipitator	TSP[a]	28,000	
C-400				
Large degreaser	Cooling coils Movable cover	TCE[b]	32,000	
Small degreaser	Cooling coils	TCE	2,400	

[a]TSP = total suspended particulates from fly ash.
[b]TCE = trichloroethylene.

Source: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 11.

The C-600 steam plant emissions routinely reported are SO_2 and NO_2. SO_2 is continuously monitored in the stack as pounds of SO_2 per million British thermal units (MBtu) input to the boiler. These data are combined with fuel-usage data to arrive at monthly and annual emissions. NO_2 emissions are calculated from fuel usage and the handbook values of the quantity of NO_2 produced per pound of fuel for each type of fuel burned in this typical type of boiler. The Kentucky Air Pollution Control permit limit of 20% opacity is achieved by use of electrostatic precipitators (ESPs) operating at >99% efficiency for particulate removal. Tests have shown particulate emissions to be <0.043 g/MJ (<0.1 lb/MBtu). This emission value was used to estimate the 1987 total emission of 28,000 kg of ash as TSP. ESPs provide clear stacks while the boilers are operating, but visible emissions occur during startup, shutdown, and some maintenance activities. These periods are brief and infrequent.

The C-310 stack is used as the vent for the cascade system. Light gases travel up the cascade to be released via the C-310 stack. Gaseous fluorides and traces of uranium and technetium are released in small quantities. High-speed centrifugal separation systems and chemical trappings are used to control stack emissions. The stack gases are continuously sampled and the samples are analyzed daily.

The C-400 UF_4 pulverizer exhaust system is filtered, and the stack is continuously sampled for particulates. The sampling device is frequently checked for evidence of filter leakage and is routinely analyzed for uranium.

PGDP also operates a trichloroethylene (TCE) vapor degreaser in the C-400 cleaning building; the degreaser is large enough to accommodate the largest components of gaseous diffusion process equipment. Losses of TCE to the ventilation system are inevitable because of the large area exposed during operations. These losses are calculated and reported as a major plant emission source in Table 2.2-3.

Ambient air is sampled continuously by PGDP personnel for gaseous fluorides and radioactive particulates at four locations within the plant fence and at eight locations outside the fence. These locations are shown in Fig. 2.2-3.

The sample filters are stored at least 168 h to permit decay of the short-lived daughters of naturally occurring radon. The filters are then analyzed for alpha and beta activity. Should activity above normal levels for a specific location be found, specific nuclides can be identified. After the radioactivity measurements are made, the filters are leached with water, and fluoride content is measured by specific ion electrode analysis. A summary of 1987 PGDP ambient air monitoring data for fluorides and radioactivity is shown in Tables 2.2-4 and 2.2-5. During 1987, a total of 0.00029 Ci of uranium and 0.00089 Ci of technetium was released to the atmosphere at PGDP (Rogers and Ashburn 1988).

2.3 PORTSMOUTH

2.3.1 Meteorology

Ohio is located in the humid continental climatic zone. This zone, unique to the Northern Hemisphere, lies between the dominating polar front and the tropical climates; thus, temperature and precipitation extremes such as heat waves, cold waves, blizzards, and cloudbursts can be expected. The climate in Pike County, Ohio, is typical.

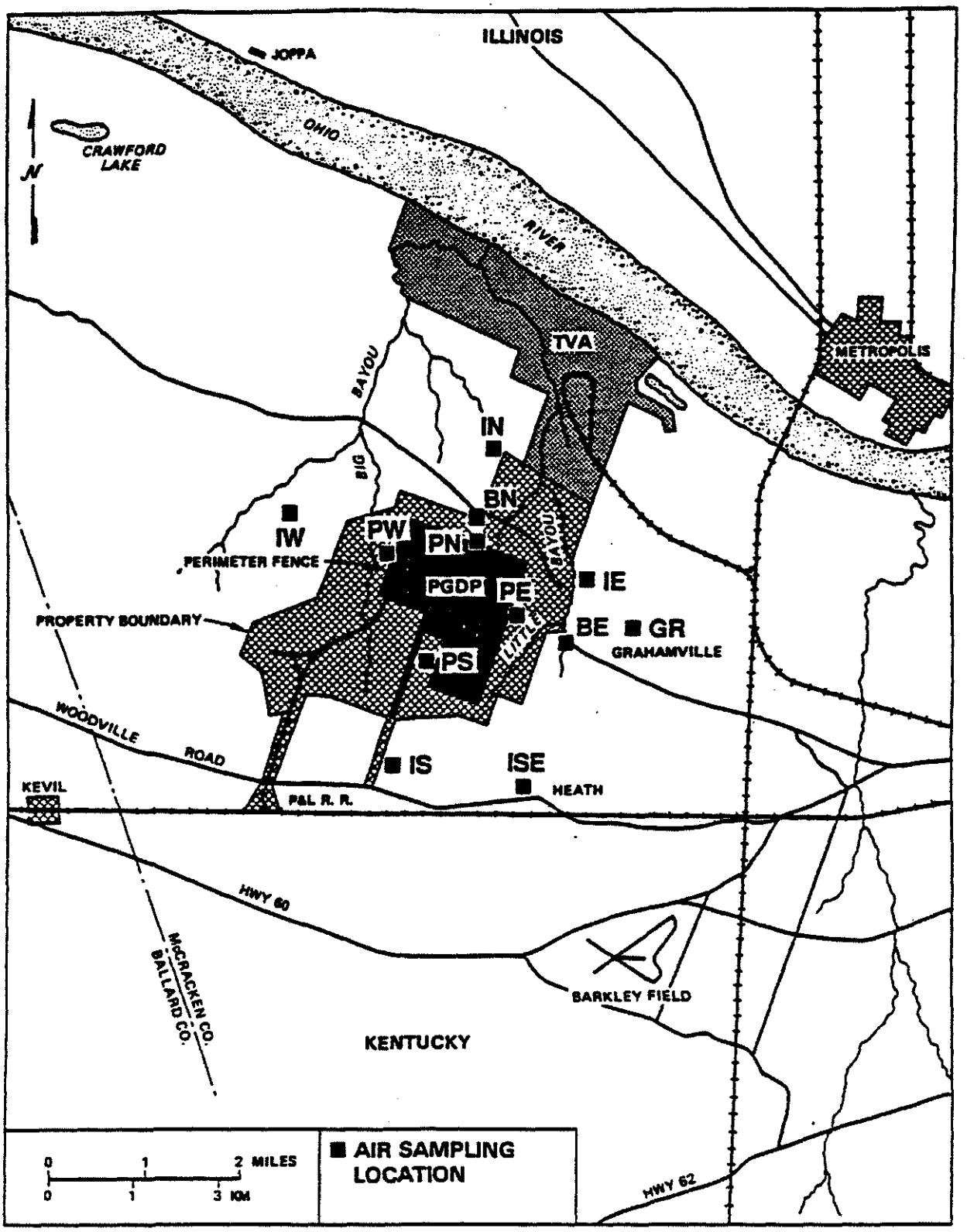


Fig. 2.2-3. Location of air sampling stations at the Paducah Gaseous Diffusion Plant. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 13.

Table 2.2-4. 1987 Paducah Gaseous Diffusion Plant environmental air sampling—fluorides

Point[a]	No. of samples	Concentration (ppb HF)			Percent of weekly standard
		Min	Max	Av[b]	
1 (PN)[c]	43	0.075	0.81	0.23	
2 (PE)[c]	37	<0.096	0.20	<0.127	
3 (PS)[c]	44	<0.084	0.15	<0.087	
4 (PW)[c]	36	<0.091	0.18	<0.097	
5 (BN)	39	<0.059	0.26	<0.14	4
6 (BE)	44	<0.080	0.14	<0.076	2
7 (1N)	41	<0.15	0.13	<0.085	2
8 (1E)	46	<0.099	0.10	<0.070	2
9 (1SE)	41	<0.46	0.13	<0.10	3
10 (1S)	46	<0.14	0.13	<0.081	2
11 (1W)	41	<0.082	0.21	<0.074	2
12 (GR)	42	<0.083	0.14	<0.077	2

[a]See Fig. 2.2-3.

[b]Kentucky Secondary Ambient Air Quality Standards (401 KAR 53:010); maximum 24-h average is 3.5 ppb as HF; maximum 1-week average is 0.97 ppb as HF; monthly average is 0.6 ppb as HF.

[c]Sampling locations are on government property inside the plant perimeter fence. For comparison, the 40-h occupational threshold limit value (TLV) for HF is 3000 ppb.

Table 2.2-5. 1987 Paducah Gaseous DiffusionPlant environmental air sampling for radioactivity

Point[a]	Gross alpha ($pCi/m^3 \times 10^{-2}$)			Gross beta (pCi/m^3)			No. of samples
	Min	Max	Av	Min	Max	Av	
1 (PN)	−0.32	1.3	0.38	−0.092	0.39	0.10	43
2 (PE)	−0.40	1.3	0.36	−0.076	0.28	0.093	37
3 (PS)	−0.28	0.85	0.36	−0.11	0.26	0.090	44
4 (PW)	−0.49	0.55	0.26	−0.22	0.28	0.078	36
5 (BN)	−0.46	1.2	0.29	−0.19	0.24	0.091	39
6 (BE)	−0.23	2.9	0.45	−0.10	0.27	0.096	44
7 (1N)	−0.42	2.3	0.45	−0.12	0.34	0.11	41
8 (1E)	−0.52	1.8	0.35	−0.22	0.35	0.11	46
9 (1SE)	−3.5	2.3	0.56	−0.10	0.54	0.12	41
10 (1S)	−0.19	0.6	0.27	−0.13	0.26	0.088	46
11 (1W)	−0.19	0.9	0.29	−0.11	0.28	0.095	41
12 (GR)	−0.35	1.11	0.36	−0.12	0.32	0.10	42

[a]See Fig. 2.2-3.

Source for Tables 2.2-4 and 2.2-5: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 14.

Pike County has a generally moderate climate. The National Oceanic and Atmospheric Administration maintained a weather station (temperature and precipitation only) in Waverly, ~11 km (~6.8 miles) north of the plant, from 1889 until the early 1980s. The heaviest rainfall occurs in July and August, mostly by thunderstorms, and flash floods are common in the area. Winter rainfall occurs mostly prior to, or simultaneously, with frontal passages and frequently lasts from two to four days, causing frequent general flooding in all streams.

Precipitation at Waverly varies widely from year to year but averages ~101 cm (~39.8 in.). The precipitation is usually well distributed, although fall is often the driest season. Average annual precipitation levels for the period 1963–74 are plotted in Fig. 2.3-1, and the average monthly precipitation levels for the period 1936–74 are plotted in Fig. 2.3-2. The maximum monthly and maximum daily precipitation totals for 1936–74 were 35.3 cm (13.9 in.) in January 1937 and 8.6 cm (3.38 in.) on March 10, 1964, and June 26, 1971. Table 2.3-1 provides monthly and annual average precipitation data for 1959–88 from Huntington, West Virginia, located 78 km (48 miles) southeast of PORTS.

Thundershowers are common from April to August and occur on an average of 45 days per year. Locally heavy rains may accompany showers or thundershowers, and 24-h totals of 2.2, 2.8, 3.1, 3.6, 4.0, and 4.3 in. can be expected every 2, 5, 10, 25, 50, and 100 years respectively (PORTS 1977, p. 2-207).

Snowfall for Waverly averages 51.8 cm (20.4 in.), but varies considerably. Snowfall may occur during January, February, March, April, May, November, or December. Average monthly snowfall is greatest during January and February [13.2 and 12.2 cm (5.5 and 5.1 in. respectively)] and least during April [0.36 cm (0.15 in.)]. The maximum monthly snowfall was 58.4 cm (23 in.), in January 1948, and the maximum daily snowfall was 28 cm (11 in.), on November 26, 1950.

The relative humidity averages at Waverly are approximately 80% at 1 and 7 a.m., 60% at 1 p.m., and 70% at 7 p.m.. The average relative humidity for 1973 and 1974 was 69.7%, and the average maximum and minimum relative humidity for these years was 90.5% and 48.8% respectively (PORTS 1977, p. 2-207). While these data are not recent, the values shown would be typical for any year on an average basis.

For the PORTS area, the winter months are moderately cold, with an occasional severe cold wave that lasts a few days. The four seasons are nearly equal in length; autumn is the most pleasant season, with warm days and cool nights. Each year temperatures are 0°C (32°F) or lower on an average of 112 d, and temperatures fall below 18°C (0°F) on 3 d. The summers are moderately warm and humid, with an average of 27 d that have temperatures of 32°C (90°F) or above per year. Large differences in surface temperatures are common within the county, especially in hilly areas. These differences usually occur in October and occur when cool, dense air moves down the slopes and displaces the warm air in the valleys. This air movement usually results in large temperature variations between the hilltops and the valley floors.

During the period 1936–1974, the average temperature at Waverly was 12°C (53.6°F), which was approximately 8°C (46.5°F) below the average temperature for south-central Ohio. The average daily maximum and minimum temperatures for the period were 18.5°C (65.3°F) and 5.2°C (41.4°F) respectively. The Waverly average annual temperatures for the period 1963–1974 are plotted in Fig. 2.3-3; the maximum and minimum average monthly temperatures and the average annual temperatures for the period 1936–1974 are plotted in Fig. 2.3-4. Temperature extremes usually occur shortly after July 21 and December 22; the records are 40.5°C (105°F), recorded on July 30, 1940, and –31.7°C (–25°F), recorded

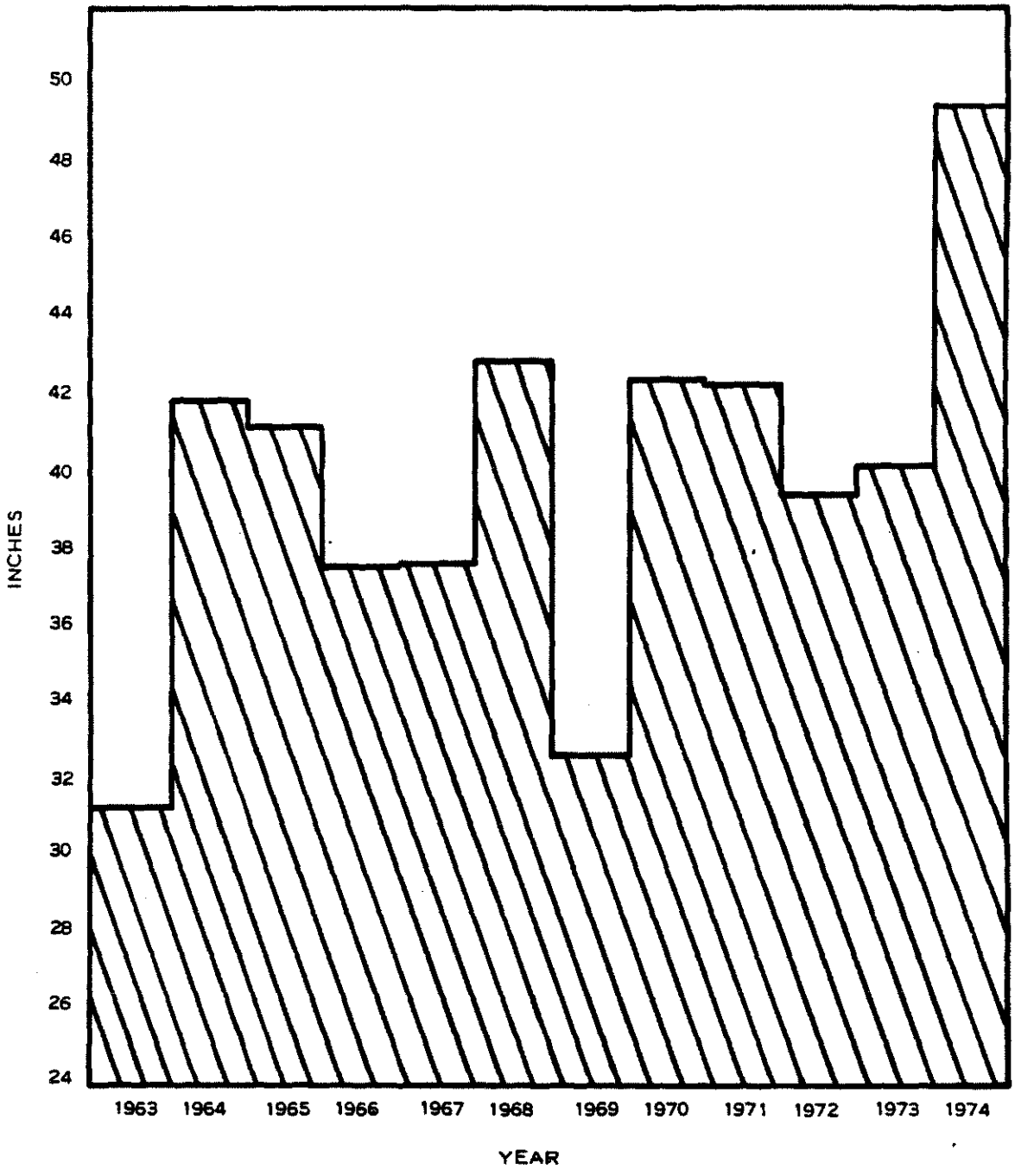


Fig. 2.3-1. Average annual precipitation at Waverly from 1963 to 1974. Note that inches may be converted to centimeters by multiplying the given value by 2.54. *Source:* U.S. Energy Research and Development Administration, *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion, Vol. 1*, ERDA-1549, Piketon, Ohio, September 1977, p. 2-209.

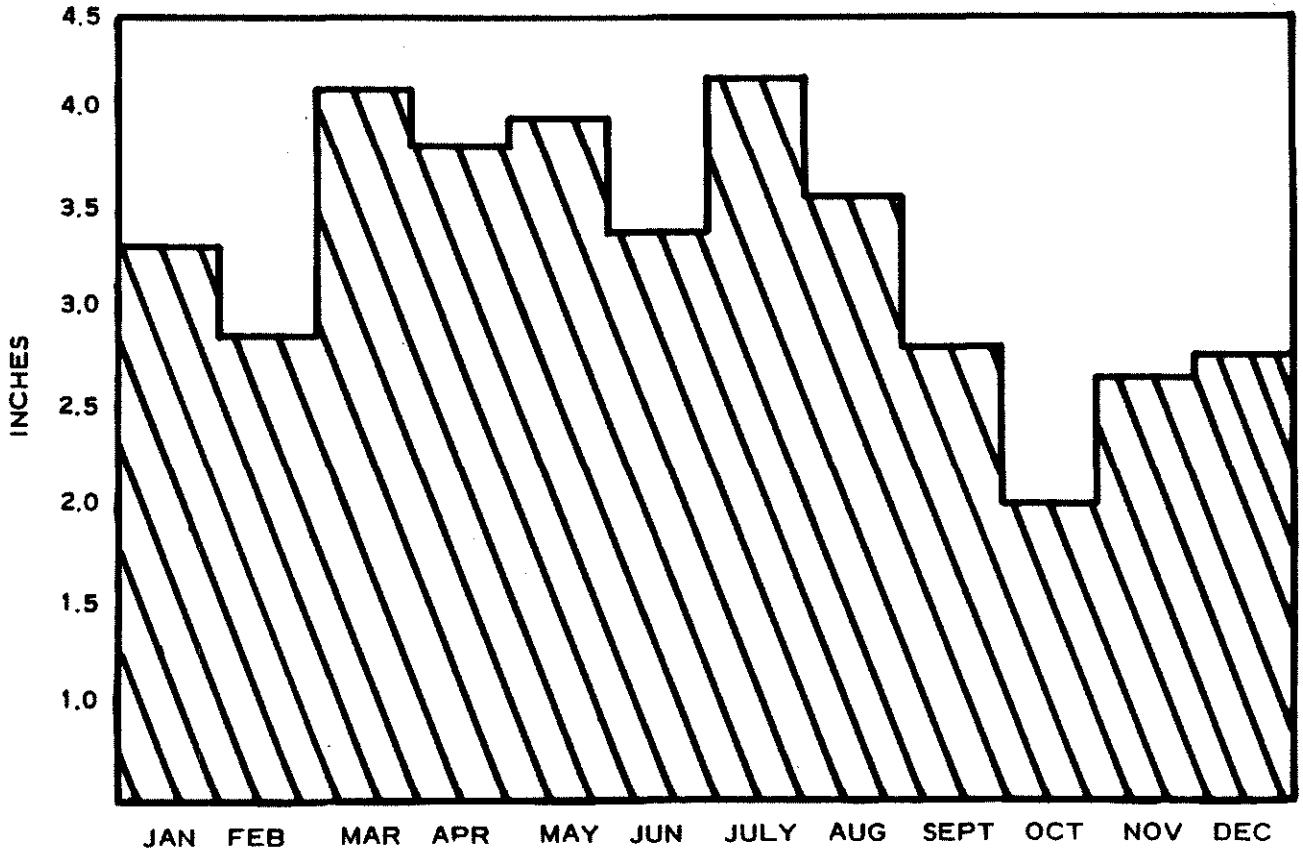


Fig. 2.3-2. Average monthly rainfall at Waverly (1936-1974). *Source:* U.S. Energy Research and Development Administration, *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion, Vol. 1*, ERDA-1549, Piketon, Ohio, September 1977, p. 2-210.

Table 2.3-1. Precipitation summary for Huntington, West Virginia

PRECIPITATION (inches) HUNTINGTON, WEST VIRGINIA

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1959	3.75	2.31	1.91	4.90	3.46	2.01	7.78	2.68	3.96	3.29	3.61	2.06	41.72
1960	2.36	4.50	2.01	1.34	2.98	5.34	4.26	3.75	2.42	1.77	1.77	2.32	34.82
1961	3.52	3.50	4.06	4.08	3.89	7.28	9.90	3.24	1.07	3.35	3.12	4.43	51.44
1962	2.62	5.66	4.57	4.06	2.58	3.81	8.57	0.68	2.51	2.80	4.66	2.97	45.49
1963	1.86	1.61	7.54	0.86	4.54	1.60	3.68	3.09	1.81	T	2.19	1.21	29.99
1964	2.11	3.07	4.54	3.09	1.25	1.97	2.18	6.21	4.53	0.80	3.37	3.90	37.02
1965	3.36	2.17	4.81	5.68	0.93	4.35	4.72	4.24	3.49	2.25	0.96	0.31	37.27
1966	3.26	3.97	1.12	6.56	1.58	0.41	6.37	4.15	5.64	2.28	3.06	2.81	41.21
1967	1.43	2.53	7.52	3.48	6.81	1.11	5.82	1.48	1.21	2.27	4.71	3.55	41.92
1968	1.72	0.53	6.05	2.81	6.10	1.67	2.59	6.03	1.14	2.89	2.41	2.20	36.14
1969	2.34	0.94	1.24	2.85	3.30	2.45	3.34	3.93	3.91	1.85	2.14	4.80	33.09
1970	1.12	3.25	3.33	3.68	3.03	3.28	3.75	4.28	2.80	5.23	2.11	4.11	39.97
1971	2.57	2.71	1.96	1.20	6.04	4.80	7.57	1.05	2.61	1.48	1.96	1.50	35.45
1972	4.79	4.90	2.76	6.07	3.82	4.39	2.69	2.06	3.32	2.02	4.38	5.52	46.72
1973	1.48	2.05	3.27	4.91	4.89	3.14	3.52	1.69	2.55	3.39	5.17	2.23	38.29
1974	5.57	1.85	4.45	2.19	9.26	4.86	1.37	4.94	3.63	1.64	4.01	2.87	46.64
1975	4.14	3.11	6.32	5.55	3.20	4.06	4.55	3.96	4.84	3.47	2.64	3.64	49.48
1976	2.84	2.38	3.90	0.74	2.41	4.25	5.48	5.72	4.27	5.54	0.73	2.17	40.43
1977	2.42	0.76	3.10	3.58	2.32	4.70	3.22	5.93	3.26	4.36	3.57	2.33	39.55
1978	6.37	1.06	3.11	4.06	4.30	1.66	4.49	4.22	1.37	3.11	2.74	8.69	45.18
1979	5.28	4.28	2.24	2.83	4.65	7.63	6.18	6.86	5.29	2.67	3.19	2.77	53.87
1980	2.46	1.71	5.04	3.11	2.64	1.95	7.94	5.91	1.89	1.57	2.96	1.82	39.00
1981	0.64	4.23	1.65	5.35	5.19	5.91	3.64	1.03	1.60	2.53	1.23	2.61	35.61
1982	4.49	2.36	4.40	1.49	6.28	4.53	3.76	4.45	2.00	1.80	4.33	3.34	43.23
1983	1.40	1.92	1.89	3.99	6.82	3.02	2.03	3.56	0.63	5.71	2.87	3.10	36.94
1984	1.82	2.09	2.45	4.46	4.45	1.75	3.37	4.66	2.67	4.87	3.85	4.36	40.80
1985	3.13	2.92	3.41	0.83	5.40	3.10	6.13	4.68	0.35	5.17	7.40	2.10	44.62
1986	1.31	3.60	1.55	0.95	3.57	3.52	5.44	3.53	3.73	1.88	6.67	3.51	39.26
1987	2.52	3.32	2.44	4.78	3.59	2.56	3.12	1.19	2.08	0.55	2.51	4.82	33.48
1988	1.96	2.42	3.01	3.10	2.02	0.77	6.88	2.69	2.65	1.91	5.52	3.17	36.10
Record Mean	3.18	2.82	3.74	3.39	4.02	3.69	4.66	3.51	2.90	2.45	3.13	3.21	40.71

Source: National Oceanic and Atmospheric Administration, *Local Climatological Data, 1988, Annual Summary—Huntington, West Virginia,* National Climate Center, Asheville, N.C.

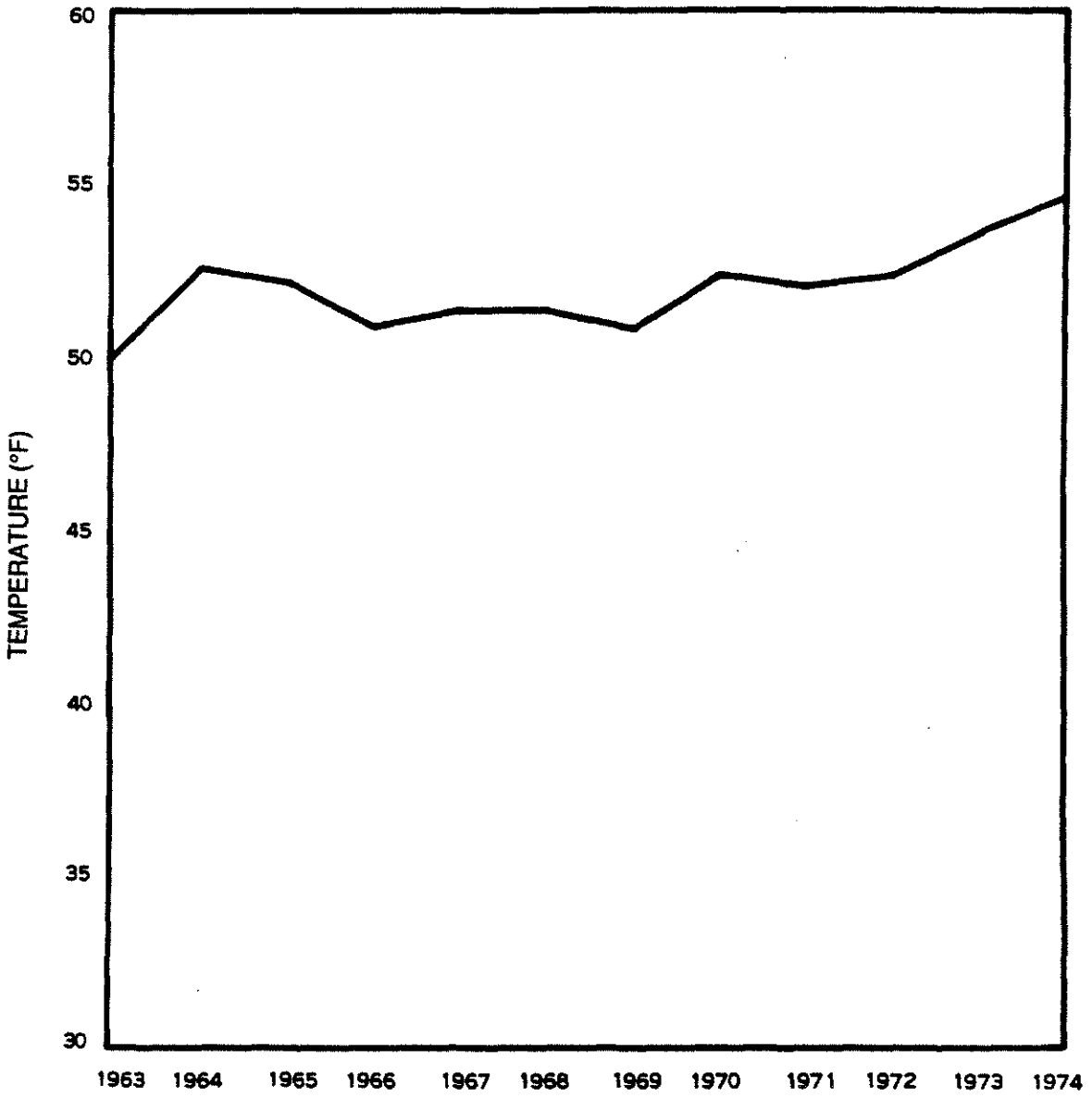


Fig. 2.3-3. Average annual air temperatures at Waverly from 1963 to 1974. *Source:* Portsmouth Gaseous Diffusion Plant, *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion,* Vol. 1, ERDA-1549, U.S. Energy Research and Development Administration, Piketon, Ohio, September 1977, p. 2-204.

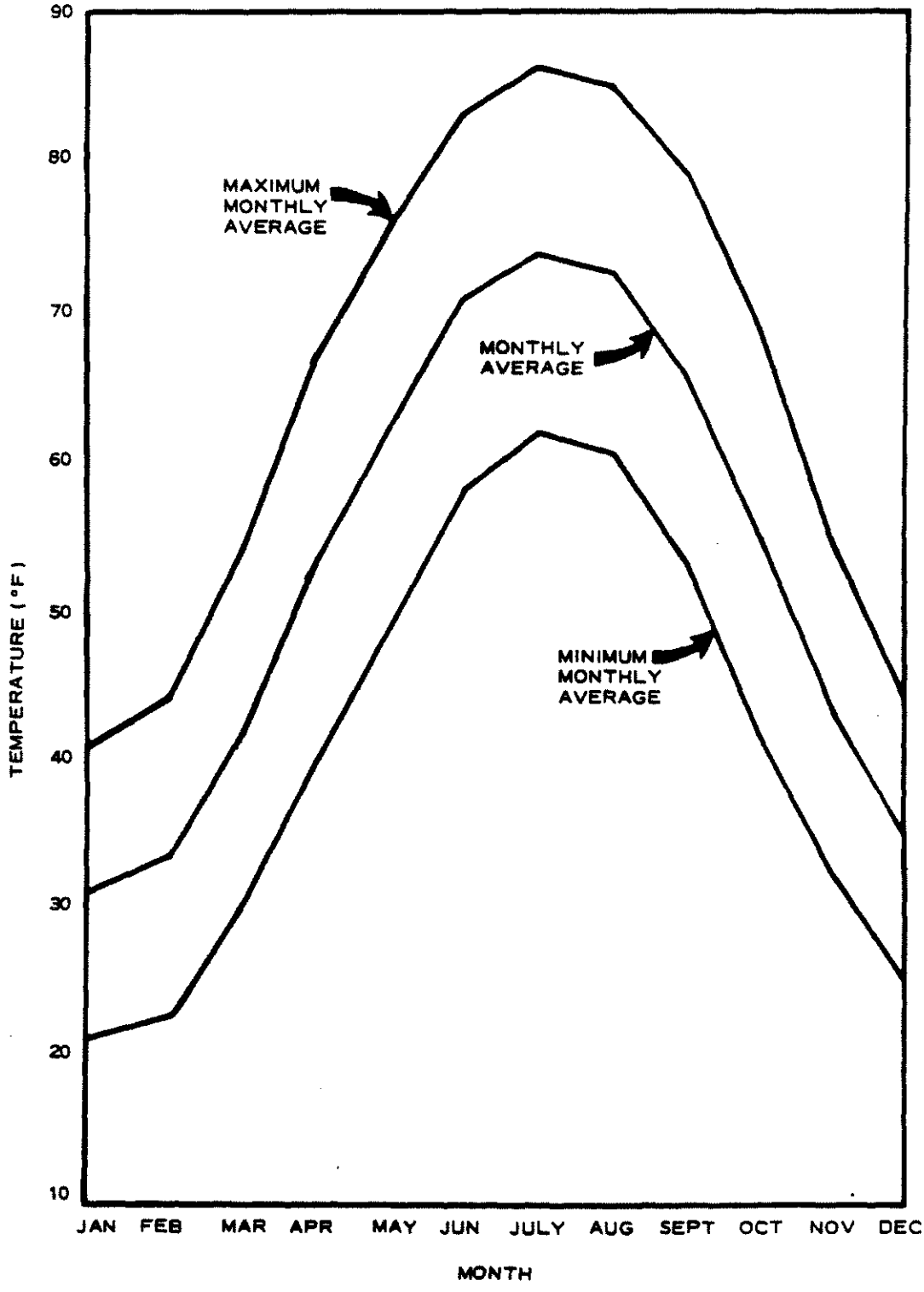


Fig. 2.3-4. Average monthly air temperatures at Waverly (1936-1974). Source: Portsmouth Gaseous Diffusion Plant, *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion,* Vol. 1, ERDA-1549, U.S. Energy Research and Development Administration, Piketon, Ohio, September 1977, p. 2-205.

on Feb. 3, 1951. Each of the maximum annual temperatures at Waverly has been equal to or greater than 33.3°C (92°F) in 9 out of 10 years, 35.5°C (96°F) in 5 out of 10 years, and 38.3°C (101°F) in 1 out of 10 years; each of the minimum annual temperatures has been equal to or less than –15.5°C (4°F) in 9 out of 10 years, –21.1°C (–6°F) in 5 out of 10 years, and –27.8°C (–18°F) in 1 out of 10 years (PORTS 1977, p. 2-203). Additional temperature data (collected at Huntington) are shown in Table 2.3-2. Monthly and annual averages are provided for the period 1959–88.

Prevailing winds at the PORTS site travel from southwest to south. Wind speeds average about 8 km/h (5 mph), although winds of up to 120 km/h (75 mph) have been recorded at the plant site. Usually, high winds are associated with thunderstorms that occur during the spring and summer seasons. Daytime wind stabilities are most commonly class D (neutral) and class C (slightly unstable) respectively. Nighttime winds are predominately class F (moderately stable). The Portsmouth facility maintains a comparatively simple meteorological monitoring system, in keeping with a comparatively simple local wind pattern. A single meteorological tower is equipped with instrument packages at the 10- and 40-m levels. Figures 2.3-5 and 2.3-6 provide wind roses for data collected at the 10- and 40-m levels in 1987 and 1988 respectively. Stability arrays, which show the same data graphically, are presented in Tables A.3-1 through A.3-4.

Tornadoes are formed during warm, humid, unstable weather conditions and are usually associated with severe thunderstorm activity. Tornado wind speeds may reach 322 km/h (200 mph) or greater, with forward speeds averaging 64 km/h (40 mph). Tornado paths average only 400 m (0.25 mile) in width and <25.7 km (<16 miles) in length, but some have been >1.6 km (>1 mile) wide and >482 km (>300 miles) long. Southern Ohio is within the midwestern tornado belt, but no tornado has ever struck the plant site. For the period 1953–62, Ohio had 235 reported tornadoes. About 70% of those occurred between April 1 and July 31, and nearly 75% touched down between 2 p.m. and 10 p.m.

At Waverly, clouds occur most frequently during winter and least frequently during summer. The percentage of possible sunshine ranges from 70% in July to 35% in December. Fog occurs most often during the late summer and fall and at times may reduce visibility to less than 400 m (0.25 mile) (PORTS 1977, p. 2-23).

2.3.2 Air Quality

Pike County is currently in attainment status for all criteria air pollutants (see Appendix I: Mitckes 1989b). Table A.3-5 provides a summary of TSP and SO_2 monitoring data collected in 1987 at Portsmouth, which is approximately 31 km (19 miles) south of PORTS in Scioto County. Other criteria pollutants are not monitored in the vicinity.

PORTS operates numerous small sources of criteria air pollutants, but only three sources are significant: the three coal-fired boilers at the X-600 steam plant that supply the plant with steam for heating the building and for fueling processes. The boilers are permitted by the Ohio Environmental Protection Agency (OEPA) with opacity, particulate, and SO_2 permits. Opacity and particulate emissions are controlled by electrostatic precipitators on each of the boilers. In 1987, the PORTS steam plant achieved 99.91% compliance with the opacity limits and 100% compliance with the SO_2 limits stipulated by its environmental permits.

Table 2.3-2. Temperature summary for Huntington, West Virginia

AVERAGE TEMPERATURE (deg. F) HUNTINGTON, WEST VIRGINIA

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1959	33.3	39.7	43.7	56.7	69.9	72.5	77.1	79.2	72.0	59.4	44.7	40.7	57.4
1960	38.8	34.7	33.8	60.0	62.4	71.7	74.9	77.6	70.5	58.7	47.4	31.2	55.2
1961	29.8	42.0	49.4	50.4	60.4	69.8	75.0	75.3	72.7	58.3	47.2	38.1	55.7
1962	33.4	39.2	41.8	52.0	69.0	70.4	72.0	72.3	63.9	57.9	43.3	30.4	53.8
1963	27.0	28.1	50.8	59.0	63.6	69.8	71.4	70.4	65.3	60.6	46.5	25.3	53.1
1964	34.2	32.1	46.4	58.0	66.0	71.7	76.0	73.0	65.7	52.2	48.0	39.4	55.2
1965	33.9	35.9	40.9	56.2	69.3	71.9	74.5	73.2	69.2	54.2	47.8	41.6	55.7
1966	26.6	34.3	46.4	52.5	61.2	72.4	76.4	72.0	65.1	53.0	47.0	36.2	53.6
1967	39.3	32.0	48.1	56.3	59.2	73.1	71.4	70.4	62.9	55.2	40.6	38.9	54.0
1968	29.4	27.4	45.8	55.7	60.3	70.3	75.2	73.6	67.0	56.7	47.1	33.8	53.5
1969	31.7	35.6	38.6	56.1	64.1	72.6	77.9	75.0	66.3	55.3	42.1	30.7	53.9
1970	27.3	33.9	40.9	56.7	65.7	71.4	73.5	73.4	72.7	58.6	47.2	39.0	55.0
1971	29.6	37.3	41.9	54.0	60.6	73.3	71.9	71.8	71.0	63.9	44.8	45.6	55.5
1972	35.8	34.6	43.5	54.1	62.2	66.3	74.6	72.3	69.2	51.0	42.9	40.4	53.9
1973	34.2	33.8	53.2	52.5	61.1	74.3	76.4	75.9	71.2	61.0	48.1	37.6	56.6
1974	41.9	37.9	49.4	58.1	64.5	68.4	75.4	73.8	63.4	54.1	46.4	38.6	56.0
1975	37.3	39.6	42.4	52.7	68.1	73.2	75.0	78.4	65.1	58.0	50.1	38.6	56.6
1976	31.6	46.4	51.9	56.0	62.6	72.2	72.7	72.1	63.2	50.1	39.2	32.3	54.2
1977	19.7	35.1	50.4	60.3	68.2	69.1	78.6	75.4	68.8	54.2	50.2	35.1	55.4
1978	25.1	24.7	42.3	56.9	62.2	73.1	76.4	75.9	72.1	54.1	48.0	38.5	54.1
1979	26.3	28.6	49.5	55.6	63.7	70.1	74.0	74.4	67.4	55.4	48.4	39.1	54.4
1980	34.6	29.2	41.9	53.4	64.7	70.5	77.7	77.8	70.7	53.9	43.7	36.5	54.6
1981	28.2	37.1	42.7	60.5	60.8	73.6	75.6	74.1	67.2	55.2	45.4	34.2	54.6
1982	27.5	34.5	45.9	50.6	68.0	67.5	74.4	69.8	63.9	57.6	49.7	45.5	54.6
1983	34.7	37.9	48.0	52.3	60.8	71.7	78.6	79.8	69.1	57.3	46.9	30.3	55.6
1984	28.4	41.7	41.8	54.8	61.6	75.2	73.4	75.6	65.8	62.9	42.9	45.7	55.8
1985	25.9	32.1	48.5	59.6	64.9	70.2	74.3	72.1	67.9	61.0	53.3	32.6	55.2
1986	33.7	39.4	47.2	58.7	66.6	73.2	77.9	72.9	70.8	58.3	45.8	36.2	56.7
1987	33.2	37.5	47.1	53.4	68.7	73.5	76.6	77.4	68.9	51.0	49.7	39.2	56.4
1988	31.2	35.1	46.1	54.3	63.6	71.5	78.0	77.0	66.9	49.4	46.9	37.4	54.8
Record Mean	33.3	36.2	45.3	55.9	64.6	72.3	75.8	74.7	68.3	57.2	46.2	37.1	55.6
Max	42.1	45.9	56.1	67.9	76.7	83.8	86.7	85.7	79.7	69.0	56.3	45.9	66.3
Min	24.5	26.5	34.4	43.9	52.4	60.8	65.0	63.7	56.8	45.4	36.0	28.3	44.8

Source: National Oceanic and Atmospheric Administration, *Local Climatological Data, 1988, Annual Summary—Huntington, West Virginia,* National Climate Center, Asheville, N.C.

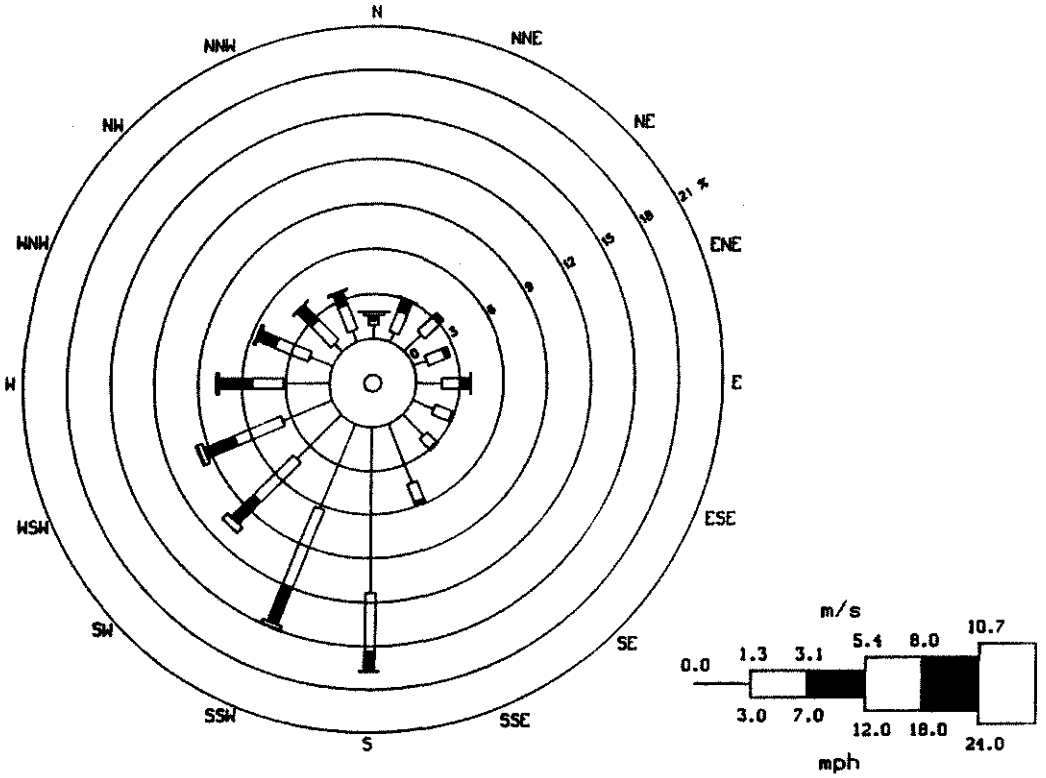


Fig. 2.3-5. Wind rose for Portsmouth Gaseous Diffusion Plant (40 m) level for 1988, with 68.9% of possible data.

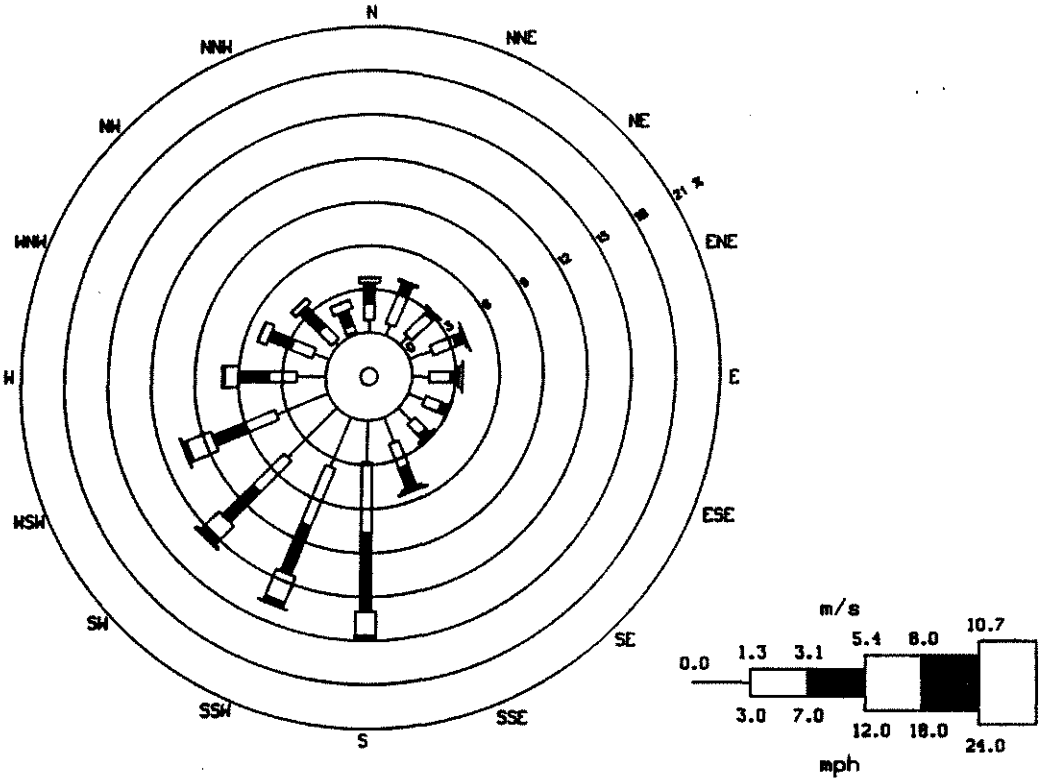


Fig. 2.3-6. Wind rose for Portsmouth Gaseous Diffusion Plant (10 m) for 1988, with 68.9% of possible data.

In addition to emissions from the X-600 steam plant boilers, PORTS also uses liquid SO_2 from 1-ton cylinders for treatment of the plant cooling-water blowdown at the X-616 liquid effluent treatment facility. No SO_2 odor is normally present around the X-616 facility, indicating that essentially all of the SO_2 is consumed. In the absence of hard data, however, PORTS assumes that 5% of the SO_2 escapes to the atmosphere.

The second largest source of criteria pollutants at PORTS is the X-735 sanitary landfill, which has air-emission permits for fugitive dust emissions from the landfill and the unpaved roads and parking areas attached to it.

PORTS also recovers uranium from decontamination solutions used on-site and uses solid chemical adsorbents to control trace radionuclide emissions. Both operations can generate radioactive airborne particles. To protect workers and the environment, these materials are handled inside filtered gloveboxes. All gloveboxes exhaust through high-efficiency particulate air (HEPA) filters, which have a specified minimum capture efficiency of 99.97%.

The bulk of the fluorides emitted from PORTS is released from the cascade vents and from coal burning in the X-600 steam plant. The gaseous diffusion process also generates a large amount of heat that must be removed by the plant cooling system. PORTS uses a two-stage system with Freon 114 as the intermediate coolant. Inevitably, because of the large size of the cooling system, a considerable amount of the Freon leaks directly into the air. Current estimates of Freon emissions are based on purchased amounts, typically two to three tank cars (~75 to 100 tons) per year. Additionally, PORTS uses both organic and inorganic solvents for cleaning purposes (Rogers et al. 1988, pp. 13–14). Plant-wide air emissions for 1987 as estimated by PORTS personnel are indicated in Table 2.3-3.

Since 1964, PORTS has maintained a network of on-site and off-site permanent monitoring stations to collect ambient air samples continuously for radionuclides and gaseous fluorides. Figure 2.3-7 indicates the location of the off-site air monitors. Tables 2.3-4 and 2.3-5 present summaries of the gross α and gross $\beta\gamma$ radiation measurements collected at these locations in 1987. The tables give the number of samples; the average, minimum, and maximum concentrations; and the standard deviation of the concentrations at each air-monitoring station, along with the most appropriate DOE-Derived Concentration Guideline (DCG) for comparison.

The net average α-concentration in 1987 was 0.0012 pCi/m^3 above background, and the net average $\beta\gamma$-concentration was 0.006 pCi/m^3 above background. A consequence of low ambient concentrations is that it is difficult, if not impossible, to actually analyze for specific radionuclides (e.g., uranium, technetium). PORTS therefore assumes that all the net α-concentration is from uranium emissions from PORTS and that all the net $\beta\gamma$-concentration is from technetium and uranium daughters in the same proportion as the measured emissions.

Table 2.3-6 presents a summary of the 1987 weekly ambient fluoride sampling program in the same format as the previous tables. For this table, the standards used are state ambient air standards from Kentucky and Tennessee. Although these standards are not legally binding on an Ohio facility, neither Ohio nor EPA has issued standards for ambient gaseous fluorides. Ambient monitoring of gaseous fluorides showed 100% compliance with the Tennessee air quality standards, 100% compliance with the Kentucky primary standard, and 94% compliance (18 exceedances) with the Kentucky secondary standard (Rogers et al. 1988, pp. 19–25).

Table 2.3-3. 1987 Portsmouth Gaseous Diffusion Plant total air emissions

Pollutant	kg/year	Ci/year	ton/year
SO_2			3300
Freon 114[a]			460
Nitrogen[b]			150
Cl_2[a]			140
TCA[a]			70
Fluorides			11
Argon[b]			11
CO_2[b]			7
Ammonia[b]			6
Freon 113[b]			6
TCE[b]			3
Other solvents[b]			3
Alcohol[b]	980		
Oxygen[c]	280		
Helium[b]	280		
Acetylene[d]	9		
Hydrogen[b]	0.5		
^{234}U	0.00707	0.0435	
^{235}U	0.669	0.00143	
^{236}U	0.000032	0.000002	
^{238}U	1.13	0.000376	
^{99}Tc	0.00989	0.169	
Uranium daughters	1.89×10^{-11}	0.00218	

[a]See text.

[b]Assume 100% of material issued from stores is emitted.

[c]Assume 5% of material issued from stores is emitted and remainder is consumed in combustion.

[d]Assume 1% of material issued from stores is emitted and remainder is consumed in combustion.

Source: J. G. Rogers et al., *Environmental Surveillance of the U. S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 15.

Table 2.3-4. 1987 Portsmouth Gaseous Diffusion Plant gross alpha concentrations in ambient air

Location	No. of samples	Concentration (pCi/m³)			Standard deviation	DCG
		Av	Min	Max		
			Off-site			
A3	11	<0.005	<0.003	0.009	0.002	4[a]
A6[b]	3	<0.005	<0.003	0.007	N/A	
A8[b]	2	0.004	0.004	0.004	N/A	
A9[b]	3	<0.003	0.002	0.003	N/A	
A12	12	<0.006	0.004	0.009	0.002	
A15[b]	3	<0.004	0.003	0.005	N/A	
A23[b]	3	0.005	0.004	0.007	N/A	
A24	12	<0.004	0.003	0.008	0.001	
A28	11	<0.004	<0.002	0.008	0.002	
A29	12	<0.005	<0.003	0.007	0.001	
			On-site			
A10	12	<0.005	<0.002	0.010	0.002	4[a]
A35	11	<0.007	<0.003	0.030	0.007	
A36	12	<0.005	<0.003	0.015	0.003	
A38	12	<0.004	<0.002	0.011	0.002	
A39[b]	4	<0.013	0.005	0.027	0.009	
A40	9	<0.008	<0.003	0.028	0.007	

[a]^{234}U DCG from second draft of DOE Order 5480.xx.
[b]New air sampling stations, October through December data only.
Note: Limit of detection is 0.0025 pCi/m³, based on 180-m³ sample volume. Actual limit of detection will vary inversely with individual sample volumes.

Table 2.3-5. 1987 Portsmouth Gaseous Diffusion Plant gross beta concentrations in ambient air

Location	No. of samples	Concentration (pCi/m³)			Standard deviation	DCG
		Av	Min	Max		
			Off-site			
A3	11	0.040	0.025	0.059	0.011	10,000[a]
A6[b]	3	0.041	0.027	0.056	N/A	
A8[b]	2	0.039	0.031	0.046	N/A	
A9[b]	3	0.035	0.025	0.052	N/A	
A12	12	0.038	0.024	0.054	0.008	
A15[b]	3	0.038	0.028	0.053	N/A	
A23[b]	3	0.035	0.029	0.045	N/A	
A24	12	0.036	0.016	0.048	0.009	
A28	11	0.034	0.025	0.052	0.009	
A29	12	<0.038	0.021	0.061	0.011	
			On-site			
A10	12	<0.028	<0.011	0.055	0.013	10,000[a]
A35	11	<0.042	0.020	0.149	0.036	
A36	12	0.037	0.029	0.049	0.006	
A38	12	<0.027	<0.011	0.040	0.009	
A39[b]	4	0.047	0.033	0.063	0.011	
A40	9	<0.054	0.033	0.152	0.036	

[a]^{99}Tc DCG from second draft of DOE Order 5480.xx.
[b]New air sampling stations, October through December data only.
Note: Limit of detection is 0.012 pCi/m³, based on 180-m³ sample volume. Actual limit of detection will vary inversely with individual sample volumes.

Source for Tables 2.3-3 and 2.3-4: J. G. Rogers et al., *Environmental Surveillance of the U. S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, pp. 22-23.

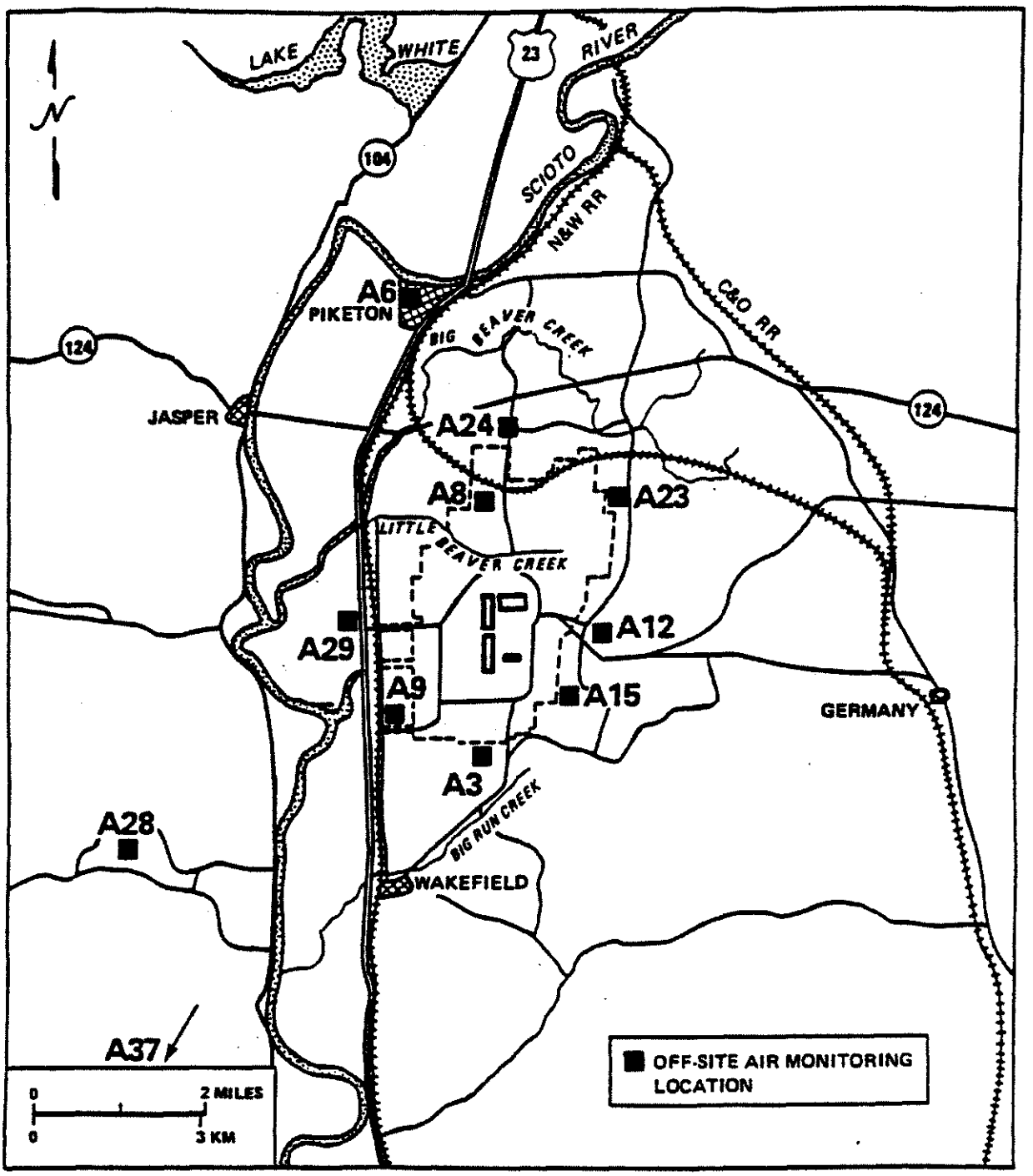


Fig. 2.3-7. Off-site air monitoring locations at the Portsmouth Gaseous Diffusion Plant. *Source:* J. G. Rogers et al., *Environmental Surveillance of the U. S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987,* ES/ESH-4/V4, POEF-1180, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 20.

Table 2.3-6. 1987 total fluoride concentrations (as HF) in ambient air

Location	No. of samples	Concentration ($\mu g/m^3$)			Standard deviation	Ky./Tenn. standards[a]
		Av	Min	Max		
			Off-site			
A3	46	<0.36	<0.08	1.16	0.22	0.8/1.6
A6[b]	7	0.51	0.18	0.97	0.32	
A8[b]	5	0.56	0.25	1.12	0.31	
A9[b]	6	0.29	0.13	0.60	0.18	
A12	43	<0.34	<0.05	<0.87	0.19	
A15[b]	6	0.40	0.18	0.78	0.21	
A23[b]	5	0.37	0.23	0.62	0.13	
A24	35	<0.30	0.08	0.93	0.17	
A28	38	<0.32	0.02	<1.44	0.27	
A29	44	<0.43	<0.10	1.39	0.24	
			On-site			
A10		Did not sample fluorides in 1987				
A35		Did not sample fluorides in 1987				
A36	41	<0.23	<0.05	0.62	0.14	0.8/1.6
A38		Did not sample fluorides in 1987				
A39[b]	6	0.53	0.28	0.88	0.24	
A40	34	<0.43	<0.06	1.00	0.30	

[a]Kentucky State Standard/Tennessee State Standard. Neither U.S. EPA nor Ohio EPA has issued ambient air standards for gaseous fluorides.

[b]New air sampling stations, October through December data only.

Note: Limit of detection is 0.12 $\mu g/m^3$, based on 42-m^3 sample volume. Limit of of detection will vary inversely with individual sample volumes.

Source: J. G. Rogers et al., *Environmental Surveillance of the U. S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., 1988, p. 24.

2.4 REFERENCES

2.4.1 Oak Ridge

Rogers, J. G. et al. 1988. *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.

TAPCD (Tennessee Air Pollution Control District) 1989. *Ambient Air Quality Report*, Nashville, Tenn.

2.4.2 Paducah

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site*, DOE/EA-0155, Paducah Gaseous Diffusion Plant, Paducah, Ky., August.

Division of Air Quality 1989. *Ambient Air Quality Summary Statistical Report*, Frankfort, Ky.

Rogers, J. G., and Ashburn, D. L. 1988. *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.

2.4.3 Portsmouth

OEPA (Ohio Environmental Protection Agency) 1989. *Ohio Air Quality Report*, Columbus, Ohio, June 12, 1989.

PORTS (Portsmouth Gaseous Diffusion Plant) 1977. *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion*, ERDA-1549, Vol. I, Energy Research and Development Administration, Piketon, Ohio, September.

Rogers, J. G., et al. 1988. *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.

APPENDIX A - AIR QUALITY/METEOROLOGY

3. GEOLOGY

3.1 OAK RIDGE

3.1.1 Topography and Physiography

ORGDP is located near the western edge of the Valley and Ridge Physiographic Province, as shown in Fig. 3.1-1. The province is characterized by a series of long, narrow ridges and slightly broader, intervening valleys, all trending northeast-southwest. The region is underlain by Paleozoic sedimentary rocks, which were intensely folded and faulted by compressional forces from the southeast during late Paleozoic time (Beavers et al. 1982, p. 5).

To the east of the Valley and Ridge Province lies the Blue Ridge Province, which consists of Precambrian age rocks that were intensely folded and metamorphosed during late Precambrian time. These Precambrian structures were subsequently greatly modified by middle and late Paleozoic tectonic pressures resulting in the crystalline rocks currently developed in the province. The Cumberland Plateau, part of the Appalachian Plateau Physiographic Province, lies west of the Valley and Ridge Province. The Cumberland Plateau is an area of nearly flat-lying Paleozoic sedimentary rocks that have been deeply dissected by erosion (Beavers et al. 1982, pp. 5–7).

ORGDP is located at the southwest end of East Fork Valley at the confluence of Poplar Creek and the Clinch River. The valley is flanked on the northwest by Blackoak Ridge and on the southeast by Pine Ridge (Fig. 3.1-2). McKinney Ridge, which lies northeast of ORGDP, appears to represent a structurally isolated remnant or outlier of rock (a klippe) that has been separated from the main body of a local thrust sheet by erosion (Beavers et al. 1982, pp. 8–9). The ridges have a fairly uniform elevation of 305–335 m (1000–1100 ft) ; the valleys are ~244 m (~800 ft) in elevation. The maximum relief in the immediate vicinity of ORGDP is 128 m (420 ft) from the surface of the Clinch River to the top of McKinney Ridge. The elevation of ORGDP varies from ~229 m (~750 ft) to ~244 m (~800 ft). Existing structures at the site lie within the floodplain and terrace lands of Poplar Creek, typically between the 232- to 238-m (760- to 780-ft) contours (DOE 1979, p. 4-6).

3.1.2 Structure, Stratigraphy, and Lithology

The area surrounding ORGDP is probably the most structurally complex part of the Oak Ridge Reservation (ORR). The only detailed geologic map of the ORGDP vicinity was prepared by R. H. Ketelle of ORNL in 1986 (Fig. 3.1-2). Data depicted on this map show the intense folding of the Lower Paleozoic sedimentary rock that accompanied the development of imbricate thrust sheets in the area. Ketelle's work has subsequently been modified by various contractors working at ORGDP (Fig. 3.1-3); however, the newer map generalizes much of the data provided by Ketelle's original map and also covers a much smaller area.

The dominant structural feature in the ORGDP vicinity is the Whiteoak Mountain Thrust Fault, which trends northeasterly across the southern border of the plant (Fig. 3.1-2). The Whiteoak Mountain Fault is actually a broad zone of faulting, where the rocks are broken into 4 or 5 separate slices on the northeastern side of the plant (Fig. 3.1-2). In this

Fig. 3.1-1. Oak Ridge physiographic map. *Source:* J. E. Beavers, W. E. Manrod, and W. C. Stoddart, *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio Department of Energy Reservations,* K/BD-1025/R1, December 1982.

ORNL-DWG 86-9769

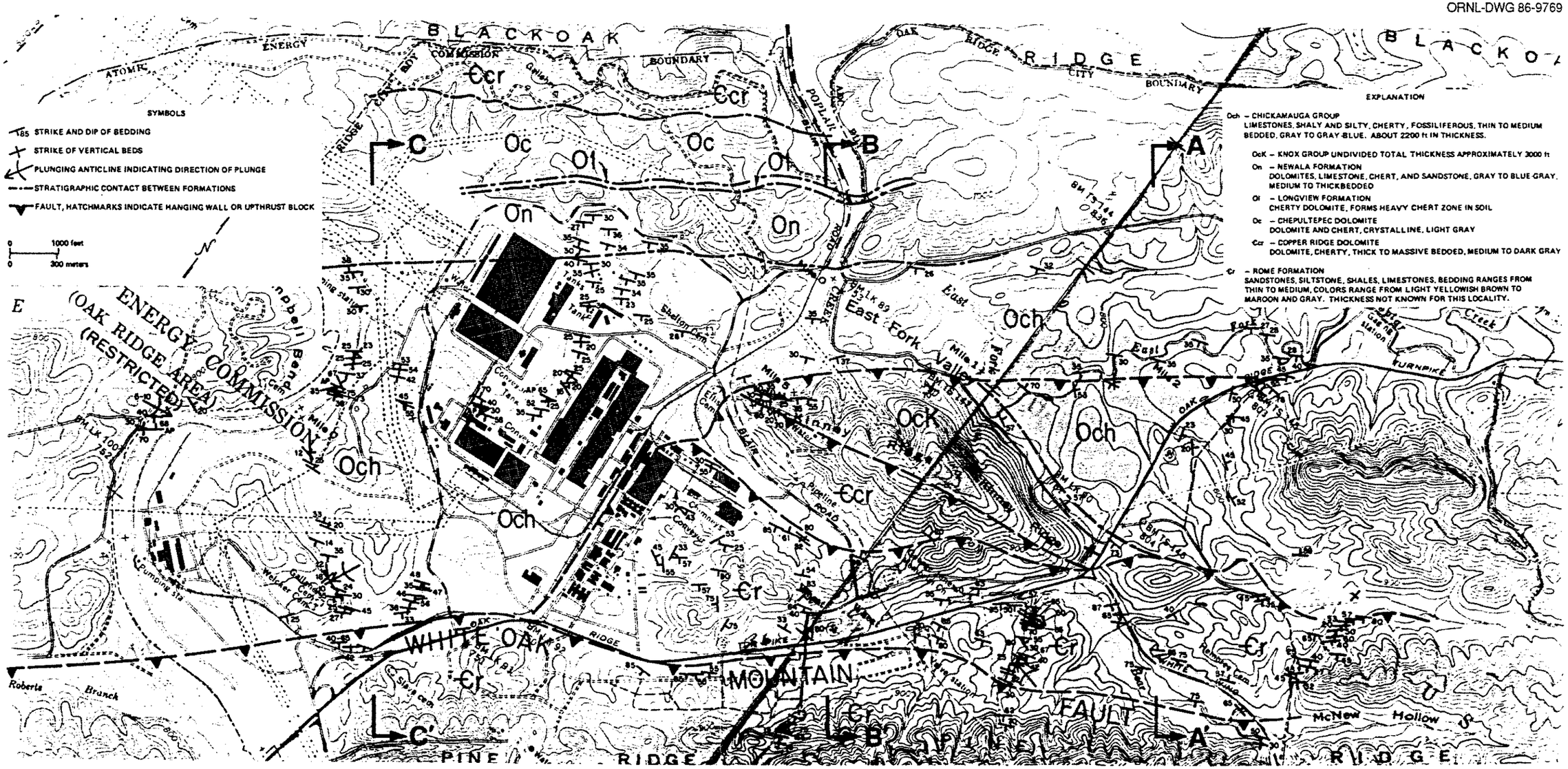


Fig. 3.1-2. Geologic map of the area surrounding the Oak Ridge Gaseous Diffusion Plant. *Source:* Unpublished data from R. H. Ketelle, Oak Ridge National Laboratory, Oak Ridge, Tenn.

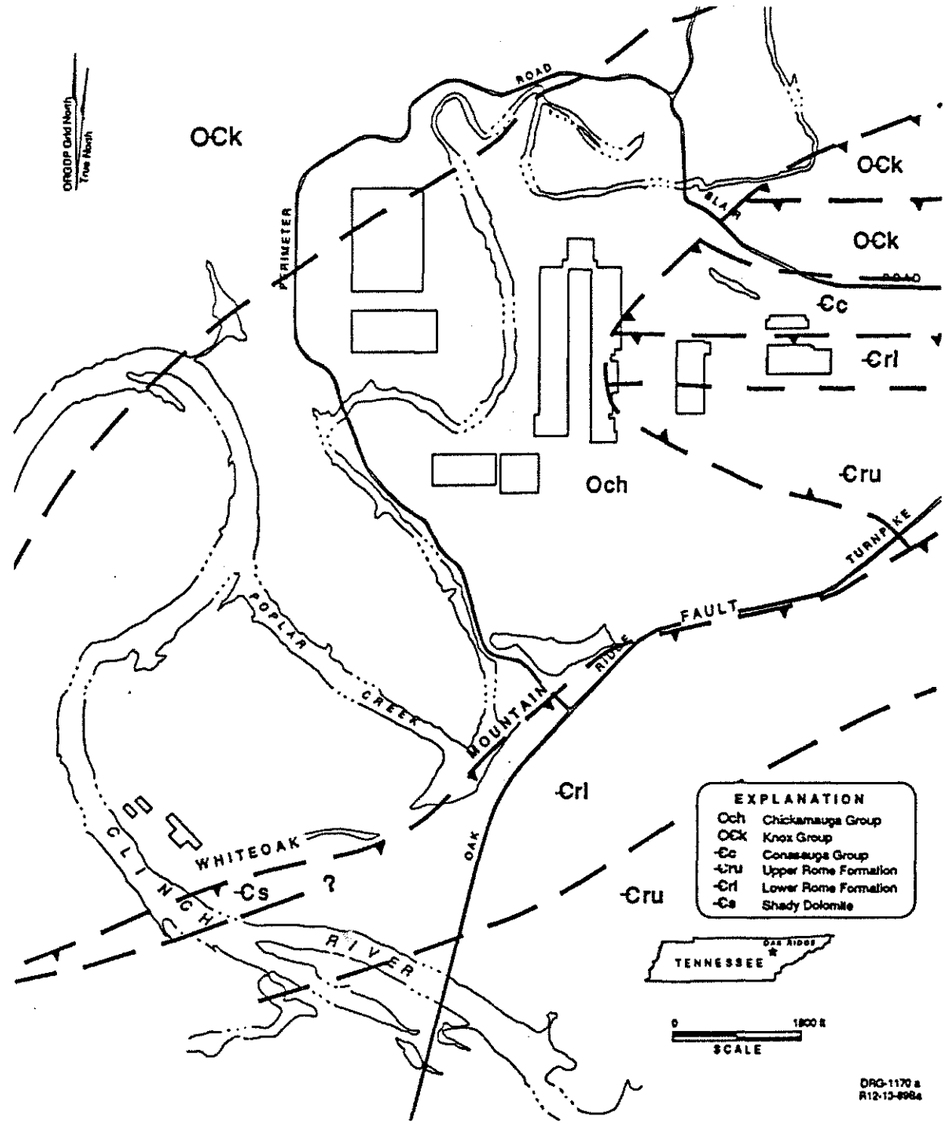


Fig. 3.1-3. Geology in the vicinity of the Oak Ridge Gaseous Diffusion Plant.
Source: Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

area the erosion-resistant Rome Formation and Knox Group have been thrust over the Chickamauga Group to form McKinney Ridge (Geraghty and Miller 1989, pp. 3-7 to 3-8). As shown in Fig. 3.1-2, a sinuous, low-angle fault diverges from the Whiteoak Mountain Fault and trends in a northerly direction across the plant area, roughly paralleling the topography and truncating two east-trending thrust faults. The characteristics of these fault planes (i.e., their effect on the movement of groundwater across the plant site) has not been determined, although it has been speculated that they may represent preferential pathways for fluid movement because of increased weathering of rocks within the zone of faulting (Geraghty and Miller 1989, p. 3-7).

Recent studies have illustrated the presence of joints in the bedrock surrounding ORGDP, although the joint spacing is highly variable (Rothschild et al. 1984; Sledz and Huff 1981). Studies to date have generally agreed that at least one major joint set roughly parallels the geologic strike of the area and dips at ~40° to the northwest. A second steeply dipping joint set strikes about N12°W (Geraghty and Miller 1989, p. 3-8).

Figure 3.1-4 is a generalized stratigraphic section of ORR. The units present in the vicinity of ORGDP are Lower Cambrian to Middle Ordovician sandstones, siltstones, shales, dolostones, and limestones. From oldest to youngest, these geologic units are the Shady Dolomite, the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Group. Each of these units is described in detail.

3.1.2.1 Shady Dolomite

The occurrence of the Shady Dolomite in the vicinity of ORGDP has been documented through drilling conducted across the Clinch River, immediately west of the plant and at the very western edge of the ORGDP property near the K-720 Fly Ash Pile (Geraghty and Miller 1989, p. 3-5). The occurrence of the Shady Dolomite along strike to the east across the plant area has not been documented; however, R. H. Ketelle observed the Shady Dolomite just east of ORGDP during geological field mapping in 1976 (Geraghty and Miller 1989, p. 3-5).

The Shady Dolomite consists of crystalline, white, gray to light yellowish gray dolostone; and magnesian limestones. Silica as chalcedonic chert and brown to gray jasperoid in a yellow to red clay identify the weathered Shady Dolomite. The complete thickness of the Shady Dolomite is not preserved on ORR because of faulting. Where the Shady Dolomite has been encountered in drilling near ORGDP, the unit was highly fractured and contained numerous vugs.

3.1.2.2 Rome Formation

The Rome Formation underlies Pine Ridge to the south of ORGDP. Lithologically, the Rome Formation is predominantly a siltstone and shale with fine-grained sandstones and zones of impure dark-colored dolostone and magnesian limestone. The clastic rocks are typically maroon to gray-green colors. Glauconite and mica are typical accessory minerals. The true thickness of the Rome Formation is difficult to establish because it is bounded at its base by thrust faults and in many places is internally faulted and otherwise deformed. McReynolds (1988) has suggested that the actual thickness of the Rome Formation on ORR is between 90 and 125 m (300 and 400 ft). In other parts of eastern Tennessee, however, the Rome Formation is at least 360 m (1200 ft) thick (MMES/UT 1989, p. 7).

PERIOD	GROUP	FORMATION	THICKNESS	CHARACTERISTICS OF ROCKS
MISSISSIPPIAN		FT. PAYNE	80 FT	IMPURE LIMESTONE AND CALCAREOUS SILTSTONE, WITH ABUNDANT CHERT
DEVONIAN		CHATTANOOGA SHALE	25 FT	SHALE, BLACK, FISSILE
SILURIAN		ROCKWOOD	700 FT	SILTSTONE, SANDSTONE, AND SHALE; YELLOW TO TAN AND BROWN
ORDOVICIAN		SEQUATCHIE	300 FT	SHALE, SHALY LIMESTONE, SANDY SHALE, CALCAREOUS; MAROON TO GRAY OLIVE
	CHICKAMAUGA		2000 FT	LIMESTONE, SHALY LIMESTONE, CALCAREOUS SILTSTONE, AND SHALE; MOSTLY GRAY, PARTLY MAROON; WITH CHERTY ZONES IN LOWER UNITS
	KNOX	MASCOT KINGSPORT LONGVIEW CHEPULTEPEC COPPER RIDGE	3000 FT	DOLOSTONE AND DOLOMITIC LIMESTONE; LIGHT TO DARK GRAY; WITH PROMINENT CHERT ZONES
CAMBRIAN	CONASAUGA	MAYNARDVILLE NOLICHUCKY MARYVILLE ROGERSVILLE RUTLEDGE PUMPKIN VALLEY	1800 FT	LIMESTONE, SILTSTONE, AND SHALE; GRAY, OLIVE, BROWN
		ROME FORMATION	800+ FT	SANDSTONE AND SHALE WITH DOLOMITIC LIMESTONE LENSES; VARIEGATED WITH YELLOW, BROWN, RED, MAROON, AND OLIVE-GREEN
		SHADY DOLOMITE	?	DOLOSTONE; CHERTY; NUMERSOUS VUGS AND FRACTURES

Fig. 3.1-4. Generalized geologic section of the Oak Ridge Reservation. *Note:* to convert feet (ft) to meters, multiply by 0.3048.

Sandstone beds, which range in thickness from 7.6 to ~38 cm (3 to ~15 in.), are more abundant in the upper half of the formation than in the lower. The sandstone is composed of light-gray to light-brown, fine- to medium-grained quartz sand, cemented with silica or iron oxide. Weathered surfaces of the sandstone generally are dark brown or reddish brown. Siltstone in the Rome Formation is generally light to dark brown and green brown, thin-bedded, with irregular bedding surfaces along which small flakes of mica are concentrated. The typical sandstones and siltstones of the Rome Formation are characterized by abundant primary sedimentary structures, such as ripple marks, rill marks, mud cracks, raindrop imprints, and salt crystal casts.

The lower contact of the Rome is not exposed in the Oak Ridge area, as it is everywhere in fault contact with younger rocks which it overlies. The upper contact with shale of the Conasauga Group is gradational and is typically chosen by a change in coloration of shales (McMaster 1962, p. 6-8).

3.1.2.3 Conasauga Group

Because the Conasauga Group has historically been the primary geologic unit for radioactive waste disposal activities, it is the most thoroughly studied rock unit on ORR. Detailed descriptions of the lithologic characteristics of the Conasauga from the examination of core are available in Haase et al. (1985) and Lee and Ketelle (1989). The roughly 520 m (1700 ft) of the Conasauga Group is divided into six formations. These are, in stratigraphic order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale, and Maynardville Limestone. Each of these formations is described.

The Pumpkin Valley Shale may be divided into two parts. The lower Pumpkin Valley Shale consists of reddish brown and gray to greenish gray shale with thin interbeds of siltstone and silty, fine-grained sandstone. The sandstones are heavily bioturbated. The upper Pumpkin Valley consists of laminated to thin-bedded, dominantly reddish brown, reddish gray, and gray shale with thin, wavy, and planar-laminated siltstone lenses. Shales are generally fissile and may be massive or thinly laminated. Thin partings of fine-grained glauconite pellets are ubiquitous (MMES/UT 1989, p. 8).

The Rutledge Limestone consists of light gray, thin-bedded limestone interbedded with dark gray or maroon thin-bedded shale. In general, bedding is thicker and lithologies are more homogeneous in the lower Rutledge. In contrast to the distinct glauconite partings of the Pumpkin Valley, the frequent incorporation of glauconite throughout the thin limestone beds of the Rutledge is evidence of bioturbation of the sediments prior to lithification (MMES/UT 1989, p. 8).

The Rogersville Shale contains lower and upper lithologies separated by the Craig Limestone Member (Rodgers and Kent 1948). The lower Rogersville consists of dark gray and greenish gray shale containing thin laminated and bioturbated argillaceous limestone lenses. The Craig Member is recognized on ORR as ~3 m (~10 ft) of fossiliferous limestone and argillaceous limestone. The upper Rogersville is dominated by thinly laminated maroon shale containing light gray calcareous siltstone lenses and glauconitic partings (MMES/UT 1989, p. 8).

The Maryville Limestone consists of intraclastic, oolitic, and wavy-laminated limestone interbedded with dark gray shale. Shales typically contain wavy-laminated, coalesced lenses of light gray limestone and calcareous siltstone. In contrast to the underlying, more shale-

rich formations, the Maryville's silty limestone content makes it a minor ridge-forming unit in the region (MMES/UT 1989, p. 11).

The Nolichucky Shale is generally divided into unnamed lower and upper shale members separated by the Bradley Creek Member. The lower Nolichucky is medium- to thick-bedded shale and limestone or calcareous siltstone. Shales are gray, olive gray, and maroon. Limestones are intraclastic or more typically oolitic with glauconite occurring occasionally. The Bradley Creek Member is described as more than 10 m (30 ft) of micritic and oolitic limestone. The upper Nolichucky is dark gray shale with planar and wavy laminated or ribbon-bedded limestone. Several thick (1-m or ~3-ft) oolitic limestones occur in the upper Nolichucky (MMES/UT 1989, p. 11).

Regionally, the Maynardville Limestone has been formally divided into a lower Low Hollow Limestone Member and an upper Chances Branch Dolomite Member (Harris and Mixon 1970; Harris 1965). The Low Hollow is generally a ribbon-bedded or mottled, fine- to medium-grained, dolomitic limestone with incipient bedding stylolites and irregular oolitic limestones. Several dark gray shale beds occur in the lower portion of the unit. The Chances Branch consists of bioturbated and thinly laminated, fine- to medium-grained, massively bedded dolomicrite and dolomitic limestone (MMES/UT 1989, p. 11).

3.1.2.4 Knox Group

The Knox Group is an Upper Cambrian–Lower Ordovician dolomite and limestone sequence that is stratigraphically divisible into five formations: the Cambrian Copper Ridge Dolomite, the Ordovician Chepultepec Dolomite, Longview Dolomite, Kingsport Formation, and Mascot Formation. Total thickness ranges from 700 to 1000 m (2000 to 3000 ft) in East Tennessee, with the Copper Ridge Dolomite approximately one-third of the total. The Knox Group is the principal strong unit to support the folding and low angle thrust faulting that occurs throughout the Valley and Ridge and Cumberland Plateau regions. Each unit is described.

The Copper Ridge Dolomite is characterized as massively bedded, cherty dolomite with beds ranging from 20 to 70 cm (8 to 28 in.). Most of the dolomite is saccharoidal and medium to dark gray in the lower part of the unit with finer-grained medium to light gray dolomite occurring in larger amounts toward the top. Micritic algal limestone in minor amounts has been noted in the upper part of the Copper Ridge in and southeast of the Mascot-Jefferson City zinc district (Bridge 1956; Hatcher 1965) but is not clearly present in either of the strike belts represented in ORR. The Copper Ridge Dolomite is characterized by medium to coarsely crystalline, thick-bedded, dark brownish gray saccharoidal dolomite that gives off a fetid (petroliferous) odor when broken. This lithology dominates in the lower two-thirds of the unit, but toward the top, the medium to light gray fine-grained, medium- to thick-bedded dolomite typical of the entire Knox Group is more common (MMES/UT 1989, pp. 11–12).

The Copper Ridge is a siliceous unit and is a common ridge former in the Valley and Ridge Province. Bedded oolitic chert in which the ooids are concentrically banded with alternating light tan and dark brown to black rings is common. Also common is black algally laminated chert that has a waffle-iron appearance on weathered bedding surfaces and resembles cabbage heads in cross-section. Quartz sandstone beds up to 20 cm (8 in.) thick are common in the upper part of the unit, and a 10-cm (4-in.-) thick zone of sandstone may occur at the base. Other varieties of nodular and bedded chert may be present locally (MMES/UT 1989, pp. 11–12).

The Chepultepec Dolomite is less siliceous than the Copper Ridge and is a valley former in the Valley and Ridge of East Tennessee. Most of the Chepultepec is composed of light gray, fine-grained, medium-bedded dolomite of the type found elsewhere in the Knox Group. It is characterized by the presence of oolitic chert beds, dolomoldic chert, and a prominent zone of quartz- and dolomite-cemented sandstone at the base. This sandstone ranges from ~1–5 m (~3–15 ft) thick on ORR (MMES/UT 1989, p. 12).

The Longview Dolomite is the thinnest unit in the Knox Group [~42 m (~138 ft) thick] and is composed of medium- to light gray, thin- to medium-bedded siliceous dolomite. The finer-grained dolomite is locally replaced by coarsely recrystalline dolomite. Bedded and nodular chert is commonly visible in fresh exposures, but the massive, porous porcelaneous white chert that appears in weathered profiles is rarely visible in fresh rock or core. These blocks of massive chert may be as much as 1 m (3 ft) or more thick and up to 2 to 3 m (10 ft) long (MMES/UT 1989, p. 12).

The Kingsport Formation is composed of medium gray to light gray, fine- to medium-grained dolomite typical of the Knox Group; coarse-grained, light gray recrystalline dolomite; fine-grained, pinkish gray dolomite near the top; and massively bedded, mottled, micritic limestone near the base. Nodular chert, some bedded chert, and dolomite- to quartz-cemented sandstone also occur in the Kingsport (MMES/UT 1989, p. 12).

The Mascot Dolomite consists mostly of the same kinds of dolomite that occur in the Kingsport, with greater amounts of mottled pinkish and greenish gray dolomite in the upper part. Micritic limestone beds occur mostly in the upper part of the unit but do not comprise a large part of the unit. Nodular and bedded chert is more abundant in the lower Mascot than in the Kingsport, accounting for the tendency of the Mascot to form a low ridge—but not as prominent a ridge as those formed by the Longview and Copper ridge. Jasperoid chert is also present in this unit. Dolomite- and quartz-cemented sandstone occurs mostly in the lower part of the Mascot. One or more zones of chert-matrix sandstone occur at the base of the Mascot and serve as a marker that separates the Mascot from the Kingsport. Where the chert-matrix sandstone is not present, the combined unit has been called the Newala Formation. The Mascot has the greatest variability in thickness because of erosion on the Middle Ordovician unconformity (MMES/UT 1989, pp. 12–13). Thickness of the Mascot averages from ~48 m (~160 ft) to 61 m (200 ft) on ORR.

3.1.2.5 Chickamauga Group

The Chickamauga Group represents deposition on a regionally extensive disconformity on the top of the Knox. The unconformity is recognized by the presence of angular dolomitic intraclasts with pale olive and purplish maroon limestone immediately above the dense, fine-grained Mascot Formation. Depositional thickness of the lower part of the Chickamauga Group is highly variable because of the variability of relief on the unconformity (MMES/UT 1989, p. 13).

In upper northeastern Tennessee, the Chickamauga Group has been divided into 10 separate formations, which in stratigraphic order are the Blackford, Five Oaks, Holston, Lincolnshire, Rockdell, Benbolt, Wardell, Bowen, Witten, and Moccasin formations (Ruppel and Walker 1984, pp. 568–83). On ORR, extensive field mapping and detailed core analysis have shown that Chickamauga stratigraphic terminology used in upper northeastern Tennessee does not exactly match time equivalent rocks on ORR. This is especially true on the northwestern side of ORR near ORGDP, where it appears that the depositional setting for these rocks was very different from that of the Chickamauga in upper

northeastern Tennessee. Therefore, Chickamauga Formation names are not used on ORR. Detailed descriptions of the Chickamauga Group on ORR from field mapping and subsurface data are available in Stockdale (1951) and Lee and Ketelle (1988). On ORR more than 400 m (1300 ft) of Chickamauga comprises four variably thick maroon shale-dominated units separated by gray limestones (MMES/UT 1989, pp. 13–14).

The lower portion of the Chickamauga Group consists of more than 60 m (200 ft) of maroon calcareous siltstone and fissile shale with numerous thin limestone beds in the upper part. Vertical burrows commonly occur throughout this unit. The upper part of this lithology forms the northern face of Rogers Quarry on ORR (MMES/UT 1989, pp. 13–14).

The 46-m (150-ft) thick middle Chickamauga limestone unit consists of a lower dense cherty limestone and an upper shaly and fossiliferous lithofacies. The lower half of the middle limestone generally consists of nodular and thick-bedded limestone containing abundant nodular and bedded chert. This unit produces a discontinuous topographic rise throughout Bethel Valley to the southeast of ORGDP. The upper half of the middle limestone unit consists of nodular limestone and calcareous siltstone with a distinctive yellowish buff weathered color. This yellowish buff color can be seen in soils in the area. Thin beds of shelly and bryozoan-rich fossil hash occur locally in this unit (MMES/UT 1989, pp. 13–14).

The uppermost Chickamauga unit contains a very thin 4- to 6-m (13- to 18-ft) distinctive maroon calcareous siltstone and shale overlain by more than 75 m (246 ft) of limestone, nodular limestone, and calcareous siltstone. The maroon lithology is poorly exposed on ORR, but its identification on small discontinuous topographic rises confirms the position in the section. The limestone is thin- to thick-bedded, with frequent fossiliferous and burrowed horizons. This unit is gray, olive, and maroonish in color (MMES/UT 1989, pp. 13–14).

3.1.3 Soils

No detailed site-specific studies of soil characteristics at ORGDP have been conducted and, therefore, no site-specific soils data were available. However, a generalized description of soils in the Oak Ridge area is given by Carroll (1961), and detailed descriptions of soils in the nearby Whiteoak Creek Basin and at the Bear Creek Valley Site are given in McMaster and Waller (1965) and in Lietzke et al. (1988) respectively (DOE 1979, p. 4-10).

3.2 PADUCAH

3.2.1 Topography and Physiography

Paducah Gaseous Diffusion Plant (PGDP) is located on essentially flat terrain between Little Bayou Creek and Bayou Creek. Both of these creeks drain to the north into the Ohio River. The site is located near the northern terminus of the Mississippi Alluvial Plain or Mississippi Embayment portion of the Atlantic and Gulf Coastal Plain physiographic province in western Kentucky (Dames and Moore 1973, p. 5). This area is bordered on the north and east by the Highland Rim portion of the Interior Low Plateaus, an area of low plateaus on stratified sedimentary rock. On the west, the Mississippi

Embayment is bounded by the Ozark physiographic province, an area of high, hilly landscape including its northeastern extension, the St. Francois Mountains.

The topographically low Mississippi Embayment was a large sedimentary trough oriented nearly north-south that existed during Cretaceous and Tertiary time and received sediments from the central part of the North American continent (Early, Sigmon, and Williams 1989, p. 13). These Cretaceous and Tertiary sediments overlie the depressed Paleozoic basement rocks. The highland border areas surrounding the embayment are composed of relatively resistant Paleozoic sedimentary rocks. Paleozoic geologic features between the highland rim and the embayment were continuous prior to the subsidence of the embayment, which began in Late Cretaceous time. Thus, it is believed that geologic structural features exposed in the highlands can be extended under the sedimentary mantle of the embayment (Dames and Moore 1973, p. 7).

3.2.2 Structure, Stratigraphy, and Lithology

PGDP lies within a gently warped region of large domes, basins, and folds connected and crossed by complex Fault Systems. The following are the major fault zones of this region, as shown in Appendix C, Fig. C-3:

1. the New Madrid Fault Zone (now known by some as the Reelfoot Rift Zone), a broad belt of northeastward-southwestward trending faults, which extends from near Vincennes, Indiana, more than 322 km (200 miles) southwest into northeastern Arkansas;

2. the Cottage Grove–Rough Creek–Shawneetown Fault System, which trends east-west across central Kentucky into southern Illinois, where it crosses the New Madrid Fault Zone;

3. the St. Genevieve Fault System, which trends southeastward from near St. Louis, Missouri, crosses the New Madrid Fault Zone, then probably continues as a buried fault beneath the Mississippi Embayment into northwestern Tennessee; and

4. the Western Kentucky Faulted Area, which consists of a series of northeast–southwest trending faults bounded on the north by the Rough Creek–Shawneetown System and on the northwest by the New Madrid Fault System. The faults probably extend southwestward under the Mississippi Embayment sediments.

Figure 3.2-1 shows the general surficial geology in the PGDP vicinity. The sedimentary sequence found in the region unconformably overlies northward-dipping Paleozoic limestones and shales (Fig. 3.2-2). This sequence consists mainly of fine- to medium-grained clastic materials including, from oldest to youngest, the Little Bear Soil (the unit that denoted the unconformity on the Paleozoic limestone surface), the Tuscaloosa Formation (a basal gravel), the McNairy Formation, the Clayton Formation (the McNairy and Clayton Formations cannot be differentiated solely on lithology and are normally mapped as a single unit in the area), the Porters Creek Clay, and undifferentiated Eocene sands (Fig. 3.2-2). These strata dip gently to the southwest toward the axis of the Mississippi Embayment (Early, Sigmon, and Williams 1989, p. 13).

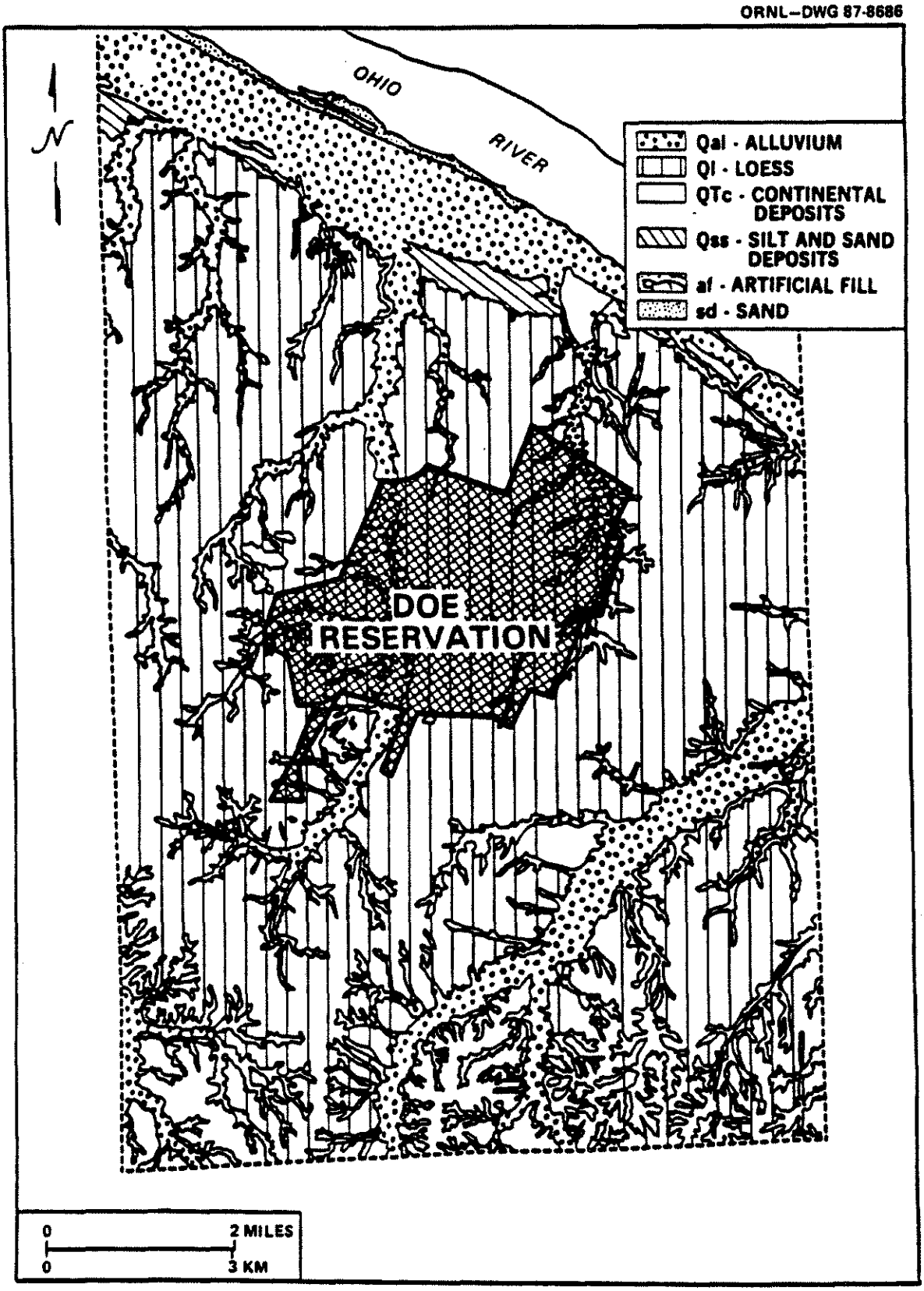


Fig. 3.2-1. Geologic map of the Paducah Gaseous Diffusion Plant site. *Source:* J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988*, ES/ESH-8V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.

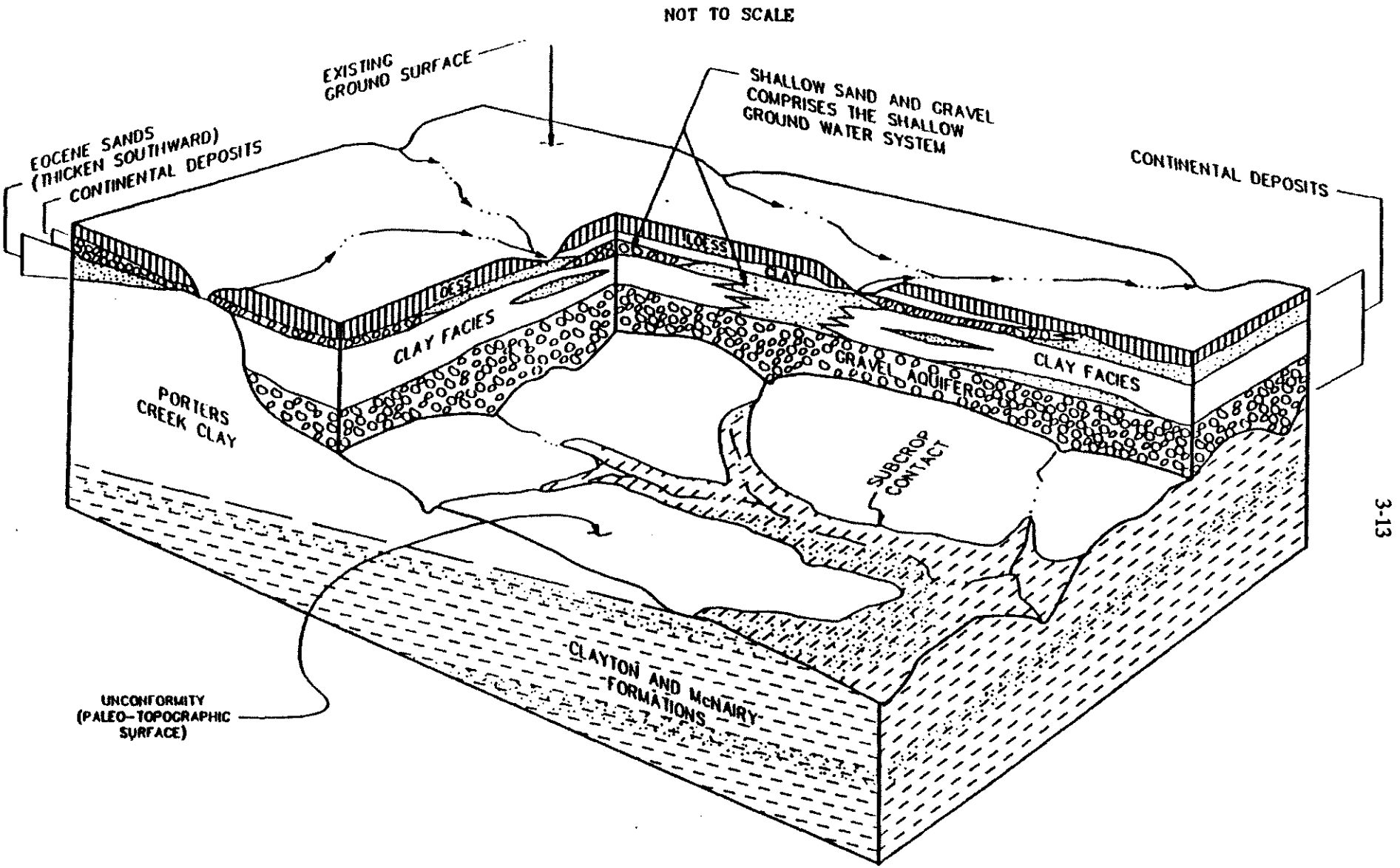


Fig. 3.2-2. Conceptual Stratigraphy in the vicinity of the Paducah Gaseous Diffusion Plant. *Source:* Environmental and Energy Services Company (ERC)/Engineering, Design, and Geosciences Group, Inc. (EDGe), *The Geologic Setting of the DOE Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Nashville, Tenn.*, Nov. 11, 1989.

Following deposition of these units, uplift occurred in the area and an erosional surface developed, truncating the sediments in the area immediately beneath PGDP. Subsequently, during later Tertiary and Quaternary time, a formation unit designated as the Continental Deposits was laid down in the region, creating an angular unconformity with the underlying sediments (Fig. 3.2-2). During the Pleistocene, loess (a layer of unstratified, wind-blown material) generated by glacial activity to the north was deposited on top of the Continental Deposits.

The regional post-Paleozoic sedimentary sequence is described in Fig. 3.2-3. However, the three-dimensional character of each of these depositional units at PGDP had not been investigated in detail until recently. Beginning in 1986, two borehole transects were drilled across the PGDP site, approximately normal to each other (Appendix B, Fig. B.1) (EDGe 1989, p. 5). These borehole transects led to the preparation of two cross-sectional profiles that provide a more detailed picture of the stratigraphic relationships between each of the depositional units in the subsurface (Appendix B, Figs. B.2 and B.3). In addition, these profiles may be used to delineate the nature and areal extent of water-bearing lithological units and to characterize the potential migration pathway for contaminant-bearing fluids. These figures will be referred to in the following detailed discussions of each of the depositional units.

3.2.2.1 Little Bear Soil

The Little Bear Soil denotes the regional unconformity on the Paleozoic limestone surface. This unit lies at a depth of 91–152 m (300–500 ft) below ground surface, and no borings drilled in the immediate PGDP area extend this deep. However, ~11 yd (~35 ft) of this clay was penetrated at the Tennessee Valley Authority (TVA) Shawnee Steam Plant to the north. The material was composed of red and brown silty clay with chert fragments and limonite nodules (ERC/EDGe 1989, p. 10).

3.2.2.2 Tuscaloosa Formation

The late Cretaceous Tuscaloosa Formation has not been penetrated by drilling in the immediate area of PGDP; however, it is likely that this unit is present at depth. Normally, this unit is 6–9 m (20–30 ft) thick, but a groundwater well at Metropolis encountered up to 51 m (168 ft) of chert gravel with a clay-sand matrix thought to represent the Tuscaloosa Formation. Greater thicknesses of this unit across the area may represent infilling of sinkholes or channels developed on the unconformity on top of the Paleozoic bedrock surface (ERC/EDGe 1989, p. 10).

3.2.2.3 Clayton-McNairy Formations

The Clayton and McNairy Formations at PGDP are mapped as one lithological unit because the two formations cannot be distinguished by gross lithological properties and can only be distinguished by differentiation of the unique fossil pollen assemblages characteristic of Paleocene and Cretaceous aged deposits (EDGe 1989, p. 20). On a regional basis, these marine formations, which underlie all the plant area, have been described as consisting of interlensing and interlaminated clay and sand. Colors range from white to light gray, dark gray, orange, and brown. Mineralogically, this unit is composed of 25–50% quartz, 5–10% feldspar, 30–60% clay, and some heavy minerals. During the recent groundwater monitoring

ORNL-DWG 90-7037

SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING
QUATERNARY	Pleistocene and Recent		Alluvium		0–40'	Brown or gray sandy and silty clay or clayey silt with streaks of sand. Some brown sand with streaks of clay and silt.	Recent flood-plain deposits in the valleys of the Ohio River and its larger tributaries.
QUATERNARY	Pleistocene		Loess		0–43'	Brown or yellowish-brown unstratified silty clay.	Wind-laid deposits covering all upland areas.
QUATERNARY	Pleistocene		Gravel sand and clay[1]		0–60'	Orange to yellowish-brown clayey silt, some very fine sand, trace of fine to medium sand; occasional layers of light gray clay. Often micaceous.	Continental deposits underlying loess throughout the area. Occasionally present beneath the alluvium.
QUATERNARY / TERTIARY	Pleistocene / Pliocene(?)		Gravel sand and clay[1]		3–121' / 3–61'	Reddish-brown silty and sandy gravel, trace of clay; occasional lenses of clay.	Continental deposits lying on an irregular surface consisting of channels and terraces cut by an intricate drainage system into sediments of Paleocene and Cretaceous ages. Coastal-plain sediments of Eocene age may underlie the gravel near the intersection of Bethel Church Road and the south edge of the quadrangle.
TERTIARY	Paleocene	Midway	Porters Creek Clay		0–88'	Dark gray montmorillonitic clay, often silty or sandy; occasionally micaceous. Glauconitic at the base and in the upper part.	Marine deposit underlying the Pliocene(?) and Pleistocene gravel south of the 330-foot water-level contour. Pinched out near the contour; it thickens southward.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]		200–300'	Grayish-white to dark gray micaceous clay, often silty, interbedded with light gray to yellowish-brown very fine- to medium-grained sand. The upper part is mostly clay; the lower part is predominantly micaceous fine sand.	Deltaic deposits underlying the Porters Creek Clay south of the 330-foot water-level contour and the Pliocene(?) and Pleistocene gravel north of it.
CRETACEOUS	Upper Cretaceous		Tuscaloosa Formation		0–7	White, well-rounded or broken chert gravel with tripolitic clay matrix.	Discontinuous stream-laid deposits on post-Paleozoic erosion surface. Present in parts of adjacent quadrangles; may be present in this area.
MISSISSIPPIAN			Carbonate rocks undifferentiated		300–500'	The Paleozoic consolidated rocks underlying the Cretaceous sediments are the "bedrock" of well drillers. Dark gray limestone interbedded with chert.	Underlies the entire area.

[1] Age undetermined. Estimates of age range from Pliocene(?) to Pleistocene
[2] Upper part may include layers of Clayton age

Fig. 3.2-3. Generalized Columnar Section of Geologic Formations in the Vicinity of the Paducah Gaseous Diffusion Plant. *Note:* to convert feet to meters, multiply the given value by 0.3048. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

program at PGDP, the Clayton-McNairy Formations have been encountered in 13 drill borings, although the total thickness of the formation was not penetrated in any boring. The materials that have been examined consist of clay. This clay is variably silty and sandy, with fine sand seams being typically dark gray. The clays exhibit lenses of silt that contain variable amounts of clay and sand. The clay and silt intervals are occasionally lignitic and pyritic. The thickest sand interval within this unit on the Paducah Reservation thus far encountered was in Boring S-1 (Appendix B, Figs. B.2 and B.3), immediately beneath the Porters Creek Clay contact. This sand interval has an apparent thickness of 6–9 m (20–30 ft). Although the sand intervals are typically very dense, their permeability may be sufficient to create a pathway for contaminant migration from PGDP. Based on recent drilling at the PGDP site and extrapolating from drilling done at the TVA Shawnee Steam Plant, the aggregate thickness of these formations at PGDP is probably ~80 m (~265 ft) (ERC/EDGe 1989, p. 9).

The available engineering data indicate that the cohesive intervals of the Clayton-McNairy Formations have liquid limits ranging from ~31 to 56 and plasticity indexes of 8 to 30. The formations collectively exhibit stiff-to-hard consistencies where cohesive and dense-to-very-dense consistencies were granular. However, one recent boring on the reservation penetrated a very loose sand at elevation ~75 m (245 ft) mean sea level (MSL) (ERC/EDGe 1989, pp. 9–10).

3.2.2.4 Porters Creek Clay

The Porters Creek Clay is present beneath the southern part of PGDP and extends southward, where it has not been removed by post-Paleocene erosion. Thus, beneath most of PGDP, the Porters Creek Clay has been removed by erosion and the Continental Deposits have been deposited directly on top of the Clayton-McNairy Formations. This relationship is illustrated conceptually in Figs. 3.2-3 and 3.2-4 and in the cross-sectional profiles X-X and Y-Y (Appendix B, Figs. B.2 and B.3), which illustrate an angular unconformity between the Continental Deposits and the Mississippi Embayment sediments. As shown in these figures, the angular unconformity is configured such that the subcrop contact of the Porters Creek Clay with the Clayton-McNairy Formations occurs immediately beneath PGDP where the paleotopographic surface truncates the Porters Creek Clay.

The regional structural dip of the Porters Creek Clay is southerly at <1°. Regionally, this unit has been characterized as a dark gray, medium gray, and olive colored micaceous marine clay. The unit also contains intervals of light to dark gray and olive gray sand that is in part glauconitic. The uppermost part of the unit may contain spheroidal concretions of limonite up to 0.6 m (2 ft) in diameter. Drill hole data show that the formation ranges from 20 to 46 m (65 to 152 ft) in thickness (EDGe 1989, pp. 19–20; ERC/EDGe 1989, p. 9).

The average composition of the Porters Creek Clay is 70% clay, 10% quartz, and 20% other minerals. Engineering data for this formation is sparse; however, one liquid limit test yielded a value of 85 with a plasticity index of 23. Penetration resistances indicate that this formation is very stiff to hard in consistency but that it contains fractures (desiccation cracks) that give it a blocky structure. Tests of its vertical permeability range from 10^{-6} to 10^{-9} cm/s, depending upon the presence or absence of secondary fractures (ERC/EDGe 1989, p. 9).

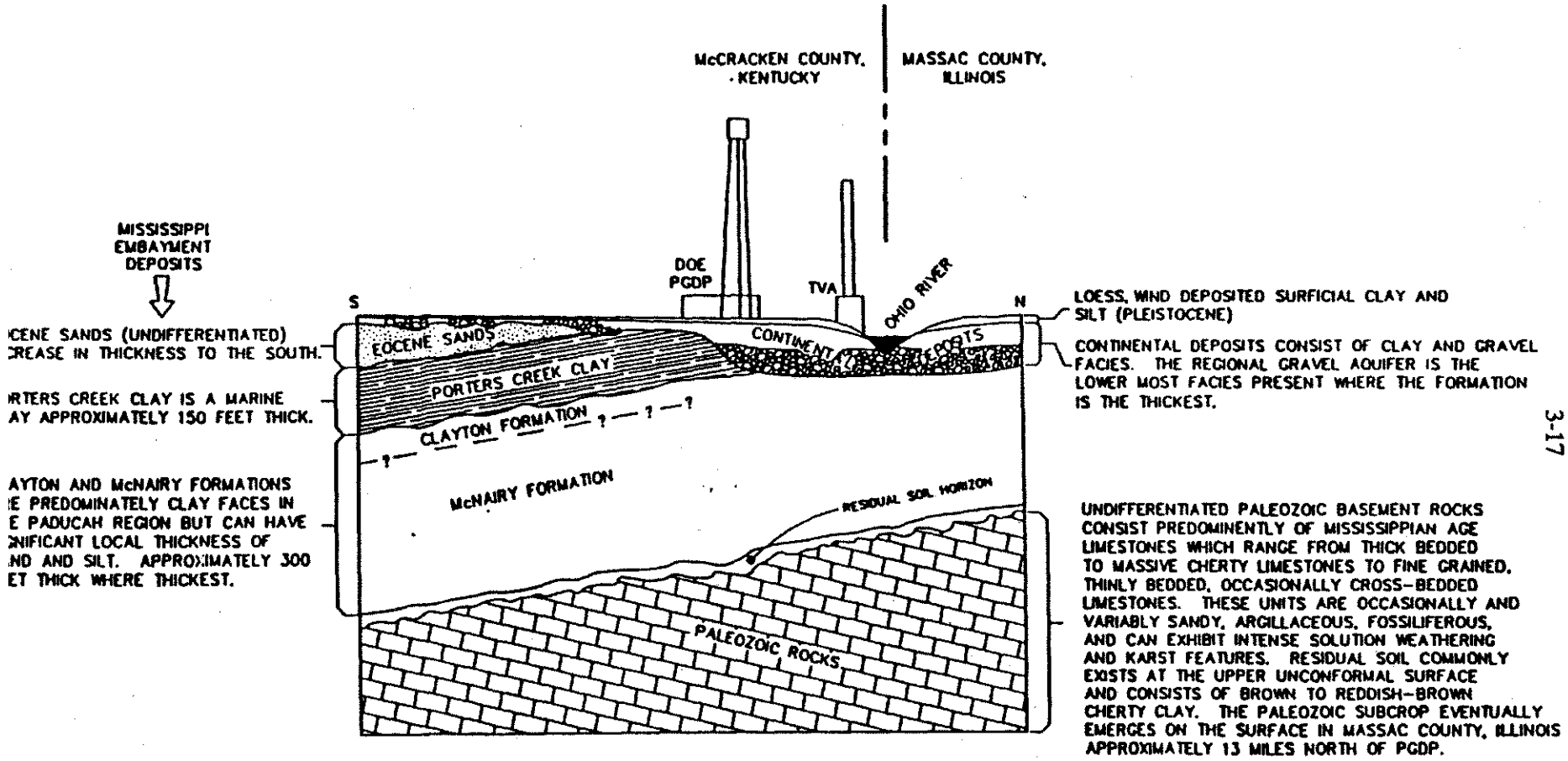


Fig. 3.2-4. Stratigraphic relationship of Mississippi embayment deposits to the Paleozoic basement.

3.2.2.5 Undifferentiated Eocene Sands

These marine formations, the Claiborne and Wilcox Formations, are Eocene in age and are apparently present to the south of PGDP, where they have not been removed by erosion. As with the Clayton-McNairy Formations, these formations cannot be differentiated based on lithology; spores and pollen must be used. The units are composed of interbedded and interlensing micaceous fine sand, silt, and clay that occur in varying colors. Engineering data for these formations are unavailable. Average mineralogical compositions are 55% quartz, 40% clay, and 5% other minerals (ERC/EDGe 1989, p. 8).

3.2.2.6 Continental Deposits

The Continental Deposits can be subdivided into two facies: a lower gravel or sandy gravel (Gravel Facies) that varies in thickness from 0 to ~32 m (0 to ~106 ft) and an upper clay-sand unit (Clay Facies) with a comparable range in thickness (Olive 1966; Finch 1967). The Gravel Facies was interpreted by Potter (1955a,b) as alluvial fan/braided stream deposits. It appears to be continuous throughout the PGDP region, although its thickness is highly variable because it was deposited on the irregular surface of the underlying unconformity (ERC/EDGe 1989, pp. 7–8). This unit extends northward to the Ohio River (Davis, Lambert, and Hansen 1973, pp. 35–36). The stratigraphy in the vicinity of the PGDP is conceptually illustrated in Fig. 3.2-3.

The lower Gravel Facies of the Continental Deposits was deposited on an erosional surface that displayed significant topographic relief. Figure 3.2-5 from Early, Sigmon, and Williams (1989, p. 18) illustrates the configuration of this erosional surface based on data from numerous auger holes drilled by the U.S. Geological Survey and subcontractors working at PGDP (Olive 1966; Finch 1967; Geotek 1979, 1980; D'Appolonia 1983; MCI 1986; EDGe 1987b; ERC/EDGe 1989). This structural contour map illustrates the presence of a prominent channel that passes in a northerly direction through the PGDP and extends northward toward the Ohio River. A second, less prominent channel that exhibits a similar orientation is present near the eastern PGDP boundary (Early, Sigmon, and Williams 1989, p. 19). Finch (1967) noted that detailed drilling at the site of the TVA Shawnee Power Plant to the north revealed that on a fine scale, the erosional surface is extremely rough. Therefore, the smoothness of the contours presented in Fig. 3.2-5 is probably an artifact of the limited data available for the PGDP area (Early, Sigmon, and Williams 1989, p. 19).

The origin and depositional history of the Gravel Facies have been investigated by Potter (1955a,b). He concluded that during Pliocene-Pleistocene time, several large coalescing alluvial fans developed in the northern Mississippi Embayment region. Deposition of the gravel then occurred in a high-energy braided stream environment, closely associated with the alluvial fans. Braided streams are characterized by numerous channels that intersect and, on a large scale, often have a configuration similar to braided strands of rope. Potter (1955b) reported that the original gravel deposits were extensively eroded and reworked after deposition; thus, the Gravel Facies of the Continental Deposits underlying PGDP may have been subjected to reworking processes (Early, Sigmon, and Williams 1989, p. 20).

A structural contour map drawn on top of the Gravel Facies is shown in Fig. 3.2-6. This map is based on a limited database, but it appears that the western channel identified in Fig. 3.2-5 persisted throughout deposition of the unit, although its position shifted somewhat, possibly because of normal channel migration over time. The eastern channel

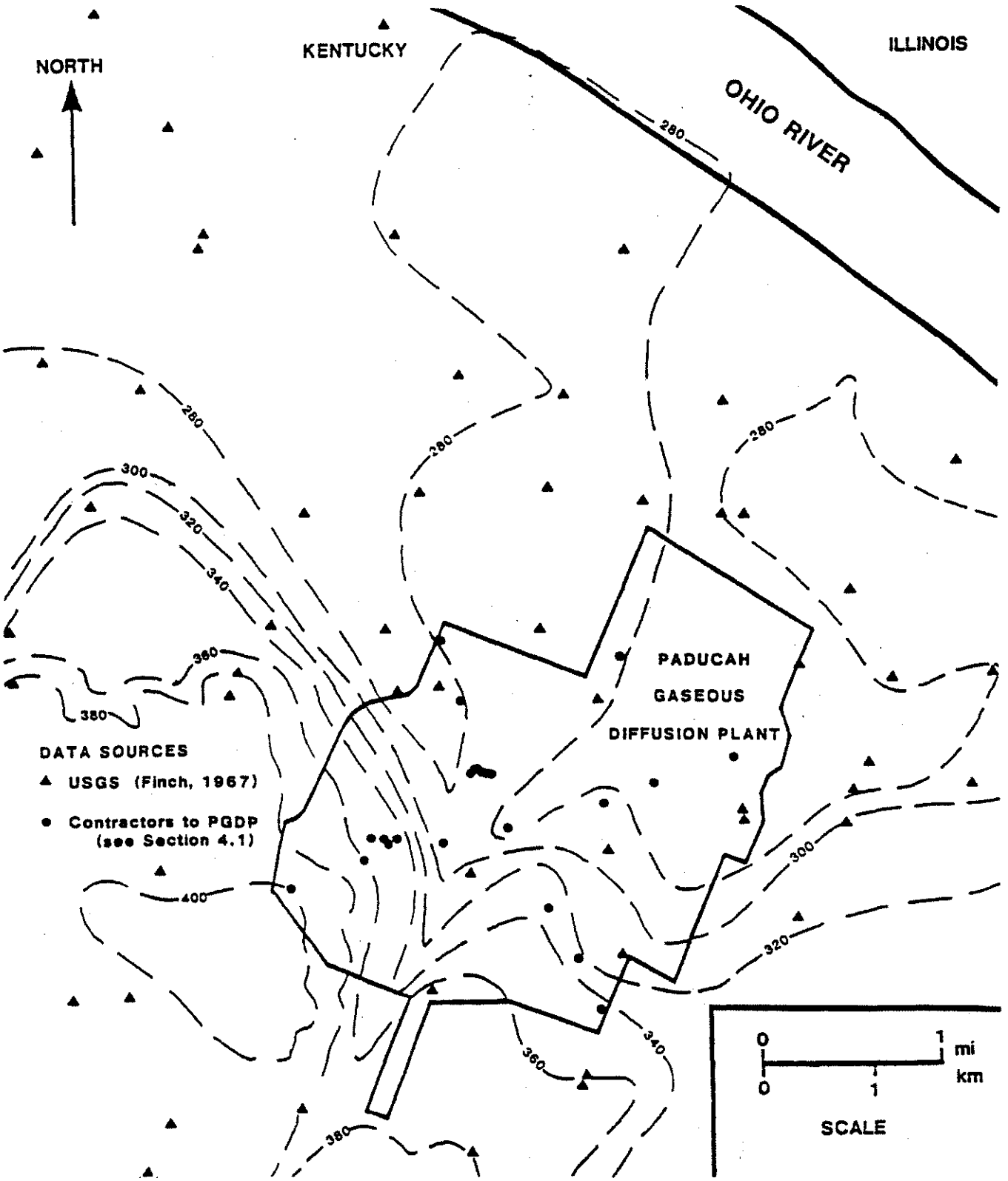


Fig. 3.2-5. Elevation of Erosional surface cut on rocks of Eocene, Paleocene, and Late Cretaceous Age in the vicinity of the Paducah Gaseous Diffusion Plant. Contours are in feet above mean sea level; to convert feet to meters, multiply the given value by 0.3048. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

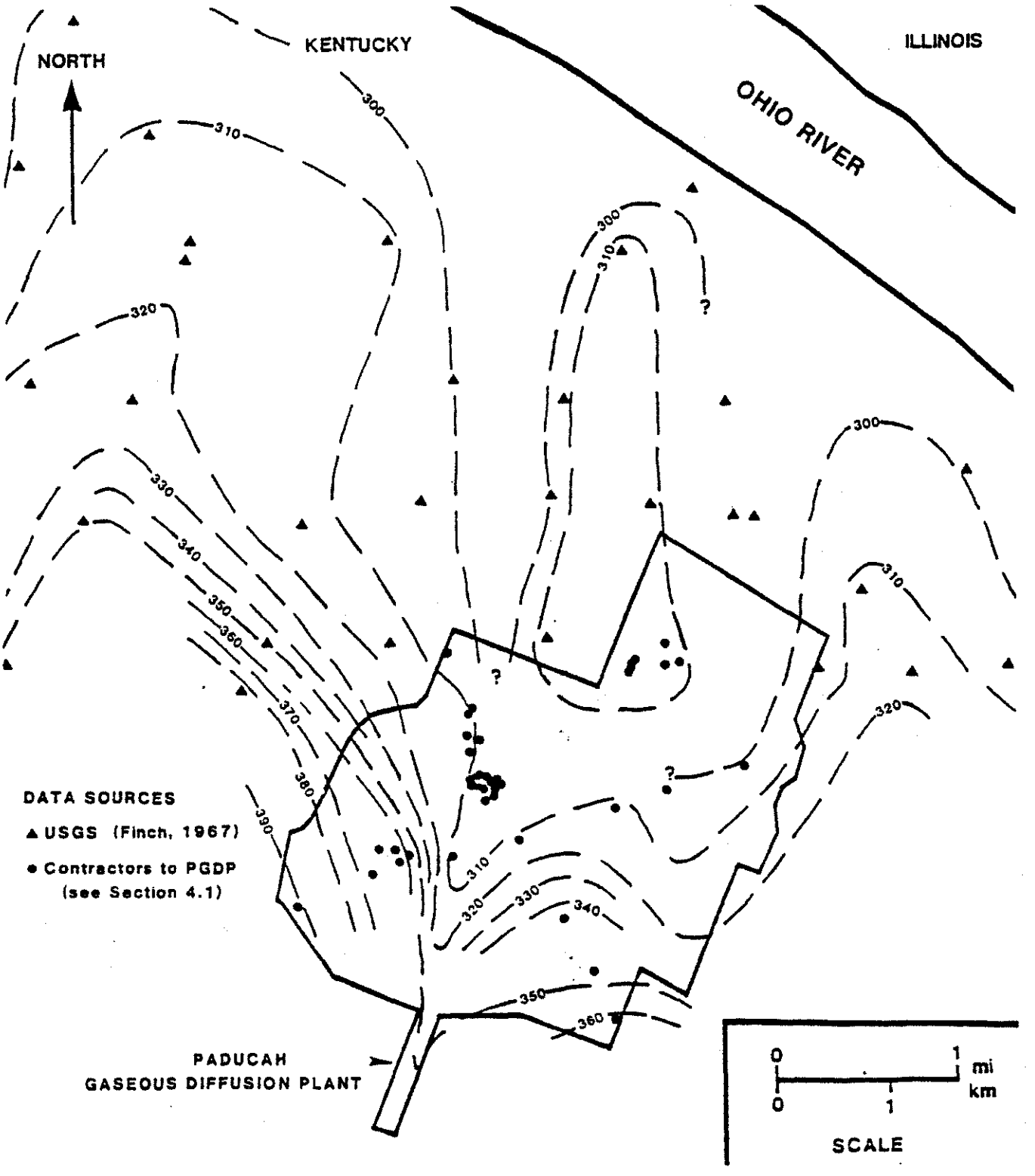


Fig. 3.2-6. Elevation of the top of the regional gravel aquifer in the vicinity of the Paducah Gaseous Diffusion Plant. Contours are in feet above mean sea level; to convert feet to meters, multiply the given value by 0.3048. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

depicted in Fig. 3.2-5 also appears to have persisted through the deposition of the Gravel Facies, although the available data are insufficient to conclusively define its configuration. These paleochannels may be significant pathways for contaminant migration across the PGDP site because channels typically are sites of deposition of coarse, highly porous sediments that are more transmissive to groundwater than surrounding sediments. Typically, groundwater and contaminants tend to be focused into channel deposits and migrate along these preferential pathways (Early, Sigmon, and Williams 1989, p. 20). (See Sect. 6.2 for further discussion.)

Figures 3.2-7 and 3.2-8 show the interpreted paths of the stream channels that existed at the base and top of the Gravel Facies respectively. Also included in these figures are patterned areas where cobble zones have been reported from soil borings within the gravel. Note that these regions appear to conform roughly to the locations of parts of the inferred channels. Although drilling log data are limited from the area, it is significant to note the apparent absence of cobbles in borings distant from the inferred channels. This evidence lends support to the paleochannel hypothesis because, based on modern analogues, the coarsest stream deposited sediments are found within the channels where stream velocities are greatest (Early, Sigmon, and Williams 1989, p. 22).

A generalized isopach map of the Gravel Facies is presented in Fig. 3.2-9. South of PGDP, a veneer of gravel exists at or near the surface and is exposed in numerous pits in the vicinity of the abandoned Kentucky Ordnance Works, located adjacent to the southwest corner of PGDP. It is uncertain whether this gravel is directly correlative to the Gravel Facies. Soil boring data presented in EDGe (1989) do not extend far enough to the south to resolve this question. However, stratigraphic correlation profiles in ERC/EDGe (1989, Profiles X-X; Y-Y in data Appendix) demonstrate that near the southern boundary of PGDP, the Gravel Facies exists along the base of an escarpment that was carved into the underlying sediments by an ancient river. The gravel occurs as a thin layer [<13 m (<10 ft) thick] that thickens rapidly to the north. North of PGDP near the Ohio River, the Gravel Facies is again thin. This configuration is consistent with the inferred depositional setting of the margins of a floodplain of a major river system. The thick zone of gravel appears to occupy the deepest part of the former river channel within an inferred meander (Early, Sigmon, and Williams 1989, p. 27).

Engineering data indicate that the Gravel Facies is relatively uniform and very dense. Standard penetrometer blow counts for these materials are typically 50 or more. Accordingly, it has a high shear strength and a relatively low coefficient of compressibility (ERC/EDGe 1989, pp. 7–8).

The Clay Facies of the Continental Deposits is believed to consist of discontinuous, fine sand lenses and minor gravel and cobbles that are enclosed within a dominant clay (MCI 1986; EDGe 1987a, 1988; Early, Sigmon, and Williams 1989, p. 27). This interpretation is based on limited data, and the lack of continuity of the interbedded sands, gravel, and cobbles cannot be definitely verified. Available exploratory boring data show considerable lateral and horizontal variability of this facies. This interval varies in thickness from 15 to 18 m (45 to 60 ft). The clays vary in color from yellowish brown to brownish gray. The unit is variably micaceous, and most of the gravel is composed of subangular to angular chert (ERC/EDGe 1989, p. 7).

From an engineering standpoint, the Clay Facies exhibits penetration resistances that classify the cohesive intervals as firm to stiff ($N \geq 10$) with rare soft intervals ($N \leq 4$); the noncohesive intervals are predominantly medium dense to dense in consistency. Dry

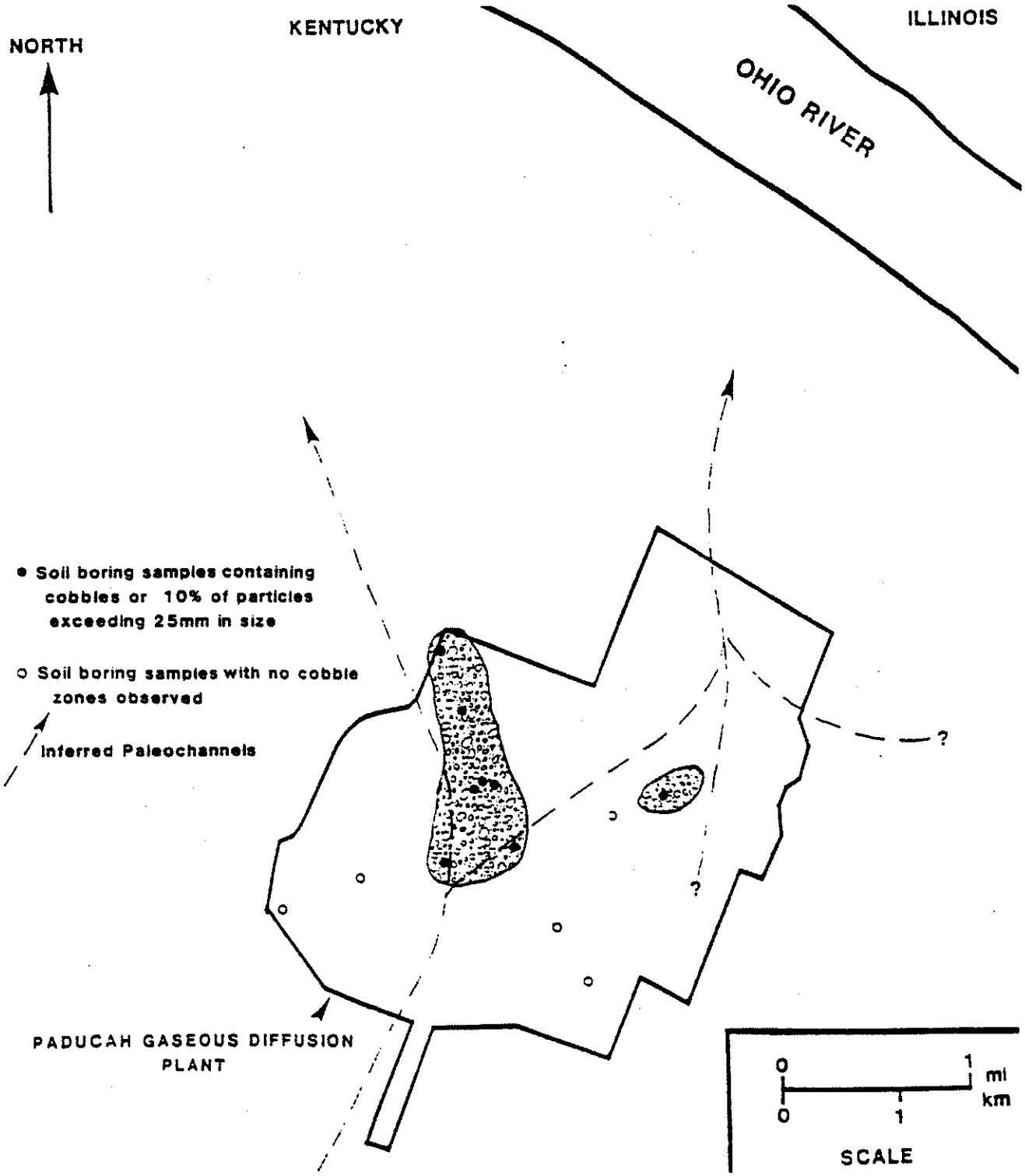


Fig. 3.2-7. Inferred location of paleochannels and coarse gravel sediments in the lower part of the gravel aquifer. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

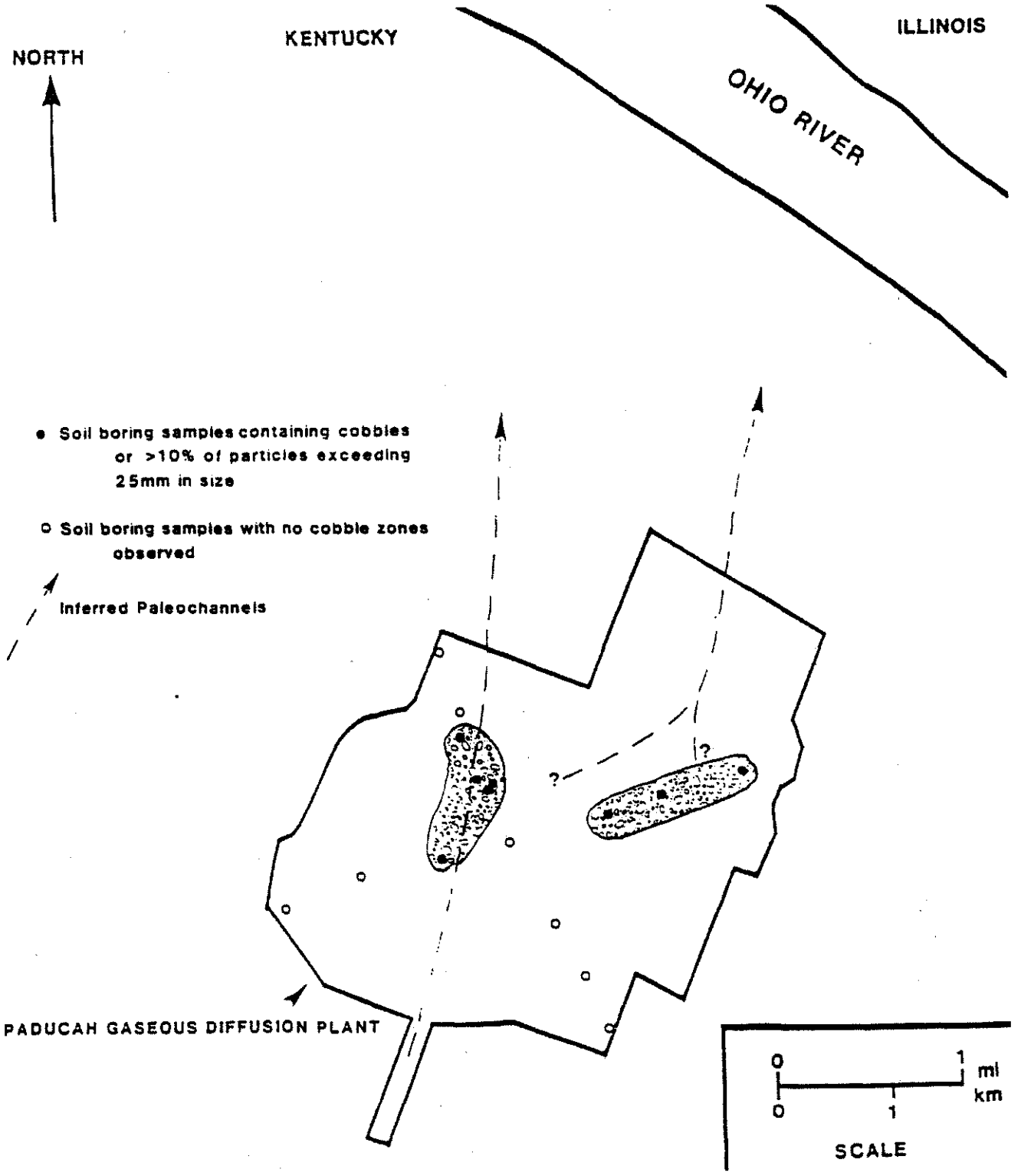


Fig. 3.2-8. Inferred location of paleochannels and coarse gravel sediments in the upper part of the gravel aquifer. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

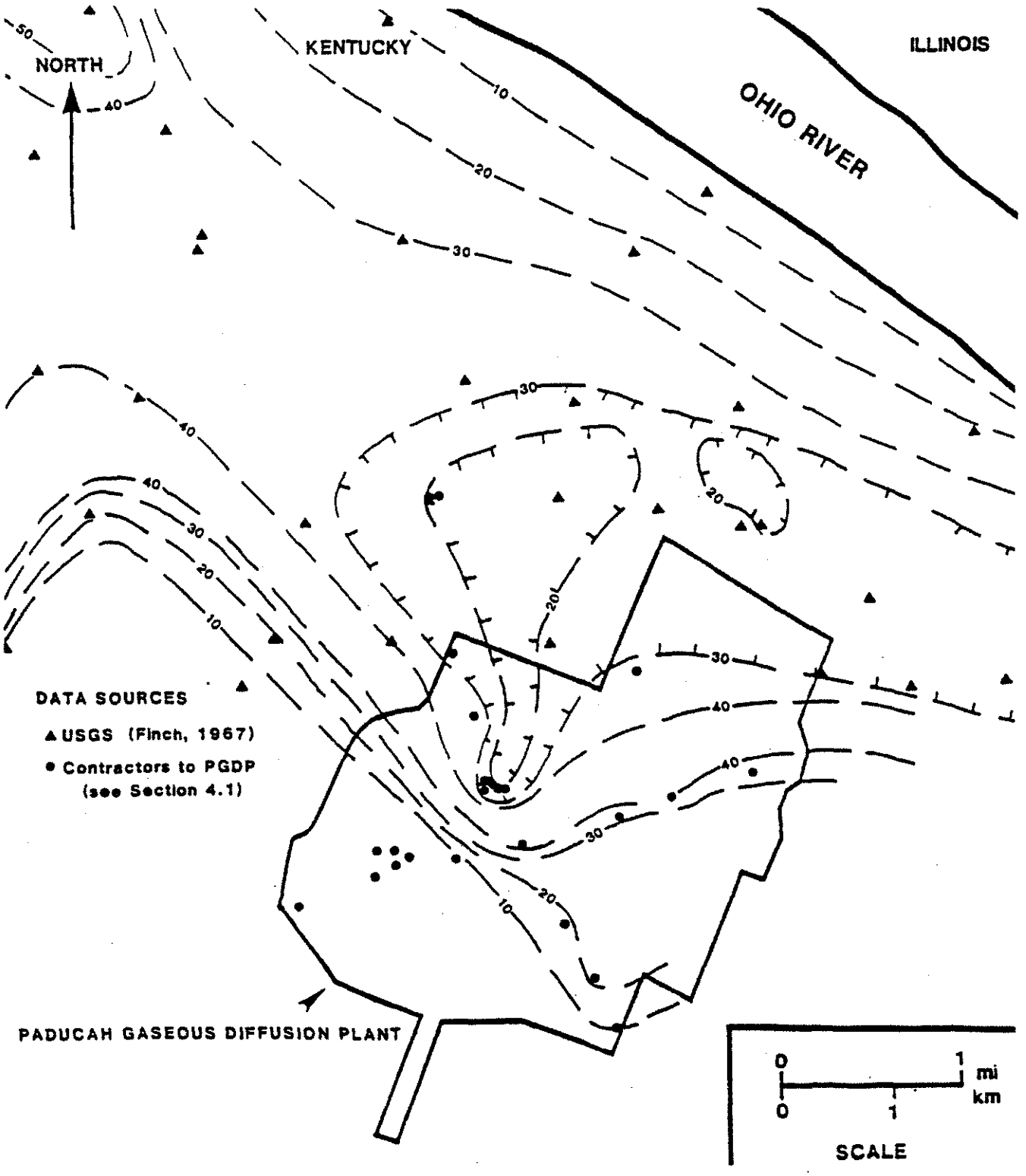


Fig. 3.2-9. Isopach map of the gravel aquifer in the vicinity of the Paducah Gaseous Diffusion Plant. Thicknesses are in feet. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

densities range from 6 to 8 kg/m^3 [98 to 131 pounds per cubic feet (pcf)], depending upon material type (ERC/EDGe 1989, p. 7).

3.2.3 Soils

The surficial soil at PGDP consists of up to 7.6 m (25 ft) of unstratified loess (wind-deposited material) that consists of yellowish brown clayey silt and silty clay with local iron oxide concretions. Some of the loess below the elevation of ~121 m (~400 ft) MSL may have been reworked by flood waters during the Pleistocene Epoch. The base of the loess within the reservation is generally at 107–110 m (350–360 ft) MSL (ERC/EDGe 1989, p. 6).

The loess exhibits penetration resistances (N values according to ASTM D 1586) between 4 and 38, with most values in the mid-teens. It is classified as a CL/ML soil in the Unified Soil Classification System (Woods 1960), having the following average properties: 45% quartz, 45% clay, 10% feldspar, in-place dry density of 5.9–6.5 kg/m^3 (95–105 pcf) a liquid limit of 31 to 41, and a plasticity index of 5 to 21. It is relatively compressible and has a low to moderate shear strength (ERC/EDGe 1989, p. 6).

Additional information on soil associations and characteristics in the vicinity of PGDP may be found in SCS (1976).

3.3 PORTSMOUTH

3.3.1 Topography and Physiography

The regional and local topography at Portsmouth Gaseous Diffusion Plant (PORTS) has been summarized in detail in ERDA (1977, pp. 2-136 to 2-143), LETC (1978, pp. 4-2 to 4-4, 5-1 to 5-2, 7-1 to 7-2; 1982, pp. 2-1, 2-2, 3-1, and 3-2), Blumberg et al. (1983, pp. B-3 to B-4); and Rogers et al. (1988, p. 8). The following description is a condensed summary of these sources. The PORTS site is located near the western edge of the Appalachian Plateau Physiographic Province (Fig. 3.3-1). Streams have eroded the plateau in the area forming the typical hills, ridges, knobs, and valleys of the province (Blumberg et al. 1983, p. B-3). Crests of hills and ridges in the area do not exceed 366 m (1200 ft) (all elevations in this section are relative MSL). The topographically lowest feature in the area is the Scioto River, which has an elevation of ~162 m (~530 ft) near the site (LETC 1978, p. 4-2). The major topographic features in the region are the abandoned valleys of the extinct Newark River (now occupied by the Scioto River) and the extinct Teays River (now occupied by Big Beaver Creek and McConnel Creek). The PORTS site lies in a less distinct valley of the abandoned Portsmouth River, which is generally oriented north to south (Fig. 3.3-2).

Before the construction of PORTS, the original ground surface in the area where the Gas Centrifuge Enrichment Plant (GCEP) facilities were recently constructed sloped gently to the north and south from a surface drainage divide at approximately site grid line N 6500. A surface drainage feature trending west-northwest was located near the northern limit of the GCEP/AVLIS site, while the southern part of the site was drained by south- and southwest-flowing tributaries of the west-flowing stream located adjacent to South Construction Area Road. Grading associated with construction of the PORTS facilities changed the topography of the GCEP/AVLIS area only slightly. The exception was along drainage features at the site where as much as 4.6–6.1 m (15–20 ft) of fill material was placed (LETC 1978, p. 4-3). The majority of this material was removed by undercutting

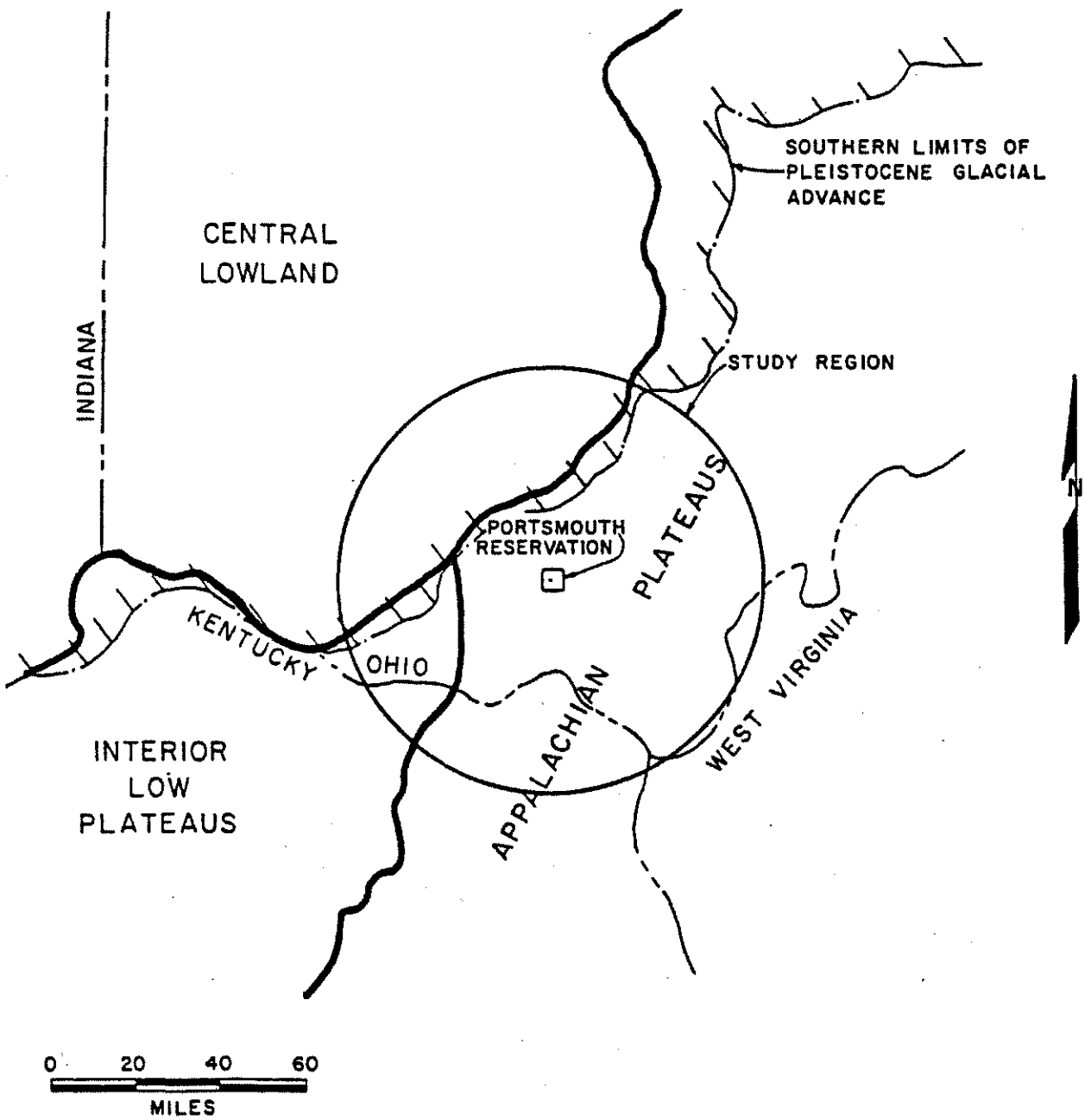


Fig. 3.3-1. Regional physiography. *Source:* Law Engineering and Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978.

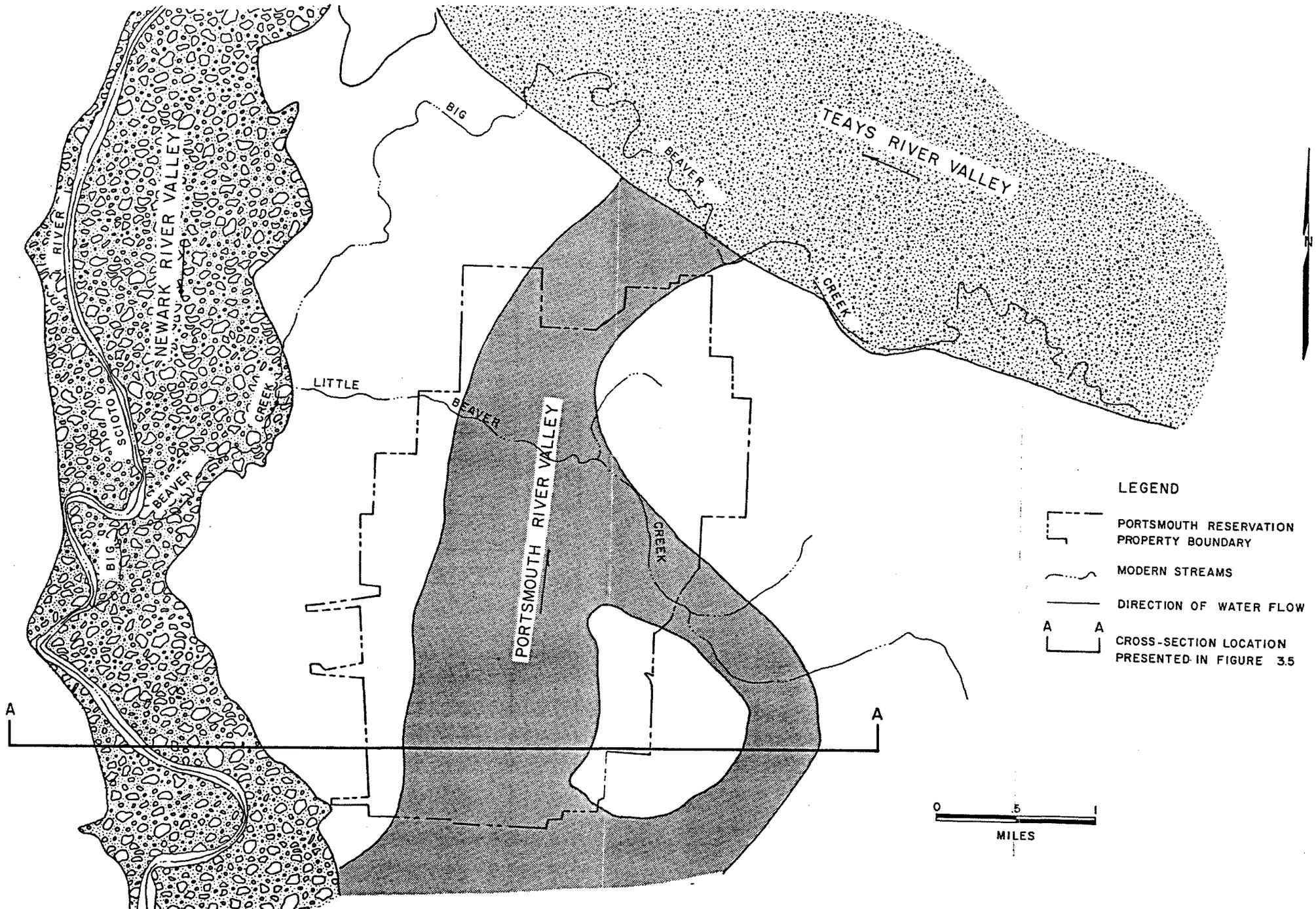


Fig. 3.3-2. Paleochannel map of the study region. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978.

during construction of the GCEP facilities. The present-day ground surface inside the west Perimeter Road is now relatively flat.

The landforms in the region developed primarily as a result of Pleistocene continental glaciation. The southern terminus of glaciation was located ~32 km (~20 miles) north of the site near the town of Chilicothe (Blumberg et al. 1983, p. B-3). Prior to glaciation, the site area was occupied by the Portsmouth River, a major north-flowing tributary of the Teays River System. The Teays River, located ~5.6 km (~3.5 miles) north of the GCEP site (Fig. 3.3-2), was a mature stream, which cut a 2.4-km (1.5-mile) -wide valley with a flat bottom and steep sides. During an early glacial advance (~1.5 million years ago), glacial ice dammed the lower reaches of the Teays River, causing lakes to form in the drown river valleys of the preglacial drainage system (LETC 1978, pp. 5-9 to 5-13; Blumberg et al. 1983, p. B-3). The PORTS site, located in one of these valleys, was submerged, and lake bottom sediments partially filled the old Portsmouth River channel (Blumberg et al. 1983, p. B-3).

The Newark River Valley, where the present day Scioto River flows, was eroded by meltwaters from subsequent glaciation (Illinoian and Wisconsin glaciation). Meltwater from these glaciers carried an abundance of glacial sediments into the Newark River valley, locally up to 30.5 m (100 ft) thick. The Scioto River, which currently occupies the old Newark River valley, did not come into existence until the final retreat of the Wisconsin ice (Stout and Lamb 1938). Subsequent to the formation of the Scioto valley, erosion by tributaries such as Little Beaver Creek and Big Run has cut through the Scioto valley wall and old lake fill sediments to produce the existing topography (Blumberg et al. 1983, p. B-3).

3.3.2 Structure, Stratigraphy, and Lithology

The major geologic provinces in the Ohio region are shown in Fig. 3.3-3. The major provinces include the Cincinnati and Findlay arches, which are bounded on the north, west, and east by the Michigan, Illinois, and Appalachian basins respectively (Fig. 3.3-4). The PORTS site is located near the axis of the north-south trending Waverly Arch. Figure 3.2-9 is a regional geologic cross-section drawn north of the PORTS site. Note that the geologic units exposed at the surface become progressively younger east and west from the crest of the Findlay Arch (LETC 1978, p. 5-3). One geologic feature of note in the region is the Serpent Mound cryptoexplosion structure, located at the common boundaries of Adams, Highland, and Pike counties, ~35 km (~22 miles) west of the PORTS site (Kouchy and Reidel 1987, pp. 431–436). This cryptoexplosion structure is characterized as a circular feature that is highly faulted and brecciated with a central uplifted area.

The rocks exposed in the southern part of Ohio were deposited during the Paleozoic Era over a basement complex of igneous and metamorphic rocks of Precambrian age. During much of the Paleozoic Era, this region was covered by epicontinental seas, resulting in the deposition of successive layers of clays, calcareous clays, sands, and gravels (LETC 1978, p. 5-2). As Paleozoic deposition progressed and the sediments became lithified into rock, the region underwent structural deformation. The vertical displacements formed broad arches and basins of sedimentary materials over the Precambrian igneous and metamorphic basement rocks. In some of the arches, the Precambrian core is now exposed at the surface, while in some of the basins >3050 m (>10,000 ft) of sediments were deposited (LETC 1978, p. 5-2).

During the Permian Period near the end of the Paleozoic Era, the region was uplifted during the Appalachian orogeny, resulting in a change from a predominantly depositional

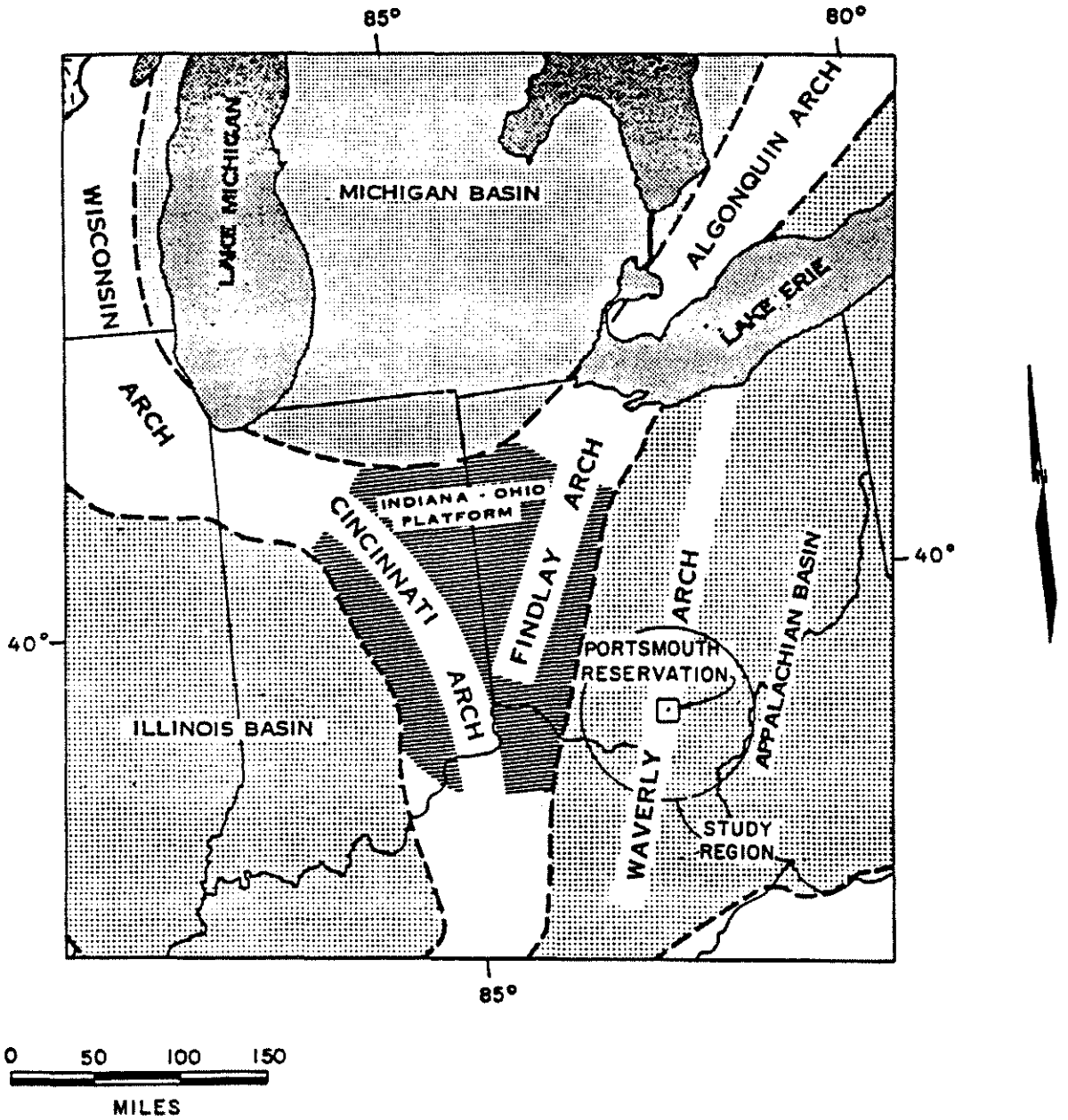


Fig. 3.3-3. Regional geologic structure map. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978.

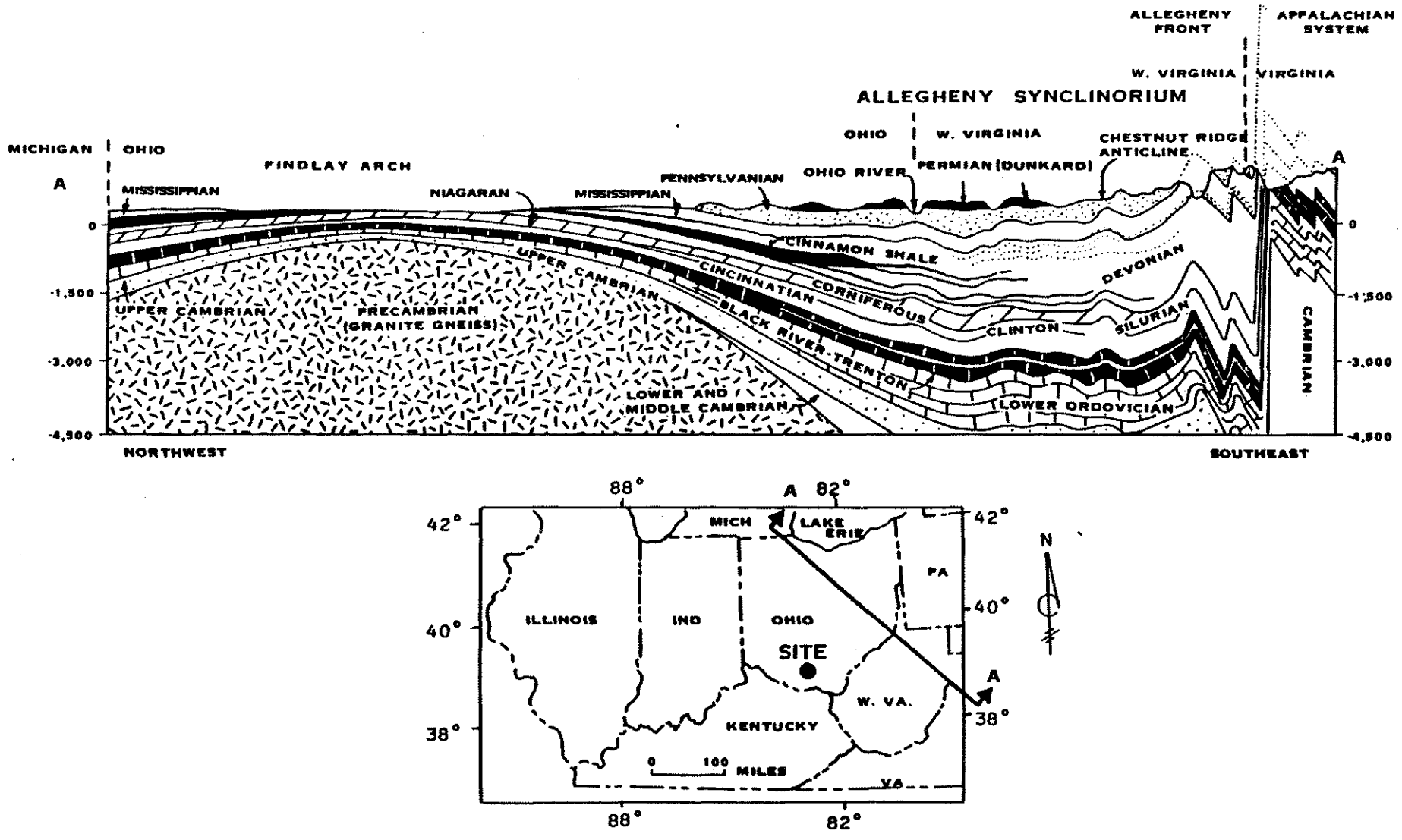


Fig. 3.3-4. Regional geologic section. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978.

to an erosional environment. Thus, no Mesozoic age sedimentary rocks are found in this region. The extremely long erosional period (from the Permian, 230 million years ago, to the present) is represented only by (1) the alluvial and lacustrine accumulations of sand, silt, and clay deposited by the Teays River system and (2) unconsolidated glacial tills and alluvial silts, sands, and gravels deposited during the Quaternary Period (within the last one million years).

Figure 3.3-5 shows the generalized stratigraphic section for the Ohio region with typical unit thicknesses, following the nomenclature used by Channas (1971). The following description of the regional stratigraphy is taken primarily from ERDA (1977, pp. 2-144 to 2-152) and LETC (1978, pp. 5-3 to 5-13, 7-1 to 7-10; 1982, pp. 3-6 to 3-10).

3.3.2.1 Paleozoic Era

In southern Ohio, few wells have penetrated the entire stratigraphic section to the Precambrian basement. However, a chemical disposal well (Ohio Permit No. 212) in Green Township, Scioto County, ~48 km (~30 miles) southeast of the site, was drilled through ~1701 m (~5580 ft) of Paleozoic sediments into the Precambrian basement rock. Stratigraphic thicknesses of the sedimentary strata penetrated by this well were as follows:

Depositional period	Thickness (m)	Thickness (ft)
Mississippian	235	770
Devonian	223	730
Silurian	224	733
Ordovician	607	1992
Cambrian	413	1355

Cambrian

Lower and Middle Cambrian sediments are not present throughout most of the region, although a thick Lower Cambrian clastic sequence was deposited in the Appalachian Basin in the Valley and Ridge province southeast of the PORTS site. In addition, a gravel deposit or "granite wash" of probable Cambrian age with a maximum thickness of 152 m (500 ft) has been identified throughout most of Ohio and Indiana and parts of Kentucky. Upper Cambrian sandstones, shales, and dolostones are present throughout the area. Overlying these units is the Late Cambrian to Early Ordovician Beekmantown Group. This group is essentially an equivalent of the Knox Group exposed in the southeastern United States.

Ordovician

The Lower Ordovician in the area of southern Ohio area is represented by the Beekmantown Group. Unconformably overlying the Beekmantown is the Middle Ordovician Chazy Group, primarily a series of limestones with a basal sandstone unit. Overlying the Chazy Group is the Middle Ordovician Black River Group, a series of interbedded dolomites, limestones, and thin shales. The Upper Ordovician in Ohio is represented primarily by shales with minor argillaceous limestones.

ERA	SYSTEM	GROUP	FORMATION	ROCK TYPE	APPROXIMATE THICKNESS IN OHIO (FT.)
PALEOZOIC	PERMIAN	DUNKARD	GREENE	INTERBEDDED SANDSTONES AND SHALES · COAL LOCALLY	405
			WASHINGTON	INTERBEDDED SANDSTONES SHALES, LIMESTONE AND COAL	221
	PENNSYLVANIAN		MONONGAHELA	INTERBEDDED SANDSTONES, SHALES, LIMESTONES AND COAL	247
			CONEMAUGH	INTERBEDDED SANDSTONES, SHALES, LIMESTONES AND COAL	400
			ALLEGHENY	INTERBEDDED SANDSTONES, SHALES, LIMESTONES AND COAL	212
			POTTSVILLE	INTERBEDDED SANDSTONES, SHALES, LIMESTONES AND COAL	256
	MISSISSIPPIAN		MAXVILLE LIMESTONE	LIMESTONE	
		WAVERLY	LOGAN	SANDSTONE, CONGLOMERATE & SHALE	166
			CUYAHOGA	CONGLOMERATE, SHALE & SANDSTONE	339
			SUNBURY SHALE	SHALE	20
			BEREA SANDSTONE	SANDSTONE	35
			BEDFORD SHALE	INTERBEDDED SHALES & SANDSTONES	85
	DEVONIAN		OHIO SHALE	SHALE	600
			OLENTANGY SHALE	SHALE WITH LIMESTONE INTERBEDS	20
		ONONDAGA	DELAWARE LIMESTONE COLUMBUS LIMESTONE	LIMESTONE	150
			ORISKANY	SANDSTONE	
		MONROE	DETROIT RIVER DOLOMITE	DOLOMITE	
			HELDERBERG LIMESTONE	LIMESTONE & DOLOMITE	
			SYLVANIA SANDSTONE	SANDSTONE	
	SILURIAN		BASS ISLANDS DOLOMITE TYMOCHTEE DOLOMITE GREENFIELD DOLOMITE	DOLOMITE	570
		ALBION MAGARA	LOCKPORT DOLOMITE	DOLOMITE	230
			CLINTON	LIMESTONE & DOLOMITE WITH SHALES & SILTSTONES	
			BRASSFIELD LIMESTONE	LIMESTONE	67
			CATARACT	SANDSTONE & SHALE	83
	ORDOVICIAN		QUEENSTON SHALE	SHALE & ARGILLACEOUS LIMESTONE	
			REEDSVILLE SHALE	SHALE	
			TRENTON LIMESTONE, DOLOMITE	LIMESTONE OR DOLOMITE	185
		BLACK RIVER	EGGLESTON LIMESTONE	LIMESTONE OR DOLOMITE	425
			MOCCASIN LIMESTONE LOWVILLE LIMESTONE — PLATTEVILLE		
		CHAZY	UPPER CHAZY LIMESTONE	LIMESTONE	FORMATIONAL NOMENCLATURE VARIES GEOGRAPHICALLY AND THICKNESSES ARE NOT WELL KNOWN
			MIDDLE CHAZY LIMESTONE	LIMESTONE	
			LOWER CHAZY DOLOMITE	DOLOMITE	
	CAMBRIAN	BEEKMANTOWN	LAMBS CHAPEL DOLOMITE CHEPULTEPEC DOLOMITE	DOLOMITE	
		LEE VALLEY	COPPER RIDGE DOLOMITE	DOLOMITE	
			MAYNARDVILLE DOLOMITE	DOLOMITE	
		CONASAUGA	CONASAUGA SHALE	SHALE	
			ROME	INTERBEDDED SILTSTONE, SANDSTONE SHALE & QUARTZITE	
			SHADY DOLOMITE MT. SIMON SANDSTONE	DOLOMITE & SANDSTONE	
	PRE-CAMBRIAN		BASEMENT COMPLEX		

Fig. 3.3-5. Regional stratigraphic column. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978. *Note:* to convert feet (ft) to meters, multiply the given value by 0.3048.

Silurian

In eastern Ohio, the Lower Silurian is represented predominantly by a series of sandstones and shales with some limestones and dolostones of the Albion Group that unconformably overlie Ordovician strata. Alternating shales and limestones of the Niagara Group were deposited during the Middle Silurian. The Upper Silurian and Lower Devonian are represented by the Monroe Group, with the dolomite of Silurian age unconformably overlain by sandstone, limestone, and dolostones of Devonian age that are themselves separated by many intragroup unconformities. The upper portion of the Silurian Greenfield Limestone is exposed in the western part of Pike County in the deeper tributaries of the Sunfish Creek system. In exposed sections this unit never exceeds 7.6 m (25 ft) in thickness. The unit is a dolomitic limestone, distinguished by its light brown color and thin, even bedding.

Devonian

In the Ohio region, the Middle Devonian limestones of the Onondaga Group are unconformably overlain by the Middle Devonian (?) Olentangy and the Upper Devonian Ohio Shales. In Pike County, the Olentangy and Ohio Shales are collectively 91–122 m (300–400 ft) thick (Smith and Schmidt 1953). The units are shown collectively in Fig. 3.3-6 as the Ohio Shale. The contact between the two shale sequences cannot be readily distinguished, but Hoover (1967) believed the contact to be "the uppermost gray shale bed in contact with a black shale layer" (ERDA 1977, p. 2-147).

According to Hoover (1967), the Olentangy Shales are bluish gray to greenish in color and may be up to 18 m (58 ft) thick. Black fissile shale beds are present in the upper parts of the formation. The unit is typically non-laminated and locally may contain calcareous concretions (ERDA 1977, p. 2-147).

The Ohio Shale is stratigraphically equivalent to the Antrim Formation of Michigan, the New Albany Formation of Indiana, and the Chattanooga Shale of Tennessee (Beavers 1975). In Pike County, the Ohio Shale is usually exposed only in the Scioto River Valley, where it is found in the beds of streams that empty into the valley. This shale unit is black, containing up to 10% organic material, thinly bedded, fissile, and weather resistant. The Ohio shales are also recognized for their oil-bearing properties and for their uranium content of 0.003% (ERDA 1977, p. 2-147).

Mississippian

Mississippian age strata in Ohio consist of the clastics of the Waverly Group and the Maxville Limestone. The Maxville Limestone was mostly removed by erosion in the Pike County region and is marked by only localized fragments of cherty material along the unconformable contact between the Mississippian and Pennsylvanian systems (Stout 1916). However, the Waverly Group, which consists of the Bedford Shale, the Berea Sandstone, the Sunbury Shale, the Cuyahoga Formation, and the Logan Formation, is the uppermost rock unit that is encountered during subsurface drilling at the PORTS site; thus, this group will be discussed in greater detail in this section. Detailed rock descriptions are available from subsurface drilling in the areas of the GCEP/AVLIS facilities (LETC 1978), the PORTS add-on site (COE 1977), and the area investigated for the GCEP landfills (LETC 1982).

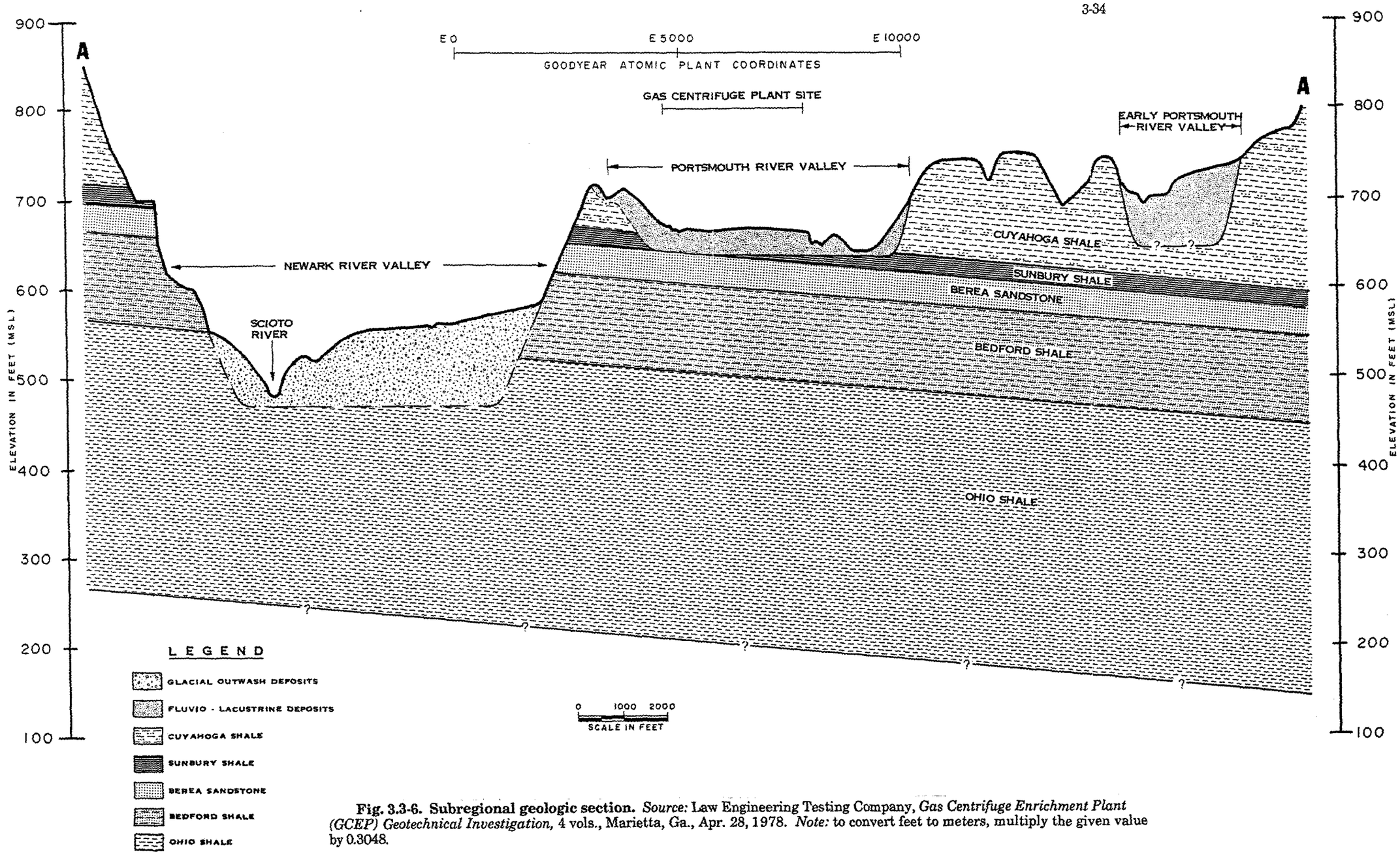


Fig. 3.3-6. Subregional geologic section. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978. *Note:* to convert feet to meters, multiply the given value by 0.3048.

Bedford Shale. The Bedford Shale in eastern Pike County is exposed along the Scioto River Valley from the southern boundary of the county to the northern part of Seal Township (Stout 1916). The formation is primarily reddish, chocolate, or gray shale with interbedded thin sandstone beds. Overall, the formation is 26 m (~ 85 ft) thick. The sandstone interbeds are most commonly found in the middle part of the formation. The bedding surfaces of these sandstone beds exhibit oscillation ripple marks, and some contorted sandstone beds are present in the upper part of the formation.

During the geotechnical investigation at the site of the GCEP/AVLIS facilities, the Bedford Shale was encountered in 21 coreholes. Each of these borings terminated in the Bedford and thus did not reach the underlying Ohio Shale. The greatest depth of penetration into the Bedford near the GCEP/AVLIS site was reached by the Corps of Engineers (COE 1977), ~1370 m (~4500 ft) east of the GCEP area (LETC 1978, p. 7-9). At that location, the Bedford Shale is ~30 m (98 ft) thick. The Bedford Shale underlies the entire GCEP/AVLIS site. It is a moderately hard to soft, thinly bedded to laminated gray shale with interbeds and laminations of hard, fine-grained gray sandstone and some hard siltstone that is often ripple marked. Sandstone is evenly distributed throughout the shale and makes up one-third to one-half of the formation. Locally the sandstone may be calcareous. Permeability data for the formation are presented in Table 3.3-1.

Berea Sandstone. There is no distinct change in lithology from the Bedford Shale to the overlying Berea Sandstone. Upward in the section, there is a gradual decrease in shale content and a gradual increase in the number and thickness of the fine-grained sandstone layers. At a point where sandstone predominates, the Berea Formation begins. In Pike County, the Berea Sandstone consists almost entirely of bedded sandstones, although some thin shale interbeds or laminae are common. The sandstones are characteristically ripple marked, jointed at right angles to bedding, bluish gray in color, contorted near the base, and are ~6–11 m (20–35 ft) thick. The upper ~2–3 m (6–10 ft) of Berea is massive with few bedding planes or shale laminae. Regional stratigraphic descriptions of this cap rock lithology usually state that this unit is brown, in contrast to the underlying units, possibly as a result of leaching from the overlying highly carbonaceous and pyritic Sunbury Shale. However, the Berea penetrated during drilling as part of the site characterization for the GCEP landfill was gray rather than brown (LETC 1982, p. 3-7). The Berea Sandstone is composed almost entirely of quartz sand, but it also contains small amounts of argillaceous material and iron compounds. Contortions of some of the sandstone beds previously have been interpreted as resulting from soft sediment deformation, which occurred after deposition and prior to lithification (LETC 1982, p. 3-7 to 3-8).

The Berea Sandstone was cored at 68 locations and completely penetrated at 17 locations during the geotechnical investigation at the GCEP/AVLIS site. The average thickness of the Berea at the GCEP site is ~9 m (~30 ft). There is no distinct change between the Berea and the underlying Bedford Shale at the site. The Berea is largely unweathered; however, at the GCEP site, a few feet may have been eroded by the Portsmouth River. The sandstone is generally gray except for the top few feet, which have generally been stained yellow brown. The unit is hard to very hard, thick-bedded and fine-grained with occasional shale laminations, swirls, or blebs in the top ~6 m (20 ft) and many shale laminations and interbeds in the lower ~3 m (10 ft). The permeability of the Berea from one borehole is shown in Table 3.3-1.

Table 3.3-1. Summary of packer-type permeability tests

Boring #	Interval Tested (Depth in ft from ground surface)	Geologic Formation	Total Head Applied (in ft of water)	Permeability, K In ft/minute
PB-1	85 - 95	Bedford Shale	62.2	2.2×10^{-5}
PB-8	95 - 125	Bedford Shale	52.5/70.9	No Flow
PB-8	125 - 155	Bedford Shale	86.3	Technical Problems with seal
PB-75	60 - 98	Bedford Shale	49.7	No Flow
PB-83	90 - 114	Bedford Shale	50.2	3.4×10^{-5}
PB-179	48 - 64	Berea Sandstone	66.5	1.36×10^{-5}
P-653	4 - 43	Bedford Shale	28.6	4.83×10^{-5}
P-653	4 - 43	Bedford Shale	51.7	6.98×10^{-5}
P-653	13 - 43	Bedford Shale	28.6	4.09×10^{-5}
P-653	13 - 43	Bedford Shale	51.7	6.18×10^{-5}
P-653	23 - 43	Bedford Shale	28.6	2.62×10^{-5}
P-653	23 - 43	Bedford Shale	51.7	1.21×10^{-4}
P-653	33 - 43	Bedford Shale	28.6	3.64×10^{-5}
P-653	33 - 43	Bedford Shale	51.7	3.98×10^{-5}
P-653	33 - 43	Bedford Shale	74.8	3.12×10^{-5}
P-654	4 - 27	Bedford Shale	30.1	No Flow
P-654	4 - 27	Bedford Shale	53.2	1.64×10^{-5}
P-654	7 - 27	Bedford Shale	30.1	No Flow
P-654	7 - 27	Bedford Shale	53.2	No Flow

Table 3.3-1 (continued)

Boring #	Interval Tested (Depth in ft from ground surface)	Geologic Formation	Total Head Applied (in ft of water)	Permeability, K In ft/minute
P-654	17 - 27	Bedford Shale	30.1	No Flow
P-654	17 - 27	Bedford Shale	53.2	No Flow
P-654	17 - 27	Bedford Shale	76.3	No Flow
P-655	22 - 42	Bedford Shale	32.1	1.58×10^{-3}*
P-655	32 - 42	Bedford Shale	43.6	6.43×10^{-5}*
P-655	32 - 42	Bedford Shale	66.7	7.85×10^{-5}*
P-655	32 - 42	Bedford Shale	89.8	1.04×10^{-4}*

*Experienced loss of drilling water while coring rock.

Note: to convert feet (ft) to meters, multiply the given value by 0.3048.

Source: Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., Apr. 28, 1978.

Sunbury Shale. The Sunbury Shale crops out at a few small localities in eastern Pike County. This formation is a black, fissile, highly carbonaceous shale that is generally ~6 m (~20 ft) thick, although the thickness is variable. The Sunbury locally may contain pyrite nodules. The Sunbury Shales are highly weather resistant, but upon weathering the shales form thin plates as opposed to the powders formed by the weathering of the Bedford Shales (Stout 1916, pp. 425–598).

The Sunbury was completely penetrated in 32 locations during the geotechnical investigation at the GCEP/AVLIS site. The average thickness of the Sunbury at the site is ~3 m (~10 ft), with a maximum of ~6 m (~20 ft). The Sunbury was eroded by the Portsmouth River over portions of the site where this unit is absent and is thin in areas where it underlies older lake and river deposits. At the site, the Sunbury is moderately hard, carbonaceous, and fissile and commonly contains pyrite and marcasite nodules (LETC 1978, p. 7-8).

Cuyahoga Formation. The Cuyahoga Formation is predominantly composed of gray shale, but also contains some sandstones and conglomerates (LETC 1982, p. 3-8). In eastern Pike County, this formation averages ~91 m (~ 300 ft) thick, where it is not affected by erosion. The shales in the Cuyahoga, which are generally confined to the upper part of the formation, vary in color from red to gray. The sandstones are thinly bedded to massive, gray to brown, fine-grained, and ferruginous (ERDA 1977, p. 2-150).

The Cuyahoga was the uppermost formation encountered during the geotechnical investigation at the GCEP/AVLIS site (LETC 1978, p. 7-8). Within the area of the GCEP geotechnical investigation, the Cuyahoga is present only on the ridge to the west of the site. Its lower contact is near elevation 665; consequently, it was removed over most of the site by the old Portsmouth River. At the GCEP/AVLIS site, unweathered rock is moderately hard, gray to gray-green, thinly laminated shale with laminae or very thin lenses of sandstone. Limonite is often associated with the sandstone lenses. The unit is identifiable in its decomposed state by its gray-green color, clayey texture, thin bedding, and the presence of small flat remnant sandstone pieces.

Logan Formation. The Logan Formation crops out locally in eastern Pike County and is characterized predominantly as a buff, gray, and blue-gray sandstone with conglomerates and local shaley units. This formation averages from ~30 to 46 m (100 to 150 ft) in thickness; however, the thickness is highly variable because of both the variation in depositional thickness of the unit and the presence of an erosional unconformity that formed after Mississippian time (LETC 1978, p. 5-8). The Byer Sandstone Member of this formation contains some thick-bedded to massive, fine-grained sandstone, usually yellow in color. Although not exposed in Pike County, the Allensville and Vinton Members of the formation are also composed of yellow sandstone and sandy shales. The Logan Formation was not encountered during the geotechincal investigation at the GCEP/AVLIS site.

Pennsylvanian

The Pennsylvanian System is represented in Pike County by the Pottsville Formation. This formation averages ~91 m (~300 ft) in thickness throughout the county. The Sharon Conglomerate Member comprises the lower half of the formation; the Sharon Coal, Sharon Iron Ore, Sciotoville Clay, and the Anthony Coal Members make up the upper half of the formation. This Sharon Conglomerate Member consists of massive, coarse-grained, cross-bedded conglomerate with large quartz pebbles, but it may locally grade into a coarse-grained sandstone. About 90% of the conglomerate is composed of well-rounded, polished

grains and pebbles (ERDA 1977, p. 2-151). The Sharon Coal lies directly above the conglomerate. The coal is variable in composition from bone coal to a carbonaceous shale (Stout 1916, pp. 425–598). The Sharon Iron Ore may be found in small scattered deposits above the Sharon Conglomerate Member. These deposits range from ~10 to 46 cm (4 to 18 in.) thick and have locally been mined as ore. The Sciotoville Clay Member and the Anthony Coal are poorly developed and thus are rarely present in Pike County (ERDA 1977, p. 2-151).

3.3.2.2 Cenozoic Era

Cenozoic deposits in Ohio are restricted to glacial tills; fluvial deposits of clay, silt, sand, and gravel; and lacustrine sediments of clay, silt, and fine sand. These deposits are mostly Quaternary in age. Only the extreme northwest corner of Pike County was covered by continental glaciation. However, drainage in Pike County was significantly modified as a result of continental glaciers. The Quaternary deposits, usually ~9–18 m (30–60 ft) thick, are found in the bottoms of valleys formerly occupied by the old Teays River or its tributaries, or currently occupied by the Scioto River and its tributaries.

The PORTS site is located in the Portsmouth River valley, a major tributary valley of the old Teays River, which was the master stream in the region prior to glaciation during the Pleistocene Epoch. During an early glacial advance (~1.5 million years ago), a glacier dammed the lower reaches of the Teays River and formed a series of finger lakes in the Teays River valley in tributary stream valleys. Sediments derived from both the inflowing river and its tributaries and melting along the glacial front (fluvial-lacustrine deposits) filled the stream valleys to an elevation at least 262 m (860 ft) above sea level. As shown in Table 3.3-2, these deposits have been studied by several researchers, and the nomenclature applied to these deposits has varied. Hoyer (1976) has studied the age and lithology of these deposits along the principal Teays valley in Pike, Jackson, Scioto, and Gallia counties. The nomenclature of Hoyer (1976) has gained wide acceptance and is followed here. The following discussion is a summary of the work of Hoyer (1976) as described in LETC (1978, pp. 5-11 to 5-13).

Teays Formation. The Teays Formation is made up of the Gallia Sand Member and the Minford Clay Member. Hoyer (1976) includes the basal sand and the predominant clay in one formation because (1) there was no compelling evidence to suggest an unconformable contact between them, (2) the sand and clay interfinger in some areas, and (3) the consistency between areas studied indicated a transitional environment from fluvial to lacustrine. The sediments of the Teays Formation were of fluvial origin, deposited by the preglacial Teays drainage system, and fluvial-lacustrine deposits formed following the blocking of the Teays drainage. Sedimentation continued until the lake waters developed a new outlet.

The Gallia Sand Member is the basal unit and is found below the 200-m (656-ft) elevation. It is not found in some areas near the edge of the main Teays valley or on bedrock highs. The coarse- to fine-grained sand is subangular to subrounded quartz with accessory minerals of muscovite and feldspar. The coarser sands occur near the base of the unit, and in some areas a pebbly gravel containing large clasts of local bedrock is present. These indicate that the Teays River was actively downcutting at the time the Gallia Sand was deposited. Some interbedded silt and clay layers in the Gallia Sand Member may represent slackwater deposits of normal fluvial origin. The basal contact of the Gallia Sand

Table 3.3-2. Comparative stratigraphic nomenclature for Teays System sediments

West Virginia			Ohio			
Campbell 1900	Rhodehamel and Carlston 1963	Neff and others 1970	Stout and Schaaf 1931	Lockwood 1954	Hoyer 1976	
	Colluvium and later silts	Sandy silt Silt		Soil	Loess, alluvium and colluvium	
Teay	Minford	Light gray rhythmite	Minford	Minford	Teays	Minford Clay member
	Silt	Ferruginous rhythmite	Silt	Clay		
Formation	Sand and gravel	Sand, gravel and clay	(sands)	Teays River sediments	Formation	Gallia Sand member

Source: Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation*, 4 vols., Marietta, Ga., Apr. 28, 1978.

with bedrock is sharp. The upper contact with the Minford Clay may be sharp or transitional. The sharp upper contact is marked by an ironstone concretionary layer up to 1.9 m (0.75 in.) thick or by clay interbedded with sand. The upper contact is reddish brown in color, whether sharp or interbedded (LETC 1978, pp. 5-11 to 5-12).

At the AVLIS/GCEP site, although the Gallia is described as sands and gravels, the materials also consist of appreciable proportions of silt and clay, generally exceeding 30% by weight. Essentially, the Gallia sands and gravels were deposited within a matrix of fines. The hydraulic conductivity of the Gallia at the GCEP/AVLIS site averages $\sim 2 \times 10^{-4}$ cm/s, whereas to the north on the PORTS Reservation, the hydraulic conductivity averages $\sim 10^{-3}$ cm/s (LETC 1978, Table 7-1; LETC 1982, p. 3-21).

The Minford Clay Member is a laminated clay commonly called the Minford silt, although it contains 85% clay-sized material (Hoyer 1976). Although portions of the ~0- to 24-m- (0- to 80-ft-) thick clay layer appear massive, Hoyer (1976) has noted that fine laminae are present. If the fine laminae are varves (a series of depositional laminae, each representing a single year), between 11,000 and 25,000 years were required for deposition of this clay unit. In order of abundance, the clay minerals present in the Minford are primarily illite, chlorite, vermiculite, a mixed-layered clay, and an expandable clay of the Montmorillonite Group. Quartz and potassium feldspar make up the majority of the silt-sized fraction. Some carbonate (~6%) has been reported in the gray clay; and nodular, tubular, or platy iron concretions are present. In one tributary valley, Hoyer (1976) noted that the Minford Clay rests on a sandy alluvial and colluvial unit, suggesting that the deposition of sediment in the tributary valleys was not as uniform as in the main Teays Valley. The Minford Clay was not observed by Hoyer at elevations >262 m (>860 ft) or <195 m (<640 ft) (LETC 1978, p. 5-12).

At the GCEP/AVLIS site, the lacustrine deposits of the Minford Clay Member represent the surficial soils over much of the area. These deposits were encountered in 385 of 416 boreholes during the site geotechnical investigation. At the site, these deposits consist primarily of overconsolidated lean clays (~59%) and silts (~33%) but also relatively small amounts of highly plastic or fat clay (~8%) that is limited primarily to the upper part of this unit. These material percentages contrast with percentages given in a similar investigation of the Minford at the site proposed for the GCEP low-level waste landfill where the Minford consisted primarily of clayey silt with discontinuous lenses of gravel and clay (Lee et al., 1984, p. 367). Silt content at that site ranges from 34 to 90% (average 63%), and clay content ranges from 7 to 65% (average 29%) (Lee et al. 1984, p. 367). Atterberg limit tests were performed on these materials at both the GCEP/AVLIS site and at the GCEP landfill site, and samples of the Minford from the GCEP/AVLIS site were analyzed using X-ray diffraction. Detailed results of these tests are provided in LETC (1978, 1982), Blumberg et al. (1983), and Lee et al. (1984). Laboratory permeabilities for Minford clays average $\sim 2 \times 10^{-7}$ cm/s, whereas Minford silts and clayey silts average $\sim 4 \times 10^{-6}$ cm/s (LETC 1978, Table 7-1; LETC 1982, p. 3-21).

In some areas surface soils are developed within the Teays Formation. In other areas, a mixture of colluvium, alluvium, and loess overlies bedrock of the Teays Formation. This material averages ~2.4 m (8 ft) in thickness and is a sandy loam to silty clay with some sand and gravel. The basal contact is sharp and sometimes marked by a concentration of gravel, indicating an episode of erosion following deposition of the Minford Clay (LETC 1978, p. 5-13). In addition to Recent alluvium and colluvium, man-made fill, which was placed during the construction of the PORTS facilities, was identified over much of the GCEP/AVLIS site prior to construction of the GCEP facilities. The majority of the area

was covered with <0.3 m (<1 ft) of the fill; however, in some locations, LETC (1978, p. 4-3) estimated the maximum depth of man-made fill to be 4.6–6.1 m (15–20 ft). With the exception of variable penetration resistances and the occasional presence of organic material, man-made fill generally is indistinguishable from the surficial Pleistocene deposits (LETC 1982, p. 3-9).

3.3.3 Soils

A detailed description of soils in the vicinity of PORTS was given in Powell and McLoda (1971). This original work was used as the source for the detailed soil associations description for PORTS, given in ERDA (1977). Additional detailed information on soil associations and soil properties in the vicinity of PORTS may be found in ODNR (1985).

3.4 REFERENCES

3.4.1 Oak Ridge

Beavers, J. E., Manrod, W. E., and Stoddart, W. C. 1982. *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio Department of Energy Reservations*, K/BD-1025/R1, December.

Bridge, J. 1956. *Stratigraphy of the Mascot-Jefferson City Zinc District, Tennessee*, U. S. Geological Survey Professional Paper 277, 76 pp.

Carroll, D. 1961. *Soils and Rocks of the Oak Ridge Area, Tennessee*, Trace Elements Investigations Report 785, U.S. Geological Survey, June.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, DOE/EA-0106, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee, December.

Geraghty and Miller Environmental Services, Inc. 1989. *Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant*, draft, December 15.

Haase, C. S., Walls, E. C., and Farmer, C. D. 1985. *Stratigraphic and Structural Data for the Conasauga Group and the Rome Formation on the Copper Creek Fault Block near Oak Ridge, Tennessee: Preliminary Results from Test Borehole ORNL-JOY No. 2*, ORNL/TM-9159, Oak Ridge National Laboratory, Oak Ridge, Tenn., June.

Harris, L. D. 1965. *Geologic Map of the Tazewell Quadrangle, Claiborne County, Tennessee*, U.S. Geological Survey Geological Quadrangle Map GQ-465.

Harris, L. D., and Mixon, R. B. 1970. *Geologic Map of the Howard Quarter Quadrangle, Northeastern Tennessee*, U.S. Geological Survey Geological Quandrangle Map GQ-842.

Hatcher, R. D., Jr. 1965. *Structure of the Northern Portion of the Dumplin Valley Fault One in East Tennessee*, unpublished Ph.D. dissertation, The University of Tennessee, Knoxville, 168 pp.

Lee, R. R., and Ketelle, R. H. 1989. *Geology of the West Bear Creek Valley Site*, ORNL/TM-10887, Oak Ridge National Laboratory, Oak Ridge, Tenn., January.

Lee, R. R., and Ketelle, R. H. 1988. *Subsurface Geology of the Chickamauga Group at Oak Ridge National Laboratory*, ORNL/TM-10749, Oak Ridge National Laboratory, Oak Ridge, Tenn., May.

Lietzke, D. A., Lee, S. Y., and Lambert, R. E. 1988. *Soils, Surficial Geology, and Geomorphology of the Bear Creek Valley Low-Level Waste Disposal Development and*

Demonstration Site, ORNL/TM-10573, Oak Ridge National Laboratory, Oak Ridge, Tenn.

MMES/UT (Martin Marietta Energy Systems, Inc., and The University of Tennessee, Knoxville) 1989. *Field Guide and Perspective on the Geology and Hydrology of the Oak Ridge Reservation*, October 6.

McMaster, W. M. 1962. *Geologic Map of the Oak Ridge Area, Tennessee*, U.S. Atomic Energy Commission and U.S. Geological Survey.

McMaster, W. M., and Waller, H. D. 1965. *Geology and Soils of Whiteoak Creek Basin, Tennessee*, ORNL/TM-1108, Oak Ridge National Laboratory, Oak Ridge, Tenn., May, pp. 16–21.

McReynolds, J. A. 1988. *Paleoenvironment and Facies Relations of the Lower Cambrian Rome Formation Along Haw Ridge on the U.S. Department of Energy Reservation, Oak Ridge Area in Roane and Anderson Counties, Tennessee*, unpublished Master's thesis, The University of Tennessee, Knoxville.

Rodgers, J., and Kent, D. F. 1948. *Stratigraphic Section at Lee Valley, Hawkins County, Tennessee*, Tennessee Division of Geology Bulletin 55.

Rothschild, E. R., et al. 1984. *Investigation of Sub-Surface Mercury at the Oak Ridge Y-12 Plant*, ORNL/TM-9092, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Ruppel, S. C., and Walker, K. R. 1984. "Petrology and Depositional History of a Middle Ordovician Carbonate Platform: Chickamauga Group, Northeastern Tennessee," *Geolo. Soc. Am. Bull.* 95, pp. 568–83.

Sledz, J. S., and Huff, D. D. 1981. *Computer MOdel for Determining Freacture Porosity and Permeability in the Conasauga Group*, ORNL/TM-7695, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Stockdale, P. B. 1951. *Geologic Conditions at the Oak Ridge National Laboratory (X-10) Area Relevant to the Disposal of Radioactive Waste*, ORO-58, Department of Energy, Oak Ridge, Tenn.

3.4.2 Paducah

D'Appolonia 1983. *Final Report, Ground Water Monitoring Program, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Project No. 82-1397, ESO 15603, prepared by D'Appolonia Waste Management Services, June.

Dames and Moore 1973. *Seismic Design Criteria, Gaseous Diffusion Plants, Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio*, prepared by Dames and Moore, San Francisco, April.

Davis, R. W., Lambert, T. W., and Hansen, A. J. 1973. *Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky*, Water Supply Paper 1987, U.S. Geological Survey, 66 pp.

EDGe (Engineering, Design, and Geosciences Group, Inc.) 1987a. *Ground Water Monitoring Plan for the Department of Energy Paducah Gaseous Diffusion Plant (DOE/PGDP) Reservation, Paducah, Ky.*, Nashville, Tenn., Mar. 26.

EDGe (Engineering, Design, and Geosciences Group, Inc.) 1987b. *Martin Marietta Energy Systems Paducah Gaseous Diffusion Plant, Paducah, Ky., C-404 Post-Closure Activities*, ESO 16749, Nashville, Tenn., December.

EDGe (Engineering, Design, and Geosciences Group, Inc.) 1988. *RCRA Facility Investigation, C-400 Trichloroethylene Spill Site, Paducah Gaseous Diffusion Plant*, Nashville, Tenn., March.

EDGe (Engineering, Design, and Geosciences Group, Inc.) 1989. *Ground Water Monitoring Phase 2*, ESO 16749, Nashville, Tenn., Mar. 23.

ERC/EDGe (Environmental and Energy Services Company (ERC)/Engineering, Design, and Geosciences Group, Inc.) 1989. *The Geologic Setting of the DOE Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, draft, Nashville, Tenn., Nov. 11.

Early, T. O., Sigmon, C. F., and Williams, R. T. 1989. *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant*, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3.

Finch, W. I. 1967. *Geologic Map of Part of the Joppa Quadrangle, McCracken County, Kentucky*, Map GQ-652, U.S. Geological Survey.

Geotek Engineering Company 1979. *Subsurface Investigation for Sanitary Landfill at Paducah Gaseous Diffusion Plant*, 86B-24700V-PO7, Nashville, Tenn., November.

Geotek Engineering Company 1980. *Subsurface Investigations for PGDP Hazardous Landfill UCC Release No. P-08*, UCC Order No. 86B-24700V, Nashville, Tenn., January.

MCI Consulting Engineers, Inc. 1986. *Martin Marietta Energy System Paducah Gaseous Diffusion Plant, Kentucky Groundwater Monitoring*, ESO 16380, MCI Project No. 2211710, Nashville, Tenn., Dec. 23.

Olive, W. W., 1966. *Geologic Map of the Heath Quadrangle, McCracken and Ballard Counties, Kentucky*, Map GQ-561, U.S. Geological Survey.

Potter, P. E. 1955a. "The Petrology and Origin of the Lafayette Gravel," Part I, Mineralogy and Petrology, *J. of Geol.* 63, 1–38.

Potter, P. E. 1955b. "The Petrology and Origin of the Lafayette Gravel," Part II, Geomorphic History, *J. of Geol.* 63, 115–32.

Soil Conservation Service 1976. *Soil Survey of Ballard and McCracken Counties, Kentucky*, U.S. Department of Agriculture, February.

Woods, K. B., ed. 1960. *Highway Engineering Handbook*, McGraw, New York, 1622 pp.

3.4.3 Portsmouth

Beavers, J. E. 1975. *Seismic Design Criteria for Shared Site New Uranium Enrichment Facilities, Part I*, Report K-D-3154, March.

Blumberg, R., et al. 1983. *GCEP Waste Pathways Analysis Study*, K/D-5375, Oak Ridge National Laboratory, Oak Ridge, Tenn., January, 84 pp.

Channas, J. 1971. *Future Petroleum Provinces of the United States*, American Association of Petroleum Geologists Memoir 15, 1971, pp. 1254–60.

COE (U.S. Army Corps of Engineers) 1977. *Title I Design Foundation Investigation for Static Loading, Gaseous Diffusion Add-On Plant, Portsmouth, Ohio*, Miscellaneous Paper S-77-20, U.S. Army Engineer Waterways Experiment Station, Soils and Pavements Laboratory, Vicksburg, Miss., November.

ERDA (U.S. Research and Development Administration) 1977. *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion, 1977*, ERDA-1549, 2 vols., September.

Hoover, K. V. 1967. *Devonian-Mississippian Shale Sequences in Ohio*, Information Circular No. 27, Ohio Department of Natural Resources, Division of Geological Survey.

Hoyer, M. C. 1976. *Quaternary Valley Fill of the Abandoned Teays Drainage System in Southern Ohio*, unpublished Ph.D. dissertation, Ohio State University.

Kouchy, F. L., and Reidel, S. P. 1987. *The Serpent Mound Disturbance, South-Central Ohio*, Geological Society of America Centennial Field Guide—North Central Section, pp. 431–6.

Lee, D. W., et al. 1984. *Environmental Pathways Analysis for Evaluation of a Low-Level Waste Disposal Site*, IAEA-CN-43/282, International Atomic Energy Agency, Vienna, pp. 363–79.

LETC (Law Engineering Testing Company) 1982. *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report*, Denver, May 13.

LETC (Law Engineering Testing Company) 1978. *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation*, Marietta, Ga., 4 vols., April 28.

ODNR (Ohio Department of Natural Resources) 1985. *An Inventory of Ohio Soils Pike County*, Progress Report No. 76.

Powell, K. L., and McLoda, N. A. 1971. *Soil Associations of Pike County*, Ohio Department of Natural Resources, Division of Lands and Soil.

Rogers, J. G., et al. 1988. *Environmental Surveillance of the U. S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., April.

Smith, R. C., and Schmidt, J. J. 1953. *The Water Resources of Pike County, Ohio*, Information Circular No. 1, Ohio Department of Natural Resources, Division of Water, pp. 1–12.

Stout, W. 1916. *Geology of Southern Ohio*, Bulletin 20, Ohio Department of Natural Resources, Division of Geological Survey, pp. 425–58.

Stout, W., and Lamb, G. F. 1938. "Physiographic Features of Southeastern Ohio," Ohio *J. of Sci.* 38(2), p. 1-34. [Reprinted by Ohio Department of Natural Resources, Division of Geological Survey.]

4. SEISMICITY

4.1 FAULTS AND SEISMICITY

4.1.1 Regional Faults and Seismicity

Figure C-3 of Appendix C (modified after Hadley and Devine 1974, Map MF-620, sheets 1 and 2 combined) shows the locations of major fault and seismic source zones of the midwestern and southeastern United States. DOE's ORGDP is located adjacent to the Cumberland Escarpment within the Valley and Ridge portion of the Appalachian Highlands approximately 80 km (50 miles) northwest of the Great Smoky Fault. The Valley and Ridge province is characterized by a series of northeast- to southwest-trending folds and thrust faults. The faults override one another to form a series of parallel ridges and valleys. Although these faults have not been examined in detail for evidence of Holocene or Pleistocene rupture, no spacial correlation between them and historical seismicity has been observed. Historical earthquakes in the region are deep focus events, whereas the series of thrust faults in the Valley and Ridge province are shallow, surficial features (Bollinger and Wheeler 1988, p. 1). The Nuclear Regulatory Commission (NRC) has conducted safety evaluation reports for nuclear power reactors in the Appalachian Highlands, and the evidence suggests that these faults are inactive (NRC 1983 p. 2-18).

The ORGDP facility lies within the Southern Appalachian seismic zone (Bollinger 1973, p. 1786). The Southern Appalachian seismic source zone extends from western Virginia to central Alabama sub-parallel to the Valley and Ridge and Blue Ridge physiographic provinces (bounded by the Cumberland escarpment and Brevard Fault Zone and separated by the Great Smoky Fault) and sub-parallel to the regional geologic structure. The largest recorded earthquakes in the Southern Appalachian seismic zone were those occurring near Gadsden, Alabama, on January 27-28, 1905 [modified Mercalli intensity (I_{mm}) = VIII], and in Giles County, Virginia, on May 31, 1897 [m_b = 5.8; (I_{mm}) = VIII (Bollinger and Wheeler 1988, p. 3; Dames and Moore 1973, p. 5)]. These earthquakes were located about 250 and 350 km (155 and 217 miles), respectively, from Oak Ridge, and the intensities at such a distance were far below the level at which damage would be expected to occur (Dames and Moore 1973, p. 5). The most severe earthquake local to Oak Ridge (I_{mm} = VII) occurred northeast of Knoxville, Tennessee, on March 28, 1913 (Dames and Moore 1973, p. 5).

4.1.2 Probabilistic Risk Assessment

According to the International Conference of Building Officials (ICBO) *Uniform Building Code* (ICBO 1988, p. 178) (see Appendix C, Fig. C-1), ORGDP is located in Seismic Zone 2A, where moderate earthquake damage would be expected. However, the plant lies near the boundary between Seismic Zone 2A and Seismic Zone 1, where only minor earthquake damage would be expected. The horizontal effective peak ground acceleration (EPGA) ranges from 0.10 to 0.20 g for ground motions having a nominal 500-year return period in Seismic Zone 2A. The Federal Emergency Management Agency (FEMA 1988) estimates that the EPGA for ORGDP would be 0.10 g, the lower end of the range in Seismic Zone 2A. The ground motions described here have a 10% probability of being exceeded at least once in 50 years at ORGDP and would be equivalent to

earthquakes with I_{mm} = VII (refer to Appendix C, Table C-2 for felt effects of earthquake ground motions for various modified Mercalli intensities).

Table 4.1-1 provides a number of independent estimates of peak ground accelerations (PGAs) at ORGDP for return periods ranging up to 1000 years. These PGA estimates are for buildings constructed on rock or firm ground. Independent investigators were Blume (1973), Dames and Moore (1973), the TERA Corp. (1981), Beavers (1974), Wiggins (1981), Hand and Hoskins (1981), FEMA (1988, pp. 15 and 23), and Beavers, Manrod, and Stoddart (1982, p. 29), who compiled most of the data and references appearing in Table 4.1-1 and summarized the findings of each investigation. Mean 1000-year PGAs range from 0.12 g (Dames and Moore 1973) to 0.19 g (the TERA Corp. 1981). Minimum and maximum 1000-year PGAs range from 0.09 to 0.31 g (Blume 1973). These widely varying estimates result from uncertainties in the boundaries of seismic source regions, earthquake recurrence relationships, the magnitude of the maximum earthquake in each seismic source region, and the attenuation of earthquake energy as a function of distance (Coats and Murray 1984, p. 14) as well as differing methodologies.

DOE (1989, p. 1-2) currently endorses the TERA Corp.'s seismic hazard analyses for the DOE seismic design guidelines. The TERA Corp.'s results for Portsmouth, Paducah, and ORGDP are presented in Appendix C, Table C-1. However, DOE acknowledges that seismic hazard estimates have been changing rapidly in the past 5 years.

4.1.3 Deterministic Risk Assessment

Figure 4.1-1 is a map of historically and instrumentally recorded strong-motion [body-wave magnitude (m_b) ≥ 5.5; I_{mm} ≥ VII] earthquakes within 640 km (400 miles) of ORGDP. This map was compiled from current (October 1989) computer-stored data provided the National Oceanic and Atmospheric Administration (NOAA) Geophysical Data Center in Boulder, Colorado. Although the locations of some of the earlier earthquakes (before 1900) are not well known, the map provides a fairly complete history of strong-motion earthquakes over the past 300 years.

As shown in Fig. 4.1-1, a center of major seismic activity is located far to the west of the ORGDP in northeastern Arkansas, southeastern Missouri, western Kentucky, western Tennessee, and southern Illinois (an area known as the New Madrid Seismic Source Zone or Reelfoot Rift Zone). Some seismologists believe that the moderately active Wabash valley seismic zone of southeastern Illinois and southwestern Indiana is a northeastern extension of this major center of seismic activity. These seismic source zones are described in greater detail in Sect. 4.2. Other moderately active seismic source zones are those of Anna, Ohio; the Southern Appalachian Seismic Zone (where ORGDP is located) that include eastern Tennessee and western and central Virginia; and the Georgia-South Carolina Seismic Zone. The region surrounding ORGDP is characterized as one of moderate seismicity, a characterization that is consistent with the ICBO (1988, p. 178) seismic zone map of the United States (Seismic Zone 2A in Fig. C-1 of Appendix C).

Figure 4.1-2 shows the locations of 11 strong-motion earthquakes with m_b ≥ 6.0 or I_{mm} ≥ VIII (NOAA 1989, computer data file). Table 4.1.2 lists provides information about these earthquakes. At least three (and perhaps four) great earthquakes occurred between December 16, 1811, and February 7, 1812. The earthquakes, ranging from m_b = 6.9 to 7.3 (I_{mm} = XI to XII), occurred between Marked Tree, Arkansas, and New Madrid, Missouri. Earthquakes 1a, 2a, and 3 in Fig. 4.1-2 and Table 4.1-2 are three co-located events

Table 4.1-1. Oak Ridge seismic hazard study results[a]

Return period (years)	Study results in terms of peak ground acceleration							
	Blume	Dames and Moore	The TERA Corp.	Beavers	Wiggins	Hand and Hoskins	ATC 3-06 (effective peak ground acceleration)	Beavers, Manrod, and Stoddart 1982
100	0.02 g[a,b] 0.08 g	0.060 g	0.08 g	0.06 g	0.08 g 0.10 g	NA[c]	0.05 g	0.06 g
500	0.04 g 0.14 g	0.010 g	0.15 g	0.15 g	0.19 g	0.08 g	0.10 g	0.12 g
1,000	0.09 g 0.31 g	0.12 g	0.19 g	NA	NA	NA	0.14 g	0.15 g

[a]g = acceleration due to gravity.
[b]Double values represent peak-ground-acceleration ranges recommended.
[c]Not available.
Source: Modified from J. E. Beavers, W. E. Manrod, and W. C. Stoddart, *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio Department of Energy Reservations,* K/BD-1025/R1, December 1982.

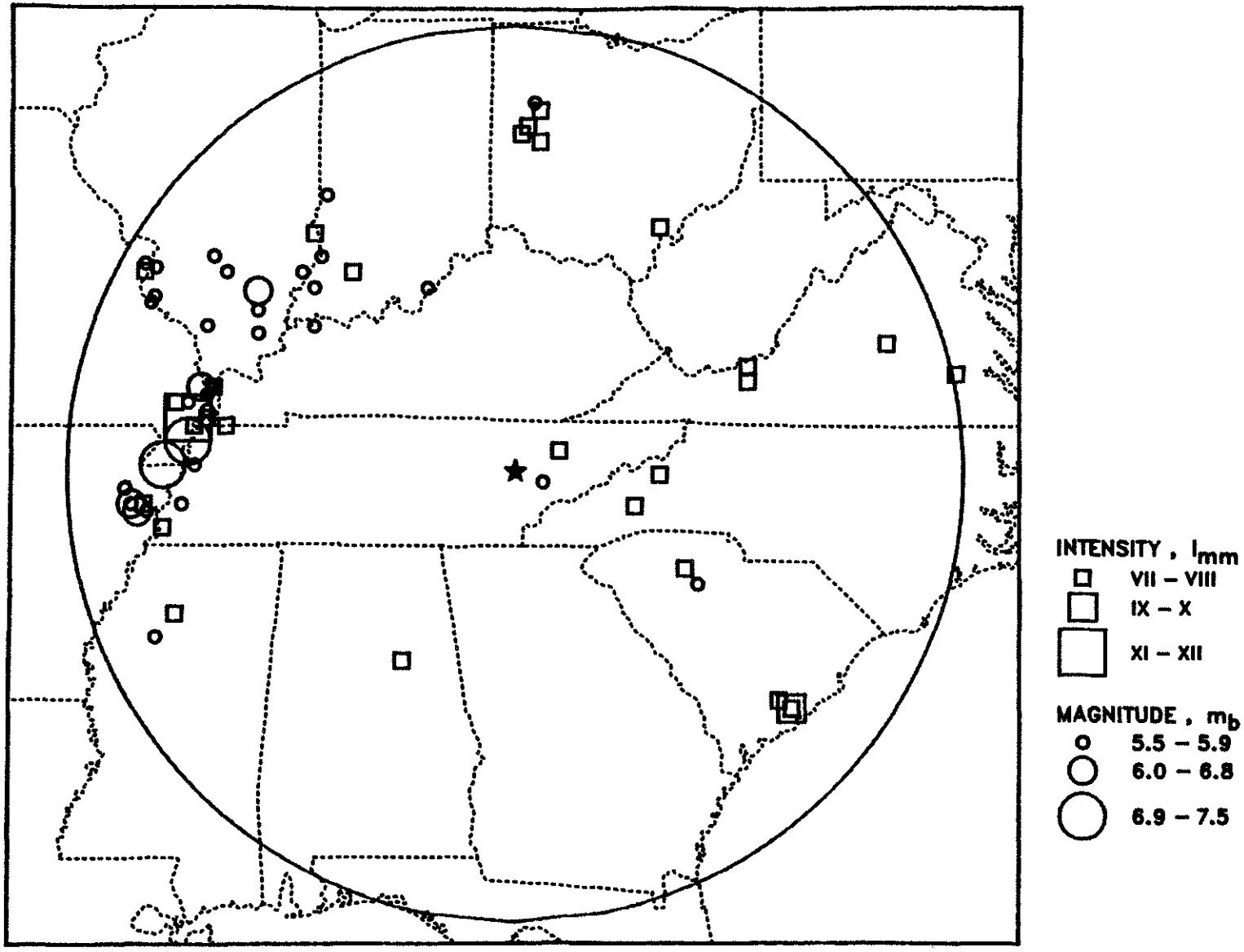
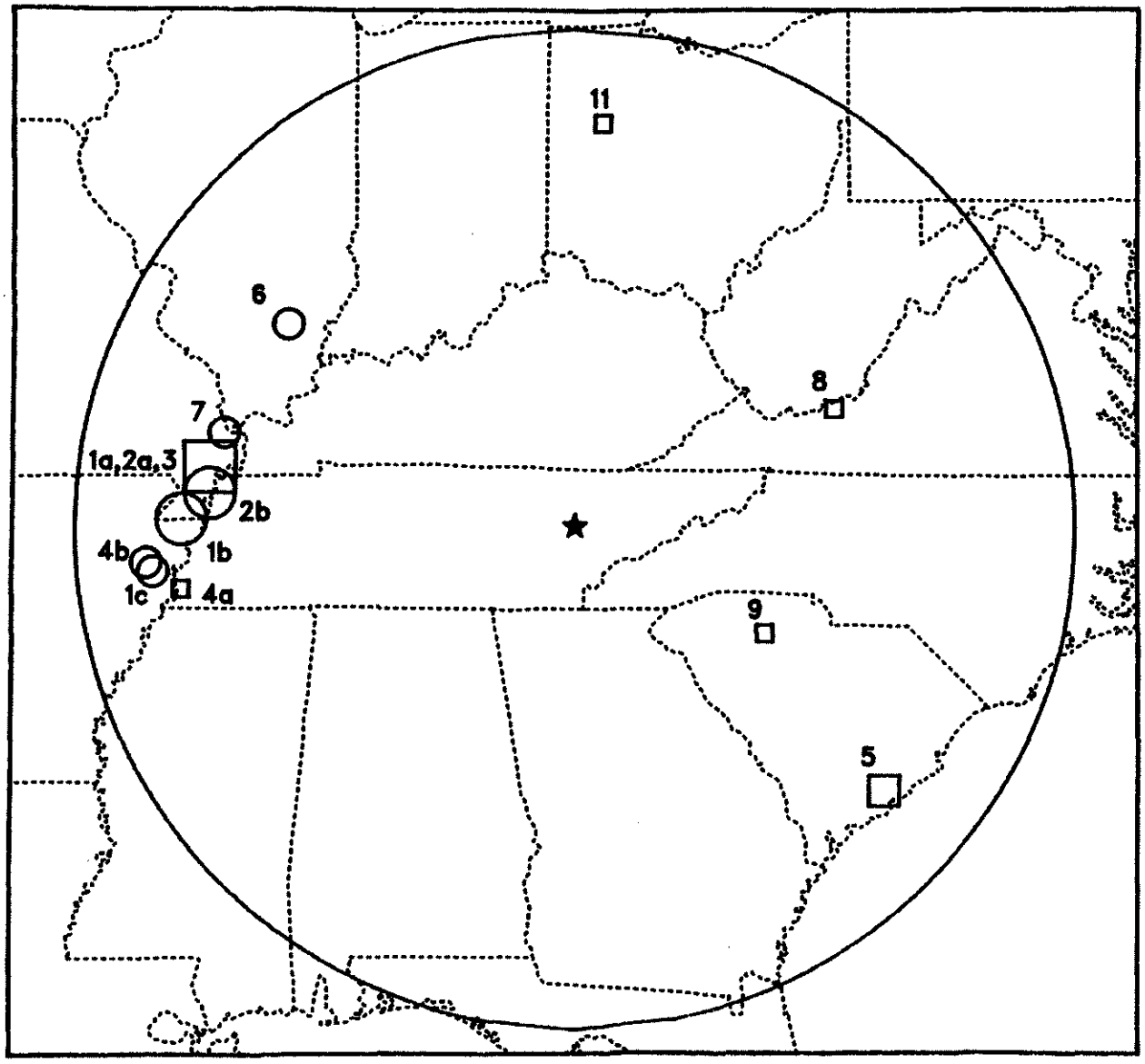


Fig. 4.1-1. Strong-motion earthquakes ($m_b \geq 5.5$, $I_{mm} \geq$ VII) within 640 km of the Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn. *Source:* based on National Oceanic and Atmospheric Administration, *Computer-stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.



Earth-quake	Nearby population center
1a	New Madrid, Mo.
1b	Blytheville, Ark.
1c	Marked Tree, Ark.
2a	New Madrid, Mo.
2b	Caruthersville, Mo.
	Ridgely, Tenn.
3	New Madrid, Mo.
4a	Memphis, Tenn.
4b	Marked Tree, Ark.
5	Charleston, S.C.
6	Fairfield, Ill.
7	Charleston, Mo.
8	Giles Co, Va.
9	Spartanburg, S.C.
11	Anna, Ohio

INTENSITY, I_{mm}

VIII

IX – X

XI – XII

MAGNITUDE, m_b

6.0 – 6.8

6.9 – 7.5

Fig. 4.1-2. Strong-motion earthquakes ($m_b \geq 6.0$, $I_{mm} \geq$ VIII) within 640 km of the Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn. *Source:* based on National Oceanic aππnd Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.

Table 4.1-2. Descriptions of ten strong-motion earthquakes ($m_b \geq 6$ or $I_{mm} \geq$ VIII) within 640 km of the Oak Ridge Gaseous Diffusion Plant[a]

Numerical identification from Fig. 4.1-2[b]	Nearby population center	Year	Month	Day	Longitude	Latitude	m_b	I_{mm}
1a	New Madrid, Mo.	1811	12	16	89.6	36.6	NA[c]	XII
1b	Blytheville, Ark.	1811	12	16	90.0	36.0	7.3	XI
1c	Marked Tree, Ark.	1811	12	16	90.4	35.4	6.9	XI
2a	New Madrid, Mo.	1812	1	23	89.6	36.6	NA	XII
2b	Caruthersville, Mo./ Ridgley, Tenn.	1812	1	23	89.6	36.3	7.2	XI
3	New Madrid, Mo.	1812	2	7	89.6	36.6	NA	XII
4a	Memphis, Tenn.	1843	1	5	90.0	35.2	NA	VIII
4b	Marked Tree, Ark.	1843	1	5	90.0	35.2	6.2	VIII
5	Charleston, S.C.	1886	9	1	80.0	32.9	NA	X
6	Fairfield, Ill.	1891	9	27	88.5	38.25	6.1	VII
7	Charleston, Mo.	1895	10	31	89.4	37.0	6.3	IX
8	Giles Co., Va.	1897	5	31	80.7	37.3	5.8	VIII
9	Spartanburg, S.C.	1913	1	1	81.7	34.7	NA	VIII
11	Anna, Ohio[c]	1937	3	9	84.0	40.6	NA	VIII

[a]m_b = body-wave magnitude; I_{mm} = modified Mercalli intensity.
[b]Buffalo, N.Y., earthquake (10) of 1929 is deleted from the table because it was more than 640 km from Oak Ridge.
[c]Not available.
Source: National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo., 1989.

occurring at different times in the 1811-1812 series of earthquakes. Earthquakes 1, 2, and 4 have uncertain epicentral locations (1a, 1b, and 1c; 2a and 2b; 4a and 4b respectively).

NRC (1983, p. 2-18) provides an estimate for the maximum regional seismic intensities associated with a strong-motion earthquake similar to the Giles County, Virginia, earthquake of May 31, 1897. This estimate is based on the assumption that the 1897 Giles County earthquake [m_b = 5.8, I_{mm} = VIII (Bollinger and Wheeler 1988, p. 3)] could occur in the vicinity of Oak Ridge (NRC 1983, p. 2-18).

4.1.4 Liquefaction and Ground-Motion Magnification

The potential for liquefaction and ground-motion magnification has not been investigated at ORGDP. Parts of the ORGDP site have been leveled using fill material, and alluvial sediments are known to exist in some areas of the plant. However, most of ORGDP is underlain by strata of the Chickamauga Group, where generally thin, clay-rich soils develop. Definitive determinations regarding the potential hazards of liquefaction or ground-motion magnification await the acquisition and analysis of soils engineering data.

4.2 PADUCAH FAULTS AND SEISMICITY

4.2.1 Regional Faults and Seismic Source Zones

Figure C-3 of Appendix C (modified from Hadley and Devine 1974, Map MF-620, sheets 1 and 2 combined) shows the locations of major fault and seismic source zones, respectively, in the midwestern United States. DOE's Paducah facility is located near the northeastern end of the New Madrid Fault (Reelfoot Rift) Zone. According to Mitchell et al. (in press), the Reelfoot Rift Zone extends beyond Paducah along the Shawneetown Fault and terminates against the Cottage Grove–Rough Creek Fault Zone. Braile et al. (1982, p. 175) suggest that the Wabash Valley Fault Zone may be an extension of the Reelfoot Rift Zone. Thus, the Paducah facility may be either in or out of the Reelfoot Rift Zone, depending on a given point of view.

The seismically active New Madrid Fault Zone (Mitchell et al. in press) has been mapped in the subsurface of the Reelfoot Rift Zone by Hamilton and Zoback (1982, pp. 55–82), but evidence of surface rupture along this fault has not been confirmed. Nuttli (1981, p. 40) states that strong-motion earthquakes seldom, if ever, produce surface ruptures in the central or eastern United States. Current knowledge of the New Madrid Fault Zone indicates that no significant potential exists for a surface rupture to occur at DOE's Paducah facility during an earthquake. According to Bonilla's maps (1982, p. 2A) no known Holocene or Pleistocene surface faults exist in the central or eastern United States.

Although several strong-motion earthquakes have occurred near the Ste. Genevieve, Cottage Grove, and Wabash Valley Fault Zones, these zones differ from the New Madrid Fault Zone in that no spatial correlation between them and historical seismicity has been substantiated. Current knowledge indicates that these faults are inactive.

Seismic Source Zone 55 (Thenhaus 1983, pp. 20–23) is a northeast-trending area of seismicity coincident with the Reelfoot Rift Zone of northeastern Arkansas, southeastern Missouri, southern Illinois, and extreme western parts of Tennessee and Kentucky. Mitchell et al. (in press) contend that this zone should extend to the northeast as far as the southern boundary of Thenhaus' Seismic Source Zone 56 (1983, pp. 22 and 23), which is coincident with the Wabash Valley Fault Zone. Mitchell also would terminate Seismic Source Zone

55 on the south at the Tennessee-Mississippi state line. According to Thenhaus (1983, p. 23), maximum expected earthquakes in Seismic Source Zones 55 and 56 would have body-wave magnitudes (m_b) of 7.5 and 6.5 respectively.

4.2.2 Probabilistic Risk Assessments

The Paducah facility is located in Seismic Zone 2A, near the boundary of Seismic Zone 3, according to the ICBO *Uniform Building Code* (1988, p. 178) (Appendix C, Fig. C-1). The U.S. Federal Emergency Management Agency (FEMA) estimates (1988, p. 15) that an EPGA of 0.20 g has a 10% probability of exceedance at least once in 50 years (a nominal return period of 500 years) at the boundary between Seismic Zones 2A and 3 (Appendix C, Fig. C-2). The uncertainty associated with this EPGA is perhaps ±0.05 g. Earthquakes in Seismic Zone 3 are expected to produce major damage approximately once every 500 years, corresponding to an I_{mm} of VIII or higher, for which felt effects are described in Appendix C, Table C-2.

Table 4.2-1 provides several independent estimates of peak ground accelerations (PGA) at the Paducah facility for return periods ranging up to 1000 years. These PGA estimates are for buildings constructed on rock or firm ground. Independent investigators were Blume (1973); Dames and Moore (1973); the TERA Corp. (1981); Beavers (1974); Wiggins (1981); FEMA (1988, pp. 15 and 23); and Beavers, Manrod, and Stoddart (1982, p. 53), who compiled most of the data and references appearing in Table 4.2-1 and who summarized the findings of each investigation. Mean 1000-year PGAs range from 0.18 g (Dames and Moore 1973) to 0.45 g (the TERA Corp. 1981). Minimum and maximum 1000-year PGAs range from 0.09 to 0.45 g (Blume 1973). These widely varying estimates result from uncertainties in the boundaries of seismic source regions, earthquake recurrence relationships, the magnitude of the maximum earthquake in each seismic source region, and the attenuation of earthquake energy as a function of distance (Coats and Murray 1984, p. 14), as well as differing methodologies.

DOE 1989 (p. 1-2) endorses the results of the TERA Corp.'s seismic hazard analyses for setting seismic design guidelines. However, DOE acknowledges that seismic hazard estimates have been changing rapidly in the past 5 years. The TERA Corp.'s results for the Paducah, Portsmouth, and ORGDP facilities are presented in Appendix C, Table C-1.

4.2.3 Deterministic Risk

Figure 4.2-1 is a map of historically and instrumentally recorded strong-motion ($m_b \geq 5.5$; $I_{mm} \geq$ VII) earthquakes within 640 km (400 miles) of the Paducah facility. This map was compiled from current (October 1989) computer-stored data provided by the NOAA Geophysical Data Center in Boulder, Colorado. Although the locations of some of the earlier (before 1900) earthquakes are not well known, the map provides a fairly complete history of strong-motion earthquakes during the past 300 years.

As shown in Fig. 4.2-1, two major centers of seismic activity are located near the Paducah facility. The most seismically active area in the eastern United States (known as the New Madrid Seismic or Reelfoot Rift Zone [Seismic Source Zone 55 from Thenhaus 1983, pp. 20–23]) is located immediately to the south-southwest of Paducah in southeastern Missouri, southern Illinois, western parts of Kentucky and Tennessee, and northeastern Arkansas. Another seismically active area (the Wabash Valley Fault Zone [Seismic Source Zone 56 from Thenhaus 1983, pp. 22 and 23]) is located immediately northeast of Paducah

Table 4.2-1. Paducah seismic hazard study results

Return period (years)	Study results in terms of peak ground acceleration						
	Blume	Dames and Moore	The TERA Corp.	Beavers	McGuire Shedlock, and Nuttli	ATC 3-06 (effective peak ground acceleration)	Beavers, Manrod, and Stoddart 1982
100	0.03 g[a,b] 0.13 g	0.08 g	0.14 g	0.15 g	NA[c]	0.10 g	0.12 g
500	0.07 g 0.30 g	0.15 g	0.32 g	0.30 g	0.25 g	0.20 g	0.25 g
1000	0.09 g 0.45 g	0.18 g	0.45 g	NA	0.25 g 0.40 g	0.26 g	0.35 g

[a]g = acceleration due to gravity.
[b]Double values represent PGA ranges recommended.
[c]Not available.
Source: Modified from J. E. Beavers, W. E. Manrod, and W. C. Stoddart, *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio Department of Energy Reservations,* K/BD-1025/R1, December 1982.

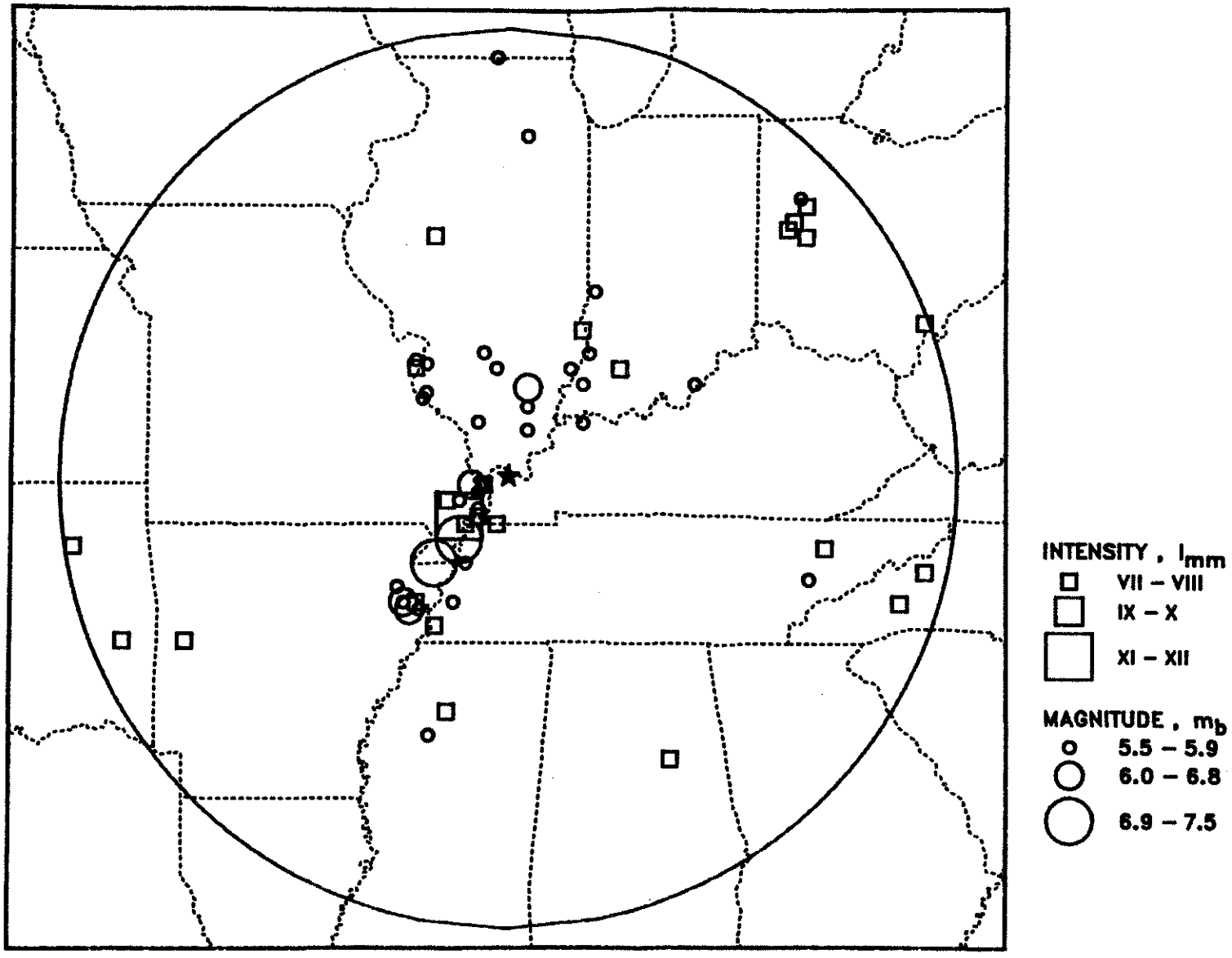


Fig. 4.2-1. Strong-motion earthquakes ($m_b \geq 5.5$, $I_{mm} \geq$ VII) within 640 km of Paducah, Kentucky. *Source:* based on National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.

in southeastern Illinois and southwestern Indiana. As stated previously, some seismologists regard the Wabash Valley Fault Zone as a less-active continuation of the New Madrid Seismic Zone.

Figure 4.2-2 shows the locations of seven strong-motion earthquakes with $m_b \geq 6.0$ or $I_{mm} \geq$VIII (NOAA 1989, computer data file). Table 4.2-2 lists important facts pertaining to these earthquakes. At least three (or perhaps four) great earthquakes occurred between December 16, 1811, and February 7, 1812; they ranged from m_b = 6.9 to 7.3 (I_{mm} = XI to XII) and were located between Marked Tree, Arkansas, and New Madrid, Missouri. Earthquakes 1a, 2a, and 3 are three co-located events occurring at different times in the 1811–1812 series of earthquakes. Earthquakes numbered 1, 2, and 4 have uncertain epicentral locations (1a, 1b, and 1c; 2a and 2b; 4a and 4b respectively). The Charleston, Missouri, earthquake of October 31, 1895 (m_b = 6.3; I_{mm} = IX) was located fewer than 80 km (50 miles) west of Paducah, Kentucky.

Algermissen and Hopper (1984, Map MF-1712) provide estimates for the maximum regional seismic intensities associated with a great earthquake (similar to the earthquake series of 1811–1812) occurring in the New Madrid Seismic Zone. Based on their data, the maximum I_{mm} in McCracken County, Kentucky (where Paducah is located), would probably equal X. This estimate is based on the assumptions that I_{mm} = XII on the northeastern edge of the New Madrid Seismic Zone and that McCracken County is outside the zone. Appendix C, Table C-2, contains a description of earthquake damage as a function of I_{mm}.

4.2.4 Liquefaction and Ground-Motion Magnification

The potential for liquefaction and ground-motion magnification is being investigated. These phenomena cannot be ruled out at this time. Poorly consolidated Neogene deposits are present as described in Sect. 3 and, in combination with strong-motion earthquakes as described previously in this section, could liquefy or could produce strong ground-motion magnification. A more definitive statement regarding these potential hazards awaits the acquisition and analysis of standard penetrometer and cross-hole seismic data.

4.3 PORTSMOUTH FAULTS AND SEISMICITY

4.3.1 Regional Faults and Seismicity

Figure C-3 of Appendix C (modified from Hadley and Devine 1974, Map MF-620, sheets 1 and 2 combined) shows the locations of major fault and seismic source zones, respectively, of the midwestern United States. The Kentucky River Fault Zone and Bryant Station–Hickman Creek Fault are closest to the Portsmouth facility, the latter fault being roughly 100 km (60 miles) to the southwest of the Portsmouth facility at its closest approach. Although these faults have not been examined carefully for evidence of Holocene or Pleistocene ruptures, no spatial correlation between them and historical seismicity has been observed. Nuttli (1981, p. 40) states that strong-motion earthquakes seldom, if ever, produce surface ruptures in the eastern United States. Thus, a future earthquake probably would not cause any surface ruptures at the Portsmouth facility.

Seismic Source Zone 60 (Thenhaus 1983, pp. 23 and 24) is a north-northeast trending area of seismicity in central and eastern Ohio (where the Portsmouth facility is located) and northeastern Kentucky. The northern part of the zone is parallel to the regional strike of Paleozoic rocks, and the southern part is bounded by the Kentucky River and the Bryant

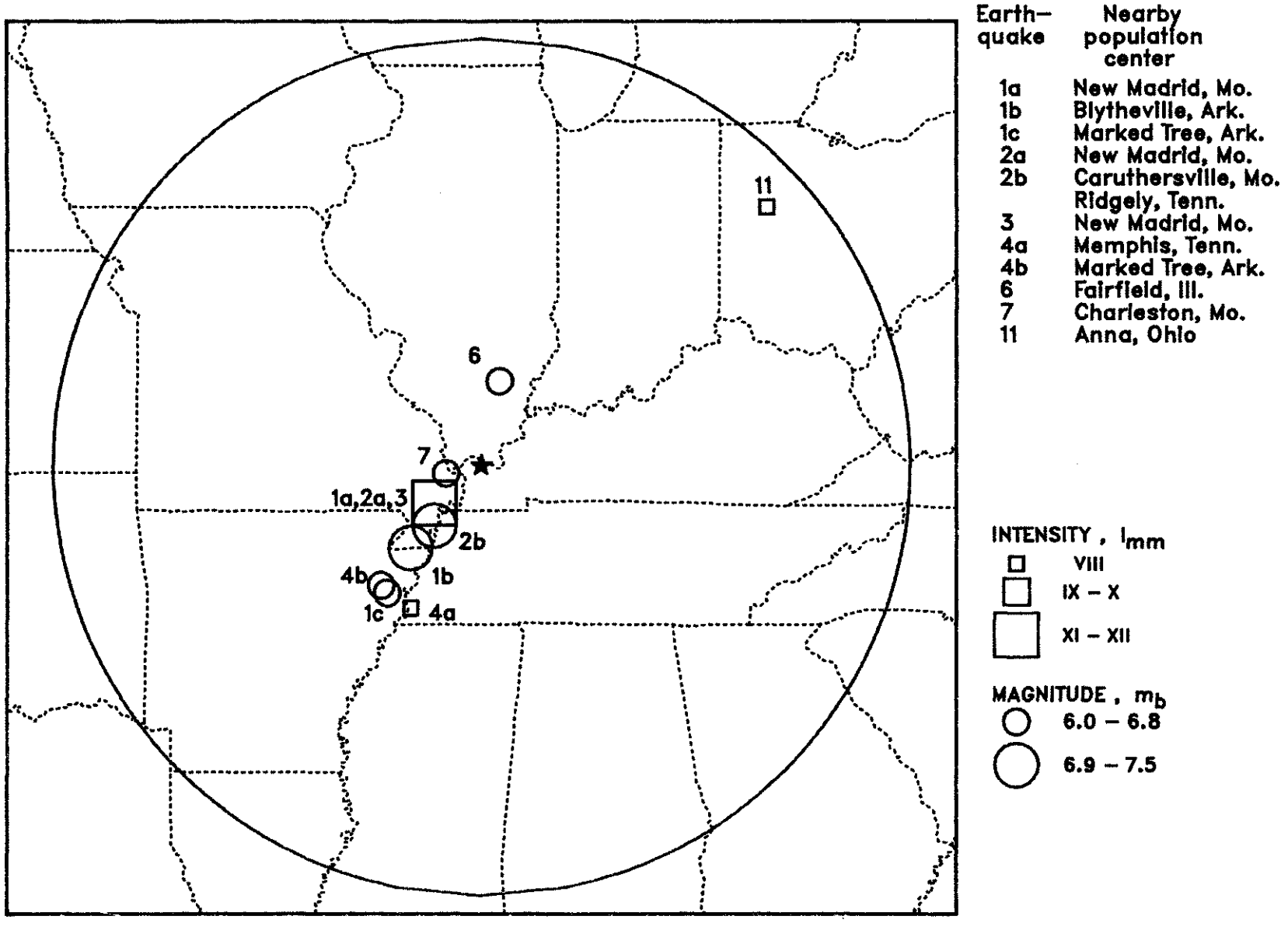


Fig. 4.2-2. Strong-motion earthquakes ($m_b \geq 6.0$, $I_{mm} \geq$ VIII) within 640 km of Paducah, Ky. *Source:* based on National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.

Table 4.2-2. Descriptions of seven strong-motion earthquakes ($m_b \geq 6$ or $I_{mm} \geq$ VIII) within 640 km of the Paducah facilities[a]

Numerical identification from Fig. 4.2-2[b]	Nearby population center	Year	Month	Day	Longitude	Latitude	m_b	I_{mm}
1a	New Madrid, Mo.	1811	12	16	89.6	36.6	NA[c]	XII
1b	Blytheville, Ark.	1811	12	16	90.0	36.0	7.3	XI
1c	Marked Tree, Ark.	1811	12	16	90.4	35.4	6.9	XI
2a	New Madrid, Mo.	1812	1	23	89.6	36.6	NA	XII
2b	Caruthersville, Mo./ Ridgley, Tenn.	1812	1	23	89.6	36.3	7.2	XI
3	New Madrid, Mo.	1812	2	7	89.6	36.6	NA	XII
4a	Memphis, Tenn.	1843	1	5	90.0	35.2	NA	VIII
4b	Marked Tree, Ark.	1843	1	5	90.5	35.5	6.2	VIII
6	Fairfield, Ill.	1891	9	27	88.5	38.25	6.1	VII
7	Charleston, Mo.	1895	10	31	89.4	37.0	6.3	IX
11	Anna, Ohio	1937	3	9	84.0	40.6	NA	VIII

[a]m_b = body-wave magnitude; I_{mm} = modified Mercalli intensity.

[b]Charleston, S.C., earthquake (5) of 1886; Giles Co., Va., earthquake (8) of 1897; Spartanburg, S.C., earthquake (9) of 1913; and Buffalo, N.Y., earthquake (10) of 1929 are deleted from the table becuase they occurred >640 km from Paducah.

[c]Not available.

Source: National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data*, National Geophysical Data Center, Boulder, Colo., 1989.

Station–Hickman Creek faults. The largest recorded earthquake (m_b = 5.3; I_{mm} = VII) in this zone was the Sharpsburg, Kentucky, earthquake of July 1980.

4.3.2 Probabilistic Risk Assessment

The Portsmouth facility is in Pike County, Ohio, and is located in Seismic Zone 1 according to ICBO's *Uniform Building Code* (1988, p. 178) (Appendix C, Fig. C-l). The horizontal EPGA = 0.075g ± 0.025 g for ground motions having a nominal 500-year return period in Seismic Zone 1, according to data collected from a variety of sources [ICBO 1988, p. 168; Applied Technology Council (ATC) 1978, p. 316; Algermissen and Perkins 1976, Plate 2; and FEMA 1988, p. 15]. The 1988 FEMA map (p. 15) (Appendix C, Fig. C-2) suggests that the EPGA of the Portsmouth facility is 0.05 g, the lower end of the range of EPGAs in Seismic Zone 1 [older Uniform Building Code maps show that Portsmouth is near the boundary between Seismic Zones 1 and 0 (the 0.05-g contour of Fig. C-2)]. The above-described ground motions have a 10% probability of being exceeded at least once in 50 years at Portsmouth and would be equivalent to earthquakes with I_{mm} of V or VI (refer to Appendix C, Table C-2 for felt effects of earthquake ground motions for various modified Mercalli intensities).

Table 4.3-1 provides several independent estimates of PGAs at the Portsmouth facility for return periods ranging up to 1000 years. These PGA estimates are for buildings constructed on rock or firm ground. Independent investigators were Blume (1973); Dames and Moore (1973); the TERA Corp. (1981); Beavers (1974); Wiggins (1981); FEMA (1988, pp. 15 and 23); and Beavers, Manrod, and Stoddart (1982, p. 77), who compiled most of the data and references appearing in Table 4.3-1 and who summarized the findings of each investigation. Mean 1000-year PGAs range from 0.07 g (Dames and Moore 1973) to 0.15 g (Beavers 1974). Minimum and maximum 1000-year PGAs range from 0.07 g (see Table 4.3-1) to 0.28 g (Blume 1973). These widely varying estimates result from uncertainties in the boundaries of seismic source regions, earthquake recurrence relationships, the magnitude of the maximum earthquake in each seismic source region, and the attenuation of earthquake energy as a function of distance (Coats and Murray 1984, p. 14), as well as differing methodologies. The 1000-year return period mean PGA estimates of the TERA Corp. (1981) and Beavers et al. (1982, p. 77) are in near agreement—0.11g and 0.10g respectively. Such ground motions have about a 10% probability of occurring at least once in 100 years and would be equivalent to an I_{mm} of VI or VII (Appendix C, Table C-2).

DOE (1989, p. 1-2) endorses the results of the TERA Corp.'s seismic hazard analyses for setting seismic design guidelines. However, DOE acknowledges that seismic hazard estimates have been changing rapidly in the past 5 years. The TERA Corp.'s results for the Portsmouth, Paducah, and ORGDP facilities are presented in Appendix C, Table C-1.

4.3.3 Deterministic Risk Assessment

Figure 4.3-1 is a map of historically and instrumentally recorded strong-motion $m_b \geq 5.5$; $I_{mm} \geq$ VII earthquakes within 640 km (400 miles) of the Portsmouth facility. This map was compiled from current (October 1989) computer-stored data provided by NOAA's Geophysical Data Center in Boulder, Colorado. Although the locations of some of the earlier (before 1900) earthquakes are not well known, the map provides a fairly complete history of strong-motion earthquakes during the past 300 years.

Table 4.3-1. Portsmouth seismic hazard study results

Return period (years)	Study results in terms of peak ground acceleration								
	Blume	Dames and Moore	The TERA Corp.	Beavers and GCEP	Wiggins	Law Engineering Testing Company	ATC 3-06 (effective peak ground acceleration)	Zimmer and Marble Hill	Beaver, Manrod, and Stoddart 1982
100	0.03 g[a,b] 0.07 g	0.03 g	0.05 g	0.04 g	0.05 g 0.07 g	NA[c]	0.02 g	0.06 g	0.03 g
500	0.06 g 0.20 g	0.06 g	0.09 g	0.10 g	0.13 g 0.17 g	0.08 g	0.05 g	0.10 g	0.08 g
1000	0.08 g 0.28 g	0.07 g	0.11 g	0.15 g	NA	NA	0.07 g	0.20 g	0.10 g

[a]g = acceleration due to gravity.
[b]Double values represent peak-ground-acceleration ranges recommended.
[c]Not available.
Source: Modified from J. E. Beavers, W. E. Manrod, and W. C. Stoddart, *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio Department of Energy Reservations,* K/BD-1025/R1, December 1982.

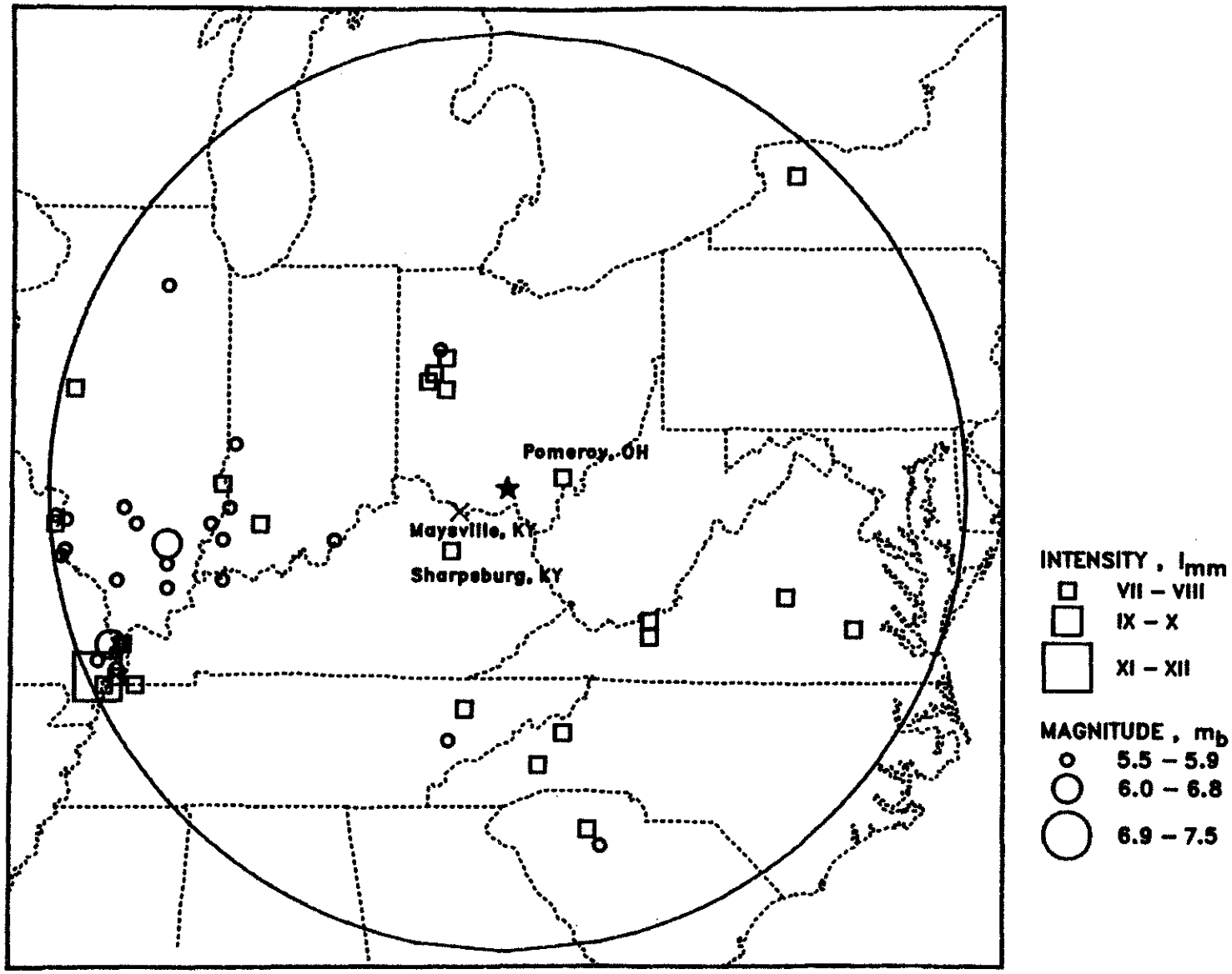


Fig. 4.3-1. Strong-motion earthquakes ($m_b \geq 5.5$, $I_{mm} \geq$ VII) within 640 km of Portsmouth, Ohio. *Source:* based on National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.

As shown in Fig. 4.3-1, a center of major seismic activity is located far to the west of the Portsmouth facility, in southeastern Missouri, western Kentucky, western Tennessee, southern Illinois, and northeastern Arkansas (known as the New Madrid Seismic Source Zone or Reelfoot Rift Zone). Some seismologists believe the moderately active Wabash Valley Seismic Zone of southwestern Indiana is a northeastern extension of this center of major activity. The above seismic source zones are described in greater detail in Sect. 4.2. Other moderately active seismic source zones are those of Anna, Ohio—the Southern Appalachian Seismic Zone (including eastern Tennessee and western and central Virginia) and the Georgia–South Carolina Seismic Zone. A 100-km (62-mile) region surrounding the Portsmouth, Ohio, facility is characterized as one of minor seismicity, which is consistent with ICBO's seismic zone map (1988, p. 178) of the United States (Seismic Zone 1 of Fig. C-1, Appendix C) and Seismic Source Zone 60 (Thenhaus 1983, pp. 22 and 23).

Two strong-motion earthquakes have been recorded within 160 km (100 miles) of the Portsmouth facilities: the Sharpsburg, Kentucky, earthquake of July 1980 and the Pomeroy, Ohio, earthquake of November 5, 1926 (Fig. 4.3-1). The Sharpsburg earthquake was felt as I_{mm} = VII at Maysville, Kentucky, on the Ohio River about 64 km (40 miles) west of the Portsmouth facilities, but only as I_{mm} = VI in the epicentral area of Sharpsburg. The higher intensity at Maysville is believed to be attributable to the construction of buildings on Ohio River alluvium.

Like Maysville, I_{mm} of earthquakes near Anna, Ohio, may have been unusually large because of thick Pleistocene alluvium or because the earthquakes may be related to the Finlay Arch (Fig. C-3 of Appendix C) (Thenhaus 1983, pp. 22 and 23). The city of Anna lies on top of the ancestral Teays River valley.

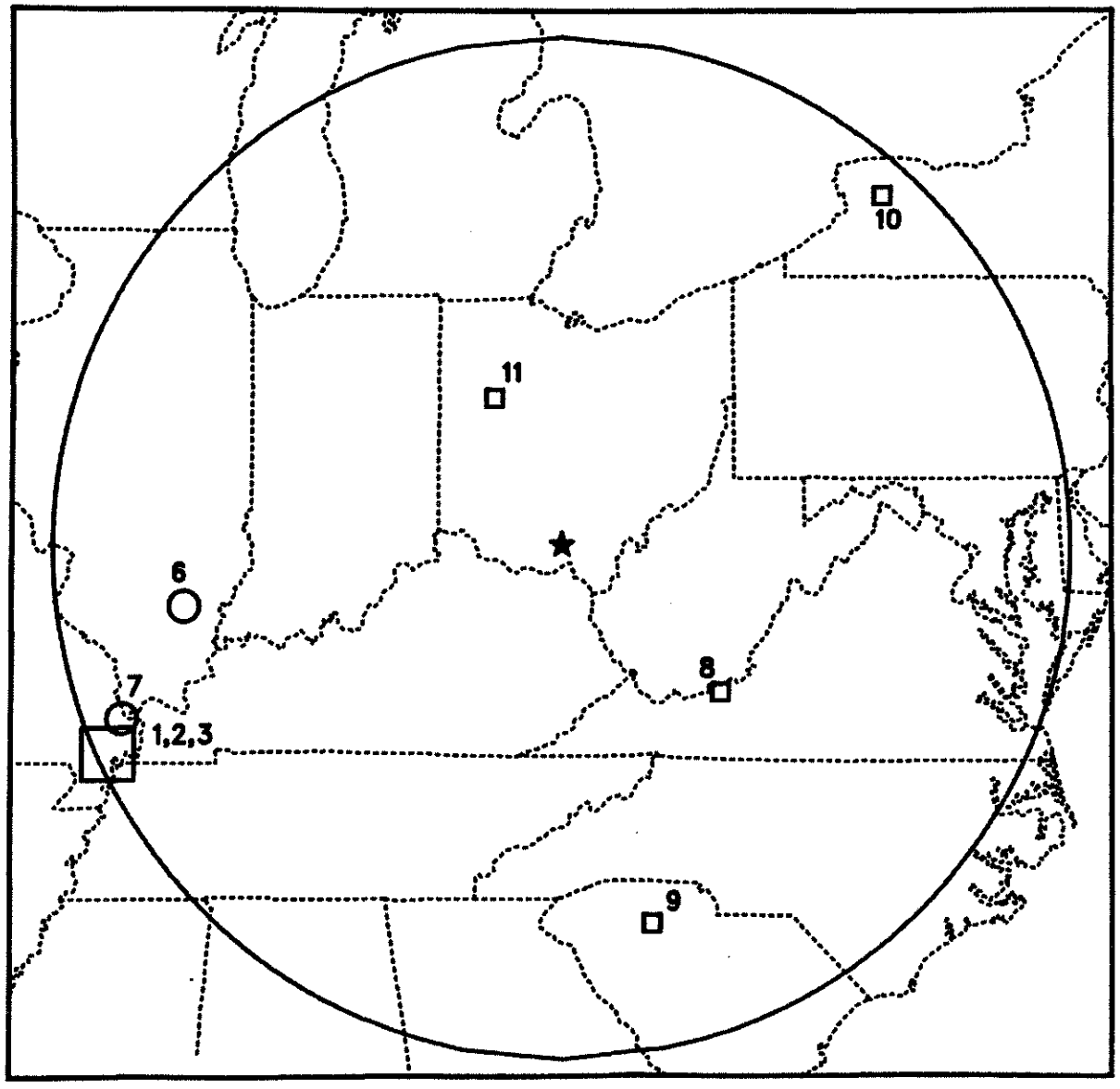
Table 4.3-2 provides a list of all strong-motion earthquakes of $m_b \geq 6.0$ or $I_{mm} \geq$ VIII within 640 km (400 miles) of the Portsmouth facility (NOAA's computer data file). These earthquakes are identified numerically in Fig. 4.3-2. The majority of large earthquakes occurred in southeastern Missouri and southern Illinois in the New Madrid Seismic (Reelfoot Rift) Zone and the Wabash Valley Seismic Zone. The South Carolina–Georgia Seismic Zone (Bollinger 1973, p. 1786) is the only other eastern United States seismic zone that experienced more than one earthquake with $m_b \geq 6$ or $I_{mm} \geq$ VIII [not shown in Fig. 4.3-2 is the Charleston, South Carolina, earthquake of 1886 (I_{mm} = X) that occurred near the Atlantic coastline, more than 640 km (400 miles) from Portsmouth]. Other large strong-motion earthquakes are widely scattered throughout the eastern United States, as shown in Fig. 4.3-2.

Earthquakes occurring in the Reelfoot Rift Zone (described in detail in Sect. 4.2) are capable of producing ground motions at the Portsmouth facility similar to or greater than those experienced at Maysville, Kentucky, during the Sharpsburg, Kentucky, earthquake of 1980. Based on data provided by Algermissen and Hopper (1984, Map MF-1712), a great earthquake (m_b = 7.5) similar to the 1811–1812 sequence of Reelfoot earthquakes is capable of causing an I_{mm} of VIII (see Appendix C, Table C-2) in Pike County, Ohio, where the Portsmouth facility is located. Algermissen and Hopper (1984, Map MF-1712) estimate the recurrence interval for strong-motion earthquakes to be between 600 and 1000 years in the Reelfoot Rift Zone as a whole. However, maximum damage at the Portsmouth facility would occur only if the earthquake's epicenter were located near the northern end of this zone.

Table 4.3-2. Descriptions of nine strong-motion earthquakes ($m_b \geq 6$ or $I_{mm} \geq$ VIII) within 640 km of the Portsmouth facilities[a]

Numerical identification from Fig. 4.3-2[b]	Nearby population center	Year	Month	Day	Longitude	Latitude	m_b	I_{mm}
1a	New Madrid, Mo.	1811	12	16	89.6	36.6	NA[c]	XII
2a	New Madrid, Mo.	1812	1	23	89.6	36.6	NA	XII
3	New Madrid, Mo.	1812	2	7	89.6	36.6	NA	XII
6[c]	Fairfield, Ill.	1891	9	27	88.5	38.25	6.1	VII
7	Charleston, Mo.	1895	10	31	89.4	37.0	6.3	IX
8	Giles Co., Va.	1897	5	31	80.7	37.3	NA	VIII
9	Spartanburg, S.C.	1913	1	1	81.7	34.7	NA	VIII
10	Buffalo, N.Y.	1929	8	12	78.33	42.92	NA	VIII
11	Anna, Ohio	1937	3	9	84.0	40.6	NA	VIII

[a]m_b = body-wave magnitude; I_{mm} = modified Mercalli intensity.
[b]Memphis, Tenn., earthquake (4) of 1843 and Charleston, S.C., earthquake (5) of 1886 are deleted from the table because they are >640 km from Portsmouth.
[c]Not available.
Source: National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo., 1989.



Earth-quake	Nearby population center
1	New Madrid, Mo.
2	New Madrid, Mo.
3	New Madrid, Mo.
6	Fairfield, Ill.
7	Charleston, Mo.
8	Giles Co, Va.
9	Spartanburg, S.C.
10	Buffalo, N.Y.
11	Anna, Ohio

INTENSITY, I_{mm}

- VIII
- IX – X
- XI – XII

MAGNITUDE, m_b

- 6.0 – 6.8
- 6.9 – 7.5

Fig. 4.3-2. Strong-motion earthquakes ($m_b \geq 6.0$, $I_{mm} \geq$ VIII) within 640 km of Portsmouth, Ohio. *Source:* based on National Oceanic and Atmospheric Administration, *Computer-Stored Earthquake Information Open-File Data,* National Geophysical Data Center, Boulder, Colo.

4.3.4 Liquefaction and Ground-Motion Magnification

Information regarding potential damage from liquefaction or soil-structure interaction (rapid loss of foundation strength or ground-motion magnification respectively) is provided by Law Engineering Testing Company (LETC) (1977). LETC compiled numerous lithologic logs and standard penetrometer tests as well as a few geophysical logs at the Portsmouth facility during foundation investigations for DOE's Gas Centrifuge Program.

The soil foundation beneath DOE's facilities at Portsmouth consists mainly of Pleistocene lake-bed sediments (the Minford Silt) overlying a thin deposit of Pleistocene alluvium and Paleozoic shale and sandstone. Although these stratigraphic units are discussed in detail in Sect. 3, a brief discussion of their engineering characteristics is provided here. The Minford Silt is 9 to 12 m (30 to 40 ft) thick and generally stiff to very stiff, based on standard penetrometer tests. Lake-bed sediments located above the water table are generally described as inorganic clays ranging from low to high plasticity. Below the water table [1 to 6 m (3 to 20 ft) below the surface], these deposits are richer in silt but retain their stiffness. In some places the Minford Silt is overlain by 1 or 2 m (3 to 7 ft) of fill material or underlain by 1 or 2 m of Pleistocene alluvium. Some fill material is soft and is classified as an inorganic clay ranging from low to high plasticity. The underlying alluvium is a mixture of clay, silt, sand, and gravel and ranges in consistency and density from firm to very dense (based on the results of standard penetrometer tests). Indurated Paleozoic shale and sandstone underlies the Pleistocene alluvium.

The potential for earthquake-induced liquefaction at the Portsmouth facility is relatively low. According to Seed and Idriss (1971, p. 1250), liquefaction is most likely to occur beneath the water table where soils are rich in cohesionless, fine sand. As described above, however, the Minford Silt is a cohesive soil, relatively rich in clay and silt and relatively poor in fine sand. Liquefaction of the Minford Silt is unlikely to occur at a PGA < 0.15 g, based on the use of Seed and Idriss' field-oriented methodology for determining liquefaction potential (1971, pp. 1260 and 1261) and standard penetrometer data provided by LETC (1977). The estimated return period for PGA = 0.15 g is ~7500 years or 3000 ± 1000 years at the Portsmouth facility, based on data provided by FEMA (1988, pp. 15 and 23) and Coats and Murray (1984, p. 66) respectively. The above estimates reflect a wide range of uncertainty in the probability of occurrence of earthquakes that have large peak ground accelerations.

The potential for soil-structure interaction (ground motion magnification) is slight, based on the above soil descriptions and a limited amount of cross-hole seismic velocity data provided by LETC (1977). The shear wave velocity in the Minford Silt ranges from 250 to 275 m/s (800 to 900 ft/s). Accordingly, soils beneath the Portsmouth site are predominantly Soil Profile Type S1, with possibly some Soil Profile Type S3 as defined by FEMA (1988, pp. 26 and 27). Normalized response spectra recommended for use in building codes are presented in FEMA (1988, p. 27). Structures with fundamental periods greater than 1 s sited on S1 soils are not subject to significant spectral magnification.

4.4 REFERENCES

4.4.1 Oak Ridge

Beavers, J. E. 1974. *Seismic Design Criteria for Shared Site New Uranium Enrichment Plants—General Design Recommendations, Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee*, K-D-3154, Oak Ridge, Tenn.

Beavers, J. E., Manrod, W. E., and Stoddart, W. C. 1982. *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations*, K/BD-1025/R1, Oak Ridge, Tenn.

Blume (John A. Blume and Associates, Engineers) 1973. *Seismic Investigations for the AEC Gaseous Diffusion Plants*, JABE-UCC-01, San Francisco, prepared for the Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

Bollinger, G. A. 1973. "Seismicity of the Southeastern United States," *Bull. Seismol. Soc. Am.* 63 (5), 1785–1808.

Bollinger, G. A., and Wheeler, R. L. 1988. *The Giles County, Virginia, Seismic Zone—Seismological Results and Geological Interpretations,* U.S. Geological Survey Professional Paper 1355, U.S. Government Printing Office.

Coats, D. W., and Murray, R. C. 1984. *Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites*, UCRL-53582 Rev 1, Lawrence Livermore National Laboratory, Livermore, Calif.

Dames and Moore 1973. *Seismic Design Criteria, Gaseous Diffusion Plants, Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio*, prepared for Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

DOE (U.S. Department of Energy) 1989. *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, draft, UCRL-15910, Washington, D.C.

FEMA (U.S. Federal Emergency Management Agency) 1988. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, Building Seismic Safety Council, Washington, D.C.

Hadley, J. B., and Devine, J. F. 1974. *Seismotectonic Map of the Eastern United States,* Miscellaneous Field Study Map MF-620, U.S. Geological Survey, Denver.

Hand, F. R., and Hoskins, J. M. 1981. "Seismic Risk Analysis of the TVA Service," pp. 917-35 in *Proceedings Earthquakes and Earthquake Engineering: The Eastern United States,* Vol. 2, ed. J. E. Beavers, Ann Arbor Science Publishers, Inc., Ann Arbor, Mich., September.

ICBO (International Conference of Building Officials) 1988. *Uniform Building Code*, Whittier, Calif.

NOAA (National Oceanic and Atmospheric Administration) 1989. *Computer Stored Earthquake Information Open-File Data*, National Geophysical Data Center, Boulder, Colo.

NRC (Nuclear Regulatory Commission) 1983. *Safety Evaluation Report Related to the Construction of the Clinch River Breeder Reactor Plant,* NUREG-0968, Office of Nuclear Reactor Regulation.

TERA Corporation 1981. *Seismic Hazard Analysis for Oak Ridge National Laboratory and the Paducah, Portsmouth, and FMPC Sites*, Lawrence Livermore National Laboratory, Livermore, Calif.

Wiggins (J. H. Wiggins Company) 1978. *Seismic Criteria for Design, Analysis, and Test of the Gas Centrifuge,* Technical Report No. 77-1315-1, prepared for the AiResearch Manufacturing Company of California (AiR), Torrence, Calif.

4.4.2 Paducah

Algermissen, S. T., and Hopper, M. G. 1984. "Estimated maximum regional seismic intensities associated with an ensemble of great earthquakes that might occur along the New Madrid seismic zone, east-central United States," Miscellaneous field studies map MF-1712, U.S. Geological Survey, Reston, Va.

Beavers, J. E. 1974. *Seismic Design Criteria for Shared Site New Uranium Enrichment Plants—General Design Recommendations, Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee*, K-D-3154, Oak Ridge, Tenn.

Beavers, J. E., Manrod, W. E., and Stoddart, W. C. 1982. *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations*, K/BD-1025/R1, Oak Ridge, Tenn.

Blume (John A. Blume and Associates, Engineers) 1973. *Seismic Investigations for the AEC Gaseous Diffusion Plants*, JABE-UCC-01, San Francisco, prepared for the Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

Bonilla, M. G., 1982. *Evaluation of Potential Surface Faulting and Other Tectonic Deformation*, U.S. Nuclear Regulatory Commission, NUREG/CR-2991, Washington, D.C.

Braile, L. W., et al. 1982. *The Northeastern Extension of the New Madrid Seismic Zone*, U.S. Geological Survey Professional Paper 1236-L, U.S. Government Printing Office, Washington, D.C.

Coats, D. W., and Murray, R. C. 1984. *Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites*, UCRL-53582 Rev 1, Lawrence Livermore National Laboratory, Livermore, Calif.

Dames and Moore 1973. *Seismic Design Criteria, Gaseous Diffusion Plants, Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio*, prepared for Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

DOE (U.S. Department of Energy) 1989. *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, draft, UCRL-15910, Washington, D.C.

FEMA (U.S. Federal Emergency Management Agency) 1988. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, Building Seismic Safety Council, Washington, D.C.

Hadley, J. B., and Devine, J. F. 1974. *Seismotectonic Map of the Eastern United States,* Miscellaneous Field Study Map MF-620, U.S. Geological Survey, Denver.

Hamilton, R. M., and Zoback, M. D. 1982. *Tectonic Features of the New Madrid Seismic Zone from Seismic-Reflection Profiles*, U.S. Geological Survey Professional Paper 1236-F, U.S. Government Printing Office, Washington, D.C.

ICBO (International Conference of Building Officials) 1988. *Uniform Building Code*, Whittier, Calif.

Mitchell, B. J., et al. in press. *Seismotectonics of the Central United States*, Department of Earth and Atmospheric Sciences, Saint Louis University, St. Louis.

NOAA (National Oceanic and Atmospheric Administration) 1989. *Computer Stored Earthquake Information Open-File Data*, National Geophysical Data Center, Boulder, Colo.

Nuttli, O. W. 1981. "Similarities and Differences Between Western and Eastern Earthquakes, and their Consequences for Earthquake Engineering," *Proceedings, Earthquakes and Earthquake Engineering: the Eastern United States*, J. E. Beavers, ed., vol. 1, Ann Arbor Science Publishers, Ann Arbor, Mich.

TERA Corporation 1981. *Seismic Hazard Analysis for Oak Ridge National Laboratory and the Paducah, Portsmouth, and FMPC Sites*, Lawrence Livermore National Laboratory, Livermore, Calif.

Thenhaus, P. C. 1983. *Summary of Workshops Concerning Regional Seismic Source Zones of Parts of the Conterminous United States Convened by the U.S. Geological Survey 1979-1980, Golden, Colorado*, U.S. Geological Survey Circular 898, Alexandria, Va.

4.4.3 Portsmouth

Algermissen, S. T., and Hopper, M. G. 1984. "Estimated maximum regional seismic intensities associated with an ensemble of great earthquakes that might occur along the New Madrid seismic zone, east-central United States," Miscellaneous field studies map MF-1712, U.S. Geological Survey, Reston, Va.

Algermissen, S. T., and Perkins, D. M. 1976. "A probabilistic estimate of maximum acceleration in rock in the contiguous United States," U.S. Geological Survey Open-File Report 76-416, Denver.

ATC (Applied Technology Council) 1978. *Tentative Provisions for the Development of Seismic Regulations for Buildings*, National Bureau of Standards Special Publication 510, U.S. Government Printing Office, Washington, D.C.

Beavers, J. E. 1974. *Seismic Design Criteria for Shared Site New Uranium Enrichment Plants—General Design Recommendations, Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee*, K-D-3154, Oak Ridge, Tenn.

Beavers, J. E., Manrod, W. E., and Stoddart, W. C. 1982. *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations*, K/BD-1025/R1, Oak Ridge, Tenn.

Blume (John A. Blume and Associates, Engineers) 1973. *Seismic Investigations for the AEC Gaseous Diffusion Plants*, JABE-UCC-01, San Francisco, prepared for the Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

Bollinger, G. A. 1973. "Seismicity of the Southeastern United States," *Bull. Seismol. Soc. Am.* 63 (5), 1785–1808.

Coats, D. W., and Murray, R. C. 1984. *Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites*, UCRL-53582 Rev 1, Lawrence Livermore National Laboratory, Livermore, Calif.

Dames and Moore 1973. *Seismic Design Criteria, Gaseous Diffusion Plants, Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio*, prepared for Union Carbide Corporation, Nuclear Division, Oak Ridge, Tenn.

DOE (U.S. Department of Energy) 1989. *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, draft, UCRL-15910, Washington, D.C.

FEMA (U.S. Federal Emergency Management Agency) 1988. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, Building Seismic Safety Council, Washington, D.C.

Hadley, J. B., and Devine, J. F. 1974. *Seismotectonic Map of the Eastern United States*, Miscellaneous Field Study Map MF-620, U.S. Geological Survey, Denver.

ICBO (International Conference of Building Officials) 1988. *Uniform Building Code*, Whittier, Calif.

LETC (Law Engineering Testing Company) 1977. *Geotechnical Investigation for the Gas Centrifuge Enrichment Plant, Portsmouth, Ohio*, prepared for the U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, Tenn.

NOAA (National Oceanic and Atmospheric Administration) 1989. *Computer Stored Earthquake Information Open-File Data*, National Geophysical Data Center, Boulder, Colo.

Nuttli, O. W. 1981. "Similarities and Differences Between Western and Eastern Earthquakes, and their Consequences for Earthquake Engineering," *Proceedings, Earthquakes and Earthquake Engineering: the Eastern United States*, J. E. Beavers, ed., vol. 1, Ann Arbor Science Publishers, Ann Arbor, Mich.

Seed, H. B., and Idriss, I. M. 1971. "Simplified Procedure for Evaluating Soil Liquefaction Potential," *J. Soil Mech. and Found. Div.*, American Society of Civil Engineers.

TERA Corporation 1981. *Seismic Hazard Analysis for Oak Ridge National Laboratory and the Paducah, Portsmouth, and FMPC Sites*, Lawrence Livermore National Laboratory, Livermore, Calif.

Thenhaus, P. C. 1983. *Summary of Workshops Concerning Regional Seismic Source Zones of Parts of the Conterminous United States Convened by the U.S. Geological Survey 1979-1980, Golden, Colorado*, U.S. Geological Survey Circular 898, Alexandria, Va.

Wiggins (J. H. Wiggins Company) 1981. *Seismic Criteria for Design, Analysis, and Test of the Gas Centrifuge of Portsmouth, Ohio*, Technical Report No. 80-1374-6, AiR Document No. U81-450.

5. SURFACE WATER

5.1 OAK RIDGE

5.1.1 Hydrology

The Oak Ridge Gaseous Diffusion Plant (ORGDP) site is located near the confluence of the Clinch River and Poplar Creek on the Oak Ridge Reservation (ORR) (Fig. 5.1-1). Effluent discharges from ORGDP are to both the Clinch River and Poplar Creek. Water withdrawal for facility operations is from two points on the Clinch River (see Fig. 5.1-1). The Clinch River is a tributary to the Tennessee River at river kilometer (RK) 913.4 [river mile (RM) 567.7].

The Clinch River originates in the southwest corner of Virginia near the Kentucky border, 280 air km (175 air miles) northeast of Oak Ridge. The river flows southwest for more than 560 km (350 miles) before merging with the Tennessee River near Kingston, Tennessee. The Clinch drainage basin encompasses an area of 11,400 km^2 (4413 $miles^2$). Melton Hill Dam was constructed on the Clinch River upstream of ORGDP in 1962; the dam gates were closed on May 1, 1963. Melton Hill Reservoir has a volume of 146,234 m^3 (118,600 acre-ft) at the normal maximum pool elevation of 242 m (795 ft). The reservoir establishes the eastern and southern boundaries of ORR for a distance of ~63 km (39 miles) from Clinch River kilometer (CRK) 79 (RM 49) above Melton Hill Dam to CRK 16 (RM 10), ~3 km (1.8 miles) downstream from the mouth of Poplar Creek near ORGDP. Both width and depth of the Clinch River below Melton Hill Dam are 52 to 60 m (175 to 200 ft) and at least 3 m (9 ft) at all pool elevations respectively (see Appendix I: Tolbert 1990f). Discharge information for the Clinch River at Melton Hill Dam is summarized in Table 5.1-1 (see also Table C.1-1, Appendix C). Zero discharge has occurred on many days from Melton Hill Dam (USGS 1988, p. 115; Loar, Solomon, and Cada 1981, p. 20). The greatest number of consecutive days (74) of zero discharge from the dam occurred in 1966. The only year of no days of zero discharge was 1979 (Alexander et al. 1984, Part B, p. 15).

Portions of the southwestern and western boundaries of ORR include the Clinch River and Poplar Creek in the vicinity of ORGDP and are established by the backwaters of Watts Bar Reservoir on the Tennessee River. In the vicinity of ORGDP, the Clinch River reach of Watts Bar Reservoir ranges in width from 90 to 180 m (300 to 600 ft) and in depth from 6.7 to 7.3 m (22 to 24 ft) at the full-pool elevation of 227 m (745 ft) (DOE 1979, p. 4-13). The average stream slope is ~0.45 m/km (2.4 ft/mile) from RK 0 to 129 (RM 0 to 80) (Alexander et al. 1984, Part B, p. 11). ORR is composed of a series of relatively small drainage basins traversed by streams that ultimately reach the Clinch River (Fig. 5.1-1). Poplar Creek in the ORGDP vicinity receives drainage from a 350-km^2 (136-$mile^2$) area, including the northwestern sector of the reservation. The topographic relief of this basin exceeds that of all others in the Oak Ridge area. Water flows from the Cumberland Mountain region of the Appalachian Plateau Province [elevations > 975 m (> 3200 ft)] to valleys in the Valley and Ridge Physiographic Unit [elevations ~ 220 m (740 ft) near the mouth]. The basin is ~65% wooded, and the remainder is primarily farmland (see Sect. 8.1). Some contamination of Poplar Creek occurs upstream of the site from the extensive surface coal mining that has occurred in the Cumberland Mountains.

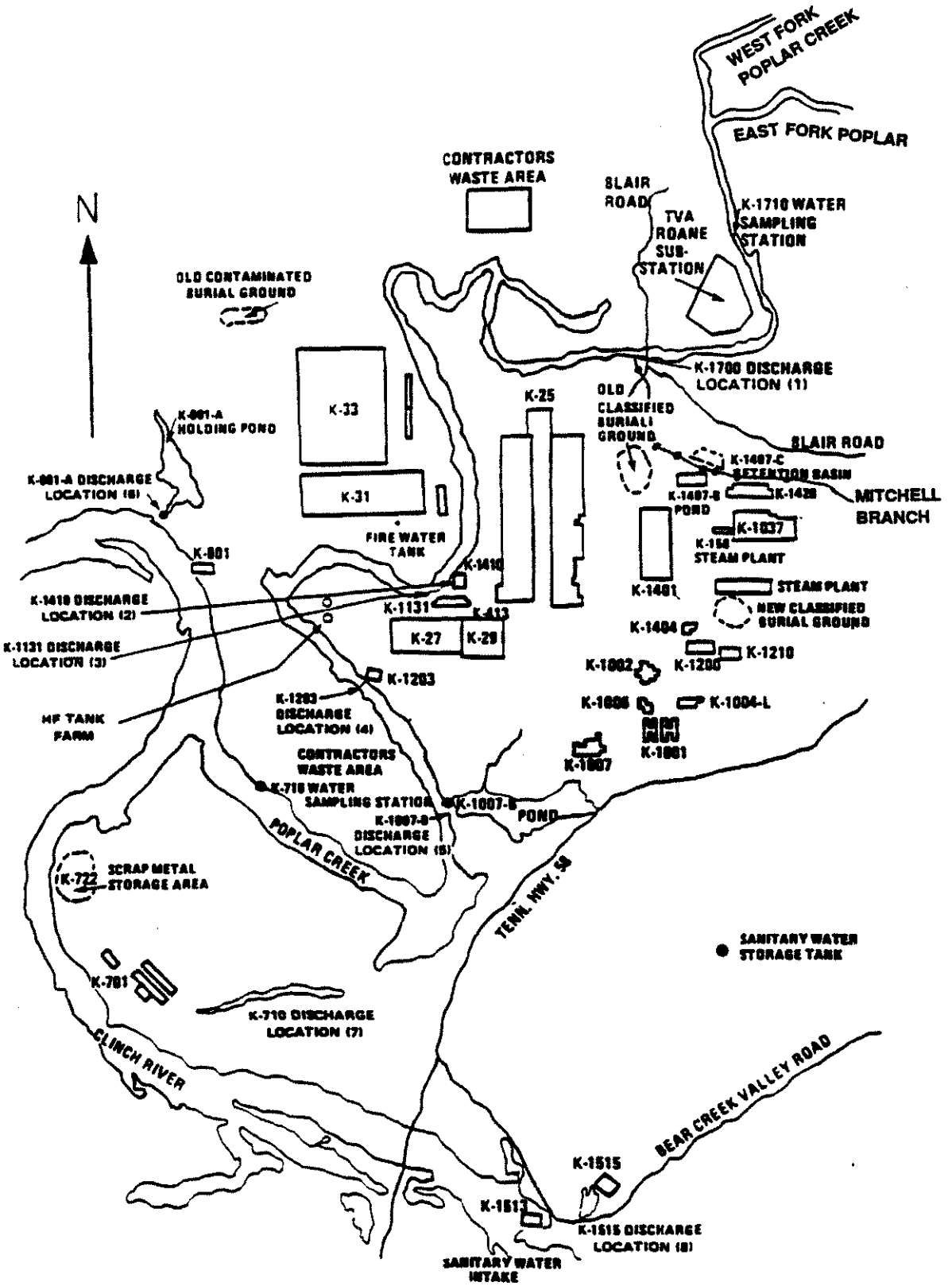


Fig. 5.1-1. Oak Ridge Gaseous Diffusion Plant Site Map. *Source:* modified from U.S. Department of Energy, *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site,* DOE/EA-0106, December 1979. *Note:* biological monitoring locations (•) for Mitchell Branch indicate locations of major facility drains to the creek.

Table 5.1-1. Average, minimum, and maximum flows for the major water bodies in the Oak Ridge Gaseous Diffusion Plant vicinity for 1988

Water body	Flow (m^3/s)[a] Average	Minimum (date)	Maximum (date)
Clinch River	128	0[b]	1120
Poplar Creek	4.6	0.1 (7/31, 8/5–6/87 8/25–26/87, 7/10–11/88)	322 (4/5/87)
East Fork Poplar Creek	1.4	0.33 (7/1/82)	116 (11/28/73)
Mitchell Branch (1987)	0.01[c]	0	

[a]Cubic meters per second can be converted to cubic feet per second by dividing the given values by 0.02832.
[b]Zero discharge has occurred on many days since the closure of the Melton Hill Dam gates in 1963.
[c]*Source:* Datum from J. G. Smith et al. *First Annual Report on the ORGDP Biological Monitoring and Abatement Program,* ORNL/TM-Draft, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1988.
Source: Data based on *Water Resources Data for Tennessee: U.S. Geological Survey Water Report,* TN-88.1, pp. 115, 131, and 132, prepared in cooperation with the state of Tennessee and other agencies.

East Fork Poplar Creek drains an area of 77 km^2 (30 $miles^2$) and empties into Poplar Creek at RK 8.8 (RM 5.5) (Fig. 5.1-1). The headwaters of East Fork Poplar Creek are located in the Y-12 Plant area, where they receive discharge in the form of cooling tower blowdown, waste-stream condensate, and process cooling water (Loar et al. 1988, p. 7). The creek flows northwestward through the city of Oak Ridge, where it receives discharge from the west-end sewage treatment plant following tertiary wastewater treatment (see Appendix I: Robinson 1989).

Flow in the Tennessee and Clinch rivers and Poplar Creek is highly influenced by discharge from Melton Hill and Watts Bar dams. Thus, flow in the vicinity of ORGDP can be upstream, downstream, or zero. Average, minimum, and maximum flows of record for the major water bodies in the ORGDP vicinity are shown in Table 5.1-1. For water year 1988, zero discharge at Melton Hill Dam occurred once in February and twice in March (USGS 1988, p. 115). The rare zero flow generally occurs on weekends when industrial power requirements are reduced. During peak demands, intermittent releases as great as 510 m^3/s (18,000 cfs) may occur on weekdays. Pulsations in river flow may be particularly pronounced in the late winter months, when reservoir levels are elevated because of heavy precipitation and the requirements for flood control and hydroelectric power generation are greatest.

5.1.2 Water Quality

Temperatures in the waters bordering ORR are generally characterized by minimum temperatures usually a few degrees above freezing and maximum temperatures lower than 27°C (80°F). Temperatures in the Clinch River may fluctuate drastically, however, as the result of hypolimnetic water releases from Melton Hill Reservoir and the backup of epilimnetic waters from Watts Bar Reservoir. Table 5.1-2 shows representative temperature data for water bodies near ORGDP. Table D.1-2 (Appendix D) provides more detailed temperature data for the Clinch River.

Several water chemistry surveys have been conducted in the vicinity of ORGDP (PMC, TVA, and ERDA 1977; Exxon 1976; DOE 1979). Water quality data collected during 1987 from the Clinch River and Poplar Creek in the vicinity of ORGDP (Rogers et al. 1988, Vol. 2, pp. 38–41) are summarized in Table 5.1-3. Results of water quality sampling in the Clinch River below Melton Hill Dam and in Mitchell Branch are presented in Appendix D, Table D.1-2 and Fig. D.1-1 respectively; Table D.1-3 provides general water quality information from 1977 through 1978 and Table D.1-4 provides information on water bodies in the ORGDP vicinity. The most recent general characterization of water quality in Poplar Creek and the Clinch River was documented in 1978. Information on historical effluent discharges from the ORGDP facility are detailed in the environmental assessment (EA) for the site (DOE 1982, Sects. 2.2.3 and 4.4). Information on National Pollutant Discharge Elimination System (NPDES) monitored effluent discharges from the ORGDP facility is contained in Tables 2.2.63 through 2.2.67 of Rogers et al. (1988, Vol. 2, pp. 118–35). Effluent discharge monitoring sites are shown in Fig. 5.1-2.

When compared with the primary and secondary national drinking water standards (EPA 1986), only nitrate nitrogen is elevated in the Clinch River and Poplar Creek. In 1987, nitrate nitrogen exceeded the primary drinking water standard (10 mg/L) between K-1710 (upstream) and K-716 (downstream) in Poplar Creek within the ORGDP boundaries (Fig. 5.1-1, Table 5.1-3) (Rogers et al. 1988, p. 63). Manganese also was elevated in the water quality samples; however, the source of manganese is upstream of the ORGDP

Table 5.1-2. Average, maximum, and minimum temperatures recorded for major water bodies in the Oak Ridge Gaseous Diffusion Plant vicinity

Water body	Temp. (°C)		
	Average	Maximum	Minimum
Clinch River[a]	14.9	20.5	8
Poplar Creek[a]	12.5	24.5	4.5
East Fork Poplar Creek[a]	12.5	22	5
Mitchell Branch[b] (April–June 1988)	21	29.5	12.1

[a]*Source:* Based on data from U.S. Geological Survey, *Water Resources Data for Tennessee: Water Data Report,* TN-88.1, pp. 116 and 302, prepared in cooperation with the state of Tennessee and other agencies, 1988.
[b]*Source:* J. G. Smith, *First Annual Report on the ORGDP Biological Monitoring and Abatement Program,* Draft ORNL/TM report, pp. 19–22, Oak Ridge National Laboratory, Oak Ridge, Tenn.

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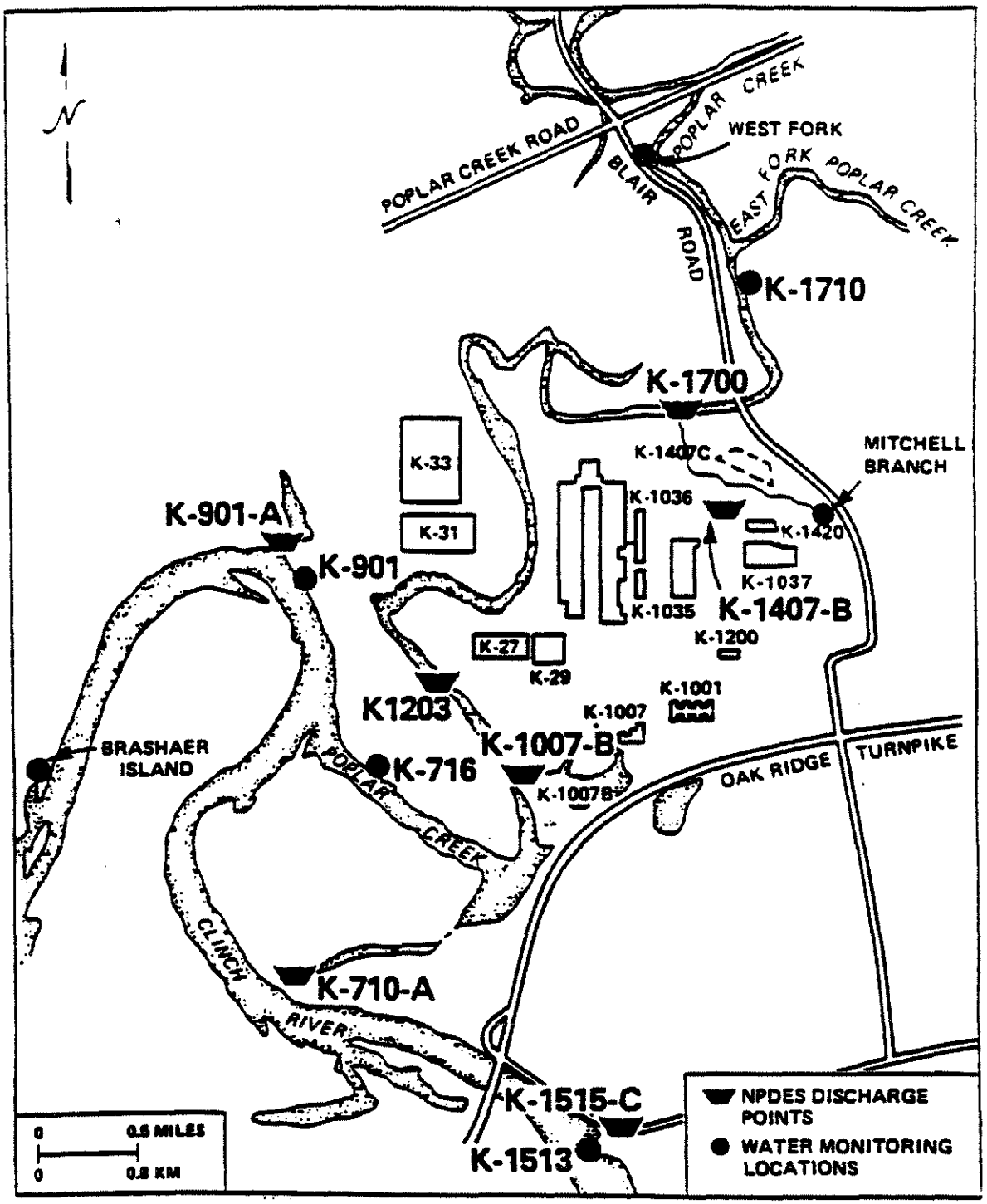

Fig. 5.1-2. Oak Ridge Gaseous Diffusion Plant and perimeter National Pollutant Discharge Elimination System (NPDES) discharge points and water monitoring locations. *Source:* Reprinted from J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987,* ES/ESH-4V1, p. 62, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April 1988, 247 pp.

Table 5.1-3. Water quality data from the Clinch River and Poplar Creek in the Oak Ridge Gaseous Diffusion Plant vicinity for 1987

1987 concentrations at West Fork Poplar Creek[a]			
Parameter[c]	Concentration (mg/L)		
	Max	Min	Av
Arsenic	<0.005	<0.005	<0.005
Mercury	<0.0002	<0.0002	<0.0002
COD	11	<5	<7
SS	29	1	12
DS	252	116	186
pH (units)	8.0	7.3	
Cyanide	0.01	<0.002	<0.003
Ammonia nitrogen	<0.2	<0.2	<0.2
Fluoride	0.3	<0.1	<0.2
Nitrate nitrogen	1.3	<0.11	<0.35
Sulfate	80	27	44
Chromium	<0.01	<0.01	<0.01
Copper	<0.004	<0.004	<0.004
Manganese	0.38	<0.010	<0.102
Nickel	<0.050	<0.050	<0.050
Sodium	7.3	2.4	5.2
Zinc	0.054	<0.020	<0.023
Cadmium	<0.002	<0.002	<0.002
Lead	0.014	<0.004	<0.005

1987 concentrations at K-716[b]			
Parameter[c]	Concentration (mg/L)		
	Max	Min	Av
Arsenic	<0.005	<0.005	<0.005
Mercury	0.0005	<0.0002	0.0002
COD	14.5	<5	<7.1
SS	22	5	14
DS	214	136	177
pH (units)	8.5	7.6	
Cyanide	0.14	<0.002	<0.005
Ammonia nitrogen	0.2	<0.2	<0.2
Fluoride	0.6	<0.1	<0.2
Nitrate nitrogen	33.6	0.24	3.38
Sulfate	40	23	30
Chormium	<0.01	<0.01	<0.01
Copper	0.054	<0.004	0.009
Manganese	1.5	<0.01	<0.08
Nickel	<0.050	<0.050	<0.050
Sodium	8.6	4.0	6.7
Zinc	0.054	<0.020	<0.023
Cadmium	<0.002	<0.002	<0.002
Lead	0.005	<0.004	<0.004

Table 5.1-3. (continued)

Parameter[c]	1987 concentrations at K-1710[d] Concentration (mg/L) Max	Min	Av	1987 concentrations at Clinch River[e] Concentration (mg/L) Max	Min	Av
Arsenic	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mercury	0.0004	<0.0002	0.0002	<0.0002	<0.0002	<0.0002
COD	11	<5	<7	28	<5	<9
SS	17	4	11	13	<4	<8
DS	310	132	215	216	138	165
pH (units)	8.0	7.7		8.4	7.6	
Cyanide	0.017	<0.002	<0.006	0.003	<0.002	<0.002
Ammonia nitrogen	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluoride	0.70	<0.10	<0.44	0.5	<0.1	<0.1
Nitrate nitrogen	10	0.68	2.0	0.61	0.17	0.40
Sulfate	49	32	40	25	14	21
Chromium	0.041	<0.010	<0.013	<0.01	<0.01	<0.01
Copper	0.050	<0.0040	<0.008	<0.004	<0.004	<0.004
Manganese	0.250	0.022	0.114	0.074	<0.01	0.02
Nickel	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Sodium	15.0	4.0	10.0	5.6	2.6	4.7
Zinc	0.13	<0.02	<0.03	0.24	<0.02	<0.02
Cadmium	<0.002	<0.002	<0.002	0.003	<0.002	<0.002
Lead	0.007	<0.004	<0.004	0.025	<0.004	<0.007

[a]See Fig. 5.1-1. *Source:* Based on J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/VI, prepared by Martin Marietta Energy Systems, Inc., for U.S. Department of Energy, April 1988, 247 pp., Table 2.2.13.

[b]*Source:* Based on J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/V1, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April 1988, 247 pp., Table 2.2.8.

[c]COD = Chemical oxygen demand.
SS = Suspended solids.
DS = Dissolved solids.

[d]*Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/V1, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April 1988, Table 2.2.7.

[e]*Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/V1, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April 1988, Table 2.2.11.

facility (Rogers et al. 1988, p. 63). No standards have been established for manganese. Conductivity and hardness in Mitchell Branch increased with distance downstream through the ORGDP site. Total residual chlorine also increased in the creek as the result of ORGDP discharge, although levels were usually near zero before the discharge entered Poplar Creek (Smith et al. 1988, pp. 44–46).

The Clinch River and Poplar Creek can be characterized as moderately hard water bodies. The principal cation is calcium, and the anionic composition is dominated by bicarbonate and carbonate. Consequently, these waters are well buffered and have a slightly alkaline pH that seldom varies more than one pH unit (Table 5.1-3).

Studies of heavy-metal concentrations in the sediments of the Clinch River above and below ORGDP (Loar et al. 1981, pp. 64–70) showed that chromium, copper, lead, mercury, nickel, and zinc were elevated (Table 5.1-4). All of these metals have historically been discharged at one or more locations at ORGDP. The concentrations of metals in the sediments varied among sites and were determined to vary according to sampling method and analysis (Loar et al. 1981, pp. 64–70). Table 5.1-5 shows the concentrations of various elements in Clinch River and Poplar Creek sediments near ORGDP in 1987; Fig. 5.1-3 shows the location of these sampling sites. Concentrations of selected metals from a 1984 survey are shown in Table 5.1-6 (TVA 1985, Vol. 1, p. 51). Comparison of 1978, 1984, and 1987 results show that metal levels continue to be elevated in stream sediments in the ORGDP vicinity.

The water quality of Mitchell Branch within the ORGDP facility is heavily influenced by process water and storm drain effluents. Discharge from the facility to Mitchell Branch accounts for ~31% of the flow in the lower portion of the stream (Smith et al. 1988, pp. 3–6). Water quality in Mitchell Branch is characterized by (1) moderate levels of dissolved solids and occasional high levels of turbidity, (2) relatively low levels of nutrient enrichment, (3) elevated levels of most metals and some organics, and (4) high temperatures (Smith et al. 1988, p. 13). Seven of the nine metals measured exceeded concentrations that are typical of small, relatively undisturbed streams on ORR. With the exception of aluminum, lead, and zinc, all metals had a median concentration at or below the detection limit in each of the past three years (Smith et al. 1988, pp. 14–16) (see Tables 5.1-7 and 5.1-8).

5.1.3 Water Use

At full-scale operation, ORGDP withdrew 0.4 m^3/s (15 cfs) of water from the Clinch River for makeup cooling water. As a result of the plant's conversion to standby status in 1985, the current cooling water makeup demand is 0.2 m^3/s (7 cfs) (see Appendix I: Bowman 1989). ORGDP withdraws 0.19 m^3/s (3 cfs) from the Clinch at K-1513 (Fig. 5.1-1) for sanitary purposes and cooling water makeup as well as fire suppression (see Appendix I: Bowman 1989). The current total water withdrawal for ORGDP at CRK 18.5 (CRM 11.5) [0.1 m^3/s (3.8 cfs)] ~ 0.08% of the average flow. Of the total withdrawal, ~10% [0.01 m^3/s (0.38 cfs)] is returned to the river as treated sewage or blowdown water. No other industrial or municipal users withdraw water from the Clinch River in the ORGDP vicinity (Alexander et al. 1984, Part B, p. 274). The city of Kingston withdraws ~0.014 m^3/s (0.49 cfs) from the Clinch River ~ 34 km (21 miles) downstream from ORR. This volume supplies ~9% of the city's municipal water needs; the remainder is obtained from groundwater (Oakes et al. 1987, p. 14).

Table 5.1-4. Mean concentrations (μg/g, dry wt; range in parentheses) of nine elements in sediment samples[a] collected during three surveys at various stations in the Clinch River in the vicinity of the Oak Ridge Gaseous Diffusion Plant (ORGDP)

Element	CRBR survey[b]		ORGDP survey		1974-75 survey
	March 1974 (CRM 17.9-15.1)	April 1975 (CRM 17.9-15.1)	(CRM 12.5)	(CRM 9.8)	(CRM 11.0)
Al	6240 (3,900–10,000)	>10,000 (*c*)	32,000 (24,000–40,000)	N/A	N/A
Cd	<2 (*c*)	<0.5 (*c*)	<5 (*c*)	<5 (*c*)	<2 (<2–2)
Cr	16 (5–30)	20 (*c*)	55 (38–92)	87 (48–126)	21 (10–32)
Cu	18 (15–25)	11 (7–15)	23 (13–40)	16 (8–23)	34 (14–54)
Pb	<15 (*c*)	26 (22–31)	36 (10–90)	38 (28–47)	22 (20–24)
Mn	1900 (700–2900)	400 (*c*)	1290 (230–2290)	406 (180–632)	N/A
Hg	<100 (*c*)	0.04 (0.02–0.08)	<0.4 (<0.1–0.5)	0.35 (0.3–0.4)	34.6 (17.3–51.9)
Ni	7 (5–10)	40 (*c*)	179 (27–600)	55 (36–73)	N/A
Zn	46 (30–60)	33 (30–40)	75 (28–120)	45 (14–75)	NS

[a]Values based on bulk (unsieved) samples in ORGDP study. Samples sieved through 0.635-cm (0.25-in.) mesh and No. 30 (520-μm) mesh screens in the CRBR and 1974-75 studies respectively. The number of samples (n) collected were as follows: CRBR survey, n = 5 (March) and n = 3 (April); ORGDP survey, n = 4 (Station PS-1) and n = 2 (Station PS-20); 1974-75 survey (n = 2). N/A = data not available in μg/g. NS = not sampled.

[b]*Source:* Project Management Corporation (1975), Tables 2.7-=37 and 2.7-38.

[c]All samples. *Source:* Loar et al. (1981, p. 69, Table 1.4-8).

Table 5.1-5. 1987 concentrations of various elements in stream sediment samples near Oak Ridge Gaseous Diffusion Plant[a]

Element		Concentration (μg/g, dry wt)[b]							
		SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8
Aluminum	Oct	7.000	5.700	9.000	140.000	130.000	8.600	6.500	5.200
	Nov	15.000	14.000	11.000	14.000	15.000	13.000	5.000	2.600
	av	11.000	9.850	10.000	77.000	72.500	10.800	5.750	3.900
Cadmium	Oct	<0.30	<0.30	<0.30	<0.30	0.30	<0.30	<0.30	<0.30
	Nov	<0.30	1.5	<0.30	<0.30	2.5	<0.30	<0.30	<0.30
	av	<0.30	<0.9	<0.30	<0.30	1.4	<0.30	<0.30	<0.30
Chromium	Oct	33	22	15	39	39	32	9.9	9.4
	Nov	26	41	22	31	260	70	11	6.2
	av	29.5	31.5	18.5	35	149.5	51	10.5	7.8
Copper	Oct	24	12	16	130	49	22	8.1	4.4
	Nov	17	69	30	43	83	68	9.2	2.9
	av	20.5	40.5	23	86.5	66	45	8.7	3.7
Lead	Oct	18.1	12.6	16.6	45	46	19.5	9.1	9.1
	Nov	16	41	22.8	32	94	20	13.9	5.0
	av	17.1	26.8	19.7	38.5	70	19.8	11.5	7.1
Manganese	Oct	270	170	490	720	920	650	2,000	560
	Nov	560	660	610	690	510	600	860	390
	av	415	415	550	705	715	625	1,430	475
Mercury	Oct	6.4	5.3	3.7	5.9	25	7.2	<1.0	<1.0
	Nov	1.2	32	6.0	5.1	33	25	<1.0	<1.0
	av	3.8	18.7	4.9	5.5	29	16.1	<1.0	<1.0
Nickel	Oct	35	33	25	240	27	37	9.8	9.1
	Nov	24	120	43	69	36	69	10	5.2
	av	29.5	76.5	34	154.5	31.5	53	9.9	7.2
Thorium	Oct	<20	<20	<20	<20	<20	<20	<20	<20
	Nov	<20	<20	<20	<20	<20	<20	<20	<20
	av	<20	<20	<20	<20	<20	<20	<20	<20
Uranium	Oct	5	5	6	8	14	7	3	2
	Nov	0.5	1.0	0.9	1.4	4.01	1.2	0.03	<0.2
	av	2.8	3	3.5	4.7	9	4.1	1.5	<1.1
Zinc	Oct	80	51	65	140	150	75	45	27
	Nov	65	140	110	140	160	91	36	14
	av	72.5	95.5	87.5	140	155	83	40.5	20.5

[a]See Fig. 5.1-3.

[b]SS1, SS2, SS3, SS4, SS5, SS6, SS7, and SS8 = sediment sampling stations.

Source: J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/VI, prepared by Martin Marietta Energy Systems, Inc., for U.S. Department of Energy, April 1988, 247 pp.

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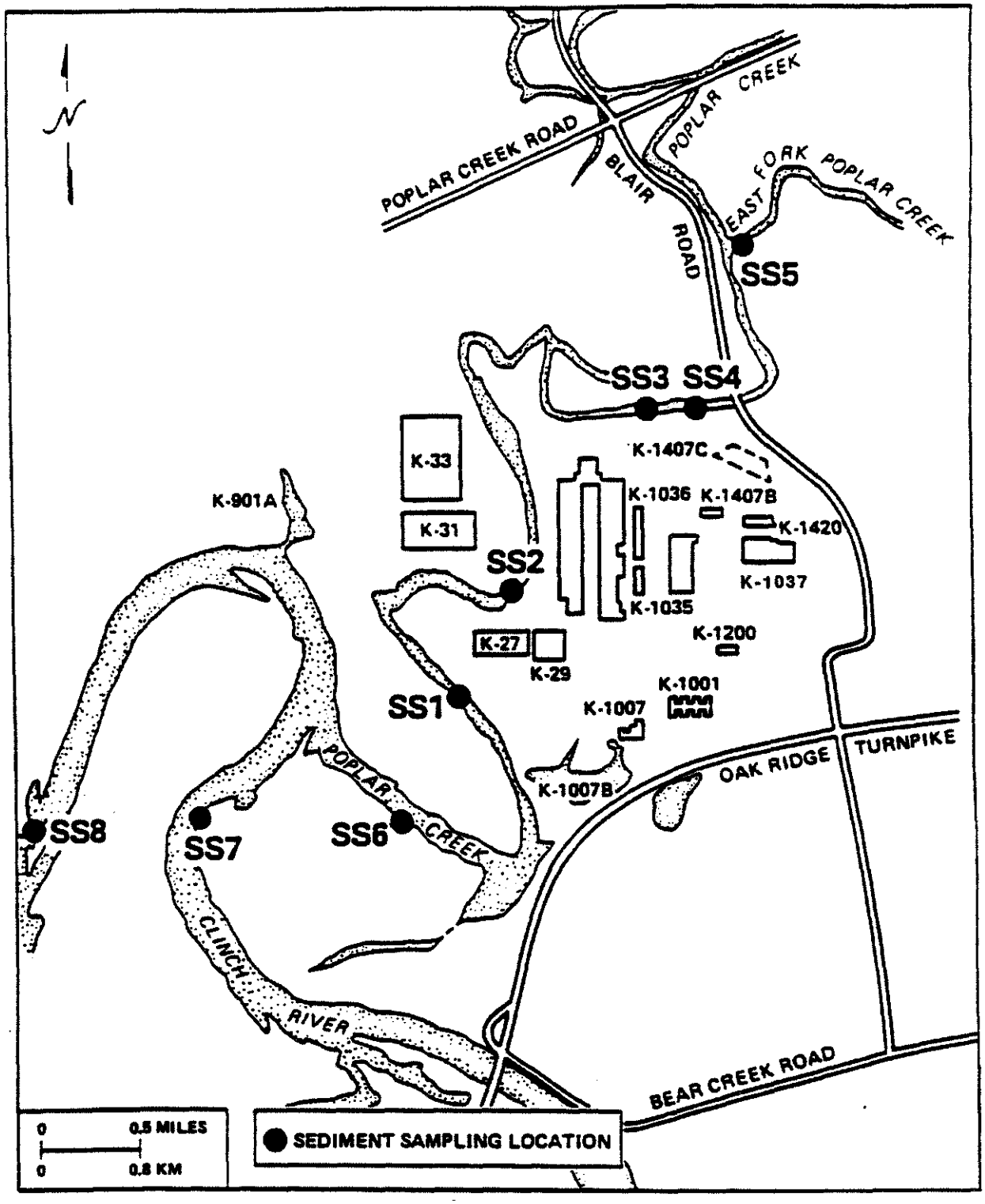

Fig. 5.1-3. Stream sediment sampling locations at Oak Ridge Gaseous Diffusion Plant. *Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987,* ES/ESH-4/V1, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April 1988, 247 pp.

Table 5.1-6. Concentrations of metals in stream sediment samples collected in the Oak Ridge Gaseous Diffusion Plant vicinity in 1984
[All values are given in parts per million (equivalent to mg/kg).]

Metal	East Fork Poplar Creek			Bear Creek			White Oak Creek			Poplar Creek		
	Max	Min (n=16)	Mean	Max	Min (n=3)	Mean	Max	Min (n=4)	Mean	Max	Min (n=3)	Mean
Hg	165.0	11.0	40.0	0.7	<0.1	0.3	6.0	2.2	3.3	5.9	0.1	3.4
As	14.0	3.8	6.9	11.0	4.8	6.5	12.0	5.0	8.7	11.0	7.4	8.9
Ca	8.2	<0.5	1.6	8.6	<0.5	8.6	2.4	0.6	1.4	3.5	2.1	2.9
Cr	58.0	24.0	37.0	35.0	16.0	22.0	290.0	66.0	163.0	38.0	19.0	27.0
Pb	170.0	36.0	30.0	85.0	35.0	52.0	51.0	33.0	40.0	38.0	23.0	32.0
Ni	74.0	20.0	37.0	155.0	28.0	67.0	30.0	24.0	26.0	65.0	43.0	56.0
Ag	45.0	2.0	8.0	<1.0	<1.0	<1.0	10.0	2.0	6.0	2.0	<1.0	2.0
Zr	590.0	350.0	448.0	500.0	430.0	500.0	480.0	260.0	365.0	470.0	220.0	340.0

Metal	Clinch River (Watts Bar)			Background station: Clinch River (Melton Hill)			Background station: Norris Reservoir[b]		
	Max	Min (n=4)	Mean	Max	Min (n=1)	Mean	Max	Min (n=3)	Mean
Hg	2.8	0.3	0.8	<0.1	<0.1	<0.1	0.1	0.1	0.1
As	11.0	5.1	8.1	17.0	17.0	17.0	26.0	16.0	22.0
Ca	4.2	0.7	1.8	0.5	0.5	0.5	<0.5	<0.5	<0.5
Cr	25.0	9.0	16.0	25.0	25.0	25.0	23.0	21.0	22.0
Pb	38.0	14.0	30.0	28.0	28.0	28.0	77.0	58.0	67.0
Ni	38.0	14.0	21.0	36.0	36.0	36.0	28.0	24.0	26.0
Ag	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zr	890.0	400.0	650.0	230.0	230.0	230.0	270.0	180.0	220.0

[a]N = number of samples collected.
[b]Values for Norris Reservoir include Clinch River miles 85.3 and 94.1 and Powell River mile 6.0.
Source: TVA (Tennessee Valley Authority), *Sediment Characterization Task 2, Instream Contaminant Study*, Office of National Resources and Economic Development, Tennessee Valley Authority, 82 pp., 1985, p. 51, Table 15.

Table 5.1-7. Median and range of concentrations of the 24 National Pollutant Discharge Elimination System parameters measured in water from lower Mitchell Branch[a] in the vicinity of the Oak Ridge Gaseous Diffusion Plant in 1985 and 1986[b]

Parameter	Type of sample[c]	Sampling frequency[d]	1985 Median	1985 Range	1986 Median	1986 Range
Organics, μg/L						
Halomethanes, total	2	3	<10	all <10	<10	5–9
Methylene chloride	2	1	<3	<3–13	<5	<5–15
Tetrachloroethene	2	1	<5	<4–26	<5	<5–13
1,1,1-trichloroethane	2	1	5	<4–20	<5	<5–32
Trichloroethene	2	1	40	<2–150	60	<5–130
Metals, μg/L						
Aluminum[e]	1	1	0.40	0.10–12.4	0.38	0.02–11.0
Beryllium	1	1	<1	all <1	<1	<0.3–<3
Cadmium	1	1	<2	<2–13	<2	<2–4
Chromium	1	1	<10	<10–50	10	<10–30
Lead	1	1	<5	<4–20	6	<4–24
Mercury	1	1	<1	<0.2–<1	<0.2	<0.2–0.7
Selenium	1	1	<5	<2–60	<5	<5–8
Silver	1	1	<10	all <10	<10	all <10
Zinc	1	1	50	<20–560	30	4–100
Conventional parameters						
Chemical oxygen demand[f]	1	2	11	<5–59	8	3–51
Dissolved solids[f]	1	1	376	133–981	604	175–2,245
Flow, L/min[f]	2	4	943	15–13,319	562	16–11,830
Fluoride	1	1	0.35	0.15–1.10	0.40	<0.10–1.5
Nitrate nitrogen[f]	1	1	0.92	0.27–4.85	0.40	<0.11–5.7
Oil and grease, mg/L	2	1	<2	<2–5	2	<2–11
pH, units	3	4	7.4	6.1–8.9	7.5	6.1–9.0
Suspended solids	1	2	16	1–62	9	<1–47
Temperature, °C	2	2	15.5	5.5–25.0	17.5	4.5–24.5
Turbidity, NTU[f,g]	2	2	12	2–260	10	2–200

[a]At river kilometer 0.12.

[b]Values were computed from the average, maximum, and minimum monthly values.

[c]1 = 24-h composite; 2 = grab; 3 = continuous.

[d]1 = two times per week; 2 = four times per week; 3 = four times per year; 4 = daily.

[e]Value is given in milligrams per liter.

[f]Median was greater than ±10% of mean; mean values ± standard deviation for these parameters in 1985 and 1986, respectively, were: chemical oxygen demand (10 ± 3 and 9 ± 2 mg/L); dissolved solids (429 ± 128 and 627 ± 159 mg/L); flow (997 ± 506 and 753 ± 617 L/min); nitrate nitrogen (0.98 ± 0.33 and 0.50 ± 0.28 mg/L); and turbidity (14 ± 7 and 12 ± 9 NTU).

[g]NTU = Nephelometric turbidity unit.

Source: J. G. Smith, *First Annual Report on the ORGDP Biological Monitoring and Abatement Program*, draft, ORNL/TM, Oak Ridge National Laboratory, Oak Ridge, Tenn., 125 pp., 1988, p. 14, Table 2-4.

Table 5.1-8. Comparison of 1987 mean values for the 24 National Pollutant Discharge Elimination System parameters routinely monitored in lower Mitchell Branch[a] and in the vicinity of the Oak Ridge Gaseous Diffusion Plant and in three storm drains[b,c]

	Mitchell Branch		Storm drain[d]		
	Median	Mean[e]	170	180	190
Organics, μg/L					
Halomethanes, total	6	6 (all 6)	f	f	f
Methylene chloride	<5	<5 (<5)	<5 (all <5)	5 (<2–10)	5 (<1–5)
Tetrachloroethene	<5	<5 (<5–29)	17 (<5–110)	5 (<2–5)	5 (<1–5)
1,1,1,-trichloroethane	<5	<5 (<5–11)	9 (<5–44)	50 (12–170)	5 (<1–10)
Trichloroethene	53	59 (<5–510)	55 (13–330)	50 (9–100)	5 (<2–11)
Metals, μg/L					
Aluminum[g]	0.27	0.56 (<0.08–12)	0.4 (<0.1–2.9)	0.97 (<0.05–12)	0.23 (<0.02–1.3)
Beryllium	<1	<1 (all <6)	<1 (all <1)	<1 (all <1)	<1 (all <1)
Cadmium	<2	2 (<2–12)	<3 (all <3)	<3 (all <3)	3 (<3–3.4)
Chromium	10	11 (<10–23)	17 (<10–32)	<10 (all <10)	<10 (all <10)
Lead	5	5 (<4–<36)	<50 (all <50)	<50 (all <50)	<50 (all <50)
Mercury	0.2	0.2 (<0.2–0.8)	<0.2 (all <0.2)	0.3 (<0.2–0.5)	0.4 (<0.2–0.8)
Selenium	<5	<5 (all <5)	<5 (all <5)	<5 (all <5)	<5 (all <5)
Silver	<10	<10 (all <10)	<10 (all <10)	<10 (all <10)	<10 (all <10)
Zinc	30	40 (<20–320)	32 (<20–65)	25 (<11–86)	49 (32–90)
Conventional parameters, mg/L					
Chemical oxygen demand	9	10 (<3–38)	6 (<3–11)	12 <3–38)	12 (<5–21)
Dissolved solids	547	517 (208–1,264)	259 (182–440)	398 (214–1,830)	291 (170–698)
Flow, L/min	421	576 (11–647)	f	f	f
Fluoride	0.5	0.6 (<0.01–6)	0.2 (<0.1–0.3)	0.2 (<0.1–1)	0.2 (<0.1–0.4)
Nitrate nitrogen[h]	0.53	0.72 (<0.11–7.68)	3.7 (1.7–10)	0.29 (<0.11–0.38)	0.50 (0.27–0.79)
Oil and grease	<2	<2 (all <2)	<2 (all <2)	(<2–4)	2 (<2–3)
pH	f	6.8–8.9	7.9 (7.6–8.3)	8.1 (7.6–8.8)	7.9 (7.0–8.5)
Suspended solids	9	9 (<1–46)	6 (<1–12)	9 (<1–71)	10 (<1–39)
Temperature, °C	16	15 (3–30)	19 (8–23)	17 (11–24)	18 (12–24)
Turbidity, NTU[h]	7	9 (<1–>180)	7 (<1–26)	20 (<1–180)	9 (<1–58)

[a]At river kilometer 0.12.
[b]See Fig. 5.1-1 for locations of drains. Drains were sampled between March and July 1987.
[c]Median values are presented for comparison with results in 1985 and 1986; sampling frequencies in the three years was the same.
[d]Additional information on sources and numbers of samples analyzed is given in Smith et al. (1988), p. 12.
[e]"Less than" values ignored in computing the mean.
[f]Not measured.
[g]mg/L.
[h]NTU = Nephelometric turbidity unit.

Source: Based on J. G. Smith et al., *First Annual Report on the ORGDP Biological Monitoring and Abatement Program*, draft, ORNL/TM, Oak Ridge National Laboratory, Oak Ridge, Tenn., 125 pp., 1988.

Reservoirs in the ORGDP vicinity (Melton Hill and Watts Bar) are used for both commercial and recreational boating. The number of recreational, commercial, and government vessels locked through Melton Hill Dam from 1987 through 1989 averaged 55, 1, and 5 vessels per year respectively (see Appendix I: Tolbert 1990f). Both Melton Hill and Watts Bar reservoirs are used extensively for recreation including swimming, fishing, and boating, although these uses are not quantified. Recreational fishing near the ORGDP site is limited to the Clinch River at the mouth of Poplar Creek; upstream, the creek is on government property.

5.2 PADUCAH

5.2.1 Hydrology

The Paducah Gaseous Diffusion Plant (PGDP) site is located in the western part of the Ohio River Basin (Fig. 5.2-1). Surface drainage from the site is to Big Bayou Creek on the western part of the site and Little Bayou Creek to the east (Fig. 5.2-2). These creeks join north of the site and empty into the Ohio River at approximately RK 1524 (RM 947). This location is ~55 km (34 miles) upstream of the confluence of the Ohio and Mississippi rivers. The site elevation ranges from 112 to 116 m (367 to 380 ft) above sea level (DOE 1982, p. 3-4). The PGDP site is above the historical high-water elevation [104.2 m (341.7 ft)] for the Ohio River; the site has not been affected by flooding (USGS 1988, p. 123) and is not located on the Ohio River 100-year floodplain (FEMA MAP 210151 0001-0095 1980).

The average discharge of the Ohio River at Metropolis, Illinois, ~6 km (4 miles) upstream from the confluence of Big Bayou and Little Bayou Creeks, is 7600 m^3/s (269,100 cfs) for the 60-year period of record (USGS 1988, p. 123). The maximum river discharge of 50,380 m^3/s (1,780,000 cfs) occurred on January 1, 1937, and the minimum discharge of 430 m^3/s (15,000 cfs) occurred on July 30, 1930 (USGS 1988, p. 123). Monthly discharge data for the Ohio River at Metropolis are given in Appendix D, Tables D.2-1, D.2-2, and D.2-3, for water years 1986, 1987, and 1988.

Big Bayou Creek drains an area of 48.2 km^2 (18.6 $miles^2$), including Little Bayou Creek. The basin is about 13 km (8.3 miles) in length and has an average length-to-width ratio of 3.7. Elevation of the basin ranges from 137 m (450 ft) at the headwaters to 88 m (290 ft) at the confluence with the Ohio River. Stream gradient decreases from about 14 m/km (75 ft/mile) in the extreme upper part of the basin to about 2 m/km (10 ft/mile) near the Ohio River (DOE 1982, p. 3-2).

Little Bayou Creek drains an area of 22 km^2 (8.5 $miles^2$). The basin is 10 km (6 miles) long and has an average length-to-width ratio of 4.2. Elevation of the basin ranges from 130 m (424 ft) in the headwater area to 88 m (290 ft) at the confluence with Big Bayou Creek. The stream gradient decreases from 9.5 m/km (50 ft/mile) in the headwater area to 2 m/km (10 ft/mile) at the mouth (DOE 1982, p. 3-2).

Both Big Bayou and Little Bayou creeks experience rapid rises in streamflow in response to precipitation. In the absence of discharge from the plant, both creeks are often dry on numerous days during May, June, October, and November (DOE 1982, p. 3-3). [Discharge from PGDP constitutes all of the normal flow in Little Bayou Creek and 85% of the flow in Big Bayou Creek (Rogers and Ashburn 1988, pp. 15 and 19).]

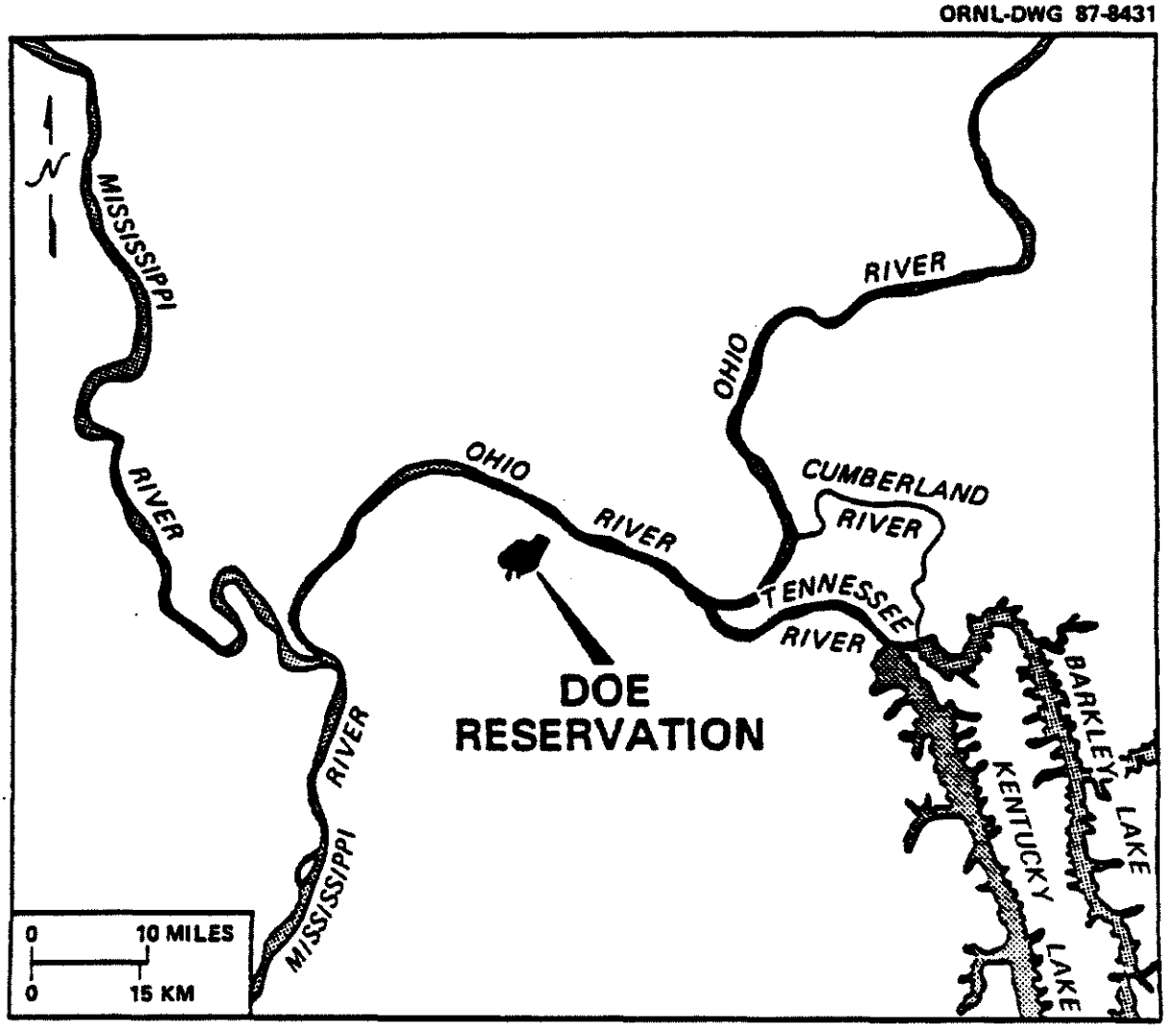

Fig. 5.2-1. Major surface waters in the Paducah Gaseous Diffusion Plant vicinity. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988.

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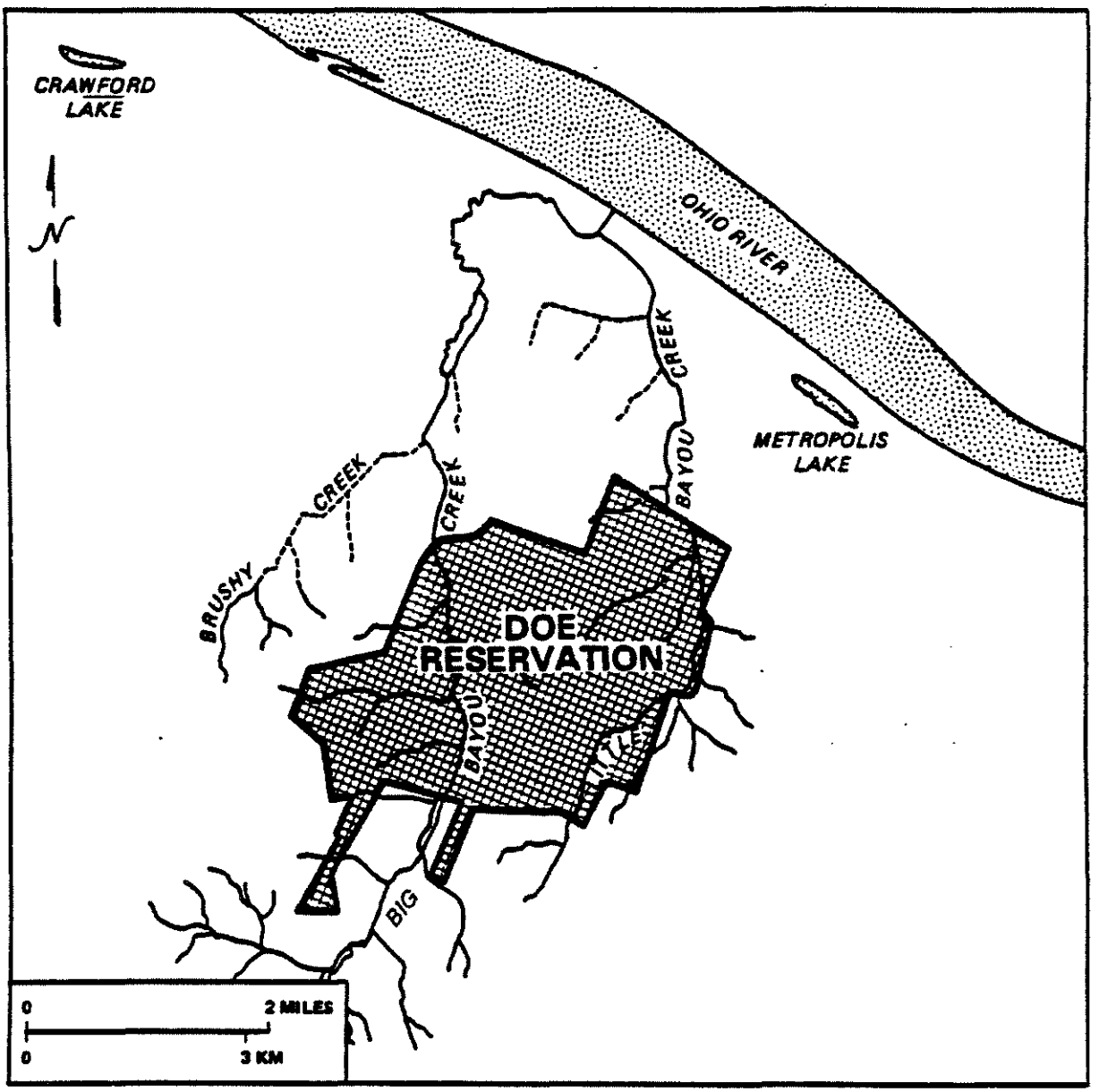

Fig. 5.2-2. Paducah Gaseous Diffusion Plant site surface hydrology systems. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988.

5.2.2 Water Quality

The water quality in the PGDP area is determined by land use, soil type, and industrial and municipal discharges. Although patches of forest exist within the area, the primary land use is agriculture (see Sect. 8.2). In addition to suspended material from agriculture and storm water runoff, waters in the region receive inputs of heavy metals via industrial and municipal discharges from urban areas. Industrial discharges to the Ohio River in the PGDP vicinity have a variety of sources (see Sect. 5.2.3). Radionuclides (primarily uranium and technetium), fluoride, nitrates, residual chlorine, chromium, and zinc are elevated in Little Bayou and Big Bayou creeks as the result of discharges from PGDP (DOE 1982, p. 3-39). Trace quantities of oil and grease and other chemicals also may occur in the plant discharge.

The water quality downstream from the discharge points of PGDP to Big Bayou and Little Bayou creeks and upstream and downstream of this discharge to the Ohio River is summarized in Table 5.2-1. Detailed information on the water quality at these sites and at Lock and Dam 53 is provided in Appendix D, Tables D.2-4 through D.2-8.

Flow in Big Bayou and Little Bayou creeks is primarily the result of discharges from PGDP. Thus, the water quality in the two streams is heavily influenced by the quality of the effluent discharges from PGDP. Historically, the ammonia level in Big Bayou Creek upstream of the PGDP site was elevated as the result of sanitary waste discharges from a small school or from industrial solid waste leachate from the old ordnance works (DOE 1982, p. 3-45). Prior to installation of a chromate-removal system at PGDP in 1977, levels of chromium and zinc were elevated in Little Bayou Creek. Discharge was routed from Little Bayou Creek to Big Bayou Creek to minimize the effect of cooling tower discharge on water quality in the creeks. Residual chlorine in the discharge from the cooling towers continues to cause elevated chlorine levels in the creeks (Oakes et al. 1987, p. 163; Birge et al. 1988, p. 2). Available water quality data for these two creeks are provided in Appendix D, Tables D.2-9 and D.2-10.

Table 5.2-2 summarizes the results of NPDES monitoring at six PGDP outfalls in 1987. The values at Monitoring Station 001 summarize the contribution of all outfalls on the west side of the facility to Big Bayou Creek. The results show that, of the eight parameters monitored, only temperature and pH exceeded the effluent limits in 1987. Station 002 summarizes all facility discharges to Little Bayou Creek on the east side of the site. The results of the monitoring show that, of the seven parameters monitored, only temperature exceeded the effluent limits. Before the 1982 installation of a chromium treatment system, the effluent limit for chromium was consistently exceeded (DOE 1982, pp. 3-44 and 3-45). The location of the monitoring sites for the 1987 NPDES permit are shown in Fig. 5.2-3. Aluminum, cadmium, copper, iron, and lead were found to be elevated in effluents from PGDP (Birge et al. 1988, pp. 2 and 83–93). Tables 5.2-3 and 5.2-4 summarize metal concentrations in receiving waters and freshwater criteria for protection of aquatic biota respectively.

In October 1987, the state of Kentucky issued a Kentucky Pollutant Discharge Elimination System (KPDES) permit for PGDP, with interim limits established until completion of a biological monitoring program. Under the KPDES permit, monitoring sites were moved from Big Bayou and Little Bayou creeks to sites on all ditches with effluent from the plant (Fig. 5.2-4). The results of compliance monitoring under limits established by the KPDES permit are presented in Table 5.2-5, which shows that chlorine levels

Table 5.2-1. Summary of water quality parameters measured in Big and Little Bayou Creeks downstream of the Paducah Gaseous Diffusion Plant facility and upstream and downstream of their discharge to the Ohio River (mg/L)

							Ohio River					
	Big Bayou Creek			Little Bayou Creek			Upstream			Downstream		
Parameter	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
pH	8.9	6.4	NA[a]	8.1	6.7	*a*	7.8	7.0	*a*	7.8	7.1	*a*
Chromium (Cr^{+6})	0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.01	<0.01	<0.01
Fluoride	1.90	0.18	0.31	0.37	0.15	0.25	0.25	0.11	0.16	0.23	0.10	0.17
NO_3 as N	2.0	<0.1	<0.8	1.3	<0.1	<0.4	3.0	<0.1	1.0	2.7	0.1	0.9
SO_4	236	41	105	760	8	40	59	16	35	61	18	40
Cl	101	14	47	46	11	25	26	10	15	26	10	16

[a]Not applicable for pH.

Source: Compiled from J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, Pt. 2, Tables 2.2.3, 2.2.4, 2.2.6, and 2.2.7.

Table 5.2-2. National Pollutant Discharge Elimination System monitoring at the Paducah Gaseous Diffusion Plant
(January 1 through October 12, 1987)

Discharge point[a]	Effluent parameter	Effluent limits (mg/L) Daily average	Daily maximum	Sources out of compliance	Number of percent of measurements in compliance
001 (Big Bayou Creek)	Chromium, total	0.3	0.5		100
	Chromium, 6+	0.05	0.08		100
	Dissolved oxygen[b]				100
	Dissolved solids	1000	1500		100
	Fluoride	3.5	4.0		100
	Oil and grease	10	15		100
	Temperature, °F[c]			6	97.9
	pH, units[d]			1	99.6
002 (Little Bayou Creek)	Chromium, total	0.3	0.5		100
	Chromium, 6+	0.05	0.08		100
	Dissolved oxygen[b]		100		
	Dissolved solids	1000	1500		100
	Oil and grease	10	15		100
	Temperature, °F[c]			7	97.5
	pH, units[d]				100
003 (chromium treatment plant)	Chromium, total	0.5	1.0		100
	Chromium, 6+	0.05	0.10		100
	Oil and grease	10	15		100
	pH, units[d]			2	99.9
	Copper	0.5	1.0		100
	Zinc	0.5	1.0		100
	Suspended solids	30	45	1	88.9
004 (sewage treatment plant)	pH, units[d]				100
	BOD_5[e]	10	15	1	88.9
	Fecal coliform, per 100 mL	200	400		100
005 & 006 (water treatment plant lagoons 1 & 2)	pH, units[f]			5	90.4
	Suspended solids	30	50	1	88.9

[a]See Fig. 2.2.5.1-3 for locations of monitoring points.
[b]Dissolved oxygen shall not be <5.0 mg/L for a 24-h period or <4.0 mg/L at any time.
[c]Temperature shall not exceed the following: January, 10°C; February, 10°C; March, 16°C; April, 21°C; May, 27°C; June, 31°C; July, 32°C; August, 32°C; September, 31°C.
[d]The pH level shall not be <6.0 or >9.
[e]BOD_5 = 5-day biochemical oxygen demand.
[f]The pH level shall not be <6.0 or >10.
Source: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, p. 21, Table 2.2.2.

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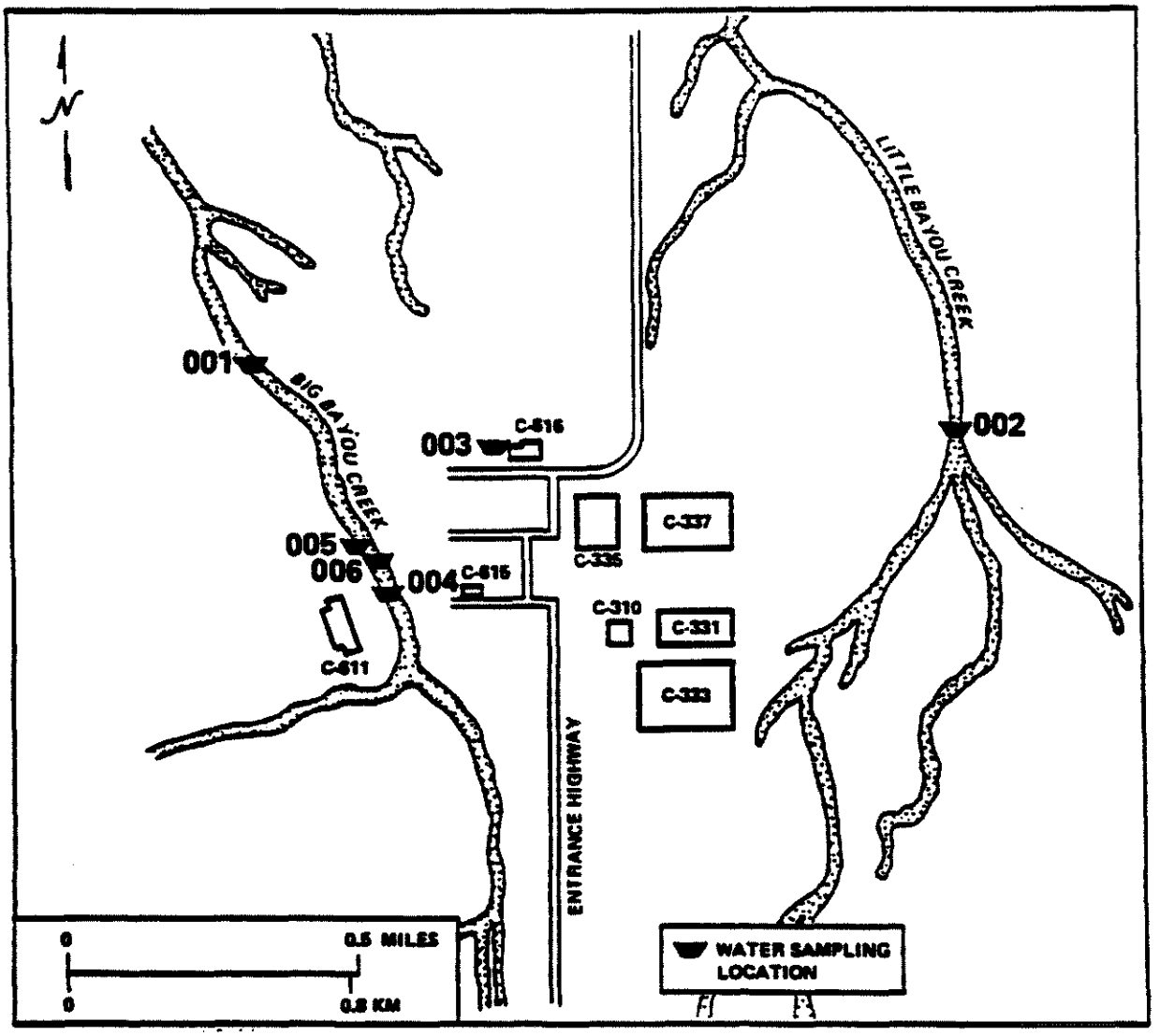

Fig. 5.2-3. National Pollutant Discharge Elimination System outfall locations at Paducah Gaseous Diffusion Plant. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988.

Table 5.2-3. Summary of metal concentrations detected in receiving water samples in the vicinity of the Paducah Gaseous Diffusion Plant

Sampling station[a]	Metal concentration (μg/L; mean ± standard deviation)							
	Al	Cd	Cr	Cu	Fe	Ni	Pb	Zn
BB1	174.4 ± 154.4	0.1 ± 0.2	0.6 ± 1.0	0.6 ± 0.5	260.4 ± 70.3	0.9 ± 0.8	0.9 ± 1.3	7.1 ± 4.2
BB2	145.6 ± 119.3	0.1 ± 0.1	0.1 ± 0.1	2.9 ± 4.8	170.8 ± 133.1	0.5 ± 0.5	0.3 ± 0.1	19.9 ± 35.9
BB3	174.4 ± 136.3	0.1 ± 0.1	0.2 ± 0.2	1.6 ± 0.6	708.9 ± 450.2	0.9 ± 0.9	<0.5	19.5 ± 32.5
BB4/4A	96.2 ± 61.4	0.2 ± 0.3	1.7 ± 1.3	2.8 ± 1.6	204.4 ± 93.6	0.8 ± 0.6	0.6 ± 0.4	19.8 ± 32.2
BB5	139.7 ± 62.0	0.2 ± 0.4	1.5 ± 1.2	4.0 ± 5.1	256.0 ± 172.5	1.0 ± 0.6	0.6 ± 0.5	9.1 ± 8.6
BB6	194.2 ± 97.1	0.5 ± 0.8	4.0 ± 6.7	4.0 ± 2.0	282.6 ± 221.1	1.5 ± 2.6	1.6 ± 1.3	0.3 ± 0.2
BB7	188.5 ± 78.1	0.3 ± 0.2	2.5 ± 2.4	3.9 ± 1.8	341.6 ± 105.7	0.6 ± 0.4	1.2 ± 0.6	0.7 ± 1.1
BB8	168.2 ± 66.7	0.9 ± 1.2	1.7 ± 1.0	3.8 ± 1.4	356.0 ± 82.9	3.1 ± 3.5	1.8 ± 1.1	1.8 ± 3.9
BB9	288.2 ± 78.5	0.6 ± 0.6	0.8 ± 0.9	3.0 ± 1.9	521.3 ± 256.8	0.8 ± 1.1	2.0 ± 1.6	0.3 ± 0.2
LB1	402.0 ± 60.1	1.1 ± 1.4	0.7 ± 0.3	8.1 ± 7.4	115.6 ± 23.3	0.6 ± 0.5	2.8 ± 2.7	0.5 ± 0.0
LB2	386.7 ± 92.6	0.2 ± 0.2	12.9 ± 20.4	2.2 ± 1.8	941.4 ± 436.6	0.4 ± 0.2	0.3 ± 0.1	12.1 ± 14.2
LB3	339.7 ± 83.6	0.8 ± 1.7	11.0 ± 18.1	2.4 ± 2.0	639.3 ± 328.4	1.4 ± 2.7	0.6 ± 0.5	5.2 ± 4.1

[a]BB = Big Bayou Creek; LB = Little Bayou Creek.

Source: W. J. Birge, J. A. Black, and T. M. Short, *Biological Monitoring Program for the Paducah Gaseous Diffusion Plant,* draft annual report submitted to Oak Ridge National Laboratory by the University of Kentucky, Lexington, December 1988 (p. 91, Table 7-3).

Table 5.2-4. Summary of freshwater criteria for chronic effects and ambient surface water data for chemicals detected in Paducah Gaseous Diffusion Plant effluents

Parameter	Freshwater criteria for chronic effects (μg/L)[a]	U.S. survey data[b]		Ohio River Basin survey data	
		Frequency of detection (%)	Mean of observed values (μg/L)	Frequency of detection (%)	Mean of observed values (μg/L)
Al[c]	150	31.1	74	21.5	141
Cd	0.66; 1.1; 2.0	2.5	9.5	2.9	7
Cr(+3)	120; 210; 370	24.5	9.7	23.6	7
Cu	6.5; 12; 21	74.4	15	72.3	23
Fe[d]	1000	75.6	52	68.6	28
Hg	0.012				
Ni	56; 96; 160	16.2	19	25.2	31
Pb	1.3; 3.2; 7.7	19.3	23	18.6	30
Zn	47	76.5	64	81.8	81
PCB[e]	0.014				
TRC[f]	11				
pH, units	6.5–9.0				

[a]*Source:* U.S. Environmental Protection Agency, *Quality Criteria for Water—1986,* EPA 440/5-86-001, 1987, unless otherwise indicated, the three values given for Cd, Cr, Cu, Ni, and Pb represent criteria specified for water hardness levels of 50, 100, and 200 mg/L of calcium carbonate respectively.

[b]*Source:* J. F. Kopp and R. C. Kroner, *Trace Metals in Waters of the United States,* U.S. Department of the Interior, Federal Water Pollution Control Administration, Cincinnati, Ohio, 1967 (as cited in Birge et al. 1988) (see citation below).

[c]*Source:* U.S. Environmental Protection Agency, *Draft—Ambient Aquatic Life Water Quality Criteria for Aluminum,* Office of Research and Development, Environmental Research Laboratory, Duluth, Minn., 1986.

[d]*Source:* Values recommended in U.S. Environmental Protection Agency, *Quality Criteria for Water—1976,* EPA 440/9-76-023, 1976. The values were adopted as a standard by the Commonwealth of Kentucky.

[e]PCB = polychlorinated biphenyl.

[f]TRC = total residual chlorine.

Source: Adapted from W. J. Birge, J. A. Black, and T. M. Short, *Biological Monitoring Program for the Paducah Gaseous Diffusion Plant,* draft annual report submitted to Oak Ridge National Laboratory by the University of Kentucky, Lexington, December 1988, p. 92, Table 7-4.

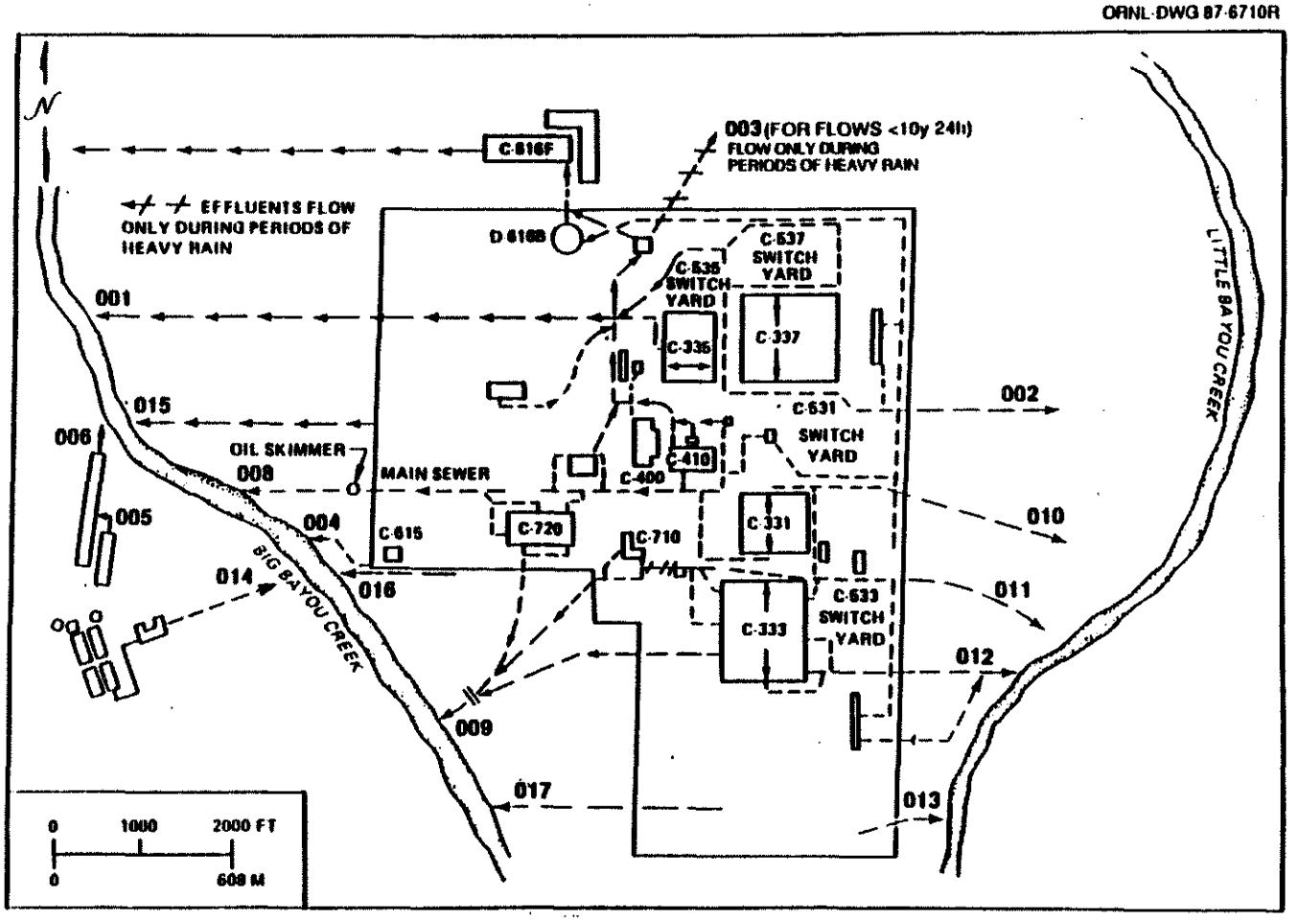

Fig. 5.2-4. Kentucky Pollutant Discharge Elimination System outfall locations at Paducah Gaseous Diffusion Plant. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987,* ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988.

Table 5.2-5. Compliance experience under interim Kentucky Preliminary Draft Environmental Statement limits, October 12–December 31, 1987, and interim limits[a] and number of violations at each outfall at the Paducah Gaseous Diffusion Plant

Permitted parameters	Outfall[b]															
	001	002	003	004	005	006	008	009	010	011	012	013	014	015	016	017
Flow	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Cr	0.15	0.31	0.15				0.1	0.23	0.5	0.85	0.76					
Zn	0.93	0.17	0.93				0.34	1.15	0.26	0.16 (1)	0.4					
Cl, residual	0.1	0.15	0.1				0.33 (2)	0.01	0.01	0.14 (3)	0.01					
Temperature, °F	93	89	93				89	89	89	95	90					
Fe	34.3	6.55	5.19				9.42	8.41	8.32	5.94	18.22					
Al	M	M	M				M	M	M	M	M			M	M	M
Cu	0.17	M	0.17				M	M	M	M	M			M	M	M
Ni	3.1	M	3.1				M	M	M	M	M			M	M	M
TSS[c]	158	M	158	45	50	50	M	M	M	M	M	271	50	427	45	45 (1)
Trichloroethylene	0.027	M	0.027				0.027	M	M	M	M					
Fluoride	4.0	5.0	4.0				5	5	5	5	5	M		M	M	
Dissolved oxygen	5.0	5	5				5	5	5	5	5					
Oil and grease	15	M	15				M	M	M	M	M	M	M	M		
pH, units	6–10	6–10	6–10	6–9	6–9	6–10.4	6–9	6–10	6–9	6–10	6–9	6–9	6–9	6–9	6–9	6–9
Uranium	M	M	M				M	M	M	M	M			M	M	M
Dissolved alpha	M	M	M				M	M	M	M	M			M	M	M
Suspended alpha	M	M	M				M	M	M	M	M			M	M	M
Dissolved beta	M	M	M				M	M	M	M	M			M	M	M
Suspended beta	M	M	M				M	M	M	M	M			M	M	M
PCB[d], μg/L	0.1	0.1	0.1				0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1
BOD_5[e]				45												
Fecal coliform				400												
Turbidity					M	M							M			
COD[f]					M							M				

[a]Chemical limits are given in milligrams per liter.
[b]M indicates monitoring requirement only; () = number of violations; 7 violations occurred in 793 analyses related to permit limits (99.12% compliance).
[c]TSS = total suspended solids.
[d]PCB = polychlorinated biphenyls.
[e]BOD_5 = 5-day biochemical oxygen demand.
[f]COD = chemical oxygen demand.

Source: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988.

exceeded KPDES permit limits on five occasions and zinc and total suspended solids on one occasion each from October through December 1987.

Monitoring during 1987–88 (Birge et al. 1988, p. 96) showed elevated levels of total residual chlorine in the effluent from outfall 008, which were close to the criteria for protection of aquatic biota.

5.2.3 Water Use

In the segment of the Ohio River from Smithland Lock and Dam at RK 1478 (RM 918.5) to the confluence of the Ohio and Mississippi rivers at RK 1578 (RM 981) are two municipal water supply intakes, six municipal discharges, and eight industrial discharges including two power plants. These sources are identified in Appendix D, Table D.2-9. Total discharge to the Ohio River from municipal sources within the above river reach is ~0.5 m^3/s (17.6 cfs) (ORSANCO 1988, p. 51). Total identified industrial discharge for this river reach is 24 m^3/s (847 cfs) (ORSANCO 1988, pp. 84–85). Within this reach are also four river terminals that handle petroleum products (ORSANCO 1988, p. 93)

The Tennessee Valley Authority's (TVA's) Shawnee Power Plant, ~6 km (4 miles) north of PGDP on the Ohio River, withdraws ~68.2 m^3/s (2406 cfs) for cooling and sanitary purposes. The average discharge from the facility is 68.3 m^3/s (2413 cfs), which includes storm water runoff and sanitary and ash pond discharge (see Appendix I: Tolbert 1990g).

PGDP also withdraws cooling water through a separate structure at the TVA intake structure on the Ohio River. The amount withdrawn depends on the production levels and power demands at PGDP. The average water withdrawal for PGDP is 0.54 m^3/s (19 cfs) (see Appendix I: Tolbert 1990e). At a maximum power production of 3040 MW, water withdrawal would be ~1.29 m^3/s (45 cfs) (see Appendix I: Tolbert 1990e). Slightly more water is used by PGDP in the winter because the lower temperatures make the softening process less efficient. At zero power consumption, the amount of water withdrawn corresponds to sanitary usage of about 0.12 m^3/s (4 cfs) (DOE 1982). The average discharge from PGDP to the Ohio River via Big Bayou and Little Bayou creeks is ~0.18 m^3/s (6.3 cfs), including blowdown from the cooling towers, sewage discharge, once-through cooling, and storm water runoff (DOE 1982, p. 3-38; see also Appendix I: Tolbert 1990e; Gross 1989).

No domestic, commercial, or industrial water withdrawals are known from either Big Bayou or Little Bayou creek. In addition to discharges from PGDP, Little Bayou Creek receives an average of 0.003 m^3/s (0.1 cfs) as storm water runoff from the Shawnee Power Plant (see Appendix I: Tolbert 1990g). As discussed in Sect. 5.2.1, discharge from PGDP constitutes a large portion of the total flow into Big Bayou and Little Bayou creeks. Without this inflow, the creeks would be intermittently dry during May–June and October–November.

5.3 PORTSMOUTH

5.3.1 Hydrology

Before construction of the Portsmouth Gaseous Diffusion Plant (PORTS), several wet-weather streams existed on the 1600-ha (4000-acre) site. Little Beaver Creek is the only natural water body remaining on the site. Surface waters in the vicinity of the Portsmouth site are shown in Fig. 5.3-1.

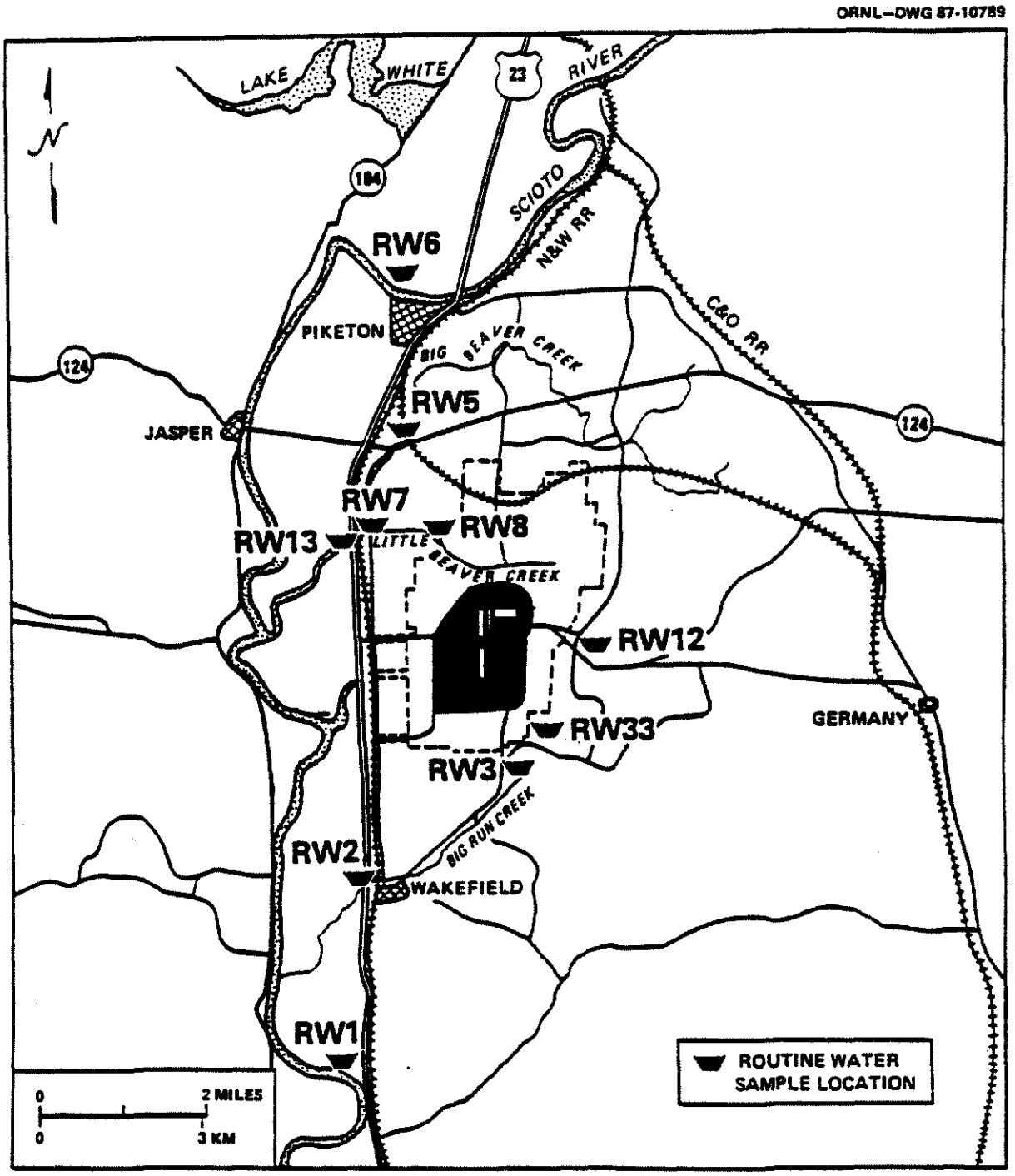

Fig. 5.3-1. Surface water sampling stations (non National Pollutant Discharge Elimination System) at the Portsmouth Gaseous Diffusion Plant. *Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987,* ES/ESH-4/V4, POEF-1180, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 227 pp., 1988.

The Scioto River originates in Auglaize County, Ohio, and flows 378 km (235 miles) through nine counties in Ohio before emptying into the Ohio River at Portsmouth. The Scioto River drains 16,860 km^2 (6510 $miles^2$), thus contributing to the second largest drainage area in Ohio. From Columbus to Portsmouth, the river gradient averages 0.32 m/km (1.7 ft/mile) (ERDA 1977, p. 3-4). The drainage area of the Scioto River above Higby, ~7 km (4 miles) downstream of the PORTS site, is 13,289 km^2 (5,131 $miles^2$) (USGS 1988, p. 141). Five of the tributaries to the Scioto River have drainage areas over 1,295 km^2 (500 $miles^2$) each: Olentangy River, Big Walnut Creek, Darby Creek, Paint Creek, and Salt Creek (ODNR 1963, p. 2 and facing page).

The average discharge of the Scioto River at Higby is 129 m^3/s (4,551 cfs). The extremes for the period of record were a maximum discharge of 5,000 m^3/s (177,000 cfs) on January 23, 1937, and a minimum of 6.9 m^3/s (244 cfs) on January 23, 1959 (USGS 1988, p. 141). Daily discharges for the Scioto River at Higby are shown in Appendix D, Table D.3-1. Effluent discharge from the PORTS facility to the Scioto River averages 0.2 m^3/s (5.9 cfs) (PMD and ECD 1989, Appendix A.3), which is 2% of the 7-day, 10-year low flow of 8.58 m^3/s (300 cfs) (ERDA 1977, p. 3-6) for the river at Higby, Ohio.

5.3.2 Water quality

Water quality data for the Scioto River in the PORTS vicinity are summarized in Appendix D, Table D.3-2 (USGS 1988, pp. 142–49). Water in the Scioto River is moderately hard [310 mg/L calcium carbonate ($CaCO_3$)] and slightly alkaline (235 mg/L $CaCO_3$ alkalinity). Information on surface water quality parameters monitored as part of the Environmental Surveillance Program and NPDES monitoring program for PORTS is contained in Appendix D, Table D.3-3. Treatment and discharge of plant effluents from the PORTS facility are controlled by NPDES permit standards. During 1986, effluent limitations for various chemical parameters were met 94 to 100% of the time (Oakes et al. 1987, pp. 55–67). Descriptions of the NPDES effluent discharge sites are given in Oakes et al. (1987, pp. 60–64); these sites are shown in Fig. 5.3-2. The non-NPDES surface water monitoring points in the PORTS vicinity are shown in Fig. 5.3-1. Figures that display compliance at each of the effluent outfalls for the period from 1982 to 1986 are contained in the 1986 environmental surveillance document for the site (Oakes et al. 1987, pp. 69–81); those for 1987 in Rogers et al. (1988, pp. 49–62).

5.3.3 Water use

The main streams in the PORTS vicinity are Sunfish Creek, Beaver Creek, and the Scioto River. Little Beaver Creek and Big Run Creek, which drain the site, are intermittent streams. Water availability from the larger streams is shown in Table 5.3-1 (ERDA 1977, p. 3-35). Groundwater supplies most of the water used in the Portsmouth plant vicinity (see Sect. 6.3). Surface waters used in the vicinity are primarily from the Scioto River and Lake White, which is the largest water supply source near the site.

Water use at the Portsmouth plant, 0.5 m^3/s (19 cfs), comes from groundwater (see Sect. 6.3). The Portsmouth facility uses 0.4 m^3/s (15 cfs) for cooling water makeup and 0.1 m^3/s (5 cfs) for sanitary purposes (PMD and ECD 1989, Appendix A.3). Historically, municipal and industrial withdrawals from the Scioto River are 3.0 m^3/s (100 cfs) and 3.7 m^3/s (130 cfs) respectively (ODNR 1963, p. 28).

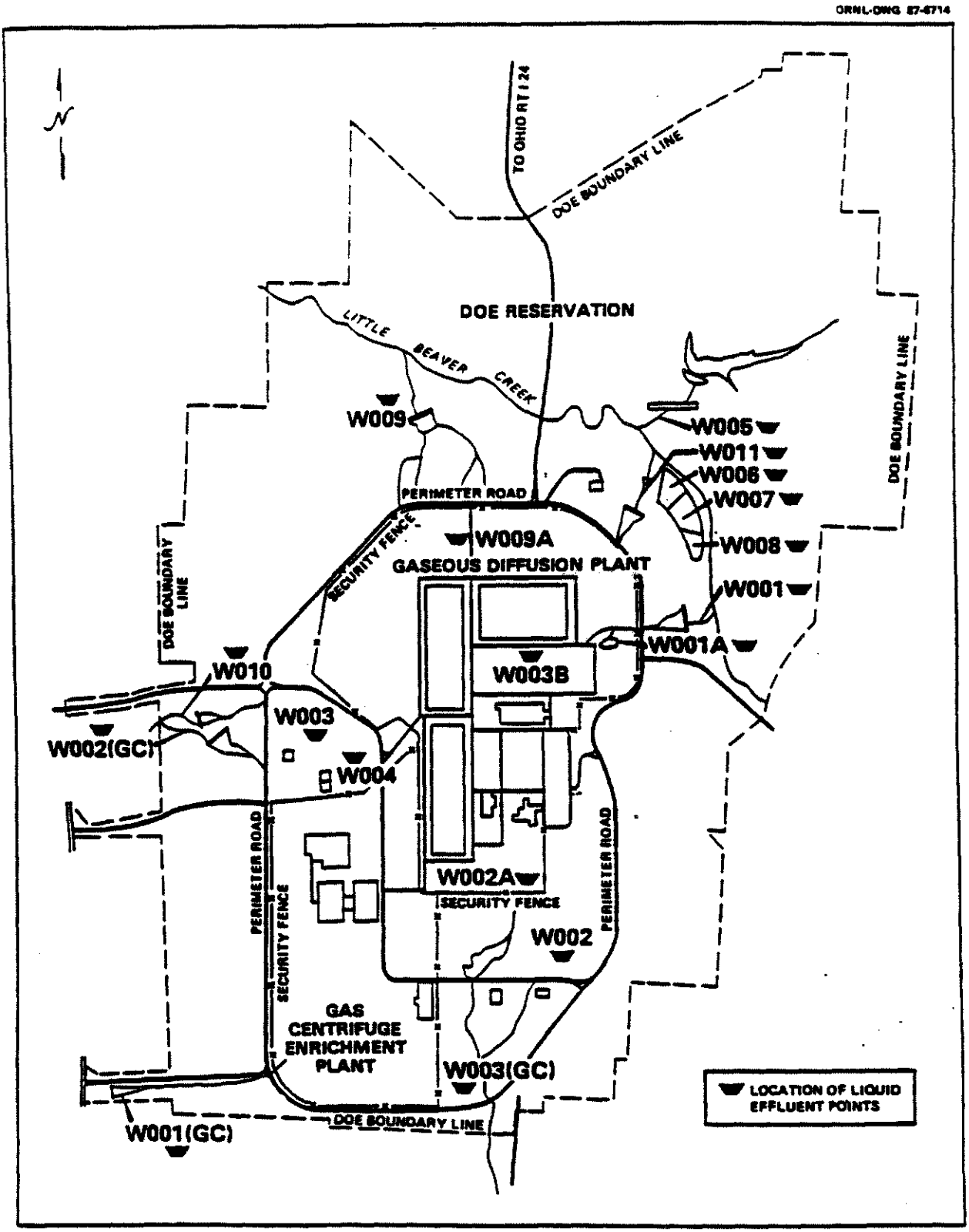

Fig. 5.3-2. Locations of National Pollutant Discharge Elimination System water sampling stations at the Portsmouth Gaseous Diffusion Plant. *Source:* J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987,* ES/ESH-4/V4, POEF-1180, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 227 pp., 1988.

Table 5.3-1. Summary of water available without additional storage

Stream and location	Drainage area (miles^2)[a]	Average flow (Mgd)[b]	Median[c] flow (Mgd)	Low[d] flow (Mgd)
Scioto River at Piketon	5824	3384	1260	315
Beaver Creek near Piketon	68.4	45.6	15.7	4.24
Sunfish Creek at its mouth	145	98.2	22.2	0.982

[a]Convert Mgd to cubic meters per second by multiplying the given value by 0.04381.
[b]Convert square miles (miles^2) to square kilometers by multiplying the given value by 2.59.
[c]Flow equaled or exceeded 50% of the time.
[d]Flow equaled or exceeded 90% of the time.
Source: Ohio Department of Natural Resources, *Water Inventory for the Scioto River Basin,* Report 17, Division of Water, Ohio Planning Inventory, 1963.

Information on discharges from the PORTS facilities to the various receiving water bodies is discussed in Oakes et al. (1987, pp. 60–67) and in Rogers et al. (1988, pp. 40–46); the locations of the various discharge points are shown in Fig. 5.3-1. Effluent discharges from PORTS occur (1) directly to the Scioto River, (2) into Little Beaver Creek and then to Big Beaver Creek prior to discharge to the Scioto River, and (3) into Big Run Creek and then into the Scioto River.

5.4 REFERENCES

5.4.1 Oak Ridge

Alexander, F. M., et al. 1984. *Drought Related Impacts on Municipal and Major Self-Supplied Industrial Water Withdrawals in Tennessee*, Part B, Water-Resources Investigations Report 84-4074, U.S. Geological Survey.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, DOE/EA-0106, December.

EPA (U.S. Environmental Protection Agency) 1986. *Quality Criteria for Water*, U.S. Environmental Protection Agency.

Exxon Nuclear Company 1976. *Nuclear Fuel Recovery and Recycling Center, Environmental Report, Docket 50564,* 441 pp.

Loar, J. M., Solomon, J. A., Cada, G. F. 1981. *Technical Background Information for the ORNL Environmental and Safety Report: Vol. II, A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 196 pp.

Loar, J. M., et al. 1988. First *Annual Report on the Y-12 Plant Biological Monitoring and Abatement Program,* draft, Environmental Sciences Division, Publ. 2984, Oak Ridge National Laboratory, Oak Ridge, Tenn., 307 pp.

Oakes, T. W., et al. 1987. *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1986*, ES/ESH-I/V2, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 522 pp.

PMC, TVA, and ERDA (Project Management Corp., Tennessee Valley Authority, and U.S. Energy Research and Development Administration) 1977. *Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant*, NUREG-0139, prepared for the U.S. Nuclear Regulatory Commission.

Rogers, J. G., et al. 1988. *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987*, ES/ESH-4/VI, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, April, 247 pp.

Smith, J. G., et al. 1988. *First Annual Report on the ORGDP Biological Monitoring and Abatement Program,* draft, ORNL/TM, Oak Ridge National Laboratory, Oak Ridge, Tenn., 125 pp.

TVA (Tennessee Valley Authority) 1985. *Sediment Characterization Task 2, Instream Contaminant Study,* Office of Natural Resources and Economic Development, 82 pp.

USGS (U.S. Geological Survey) 1988. *Water Resources Data for Tennessee,* Water Data Report TN-88.1, prepared in cooperation with the state of Tennessee and other agencies.

5.4.2 Paducah

Birge, W. J., Black, J. A., and Short, T. M. 1988. *Biological Monitoring Program for the Paducah Gaseous Diffusion Plant*, draft annual report submitted to Oak Ridge National Laboratory by the University of Kentucky, Lexington, December.

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site*, DOE/EA-0155, August.

FEMA (U.S. Federal Emergency Management Agency) 1980. Flood Insurance Rate Map 210151 0001-0095.

Oakes, T. W., Ashburn, D. L., and O'Hara, F. M. 1987. *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1986*, ES/ESH-1/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy.

ORSANCO (Ohio River Valley Water Sanitation Commission) 1988. *Ohio River Water Quality Fact Book 1988*, Cincinnati, Ohio, 157 pp.

Rogers, J. G., and Ashburn, D. L. 1988. *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy.

USGS (U.S. Geological Survey) 1988. *Water Resources Data for Illinois*, Water Data Report TL-88-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va.

5.4.3 Portsmouth

ERDA (U.S. Energy Research and Development Administration) 1977. *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site*, Vol. 1, ERDA-1555, May.

Oakes, T. W., et al. 1987. *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1986*, ES/ESH-1/V4, POEF-1158, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 312 pp. + appendix.

ODNR (Ohio Department of Natural Resources) 1963. *Water Inventory for the Scioto River Basin*, Report 17, Division of Water, Ohio Water Planning Inventory, 74 pp.

PMD and ECD (Planning and Methods Development and Environmental Control Department) 1989. *Long-Range Environmental and Waste Management Plan, Fiscal Years 1989–1995*, DOEF-2006, Martin Marietta Energy Systems, Inc., Piketon, Ohio, September.

Rogers, J. G., et al. 1988. *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 227 pp.

USGS (U.S. Geological Survey) 1988. *Water Resources Data for Ohio: Vol. 1, Ohio River Basin*, Water Data Report OH-88-1, prepared in cooperation with the state of Ohio and other agencies, Reston, Va.

6. GROUNDWATER

6.1 OAK RIDGE

A groundwater monitoring and protection program is currently being implemented at ORGDP. In 1988, the program monitored the groundwater quality at 13 separate sites using 80 monitoring wells. Plans for 1989 included an expansion of the program to include 42 monitoring sites and the use of an additional 49 wells. Figure 6.1-1 is a map of the ORGDP facility showing the locations of existing monitoring wells as of December 1989. Most of these wells are segregated into the areas of known or suspected groundwater contamination. There are 41 such sites at ORGDP. Groundwater contamination is discussed further in Sect. 6.2.

6.1.1 Aquifer Systems

At ORGDP, several aquifers may be distinguished, including a surficial aquifer and several bedrock aquifers. The characteristics of each of these types are described here.

6.1.1.1 Surficial aquifer

The surficial aquifer is made up of all the unconsolidated material overlying bedrock and consists of man-made fill, alluvium, and the residuum of weathered bedrock. The depth to bedrock at ORGDP varies from <3 m (<10 ft) in the Chickamauga Group to >21 m (>70 ft) in the Knox Group. Much of the on-site fill material consists of construction debris; pieces of concrete and wood; and excavated weathered shale, limestone, and chert mixed with clay that was placed during construction of the plant to level the ground surface (Geraghty and Miller 1989b, p. 3-4).

Alluvium is present at ORGDP along the shores of the Clinch River and, to a lesser extent, along Poplar Creek. For example, waste management site K-770 at ORGDP is located on the eastern side of the plant near the Clinch River. The underlying soil and sediments at this site appear to be floodplain deposits of very fine sand with lenses and layers of silt and clay that extend to depths of ~9 m (~30 ft), the depth of the Clinch River in this reach (Geraghty and Miller 1989b, p. 3-4).

Unconsolidated residuum overlies bedrock throughout the area, except in scattered rock outcrop areas, and is generally clayey in nature with a varying content of silt, sand, and rock fragments. With increasing depth, the clay grades into weathered rock that has retained its structural characteristics, and it becomes a material known as saprolite. Bedding and jointed surfaces usually exhibit some type of oxide staining. The transition from weathered to unweathered bedrock typically occurs through an interval of <3 to ~9 m (<10 to ~30 ft) (Geraghty and Miller 1989b, p. 3-4).

Geraghty and Miller (1989b, pp. 3-9 to 3-10) suggest that the surficial aquifer can be considered a single complex unit at ORGDP. Further, they state that at most sites the unconsolidated material is relatively homogeneous and groundwater flow is generally predictable, being downgradient and normal to the contours of the water table. Figure 6.1-2 from Geraghty and Miller (1989b) shows water table contours and groundwater flow lines, inferred from water levels in 191 wells, Poplar Creek, and the Clinch River. In

[This map is provided in a pocket after Appendix I]

Fig. 6.1-1. Well locations at the Oak Ridge Gaseous Diffusion Plant. *Source:* Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

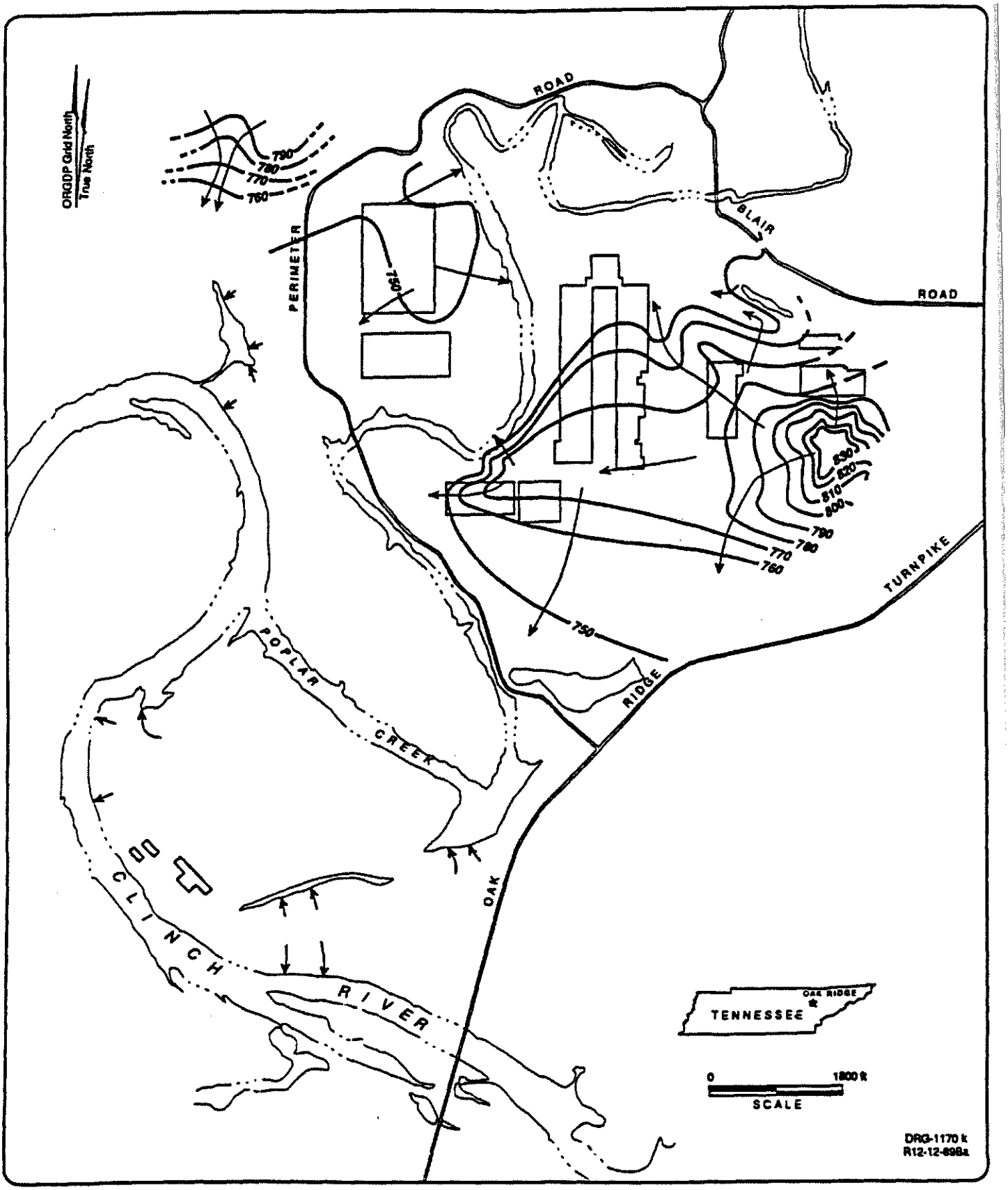

Fig. 6.1-2. Contours of the water table and inferred groundwater flow paths in the unconsolidated zone, Oak Ridge Gaseous Diffusion Plant area. *Source:* Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

areas where well data are limited, Geraghty and Miller interpreted the direction of groundwater flow based on topography and known or inferred hydrologic characteristics of an area (Geraghty and Miller 1989b, pp. 3-4 to 3-10). This model of shallow water flow is based on measured or empirically observed hydrologic parameters such as water level and hydraulic conductivity and does not account for the geologic structure of the area.

An existing database of groundwater flow information from an experimental site in Bear Creek Valley, located ~5 km (~3 miles) to the east of ORGDP, suggests that groundwater flow on ORR is somewhat more complicated than flow in porous media (Lee et al. 1989, pp. 77–79). The experimental site is underlain by complexly interbedded silty limestone and shale lithologies of the Maryville Formation of the Cambrian Conasauga Group (see Sect. 3 for a discussion of the entire Conasauga Group). Soil at the site is thin [3 m (~10 ft)] to essentially absent, and weathered bedrock extends from just beneath the surface to depths of ~3 to 10 m (~10 to 30 ft) (Lee et al. 1989, p. 3). At this site, a groundwater tracer test was performed in the shallow aquifer using a single injection well and more than 40 monitoring wells in an area ~61 by 15 m (~200 by 50 ft). The experiment was performed over a 2-year period. In contrast to the flow model of Geraghty and Miller (1989b, pp. 3-9 and 3-10), results of this experiment suggest that groundwater flow in the shallow aquifer would not be predicted by conventional porous medium analysis; rather, the direction of tracer migration was parallel to strike (35° oblique to maximum gradient) in a strongly elliptical plume that coincided with the axis of a water table divide. The rate of plume migration was irregular and seemingly unrelated to site gradient, probably attributable to local subsurface geologic conditions (Lee et al. 1989, pp. 77–79).

6.1.1.2 Bedrock aquifers

The consolidated rock units in the ORGDP area are Cambrian to Ordovician age sandstones, siltstones, shales, dolostones, and limestones. These strata have been studied and classified into groups and formations based on age, lithology, and fossil content (Keith 1895, 1896; Rodgers and Kent 1948; Rodgers 1953; Ruppel and Walker 1984). From oldest to youngest, the geologic units are the Shady Dolomite, the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Group. A description of each of these units is given in Sect. 3.

In areas where surficial unconsolidated materials are thin, the water table is generally in the underlying bedrock. Flow directions in the bedrock aquifers are strongly controlled by the orientation of the bedding planes, fractures, and solution features. Figure 6.1-3 shows the inferred contours of the potentiometric surface based on observed head differences in the bedrock aquifer. Because flow directions are controlled by geologic influences, this map can indicate only the general direction of groundwater flow. Deviations in flow as a result of anisotropy are highly variable in the bedrock aquifers, and it is likely that the groundwater moves in an angular pattern across the steeply-dipping bedding planes at fractures and then along the bedding planes in the direction of strike (Geraghty and Miller 1989b, pp. 3-4 to 3-5, 3-10).

6.1.1.3 Interaquifer flow

Figures 6.1-2 and 6.1-3 show the inferred groundwater flow conditions in the surficial aquifer and in the uppermost bedrock aquifer respectively. Geraghty and Miller (1989b, pp. 3-10 to 3-11) discuss the installation of wells in the bedrock aquifer to determine the

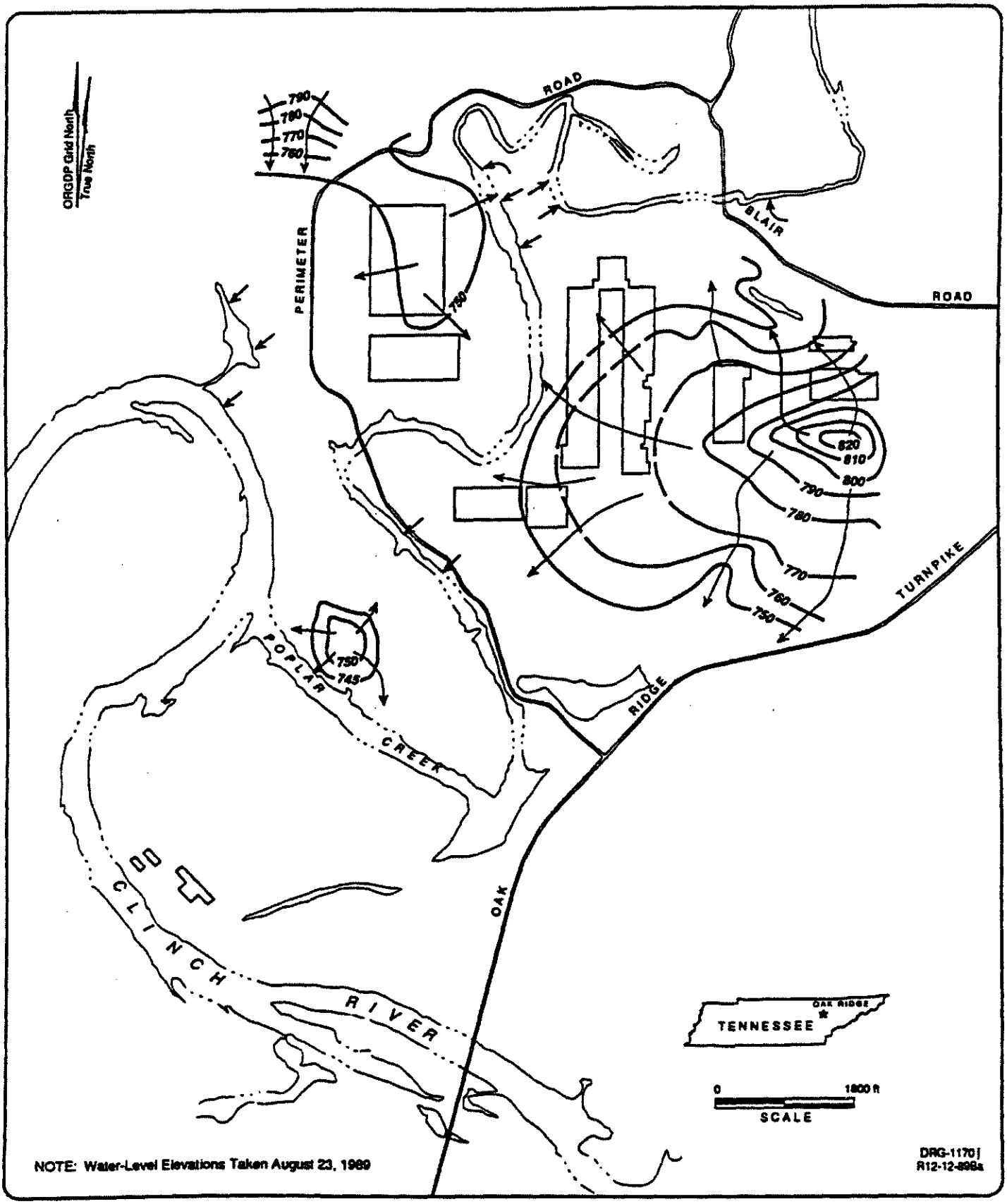

Fig. 6.1-3. Contours of the potentiometric surface and inferred groundwater flow paths in the bedrock, Oak Ridge Gaseous Diffusion Plant area. *Source:* Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

head relationship between the two aquifers and the potential for interaquifer flow. They found that in some areas the potential exists for downward movement of water from the surficial aquifer to the bedrock aquifer. However, downgradient, near areas of groundwater discharge, the head relation reverses, and the potential exists for water to move upward from the bedrock aquifer into the surficial aquifer and the Clinch River (Geraghty and Miller 1989b, p. 3-11).

6.1.2 Groundwater Quality

Figure 6.1-4 shows the locations and identification numbers of the 41 waste management sites that have been identified at ORGDP. A site-specific description of the geohydrology of each of these units may be found in Geraghty and Miller (1989b). Geraghty and Miller also include a description of wells installed in these areas [unconsolidated material wells (UNW); bedrock wells (BRW); and temporary wells (TS)] and lithologic logs obtained while drilling in these areas. Results of permeability tests on monitoring wells and piezometers in these areas are provided in Table 6.1-1.

The most recent groundwater quality data from the ORGDP site is available in the *Oak Ridge Reservation Environmental Report for 1988, Rogers, J. G., et al. 1989, Vol. 2, pp. 141–146.* Data from this report, reproduced in Appendix E, Table E.1-1, focuses on groundwater quality analyses at 13 waste management sites that were conducted as part of ORGDP's Resource Conservation and Recovery Act of 1976 (RCRA) compliance program (Rogers, J. G., et al., 1989, Vol. 1, pp. 139–197).

In 1988, three off-site wells near ORGDP were sampled for the primary drinking water parameters, volatile organics, metals, and radionuclides of concern on ORR. Results of this study were presented in the 1988 Environmental Report and are reproduced in Appendix E, Tables E.1-2 to E.1-4. All analytical results were within the normal expected range for uncontaminated groundwater except for one iron value, which exceeded the primary drinking water limit of 0.3 mg/L. The source of this elevated iron content is unknown, but the higher value may have resulted from materials and procedures used in the installation and development of the well.

6.2 PADUCAH

6.2.1 Aquifer Systems

The groundwater hydrology in the vicinity of PGDP is dominated by the Gravel Facies of the Continental Deposits, which, in the area, is called the regional gravel aquifer. Except for areas where sand units within the Clay Facies of the Continental Deposits achieve considerable lateral extent, the regional gravel aquifer is the primary unit responsible for groundwater movement across the site (EDGe 1987, p. 10).

The hydrology of the regional gravel aquifer was discussed in a series of reports by the USGS (Davis et al. 1971; Davis, Lambert, and Hansen 1973; Lambert 1966; Hansen 1966). The gravel is saturated over most of its areal extent in the region of PGDP, and wells completed within it are reported to be capable of producing yields of up to 0.063 m^3/s (1000 gpm) (Davis, Lambert, and Hansen 1973, p. 23). EDGe (1987, p. 10) reported yields between 0.003 and 0.925 m^3/s (50 and 400 gpm) from this unit.

Figure 6.2-1 illustrates the potentiometric surface for the regional gravel in the vicinity of PGDP as it appeared in 1969 (Lambert 1966; Hansen 1966). In general, the

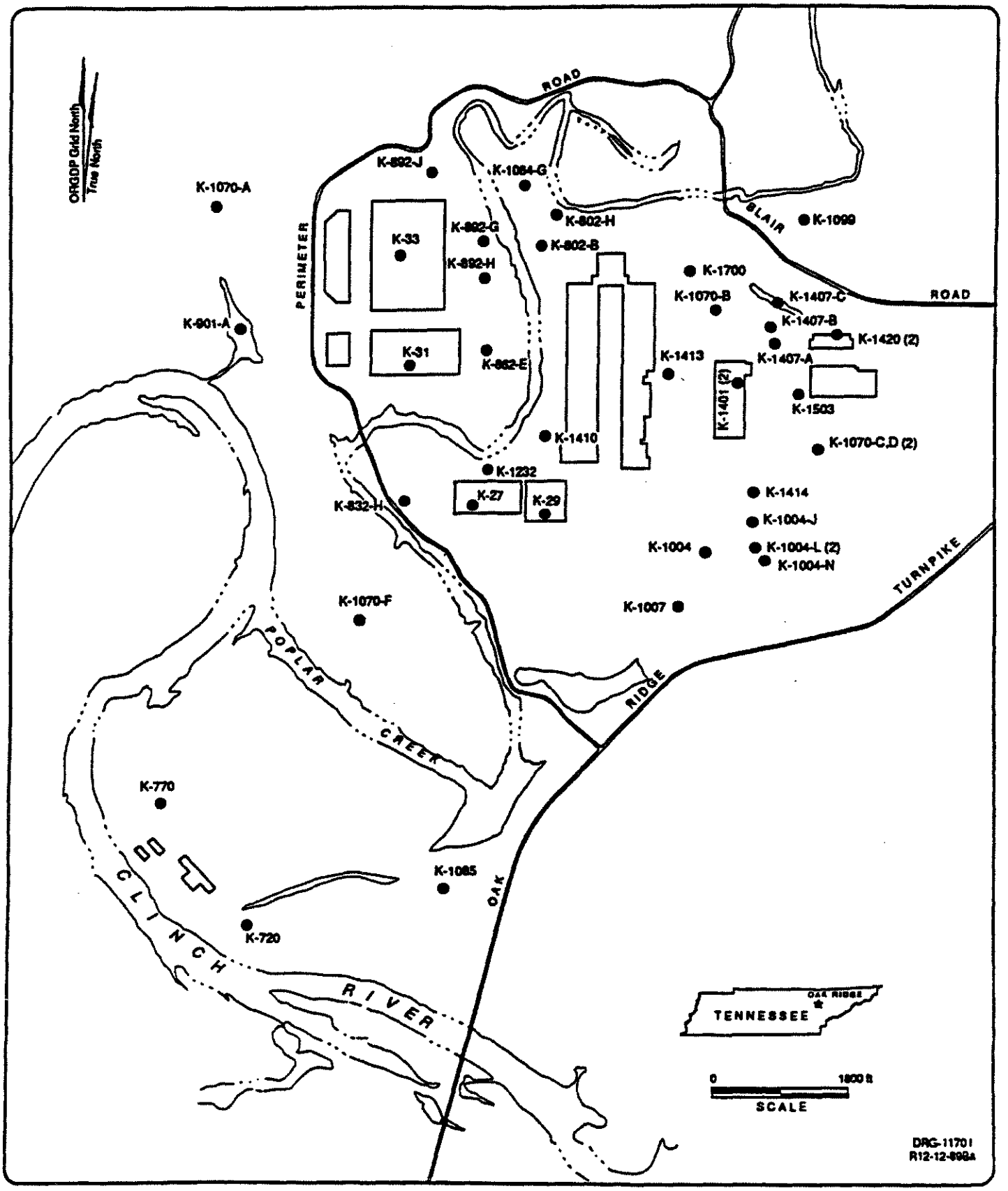

Fig. 6.1-4. Waste management sites at the Oak Ridge Gaseous Diffusion Plant.
Source: Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

Table 6.1-1. Results of permeability tests

Boring Number	Location	Method of Analysis	
		Bouwer (cm/sec)	Hvorslev (cm/sec)
UNP-1	K-1070-C,D	5.34×10^{-6}	7.04×10^{-6}
UNP-2	K-1070-C,D	5.77×10^{-7}	6.15×10^{-7}
UNP-3	K-1070-B	5.40×10^{-6}	1.66×10^{-5}
UNP-4	K-1070-B	2.79×10^{-6}	8.19×10^{-6}
UNP-5	K-1070-B	3.23×10^{-6}	4.28×10^{-6}
UNP-6	K-1085	2.48×10^{-2}	1.95×10^{-2}
UNP-7	K-1232	4.92×10^{-6}	4.11×10^{-6}
UNP-8	K-1413	8.30×10^{-5}	8.73×10^{-5}
UNP-9	K-770	1.33×10^{-5}	9.57×10^{-6}
UNP-10	K-770	3.08×10^{-4}	3.57×10^{-4}
UNP-11	K-1085	6.05×10^{-5}	6.90×10^{-5}
UNP-12	K-1070-A	1.10×10^{-6}	1.04×10^{-6}
UNP-13	K-1070-C,D	2.20×10^{-5}	1.08×10^{-5}
UNP-14	K-1070-A	1.21×10^{-6}	1.08×10^{-6}
UNP-15	K-1070-A	2.71×10^{-7}	2.94×10^{-7}
UNP-16	K-770	1.05×10^{-5}	7.80×10^{-6}
UNP-17	K-1070-C,D	2.60×10^{-4}	8.10×10^{-3}
UNW-1	K-1407-B	3.56×10^{-4}	4.21×10^{-4}
UNW-2	K-1407-B	1.44×10^{-4}	6.11×10^{-4}
UNW-3	K-1407-B	2.33×10^{-4}	4.83×10^{-4}
UNW-4	K-1407-B	1.08×10^{-4}	4.01×10^{-4}
UNW-5	K-1407-B	2.38×10^{-4}	2.16×10^{-4}
UNW-6	K-1407-C	3.72×10^{-5}	3.47×10^{-5}
UNW-7	K-1407-C	1.08×10^{-3}	6.51×10^{-3}
UNW-8	K-1407-C	1.01×10^{-4}	3.60×10^{-4}
UNW-9	K-1407-C	2.56×10^{-4}	8.23×10^{-4}
UNW-10	K-1407-C	1.06×10^{-3}	3.08×10^{-3}
UNW-11	K-1407-C	5.43×10^{-7}	2.51×10^{-7}
UNW-37	K-27	2×10^{-3}	
UNW-38	K-27	6×10^{-3}	
UNW-46	K-901-A	1×10^{-6}	
UNW-47	K-1004	4×10^{-5}	
UNW-57	K-720	1×10^{-5}	
BRW-1	K-1099	1.34×10^{-3}	
BRW-2	K-1064-G	1.54×10^{-3}	
BRW-3	K-1064-G	5.27×10^{-3}	
BRW-5	K-1070-A	5.02×10^{-5}	
BRW-6	K-1070-A	2.03×10^{-4}	
BRW-7	K-1407-B	3.58×10^{-5}	
BRW-8	K-1070-B	6.71×10^{-5}	
BRW-23	K-1070-F	2×10^{-5}	
BRW-27	K-33	2×10^{-4}	
BRW-34	K-901-A	1×10^{-3}	
BRW-36	K-1004	5×10^{-6}	
BRW-38	K-1004-L	2×10^{-4}	
BRW-46	K-1414	4×10^{-5}	

Source: Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.

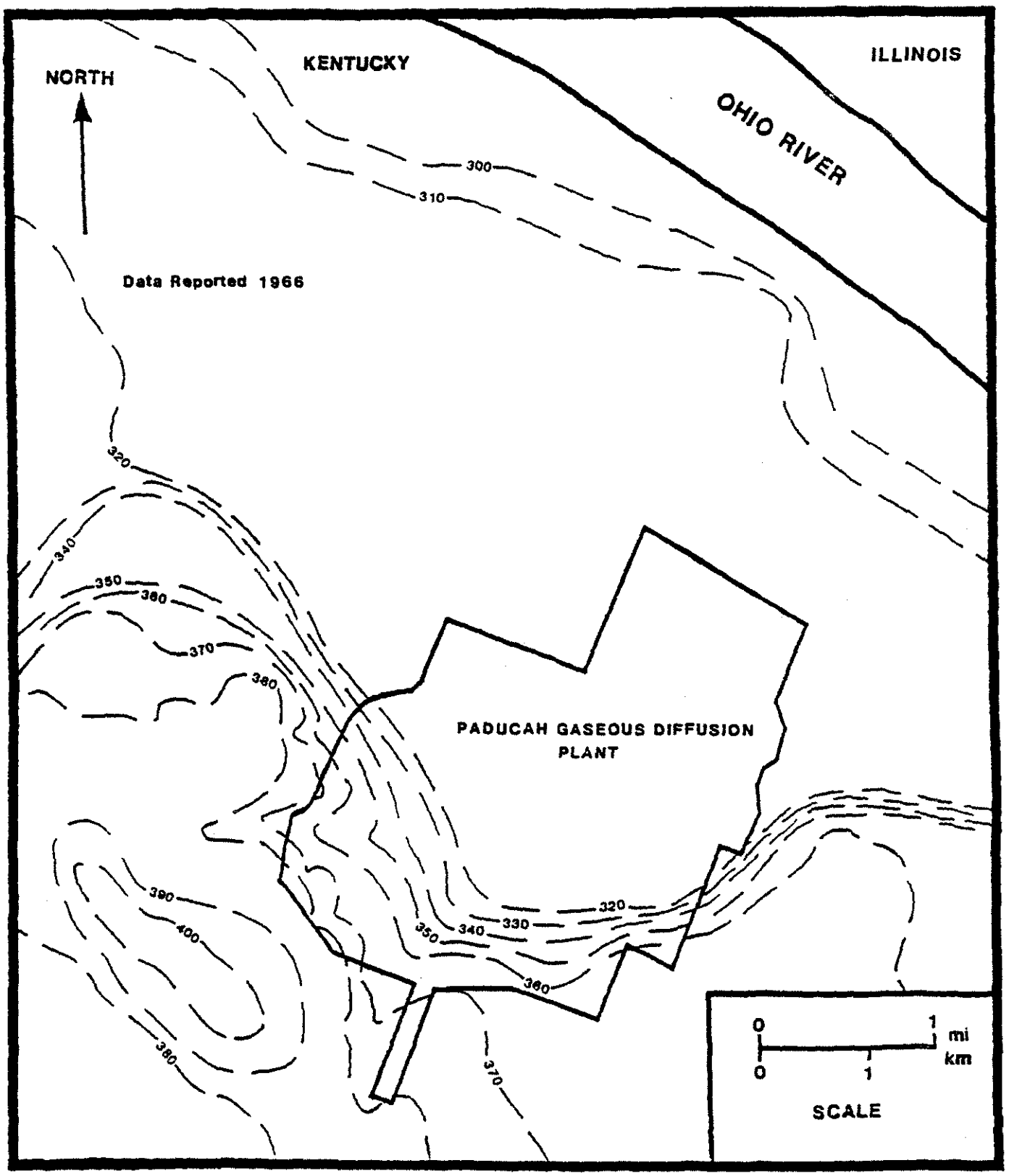

Fig. 6.2-1. Potentiometric surface for the gravel aquifer as reported in 1966. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

shape of this surface indicates that groundwater flow within the aquifer is north-to-northeasterly toward the Ohio River. Figure 6.2-2 illustrates the potentiometric surface for the regional gravel aquifer as measured on January 11 and January 12, 1989 (Early, Sigmon, and Williams 1989, p. 32) within a series of PGDP and private wells. The coverage area of the two data sets overlaps only partially, but the more recent data provide better resolution on the northern side of PGDP. Figure 6.2-2 appears to define a flow pathway that spatially coincides with the location of the westernmost paleochannel (buried ancient stream channel) illustrated in Fig. 3.2-5 (see Sect. 3), supporting the contention that the gravel aquifer is characterized by a complex of narrow, highly transmissive paleochannels (Early, Sigmon, and Williams 1989, pp. 17–27).

Table 6.2-1 is a summary of all known hydraulic conductivity (K) data for the major geologic units in this PGDP area based on measurements (both in the field and laboratory) and on estimates made from grain-size distributions (following the method of Hazen as referenced in Freeze and Cherry 1979, pp. 350–351). Figure 6.2-3 is a map showing all sites where more reliable field measurements of hydraulic conductivity for the regional gravel aquifer were obtained from specific capacity or slug tests. From these two exhibits, it is apparent that data on hydraulic conductivity of the gravel aquifer are limited and that the hydraulic conductivity varies considerably over relatively short distances. However, this variability is consistent with the deposition of the material in a braided stream complex (Early, Sigmon, and Williams 1989, p. 35).

Preliminary estimates of groundwater flow velocity within the gravel aquifer based on hydraulic conductivity values derived from slug tests and measured head gradients over areas of limited areal extent [e.g., at the C-404 facility (D'Appolonia 1983)] suggested that the flow velocities were low, on the order of 1.5 m/year (5 ft/year). However, more recent data illustrating the variability of hydraulic conductivity values in the aquifer [unpublished data collected by EDGe (1989)] were used by Early, Sigmon, and Williams (1989, pp. 35–43) to calculate the possible range of flow velocities as <0.3 m/year (<1 ft/year) (low K) to >91 m/year (>300 ft/year) (high K). However, based on the data collected by EDGe, Early concluded that within the gravel aquifer, no measurable vertical head gradients occur. These data suggest that little potential exists for transporting dissolved contaminants throughout the entire thickness of the gravel unit other than through normal diffusive and dispersive processes. Therefore, it is anticipated that contaminants that reach the gravel aquifer will remain near the upper surface of the gravel during transport. However, in a fluvial depositional setting, splitting of a contaminant plume can occur as a result of the intersection of transmissive paleochannels, resulting in contaminant dispersal. In addition, contaminants may migrate to the base of the gravel aquifer if they are present as nonaqueous liquid phases of limited solubility and with densities greater than that of water (e.g., trichloroethylene is a contaminant found at the bottom of the gravel aquifer in some areas) (Early, Sigmon, and Williams 1989, pp. 42–43).

In contrast to the large water production capability of the regional gravel aquifer, the sand lenses within the Clay Facies of the Continental Deposits were described by EDGe (1987, p. 9) as having low yields. The most recent borehole data from the PGDP site illustrate that large differences in hydraulic head exist over short lateral distances, reinforcing the interpretation that these sand lenses are discontinuous and that the unit does not constitute a continuous aquifer (EDGe 1987, pp. 9–10; EDGe 1989, pp. 14–15). Measurements of vertical hydraulic conductivity of the loess (soils) and the Clay Facies suggest that vertical migration of groundwater and contaminants through these units is likely to be very slow (D'Appolonia 1983). However, where Clay Facies sand lenses overlie the

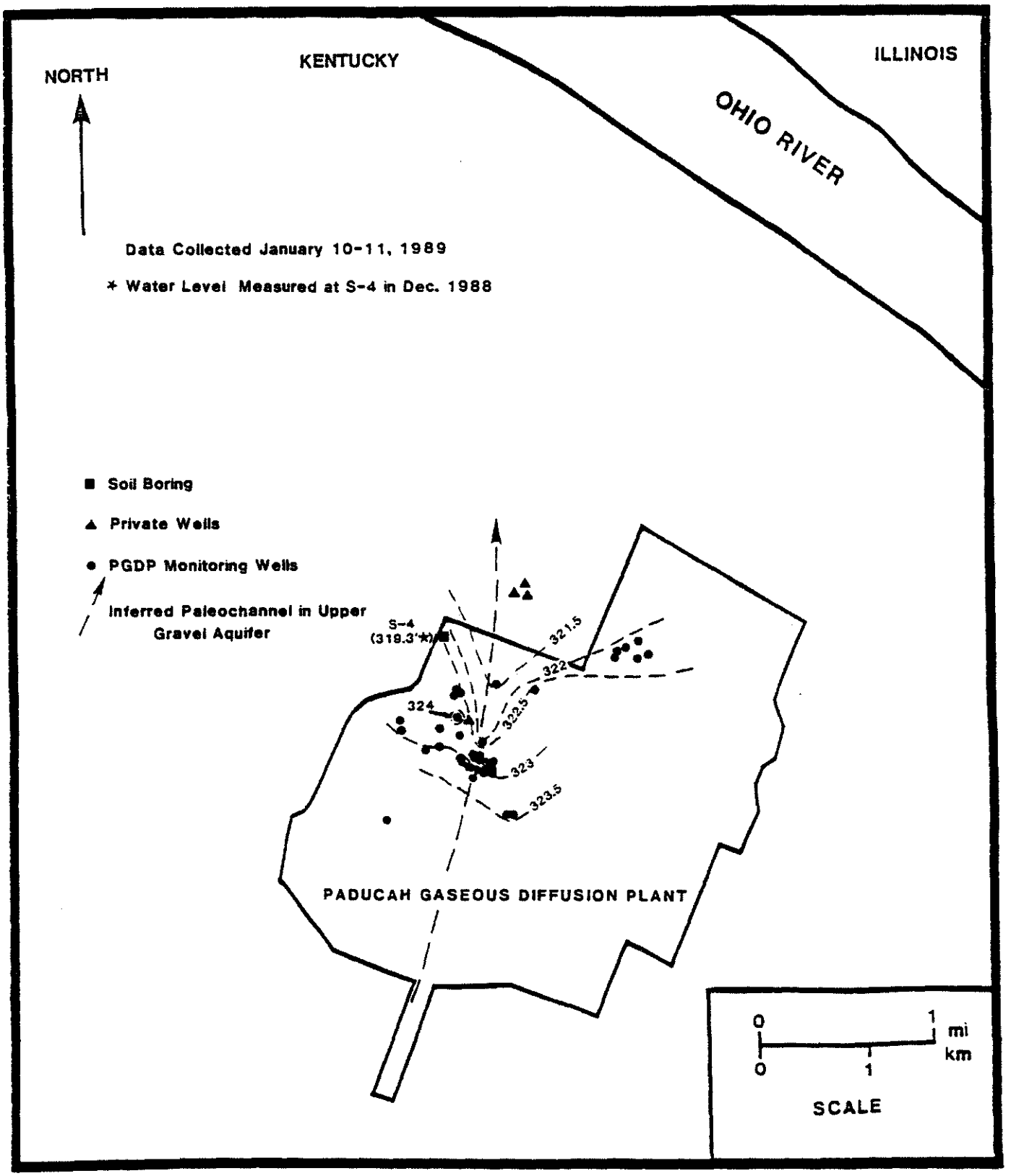

Fig. 6.2-2. Potentiometric surface for the gravel aquifer as reported for January 10–11, 1989. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

Table 6.2-1. Range of hydraulic conductivity values for major lithologies near the Paducah Gaseous Diffusion Plant

Unit	Hydraulic conductivity (cm/s)
Loess	10^{-7} to 10^{-4}
Upper cont. dep. (clay)	10^{-8} to 10^{-3}[a]
Upper cont. dep. (sand)	10^{-5} to 10^{-2}
Regional gravel aquifer	10^{-4} to 1
Porters Creek clay	10^{-9} to 10^{-7}
McNairy Formation	$<10^{-6}$ to 10^{-3}

[a]High results from Geotek (1979) not confirmed by Wehran (1980).

Source: T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Aug. 3, 1989.

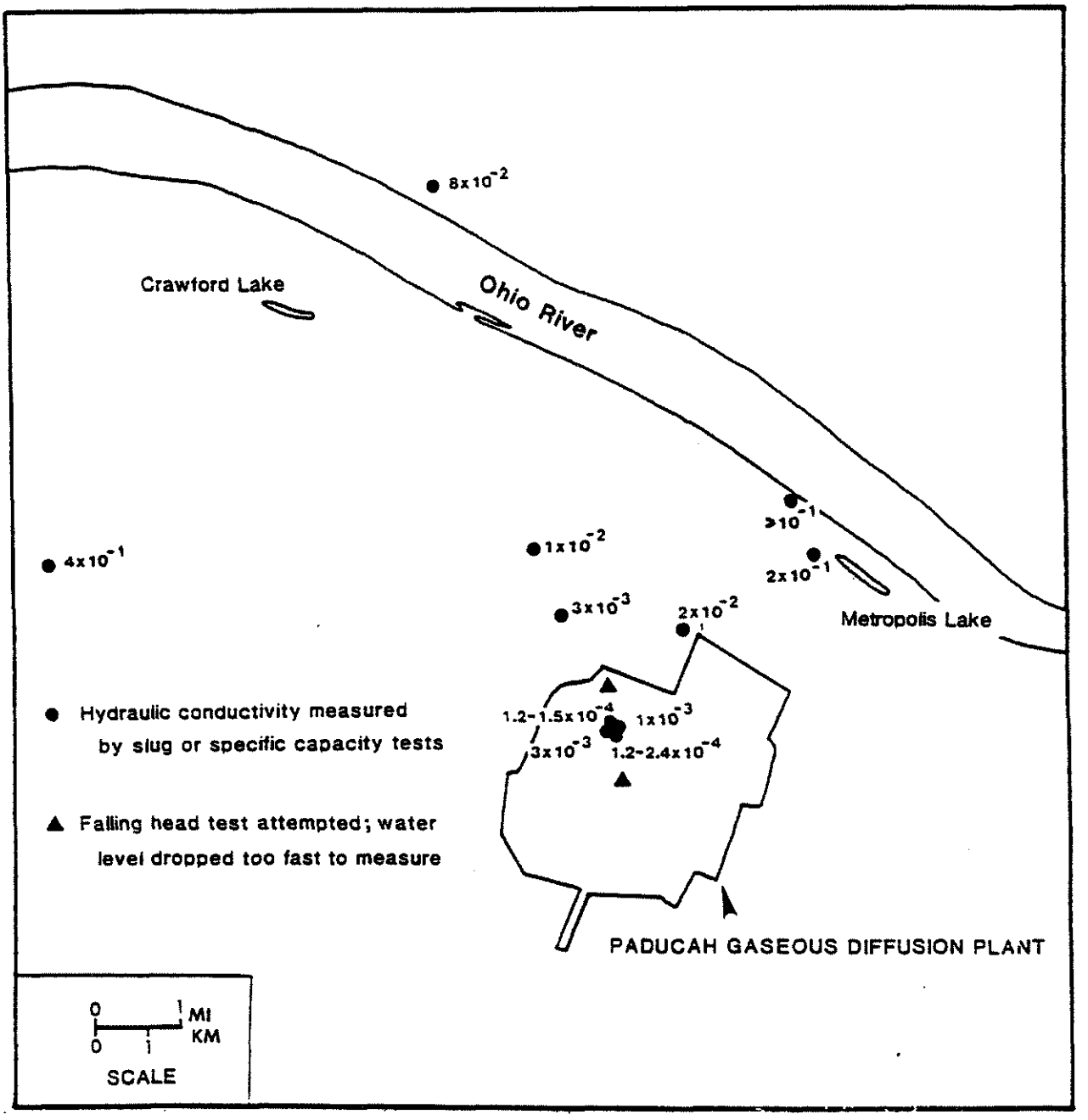

Fig. 6.2-3. Measured hydraulic conductivity values based on the results of slug and specific capacity tests in wells. *Source:* T. O. Early, C. F. Sigmon, and R. T. Williams, *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant,* Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. 3, 1989.

regional gravel aquifer, downward migration of groundwater would be facilitated. Where the Clay Facies sand lenses are isolated from the gravel aquifer by clay-rich materials, it is possible that groundwater and contaminants could be released very slowly (Early, Sigmon, and Williams 1989, pp. 43–45).

6.2.2 Groundwater Quality

Figure E.2-1 in Appendix E illustrates the locations of existing groundwater monitoring wells and piezometers in the vicinity of PGDP. Table E.2-1 is a summary of known installation data for each of the wells in the area. This information is provided for reference.

Few complete geochemical analyses of groundwater from the important hydrostratigraphic units in the vicinity of PGDP are available. The U.S. Geological Service (USGS) reported a few total analyses for samples obtained from the Continental Deposits (Davis, Lambert, and Hansen 1973, pp. 58–61), but most of the reported data are from the 1950s and early 1960s. Most available data from PGDP have been reported by contractors to DOE (e.g., Wehran 1981; D'Appolonia 1983), but they are incomplete with respect to some major cations and anions (Early, Sigmon, and Williams 1989, p. 45). Similarly, analyses performed by PGDP to meet regulatory requirements do not include a complete list of major groundwater constituents (e.g., Rogers and Jett 1989, pp. 145–156).

Recently collected data from the regional gravel aquifer, south of PGDP, are listed in Table E.2-2. These data represent the most complete background water quality dataset for the regional gravel aquifer that is currently available. However, some question still exists as to whether the gravel deposits south of the plant represent the same hydrostratigraphic unit as the gravel deposits immediately underlying PGDP and, thus, whether the data represent background groundwater quality for the gravel aquifer beneath PGDP. The data are presented here for comparison.

DOE has identified 95 waste management units (WMUs) within the PGDP site boundary that are potential sources for contaminants identified in groundwater beneath PGDP. These sites include burial grounds, drum and scrap yards, surface impoundments, storage tanks, spill sites, and surface waterways. Figure 6.2-4 shows the names and locations of the WMUs where groundwater is currently monitored. Details of each of these units may be found in Rogers and Jett (1989, pp. 27–30). During 1988, 62 wells were monitored in the PGDP on-site groundwater monitoring program. Groundwater monitoring data from 1988 are given in Tables E.2-3 through E.2-12. These values may be compared with reference compliance values shown in Table E.2-13, taken from the Safe Drinking Water Act (SDWA) and National Primary Drinking Water Regulations for Synthetic Chemicals.

In addition to known on-site groundwater contamination, off-site groundwater contamination was discovered in August 1988 north of PGDP, and a comprehensive effort was initiated to sample off-site wells. Through December 31, 1988, approximately 200 residential wells were sampled in an area circling PGDP. Analysis of these off-site well samples was limited to trichloroethylene (TCE) and ^{99}Tc after more exhaustive analyses (RCRA, Appendix IX) of the most contaminated off-site and on-site wells indicated these as the primary contaminants. Figure 6.2-5 and Table 6.2-2 show the location and analytical results, respectively, of any residential or Tennessee Valley Authority Shawnee Steam Plant monitoring well showing TCE or ^{99}Tc contamination. An on-going, off-site well monitoring program is currently being implemented at PGDP, with wells being sampled weekly,

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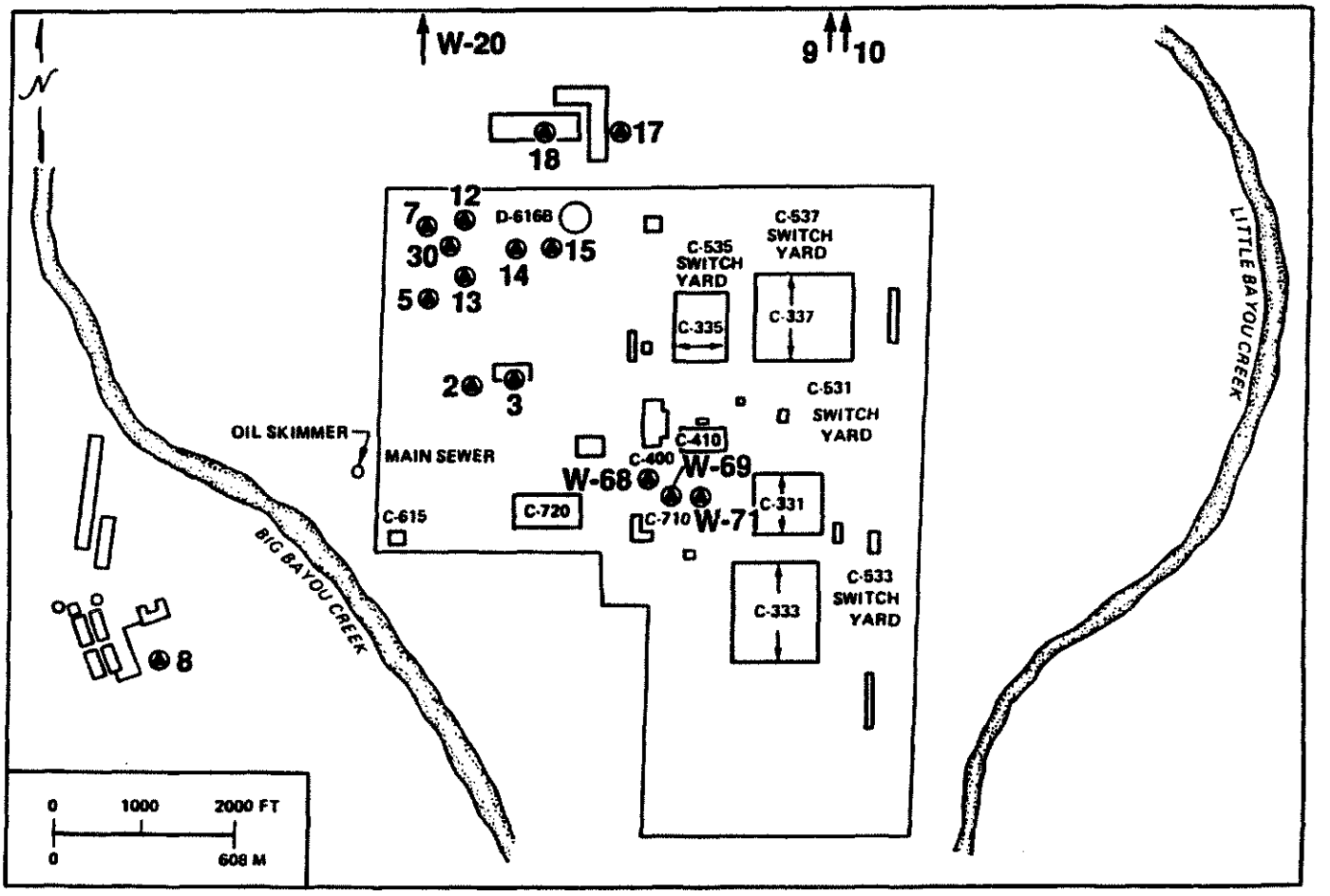

Unit[a]	Name
5	C-746-F classified burial yard
2	C-749 uranium burial ground
3	C-404 low-level radioactive waste burial ground
9	C-746-S residential landfill
10	C-746-T inert landfill
7	C-747-A burial ground
30	C-747-A burn area
13	C-746-P clean scrap yard
12	C-747-A UF_4 drum yard
14	C-746-E contaminated scrap yard
15	C-746-C scrap yard
8	C-746-K inactive sanitary landfill
17	C-616-E sludge lagoon
18	C-616-F full-flow lagoon
Well 20	Off-site horse barn, well north of PGDP
Wells 68,69,71	North of C-710, general monitoring wells

Fig. 6.2-4. Waste management units currently monitored at the Paducah Gaseous Diffusion Plant.

Source: J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn. and Paducah, Ky., May 1989.

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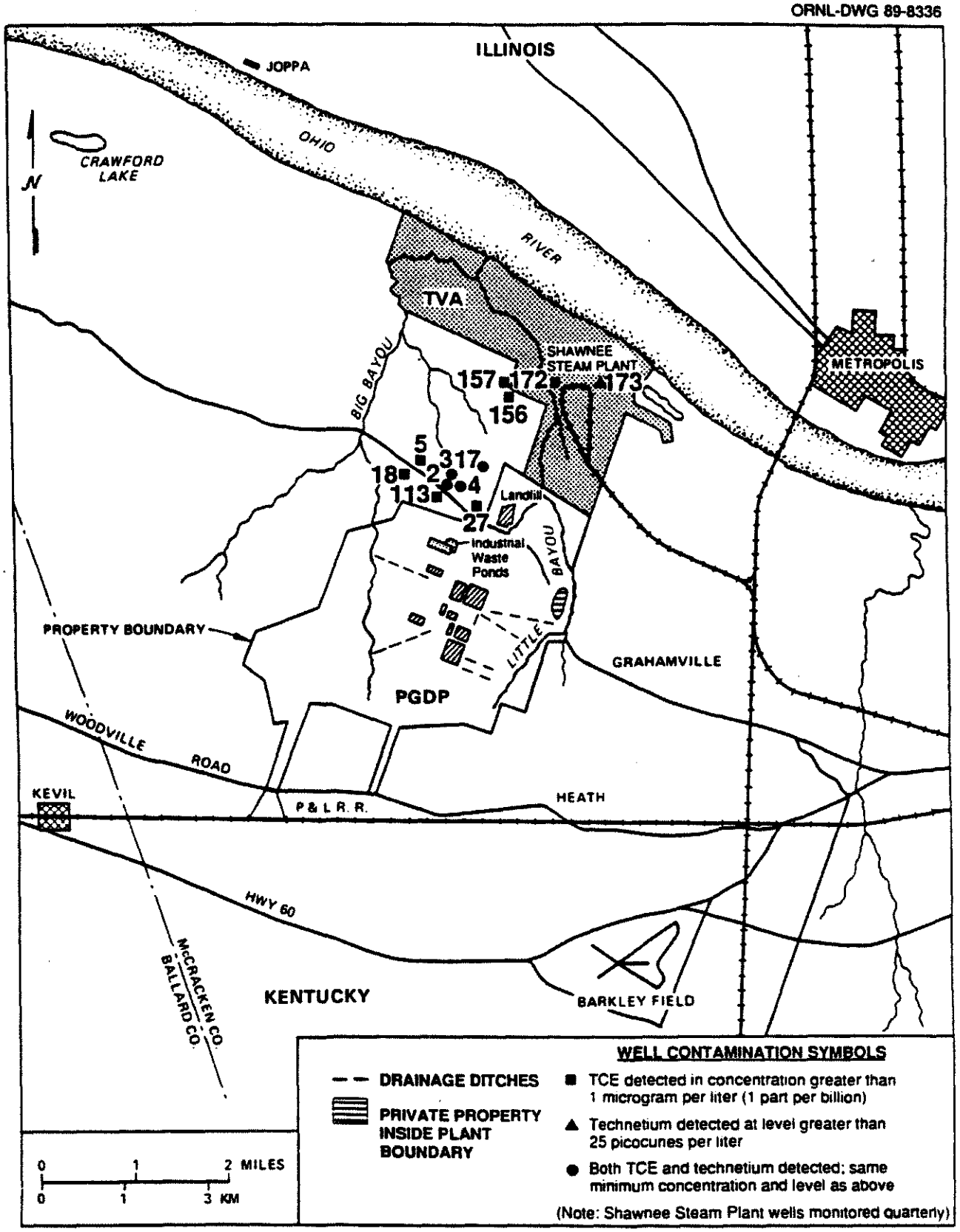

Fig. 6.2-5. Off-site groundwater sampling locations where ^{99}TC and TCE were detected.

Source: J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn. and Paducah, Ky., May 1989.

Table 6.2-2. Analytical results of off-site contaminated wells.

Location[a]	Trichloroethylene range (ppb)	Technetium-99 range (pCi/L)
2 Residence	623 to 960	342 to 408
3 Outbuilding	450 to 834	298 to 343
4 Outbuilding	20 to 43	<25 to 51
5 Residence	3 to 5	<25
17 Residence	40 to 51	69 to 83
18 Residence	<1 to 1.5	<25
27 Residence	<1 to 1	<25
113 Residence, capped well	7 to 20	<25
156 TVA well D-3	1	<25
157 TVA well D-4	5	<25
172 TVA well D-14	1	<25
173 TVA well D-27	<1	175 to 205

[a]See Fig. 6.2-5.

Source: J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988*, ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., 1989.

monthly, or bimonthly (Figs. 6.2-6 and 6.2-7), depending on proximity to PGDP and on analytical results from previous sampling of the wells (Rogers and Jett 1989, pp. 30–35).

Based on the preliminary data presented in Rogers and Jett (1989, p. 35), groundwater contamination has occurred at many of PGDP WMUs (e.g., WMUs 2, 3, 7, 12, 13, 14, 15, 30, 9, and 10) and at several wells (e.g., Wells 20, 68, 69, and 71). Contamination also extends off-site to the north. The primary contaminants are TCE and ^{99}Tc; however, it is not currently possible to resolve the sources of contamination in detail because the geometry and hydraulic properties of the aquifer system are not well understood (i.e., more monitoring wells are needed). In addition, because of the broad distribution of potential sources of groundwater contamination over most of the PGDP area and the predominant northerly migration direction, it is possible that contaminant plumes from individual sources will actually overlap.

6.3 PORTSMOUTH

6.3.1 Aquifer Systems

Data for 58 wells located within an area of 1.6 to 3.2 km (1 to 2 miles) from the PORTS site are summarized in Tables 6.3-1 and 6.3-2 from well logs obtained from the Ohio Division of Water [Law Engineering Testing Company (LETC) 1982, pp. 3-11 to 3-12]. Figure 6.3-1 shows the location and general aquifer type penetrated by each of these wells. Based on an analysis of these wells, LETC determined that three aquifers can be distinguished in the area: (1) the Scioto River alluvial aquifer (located to the west of the PORTS facilities); (2) the bedrock aquifers, consisting of shallow Mississippian shales and sandstones including the Cuyahoga Shale, the Sunbury Shale, the Berea Sandstone, and the Bedford Shale; and (3) other alluvial aquifers, including the Portsmouth River alluvial aquifer.

The Scioto River alluvial aquifer consists of alluvium deposited in the Scioto River Valley (Fig. 6.3-2). In general, these sediments consist of thick, coarse-grained glacial outwash deposits that are overlain by finer-grained Holocene alluvium. The thickness of the Scioto River alluvial aquifer ranges up to ~30 m (~100 ft), while the width of the unit ranges up to ~3.2 km (~2 miles) at some locations. The unit extends from the confluence of the Scioto and Ohio rivers to the headwaters of the Scioto in north-central Ohio (LETC 1982, p. 3-17).

The sands and gravels of the Scioto River alluvial aquifer are highly porous and permeable. The glacial outwash material yields water to wells more readily than does the finer-grained alluvium overlying the outwash material. Transmissivities and hydraulic conductivities for the Scioto River alluvial aquifer were estimated by LETC (1982, p. 3-18) from a limited data set from wells located near the PORTS plant site. The geometric mean transmissivity was estimated to be 60.85 m^3/day·m [4.9 x 10^3 gallons per day per foot (gpd/ft)]. The geometric mean hydraulic conductivity for two wells near the PORTS site was estimated as 8.2×10^{-2} cm/s.

Based on the analysis of the 58 wells located in or near the PORTS facility, 43% of the wells obtain water from the Scioto River alluvial aquifer. The average yield for Scioto River alluvial wells is 0.005 m^3/s (82 gpm), but yields may range up to ~0.032 m^3/s (500 gpm). Table 6.3-3 shows the only water quality analysis of the Scioto River alluvial aquifer water identified by LETC (1982, p. 3-18).

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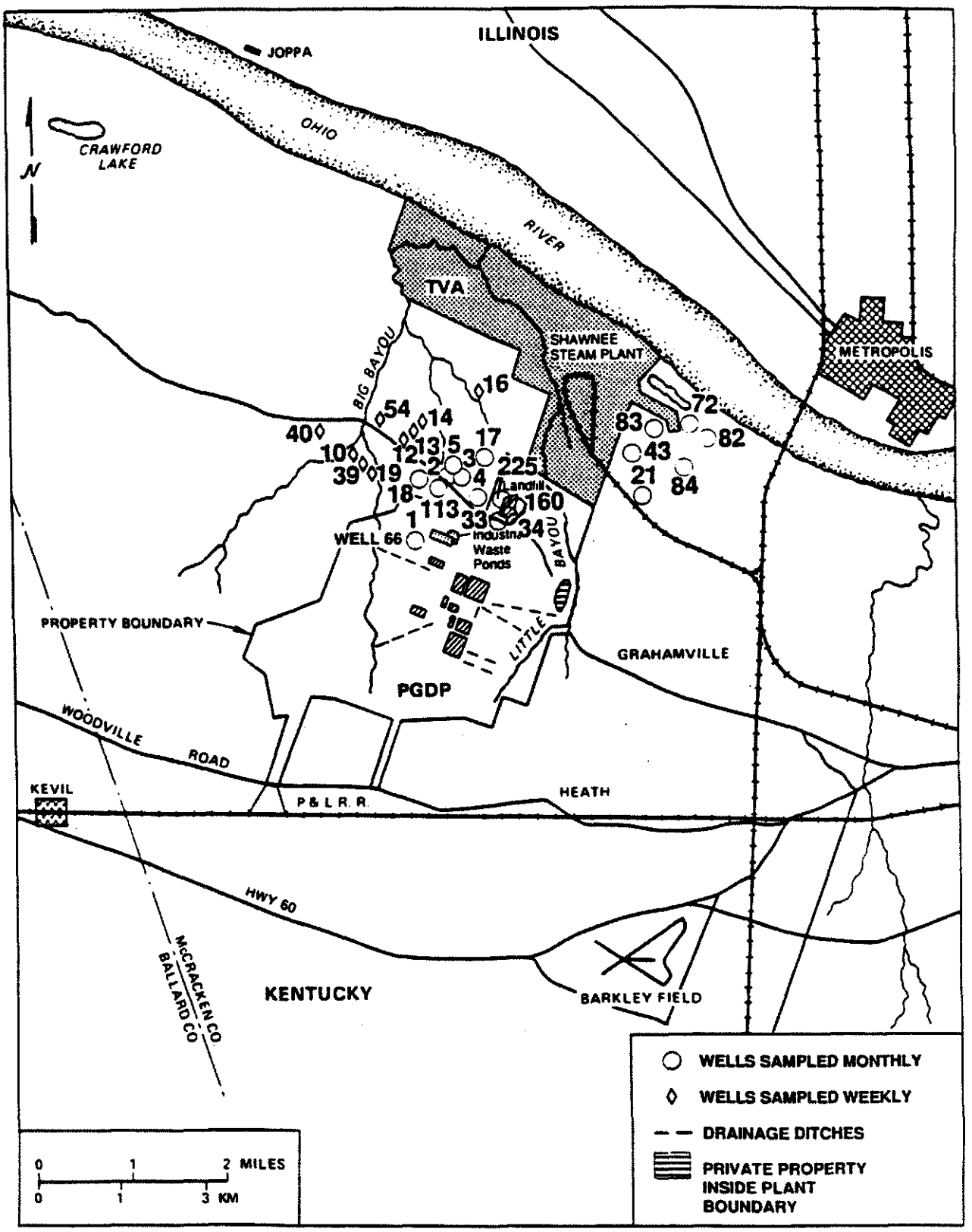

Fig. 6.2-6. Wells sampled weekly and monthly.

Source: J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn. and Paducah, Ky., May 1989.

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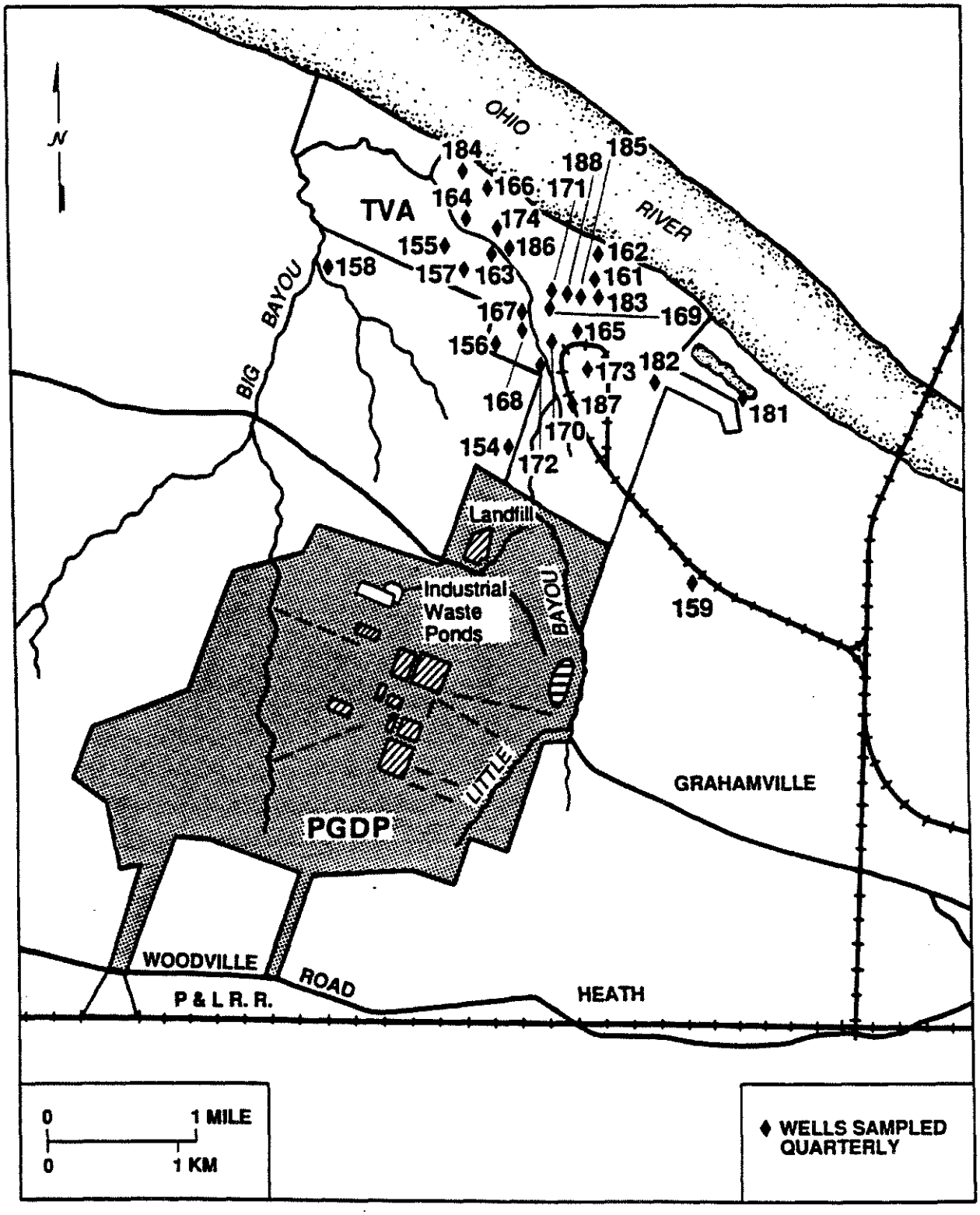

Fig. 6.2-7. Wells sampled quarterly.

Source: J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn. and Paducah, Ky., May 1989.

Table 6.3-1. Tabulation of groundwater data for located wells near the Portsmouth Gaseous Diffusion Plant

Township	Well No.	Water-Bearing Formation or Rock Type	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Well Yield (gpm)[b]	Static Water Level (ft below surface)[a]	Owner[c]
Scioto	1	Big Run alluvium	47	-	25	-	(P) Mr. Falls
	2	Big Run alluvium	66	-	6	-	(P)
	3	Ss + Sh	59	35	-	42	(P) Guy Jaynes
	4	Ss + Sh	50	27	15	-	(P) Guy Jaynes
	5	Berea Ss	70	35	-	45	(P)
	6	Sh	63	20	10	30	(P) Charles Noel
	7	Berea Ss	54	24	-	28	
	8	Sh	40	23	0.3	-	(P) Donald Ward
	9	Sh	150	20	-	-	(P)
	10	Scioto R. alluvium	36	-	-	20	(P) Whellen
	11	Ss + Sh	46	14	-	28	(P) Corbett Lovely
	12	Sh	70	8	-	30	(P) Corbett Lovely
	13	Sh	65	6	-	30	(P) Roland Jaynes
	14	Ss	60	5	0.1	-	(P)
	15	Sh	50	20	-	20	(P) Lee Hall
	16	Scioto R. alluvium	63	-	50	-	(P) Eddie West
	17	Scioto R. alluvium	72	-	50	26	(P) C. E. Fannin
	18	Scioto R. alluvium	70	-	50	26	(P) C. E. Fannin
	19	Scioto R. alluvium	55	-	-	-	(P) Will H. Acord
	20	Scioto R. alluvium	55	-	-	-	(P) John Filmore
	21	Scioto R. alluvium	55	-	-	-	(P) Carl Days
	22	Scioto R. alluvium	55	-	-	-	(P) Will H. Acord
	23	Scioto R. alluvium	55	-	-	-	(P) Merle Berkman
	24	Scioto R. alluvium	55	-	-	-	(P) E. L. Freeland
	26	Ss + Sh	117	20	0.1	55	(I) Standard Slag Company
	28	Ss	37	5	0.5	-	(P) Charles Schultz
	29	Ss + Sh	60	27	-	30	

Table 6.3-1 (continued)

Township	Well No.	Water-Bearing Formation or Rock Type	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Well Yield (gpm)[b]	Static Water Level (ft below surface)[a]	Owner[c]
Scioto	30	Sh	70	8	-	20	(P) Roland Jaynes
	32	Sh	80	59	-	50	(P) Minnie O'Dell
	34	Berea Ss	60	20	-	22	(P) George O'Dell
	35	Berea Ss	40	18	-	23	(P) George O'Dell
	36	Sh	59	32	0.3	-	(P) Jay Howard
	37	Sh	70.5	10	30	30	(P) Arthur Zimmerman
	38	Scioto R. alluvium	60	-	50	33	(P) Hugh A. Hughes
	39	Scioto R. alluvium	54	-	-	28	(P) Corbett Lovely
	40	Scioto R. alluvium	69	-	-	-	(I) Zanesville Supply Company
	41	Scioto R. alluvium	73	-	15	51	(P) W. M. Corwin
	42	Scioto R. alluvium	72	-	300	45	(I) Standard Slag Company
	44	Sh	90	75	1	50	(P) Ryman Dawson
	45	Scioto R. alluvium	79	-	20	-	(P)
	46	Scioto R. alluvium	74	-	35	46	(P) Steinhauer
	47	Scioto R. alluvium	71.5	-	-	36.5	
	48	Sh	60	41	3	26	(P) E. J. Humphrey
	49	Scioto R. alluvium	56	-	5	46	(P) E. J. Humphrey
	50	Scioto R. alluvium	52	-	15	36	(P) W. L. Williamson
	52	Scioto R. alluvium	76	72	25	55	(P) Mederia Dawson
	53	Scioto R. alluvium	72	-	25	55	(P) Mederia Dawson
	54		40	20	5	20	(P) Arnold Moore
	55	Scioto R. alluvium	58.5	-	10	32	(P) J. R. Jergeman
	56		100	-	20	15	(P) Edward Gibbs
	57		100	-	30	30	(P) Ernest Grace

Table 6.3-1 (continued)

Township	Well No.	Water-Bearing Formation or Rock Type	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Well Yield (gpm)[b]	Static Water Level (ft below surface)[a]	Owner[c]
Seal	13	Sh	65	8	-	-	(P) H. W. Bailey
	14	Ss	68	22	-	-	(P) O.C. Nance
	15	Sh	55	20	0.8	12	(P) Elmer Carter
	22	Beaver Cr.alluvium	71	-	50	-	(?) Miracle City
	23	Scioto R. alluvium	72	-	500	45	(P) J. V. Vanmeter
	24	Little Beaver Cr. alluvium	29.5	-	4.2	14	(P) J. V. Vanmeter
	34	Scioto R. alluvium	85	-	-	57	(P) Madera Brown

[a]Convert feet (ft) to meters by multiplying the given value by 0.3048.

[b]Convert gallons per minute (gpm) to liters per minute by multiplying the given value by 3.7854.

[c]P = private individual (domestic or agricultural use), I = Industrial or commercial water user, M = municipal water user, and ? = classification of user uncertain.

Source: Law Engineering Testing Company. *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, Colo., May 13, 1982.

Table 6.3-2. Data summary for located wells near the site vicinity[a]

Aquifer or rock type[b]	Number	Percentage of all wells (number ÷ 58)	Average well yield: Number	Average well yield: Yield (gpm)[c]
Ss	7	12	2	0.3
Sh	14	24	7	6.5
Ss–Sh	5	9	2	7.6
Scioto River alluvium	25	43	14	82
Other alluvium: Big Run, Little Beaver Creek, Beaver Creek	4	7	4	21
Aquifer or rock type not named	3	5	3	18
Sum total	58	100		

[a]Data summary refers to all located wells within the area designated in Fig. 6.3-1.
[b]Ss = sandstone; Sh - shale.
[c]Convert gallons per minute (gpm) to liters per minute by multiplying the given value by 3.7854.
Source: Law Engineering Testing Company, *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, Colo., May 13, 1982.

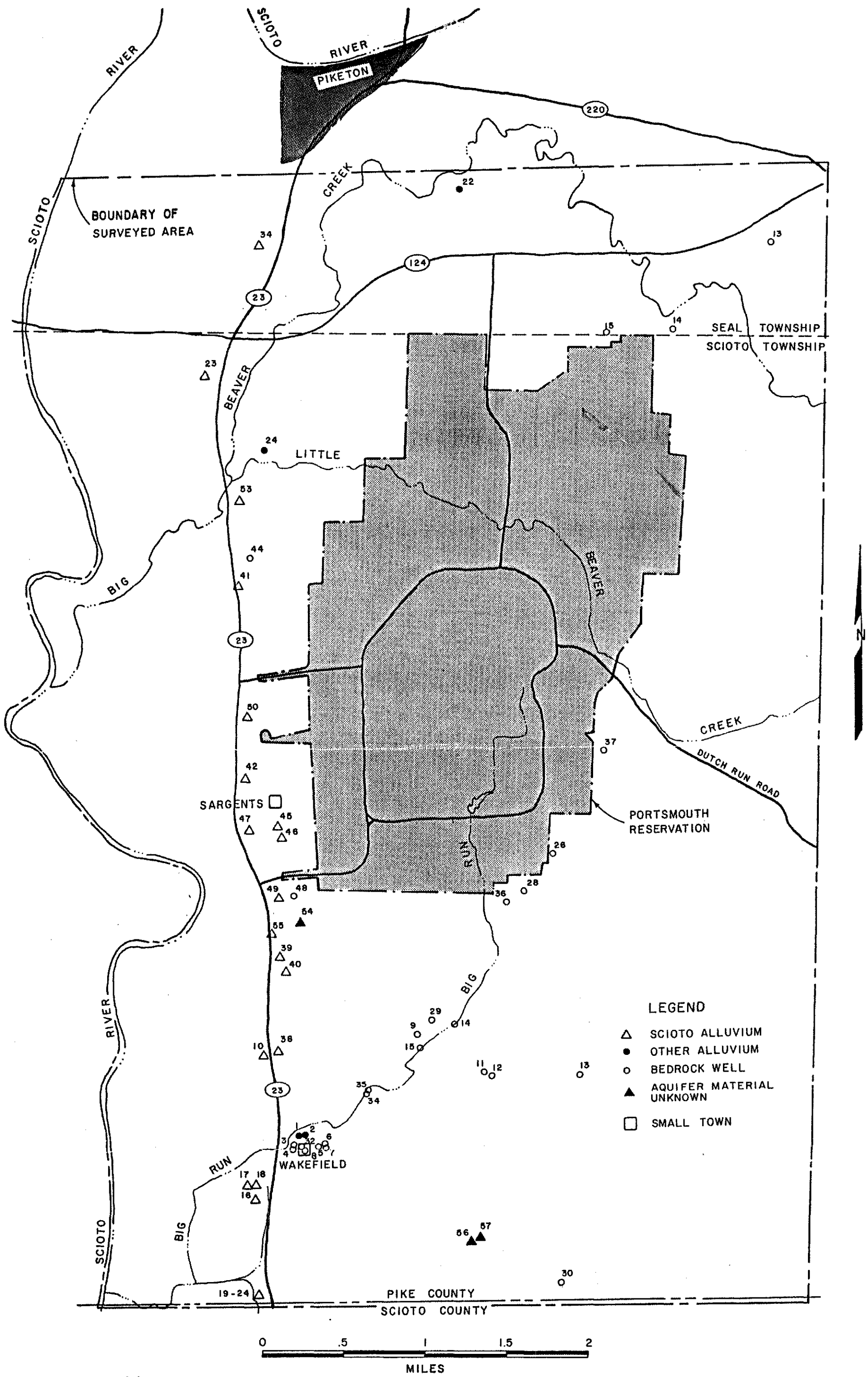

Fig. 6.3-1. Located wells near the site vicinity. *Source:* Law Engineering Testing Company, *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, Colo., May 13, 1982.

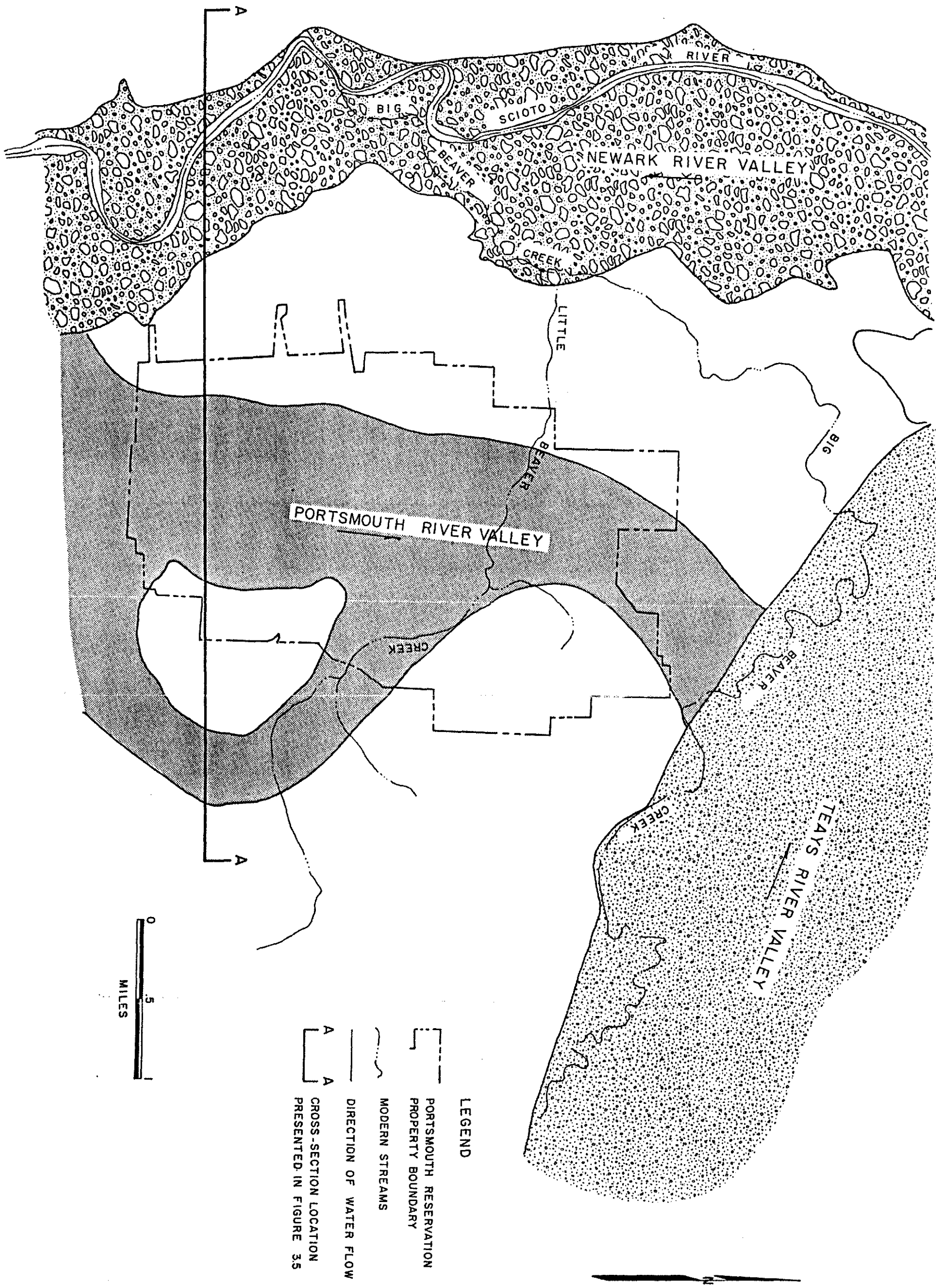

Fig. 6.3-2. Paleochannel map of the study region. *Source:* Law Engineering Testing Company, *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, Colo., May 13, 1982.

Table 6.3-3. Site vicinity water quality

Water sample	Sample date	Discharge (cfs)[a]	pH	Dissolved solids (ppm)	Total hardness (ppm)	Cl (ppm)	Sulfate (ppm)	Nitrate (ppm)	Fe (ppm)
Ground Water									
Bedrock aquifer			4.1	2909	1290	66			2.8
Scioto River alluvium			7.2	348	328	3.8			1.9
Teays River alluvium			5.8	148	48	15			16
Surface Water									
Beaver Creek—Piketon	9/11/56	9.7	6.8	914		95	551	76	
Beaver Creek—Piketon	5/09/57		8.1	225		10	61	3.4	

[a]Convert cubic feet per second (cfs) to cubic meters per second by multiplying by 0.028.

Source: Law Engineering Testing Company, *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, Colo., May 13, 1982.

Recent analysis of the hydrogeology by Geraghty and Miller (1989a, p. 1-5) has demonstrated that within the bedrock and alluvial aquifers at the PORTS facility, four primary hydrogeologic units occur at the site: the unconsolidated Minford and Gallia Members of the Teays Formation, the Sunbury Shale, and the Berea Sandstone. Figure 6.3-3 is a hydrogeologic map that illustrates the areal limits of both the unconsolidated units (Minford and Gallia combined) and each important hydrogeologic bedrock unit (the Berea Sandstone and Sunbury Shale) in the vicinity of PORTS. Figure 6.3-4 shows the average thicknesses of these units at the PORTS site and the average hydraulic conductivity (K) in meters per day (m/d) and feet per day (ft/d) for each unit (Geraghty and Miller 1989a, p. 1-9).

The geologic structure of the area, as shown in Fig. 6.3-5, is minor; the Mississippian bedrock dips gently to the east at 5.7 m/km (~30 ft/mile) or 0.3°. The figure also shows the upland setting of the abandoned Portsmouth River valley in relation to the deeply incised Newark River valley. The Scioto River valley represents the regional base level for both surface and ground waters flowing from the PORTS vicinity. The cross section also illustrates the isolated and areally limited distribution of the Minford and Gallia Members of the Teays Formation and shows that the Sunbury Shale is absent over the western portion of PORTS, eroded from the site by the Portsmouth River. This theory is supported by the structural contour map drawn on the top of the Berea Sandstone (Fig. 6.3-6). This figure also shows that several feet of the upper Berea were removed by the Portsmouth River (Geraghty and Miller 1989a, p. 1-6).

At the PORTS site, the Berea Sandstone exhibits little spatial variation in hydraulic properties. The average hydraulic conductivity for the Berea is 0.05 m/d (0.16 ft/d) (Geraghty and Miller 1989a, p. 1-10). The highest hydraulic conductivity in the Berea was measured as 0.11 m/d (0.35 ft/d) at the X-616 area, where the unit has been slightly eroded and may be slightly weathered, while the lowest hydraulic conductivity was measured as 0.03 m/d (0.1 ft/d) at both X-231B and X-701. A summary of the hydraulic conductivity data for the Berea across the PORTS site is presented in Table 6.3-4 from Geraghty and Miller (1989a, p. 1-10).

The Sunbury Shale is an important unit at PORTS because where it is present, its thickness limits the vertical communication between the underlying Berea Sandstone and the overlying Gallia sand, the two most important aquifers at the PORTS site. Where it is present, the average thickness of the Sunbury is ~3 m (~10 ft).

The unconsolidated geology of PORTS consists of several distinct hydrogeologic units, which may be divided based upon characteristic differences in grain size, composition, and hydraulic response. Primarily, these are the Gallia Member and the Minford Member. The Minford can be further subdivided into two distinct units; a lower silt unit and an upper clay unit. Together, these three units represent a fining upward sequence that indicates a change from a fluvial to a lacustrine environment of deposition.

The Gallia sand, which overlies Mississippian bedrock, underlies the Minford Member at a depth of ~7.6 m (~25 ft) below ground surface. The Gallia is discontinuous across the PORTS site. This unit has the highest hydraulic conductivity on the PORTS site and is of primary importance in understanding the potential migration of groundwater contaminants away from PORTS. Measured hydraulic conductivities for this unit range from 0.03 to 46 m/d (0.11 to 150 ft/d), with a mean of ~1.03 m/d (~3.4 ft/day). The spatial variation in Gallia hydraulic conductivity is significant. The X-231 area contains the most permeable Gallia materials, with an average of 2.16 m/d (7.1 ft/d), whereas the X-616 area exhibits the lowest Gallia conductivity, with an average of 0.37 m/d (1.2 ft/d). The highest Gallia

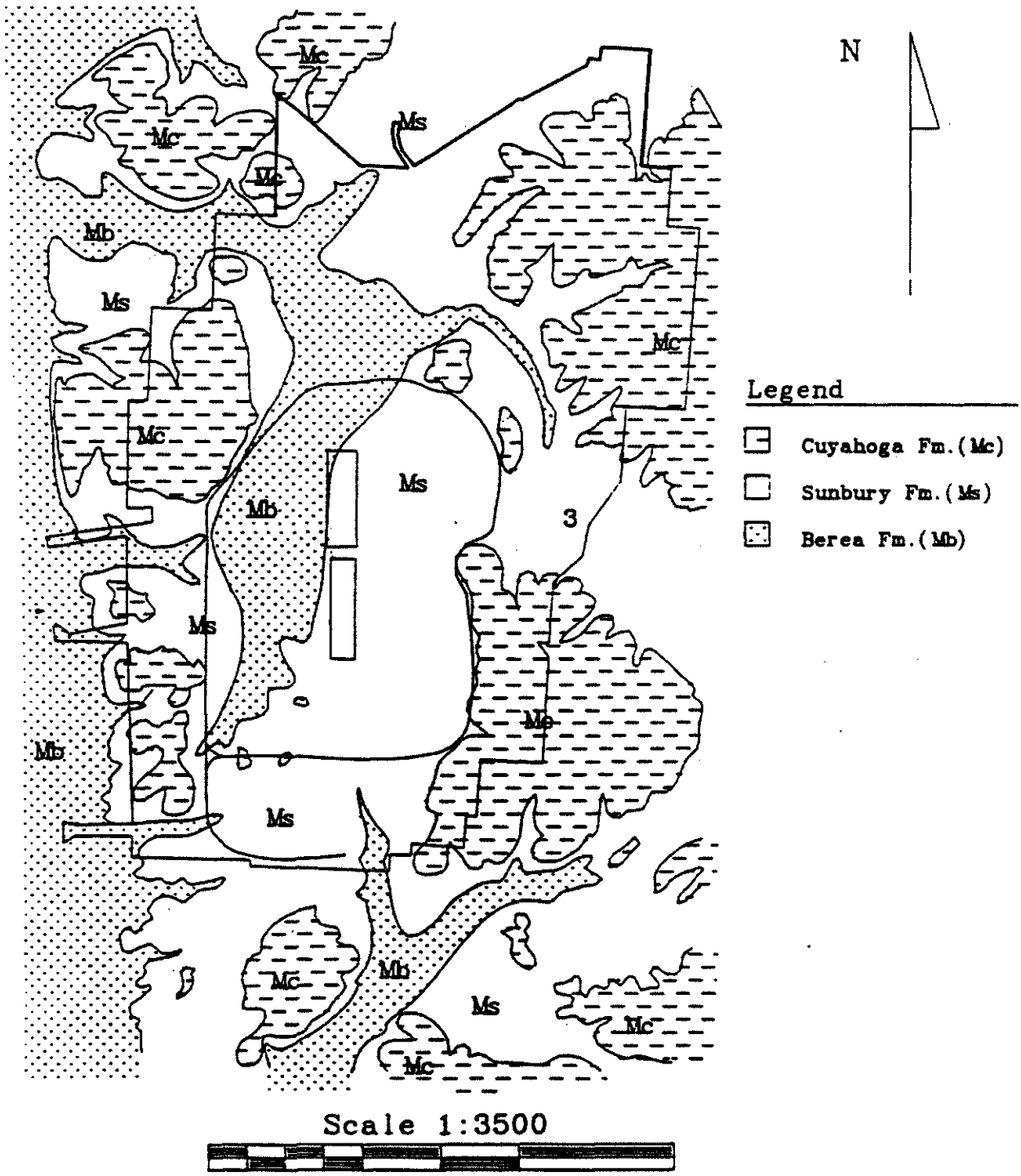

Fig. 6.3-3. Hydrogeologic map of the Portsmouth Gaseous Diffusion Plant showing approximate outcrop/subcrop patterns of Mississippian bedrock. *Source:* Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

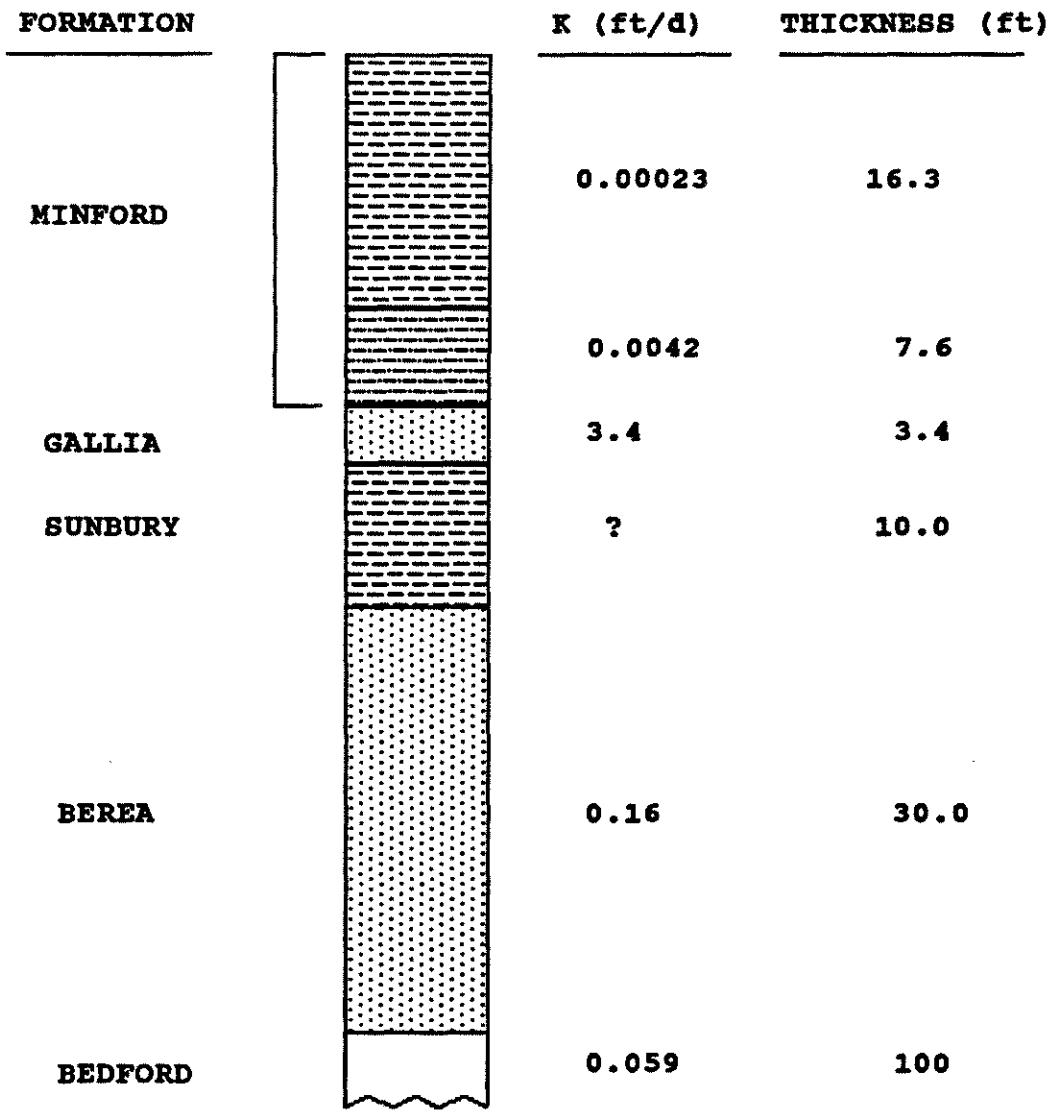

Fig. 6.3-4. Hydrogeologic column at the Portsmouth Gaseous Diffusion Plant. Note that feet (ft) can be converted to meters by multiplying by 0.3048. *Source:* Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

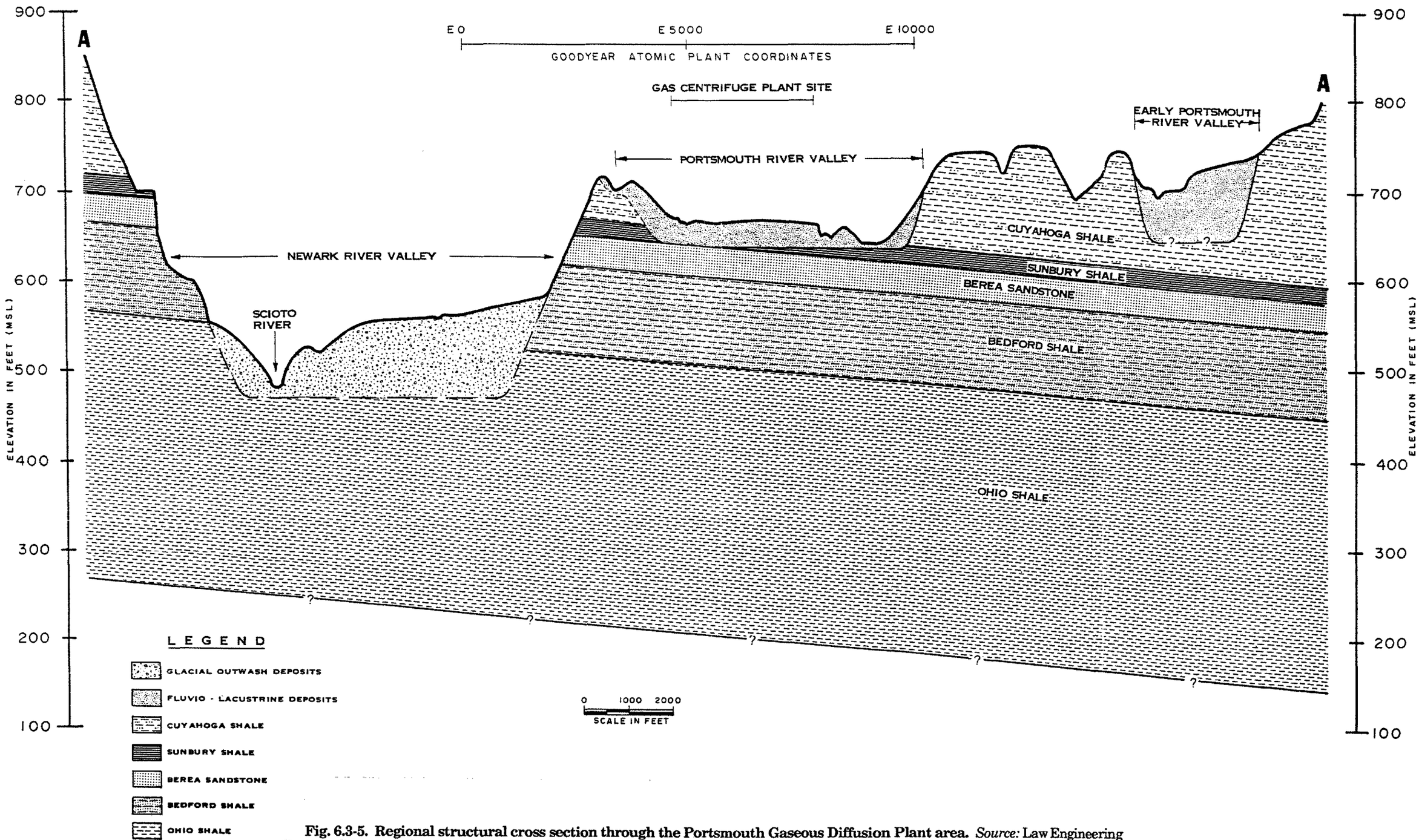

Fig. 6.3-5. Regional structural cross section through the Portsmouth Gaseous Diffusion Plant area. *Source:* Law Engineering Testing Company, *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* Marietta, Ga., Apr. 28, 1978.

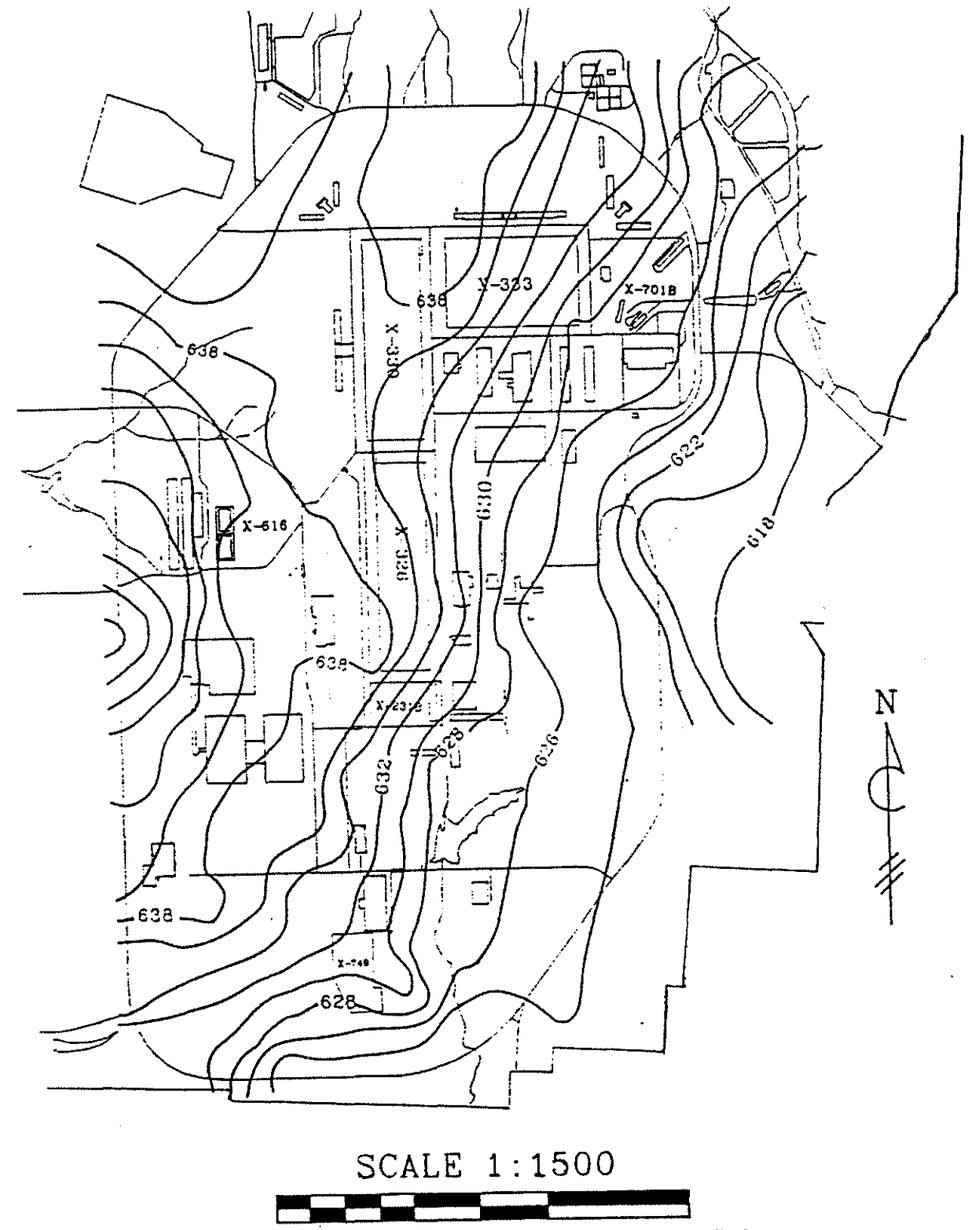

Fig. 6.3-6. Structural contour map for the top of the Berea Formation. *Source:* Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

Table 6.3-4. Summary of Gallia and Berea hydraulic conductivity data

Area	Mean hydraulic conducivity (ft/d) Gallia	Berea
Site-wide	3.4	0.16
Framework	1.9	0.2
X-231B	7.1	0.1
X-616	1.2	0.35
X-701	3.1	0.1
X-749	3.6	0.16

Note: Convert feet per day (ft/d) to meters per day (m/d) by multiplying by 0.3048.
Source: Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

permeability values generally occur wherever thicker point bar deposits are developed. A summary of the hydraulic permeability data for the Gallia across the PORTS site is presented in Table 6.3-4. The storage coefficient of the Gallia Sand was found to be highly variable, ranging in value from 0.00011 to 0.41. According to Geraghty and Miller (1989a, p. 1-10) the storage coefficient of the Gallia appears to be controlled by the thickness of the overlying Minford Clay (i.e., the thicker the Minford clay, the larger the storage coefficient of the Gallia).

Numerous laboratory estimates of hydraulic conductivity for the Minford clay and overlying Minford silt units were performed by LETC (1978). The average permeability of the Minford clay was 0.00007 m/d (0.00023 ft/d), and the average permeability of the Minford silt was 0.0013 m/d (0.0043 ft/d) (Geraghty and Miller 1989a, p. 1-9).

Groundwater flow at PORTS is controlled by the complex interactions between the Gallia and Berea units. The flow patterns are also affected by the presence and elevation of storm sewer drain pipes and their bedding and by the reduction in recharge caused by building and paved areas. Three principal discharge areas exist for all groundwaters: (1) Little Beaver Creek to the north and east, (2) Big Run Creek to the south, and (3) two unnamed drainages to the west. Groundwater flow patterns in both the Berea and Gallia are characterized by an east-west trending groundwater divide that passes through the X-616 area and the southern end of Building X-326 (Figs. 6.3-7 and 6.3-8). Other groundwater divides are also present, dividing the flow system of each unit into four sub-basins in the Gallia and three in the Berea. Groundwater flow directions in the Berea roughly parallel those in the Gallia (Geraghty and Miller 1989a, pp. 1-10 to 1-11).

6.3.2 Groundwater Quality

Groundwater quality data from the Scioto River Basin in the vicinity of PORTS were reported by the Ohio Department of Natural Resources (ODNR 1985) (see Table 6.3-5). Although the data are incomplete and the specific hydrogeologic units sampled were not identified, the depth of the well was given and the water bearing formations were described.

At the end of CY 1988, PORTS had 238 monitoring wells in 9 separate monitoring well systems and 29 monitoring wells in a loose, plant-wide framework, an increase of 100 wells from the end of CY 1987. The locations of the on-site monitoring wells at PORTS are shown in Fig. 6.3-9. The large increase in the number of monitoring wells resulted from a program that is underway to characterize the groundwater quality at the four RCRA-regulated land disposal units on the plant site: the X-616 chromium sludge surface impoundments, the X-231B oil plots, the X-701B holding pond, and the X-749 low-level radioactive waste landfill. Most of the available groundwater quality data collected in 1988 were from 38 monitoring wells that remained in the routine monitoring program, while a one-time sampling event was conducted on 249 wells (Rogers, J. G., et al. 1989, p. 63).

Data derived from the groundwater monitoring program at PORTS in 1988 were summarized in the 1988 Environmental Report for PORTS (Rogers, J. G., et al. 1989) and are presented in Appendix E. Table E.3-1 is a list of groundwater monitoring parameters and applicable regulatory standards. Data collected from specific sites at PORTS (i.e., X-701B, X-616, X-749, X-231B, X-735, and X-734) are summarized in Tables E.3-2 through E.3-28. Groundwater quality assessments and related studies performed in 1988 have shown that groundwater at three of the four RCRA-regulated sites at PORTS (i.e., the X-231B oil plots, the X-701B holding pond, and the X-749 low-level waste landfill) is contaminated. These studies showed that at the fourth RCRA site, the X-616 chromium sludge surface impoundments, groundwater quality has not been significantly affected. At the three sites

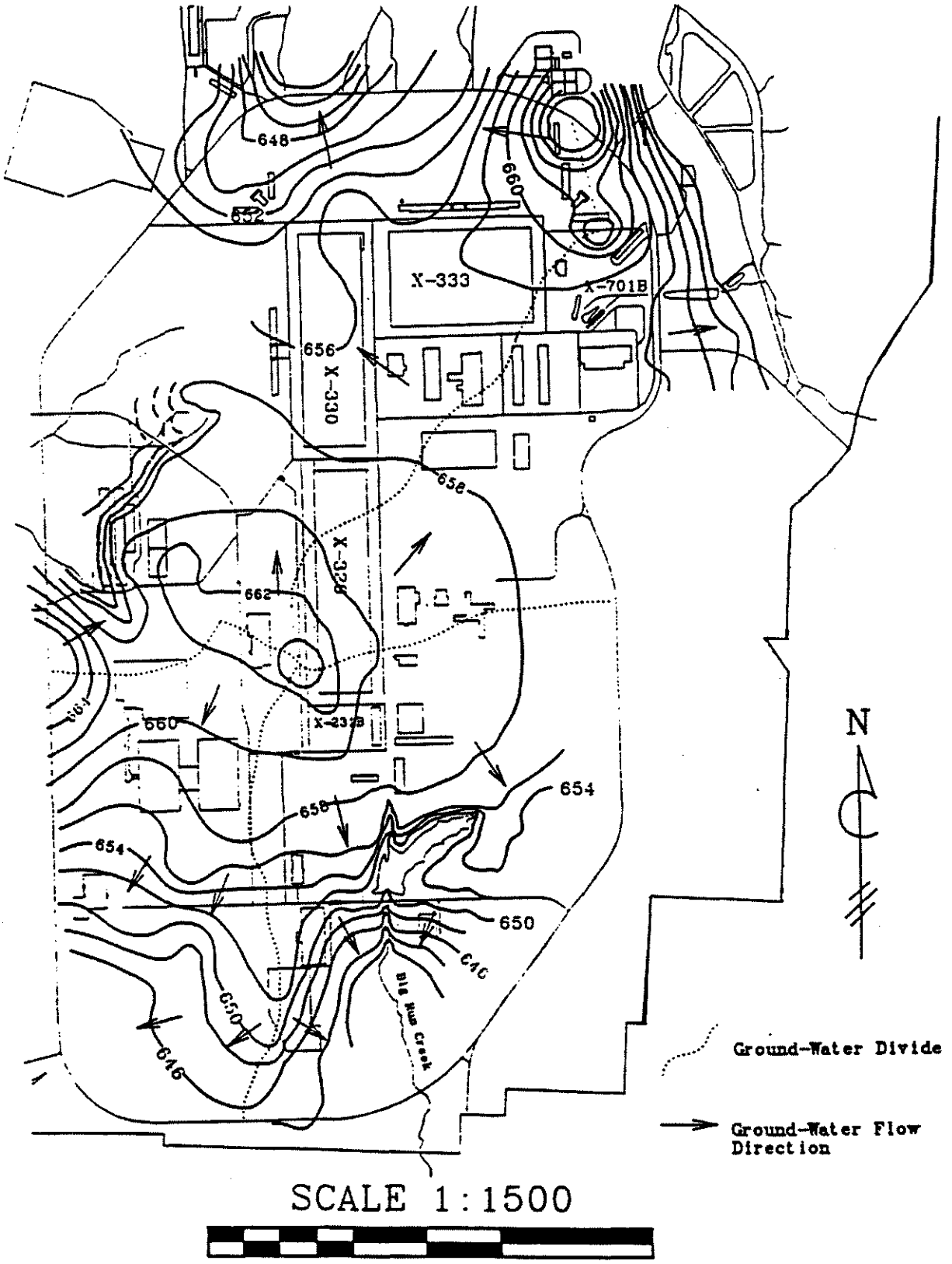

Fig. 6.3-7. Potentiometric surface for the Gallia Aquifer (December 12, 1988). *Source:* Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

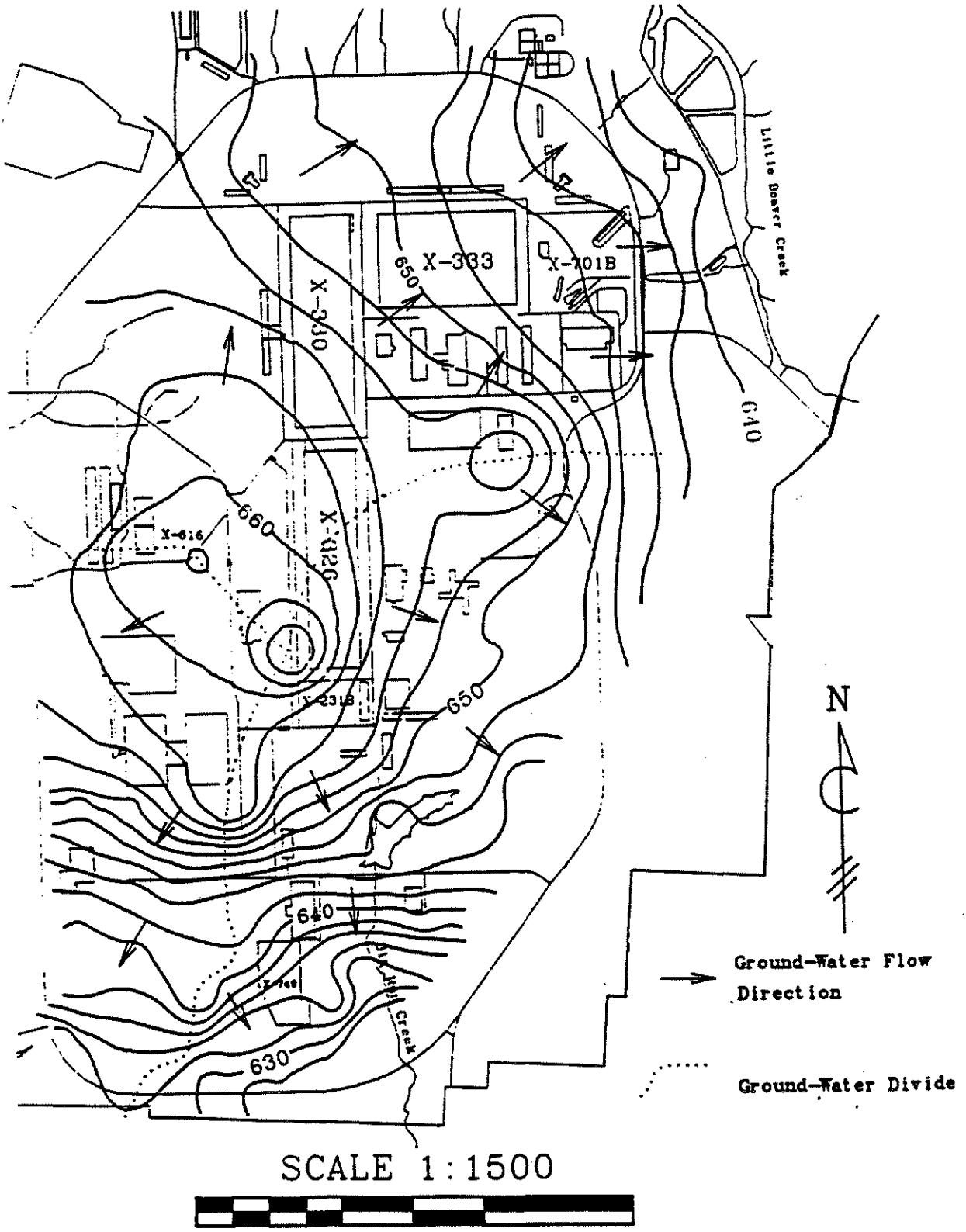

Fig. 6.3-8. Potentiometric surface for the Berea Aquifer (December 12, 1988). *Source:* Geraghty and Miller, Inc., *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* Reston, Va., May 1989.

Table 6.3-5. Groundwater quality in the vicinity of the Portsmouth Gaseous Diffusion Plant (PORTS) (analytes listed in ppm)

	Northeast of PORTS	West of PORTS
Lithology	Sand and gravel	Shale
Depth (ft)	21	70
Fe	0.32	0.21
SO_4	55	51
Cl	45	9
$CaCO_3$	109	299
Dissolved solids	257	344

Note: to convert feet (ft) to meters, multiply by 0.3048.
Source: Ohio Department of Natural Resources, *An Inventory of Ohio Soils Pike County,* Progress Report No. 76, 1985.

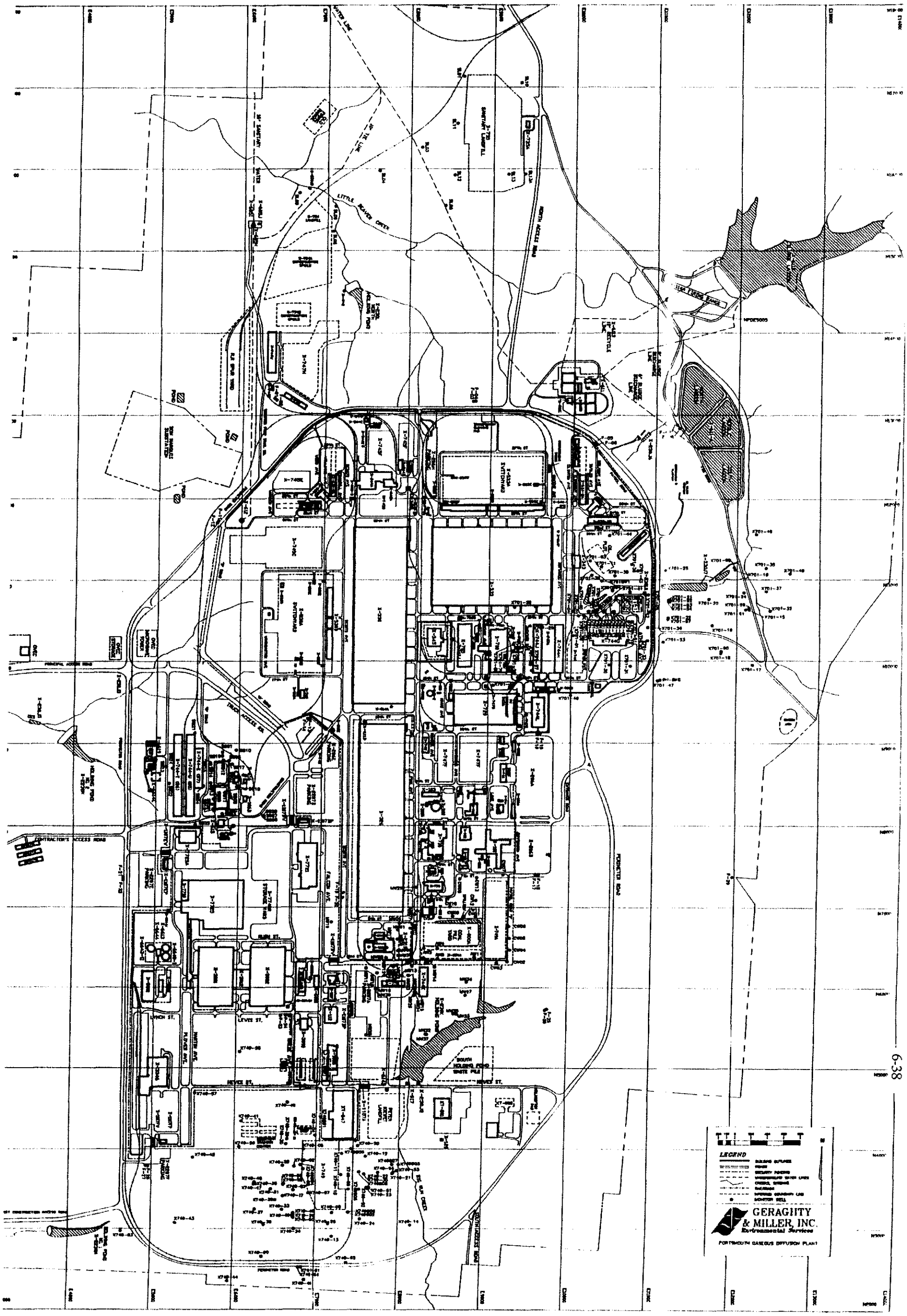

Fig. 6.3-9. Existing groundwater monitoring wells at the Portsmouth Gaseous Diffusion Plant. *Source:* Geraghty and Miller, Inc., unpublished data.

where groundwater contaminants were identified, the contaminants were mainly low-molecular-weight chlorinated aliphatic organics, such as degreasing solvents (tetrachloroethylene, trichloroethylene, trichloroethane, and Freon 113) and their degradation products. Uranium concentrations were less than 20 μg/L (ppb); for comparable alpha values, the highest determination was less than 14 pCi/L. Technetium beta activity was elevated at each of the three sites and also at the X-231A oil plot adjacent to the X-312B oil plot. The highest technetium beta activity, approximately 8600 pCi/L, was found at the X-701B site. Groundwater from three wells at the X-701B site exceeded the drinking water limit of 900 pCi/L (Rogers, J. G., et al. 1989, p. 69).

Off-site monitoring of the sanitary water systems of local residents near the PORTS facility began in 1979. This monitoring is conducted semiannually on springs and private wells that serve as the source of sanitary water for private households near PORTS (Fig. 6.3-10 and Table 6.3-6). Results of the analyses are routinely communicated to the residents. Parameters typically monitored include uranium, technetium, total alpha, and total beta. Analysis for the presence of organic compounds was added in 1986. To date, the monitored parameters have not been detected above background in any of the sampling events. The analyses from CY 1988, taken from Rogers et al. (1989, pp. 141–164) are summarized in Tables 6.3-7 and 6.3-8.

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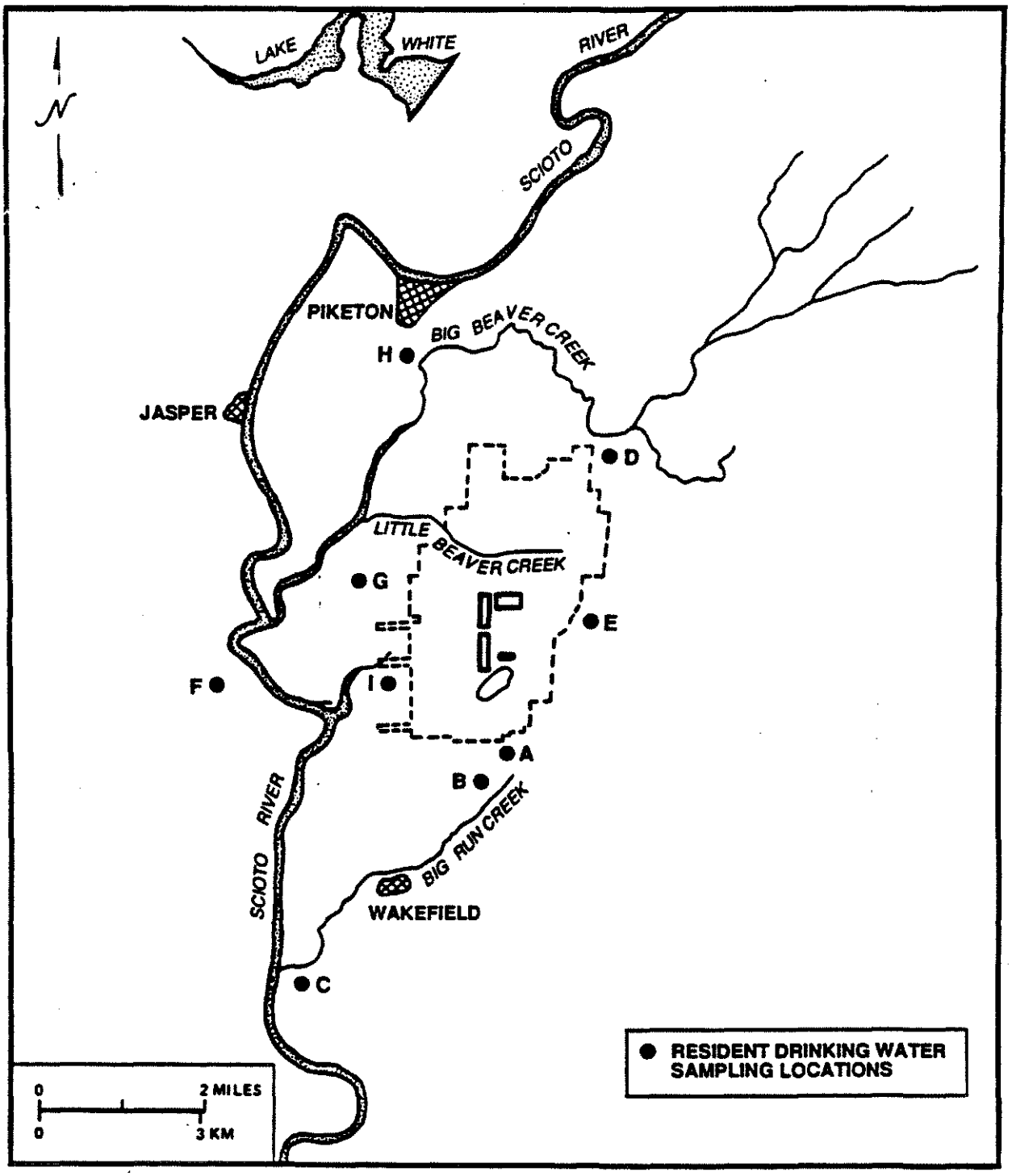

Fig. 6.3-10. Residential drinking water monitoring sites.

Source: J. G. Rogers et al., *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Oak Ridge, Tenn., and Piketon, Ohio, May 1989.

Table 6.3-6. Residential drinking water location code identification

Location[a]	Source	Location code
Bailey Chapel Road	Well	A
Big Run Road	Spring	B
Wakefield	Well	C
Taylor Hollow Road	Cistern	D
McCorkle Road	Well	E
Route 104	Well	F
U.S. Highway 23	Well	G
Wakefield Mound Road	Well	H
Wakefield Mound Road	Well	I

[a]See Fig. 2.3.2.

Table 6.3-7. Radionuclides tested in residential drinking water

Parameter	Number of samples	Concentration		
		Max	Min	Av
Uranium (mg/L)	16	0.004	<0.001	<0.001
Alpha (pCi/L)	16	5.4	0.27	1.4
Beta (pCi/L)	16	27	0	9.0
Technetium (pCi/L)	16	54	0	14

Table 6.3-8. Halogenated volatile organics tested in residential drinking water

Parameter	Number of samples	Concentration (μg/L)		
		Max	Min	Av
Methylene chloride	16	<1	ND[a]	ND
Trichlorofluoromethane	16	<1	ND	ND
1,1-Dichloroethene	16	<1	ND	ND
1,1-Dichloroethane	16	<20	ND	ND
trans-1,2-Dichloroethene	16	<1	ND	ND
Chloroform	16	4	ND	<1
Freon 113	16	<1	ND	<1
1,2-Dichloroethane	16	<20	ND	<20
1,1,1-Trichloroethane	16	<20	ND	ND
Carbon tetrachloride	16	<1	ND	ND
Bromodichloromethane	16	8	ND	<1
Trichloroethene	16	<1	ND	<1
Dibromochloromethane	16	15	ND	<1
Bromoform	16	12	ND	ND
Tetrachloroethene	16	<1	ND	ND

[a]ND = not detected.

Source for Tables 6.3-6, 6.3-7, and 6.3-8: J. G. Rogers et al., *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Oak Ridge, Tenn., and Piketon, Ohio, May 1989.

6.4 REFERENCES

6.4.1 Oak Ridge

Geraghty and Miller 1989b. *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant*, Geraghty and Miller Environmental Services, Inc., Reston, Va., Dec. 15.

Keith, A. 1895. *Morristown Quadrangle*, U.S. Geological Survey Geologic Atlas Folio 16.

Keith, A. 1896. *Morristown Quadrangle*, U.S. Geological Survey Geologic Atlas Folio 75.

Lee, R. R., et al. 1989. *Calibration of a Groundwater Flow and Contaminant Transport Computer Model: Progress Toward Model Validation*, ORNL/TM-11294, Oak Ridge National Laboratory, Oak Ridge, Tenn., September.

Rodgers, J. 1953. *Geologic Map of East Tennessee with Explanatory Text*, Bulletin 58, Part II, Tennessee Division of Geology, Nashville, Tenn.

Rodgers, J., and Kent, D. F. 1948. *Stratigraphic Section at Lee Valley, Hawkins County, Tennessee*, Bulletin 55, Tennessee Division Geology, Nashville, Tenn.

Rogers, J. G., et al. 1989. *Oak Ridge Reservation Environmental Report for 1988*, ES/ESH-8/V1 and 2, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May.

Ruppel, S. C., and Walker, K. R. 1984. "Petrology and Depositional History of a Middle Ordovician Carbonate Platform: Chickamauga Group, Northeastern Tennessee," *Geol. Soc. Am. Bull.* 95, 568-83.

6.4.2 Paducah

D'Appolonia 1983. *Final Report, Ground Water Monitoring Program, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Project No. 82-1397, ESO 15603, D'Appolonia Waste Management Services, Pittsburgh, June.

Davis, R. W., et al. 1971. *Water in the Economy of the Jackson Purchase Region of Kentucky*, Special Publication 20, Series X, Kentucky Geological Survey.

Davis, R. W., Lambert, T. W., and Hansen, A. J. 1973. *Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky*, Water Supply Paper 1987, U. S. Geological Survey.

EDGe (Engineering, Design, and Geosciences Group, Inc.) 1987. *Ground Water Monitoring Plan for the Department of Energy Paducah Gaseous Diffusion Plant (DOE/PGDP) Reservation, Paducah, Kentucky*, Nashville, Tenn., March 26.

EDGe (Engineering, Design and Geosciences Group, Inc.) 1989. *Ground Water Monitoring Phase 2*, ESO 16749, Nashville, Tenn., March 23.

Early, T. O., Sigmon, C. F., and Williams, R. T. 1989. *Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant*, Oak Ridge National Laboratory, Oak Ridge, Tenn., August 3.

Freeze, R. A., and Cherry, J. A. 1979. *Groundwater*. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Hansen, A. J. 1966. *Availability of Ground Water in the Kentucky Parts of the Joppa and Metropolis Quadrangles, Jackson Purchase Region, Kentucky*, Hydrologic Investigations Atlas HA-171, U. S. Geological Survey.

Lambert, T. W. 1966. *Availability of Groundwater in the Heath Quadrangle, Jackson Purchase Region, Kentucky*, Hydrologic Investigations Atlas HA-168, U. S. Geological Survey.

Rogers, J. G. and Jett, T. G. 1989. *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May.

Wehran Engineering 1981. *Hydrogeologic Investigation: Existing Sanitary Landfill Closure,* Middletown, N.Y., March.

6.4.3 Portsmouth

Geraghty and Miller 1989a. *Ground-Water Quality Assessment of Four RCRA Units, Portsmouth Gaseous Diffusion Plant,* Geraghty and Miller Environmental Sciences, Inc., Reston, Va., May.

LETC (Law Engineering Testing Company) 1978. *Gas Centrifuge Enrichment Plant (GCEP) Geotechnical Investigation,* 4 vols., Marietta, Ga., April 28.

LETC (Law Engineering Testing Company) 1982. *Soil and Ground Water Investigations for the GCEP Landfill Pathways Analysis—Final Report,* Denver, May 13.

ODNR (Ohio Department of Natural Resources) 1985. *An Inventory of Ohio Soils, Pike County,* Progress Report No. 76, Ohio Department of Natural Resources.

Rogers, J. G., et al. 1989. *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Piketon, Ohio, May.

7. RADIOLOGICAL ENVIRONMENT

The background radiation at sites considered for AVLIS includes natural radiation and man-made radiation from operation of current facilities. Each of the facilities (ORGDP, PGDP, and PORTS) produces an annual site environmental report to provide information to the public about the impact of the DOE facilities on the public and the environment. These reports (Rogers et al. 1989a, 1989b, and Rogers and Jett 1989) describe the environmental surveillance and monitoring activities conducted at and around ORGDP, PGDP, and PORTS. Preparation and publication of these site environmental reports is mandated by DOE Order 5400.1.

One environmental reporting goal is to ensure that the annual site environmental reports include all known quantities of radiological and nonradiological materials in effluents to all environmental media. Routine and accidental releases and those that can be quantified through material balance calculations are included. All known radiological effluent quantities are reported in these documents.

Besides providing information on the past calendar year, the site environmental reports show trend analyses over several years, when possible, to indicate increases and decreases in either concentrations or discharges from DOE facilities. They also provide estimates of radiation and chemical doses to the surrounding populations and describe how the estimates are derived. Summary tables are provided that describe the quantities of solid waste treated or disposed of on-site, shipped off-site, or placed in storage. Special projects or studies that are ongoing in support of environmental protection or surveillance are also included. The final section of the site environmental reports describes some of the quality assurance activities that are related to the generation of valid and reliable environmental data.

Because detailed radiological data are presented in the annual site environmental reports for ORGDP, PGDP, and PORTS, detailed data will not be reproduced in this AVLIS environmental data package. However, the following sections do present a summary of the exposure to the maximally exposed individual at each site and compare the exposure of this individual to radiation exposure from natural background radiation occurring in the vicinity of these DOE facilities.

7.1 OAK RIDGE

The maximally exposed individual for the ORGDP is located 4850 m (2.9 miles) west-southwest of the site. In 1988, this individual received a calculated dose of an estimated 4.0×10^{-3} mrem (effective dose equivalent) from radioactive emissions from the facility (Rogers et al. 1989a, p. 170). The population (837,000 persons) residing within 80 km (50 miles) of the facility received about 1.4×10^{-1} person-rems from facility emissions.

Measured gamma radiation from natural background around the facility averaged 80 mrem in 1988 (Rogers (1989a, p. 163). In addition, about 240 mrem, the average individual dose in the United States, could be received from naturally occurring radionuclides, including radon (NCRP 1987, p. 148). Thus, a total effective dose equivalent of about 320 mrem, mostly from natural background radiation, is estimated annually for individuals around the Oak Ridge site.

7.2 PADUCAH

The maximally exposed individual for the Paducah site is located 2000 m (1.2 miles) north of the facility. In 1988, this individual received a calculated dose of 2.9×10^{-3} mrem from facility emissions. The 500,000 persons living within 80 km (50 miles) of the facility received about 1.6×10^{-1} person-rem from Paducah emissions (Rogers and Jett 1989, p. 56). Measured background gamma radiation around the site would add ~61 mrem to the annual radiation dose from site effluents (Rogers and Jett 1989, p. 52). In addition, 240 mrem/year of internal dose (NCRP 1987, p. 148) would bring the total annual dose to ~301 mrem.

7.3 PORTSMOUTH

The maximally exposed individual for the Portsmouth site is located 1770 m (1.1 miles) east-northeast of the site. In 1988, this individual received a calculated dose of an estimated 3.8×1^{-2} mrem from facility emissions (Rogers et al. 1989b, p. 89). The 606,000 persons living within 80 km (50 miles) of the facility received about 1.8×10^{-1} person-rem from Paducah emissions. Gamma radiation from background sources averaged 90 mrem around the site (Rogers et al. 1989b, p. 83). With the 240 mrem from internal radiation (NCRP 1987, p. 148), a total dose of ~330 mrem is estimated for an individual living around the PORTS site. As is the case for other sites, most of this dose is attributed to natural background radiation.

7.4 REFERENCES

NCRP (National Council on Radiation Protection and Measurements) 1987. *Exposure of the Population of the United States and Canada from Natural Background Radiation,* NCRP Report 94, Bethesda, Md.

Rogers, J. G., et al. 1989a. *Oak Ridge Reservation Environmental Report for 1988, Vol. 1, Narrative, Summary, and Conclusions,* ES/ESH-8/V1, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May.

Rogers, J. G., et al. 1989b. *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May.

Rogers, J. G. and Jett, T. G. 1989. *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May.

8. TERRESTRIAL ECOLOGY

This section describes land use, vegetation, and wildlife surrounding the three sites. Endangered and threatened species and unique natural areas known to occur in the vicinity of the sites are also identified. A brief description of biological monitoring at each of the sites is included.

8.1 OAK RIDGE

8.1.1 Land Use

The Oak Ridge (ORGDP) site is on the 15,000-ha (37,000-acre) DOE Oak Ridge Reservation (ORR) and is located within the corporate limits of the city of Oak Ridge in eastern Tennessee. ORGDP lies in a valley between the Cumberland and southern Appalachian mountain ranges and is bordered on the west by the Clinch River. The Cumberlands are about 16 km (10 miles) northwest; 113 km (70 miles) to the southeast are the Great Smoky Mountains. The AVLIS site at ORGDP is located on land currently occupied by existing buildings, parking lots, and mowed fescue fields.

Except for the city of Oak Ridge, the land within 8 km (5 miles) of ORGDP is predominantly rural: about 35% of the area is used largely for residences, small farms, and cattle pasture and the remaining 65% is wooded. Because of the location of the ORGDP site within the federally owned ORR, there are no residences or farms in the immediate surroundings. The property west of the Clinch River is an industrial site owned by Boeing Tennessee, Incorporated. The Boeing facility, which is under construction, is surrounded by natural vegetation. The nearest residential area is ~3 km (1.9 miles) west of the site. Residences are limited to distances >7 km (4 miles) to the northeast within the East Fork Poplar Creek Valley and >5 km (3 miles) to the southwest. Oak Ridge residential areas occur no closer than ~10 km (6 miles) northeast of the site.

Farming in East Tennessee has followed the national trend: the number of farms is steadily decreasing and the remaining farms are increasing in average size. The trend has been to shift from dairying and other forms of labor-intensive farming to raising beef cattle, which requires less labor. Beef cattle production doubled from 1939 to 1964 and nearly doubled again in the 5-year period from 1964 to 1969 (DOE 1979, p. 4-3). In 1974, about 475 head of cattle were counted within 8 km (5 miles) of the site (DOE 1979, p. 4-3). At that time, scattered herds consisting of 20–30 animals, including a total of 61 milk cows were located in the southeast, southwest, and northwest quadrants. From 1974 to 1982, beef and dairy cattle numbers declined in Roane County, with very little change in beef cattle inventory from 1982 to 1987 and a small increase in dairy cattle by 1987 (Appendix F, Table F.1-1).

The principal cash crops harvested in Roane County are tobacco and corn. Table F.1-1, Appendix F, shows the land area and yields of these crops in Roane County in recent years.

Commercial forest land (land that is producing or is capable of producing crops of industrial wood and that is not withdrawn from timber use) accounts for a large portion of the land area in the surrounding counties. Many of the logged areas are replanted in fast-growing pines. From 1965 to 1986, there was an active timber management program on ORR. During that time, much of the area was selectively logged.

All of the undeveloped area of ORR is under a wildlife management agreement with Tennessee Wildlife Resources Agency (TWRA). The agreement was initiated in 1984 to reduce deer/vehicle collisions by permitting deer hunting, thus lowering the deer population.

8.1.2 Terrestrial Ecology

The terrestrial ecology of the area surrounding the ORGDP site is described in detail in DOE (1979, pp. 4-32 through 4-39) and DOE (1982, pp. 3-48 through 3-50, 3-51, 3-54, 3-55, 3-57, 3-58). Additional descriptions of ORR are summarized in Boyle et al. (1982, pp. 3-59 through 3-65). That information is summarized here with the addition of an updated description of plant communities.

8.1.2.1 Vegetation

The only vegetation at the AVLIS site at ORGDP is fescue in periodically mowed fields. The vegetation of the undeveloped portions of the areas surrounding ORGDP is similar to the vegetation of ORR as a whole (Fig. 8.1-1).

ORR plant communities are characteristic of those found in the intermountain regions of Appalachia from the Allegheny Mountains in southern Pennsylvania to the southern extension of the Cumberland Mountains in northern Alabama. The dominant association on ORR is oak-hickory forest, which is most widely distributed on ridges and dry slopes. Common overstory species are chestnut oak, black oak, northern and southern red oak, scarlet oak, white oak, and several species of hickory. Shortleaf and Virginia pine are also present. Abundant understory species include red maple, blackgum, and sourwood.

Northern hardwoods are found in coves that are interspersed along the dissected ridge system. Common overstory species in these areas are tulip-poplar, beech, sugar maple, buckeye, and white ash. Some white pine, hemlock, basswood, and magnolias also occur in these areas. Hemlock and white pine are abundant in the nearby Cumberland Mountains but uncommon in natural stands on ORR. Small areas on steep slopes and limestone bluffs along Poplar Creek on Black Oak Ridge and McKinney Ridge are good examples of this type. Cove communities often grade into floodplains in lower slope positions where more flood tolerant tree species such as boxelder, elm, sycamore, and green ash become abundant.

Much of the original forest was cleared and the land was cultivated during settlement. Except on very steep slopes, most of the remaining forest was cut for timber, although the land was not necessarily cleared and put into cultivation. Since 1942 when cultivation ended on ORR, cultivated fields have developed into forests either through natural succession or planting of pines. Many of the abandoned fields that were not planted in pines now support stands of tulip-poplar, while others contain mixtures of pine, hickory, dogwood, and other hardwoods. Between 1948 and 1954, many of the abandoned fields that were not already well stocked with naturally regenerating timber species were planted with loblolly, shortleaf, and white pines. Most of these plantations have been maintained

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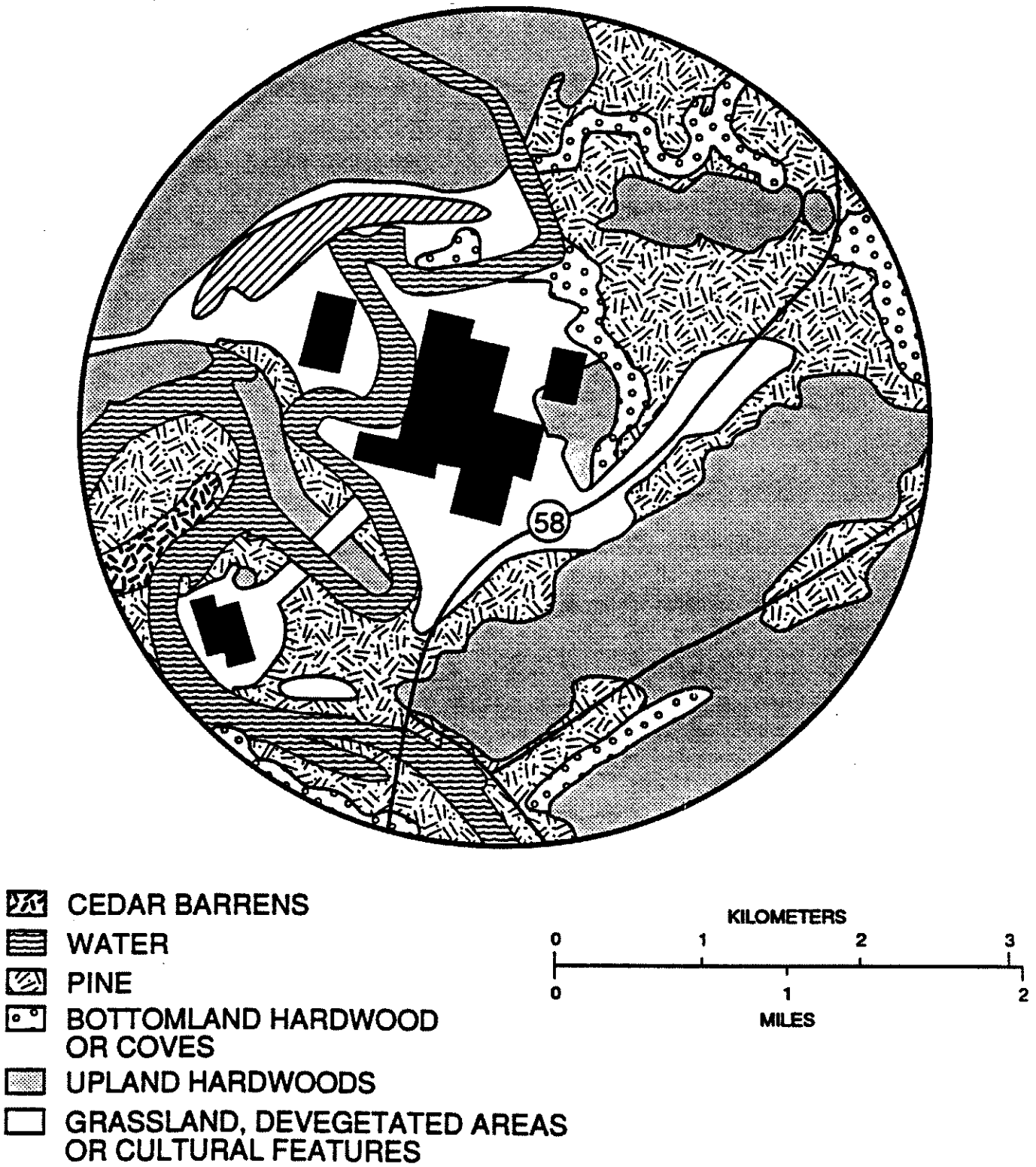

Fig. 8.1-1. General vegetation cover in the Oak Ridge Gaseous Diffusion Plant area.

with little or no invasion by hardwoods. Additional pine plantations have since been established in some areas that have been harvested. Most pine stands that currently exist are on lower slopes; relatively level, wide ridgetops; or well-drained bottomlands. Some of these areas were severely eroded prior to establishment of the pine plantations.

Although small in area, cedar barrens are fairly common on ORR. These drought-tolerant plant communities occur only on shallow, flaggy limestone soils, primarily in Bethel Valley and near Campbell Bend. Dominant species are grasses, such as little bluestem and dropseed, and a variety of forbs, with some eastern red cedars and stunted oaks. Bare rock is fairly common. Cedar barrens are habitat for several species of rare plants. Prairie species more common in the midwestern United States are also characteristic of these sites.

A narrow strip of emergent wetlands (Cowardin et al. 1979, pp. 21–22) along the Clinch River near ORGDP is dominated by cattails. Scrub-shrub wetlands (Cowardin et al. 1979, p. 22) dominated by buttonbush and false indigo occupy small low-lying areas along the river adjacent to emergent wetlands. Black willow, green ash, box elder, sycamore, and red maple forested wetlands border the shrub wetlands. See Sect. 9 of this report for further descriptions of wetlands and aquatic habitats.

8.1.2.2 Wildlife

The diversity of vegetation on ORR provides habitats for many wildlife species typical of eastern Tennessee. Toads and frogs commonly include the upland chorus frog, northern spring peeper, American toad, bullfrog, and gray tree-frog. The eastern box turtle is common and occurs in all habitats. Painted turtles and snapping turtles also occur. Probably the most abundant snakes and lizards are the northern ringneck and worm snake; the ground skink and five-lined skink; and the eastern fence lizard.

Approximately 256 species of birds occur in Tennessee, and 171 potentially occur on ORR. On the Boeing property adjacent to ORGDP, which is similar in habitats to much of ORR, 121 species have been seen. Songbirds are abundant during migration. Raptors are numerous in the area, with black and turkey vultures, red-tailed hawks, broad-winged hawks, and screech owls being common. Water birds (e.g., ducks, herons, and shorebirds) occur mainly along the Clinch River and its backwaters and ponds. A great blue heron rookery is located north of ORGDP on Poplar Creek. Waterfowl usage of the area is limited for the most part to brief stopovers during migration, although wood ducks and mallards may breed in the area and a resident population of Canada geese uses the fescue field for grazing in the proposed AVLIS site. The most common birds on the Boeing property adjacent to ORGDP are the Carolina chickadee, white-eyed and red-eyed vireo, cardinal, and tufted titmouse.

As many as 53 species of mammals may occur on ORR. White-tailed deer are abundant, as are eastern cottontail rabbits, eastern gray squirrels, opossums, woodchucks, striped skunks, raccoons, red fox, and muskrats. Bobcats, gray fox, long-tailed weasels, mink, and beaver also occur on ORR. Nine species of small mammals are known to be present. The white-footed mouse is the most abundant species and occurs in the greatest number of habitats. The golden mouse is the second most abundant small mammal. Mammals particularly associated with the floodplain and wetland areas along the Clinch River and Poplar Creek are the raccoon, mink, long-tailed weasel, muskrat, rice rat, southeastern shrew, eastern harvest mouse, and hispid cotton rat.

Canada geese are the most important of the nesting waterfowl on the reservation. Quail and mourning doves are in abundance, and ruffed grouse also occur. Wild turkeys

have been introduced on ORR as part of TWRA's management program, and deer are abundant. Several deer hunts are conducted every fall on ORR, but no other species are currently legally hunted. Although provision is made in the DOE agreement with TWRA for development of areas to enhance wildlife, no areas are currently under active management for wildlife species.

8.1.3 Endangered and Threatened Species

Numerous species of plants and animals of special concern have ranges that include the Oak Ridge area (Parr 1984, pp. 3, 7, 13; Kroodsma 1987, pp. 6–12), and several have been identified as occurring within 8 km (5 miles) of ORGDP (Table 8.1-1, Fig. 8.1-2).

False foxglove, a state-listed species under review for federal protection (USDI 1985, p. 7), has been found on limestone bluffs along the Clinch River (Parr 1984, p. 7) and Poplar Creek near ORGDP. Appalachian bugbane, another state listed species proposed for federal protection (USDI 1985, p. 12), is known to occur in two locations within 8 km (5 miles) of the site (Parr 1984, p. 7). Carey's saxifrage, also under consideration for federal listing (USDI 1985, p. 49), is found on bluffs near the Clinch River several kilometers upstream from the site. Other state listed species found within 8 km (5 miles) of the site include tall larkspur, ginseng, golden seal, Canada lily, earleaf foxglove, prairie goldenrod, and slender blazing star (Parr 1984, pp. 8–13). These species all occur on the Boeing property west of ORGDP; and black snakeroot, tall larkspur, ginseng, golden seal, southern rein orchid, and Canada lily are known to occur in other areas on ORR. Additional plant species that are listed as threatened or endangered by Tennessee, that are known to occur on ORR, and that may occur within 8 km (5 miles) of ORGDP because of the presence of suitable habitat are large fothergilla and lesser ladies' tresses (Parr 1984, p. 3).

Other plant species federally listed or proposed for listing that may occur in the area but are not currently known to be present are Virginia spirea (threatened), American hart's tongue fern (threatened), Gattinger's lobelia (status under review), and Wharton's blackberry (status under review) (see Appendix I: Bay 1989). Suitable habitats for American hart's tongue fern, which is found near limestone caves, and for Wharton's blackberry, which has been found on roadsides and in weedy areas, are present on ORR. Gattinger's lobelia has been found in cedar glades and could possibly occur in cedar barrens on ORR. Suitable habitat for Virginia spirea, which grows on rocky, frequently flooded stream banks, probably does not occur on ORR.

No federally listed threatened or endangered amphibians or reptiles are known to be within 8 km (5 miles) of ORGDP; however, several species listed by TWRA are present (DOE 1982, p. 3-57). Suitable habitat for the northern pine snake, a state-listed threatened species, exists; the species may be present but has not been observed. Two species deemed in need of management by TWRA are present near ORGDP: the Cumberland slider along the Clinch River (Watts Bar Lake) and the six-lined racerunner in an abandoned quarry.

Threatened and endangered birds potentially occurring near the site include three federally listed endangered species, one state-listed endangered species, and three state-listed threatened species (Table 8.1-1) (DOE 1982, pp. 3–58). Six species deemed in need of management by TWRA may also be present. Federally listed endangered species that may occur include the bald eagle, which has been observed feeding along the Clinch River but probably only as a transient during migration. The peregrine falcon could potentially pass through the area during migration. Lack of nesting habitat and limited hunting areas,

Table 8.1-1. Status of terrestrial species monitored by the Tennessee Department of Conservation and the Tennessee Heritage Program observed within 8 km (5 miles) of the Oak Ridge Gaseous Diffusion Plant site[a]

Species	State[b]	Federal[c]
Cumberland slider (*Trachemys scripta troostii*)	M	
Six-lined racerunner (*Cnemidophorus sexlineatus*)	M	
Black vulture (*Coragyps atratus*)	M	
Cooper's hawk (*Accipiter cooperi*)	T	
Sharp-shinned hawk (*Accipiter striatus*)	T	
Marsh hawk (*Circus cyanesus*)	T	
Red-shouldered hawk (*Buteo lineatus*)	M	
Bald eagle (*Haliaeetus leucocephalus*)	E	E
Osprey (*Pandion haliatus*)	E	E
Black-crowned night heron (*Nycticorax nycticorax*)	M	
Red-headed woodpecker (*Melanerpes erythrocephalus*)	M	
Bachman's sparrow (*Aimophila aestivalis*)	E	SR
Grasshopper sparrow (*Ammodramus savannarum*)	T	
Southeastern shrew (*Sorex longirostris*)	M	
Indiana bat (*Myotis sodalis*)	E	E
Gray bat (*Myotis grisescens*)	E	E

Table 8.1-1 (continued)

Species	State[b]	Federal[c]
Appalachian bugbane (*Cimicifuga rubifolia*)	T	SR
Tall larkspur (*Delphinium exaltatum*)	E	
Carey's saxifrage (*Sagifraga careyana*)	S	SR
Slender blazing star (*Liatris cylindracea*)	E	
Prairie goldenrod (*Solidago ptarmicoides*)	E	
Earleaf foxglove (*Tomanthera auriculata*)	E	
American ginseng (*Panax quinquefolius*)	T	
Sedge (*Carex oxylepis var pubescens*)	S	
Canada lily (*Lilium canadense*)	T	
Southern rein-orchid (*Platanthera flava*)	S	
False foxglove (*Aureolaria patula*)	T	SR
Golden seal (*Hydrastis canadensis*)	T	

[a]M = in need of management, T = threatened, E = endangered, SR = status under review, and S = special concern.

[b]*Sources:* P. Somers, "Revised List of the Rare Plants of Tennessee," *J. Tenn. Acad. Sci.* **64**, 179–84; Tennessee Wildlife Resources Commission, *Proclamation of Wildlife in Need of Management and Endangered and Threatened Species*, Proc. 86-29 and 86-30; E. B. Bunting, Tennessee Department of Conservation, Nashville, Tenn., letter to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., Dec. 5, 1989 (see Appendix I: Bunting 1989).

[c]*Sources:* R. T. Bay, U.S. Department of the Interior, Fish and Wildlife Service, Cookeville, Tenn., letter to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., Nov. 29, 1989; R. L. Kroodsma, *Resource Management Plan for the Oak Ridge Reservation, Vol. 24: Threatened and Endangered Animal Species*, ORNL/ESH-1/V24, pp. 6–12, 1987.

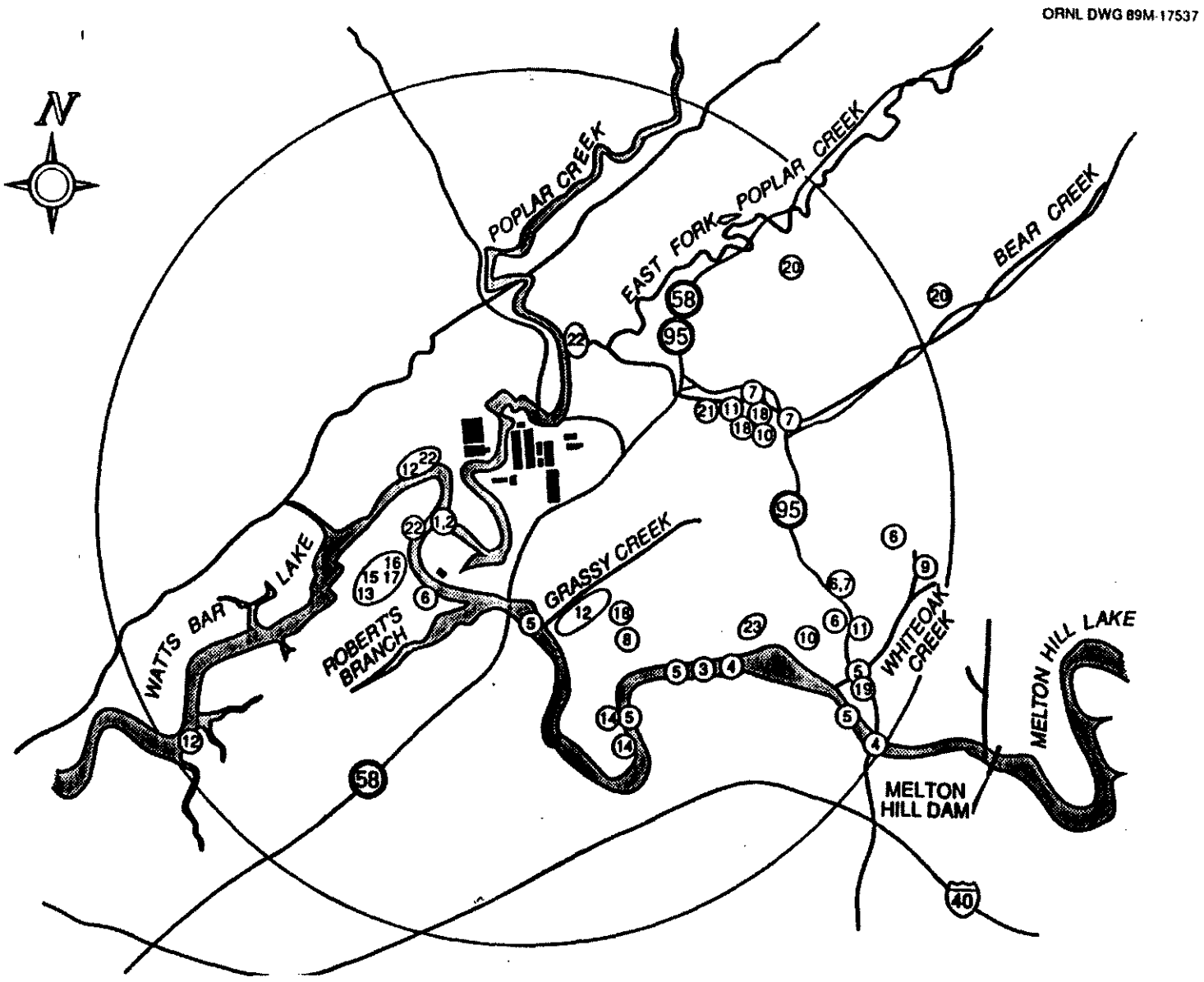

Fig. 8.1-2. Observations of species included in the Tennessee Department of Conservation data base and other records of state and federally listed species. 1 = Shiny pigtoe, 2 = Fine-rayed pigtoe, 3 = Pink mucket, 4 = Spiny river snail, 5 = Cumberland Slider, 6 = Six-lined racerunner, 7 = Mountain redbelly dace, 8 = Black vulture, 9 = Sharp-shinned hawk, 10 = Bachman's sparrow, 11 = Southeastern shrew, 12 = Appalachian bugbane, 13 = Tall larkspur, 14 = Carey's saxifrage, 15 = Slender blazing star, 16 = Prairie goldenrod, 17 = Earleaf foxglove, 18 = American ginseng, 19 = Sedge, 20 = Canada lily, 21 = Southern rein-orchid, 22 = False foxglove, 23 = Golden seal.

along with the transient nature of the species, indicate that it would be unlikely for the peregrine falcon to use the area. Historically, the peregrine has nested in Roane County. The red-cockaded woodpecker, which occurs within 25 km (15 miles) of the site, may occur on ORR, but no evidence of this species has been found. It is highly unlikely to breed in the area because of the lack of suitable nest trees, and its presence as a temporarily foraging species is not expected. Nesting of Bachman's sparrow, which is under federal status review, has been documented on ORR in the recent past, and suitable habitat is present on ORR.

The osprey, a state-listed species, has been observed along the Clinch River, but no evidence of nesting has been observed near ORGDP. Osprey nests have been found downstream from ORGDP on Watts Bar Lake. Other state-listed species include the sharp-shinned and Cooper's hawk, which have been observed foraging in the area. The marsh hawk has been observed as a migrant. The grasshopper sparrow has been seen during breeding season on ORR, where apparently suitable grassland habitat is present. The black-crowned night heron has a colony near Watts Bar Lake and forages along the Clinch River up to Melton Hill Dam, presumably including the area near ORGDP.

Other birds deemed in need of management by TWRA that have been seen in the area are the black vulture, red-shouldered hawk, and red-headed woodpecker.

Of the federally listed mammal species, the eastern cougar is of questionable status in the region (DOE 1982, pp. 3-58 and 3-59). Although citings have repeatedly been reported for ORR and habitat is suitable, no concrete evidence of its presence is available. Gray bats have reportedly been observed over Johnson Creek west of ORGDP and over the Clinch River, and Indiana bats have been observed on ORR. None of these bat observations has been confirmed by an authoritative source.

The southeastern shrew is known to occur on ORR and is listed by TWRA as in need of management.

8.1.4. Natural Areas

Several high-quality natural areas are near the ORGDP site. Two of these areas are located on Grassy Creek on ORR ~2 km (1.2 miles) to the southeast of ORGDP. These are mature beech-maple and beech-mixed oak areas that represent climax cove communities of particularly good quality. The stands occur in a narrow stream bottom that contains many uncommon spring ephemeral plant species requiring cool, humid growing conditions. The black snakeroot (under review for federal listing) is found in this area.

An excellent example of cedar barren communities, perhaps the best in the state, occurs across the Clinch River from ORGDP on the Boeing property. This barren is a State Natural Area. As is typical for cedar barrens, the plant community is fragmented, with many small openings scattered throughout the more generally forested surroundings. The openings vary greatly in species richness and include several state listed species.

Another area of importance is the Blackoak Ridge bluffs along the bank of the Clinch River west of ORGDP. This area is the habitat for two species (false foxglove and black snakeroot) that are under review for federal listing. An additional State Natural Area that provides habitat for the false foxglove is an unusual hemlock community on limestone bluffs adjacent to Poplar Creek to the east of ORGDP.

8.1.5 Preoperational Monitoring of Biota

No systematic monitoring programs exist currently for terrestrial vegetation, wildlife, or threatened and endangered species at ORGDP. Descriptions of biota on the site have been based on observations by many personnel for several different projects on ORR. Monitoring of selected rare plant populations is currently being conducted on the Boeing property and other areas of ORR by members of the Environmental Sciences Division at Oak Ridge National Laboratory.

Terrestrial vegetation samples are collected semiannually at about a dozen locations (Fig. 8.1-3) near ORGDP and are analyzed for fluorides (DOE 1988, pp. 136 and 137). Grass and pine needles are analyzed routinely because of the importance of grass as year-round pasture for livestock and potentially toxic effects to sensitive conifers, such as pines.

8.2 PADUCAH

8.2.1 Land Use

The proposed site for AVLIS at Paducah includes existing buildings and storage areas for spent uranium inside the fenced Paducah Gaseous Diffusion Plant (PGDP) facility. PGDP is immediately surrounded by 544 ha (1344 acres) owned by DOE.

PGDP is located in a generally rural area of McCracken County, Kentucky. Part of Ballard County, Kentucky, is also within 8 km (5 miles) of PGDP (Fig. 8.2-1). The area is low in relief, with small, scattered forested areas of steep upland and riparian hardwoods surrounded by agricultural lands. Much of the land to the north of PGDP and south of the Ohio River is owned by the Tennessee Valley Authority (TVA). Within an 8-km (5-mile) radius of PGDP, ~75% of the land is agricultural or open space. Forested areas account for ~15% and urban and industrial areas for 4%.

Within the boundary of the PGDP DOE land, property is leased by the West Kentucky Wildlife Management Area, which employs practices to maintain suitable wildlife habitat and food supply. The PGDP site is mostly nonforested, consisting of areas of open grassland.

As cited in the *1982 Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site,* the 1970 Soil and Water Conservation Needs Inventory for Ballard, and McCracken counties in Kentucky and Massac County, Illinois, reported that 6% of the total area in the three counties was in Class I, the best agricultural land. Classes V–VIII lands accounted for 11.5% of the land. Erosion, excessive water, and soil limitations in the rooting zone are the dominant soil and water conservation problems of 52%, 40%, and 2% respectively. The inventory also revealed 24.4% of the land in the three-county area was forest land, 49.2% was cropland, 22.0% was range and pasture land, and 4.4% was in other land-use categories. Low pH and low organic matter content necessitate the use of lime and fertilizer for crop production.

Principal crops grown in the three-county area include corn, sorghum, wheat, soybeans, hay, and tobacco. Agricultural productivity in Ballard and McCracken counties in terms of approximate average annual yields of major crops is shown in Appendix F (Table F.2-1).

From 1978 to 1982, the number of farms decreased by 10%, the average size of farms increased by 1.6 ha (4 acres), and the area farmed decreased by 7% over that 5-year period in McCracken County (U.S. Department of Commerce 1984, pp. 120 and 130) (Appendix F,

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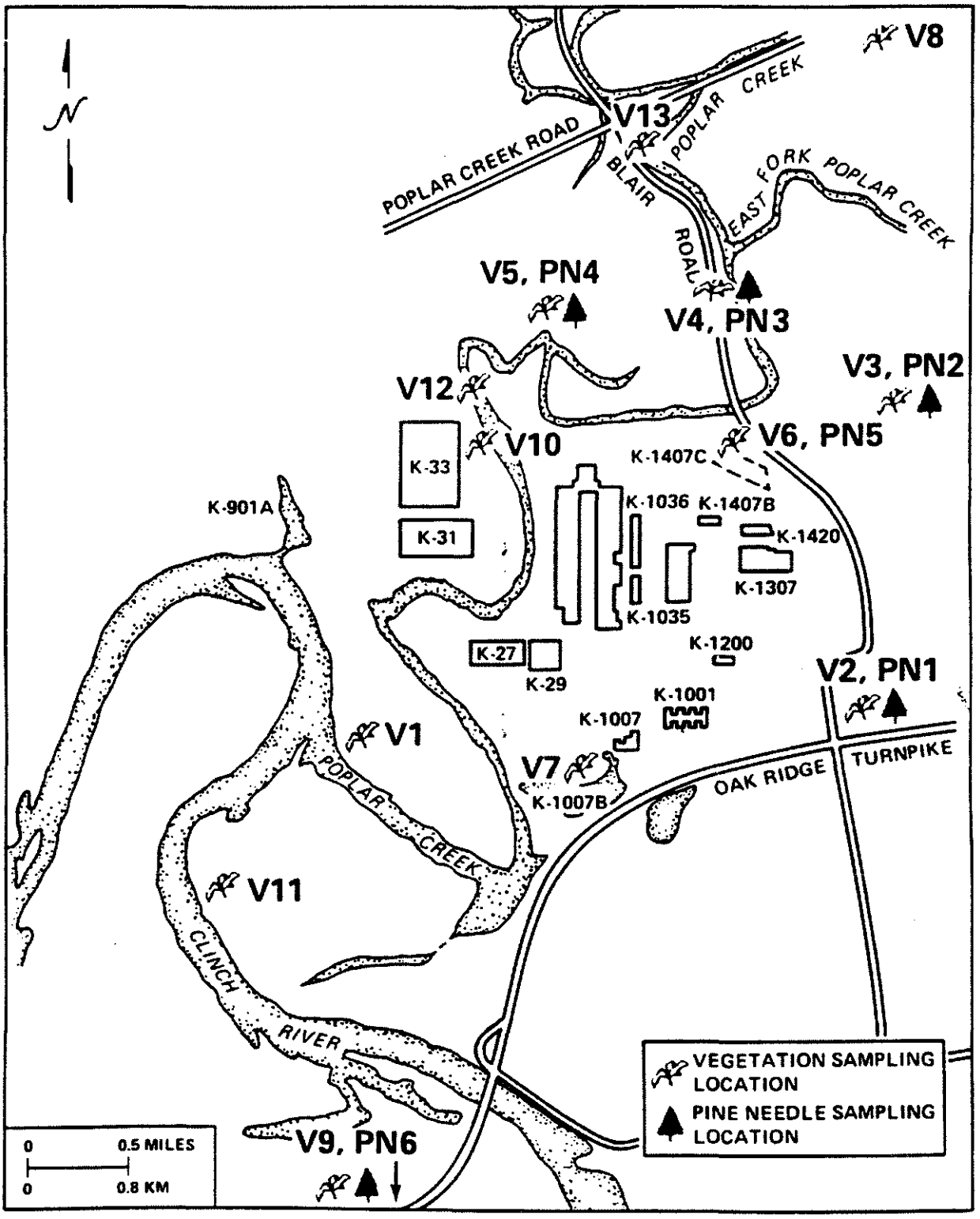

Fig. 8.1-3. Map of Oak Ridge Gaseous Diffusion Plant pine needle and grass sampling locations.

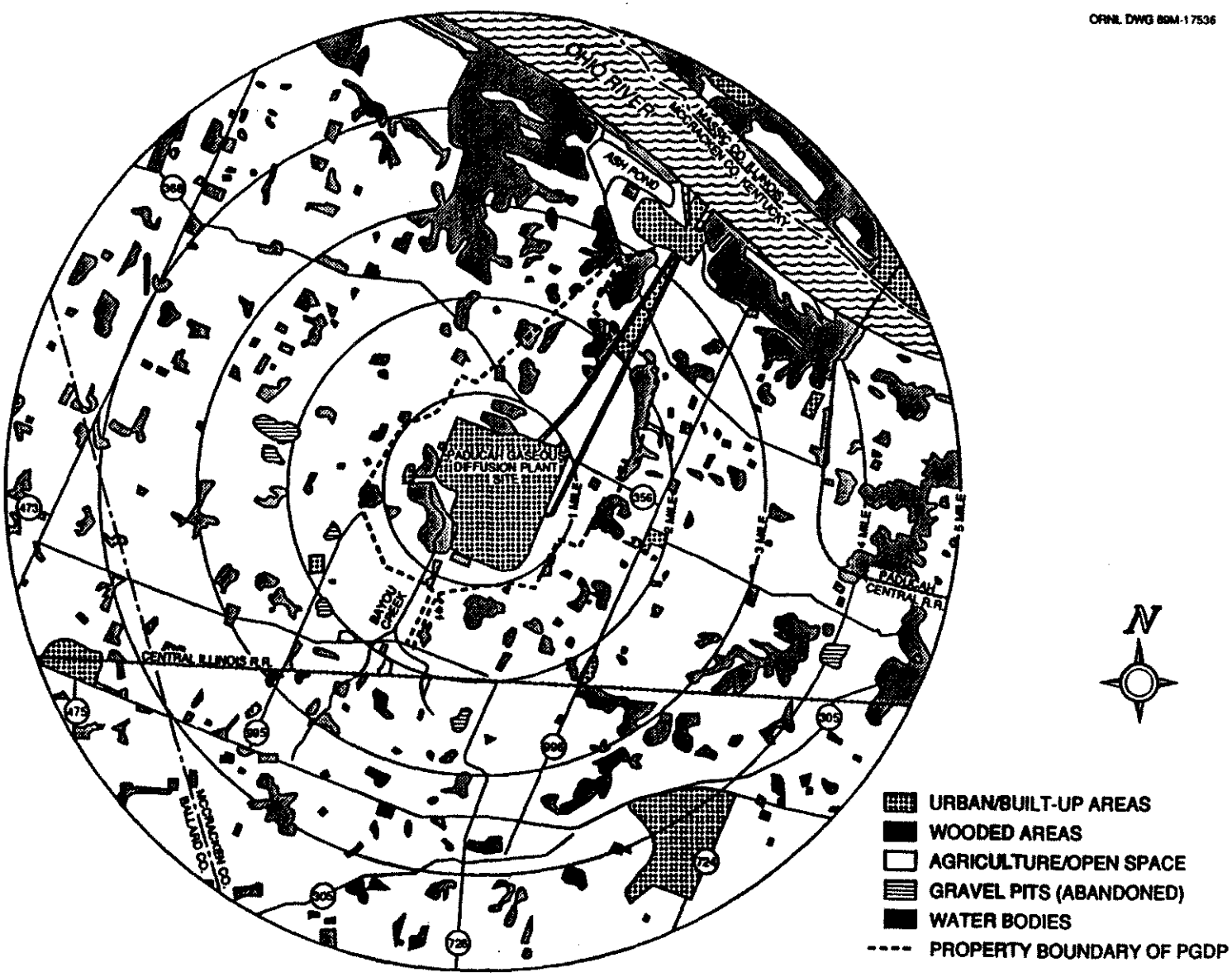

Fig. 8.2-1. General land use in the Paducah Gaseous Diffusion Plant area.

Table F.2-1). Land use changes were similar in Ballard County: an 18% decline in the number of farms was accompanied by a 14% increase in the average size of farms and a 5% decrease in the area farmed. In addition, land planted with soybeans decreased in both Ballard and McCracken counties from 1978 to 1987, while land planted with wheat increased.

On a county basis, 26% of the total land area of Ballard County and 24% of McCracken County are designated as commercial forest lands. In 1977, standing crop timber volume estimates for Ballard and McCracken counties were 46.5 million and 92.5 million board feet (109,662 and 218,145 m^3) (DOE 1982, pp. 3–37).

8.2.2 Terrestrial Ecology

The following descriptions of terrestrial vegetation and wildlife are taken primarily from DOE (1982, pp. 1-3, 2-6, 3-10, 3-11, 3-14 through 3-17, 3-19 through 3-21, 3-36, 3-37, 3-49) and Oakes et al. (1987, pp. 15, 17, 20, 22).

8.2.2.1 Vegetation

The terrestrial ecology of the PGDP DOE property is typical of that of western Kentucky except for management for wildlife. Both forested and nonforested areas occur on the site (Fig. 8.2-2). Nonforested areas are primarily grassland. Mature riparian hardwood forests dominate the communities on the banks of Little Bayou and Big Bayou creeks. Small woodlots above the stream banks and on the remainder of the site are dominated by upland tree species. Immature hardwood forests are sparsely scattered over the site. The proposed AVLIS site is in existing buildings and uranium storage areas without natural vegetation.

Upland forest communities are primarily oak-hickory with southern red oak, shagbark hickory, and post oak dominant but many other species present. Riparian forests share many species with the uplands, but river birch, black willow, and cottonwood are dominant. The riparian forest forms a continuous, though narrow, band along the entire length of both water courses.

As a result of game management practices, natural succession of fields to forest has generally been prevented. Immature forest occurs only on edges of woodlots and in areas previously cut, such as power line rights-of-way and railroad cuts.

Except for the existing facilities, virtually all nonforested areas within the PGDP DOE property are managed by personnel from either PGDP or the West Kentucky Wildlife Management Area for wildlife habitat and food supply. Management consists of mowing, planting, and controlled burning. Strips are mowed every other year, maintaining grasses as the dominant vegetation. In areas where mowing is intentionally omitted, woody species invade the area. Woody species include sassafras, wild black cherry, red maple, and sumac. Numerous 0.1-ha (0.25-acre) wildlife food plots and a few larger cultivated fields are maintained.

An inventory of vascular plants on the adjacent TVA property is included in Appendix F (Table F.2-2).

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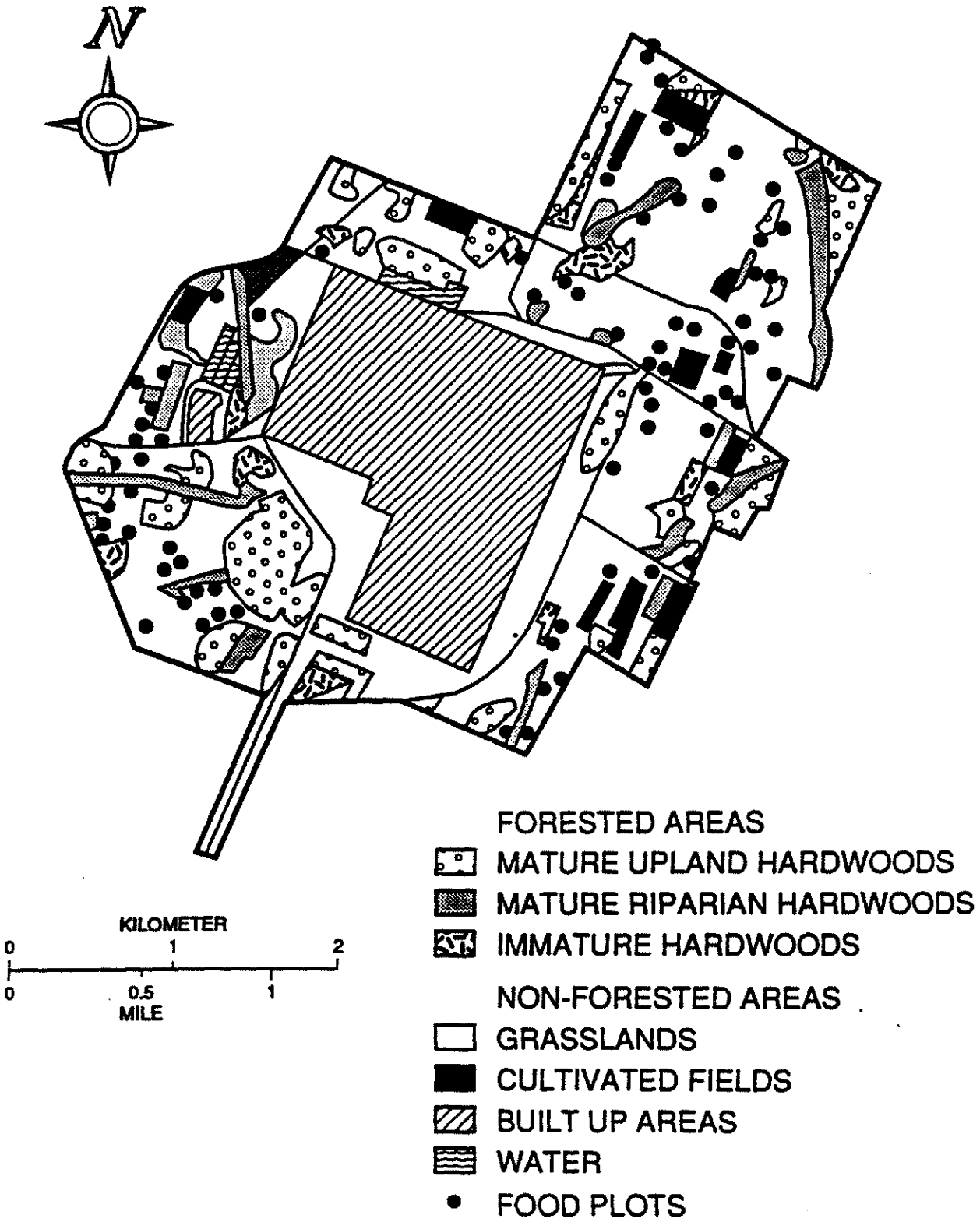

Fig. 8.2-2. General vegetation at Paducah Gaseous Diffusion Plant.

8.2.2.2 Productivity

Net primary productivity (NPP) has been estimated at 8600, 7600, and 2430 kg/ha/year (7673, 6781, and 2168 lbs/acres/year), respectively, for the riparian, upland oak-hickory, and immature forests. These values are similar to NPP estimates for comparable forests in surrounding areas. The standing crop (dry weight of aboveground parts of trees) of riparian and oak-hickory forests is estimated to be 220 and 207 $\times 10^3$ kg/ha (98 and 92 tons/acre) respectively. NPP in grasslands has been estimated to be 2200 to 3400 kg/ha/year (1963 to 3033 lbs/acre/year).

8.2.2.3 Wildlife

On the borderline between the Alluvial Forest Avifaunal Region and the Limestone Plateau Avifaunal Region, PGDP is characterized by birds from both regions. The red-bellied woodpecker, wood thrush, red-eyed vireo, Kentucky warbler, and rufous-sided towhee have been seen regularly at PGDP. Roadside bird surveys conducted during the breeding season of 1977 listed the following species as most common at PGDP: bobwhite, cardinal, indigo bunting, common grackle, and rufous-sided towhee. Based on transect data, riparian woods were most diverse in bird species, followed by fields with tree groves; game management areas with food strips along tree rows; upland mature oak-hickory woodlots; grass, weed, and shrub fields under powerlines; and grass and weed fields. The greatest number of individual birds occurred in game management areas.

Based on midday surveys of 10 ponds at PGDP, water birds (e.g., waterfowl, shorebirds, wading birds) do not use the small ponds on the PGDP site extensively during the breeding season. Migrating waterbirds do not stop at PGDP in large numbers because of the lack of appropriate habitat. Most of the ducks and geese migrating in the vicinity of PGDP rest and/or overwinter at the Ballard County Wildlife Management area 41 km (25 miles) west of PGDP.

Diurnal raptors are not numerous on the plant property. It is likely that many of the land birds and raptors found in the area of Land Between the Lakes migrate through PGDP property.

The two major game bird species at PGDP are the bobwhite and mourning dove. Ducks and woodcock also use the site. Although hunting is not permitted on the PGDP property, portions are leased to the Kentucky Department of Fish and Wildlife Resources and are managed for bobwhite and mourning dove. Birds using the PGDP site are probably shot in adjacent hunting areas.

Mammal species at PGDP are primarily those found in ecotones and fields. Game management activities have resulted in increased abundances of rodents, rabbits, and deer. The most abundant species on the site is the house mouse. It occurs primarily in fields, with particularly high densities in grain-type food plots planted for wildlife. Deer and cottontail rabbits are common to all parts of the site. Deer use the woodlots for cover and forage in both woodlots and fields. Forest edges and fence rows provide cover for rabbits, which feed primarily in the managed grasslands and fields. In recent years, the rabbit population on the site has fluctuated for unknown reasons. Disease (i.e., tularemia) has been suspected.

Gray and fox squirrels, white-footed mice, and meadow jumping mice are found in forested areas. The white-footed mouse is the most common mammal in the forested areas. The southeastern shrew occurs in fields and along fence rows and edges. Western moles

are found in the drier areas with loose soils. Few small herbivorous rodents (e.g., voles) are present on the site. Muskrat, mink, and beaver are present in both Big and Little Bayou. Muskrats are more common in management area ponds adjacent to the PGDP property. Raccoons and foxes, being more mobile than smaller mammals, use all habitats of the site for foraging and denning. Forests are used mainly for cover, while fruits, berries, and small prey are found in other areas.

Deer and eastern cottontail rabbit populations in the West Kentucky Wildlife Management Area, which includes part of the PGDP property, are managed for recreational hunting.

American and Woodhouse's toads are found in essentially all terrestrial portions of the site, while frogs, particularly southern leopard and green frogs, are found in and along the streams and ponds. Slimy salamanders occur in most forest situations.

The eastern box turtle is ubiquitous and is the most abundant reptile. Red-eared turtles and common snapping turtles are found in most water bodies. The black racer is one of the most common snakes on the PGDP site.

8.2.3 Endangered and Threatened Species

The following information is based on data from the Kentucky Natural Heritage Program and does not reflect a systematic survey for threatened and endangered species on the site.

No federally listed threatened or endangered birds were observed during breeding bird surveys in 1977, nor is the habitat at PGDP suitable as breeding or wintering areas for threatened or endangered birds (Table 8.2-1). However, two species (golden eagle and osprey) considered endangered in Kentucky and the federally listed endangered bald eagle have been known to spend part of the winter at the Land Between the Lakes, ~64 km (40 miles) southeast of PGDP. A few bald eagles and one or two golden eagles also spend part of the winter at the Ballard County Wildlife Management Area, ~41 km (25 miles) west of PGDP. The arctic peregrine falcon may also occur in the area (see Appendix I: Bay 1989), although it has not been observed. Bachman's sparrow, under federal status review, may also occur in the area in old fields, fields, or areas with tall grass and scattered pines.

Two species of birds listed as endangered or of special concern by the Kentucky Academy of Science and Kentucky State Nature Preserves Commission (see Appendix I: Hannan 1989) have been seen on or near PGDP (Table 8.2-1, Fig. 8.2-3). One of these, Bell's vireo, has been seen in the West Kentucky State Wildlife Management area of the PGDP DOE property west of the proposed site. The hooded merganser and Bell's vireo were seen within 8 km (5 miles) of the proposed PGDP site, but not on DOE property.

The southeastern myotis, which is on the Kentucky list of endangered species, probably occurs on the site, at least while foraging. It is usually associated with caves but may also be found in culverts, buildings, and trees and under bridges.

One species of reptile, the copperbelly water snake, is listed as of special concern in Kentucky and is a candidate for listing as federally endangered. It has been found in the Metropolis Lake State Nature Preserve.

Table 8.2-1. Status of species monitored by the Kentucky Academy of Science-Kentucky State Nature Preserves Commission (KAS-KSNPC) located within 8 km (5 miles) of the Paducah Gaseous Diffusion Plant

Species	Status	
	KAS-KSNPC	U.S. Fish and Wildlife Service
Water hickory (*Carya aquatica*)	Special concern	
Hair grass (*Muhlenbergia glabriflora*)	Special concern	
Sweet coneflower (*Rudbeckia subtomentosa*)	Threatened	
Small skullcap (*Scutellaria leonardii*)	Special concern	
Compass plant (*Silphium laciniatum*)	Special concern	
Hooded merganser (*Lophodytes cucullatus*)	Endangered	
Bell's vireo (*Vireo bellii*)	Special concern	
Copperbelly water snake (*Nerodia erythrogaster neglecta*)	Special concern	Federal candidate for listing

Source: R. R. Hannan, Kentucky State Preserves Commission, Frankfort, Ky., letter to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., Nov. 6, 1989 (see Appendix I: Hannan 1989).

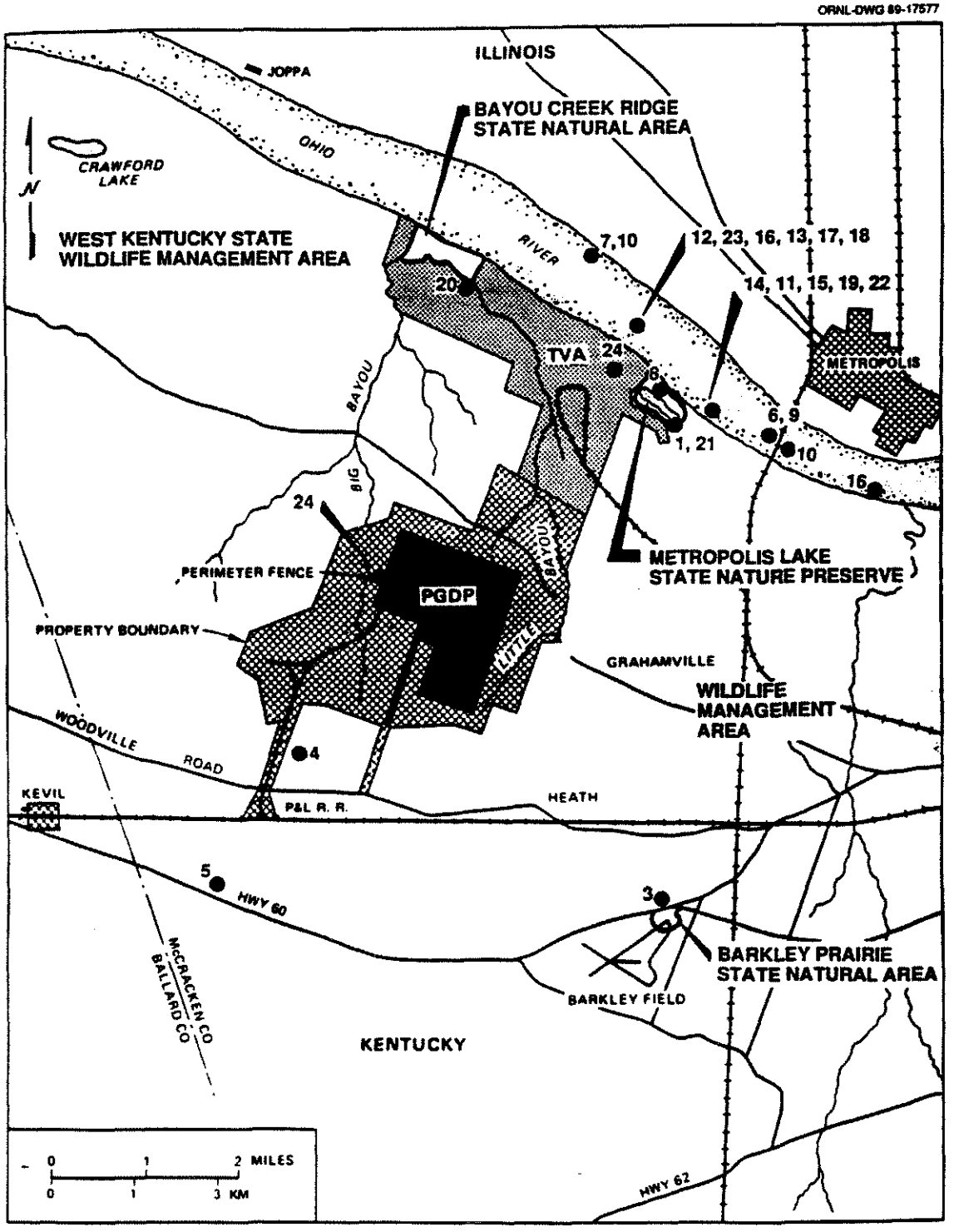

Fig. 8.2-3. Locations of species and unique communities monitored by the Kentucky Academy of Science and Kentucky State Nature Preserves Commission near the Paducah Gaseous Diffusion Plant. 1 = Water hickory, 2 = Hair grass, 3 = Sweet coneflower, 4 = Small skullcap, 5 = Compass plant, 6 = Pink mucket, 7 = Pocketbook, 8 = Crayfish, 9 = Orange-footed pimpleback, 10 = Bullhead (mollusk), 11 = Rabbitsfoot, 12 = Blue sucker, 13 = Lake chubsucker, 14 = Chain pickerel, 15 = Cypress minnow, 16 = Chestnut lamprey, 17 = Black buffalo, 18 = Alligator gar, 19 = Spotted sunfish, 20 = Hooded merganser, 21 = Copperbelly water snake, 22 = Taillight shiner, 23 = Northern madtom, 24 = Bell's vireo.

8.2.4 Natural Areas

Three high quality natural areas of great significance lie within 8 km (5 miles) of the site. These areas are the Barkley Prairie State Natural Area on the Barkley Airfield, Metropolis Lake State Nature Preserve adjacent to the TVA Shawnee Steam Plant, and the Bayou Creek Ridge State Natural Area on the TVA Shawnee Steam Plant Reservation (Fig. 8.2-3). The slough at Bayou Creek Ridge contains scattered cypress, water tupelo, some large timber, and thickets with snakes and birds that may be of special interest. Other slough areas between the plant and the Ohio River may provide similar habitats worthy of protection. The Ballard County Wildlife Management Area is potentially a part of the Kentucky Nature Preserve system.

8.2.5 Preoperational Monitoring of Biota

No systematic programs exist currently for monitoring distribution, abundance, and productivity of terrestrial vegetation, wildlife, or threatened and endangered species at PGDP. Descriptions of biota on the site have been based on observations by many personnel for several different projects on the DOE PGDP land.

The only nonradiological sampling of the biota is for fluorides (Rogers and Ashburn 1988, pp. 35, 38, 39). Bimonthly vegetation samples are obtained from 18 locations (Fig. 8.2-4) every 3 months. Grass is collected, allowed to dry, and then ground in a cutting mill. Samples are analyzed for fluoride. The primary objective of vegetation sampling is to determine the total fluorides in foliage for comparison with Kentucky air pollution control regulations.

8.3 PORTSMOUTH

8.3.1 Land Use

The proposed site for AVLIS at Portsmouth is inside existing buildings that are inside the fenced Portsmouth Gaseous Diffusion Plant (PORTS) facility. PORTS is immediately surrounded by 16.2 km^2 (6.25 $miles^2$) of property owned by DOE. Selected portions of the DOE property are grazed by cattle. Wayne National Forest is adjacent to the PORTS DOE property on the east and southeast. The Brush Creek State Forest is a little more than 1.6 km (1 mile) southwest of the property and west of the Scioto River.

PORTS is located in the Scioto River basin near the border of Pike and Scioto counties in the Appalachian foothills. Except for the Scioto River floodplain, Pike and Scioto counties consist primarily of marginal farmland (including cropland, woodlot, and pasture) and densely forested hills, including Pike State Forest, Brush Creek Forest, and portions of Wayne National Forest. Land use for the Scioto River basin is 60% cropland, 9% pasture, 21% forest, 7% urban, and <1% mine disturbed (Ohio River Sanitation Commission 1988, p. 25). Land use for Pike County is approximately 55% forested and 45% agricultural (ERDA 1977a, p. 2-298). Figure 8.3-1 shows land use within an 8-km (5-miles) radius of the plant (Rogers et al. 1988, p. 9).

Productive croplands lie mostly on or adjacent to the Scioto River floodplain and are farmed intensively, particularly with row crops such as corn and soybeans. Other produce such as tomatoes, cabbage, and fruits is also cultivated in these areas. Hillsides and terraces are more commonly used for cattle pasture. Until recently, both dairy and beef cattle were

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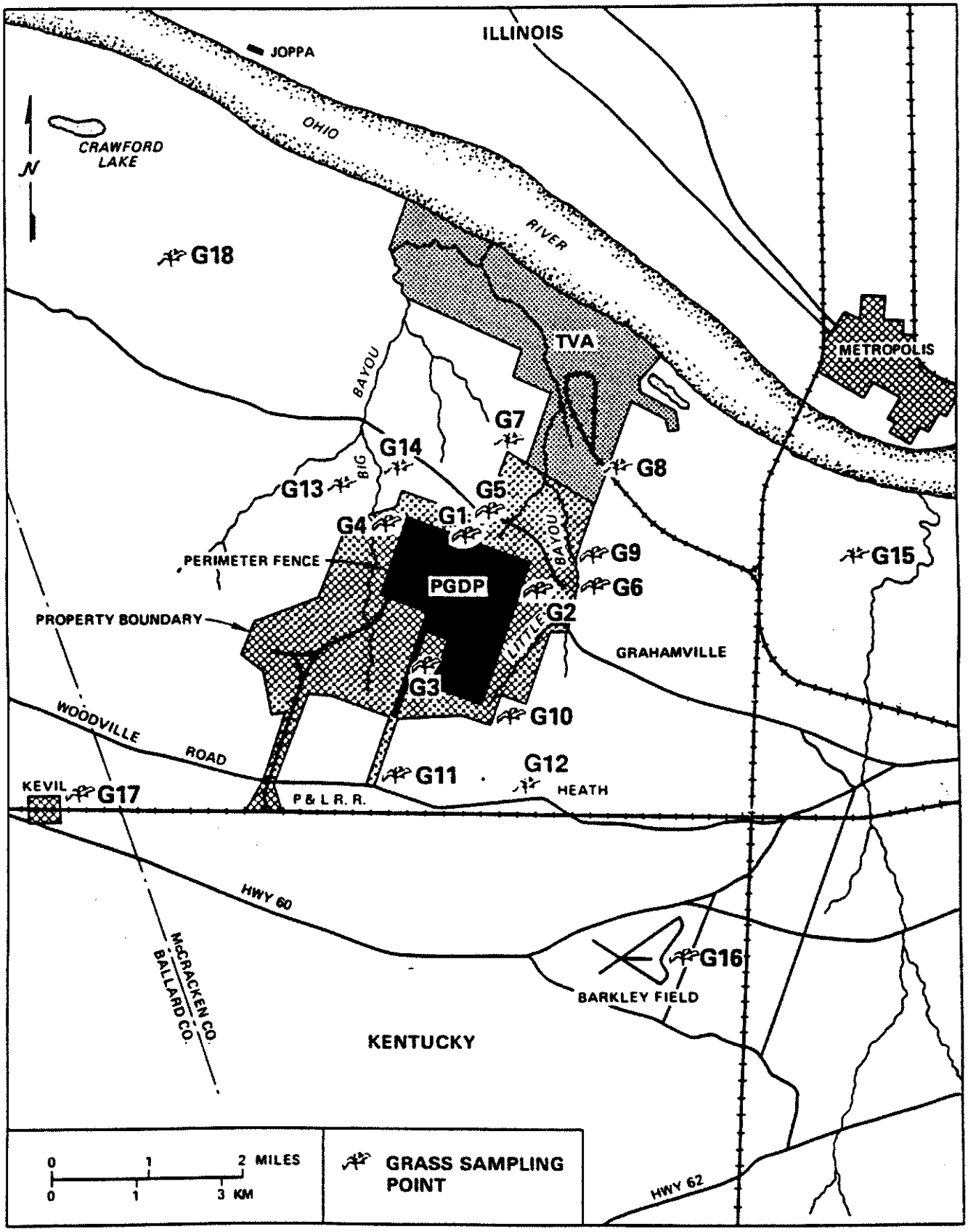

Fig. 8.2-4. Grass sampling locations.

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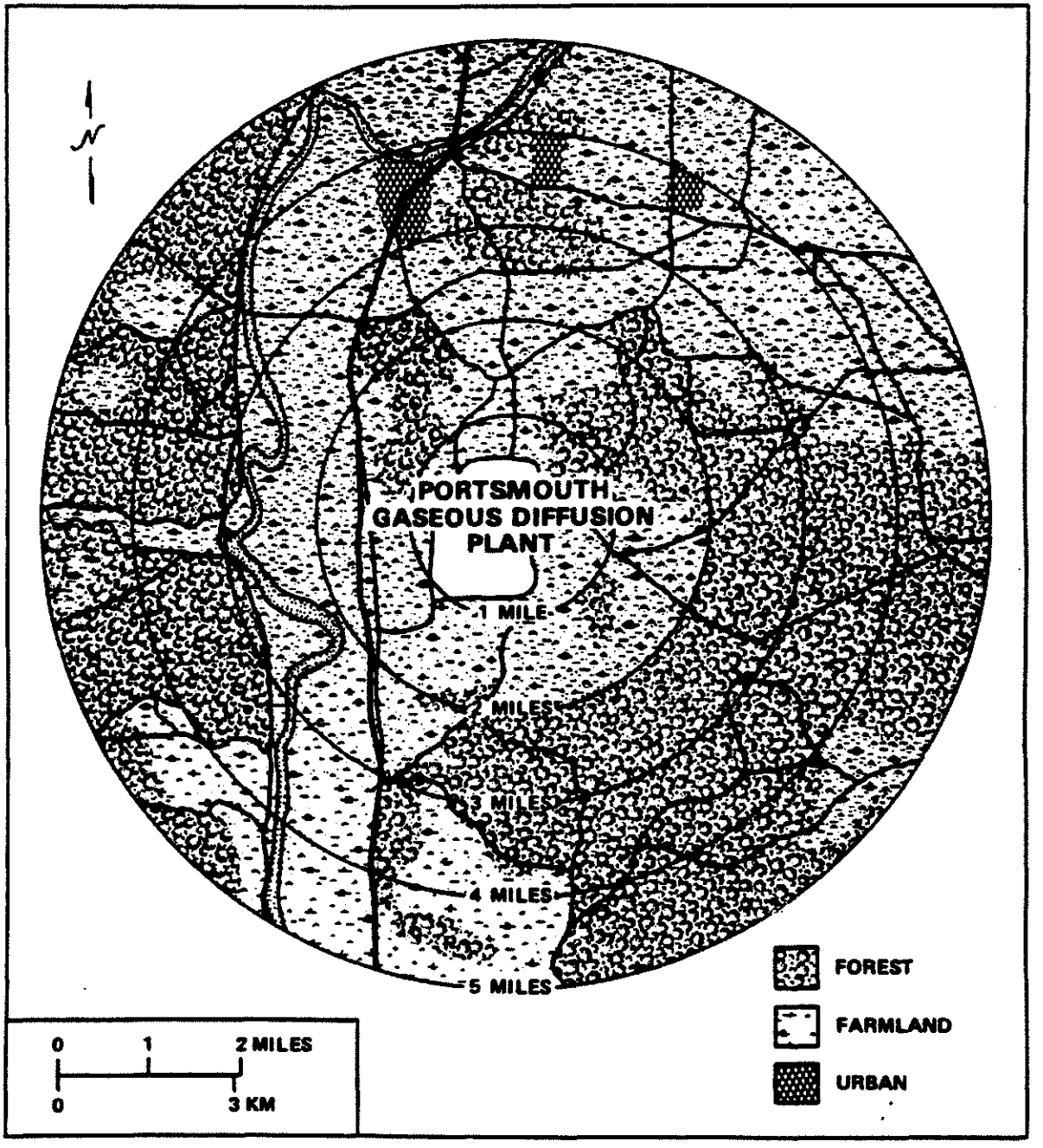

Fig. 8.3-1. General land use surrounding the Portsmouth Gaseous Diffusion Plant.

raised in the area of the Portsmouth site, but in 1987, only beef cattle were pastured within 16 km (10 miles) of the site (Rogers et al. 1988, p. 8). Other farm animals such as horses, pigs, sheep, goats, and chickens are raised to a lesser extent.

Land in privately owned farms has been steadily decreasing in recent years. In 1987, 38.4% of Pike County was utilized agriculturally (Ohio Agricultural Statistics Service 1987, p. 17) compared with 94.9% in 1958 and 45.9% in 1964 (ERDA 1977a, p. 2-300). There was little change in agricultural land use from 1982 to 1987 (Appendix F, Table F.3-1). Livestock, acreage, and productivity of major crops in Pike and Scioto counties are shown in Table F.3-1, Appendix F.

Commercial woodlands are predominantly sawtimber stands with a lesser proportion of pole-timber stands (Rogers et al. 1988, p. 8). Maple farming (for maple syrup) has recently become common among local farmers. About 9900 ha (24,400 acres) of farmland (including cropland, woodlot, and range pasture) and 9900 ha (24,400 acres) of forest lie within a 13-km (8-mile) radius of the plant. There are also 200 ha (500 acres) in urban areas. The amount and productivity of forest property in Pike County is similar to that of surrounding counties.

8.3.2 Terrestrial Ecology

The following descriptions of terrestrial vegetation and wildlife are taken primarily from Rogers et al. (1988, pp. 1, 2, 8, 9), ERDA (1977a, pp. 2-10, 2-12, 2-224, 2-225, 2-298, 2-300, 2-301, 2-302, 2-304, 2-305, 2-306, 2-319, 2-321), and ERDA (1977b, pp. B-6, B-12-B-14, B-18, B-21, B-24, B-39, B-51, B-55, B-57, B-59-62, B-64). Surveys of mammals, birds, reptiles, amphibians, arthropods, woody and herbaceous plants, and wildlife food plants are available (ERDA 1977b, pp. B-8-B-11, B-14-B-15, B-17, B-19, B-20, B-22, B-23, B-25-B-38, B-40-B-50, B-52-B-54, B-56, B-79).

8.3.2.1 Vegetation

Much of the land on which PORTS was constructed was originally cropland. The existing site has been landscaped so that areas not occupied by buildings and roads are mowed grassy fields. A few wooded areas also exist.

The surrounding DOE property contains pasture; old fields; upland, bottomland, pine forest; second growth hardwoods; and scrub thicket (Fig. 8.3-2). Much of the site was logged in 1977. A survey of woody and herbaceous species found at the site is listed in ERDA Tables B.2 and B.3 (1977b, pp. B-8 through B-11).

The areas of the DOE property that are grazed by cattle include both open pasture and forest. Pasture areas are dominated by grasses. Natural forests on the DOE property and in the vicinity of PORTS, including woodlots, are dominated by white oak and red oaks, with some hickory. Maple, ash, pine, and sycamore are also common tree species. Very dry or infertile soils are dominated by small stands of pine or black locust. Logged areas support scattered young oaks, hickories and an abundance of brambles. Noncanopy species vary throughout the area, with sumac, poison ivy, and blackberry being most common.

8.3.2.2 Productivity

Forest productivity on the site has been estimated to be 4.05, 3.01, 1.26, and 0.99 m^3/ha/year (58, 43, 18, and 14 ft^3/acres/year) for upland mixed hardwoods, oak-hickory,

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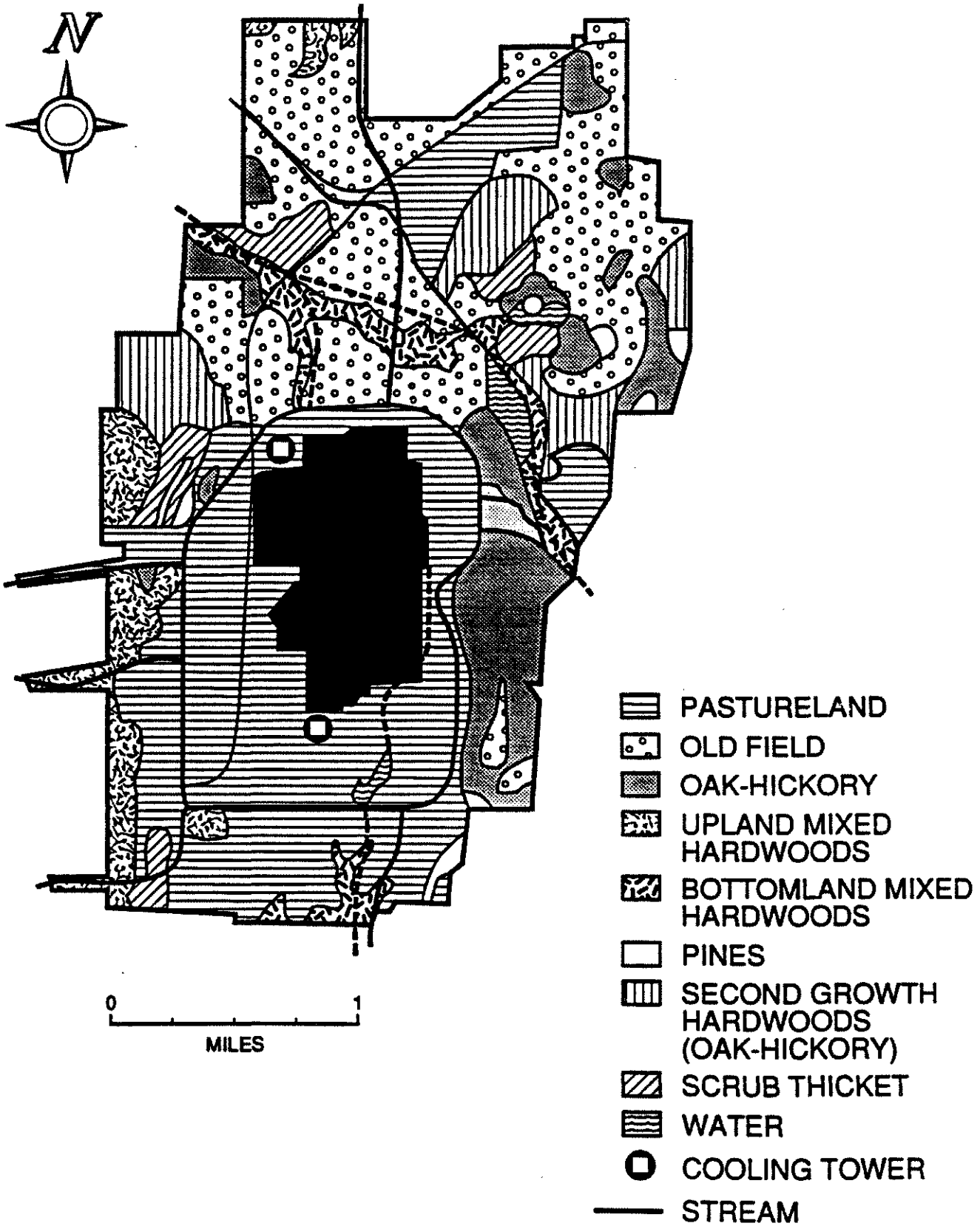

Fig. 8.3-2. Vegetation at Portsmouth Gaseous Diffusion Plant.

second growth hardwoods, and scrub thickets respectively. Bottomland hardwood and pine stands are estimated to produce between 1.41 and 2.79 m^3/ha/year (20 and 40 ft^3/acres/year). Pasture production has been estimated to range from 1120 to 6720 kg/ha/year (0.5 to 3 tons/acre/year). The standing crop of old field vegetation in 1975 was 3136 kg/ha (1.4 tons/acre).

8.3.2.3 Wildlife

Local animal species are typical of southern Ohio. Twenty-two species of mammals have been observed on the site. The most abundant are the white-footed mouse, short-tailed shrew, and eastern cottontail; these occur on most areas of the site. White-tailed deer are also common. The five most abundant bird summer residents are the common grackle, starling, red-winged blackbird, indigo bunting, and field sparrow. In 1975 and 1976, 69 bird species were seen during the breeding season; of these, 32 were permanent residents. Fifteen additional species were seen during the winter. Many migratory birds stop at the site, and migratory waterfowl commonly use the detention ponds.

The most abundant amphibians are American toads and northern dusky salamanders. Various species of frogs also occur in the streams, ponds, and lakes of the site. The most common reptiles are eastern box turtle, black rat snake, and northern black racer. Numerous other species of snakes and turtles are present to lesser extents.

Commercially and recreationally important wildlife occurring on the site include deer, Eastern cottontails, fox squirrels, muskrats, bullfrogs, mallards, wood ducks, bobwhites, and mourning doves. Although low in density both on and off the site, the deer population is higher on-site [~5/km^2 (~2/$mile^2$)] than off-site [0.8–1.8/km^2 (0.3–0.7/$mile^2$)], presumably because of protection from hunting. Eastern cottontails favor grass fields and areas in early successional stages interspersed with fencerows and edges. Because these habitats are common on the site, the population is high. Fox and gray squirrel populations are quite low. These species favor mature hardwood stands, and few such habitats exist on the site. Muskrats are found in association with ponds on the site and probably also occur in the streams.

Bullfrogs are common throughout the site wherever water is present in ditches, ponds, and some streams. Bobwhite and mourning dove are the most abundant game birds breeding on the site. Migratory waterfowl utilize the detention ponds on the site.

8.3.3 Endangered and Threatened Species

No amphibians or reptiles occurring on the site are classified by the federal or state government as legally protected. However, the black kingsnake, listed by the Ohio State Division of Natural Areas and Preserves (DNAP) (see Appendix I: Jones 1989) as of special interest, has been observed within 8 km (5 miles) of the site (Fig. 8.3-3). The smooth softshell turtle and rough green snake may occur (ERDA 1977, p. 2-225) and are listed as of special interest and potentially threatened, respectively, by DNAP.

Suitable habitat exists for the Rafinesque's big-eared bat, listed by the DNAP as of special interest, but it is not known to be present. The only legally protected mammal listed as endangered by the state for which there is suitable habitat on the site is the river otter; however, this species is not known to be present. PORTS lies within the range of the Indiana bat, a federally listed endangered species. While no winter habitat has been

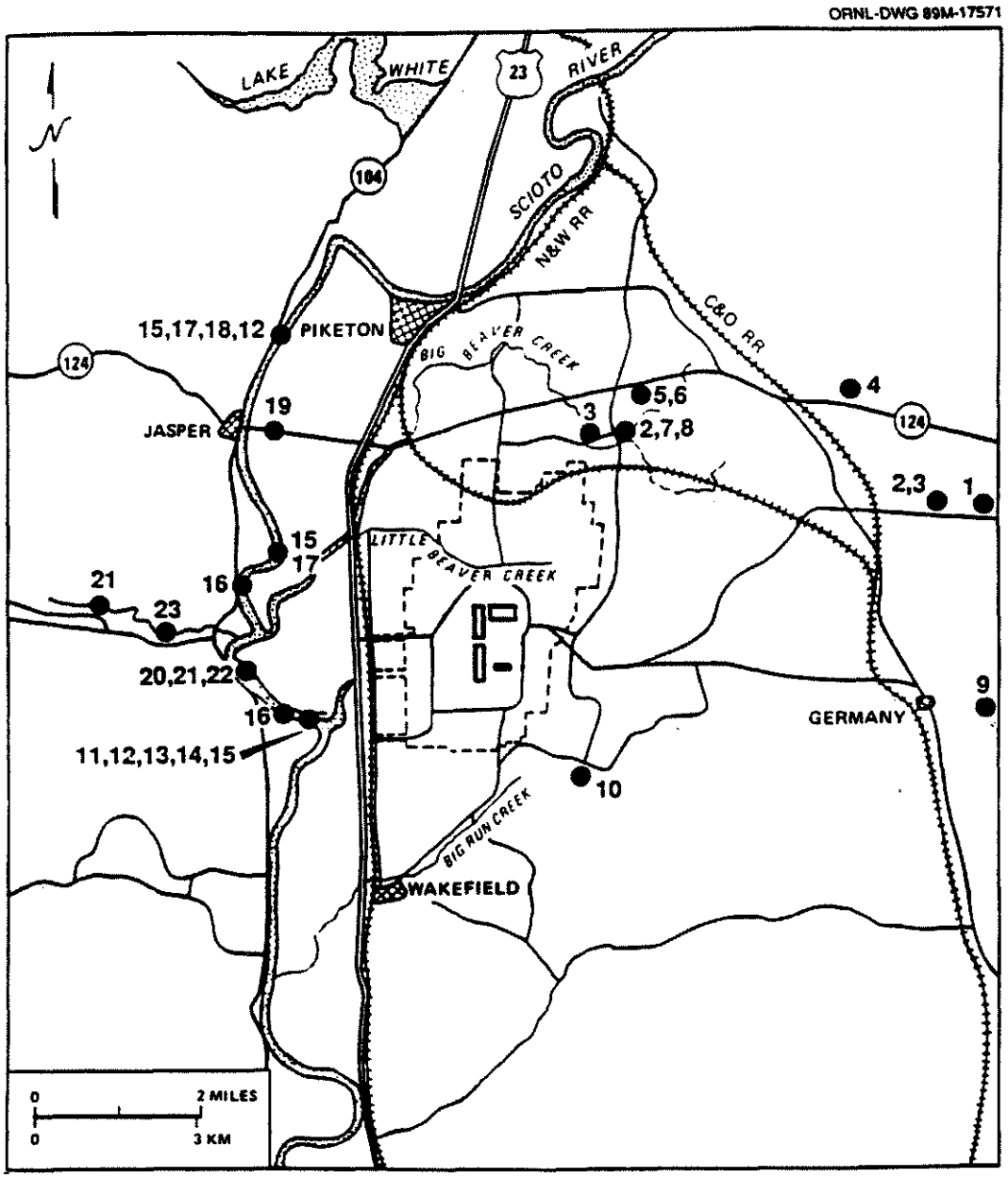

Fig. 8.3-3. **Locations of species and unique communities monitored by the Ohio Division of Natural Areas and Preserves.** 1 = Mixed broadleaf deciduous forest wetland, 2 = Short's hedge hyssop, 3 = Hyssop skullcap, 4 = Black kingsnake, 5 = Givens Marsh, 6 = Northern fox grape, 7 = Virginia meadow-beauty, 8 = Long-beaked arrowhead, 9 = False scurf-pea, 10 = Turkey vulture roost, 11 = Ebony shell, 12 = Yellow sand shell, 13 = Bullhead (mollusk), 14 = Fragile heel-splitter, 15 = Fawn's foot, 16 = False map turtle, 17 = Three-horned wartyback, 18 = Deer toe, 19 = Bur-head, 20 = River redhorse, 21 = Shortnose gar, 22 = Goldeye (fish), 23 = Silver lamprey.

identified near the site, potential summer habitat for the Indiana bat does exist, primarily along the Scioto River (see Appendix I: Kroonemeyer 1989).

No legally protected bird species on the federal or state rare or endangered species lists were found to occur on the site. Only one bird species, the sharp-shinned hawk, considered endangered in Ohio by the Ohio Division of Wildlife and of special interest by DNAP, has been seen on the site.

Although no legally protected plant species occur within 8 km (5 miles) of the site, six plant species listed by DNAP as potentially threatened have been observed (Table 8.3-1, Fig. 8.3-4).

8.3.4 Natural Areas

No national landmarks are reported in the vicinity of the plant, the nearest being Buzzardroost Rock and Lynx Prairie in Adams County about 48 km (30 miles) to the southeast. No state nature preserves are near the site; the nearest is Adams Lake Prairie north of West Union in Adams County. None of the areas designated by the National Park Service as potentially suitable for inclusion in the National Registry of Natural Landmarks were in Pike County, and none of the ten Natural Areas designated by the Ohio Biological Survey within Scioto and Pike counties are within 16 km (10 miles) of the plant site.

Two areas listed by the Ohio State Division of Natural Areas and Preserves as significant examples of wetland community types are within 8 km (5 miles) of the site (Fig. 8.3-3). One is a broad-leaved deciduous forest wetland community (Cowardin et al. 1979, p. 22) ~8 km (~5 miles) east of the site, and the other is Givens Marsh, a persistent emergent wetland dominated by cattails (Cowardin et al. 1979, pp. 21–22) ~4 km (~2.5 miles) east of the site.

8.3.5 Preoperational Monitoring of Biota

No systematic programs currently exist for monitoring distribution, abundance, and productivity of terrestrial vegetation, wildlife, or threatened and endangered species at PORTS. Descriptions of biota on the site have been based on observations for different projects on the DOE PGDP land.

Sampling of vegetation at PORTS is done to assess the impact of plant operation on vegetation and on animals that eat the vegetation. Food crop samples are analyzed for uranium, and grass samples are analyzed for uranium and fluoride. Sampling locations are shown in Figs. 8.3-4, 8.3-5, and 8.3-6 (Oakes et al. 1987, pp. 106–108). Annual samples of food crops are collected from privately owned farms and gardens surrounding the facility (Rogers et al. 1988, pp. 71, 73). Corn and tomatoes are usually available for analysis. Other crops may include cabbage, red peppers, peaches, strawberries, and cherries. Samples collected several kilometers away serve as a source of background samples. Other vegetation (grass typical of local cattle forage) samples are collected from several locations in and around PORTS at semiannual intervals. Forage samples are also collected up to 16 km (10 miles) from the plant site.

Table 8.3-1. Status of terrestrial biota monitored by the Ohio Division of Natural Areas and Preserves observed within 8 km (5 miles) of Portsmouth Gaseous Diffusion Plant

Species	Status[a]
False scurf-pea (*Orbexilum pedunculatum*)	P
Hyssop skullcap (*Scutellaria integrifolia*)	P
Long-beaked arrowhead (*Sagittaria australis*)	P
Northern Fox Grape (*Vitis labrusca*)	P
Short's hedge-hyssop (*Gratiola viscidula*)	P
Virginia meadow-beauty (*Rhexia virginica*)	P
False map turtle (*Graptemys pseudogeographica*)	S
Black kingsnake (*Lampropeltis getulus*)	S

[a]P = potentially threatened in the state of Ohio (not a legal designation);
S = special interest in the state of Ohio (not a legal designation).

Source: P. D. Jones, Ohio Department of Natural Resources, Columbus, Ohio, letter to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., Nov. 15, 1989 (see Appendix I: Jones 1989).

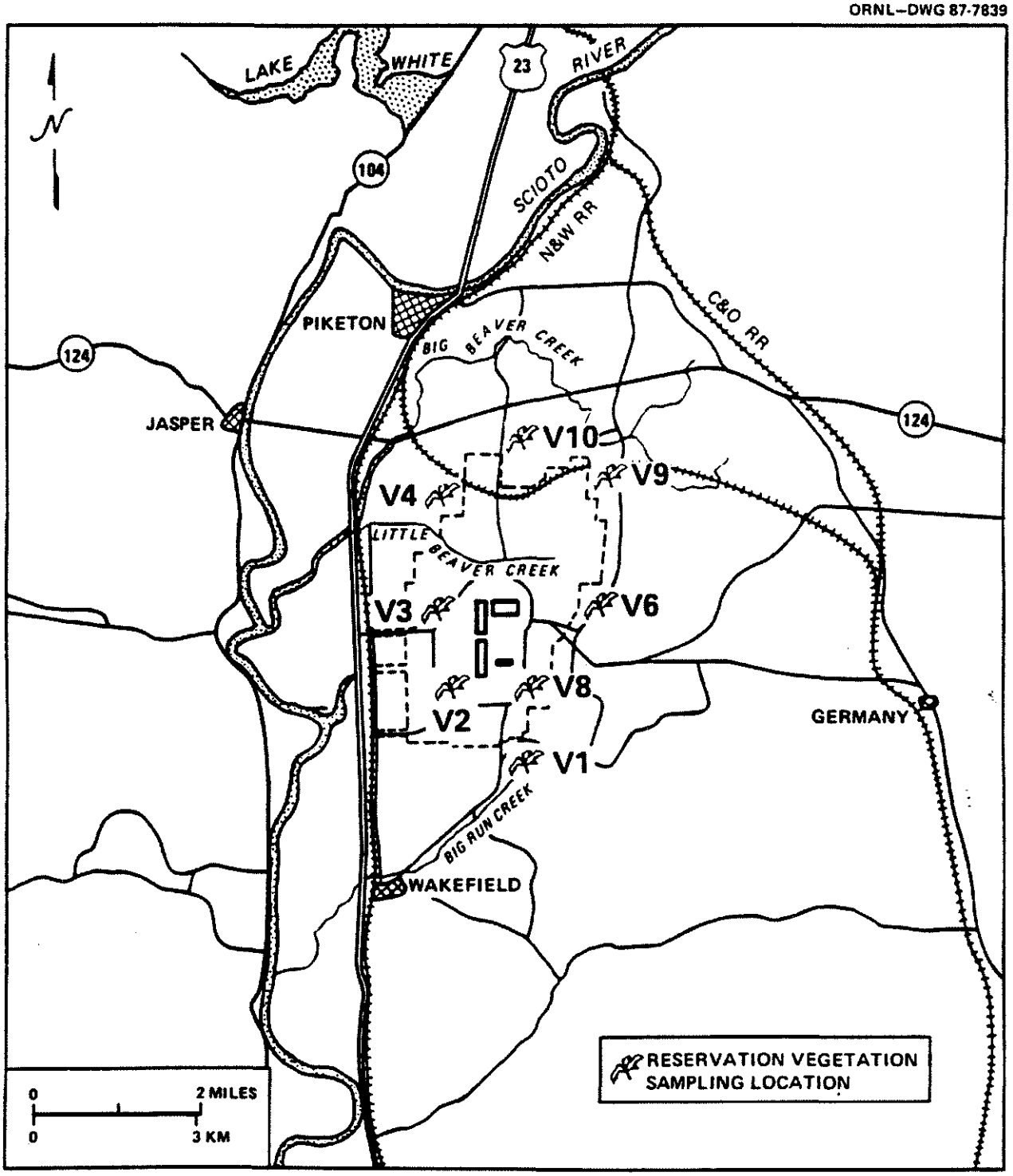

Fig. 8.3-4. Vegetation sampling sites at the Portsmouth Gaseous Diffusion Plant on the DOE reservation.

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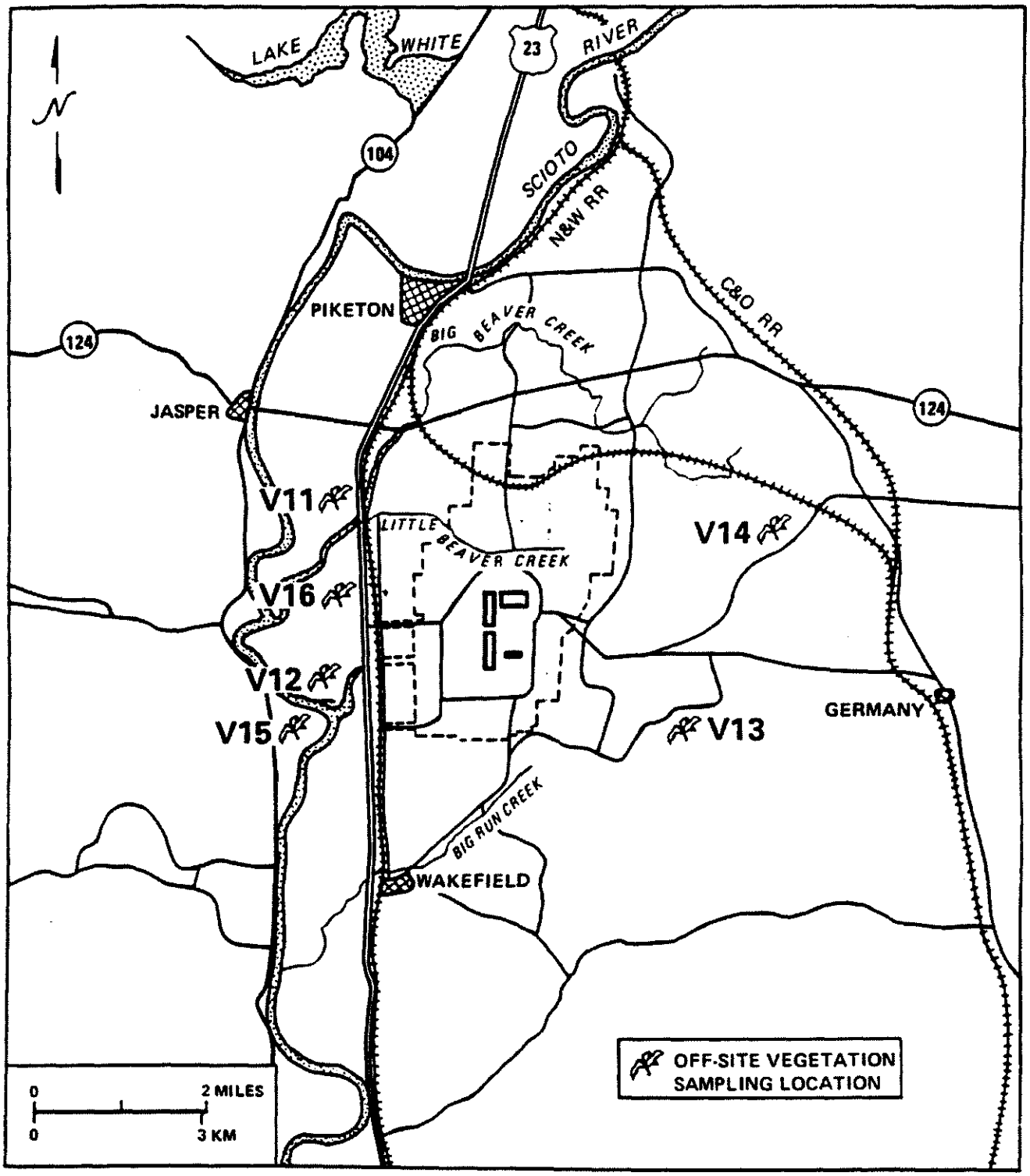

Fig. 8.3-5. Vegetation sampling sites at Portsmouth Gaseous Diffusion Plant within 5 km of the DOE reservation boundary.

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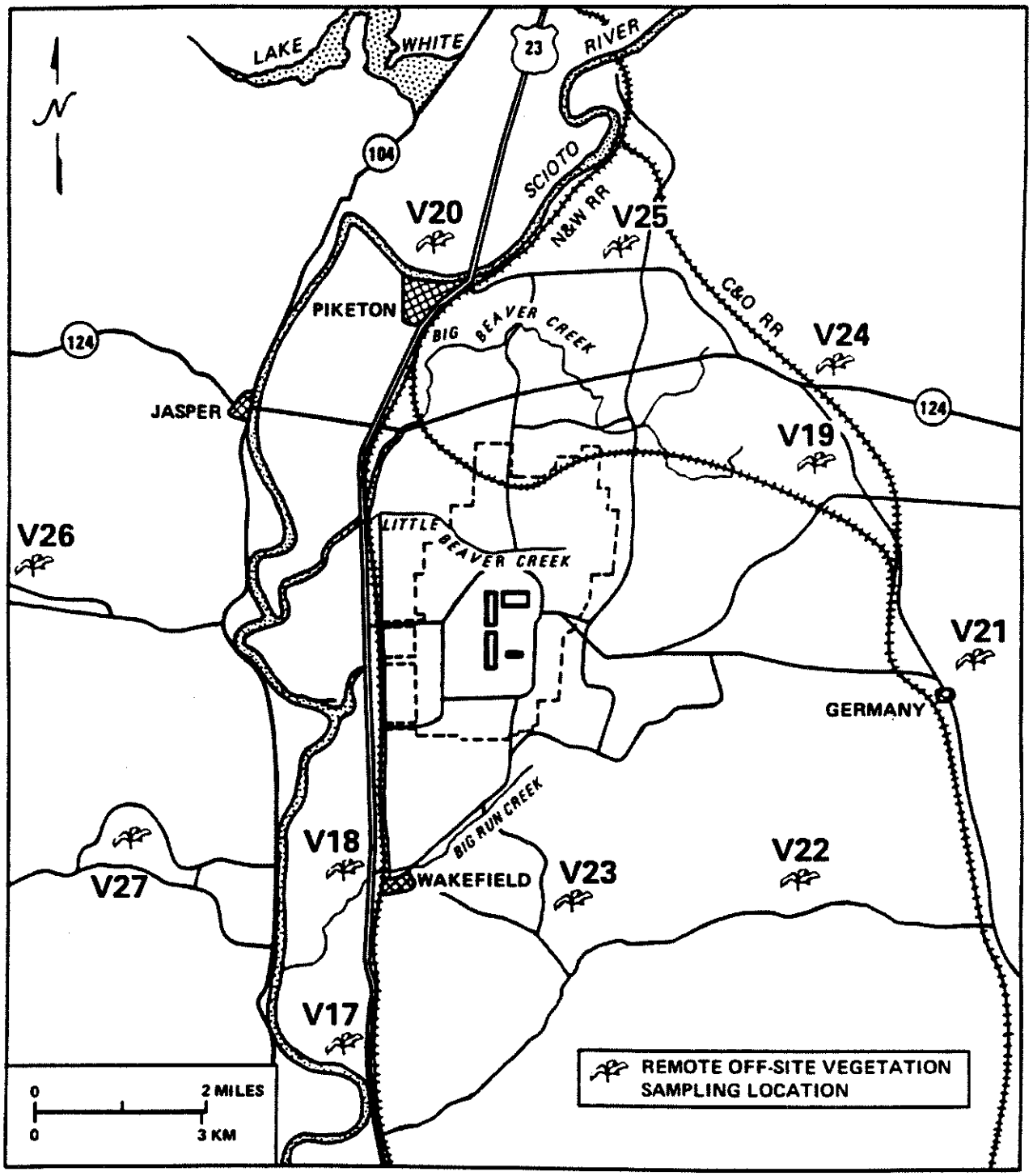

Fig. 8.3-6. Vegetation sampling sites 5–16 km (3–9 miles) from the DOE reservation boundary.

8.4 REFERENCES

8.4.1 Oak Ridge

Boyle, J. W., et al. 1982. *Environmental Analysis of the Operation of Oak Ridge National Laboratory (X-10 Site)*, ORNL-5870, pp. 3-59 through 3-65.

Cowardin, L. M., et al. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*, Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, FWS/OBS-79/31, pp. 21–22.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, EA-0106, pp. 1-2, 1-3, 4-3, 4-4, 4-32 through 4-39, 4-46.

DOE (U.S. Department of Energy) 1982. *Draft Environmental Impact Statement, Sale of Segment O of the Oak Ridge Reservation to the City of Oak Ridge, Tennessee*, EIS-0094D, pp. 3-47 through 3-51, 3-54 through 3-59.

DOE (U.S. Department of Energy) 1988. *Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1987, Vol. 1: Narrative, Summary, and Conclusions*, ES/ESH-4/V1, pp. 136, 137.

Kroodsma, R. L. 1987. *Resource Management Plan for the Oak Ridge Reservation, Vol. 24: Threatened and Endangered Animal Species*, ORNL/ESH-1/V24, pp. 6–12.

Parr, P. D. 1984. *Resource Management Plan for the Oak Ridge Reservation*, Vol. 4, Appendix D: Endangered and Threatened Plant Species, ORNL-6026/V4, pp. 3, 7-13.

U.S. Department of Commerce 1984, *1982 Census of Agriculture, Vol. 1, Geographic Area Series, Tennessee, State and County Data*, Bureau of the Census.

USDI (United States Department of Interior) 1985. "Endangered and Threatened Wildlife and Plants; Review of Plant Taxa for Listing as Endangered or Threatened Species; Notice of Review," *U.S. Fed. Regist.* **50** (188) Part 17, pp. 7, 12, 49.

8.4.2 Paducah

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site* DOE EA-0155, August, pp. 1-3, 2-6, 3-10, 3-11, 3-14 through 3-17, 3-19 through 3-21, 3-36, 3-37, 3-49.

Oakes, T. W., D. L. Ashburn, and F. M. O'Hara 1987. *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1986*. ES/ESH-1/V3, pp. 15, 17, 20, 22.

Rogers, J. G., and Ashburn, D. L. 1988. *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, pp. 35, 38, 39.

8.4.3 Portsmouth

Cowardin, L. M., et al. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*, Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, FWS/OBS-79/31, pp. 21–22.

ERDA (U.S. Energy Research and Development Administration) 1977a. *Portsmouth Gaseous Diffusion Plant Expansion, Piketon, Ohio*, Vol. 1 of 2, 1549/V1, pp. 2-10, 2-12, 2-224, 2-225, 2-298, 2-300, 2-301, 2-302, 2-304, 2-305, 2-306, 2-319, 2-321.

ERDA (U.S. Energy Research and Development Administration) 1977b. *Portsmouth Gaseous Diffusion Plant Expansion, Piketon, Ohio*, Vol. 2 of 2, 1549/V2, pp. B-6 through B-15, B-17 through B-57, B-59 through B-62, B-64, B-79).

Oakes, T. W., et al. 1987. *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1986*, ES/ESH-1/V4, POEF-1158, pp. 106–108.

Ohio Agricultural Statistics Service 1987. *Ohio Agricultural Statistics and Ohio Department of Agriculture Annual Report*, U.S. Department of Agriculture, National Agricultural Statistics Service and Ohio Department of Agriculture, Columbus, Ohio.

Ohio River Valley Water Sanitation Commission 1988. *Ohio River Water Quality Fact Book 1988*, p. 25.

Rogers, J. G., et al. 1988. *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, pp. 1, 2, 8, 9, 71, 73.

9. AQUATIC ECOLOGY

9.1 OAK RIDGE

9.1.1 Biota

The five major biotic communities in waters adjacent to ORGDP (phytoplankton, periphyton, zooplankton, benthic macroinvertebrates, and fish), described in detail in the biological monitoring report for 1977 and 1978 (Loar et al. 1981), are summarized in this section. Sampling stations for the monitoring program are identified in Fig. 9.1-1. Studies of the biota of the Clinch River in the vicinity of ORGDP were also conducted in 1974-75 as part of the Clinch River Breeder Reactor Project (PMC, TVA, and ERDA 1977, pp. 2-14 to 2-17) and in 1975-76 for the Exxon Nuclear Fuel Reprocessing and Recycling Center (Exxon 1976). The aquatic biota of Poplar Creek was described in the Exxon report (Exxon 1976) and in the 1977 and 1978 biological survey by Loar et al. (1981).

During most of the year, the phytoplankton community in the ORGDP vicinity is dominated by diatom species, with population peaks occurring occasionally among the green and blue-green components. Detailed information on the seasonal distribution and abundance of phytoplankton in the ORGDP vicinity is contained in Section 4.6.2.1 of the ORGDP environmental assessment (DOE 1979, p. 4-39) and in Loar et al. (1981, pp. 93–115).

The ORGDP EA (DOE 1979, p. 4-41) concluded that temperature may be a limiting factor to phytoplankton production in the Clinch River during the summer as well as the winter because of the hypolimnetic discharge from Melton Hill Dam. Turbidity was thought to reduce algal production in Poplar Creek because of reduced penetration of incident solar radiation. Nutrient levels in both the Clinch River and Poplar Creek were found to generally be sufficient to support large algal biomasses (DOE 1979, p. 4-41). Nutrients derived from within the stream (autochthonous inputs) exceeded those from external sources (allochthonous inputs) in the lower reaches of Poplar Creek and much of the Clinch River.

In general, the maximum abundance of zooplankton occurred in early summer and fall. Rotifers were the most abundant group of zooplankton in the Clinch River. From early May through late October, rotifers generally constituted more than 85% of the zooplankton (Loar et al. 1981, p. 149). Average annual densities of zooplankton at all three Poplar Creek sites were significantly lower than those of the Clinch River, generally because of relatively swift current, absence of productive backwater areas, and low primary production in the creek (Loar et al. 1981, pp. 149–154).

The benthic fauna in the vicinity of ORGDP is dominated by oligochaetes (aquatic earthworms) and dipteran (fly and midge) species (Table 9.1-1). Mean annual densities of benthos ranged from 412 organisms/m^2 at CRK 16.9 (CRM 10.5) to 856 organisms/m^2 at PCK 17.7 (PCM 11). The diversity of benthos in the ORGDP vicinity is low compared with that of benthic invertebrate communities in general (Loar, Solomon, and Cada 1981, pp. 164–81). The low diversity found in 1978–79 is probably a reflection of reservoir construction and the subsequent manipulation of water levels and flows in the ORGDP vicinity. The Asiatic clam, *Corbicula manilensis*, was the dominant species by weight in the ORGDP area studied by Loar, Solomon, and Cada (1981, p. 176). This species

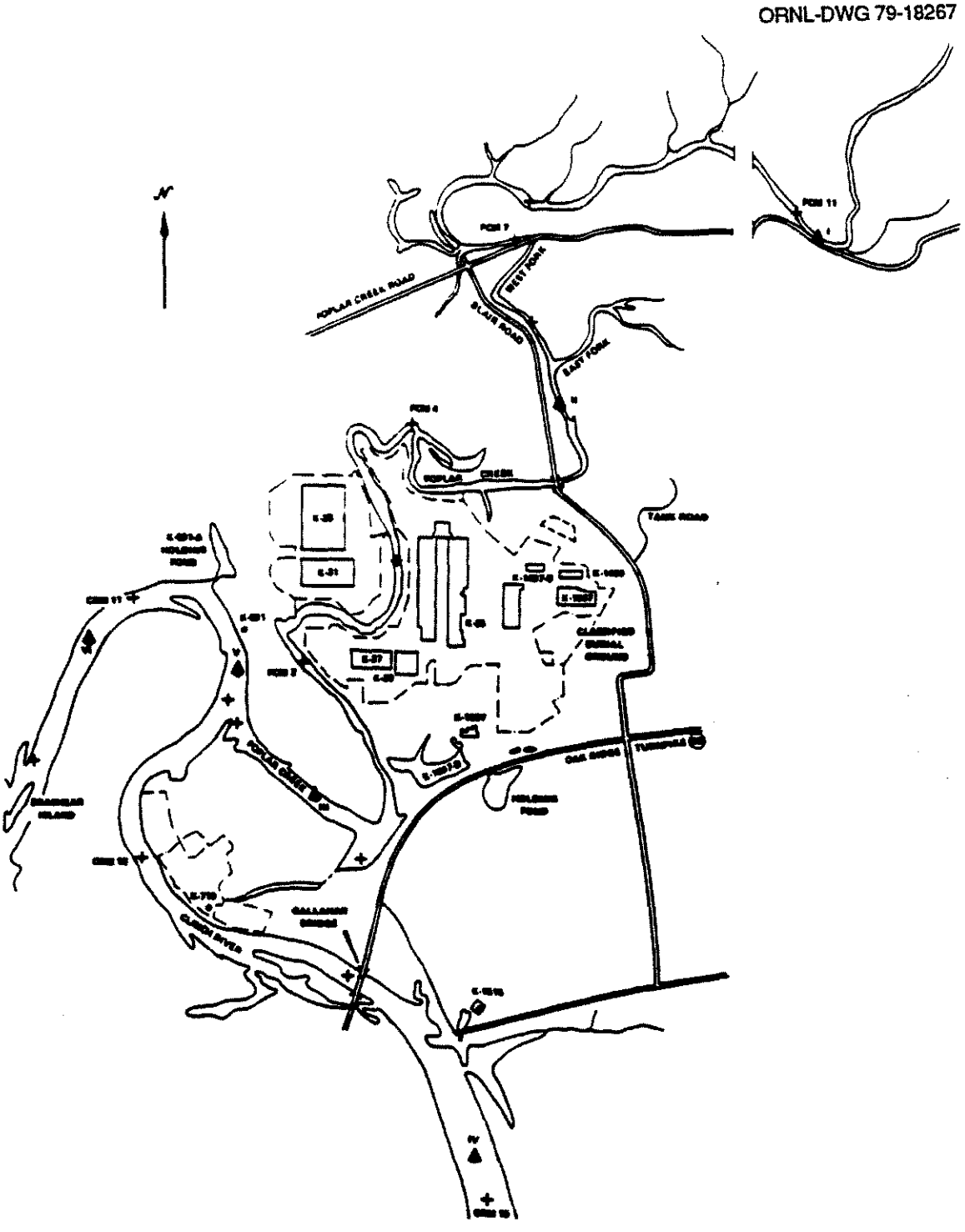

Fig. 9.1-1. Location of the six sites (▲) on Poplar Creek and the Clinch River where biological sampling was conducted during the Oak Ridge Gaseous Diffusion Plant survey, April 1977–September 1978. *Source:* Loar, J. M., Solomon, J. A., and Cada, G. F., *Technical Background Information for the ORNL Environment and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1981, p. 3, Figure 1.2-1.

Table 9.1-1. Relative abundance of benthic macroinvertebrates at the six Oak Ridge Gaseous Diffusion Plant sampling sites
(values are given in percentage)

Taxon	Poplar Creek[a]			Clinch River[a]		
	RK 17.7 (RM 11.0)	RK 8.8 (RM 5.5)	RK 0.8 (RM 0.5)	RK 24 (RM 15.0)	RK 18.5 (RM 11.5)	RK 16.9 (RM 10.5)
Diptera (total)	46.6	56.4	46.7	33.3	26.8	17.3
Chironomidae	43.3	54.4	31.2	32.5	22.3	16.3
Ceratopogonidae	2.6	0.4	2.8	0.5	2.4	
Chaoborus punctipennis		1.2	12.7	0.3	2.1	1.0
Others	0.7	0.4				
Oligochaeta (total)	26.4	32.5	34.8	38.7	51.3	44.6
Tubificidae	25.4	31.3	34.2	37.3	50.5	43.6
Others	1.0	1.2	0.6	1.4	0.8	1.0
Pelecypoda (total)	20.6	3.7	4.1	26.5	9.4	29.7
Corbicula manilensis	20.1	0.4	0.5	26.2	8.8	28.7
Others	0.5	3.3	3.6	0.3	0.6	1.0
Ephemeroptera (total)	1.7	3.3	13.2	0.6	8.7	6.4
Hexagenia limbata		3.3	13.2	0.3	8.7	6.4
Others	1.7			0.3		
Coleoptera (total)	2.2	2.5	0.3		0.8	0.5
Dubiraphia	2.2	2.5	0.3		0.5	0.5
Others					0.3	
Tricoptera	0.2	0.4		0.6	0.3	1.0
Amphipoda					1.5	
Others[b]	2.3	1.2	0.9	0.3	1.2	0.5

[a]Values were calculated from samples collected on seven sampling dates between April 1977 and March 1978. RK = river kilometer, RM = river mile.

[b]Includes the following orders: Gastropoda, Hydracarina, Isopoda, Megaloptera, Nematoda, Odonata.

Source: J. M. Loar, J. A. Solomon, and G. F. Cada, *Technical Background Information for the ORNL Environment and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1981, p. 171, Table 1.6.4-6.

probably represents the majority of the biomass of Clinch River benthic organisms and is a common component of the diet of many fish species found in the river [Sinclair and Isom (1963) as cited in DOE 1979, p. 4-44].

In the ORGDP monitoring survey (Loar et al. 1981, pp. 187–209), 28 fish species from 10 families were collected. Numerically, fish populations at the Clinch River stations were 58% game fish, 14% rough fish, and 28% forage fish (Table 9.1-2); Poplar Creek had 32% game fish, 23% rough fish, and 45% forage fish (Table 9.1-3).

Bluegill, largemouth bass, and white crappie accounted for the majority of the centrarchid numbers and biomass and—along with white, yellow, and striped bass and sauger—are the most common game fish in the ORGDP area [Loar, Burkhart, Cada 1981, pp. 203–204; Hickman 1990 and Tolbert 1990d (see Appendix I)]. Clupeids (threadfin and gizzard shad and skipjack herring), which are classified as forage fish, were the most numerous species in collections from the Clinch River in the vicinity of ORR (Loar, Burkhart, Cada 1981, pp. 187–209). In the 1977 and 1978 ORGDP survey, gizzard shad was the most common species collected from Poplar Creek and was the most common forage fish collected from the Clinch River (Loar, Burkhart, Cada 1981, pp. 203 and 208). This species continues to be the most common forage fish in the ORGDP vicinity (see Appendix I: Tolbert 1990d). Rough fish in the vicinity of ORGDP are predominantly smallmouth buffalo, spotted sucker, carp, and silver redhorse [DOE 1979, p. 4-45; Tolbert 1990d (see Appendix I)]. The tailwater fish population below Melton Hill Dam is dominated by gizzard shad, bluegill, redear sunfish, largemouth bass, yellow bass, yellow perch, quillback, carp, spotted sucker, and black redhorse in approximate order of abundance. Other species identified are referenced in Tolbert (1990h).

Information on larval fish and egg abundance in the ORGDP vicinity is presented in the ORGDP EA (DOE 1979, p. 4-45) and Loar, Solomon, and Cada (1981, pp. 213–242). Peak egg densities occurred in early May with a corresponding larval fish abundance occurring in late May through June.

In 1984, fish and invertebrate populations in East Fork Poplar Creek, Poplar Creek, Bear Creek, White Oak Creek, and the Clinch River were sampled to determine concentrations of heavy metals, radionuclides, and priority pollutant organics. Table 9.1-4 shows the results of this study and the numbers of aquatic organisms collected. This study showed that mercury, arsenic, beryllium, cadmium, chromium, copper, selenium, silver, and thallium were elevated in different organisms sampled (TVA 1986, pp. 26–35). Studies by Smith et al. (1988, pp. 107–115) showed that the species richness and density and the biomass of fish in Mitchell Branch were reduced during 1986–87, probably in response to elevated levels of residual chlorine.

Monitoring of Mitchell Branch identified 134 taxa (Table G.1-1 in Appendix G). Of these, 119 were insect taxa that belong to 10 orders. Dipterans, particularly chironomids, were the most abundant taxa (see Table G.1-2 in Appendix G). The highest densities of benthic invertebrates occurred at the upstream site and the greatest biomass at site MIK 0.86 (see Fig. D.1-1 in Appendix D for locations of the sampling sites). Information on total biomass, density, and species richness of benthic invertebrates in Mitchell Branch is shown in Table G.1-2 in Appendix G. The blacknose dace, creek chub, and redbreast sunfish, which are tolerant species, were the only species found in Mitchell Branch. The absence of other species from this stream was determined to be the result of environmental stress from effluent discharges to the stream (Smith et al. 1988, pp. 110–112).

Table 9.1-2. Total number of fish collected by gill-netting (G) and electroshocking (S) at the three Oak Ridge Gaseous Diffusion Plant sampling sites on the Clinch River, April 1977–March 1978
(number of collection periods given in parentheses)

	CRM 15.0[a]		CRM 11.5[a]		CRM 10.5[a]	
Family/species	G(4)	S(4)	G(5)	S(5)	G(5)	S(5)
Catostomidae						
River carpsucker					1	2
Silver redhorse	1			2	2	
Black redhorse				1		1
Spotted sucker					2	
Northern hog sucker	1					
Total	2			3	5	3
Centrarchidae						
Largemouth bass		6		14	1	10
Spotted bass				1		1
White crappie		1				
Bluegill	1	6		30	3	37
Redbreast sunfish				3		8
Warmouth						4
Rock bass				3		
Lepomis sp.				7		5
Total	1	13		58	4	65
Clupeidae						
Gizzard shad	9	9	16	3	29	12
Threadfin shad	7					2
Skipjack herring	3		2		14	
Total	19	9	18	3	43	14
Cyprinidae						
Carp		1		1		1
Common shiner	3					
Unidentified						1
Total	3	1		1		2
Hiodontidae						
Mooneye			1		4	
Ictaluridae						
Channel catfish			1			

Table 9.1-2. (continued)

Family/species	CRM 15.0[a]		CRM 11.5[a]		CRM 10.5[a]	
	G(4)	S(4)	G(5)	S(5)	G(5)	S(5)
Percichthyidae						
White bass	2	1	1	12		4
Yellow bass	8		1			
Striped bass					5	
Total	10	1	2	12	5	4
Percidae						
Sauger	4	1	3		5	
Sciaenidae						
Freshwater drum	—	—	1	—	5	—
Total fish collected	39	25	26	77	71	88

[a]CRM = Clinch River Mile. Miles can be converted to kilometers by multiplying the given value by 1.609.

Source: J. M. Loar, J. A. Solomon, and G. F. Cada, *Technical Background Information for the ORNL Environment and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1981, pp. 208-9, Table 1.6.5-6.

Table 9.1-3. Total number of fish collected by gill-netting (G) and electroshocking (S) at the three Oak Ridge Gaseous Diffusion Plant sampling sites on Poplar Creek, April 1977–March 1978
(number of collection periods given in parentheses)

	PCM 11.0[a]		PCM 5.5[a]		PCM 0.5[a]	
Family/species	G(4)	S(3)	G(5)	S(4)	G(5)	S(5)
Catostomidae						
Smallmouth buffalo		7	3	2	1	5
Black buffalo				2		
River carpsucker				1		1
Silver redhorse	2	17	2	2	2	1
Spotted sucker			1		2	
Total	2	24	6	7	5	7
Centrarchidae						
Largemouth bass		2		4		14
Spotted bass			1			
White crappie		2		10	1	17
Bluegill	1	3	1	9	1	19
Redbreast sunfish		1				
Orange-spotted sunfish				2		
Warmouth				1		
Lepomis sp.				8		
Total	1	8	2	34	2	50
Clupeidae						
Gizzard shad	7	26	89	20	82	13
Threadfin shad			1		2	
Skipjack herring	4				11	
Total	11	26	90	20	95	13
Cyprinidae						
Carp			4	3		2
Notropis sp.					3	
Unidentified						1
Total			4	3	3	3
Hiodontidae						
Mooneye				1		
Ictaluridae						
Channel catfish			4		12	

Table 9.1-3. (continued)

Family/species	PCM 11.0[a]		PCM 5.5[a]		PCM 0.5[a]	
	G(4)	S(3)	G(5)	S(4)	G(5)	S(5)
Lepisosteidae						
Spotted gar			1		2	
Longnose gar			1		5	
Total			2		7	
Percichthyidae						
White bass		23	26		19	
Yellow bass			1	1	1	
Striped bass					4	
Total		23	27	1	24	
Percidae						
Sauger	1		2			
Sciaenidae						
Freshwater drum	—	3	5	—	17	—
Total fish collected	15	84	142	65	166	73

[a]PCM = Poplar Creek Mile. Miles can be converted to kilometers by multiplying the given values by 1.609.

Source: J. M. Loar, J. A. Solomon, and G. F. Cada, *Technical Background Information for the ORNL Environment and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam*, ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1981, pp. 203-4, Table 1.6.5-5.

Table 9.1-4. Parameters in fish and other aquatic biota exceeding background concentrations, standards, criteria, and/or analytical detection limits

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals								
Mercury	East Fork Poplar Creek	Redbreast sunfish	.30	1.0[d]	23	1.2 *	0.24	3.3
		Largemouth bass			9	1.4 *	0.80	1.9
		White sucker			2	0.97 *	0.54	1.4
		Common carp			9	0.78 *	0.21	1.3
		Bluegill			17	0.76 *	0.20	1.2
		Rock bass			1	1.0 *	1.0	1.0
		Warmouth			1	0.96 *	0.96	0.96
		Yellow perch			1	0.93 *	0.93	0.93
		Black redhorse			1	0.57 *	0.57	0.57
		Green sunfish			1	0.52 *	0.52	0.52
		Frogs	*e*		11	1.4 *	<0.10	3.0
		Crayfish	*e*		7	0.81 *	0.24	1.7
		Snapping turtle	*e*		17	0.76 *	0.16	1.4
	Bear Creek	Bluegill			2	0.56 *	0.52	0.66
		Rock bass			11	0.31 *	0.17	0.50
		White sucker			4	0.38 *	0.24	0.49
		Northern hog sucker			2	0.31 *	0.25	0.37
	Poplar Creek	Smallmouth buffalo			2	0.93 *	0.13	1.7
		Sauger			2	0.83 *	0.37	1.3
		Largemouth bass			10	0.50 *	0.24	1.3
		Bluegill			13	0.37 *	0.18	0.82
		Carp			3	0.29	0.12	0.52
		Channel catfish			11	0.18	<0.10	0.42
	White Oak Creek	Largemouth bass			7	0.24	<0.10	0.57
		Bluegill			20	0.23	<0.10	0.56
	Clinch River (Watts Bar)	Smallmouth buffalo			10	0.49 *	<0.10	1.2
		Largemouth bass			40	0.24	<0.10	0.58
		Carp			2	0.34 *	0.21	0.47
		Bluegill			42	0.15	<0.10	0.40

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
	Clinch River (Melton Hill)	Largemouth bass			36	0.14	<0.10	0.44
Cadmium	East Fork Poplar Creek	Bluegill	0.040		17	0.014	<0.0020	0.15
		Crayfish	*e*		7	0.78 *	0.0040	1.7
		Frogs	*e*		11	0.19 *	0.044	0.50
	Bear Creek	White sucker			4	0.026	0.010	0.060
		Crayfish			1	1.5 *	1.5	1.5
		Green frog			1	0.17 *	0.17	0.17
	Clinch River (Melton Hill)	Largemouth bass			36	0.013	<0.0020	0.14
		Bluegill			30	0.013	<0.0020	0.060
	Tennessee River	Bluegill			20	0.0089	<0.0020	0.060
Arsenic	East Fork Poplar Creek	Redbreast sunfish	0.10		23	0.036	<0.020	0.13
		Crayfish	*e*		6	0.16 *	<0.020	0.40
	Bear Creek	Rock bass			10	0.24 *	<0.10	0.50
		Northern hog sucker			3	0.17 *	<0.10	0.20
		Crayfish			1	0.20 *	0.20	0.20
	Poplar Creek	Striped bass			2	0.40 *	0.20	0.60
		Largemouth bass			10	0.23 *	<0.10	0.40
		White bass			1	0.30 *	0.30	0.30
		Hybrid bass			1	0.30 *	0.30	0.30
		Carp			3	0.17 *	<0.10	0.30
		Smallmouth buffalo			7	0.13 *	<0.10	0.30
		Channel catfish			11	0.14 *	<0.10	0.20
		Bluegill			13	0.12 *	<0.10	0.20

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
	White Oak Creek	Largemouth bass			7	0.24 *	<0.10	0.40
		Hybrid bass			1	0.30 *	0.30	0.30
		Channel catfish			9	0.26 *	0.20	0.30
		Black bullhead			2	0.20 *	0.20	0.20
		Striped bass			4	0.15 *	<0.10	0.20
		Bluegill			20	0.11 *	<0.10	0.20
		Yellow bass			7	0.11 *	<0.10	0.20
	Clinch River (Watts Bar)	Bluegill			42	0.13 *	<0.10	0.40
		Largemouth bass			40	0.13 *	<0.10	0.40
		Smallmouth buffalo			10	0.12 *	<0.10	0.30
	Clinch River (Melton Hill)	Channel catfish			21	0.11 *	<0.10	0.30
	Tennessee River	Largemouth bass			20	0.13 *	<0.10	0.30
Silver	East Fork Poplar Creek	Bluegill	0.20		17	0.29 *	<0.20	0.50
		Green sunfish			1	0.50 *	0.50	0.50
		Largemouth bass			9	0.21 *	<0.20	0.30
		Redbreast sunfish			23	0.21 *	<0.20	0.30
		Crayfish	*e*		7	0.31 *	<0.20	0.60
		Snapping turtle	*e*		17	0.24 *	<0.20	0.30
	Poplar Creek	Channel catfish			11	0.24 *	<0.20	0.60
	White Oak Creek	Channel catfish			9	0.26 *	<0.20	0.50
		Black bullhead			2	0.30 *	<0.20	0.40
	Clinch River (Melton Hill)	Bluegill			30	0.32 *	<0.20	2.0

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
Chromium	East Fork Poplar Creek	Bluegill	0.10		15	0.083	<0.020	0.29
		Green sunfish			1	0.19 *	0.19	0.19
		Largemouth bass			9	0.043	<0.020	0.13
		Carp			6	0.043	<0.020	0.12
		Frogs	*e*		11	1.0 *	0.21	2.3
		Crayfish	*e*		7	0.060*	0.050	1.5
		Snapping turtle	*e*		16	0.053	0.020	0.15
	Bear Creek	Rock bass			10	0.19 *	0.0080	0.54
		Northern hog sucker			5	0.17 *	<0.020	0.48
		Redbreast sunfish			2	0.17 *	0.080	0.26
		Crayfish	*e*		1	0.34 *	0.34	0.34
		Green frog	*e*		1	0.32 *	0.32	0.32
	Poplar Creek	Rock bass			1	1.0 *	1.0	1.00
		Hybrid bass			1	0.59 *	0.59	0.59
		Smallmouth buffalo			7	0.31 *	0.020	0.54
		Channel catfish			11	0.085	<0.020	0.29
		Striped bass			2	0.16 *	0.13	0.18
		Largemouth bass			10	0.041	<0.020	0.16
		Bluegill			13	0.057	<0.020	0.15
		Carp			3	0.077	<0.020	0.11
	White Oak Creek	Bluegill			20	0.044	<0.020	0.36
		Channel catfish			9	0.087	<0.020	0.35
		Largemouth bass			7	0.043	<0.020	0.14
		Yellow bass			7	0.044	<0.020	0.12
	Clinch River (Watts Bar)	Largemouth bass			40	0.092	<0.020	0.82
		Bluegill			42	0.047	<0.020	0.57
		Carp			2	0.16 *	0.12	0.22
		Smallmouth buffalo			10	0.040	<0.020	0.14
	Clinch River (Melton Hill)	Channel catfish			21	0.091	<0.020	0.36
		Bluegill			30	0.069	0.030	0.17

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
	Tennessee River	Largemouth bass			20	0.15 *	<0.020	0.98
		Paddlefish			1	0.64 *	0.64	0.64
		Bluegill			20	0.064	<0.020	0.38
Copper	East Fork Poplar Creek	Bluegill	0.90		5	0.86	0.32	2.0
		Carp			9	0.73	0.22	2.0
	Bear Creek	Northern hog sucker			2	1.2 *	1.1	1.3
	Poplar Creek	Channel catfish			11	0.74	<0.10	4.1
		Carp			3	1.4 *	1.1	1.6
	White Oak Creek	Channel catfish			9	1.9 *	0.14	10
	Clinch River (Melton Hill)	Channel catfish			21	0.58	<0.10	1.8
Selenium	East Fork Poplar Creek	Carp	0.80		9	0.56	0.17	0.86
	Clinch River (Watts Bar)	Carp			2	1.8 *	1.0	2.6
	Clinch River (Melton Hill)	Bluegill			1	1.0 *	1.0	1.0
Beryllium	Poplar Creek	Channel catfish	0.020		11	0.022	<0.020	0.040
	White Oak Creek	Black bullhead			2	0.030	0.020*	0.040
	Clinch River (Melton Hill)	Channel catfish			21	0.026	<0.020	0.060

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
Thallium	East Fork Poplar Creek	Carp	1.0		9	1.2 *	<1.0	2.8
	Clinch River (Melton Hill)	Yellow bullhead			1	3.8 *	3.8	3.8
		Channel catfish			21	1.1 *	<1.0	3.0?
Priority pollutant organics[f]								
Total polychlorinated biphenals (PCBs)	East Fork Poplar Creek	Carp	0.10	2.0[d]	3	2.9 *	2.0	3.7
		Largemouth bass			3	0.52 *	<0.10	0.92
		Channel catfish			1	0.60 *	0.60	0.60
	Poplar Creek	Channel catfish			11	1.0 *	<0.10	3.4
	White Oak Creek	Channel catfish			9	3.2	2.2	5.6
		Carp			12	0.32 *	<0.10	1.0
	Clinch River (Watts Bar)	Channel catfish			33	0.68 *	<0.10	2.1
	Emory River	Channel catfish			11	0.71 *	<0.10	1.6
	Clinch River (Melton Hill)	Channel catfish			13	0.45 *	<0.10	4.7
	Tennessee River	Channel catfish			21	0.49 *	<0.10	1.4
Di-n-butyl phthalate	Clinch River (Melton Hill)	Yellow bullhead	g		1	1.3 *	1.3	1.3
Bis(2-ethyl hexyl) phthalate	East Fork Poplar Creek	Largemouth bass	g		4	0.89 *	0.67	1.2
Chloroform	White Oak Creek	Channel catfish	g		9	<0.050*	<0.050	0.021

Table 9.1-4. (Continued)

Parameter (mg/kg)	Stream	Species	Approximate upper limit of background concentrations[a]	Applicable standards or criteria	Observations	Observed concentrations Mean[b]	Minimum[c]	Maximum
Metals (continued)								
Radioisotopes								
Cesium-137	East Fork Poplar Creek	Largemouth bass	0.2	8.0[h]	1	2.6 *	2.6	2.6
		Spotted sucker			1	2.2 *	2.2	2.2
		Channel catfish			1	1.7 *	1.7	1.7
		Bluegill			1	1.0 *	1.0	1.0
	White Oak Creek	Bluegill			2	14.0 *	1.1	26
		Smallmouth buffalo			1	9.7 *	9.7	9.7
		Carp			2	6.7 *	5.7	7.7
		Channel catfish			1	7.3 *	7.3	7.3
		Largemouth bass			1	7.1 *	7.1	7.1
		Striped bass			1	2.6 *	2.6	2.6
	Clinch River (Watts Bar)	Largemouth bass			3	6.5 *	0.60	18

[a]Background concentrations were obtained from various sources as given in Appendix IV of source document, and do not reflect differences among species. The upper limits were applied to all species. Relevant elevated levels are best identified by comparing mean concentrations with the upper limit.

[b]For calculation of mean concentrations (or activities), less than detection limit values were assumed to equal the detection limit.

[c]Contaminant concentrations below the analytical detection limit are preceded by "<". Mean concentrations exceeding the upper limit are denoted with an asterisk (*).

[d]U.S. Food and Drug Administration action level.

[e]Comparative data were not available for nonfish aquatic biots. In the absence of these data, parameters were listed when concentrations exceeded background concentrations for fish.

[f]Seven additional priority pollutant organic compounds were identified and reported at concentrations above the detection limit (Appendix IV of source document). Exact identification of these compounds is uncertain, however, primarily because of the presence of PCBs. The values are denoted with an "R" in Appendix II in the source document, indicating possible influence by other compounds.

[g]Background concentrations not available.

[h]Reporting levels suggested by the Nuclear Regulatory Commission for radioactivity in fish samples from the vicinity of nuclear power plants, as outlined in draft NUREC-0472, Rev. 3, Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors.

Source: TVA (Tennessee Valley Authority), *Instream Contaminant Study—Task 5, Summary Report,* Office of Natural Resources and Economic Development, 1986.

9.1.2 Wetlands

The only wetland areas in the immediate vicinity of the proposed site, as identified from the U.S. Fish and Wildlife Service National Wetlands Inventory Map (FWS 1983), are palustrine, open-water areas that are permanently flooded as the result of man-made impoundments.

Along the Clinch River and Poplar Creek are several shallow open-water wetland areas adjacent to the river channel or as sloughs off the main channel. The lower section of East Fork Poplar Creek is a broad riverine wetland area characterized as a broad, meandering channel with a mud bottom. Upstream of this area, the wetland is a forested area that may be temporarily flooded in response to rainfall runoff. There are no identified natural wetland areas along Mitchell Branch within ORGDP.

9.1.3 Threatened and Endangered Species

Prior to impoundment, the Clinch River and its tributaries contained several endemic species. These organisms are now largely confined to the unaltered regions of the river above Norris Reservoir, where approximately 30 endemic mollusk species have been found. Table 9.1-5 inventories the threatened and endangered species that could occur within an 8-km (5-mile) radius of ORGDP. The locations of these species are shown in Fig. 8.1-2. The U.S. Fish and Wildlife Service (FWS) did not identify any threatened or endangered species within this area (see Appendix I: Bay 1989). The Tennessee Heritage Program identified the fine-rayed pigtoe mollusk, Alabama lamp mollusk, and spiny riversnail as occurring within a 8-km (5-mile) radius (see Appendix I: Bunting 1989).

Both the shiny pigtoe and fine-rayed pigtoe mollusks were listed as occurring in Poplar Creek and the Alabama lamp mollusk in the Little Emory River. These occurrences are listed in historical records dating from 1918; no specimens have been collected in these areas in recent years. The spiny riversnail records date from the 1950s; no specimens of this species have been collected in recent years (see Appendix I: Tolbert 1990a). The pink mucket mollusk has been collected from the Clinch River during isolated surveys in recent years. The mountain redbelly dace is found in tributaries to the Clinch River within the 8-km (5-mile) radius (see Appendix I: Tolbert 1990a).

9.2 PADUCAH

9.2.1 Biota

The fish, benthic invertebrate, and periphyton communities were described for the Ohio River, Big Bayou Creek, and Little Bayou Creek by Battelle Columbus Laboratories in 1977 and 1979. The data from the 1979 study (Eischen 1979) are summarized here and in Appendix G.2. Studies by Birge, Black, and Short (1988) show continued reduced density and diversity of macroinvertebrates downstream of effluent discharged from PGDP to Big Bayou Creek. These studies also show substantial recovery of fish populations in both Big and Little Bayou creeks since the 1978 studies (Birge, Black, and Short 1988, pp. 1–2).

The Ohio River receives industrial and municipal discharges from several large cities along its course in addition to draining agricultural lands in several states. Several smaller municipalities and industries discharge to the river in the PGDP vicinity (see Sect. 5.2).

Table 9.1-5. Aquatic species monitored by the Tennessee Natural Heritage Program that could occur within 8 km (5 miles) of the Oak Ridge Gaseous Diffusion Plant facilities[a]

Species	State status	Federal status
Invertebrates		
Shiny pigtoe mollusk	Endangered	
Fine-rayed pigtoe mollusk	Endangered	Endangered
Alabama lamp mollusk	Endangered	Endangered
Pink mucket mollusk	Endangered	
Spiny riversnail		Endangered
Vertebrates		
Mountain redbelly dace	Deemed in need of management	No legal status

Source: Tennessee Department of Conservation, Natural Heritage Program (see Appendix I: Bunting 1989).

Species found in the river are those generally associated with high inorganic nutrient concentrations and eutrophication, which are characteristic of effluent discharges. Monitoring conducted at the PGDP site in 1982 (DOE 1982, p. 3-22) indicated no benthic organisms in the Ohio River either upstream or downstream of the confluence of Big Bayou and Little Bayou creeks with the river. Sampled substrates were either too firmly compacted or contained too much sand to provide suitable benthic habitat.

Samples collected from Big Bayou Creek upstream of the PGDP discharges showed a generally diverse periphyton community with species characteristic of oxygen-rich waters. Downstream of the discharge, *Nitzschia palea* was the dominant species collected; this species is tolerant of a wide range of ecological conditions and indicates of pollution (Eischen 1979, p. 10) (Table G.2-1). Below the sewage treatment facility outfall, the algal community was dominated by species that are tolerant of high biochemical oxygen demand (BOD) areas (DOE 1982, p. 3-22). The number of species, area of standing crop, and diversity decreased with distance downstream in Big Bayou Creek (see Fig. G.2-1 in Appendix G for sampling site locations).

Monitoring of Big Bayou Creek in 1982 showed numerous fish and benthic insect species upstream of the PGDP sewage treatment plant outfall. Twelve fish species including both forage and sport were found upstream of the plant outfalls. Benthic populations including mayflies, dragonflies, damselflies, and dipteran and caddisfly larvae, which are characteristic of clean water streams, were also found upstream of the plant outfalls (DOE 1982, p. 3-22). In the 1979 study (Eischen 1979, p. 13), no benthic organisms were found immediately downstream of the discharge to Big Bayou Creek from the PGDP sewage treatment outfall (Table G.2-2 in Appendix G). Species diversity of benthic organisms at sites above the PGDP outfalls and ~3 km (~1.9 miles) downstream (Site 5) was indicative of water of intermediate quality (Eischen 1979, p. 13). Downstream of the PGDP sewage outfall, the populations and species of both fish and insects were reduced in 1982 (DOE 1982, p. 3-22). Big Bayou Creek samples taken in 1987 and 1988 showed that the sampling sites within the vicinity of the PGDP outfalls to the creek experienced at least a 71% reduction in mean density and at least a 25% reduction in mean number of macroinvertebrate taxa compared to the up- and downstream sampling sites (Birge, Black, and Short 1988, p. 33).

Bluegill, green sunfish, and creek chub were the most abundant species collected in Big Bayou Creek upstream of the PGDP discharges (Table G.2-3). Bluegill, bluntnose minnow, and creek chub were the most abundant species collected below PGDP ash pond discharge. Gizzard shad and longear sunfish were the most abundant species collected below the PGDP at Site 5 (see Fig. G.2-1 in Appendix G). Additional species collected at this site on Big Bayou Creek were the golden shiner, blackstripe topminnow, and largemouth bass (Eischen 1979, p. 17).

Just above the confluence of Big Bayou and Little Bayou creeks, fish and benthic communities showed signs of recovery. Both sport and forage fish were found as well as benthic communities characteristic of intermediate water quality. Algal communities also were indicative of intermediate water quality. Water quality and available habitat in Big Bayou Creek were suitable for spawning by several species of fish (DOE 1982, p. 3-22; Eischen 1979, p. 24; Birge, Black, and Short 1988, p. 36).

The portion of Little Bayou Creek upstream of the PGDP outfalls supports species that are indicative of systems with intermittent flow. The composition of the periphyton community in Little Bayou Creek was indicative of generally good water quality (Table G.2-4 in Appendix G). Species diversity and standing crop decreased downstream

of the PGDP discharge, although the number of species remained fairly constant (Table G.2-4 in Appendix G) (Eischen 1979, p. 20). Birge, Black, and Short (1988, p. 35) reported similar results.

During the 1979 survey, Eischen (1979) found the diversity of benthic species to be indicative of polluted water. Dipteran larvae, primarily chironomids, were the predominant individuals collected both upstream and downstream of the PGDP discharge (Eischen 1979, p. 24). In 1987–88, nematodes were the most abundant taxa found in the upper reaches of Little Bayou Creek downstream of outfalls 012, 011, and 010, while aquatic insects were more abundant downstream (Birge, Black, and Short 1988, p. 35). The most abundant fish species in Little Bayou Creek were golden shiner, redfin shiner, creek chub, and green sunfish (Table G.2-3 in Appendix G).

In studies in Little Bayou Creek, 24 benthic species including dipteran larve, fingernail clams, aquatic earthworms, amphipods, crayfish, dragonflies, damselflies, mayflies, and caddisflies were found at the upstream site (DOE 1982, p. 3-21). Five fish species including the swamp darter were also found at the site (DOE 1982, p. 3-21).

9.2.2 Wetlands

Information on wetlands in the PGDP vicinity is summarized from U.S. Fish and Wildlife Service National Wetlands Inventory Maps for the site vicinity (FWS 1988, quads Paducah SE and Joppa Ill-Ky).

No wetland areas occur on the PGDP site. However, permanently flooded excavated pits are scattered throughout the site that would provide limited aquatic habitat. Scattered riverine wetland areas with unconsolidated bottoms also exist along both Big and Little Bayou creeks. Depending upon the nature of the bottom material, these areas could provide good aquatic habitat. If composed of fine particulate material, the habitat could be generally poor for benthic species.

In the vicinity of the Ohio River, the wetland areas are generally characterized as palustrine areas with emergent vegetation. These areas are usually temporarily flooded; consequently, they provide habitat for only those aquatic species that are able to colonize ephemeral habitats. Adjacent to the Ohio River are temporarily flooded wetland areas that support broadleaf deciduous vegetation. Additional wetlands immediately adjacent to the river are created by dikes along the river; these wetlands tend to be seasonally flooded.

The Wetlands Inventory Maps (FWS 1988) indicate that the wetland areas downstream of the PGDP site along Big and Little Bayou creeks are typical of wetland areas along the Ohio River in the vicinity of other tributaries to the river.

9.2.3 Threatened and Endangered Species

Two endangered mollusk species, pink mucket and orange-footed pimpleback, that occur in the Ohio River in the site vicinity are federally listed (see Fig. 8.2-2). Two candidate aquatic species, the rabbitsfoot mollusk and blue sucker, also occur in the vicinity. Table 9.2-1 lists the state and federally listed species that can occur within an 8-km (5-mile) radius of the site. The listed aquatic species occur in the Ohio River in the site vicinity. No listed or proposed species occur in either Big or Little Bayou creek (Hannan 1989).

Table 9.2-1. Aquatic species monitored by the Kentucky Academy of Science, Kentucky State Nature Preserves Commission that could occur within 8 km (5 miles) of the Paducah Gaseous Diffusion Plant vicinity

Species	State status	Federal status
Invertebrates		
Pink mucket mollusk	Endangered	Endangered
Packetbook mollusk	Endangered	
Orange-footed pimpleback mollusk	Endangered	Endangered
Bullhead mollusk		Special concern
Rabbitsfoot mollusk	Endangered	Candidate
Crayfish	Endangered	
Vertebrates		
Blue sucker		Candidate
Lake chubsucker	Threatened	
Chain pickerel	Special concern	
Cyprus minnow	Threatened	
Chestnut lamprey	Special concern	
Black buffalo	Special concern	
Alligator gar	Threatened	
Spotted sunfish	Threatened	
Taillight shiner	Threatened	
Northern madtom	Special concern	

9.3 PORTSMOUTH

9.3.1 Biota

Aquatic systems in the vicinity of PORTS are the Scioto River, Big Beaver Creek, Little Beaver Creek, Big Run Creek, and an unnamed tributary of the Scioto River. The abundance, distribution, variety and species composition of three groups of organisms—algae, macroinvertebrates, and fishes—were investigated because of their importance to the aquatic ecosystem. These systems were studied from May 1975 to February 1976 to describe the existing biological conditions in the streams receiving effluents from the PORTS facility. Sampling locations are shown in Fig. 9.3-1. Descriptions of the sampling sites are contained in Appendix G, Table G.3-1.

9.3.1.1 Little Beaver Creek

The portion of Little Beaver Creek upstream of the plant effluent outfall is characteristic of a fairly unpolluted stream with a diverse, stable ecosystem (ERDA 1977, p. 3-21). Downstream seasonal collections of periphyton consistently showed adverse effects from the PORTS effluent discharge. Dramatic decreases in standing crop and numbers of species with accompanying changes in species composition occurred immediately below the outfall at sampling station 2 (see Fig. 9.3-1). Recovery of both numbers of individuals and species occurred at station 3, downstream of the discharge from the PORTS; however, the species present were more pollution-tolerant species with one or two predominant species (ERDA 1977, Vol. 2, Appendix B, pp. B-142 through B-146, Tables B.57 through B.60).

Upstream of the effluent discharge, the invertebrate community of Little Beaver Creek was characterized by a diverse community of macroinvertebrates typical of southern Ohio streams that may experience intermittent flow during the summer months. The predominant species at the upstream site were those that are indicative of good water quality: stoneflies, mayflies, gastropods, and fly larvae. Downstream of the PORTS effluent, pollution-tolerant species such as oligochaetes and chironomid larvae were the predominant species; numbers of both individuals and species were reduced compared to those of the upstream site (ERDA 1977, Vol. 2, Appendix B, pp. B-110 through B-113, Tables B.35 through 38).

Above the PORTS effluent discharge, five species of fish (creek chub, redbelly dace, bluntnose minnow, stoneroller minnow, and orangethroat darter) were common, and a total of 12 species were collected (Table G.3-2 in Appendix G) (ERDA 1977, Vol. 2, Appendix B., p. B-178, Table B.82). Immediately downstream of the effluent discharge only seven species were collected; of these species, only the stoneroller minnow was abundant. Further downstream, the number of species increased to 18; the fish community was dominated by the stoneroller minnow and striped shiner. Creek chubs and bluntnose minnows were the only other species ever collected in any abundance at this site; all other species were rarely collected.

9.3.1.2 Big Beaver Creek

Large increases in the populations of pollution-indicating species of periphyton occurred immediately below the discharge of Little Beaver Creek into Big Beaver Creek during spring and summer surveys in 1975 and 1976. No clearcut differences occurred in

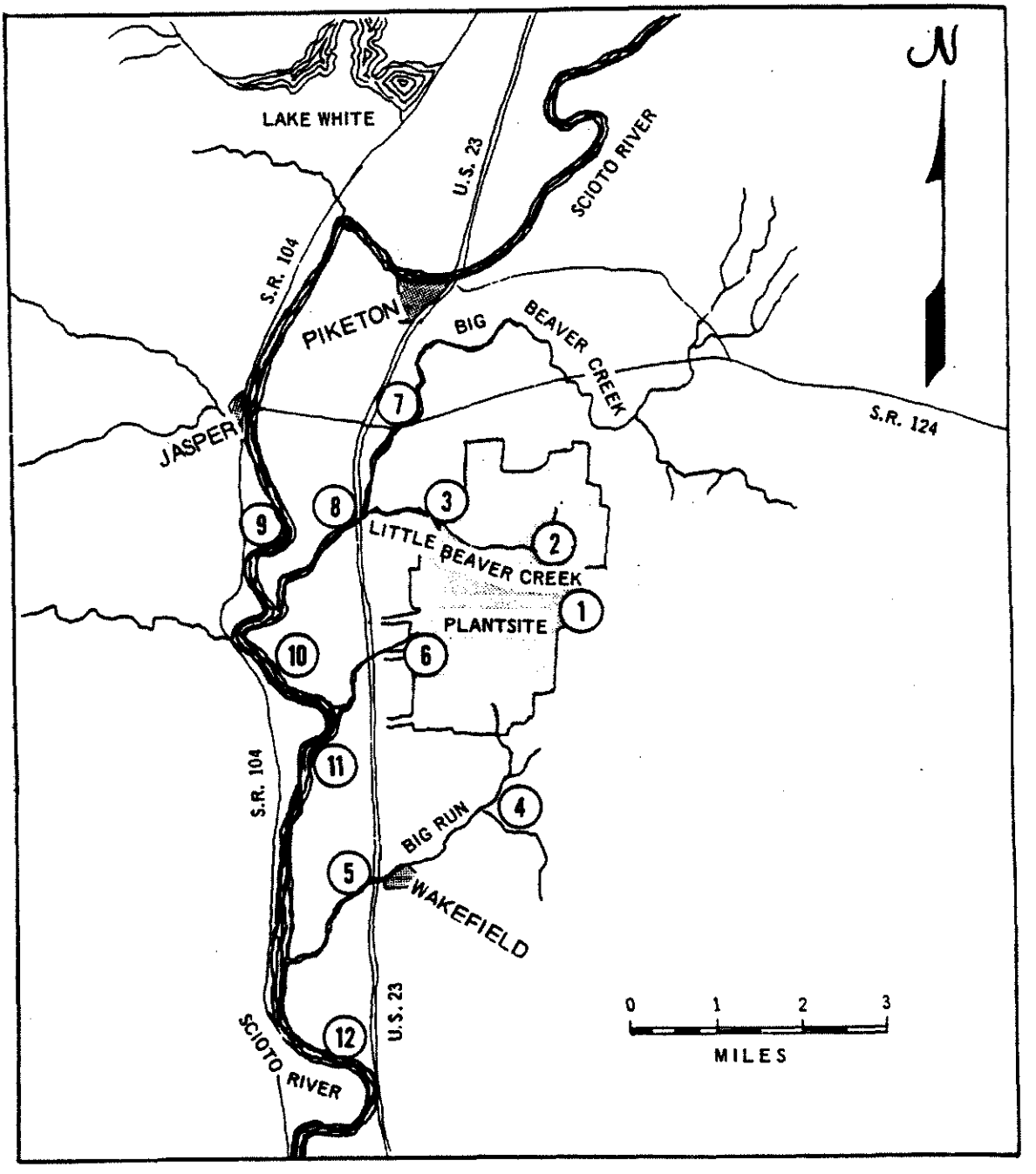

Fig. 9.3-1. Locations of aquatic sampling stations in the vicinity of the Portsmouth Gaseous Diffusion Plant. *Source:* U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, ERDA-1555, May 1977, App. B, Fig. B.17, p. B-94.

the standing crop of periphyton between the upstream and downstream sites on Big Beaver Creek. Downstream of Little Beaver Creek inflow, increases in periphyton standing crop were indicative of enrichment from that source (ERDA 1977, Vol. 2, Appendix B, Tables B.69 through 72).

Comparison of benthic macroinvertebrate populations in Big Beaver Creek upstream and downstream of the mouth of Little Beaver Creek show that no major differences occurred between the two sites. However, generally, fewer species and individuals appeared downstream of the confluence of Little Beaver Creek. Fewer species were collected from the natural stream sediments than from the artificial substrate samplers. The difference in the number of taxa was attributed to high turbidity, sedimentation, and suspended sediment scour, which created an inhospitable natural environment (ERDA, Vol. 2, Appendix B, pp. B-123 through B-130 and B.78 through B.81, Table B.43 through B.48 and B.78 through B.81).

A total of 37 species of fish was recorded from Big Beaver Creek, with similar numbers of species being collected from both sampling sites. The most abundant forage fishes in this stream were gizzard shad, emerald shiner, bluntnose minnow, and stoneroller minnow (Table G.3-3 in Appendix G) (ERDA 1977, Vol. 2, Appendix B, p. 182, Table B.84). The presence of a large number of species including clean water species such as suckers and darters indicates that the water quality in the stream is good. Two specimens of the state-listed endangered gravel chub, *Hybopsis x-punctata*, were collected from Big Beaver Creek downstream of the confluence of Little Beaver Creek.

9.3.1.3 Big Run Creek

Periphyton standing crops in Big Run Creek were consistently greater at the downstream station than at the upstream station. The 1975–76 survey concluded that the upstream station probably received organic enrichment from the facility, domestic waste, or pasture runoff upstream (ERDA 1977, Vol. 2, Appendix B, p. B-147 through B-150, Tables B.61 through B.64).

The 1975–76 benthic invertebrate sampling of Big Run Creek showed that, in the spring, the upstream site had a greater diversity of species and more individuals present than the downstream site. With increased summer temperature, the impoundment upstream of the upper site contributed to degradation of temperature, dissolved oxygen, and other water quality parameters and reductions in both numbers and types of species. Consequently, the numbers and kinds of species present at the upstream site decreased to the point that the population was dominated by chironomids and oligochaetes, which occurred in large numbers. Overall, the macroinvertebrate community at the downstream station was the most abundant and diverse of any stream sampled in the Portsmouth area and was considered to be indicative of good water quality (ERDA 1977, Vol. 2, Appendix B, pp. B-114 through B-118, Tables B.39 through B.41).

A total of 19 species of fish was collected at the downstream station compared with 6 at the upstream site. As with the macroinvertebrates, the fish population at the upstream site may have been adversely affected by water quality. The more common species at the upstream site—redbelly dace, stoneroller minnow, and orangethroat darter—are typical of small streams. Stoneroller minnows and barred fantail darters were the most common species collected at the downstream site. Although rare, carp, golden redhorse suckers, largemouth bass, bluegill, green sunfish, and longear sunfish were also collected at the downstream site. Rosefin shiner, silverjaw minnow, johnny darter, and orangethroat darter

were occasionally collected at this site. The habitat at this site was typical of larger streams with deep pools that could support a diverse fish fauna (Table G.3-4 in Appendix G) (ERDA 1977, Appendix B, p. B-180, Table B.83).

9.3.1.4 Unnamed tributary

The periphyton fauna of this tributary was similar in numbers, composition, and seasonal response to that of the upstream station on Little Beaver Creek. For both streams, the greatest periphyton densities occurred during the spring sampling period (ERDA 1977, Appendix B, p. B-142 through B-146 and B-151 through B-154, Tables B.57 through 60 and B.65 through 68).

Comparison of Tables B.78 through 81 (ERDA 1977, Appendix B, p. B-167 through B-176) shows that the habitats and macroinvertebrate communities of the unnamed tributary and Little Beaver Creek are very similar and exhibit similar seasonal responses. The seasonal distribution and abundance of the invertebrate community appears to respond to changes in temperature and water quality, as shown by decreased numbers in the summer when a thick algal mat was present.

Only three species—creek chub, redbelly dace, and stoneroller minnow—were collected from the unnamed tributary during 1975–76. These species, which are typical of small streams, were also most abundant at the upper site on Little Beaver Creek (ERDA, Vol. 2, Appendix B, pp. B-179 through B-181).

9.3.1.5 Scioto River

The standing crop and number of species of periphyton in the Scioto River were reduced downstream of the PORTS facility effluent outfall. The species composition upstream of the outfall was characteristic of a clean water system; while downstream of the plant outfall, the upstream species disappeared and the periphyton community comprised pollution-tolerant species (ERDA 1977, Vol.2, Appendix B, pp. B-160 through B-165, Tables B.73 through 76).

Overall, the numbers, types, and densities of macroinvertebrate species in the Scioto River were indicative of good water quality both upstream and downstream of the discharge of Big and Little Beaver creeks to the river. During the 1975–76 sampling period, a variety of mayfly, stonefly, caddisfly, true fly, and beetle species, which are characteristic of clean water, were collected (ERDA 1977, Vol. 2, Appendix B, pp. B-169 through B-176, Tables B.79 through 81).

Thirty-seven species of fish, including fourteen sport fish, were collected from the Scioto River during the 1975–76 sampling period. No appreciable differences were reported in the numbers of species or individuals below the confluence of Big and Little Beaver creeks with the Scioto River. Gizzard shad and emerald shiners were the most abundant species collected. Spotted bass and sunfish were the most abundant sport fish collected from the river (Table G.3-5 in Appendix G) (ERDA 1977, Vol. 2, Appendix B, pp. B-97 through B-109 and B-185, Tables B.31 through 34 and B.85).

9.3.2 Wetlands

A number of palustrine wetland areas occur along Little Beaver Creek that comprise shrub/scrub species as well as emergent vegetation. Temporarily flooded areas exist and,

during periods of low flow, may be exposed. A number of small wetland areas have been created as the result of excavation or impoundments. These areas are generally permanently flooded but may be intermittently exposed during dry periods (FWS 1983). Currently, no information is available on wetland areas along the Big Beaver Creek or the Scioto River.

9.3.3 Threatened and Endangered Species

The Ohio Natural Heritage Program lists eight mollusk species and four vertebrate species in the Scioto River within the 8-km (5-mile) radius of the PORTS facilities that are of state concern (Table 9.3-1). According to the Ohio Natural Heritage Program and FWS (FWS 1989), no federally listed threatened or endangered aquatic species occur within this radius.

Table 9.3-1. Aquatic species monitored by the Ohio Natural Heritage Program that could occur within 8 km (5 miles) of the Portsmouth facilities

Species	Status	
	State[a]	DNAP[b]
Invertebrates		
Ebony shell mollusk		Endangered
Yellow sand shell mollusk		Endangered
Bullhead mollusk	Endangered	
Fragile heel-splitter	Endangered	
Fawn's-foot mollusk		Potentially endangered
Three-horned wartyback mollusk		Threatened
Deer-toe mollusk		Threatened
Bur-head mollusk		Endangered
Vertebrates		
River redhorse sucker		Special concern
Shortnose gar		Special concern
Goldeye		Special concern
Silver lamprey	Endangered	

[a]Status assigned by the Division of Wildlife; legal state status.
[b]Status assigned by the Division of Natural Areas and Preserves; no legal state status.

9.4 REFERENCES

9.4.1 Oak Ridge

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site,* DOE/EA-0106, December.

Exxon Nuclear Co. 1976. *Nuclear Fuel Recovery and Recycling Center Environmental Report,* Docket 50564, Richland, Wash.

FWS (U.S. Fish and Wildlife Service) 1983. *Draft National Wetlands Inventory Maps.*

Loar, J. M., Solomon, J. A., and Cada, G. F. 1981. *Technical Background Information for the ORNL Environmental and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 198 pp.

Loar, J. M., et al. 1981. *Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant,* ORNL/TM-6714, prepared by Oak Ridge National Laboratory, Oak Ridge, Tenn., for the U.S. Department of Energy, 328 pp.

PMC, TVA, ERDA (Project Management Corporation, Tennessee Valley Authority, and Energy Research and Development Administration) 1977. *Final Environmental Statements Related to the Construction and Operation of the Clinch River Breeder Reactor Plant,* NUREG-0139.

Smith, J. G., et al. 1988. *First Annual Report on the ORGDP Biological Monitoring and Abatement Program,* draft, prepared by Oak Ridge National Laboratory, Oak Ridge, Tenn., for the U.S. Department of Energy, 125 pp. + appendices.

TVA (Tennessee Valley Authority) 1985. *Instream Contaminant Study—Task 2: Sediment Characterization,* Part 2, Vol. 1, Office of Natural Resources and Economic Development, 82 pp.

TVA (Tennessee Valley Authority) 1986. *Instream Contaminant Study—Task 5, Summary Report,* Office of Natural Resources and Economic Development, 232 pp.

9.4.2 Paducah

Birge, W. J., Black, J. A., and Short, T. M. 1988. *Biological Monitoring Program for the Paducah Gaseous Diffusion Plant,* University of Kentucky for Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, Tenn., 116 pp.

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site,* DOE/EA-0155, August.

Eischen, M. A. 1979. *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio.

FWS (U.S. Fish and Wildlife Service) 1988. *National Wetlands Inventory Maps.*

9.4.3 Portsmouth

ERDA (U.S. Energy Research and Development Administration) 1977a. *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 1, ERDA-1555, May.

ERDA (U.S. Energy Research and Development Administration) 1977b. *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site*, Vol. 2, ERDA-1555, May.

10. SOCIOECONOMICS

10.1 OAK RIDGE

10.1.1 Population

The proposed site is located in Roane County and is within the boundaries of the city of Oak Ridge, Tennessee. Oak Ridge straddles Roane and Anderson counties; adjacent counties include Knox, Loudon, and Morgan. The two largest cities in the area are Oak Ridge (population 26,920) and Knoxville (population 173,210); the latter is in Knox County, ~30 km east of the proposed site (USBC 1988b). Nearby cities are Oliver Springs, ~13 km north; Kingston, 14 km southwest; Harriman, 15 km west; Lenoir City, 18 km south; Farragut, 22 km southeast; and Clinton, 27 km northeast (see Table 10.1-1 for populations). Small communities closest to the site include the unincorporated Dyllis, ~3 km northwest; and Jonesville, ~6 km north. A map showing the five-county region and the cities within is provided in Fig. 10.1-1.

Anderson, Knox, Loudon, Morgan, and Roane counties, in general, experienced considerable growth in the 1970s, ranging between 11.7 and 24.6% (see Table 10.1-1). Growth rates slowed substantially between 1980 and 1986, when the average five-county growth rate was 3%. Historical population growth characteristics of the area and the large incorporated areas within each county are presented in Table 10.1-1.

The relatively slow growth rates experienced during the first half of the 1980s are expected to increase between 1986 and 2000. The fastest increase in population is expected in Morgan County, where the largest city, Wartburg, has a population of only 940. The population is projected to increase by 22% over the 20-year period between 1980 and 2000. (Note, however, that estimates by the U.S. Bureau of the Census and the Tennessee State Center for Health Statistics are considerably discrepant.) The population of Anderson County, where most of the city of Oak Ridge lies, is expected to increase only 10% between 1980 and 2000. All other counties are projected to experience growth rates in the 10–22% range. Table 10.1-2 presents population projections through 2000 for the five-county area.

10.1.2 Housing

The five-county area surrounding the Oak Ridge site has ~2430 vacant multifamily units, primarily apartments but also some duplexes; and 3940 vacant single-family units, including houses and mobile homes. The average vacancy rate of apartments in the area is 6.4% (ETDD 1989; LPAO 1988), while the vacancy rate for houses in the Knoxville Standard Metropolitan Statistical Area (SMSA) is 2.2% (FHLBB 1985). A description of the method used to determine the following vacancy estimates is included in Appendix H.

Anderson County has ~620 vacant apartments, with an overall vacancy rate of 16.1%. Efficiency units have 10% vacancy, while one-bedroom apartments have 16.7% vacancy. Two- and three-bedroom apartments also are available. The average rent for an apartment is $296 per month, while efficiencies average $281 and one-bedroom apartments average $235. In Anderson County, ~615 houses and mobile homes are for sale.

Table 10.1-1. Historical population growth characteristics for counties and principal cities in the Oak Ridge area

County City	1970 population	1980 population	1970–1980 change (%)	1986 population estimates	1980–1986% change (%)
Anderson	60,300	67,346	11.7	68,800	2.2
Oak Ridge[a]	28,319	27,662	–2.3	26,920	–2.7
Clinton	4,794	7,790	62.5	8,420	8.0
Oliver Springs[b]	3,405	3,659	7.5	3,920	7.1
Knox	276,293	319,694	16.0	329,500	3.1
Knoxville	174,587	175,045	0.2	173,210	–1.0
Farragut	*c*	6,279	*c*	7,820	24.5
Loudon	24,266	28,553	26.0	30,500	6.8
Lenoir City	5,324	5,505	9.5	5,830	5.9
Morgan	13,619	16,604	22.0	16,800	1.1
Wartburg	*c*	761	*c*	940	22.9
Roane	38,881	48,425	25.0	49,400	2.1
Harriman	8,734	8,303	–5.0	8,360	0.7
Kingston	4,142	4,441		4,660	4.8

[a]Includes the population of Oak Ridge located in Roane County.
[b]Includes those portions of Oliver Springs located in Roane and Morgan Counties.
[c]Not incorporated during this period of time.

Sources: U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988; U.S. Bureau of the Census, "Characteristics of the Population: Part 44, Tennessee," in *Census of Population: 1970*, Vol 1, 1973.

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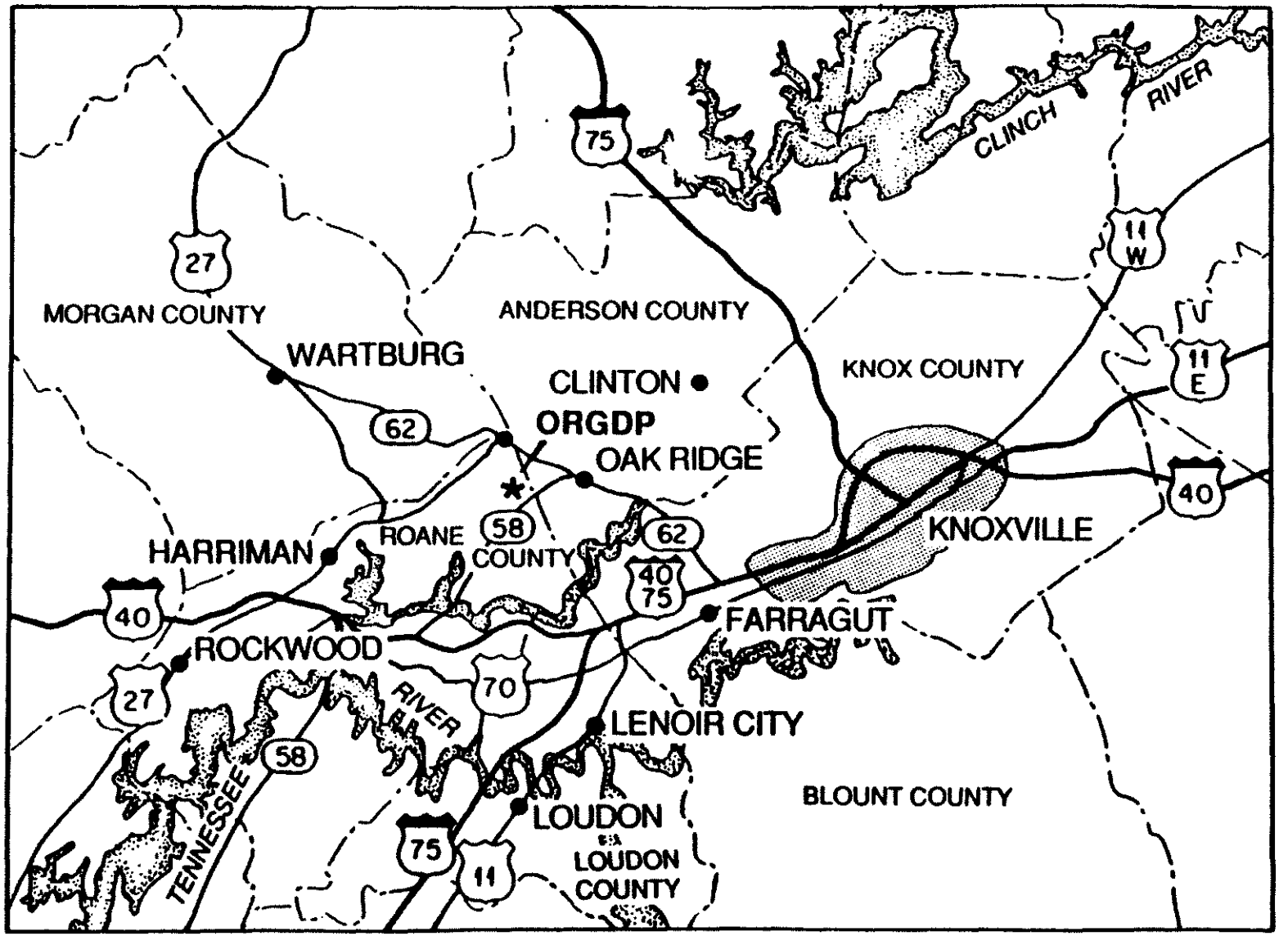

Fig. 10.1-1. Map showing the five-county region and the cities in and near the immediate impact region.

Table 10.1-2. Population estimates and projections for counties in the Oak Ridge area

County	1980[a]	1986[a]	1990[b]	2000[b]	1980–1990 change (%)	1990–2000 change (%)
Anderson	67,346	68,800	71,872	74,852	6.7	4.1
Knox	319,694	329,500	343,645	363,539	7.5	5.8
Loudon	28,553	30,500	30,573	32,304	7.1	5.7
Morgan	16,604	16,800	18,487	20,520	11.3	11.0
Roane	48,425	49,400	53,572	58,793	10.6	9.7

[a]*Source:* U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988.

[b]*Source:* Tennessee State Center for Health Statistics, *Population Estimates for the State of Tennessee*, Tennessee Department of Health and Environment, Nashville, 1986.

Knox County has the largest number of apartments but the lowest vacancy rate. Nonetheless, ~1500 apartments are vacant in Knox County. The overall vacancy rate is 4.8%; efficiency vacancy rate is 6.6%; and one-bedroom vacancy rate is 5.0%. Two- and three-bedroom apartments are also available in Knox County. The average rent for an apartment is $356. The rent for an efficiency apartment averages $250 per month, while a one-bedroom apartment rents for an average of $298. In Knox County, ~1465 houses and mobile homes are for sale.

Loudon County has only 125 vacant apartments. The overall vacancy rate is 10%. However, the vacancy rate for a one-bedroom apartment is 22.2%, despite the fact that only 16% of all apartments in Loudon County have one bedroom, and few or no efficiencies are available. The average rent is the lowest in the area at $187 per month. Loudon County has ~270 houses and mobile homes for sale.

Apartment vacancy information is not available for Morgan County. Slightly more than 250 units exist, all of which were constructed prior to 1980. Morgan County has ~150 houses and mobile homes available.

In Roane County, ~190 apartments are available, with an overall vacancy rate of 10%. Although few or no efficiency apartments exist, the vacancy rate for one-bedroom apartments is 13.2%. Two-bedroom apartments are also available in Roane County, with an average monthly rent of $230. In addition to apartments, >430 houses and mobile homes are available.

In the five-county area, >7400 hotel and motel rooms are available; >6000 are in Knoxville. Anderson County and Roane County each has ~680 rooms, and Morgan County has only 31 (TDECD 1989a,b,c,d,e,f,g). No information on hotel and motel rooms is available for Loudon County.

Appendix H includes Oak Ridge area housing information from the 1980 census.

10.1.3 Public Services

10.1.3.1 Public education

The Oak Ridge City School System includes four elementary schools, two junior high schools, and one high school. The student/teacher ratio is 22:1 for the elementary schools and 21:1 for the junior high schools and high school. Three rehabilitation centers are located in Oak Ridge (TDECD 1989g).

Clinton, in Anderson County, has a city/county school system, with three elementary schools, one junior high school, and one high school, with a total enrollment of 3078. The student/teacher ratio ranges are 17:1 at the elementary schools, 30:1 at the junior high school, and 22:1 at the high school (TDECD 1989f).

The Morgan County school system has a total of 3370 students in their two elementary schools, one high school, and three kindergarten through grade 12 (K–12) schools (see Appendix I: Skilis 1989).

Before 1987, Knox County supported two school systems—one for the county and a separate one for the city of Knoxville. On July 1, 1987, the two school systems merged to form a single county-wide system (KKCMPC 1988). The Knox County School System, with 90 schools and 50,367 students, is divided into eight districts. The largest, District Eight, includes 33% of the total enrollment in the Knoxville County School System with 12 elementary schools, 4 middle schools, and 4 high schools (KKCMPC 1988).

Data for Roane and Loudon counties were requested but have not been received.

10.1.3.2 Water

The city of Oak Ridge, in Anderson County, has a water system capacity of 1.23 to 1.31 m^3/s (28 to 30 Mgd). Usage in the city is ~0.26 m^3/s (~6 Mgd), and the DOE plants use between 0.35 and 0.39 m^3/s (8 and 9 Mgd), leaving an available capacity of between 0.53 and 0.66 m^3/s (12 and 15 Mgd) (ORCP 1988). The city of Clinton, also in Anderson County, has a capacity of 0.07 m^3/s (1.5 Mgd) and a current consumption of 0.04 m^3/s (0.90 Mgd) (TDECD 1989f).

Kingston, in Roane County, has a capacity of ~0.09 m^3/s (~2.0 Mgd), with current consumption of 0.015 m^3/s (0.35 Mgd) (TDECD 1989e). The town of Harriman, also in Roane County, has a capacity of 0.15 m^3/s (3.5 Mgd) and a current consumption reading of 0.06 to 0.07 m^3/s (1.4 to 1.7 Mgd) (TDECD 1989a). The Rockwood community has a treated water capacity of 0.26 m^3/s (6.0 Mgd) and an average daily consumption of 0.06 m^3/s (1.3 Mgd) (TDECD 1989b).

Knoxville, located in Knox County, has a treated water capacity of 2.19 m^3/s (50 Mgd) and a consumption of 1.4 m^3/s (32 Mgd) (TDECD 1989c).

Wartburg, located in Morgan County, has a water capacity of 0.015 m^3/s (0.35 Mgd) and a current consumption of 0.02 m^3/s (0.41 Mgd), indicating current overuse of the water system (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.3 Sewage treatment

Oak Ridge, in Anderson County, has a new sewage treatment facility, completed in 1983, with a 0.21-m^3/s (4.9-Mgd) nominal flow, a 0.35-m^3/s (8.0-Mgd) peak flow, and a 0.57-m^3/s (13.0-Mgd) short peak flow; an average of 0.18 m^3/s (4.1 Mgd) of sewage is treated. The treatment plant capacity is sufficient to provide for future development (ORCP 1988, p. 153). Clinton, also in Anderson County, has a sewage treatment capacity of 0.05 m^3/s (1.25 Mgd) and an average daily flow of 0.03 m^3/s (0.75 Mgd); primary treatment is used (TDECD 1989f).

Kingston, in Roane County, has a sewage treatment capacity of 0.022 m^3/s (0.51 Mgd) with current usage at 0.020 m^3/s (0.46 Mgd). Primary sewage treatment is used (TDECD 1989e). Harriman, in Roane County, has a capacity of 0.09 m^3/s (2.0 Mgd) and a flow rate of 0.035 to 0.039 m^3/s (0.8 to 0.9 Mgd) with primary treatment (TDECD 1989a). The Rockwood community has a sewage treatment capacity of 0.07 m^3/s (1.5 Mgd) and a flow rate of 0.06 m^3/s (1.3 Mgd). Primary and secondary treatment is used (TDECD 1989b).

Knoxville has a sewage treatment capacity of 3.5 m^3/s (80 Mgd) and a current usage of 1.6 m^3/s (37 Mgd). Advanced secondary-activated sludge treatment is used in the system (TDECD 1989c).

Wartburg, in Morgan County, has a sewage treatment capacity of 0.009 m^3/s (0.20 Mgd) and a current usage of 0.004 m^3/s (0.095 Mgd). Wet-season usage rises to 0.007–0.009 m^3/s (0.15–0.20 Mgd). Secondary treatment is used in the sewage system (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.4 Fire protection

The Anderson County Fire department is staffed with volunteer fire fighters. The Oak Ridge Fire Department employs 40 full-time personnel operating from three stations (ORCP 1988, p. 156). The Clinton City Fire Department has 15 full-time fire fighters and 40 volunteers (TDECD 1989f).

In Roane County, Kingston has 5 full-time fire fighters and 21 volunteers. The Harriman fire department employs 21 full-time fire fighters and has 12 volunteers on staff. The community of Rockwood has 13 full-time employees and 10 volunteers (TDECD 1989a,b,e).

The city of Knoxville, in Knox County, employs 330 full-time fire fighters and has 93 vehicles. The department has 19 manned and equipped fire stations located throughout the city (TDECD 1989c).

Wartburg, in Morgan County, has 20 volunteer fire fighters and no full-time employees (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.5 Police protection

The Anderson County Sheriff's Department and jail are located in Clinton. The jail, which can accommodate 60 inmates, has an average population of 34 inmates. The city of Clinton has 14 uniformed officers and 6 cruisers (TSPO 1982, pp. 97–98). The Oak Ridge City Police Department, also located in Anderson County, employs 47 uniformed police officers and 5 civilian emergency communications dispatchers and has 17 cars (see Appendix I: Braaten 1989).

Kingston, in Roane County, employs eight police officers and has seven cruisers. Harriman, located in Roane County, has 18 police officers and 5 cars. The Rockwood community has 14 police officers and 6 cars (TDECD 1989a,b,e).

In Knox County, the Knoxville Police Department has 278 police officers and 320 cars (TDECD 1989c).

Wartburg, in Morgan County, has two police officers and one car (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.6 Medical facilities

In general, Anderson County's health services are adequate to meet population demands. The late 1970s experienced considerable growth in the health care industry. Two hospitals are located in Anderson County; both are short-stay, general-care facilities (TSPO 1982, p. 125). Methodist Medical Center, in Oak Ridge, has 235 beds and 116 doctors. Oak Ridge also has one nursing home with 127 beds. The Clinton hospital, an affiliate of a larger Knoxville hospital, has 30 beds and 8 doctors. Clinton has one nursing home with 120 beds (TDECD 1989f,g).

Kingston, in Roane County, has two hospitals with a total of 206 available beds and 57 doctors; three nursing homes with a total of 440 beds are located in Kingston. The nearby community of Rockwood shares these facilities with Kingston. Harriman has 16 doctors, one hospital with 109 beds, and one nursing home with 170 beds (TDECD 1989a,b,e).

Knoxville, in Knox County, an important regional medical center, has 8 hospitals with 3197 beds, 12 nursing homes with 1200 beds, 2 community mental health centers, and a state mental health hospital. With ~725 doctors, the ratio of physicians and dentists per thousand population in Knox County is greater than the statewide ratio; the physician ratio is 1:638 (KKCMPC 1980a, p. 27).

Although Wartburg, in Morgan County, has no hospital, three doctors practice in the town, and a nursing home with 124 beds is located there (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.7 Recreation

The city of Oak Ridge owns and maintains 486 ha (>1200 acres) of recreation land. School playgrounds and athletic fields serve also as general recreational facilities. Most parks in the Oak Ridge area are primarily roadside or lakeside picnic areas; others provide wooded hiking trails, playgrounds (not including school playgrounds), and sports facilities (ball parks). Oak Ridge has a total of six parks, two golf courses, four softball fields, two baseball fields, and one soccer field. The Clinton area, in Anderson County, has four parks and two swimming pools (see Appendix I: Collins 1989).

In Roane County, Kingston and Rockwood have nine parks, four golf courses, and seven swimming pools. Harriman has two parks, one golf course, and two swimming pools. Facilities are avilable for boating, fishing, and hunting in the area (TDECD 1989a,b,e).

Knoxville, in Knox County, has 34 parks, 8 golf courses, and 8 swimming pools. Also in Knox County are 50 ballparks, 146 tennis courts, and >40 athletic and recreational centers (TDECD 1989c).

Wartburg, in Morgan County, has one park, a historic community (Rugby), and part of a national river and recreation area (TDECD 1989e).

Data for Loudon County were requested but have not been received.

10.1.3.8 Solid and hazardous waste facilities

In August 1982, the Anderson County Landfill had a life expectancy of one month. However, the county purchased additional property adjacent to the existing landfill. Engineering estimates are that the new landfill property has a life expectancy of 14 months. Operations are now under way to open the new landfill. Oak Ridge uses the Chestnut Ridge Landfill in Anderson County (TSPO 1982, p. 102).

Roane County has solid waste disposal facilities for Kingston, Harriman, and Rockwood (TDECD 1989a,b,e).

Knoxville, in Knox County, has a solid waste disposal plan (TDECD 1989c).

Wartburg, in Morgan County, uses a county landfill for their solid waste disposal (TDECD 1989d).

Data for Loudon County were requested but have not been received.

10.1.3.9 Emergency preparedness

ORGDP has an emergency preparedness coordinator on-site. A Comprehensive Emergency Management Plan covers all Martin Marietta Energy Systems, Inc., facilities in the state of Tennessee. ORGDP has a mutual aid agreement with other Martin Marietta Energy Systems, Inc., facilities in Tennessee including Oak Ridge and surrounding counties.

This mutual agreement is with rescue squads, fire departments, and sheriffs' departments. An emergency response plan is in place for on-site transportation accidents involving hazardous or radioactive materials (see Appendix I: Lasley 1990).

10.1.3.10 Transportation

The proposed site has good access to highway transportation (see Fig. 10.1-2). The ORGDP entrance accesses Tennessee State Route (SR) 58. Also, the plant can be directly accessed via SR 327 (Blair Road). A major east-west interstate highway, I-40, is ~10 km (~6 miles) southwest of ORGDP. A major north-south interstate highway, I-75, is within ~30 km (~19 miles). Southern Railway provides rail transportation for ORGDP. Inland water transportation including barge transport is available via the Clinch and Tennessee rivers. The nearest major commercial airport, McGhee Tyson, south of Knoxville, is ~60 km (~40 miles) from ORGDP.

Most traffic to and from ORGDP uses SR 58, which is oriented northeast-southwest through the DOE reservation along the southeast portion of the plant. SR 58 leads southwesterly from Oak Ridge, where it passes under I-40 and continues west and south before ending at SR 70 near Kingston, Tennessee. The ~8-km (~5-mile) Segment A of SR 58, leading northwesterly from the ORGDP entrance, is four lanes and narrows to two lanes on Segment B as SR 58 continues north to Oak Ridge. Southwest from the ORGDP entrance to I-40, Segment C of SR 58 is two lanes.

In 1989, the afternoon peak traffic occurred between 4 p.m. and 5 p.m. on Segment C of SR 58 (Table 10.1-3). During the afternoon peak, this segment of the highway operated at Level of Service (LOS) D, which approaches unstable traffic flow with time delays up to 75%. Segment B also experienced LOS D during the afternoon peak, between 5 p.m. and 6 p.m. Both segments, B and C, operated at LOS D also during the morning peak.

At LOS D, speeds up to 80 km/h (50 mph) can be attained under ideal weather conditions. For both segments (B and C) of SR 58, the 1989 peak hourly volume of traffic was about 200 vehicles per hour below the capacity of LOS E. Highways at LOS E have time delays > 75% with speeds < 80 km/h (< 50 mph), and passing is virtually possible. The capacity of Segment B is somewhat higher than that of Segment C because of wider shoulders and more balanced directional flow.

Segment A of SR 58 is rated LOS A during the peak morning and afternoon periods, which indicates free flow of traffic with no delays.

10.1.4 Land Use

The single largest land use in the five-county area surrounding the Oak Ridge site is commercial forestry, and the second most common use is agriculture. Knox County leads the five counties in the percentage of developed land, while Morgan County ranks last in this category.

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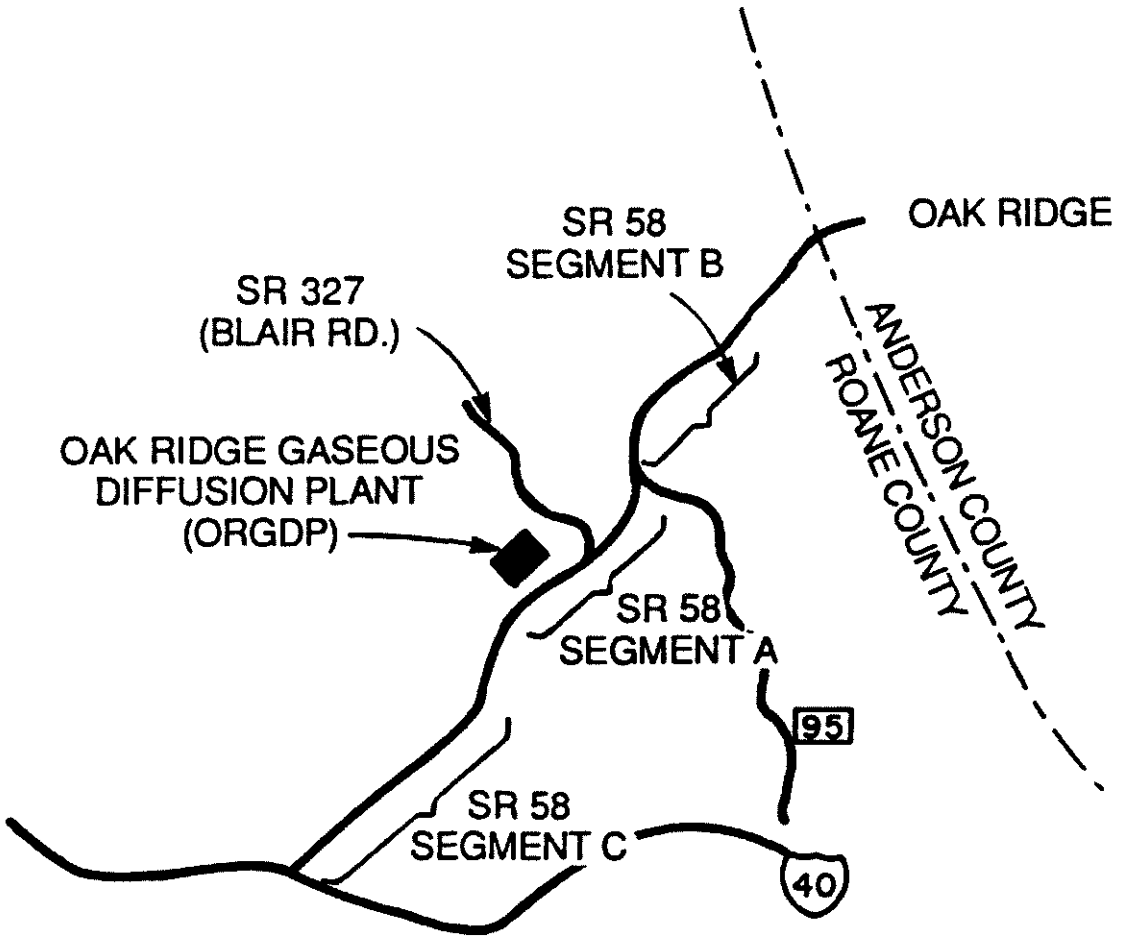

Fig. 10.1-2. Roads with potential traffic increase in vicinity of proposed site.

Table 10.1-3. Traffic counts on segments of State Route 58 near the Oak Ridge Gaseous Diffusion Plant

Segment	Adjusted 24-h total	Morning peak	Afternoon peak
C (2 lanes)	8,900	946	1,033
B (2 lanes)	9,630	1,215	1,336
A (4 lanes)	11,600	1,806	1,869

Source: B. McLean, Tennessee Department of Transportation, personal communication with J. W. Van Dyke, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 21, 1989. (Personal communications are included in Appendix I: Van Dyke 1989f.)

The predominant land use in Anderson County is commercial forestry; forests occupy 54,300 ha (134,200 acres), or 61.5%, of the area (CBER 1989). Another 16,400 ha (40,500 acres), or 18.6%, are devoted to agricultural use (USBC 1989). In Anderson County, 2,530 ha (6,250 acres) acres are used for residential purposes. Public and semipublic uses (e.g., schools, churches, and firehalls) account for 132 ha (325 acres). Commercial usage occupies <72 ha (<178 acres), while mining accounts for >20 ha (>50 acres). Transportation uses (i.e., roads and railroads) occupy slightly under 1,100 ha (2,700 acres). Industrial usage in unincorporated portions of Anderson County is only 13.6 ha (33.5 acres) (TSPO 1982). (This breakdown excludes the incorporated cities of Oak Ridge, Clinton, Norris, and Lake City because land use information is unavailable.) Development of the privately owned portions of these cities is, however, primarily residential (ORCP 1988). In Oak Ridge, 14,437 ha (35,675 acres), or 62%, is controlled by DOE (ORCP 1988). Of this area, 40% is located within Anderson County, while the remaining 60% is in Roane County. The University of Tennessee and TVA each controls ~910 ha (~2,250 acres) within the city limits of Oak Ridge (ORCP 1988). Most of the urban portion of Oak Ridge is in Anderson County.

Commercial forests occupy less land in Knox County than in Anderson but are still the largest single land use, occupying 30.2% of the area, or 41,280 ha (102,000 acres) (CBER 1989). Agricultural use ranks second at 28.0%, or 38,325 ha (94,700 acres) (USBC 1989). In this area, >29,550 ha (>73,000 acres), or 21.6%, of the land is used for residential purposes. Commercial usage of 2,113 ha (5,221 acres) exceeds the 1,352 ha (3,342 acres), or 1.0%, devoted to industrial use. Public and semipublic use accounts for 2,285 ha (5,650 acres), or 1.7%, of the area. The large number of waterways in Knox County occupy 4,369 ha (10,795 acres), a full 3.2% of the area. In this area, 11.6%, or <15,780 ha (<39,000 acres), is termed "vacant" and includes those areas of the county in which development or use is precluded because of the physical constraints of the land (KKCMPC 1980b).

Like Anderson and Knox counties, Roane County has more land devoted to commercial forestry than to any other use (CBER 1989). Forestry and agricultural use combined account for over 82% of the total area of Roane County. Forest land occupies 60%, or 60,700 ha (150,000 acres), while agriculture occupies 22.5%, or 22,660 ha (56,000 acres) of the area (USBC 1989). A breakdown of other land uses is not available for most of Roane County (LPAO 1987a).

Loudon County devotes 31,430 ha (77,665 acres), or 48.7% of its area, to agricultural use and 22,340 ha (55,200 acres), or 34.0% of its area, to commercial forestry (USBC 1989; CBER 1989). Further breakdown of land use is available for only the county's two largest cities, Loudon and Lenoir City (LPAO 1987b). These two cities encompass ~2,833 ha (~7,000 acres) of the county. Developed areas of the cities are predominantly residential and account for >486 ha (>1,200 acres). Commercial land usage in Lenoir City is 63 ha (156 acres), more than twice the 30 ha (74 acres) of commercial land in Loudon. Public and semipublic use of 191 ha (472 acres) in Lenoir City also exceeds the 51 ha (126 acres) of public and semipublic usage in Loudon. These two cities devote a total of 162 ha (400 acres) to industrial use and >255 ha (>630 acres) to transportation. Lenoir City and Loudon have ~486 and ~1012 ha (~1200 and ~2500 acres) of undeveloped land respectively (LPAO 1987b).

Although it encompasses 139,617 ha (345,000 acres), making it the largest of the five counties, Morgan County has the smallest population (16,800) and the least developed land (USBC 1989). Of this area, 78%, or 10,927 ha (27,000 acres), is used for commercial

forestry (CBER 1989). Another 13% of the county, or 17,806 ha (44,000 acres), is used for agriculture (USBC 1989). The remaining 12,545 ha (31,000 acres) is either developed or undevelopable. However, a breakdown of developed land usage in Morgan County is unavailable.

10.1.5 Economic Structure

ORGDP is located in Roane County, within the city of Oak Ridge. The ORGDP uranium enrichment operations were placed on standby status in 1985 and shut down in 1987. The work force at the facility was about 4000 before it was scaled back in 1984. In November 1989, the work force at the plant site was about 3000, although most of the work force is not related to functions of the enrichment facility.

The five-county assessment region (see Sect. 2) is dominated by the city of Knoxville and Knox County. The per capita income in the region (see Table 10.1-4) is below the national average but higher than that of the state of Tennessee. Morgan County has characteristics significantly different from those of the rest of the region, with much higher unemployment and lower per capita income. In the 1980 census, about one in four (26%) of the residents of Morgan County had incomes below the poverty level, compared with ~15% in the region. Per capita income in the region is expected to increase at an annual rate of 1.5% between 1990 and 2000, which is about the same as projected for the United States (OBES 1989).

In 1983, manufacturing accounted for 29.4% of regional earnings, government accounted for 20.3%, and services accounted for 18.4% (Table 10.1-5). Manufacturing is projected to continue to be the largest source of regional earnings; it is projected to account for 26.6% of earnings in 2000. Services are projected to increase to 23.4% of regional earnings by 2000.

Table 10.1-6 indicates the per capita level of county government revenue and taxes. The primary source of property tax is residential and farm property (see Table 10.1-7). The value of DOE's industrial operations in Anderson and Roane counties is currently not taxable.

10.1.6 Cultural, Historical, and Archaeological Resources

Numerous sites of cultural, historical, and archaeological interest are within the five-county area (Anderson, Roane, Knox, Loudon, and Morgan) surrounding ORGDP. *National Register of Historic Places* lists >80 designated sites (see Appendix H for the list provided by the Tennessee Historical Commission). The site that is in closest proximity to ORGDP is the graphite reactor at Oak Ridge National Laboratory, located ~7 km (4 miles) east of the gaseous diffusion plant (DOE 1979).

In addition to the sites listed in the *National Register of Historic Places*, many other sites of historic and archaeologic interest are located in the five-county area. Hundreds of historic sites on the Oak Ridge Reservation were surveyed by Fiedler, Ahler, and Barrington (1977). Although about half of the sites had no physical remains, about one-quarter were foundation remains, 46 were partially standing structures, and 41 were standing structures. One structure was recommended for nomination to the National Register and three were recommended for on-site preservation (Fiedler, Ahler, and Barrington 1977).

Table 10.1-4. Employment and income for counties in the Oak Ridge area

County	1989 labor force	Unemployment (%)	1987 per capita income ($)
Anderson	33,200	4.5	13,105
Knox	164,700	4.2	14,292
Loudon	14,930	4.2	10,958
Morgan	6,180	9.5	8,342
Roane	26,720	6.4	12,086
Region	245,730	4.6	13,499
Tennessee	2,385,400	4.8	12,878
United States	126,238,000	5.3	15,484

Sources: Labor Force Estimates Summary, State of Tennessee, Department of Employment Security, July 1989 (preliminary); U.S. Bureau of Economic Analysis.

Table 10.1-5. Percentage of earnings by industry for five counties in the Oak Ridge area (%)

Year	Construction	Manufacturing	Trade	Services	Government	Other
1983	4.7	29.4	16.3	18.4	20.3	10.9
1990	5.2	28.6	15.7	20.6	18.8	11.1
1995	5.2	27.5	15.6	22.2	18.3	11.2
2000	5.1	26.6	15.6	23.4	17.9	11.3

Source: Economic Information Systems Forecast, *OBERS Projections*, on-line files, Construction Engineering Research Laboratory, U.S. Army Corp of Engineering, Champaign, Ill., 1989.

Table 10.1-6. Source of county government revenues in the Oak Ridge area ($)

County	Per capita local tax	Per capita property tax	Per capita general revenue	Per capita intergovernmental revenue
Anderson	264	221	670	310
Knox	364	237	850	320
Loudon	206	135	780	280
Morgan	158	125	650	380
Roane	196	118	620	270

Source: U.S. Bureau of the Census, *County and City Data Book, 1988,* 1988, pp. 469 and 482.

Table 10.1-7. Relative assessed value of taxable property in the Oak Ridge area

County	Per capita estimated 1986 property value ($)	Total assessed value (%)			
		Residential and farm	Industrial and commercial	Personal property	Public utilities
Anderson	20,209	60	27	6	7
Knox	24,397	50	38	6	6
Loudon	24,439	54	28	12	6
Morgan	14,626	65	6	6	23
Roane	18,147	71	15	5	9

Source: B. B. Vickers and M. A. Wood (eds.), *Tennessee Statistical Abstract 1989*, The University of Tennessee, College of Business Administration, Knoxville Center for Business and Economic Research, Knoxville, Tennessee, 1989.

Further, 45 prehistoric occupation sites are within the Oak Ridge Reservation, 12 of which are located in and around ORGDP (DOE 1979).

When the ORGDP site itself reaches 50 years of age, evaluation of its historic value will be required (see Appendix I: Wolfe 1990).

10.1.7 Social Structure

The following section briefly reviews the history of ORGDP and the relationship among the community, DOE, and the plant managers. A discussion of community response to other DOE proposals and private industries that handle hazardous material is included. A more detailed discussion of these topics is included in Appendix H.

On the 150-m^2 (58-$mile^2$) DOE Oak Ridge Reservation, located in Roane and Anderson counties, are three facilities originally constructed as part of the Manhattan Project: (1) Oak Ridge National Laboratory, a national research and development laboratory; (2) Y-12, a weapons production plant; and (3) Oak Ridge Gaseous Diffusion Plant (DOE 1984). Construction of ORGDP began in 1943, and the plant reached full-scale operation in August 1945 (DOE 1979). Four additional processing buildings were constructed between 1950 and 1954 and were on line by 1956 (DOE 1979; DOE 1984). Gas centrifuge and AVLIS development and testing also have been conducted at ORGDP (DOE 1984).

The Oak Ridge area has a long history of major federal presence, beginning with Tennessee Valley Authority Projects in the 1930s. The affiliation with the federal government strengthened when the city of Oak Ridge was created in secrecy for the Manhattan Project in the early 1940s. The city of Oak Ridge incorporated as a separate municipality in 1959 but remains strongly tied to the federal government because of its dependence on the 16,000 jobs provided at the DOE complex (ORCP 1988).

Other large industries in the Oak Ridge area include Boeing Engineering Company, Tennessee Valley Authority (TVA), the Technology Corridor, and Alcoa industries. The Technology Corridor stretches from Knoxville to Oak Ridge and includes many DOE spin-off industries. Recently, forty new companies have been spawned by the environmental cleanup and monitoring projects ongoing at the Oak Ridge DOE site (see Appendix I: Morrissey 1990h).

Following World War II, management of ORGDP first was conducted by Union Carbide Nuclear Division. Martin Marietta Energy Systems assumed management in 1984. Since Oak Ridge's inception, residents and local officials in Oak Ridge and nearby communities have been strongly supportive of DOE operations and predecessor agencies in the area, primarily because of its enormmous economic impact in terms of jobs (see Appendix I: Morrissey 1990a,e,i; Schexnayder 1990m). Public support is by far stronger in the city of Oak Ridge than in surrounding communities (see Appendix I: Morrissey 1990h).

The relationship between the communities and DOE is not without problems, however. Community officials said that DOE's tendency toward secretive operations lingered for years after the Manhattan Project and just recently began to change. The change is attributed to public demands for information and involvement in decison making (see Appendix I: Schexnayder 1990m; Morrissey 1990h). Nevertheless, unanswered questions remain concerning DOE's credibility and the information it provides, as evidenced by public responses to revelations during the 1980s about environmental pollutants (see Appendix I: Morrissey 1990a,c,e,f).

Despite such concerns, residents of Oak Ridge generally have responded positively to a number of proposed or currently operating facilities in the area. In contrast, citizens in the surrounding area have had mixed responses to such projects. For instance, the proposed Monitored Retrievable Storage (MRS) facility for high-level radioactive waste, while deemed acceptable within Oak Ridge, was actively opposed by a number of citizen groups and officials in the area outside the city (see Appendix I: Morrissey 1990a,h). Opposition was based on questions of need, concerns for health and safety, and concerns about DOE credibility (TDHE 1986). Some citizens in Roane County opposed the issuance of a Resource Conservation and Recovery Act (RCRA) permit to a privately operated mixed-waste-reprocessing facility. This facility, Diversified Scientific Services, Inc., is scheduled to begin operation soon. Several other facilities have been proposed or have begun operation amidst little or no controversy. These include the International Technology Corporation toxic waste incinerator at ORGDP and Scientific Ecology Group, Inc., low-level radioactive waste reprocessing facility and incinerator (*The Oak Ridger*, October 25, 1989, p.1).

10.2 PADUCAH

10.2.1 Population

The proposed site is located in McCracken County, ~20 km west-northwest of Paducah, Kentucky, the largest city in the area with 28,370 residents (USBC 1988a,b). Adjacent counties include Ballard, Carlisle, Graves, Marshall, and Massac (Illinois). Nearby cities include Metropolis (Illinois), ~10 km northwest of the site; Mayfield, 45 km south-southeast; and Benton, 50 km southeast. Other cities in the area are small, with populations averaging <1000. Communities closest to the site include the unincorporated towns of Grahamville, Heath, Kevil, Woodville, and Rossington, all within 5 km of the site. A map depicting this six-county region and the cities and towns within is included in Fig. 10.2-1.

All six counties experienced growth during the 1970s. The most significant growth occurred in Marshall County, where the population increased by 25% during this period. The slowest growth occurred in Carlisle County, where the population increased by only 2.5% during the 1970s. This pattern of growth ended, however, in the early 1980s. In all counties, with the exception of Marshall—where slow growth continues—the population began to decline. Historical population growth characteristics of the six-county area and the largest incorporated areas within each county are presented in Table 10.2-1.

The trends witnessed in the early 1980s are expected to continue through 2000. Marshall County is projected to continue slow growth, while all other counties in the area are expected to decline in population. Ballard and Carlisle counties are expected to lead this trend, with each projected to lose 9% of its population between 1980 and 2000. Table 10.2-2 presents population projections through 2000 for the six-county area.

ORNL-DWG 89-19791

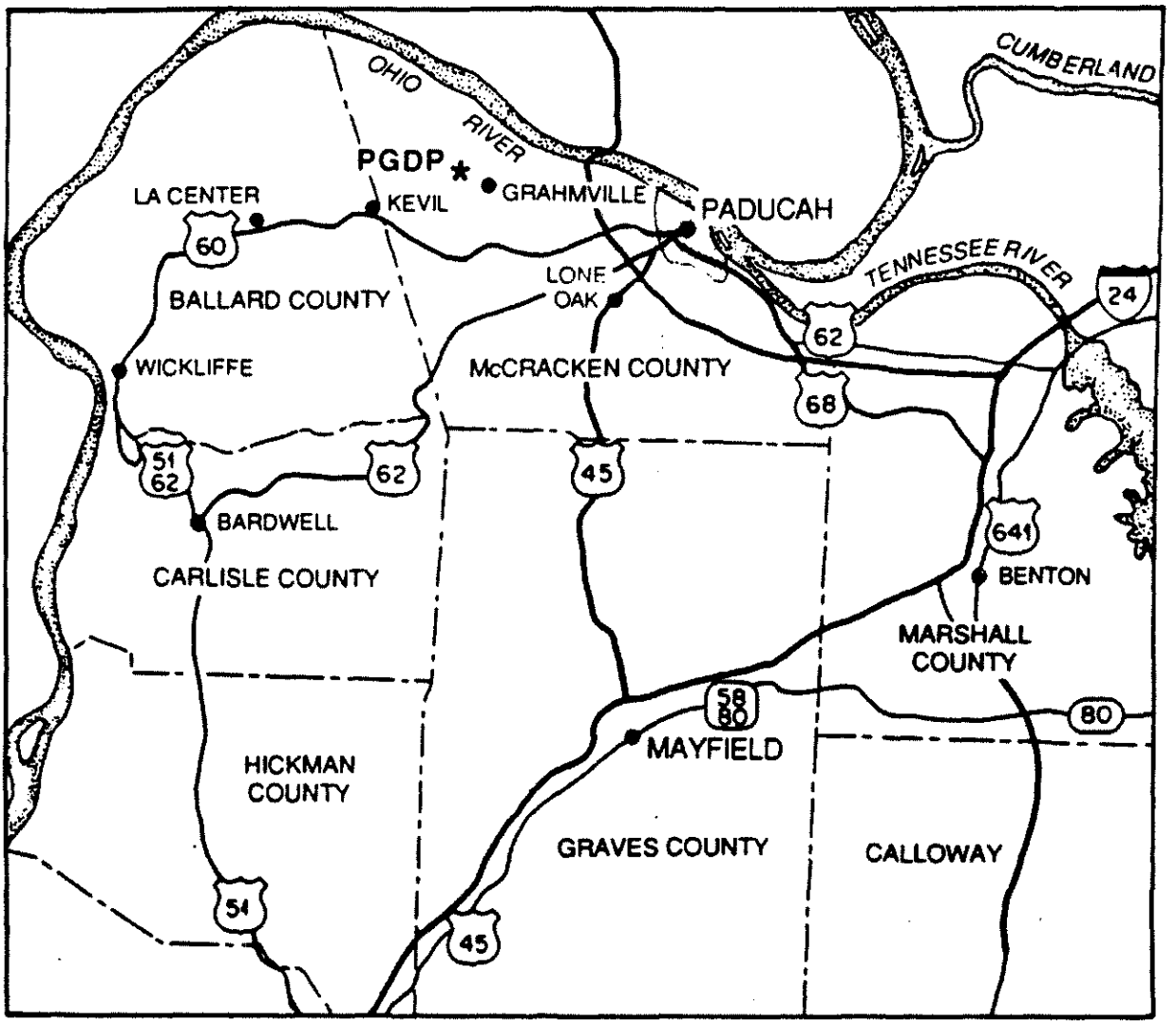

Fig. 10.2-1. Map showing the six-county region and the cities in and near the immediate impact region.

Table 10.2-1. Historical population growth characteristics for counties and principal cities in the Paducah area

County City	1970 population	1980 population	1970–1980 change (%)	1986 population	1980–1986 estimated change (%)
Ballard	8,276	8,798	6.3	8,100	–7.9
La Center	1,044	1,044	0	890	–14.7
Carlisle	5,354	5,487	2.5	5,000	–8.9
Bardwell	1,049	988	–11.3	930	–5.9
Graves	30,939	34,049	10.0	32,900	–3.4
Mayfield	10,724	10,705	0	9,900	–7.5
McCracken	58,281	61,310	5.2	60,300	–1.6
Paducah	34,479	29,315	–15.0	28,370	–3.2
Marshall	20,381	25,637	25.8	25,800	0.6
Benton	3,652	3,700	1.3	3,550	–4.0
Massac, Ill.	13,889	14,990	7.9	14,900	–0.6
Metropolis	6,940	7,171	3.3	6,970	–2.8

Sources: U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988; U.S. Bureau of the Census, "Characteristics of the Population: Part 15, Illinois, and 19, Kentucky," in *Census of Population: 1970*, Vol. 1, 1973.

Table 10.2-2. Population estimates and projections for counties in the Paducah area

County	1980[a]	1986[a]	1990[b]	2000[b]	1980–1990 change (%)	1990–2000 change (%)
Ballard	8,798	8,100	8,216	8,016	–6.6	–2.4
Carlisle	5,487	5,000	5,030	4,993	–8.3	-0.7
Graves	34,049	32,900	32,754	32,353	–3.8	–1.2
McCracken	61,310	60,300	60,132	59,090	–1.9	–1.7
Marshall	25,637	25,800	26,682	27,304	4.1	2.3
Massac, Ill.[c]	14,990	14,900	NA	NA	NA	NA

[a]*Source:* U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988.

[b]*Source:* C. M. Strauss (ed.), *1988 Kentucky Statistical Abstract*, University of Kentucky, Center for Business and Economic Research, Lexington, 1988; *Illinois Property Tax Statistics 1986*, Illinois Department of Revenue, Springfield, Ill., 1988.

[c]NA = Not available.

10.2.2 Housing

In the five Kentucky counties neighboring the Paducah site, ~300 rental units are vacant, and >1000 housing units are for sale (PADD 1990). Vacancy rates of both for-sale and for-rent units in the area are ~2.5% (PADD 1990). The procedure used to derived the following vacancy estimates is discussed in Appendix H.

Of the five Kentucky counties, McCracken County, in which the proposed site is located, has the greatest number of vacant rental units and houses for sale, with 110 vacant rental units and 600 housing units for sale. The vacancy rates for rental units and for-sale housing units are 1.5 and 3.3% respectively. In all other counties, the vacancy rate of rental units is higher than that of for-sale housing units. McCracken County has 60 recreation vehicles (RV) and trailer hookups, 50–60% of which are currently vacant.

In Ballard County, 35 of the 531 rental units are vacant. This 6.6% vacancy is the highest rate for rental units in the five-county area. In Ballard County, 62 houses are for sale and 10 trailer pads are vacant. The trailer pads are used primarily during goose-hunting season, which begins in February.

Carlisle has fewer housing units and fewer vacancies than the other four counties in the area. Only 22 rental units are vacant and 41 houses are for sale. The respective vacancy rates for rental units and for-sale units are 6.4% and 2.3%. No trailer pads are located in Carlisle County.

In Graves County, 65 rental units are vacant, making the vacancy rate 2.4%. Also, 2.3%, or 240, of the total number of owner-occupied housing units are for sale. The 10 RV/trailer hookups in Graves County currently vacant are used with greater frequency during spring and summer months.

Marshall County has the lowest vacancy rate, 1.3% or 110, of housing units for sale. Of the 1140 rental units in Marshall County, ~60 are currently vacant. Because of its proximity to Kentucky Lake, a popular recreational area, Marshall County has many RV/trailer hookup areas. Of the 1050 trailer pads in Marshall County, ~90–95% remain vacant between October and February. During peak fishing months, March through September, only 10% of the hookups may be vacant.

Housing vacancy information for Massac County, Illinois, is available from only the 1980 Census. This information is presented in Appendix H.

The five Kentucky counties neighboring the Paducah site have >2800 hotel and motel rooms, with >2600 in McCracken and Marshall counties. Carlisle County has no hotel rooms. Occupancy rates are extremely high in Marshall County during summer tourist months. The rates, ranging from $20 to $45, average ~ $30.

10.2.3 Public Services

10.2.3.1 Public education

The McCracken County School System had a 1988 total enrollment of 6665 students. Of this total, 3377 were in grades K–6; 1186 in junior high school; and 2102 in high school. Three nonpublic schools have a total of 715 students in grades K–12. A student-to-teacher ratio of 22:1 exists in the county system. The annual education expenditure ~ $1950 per student (KDED 1988, p. 29).

The city of Paducah's public elementary and secondary education is provided by the independent Paducah School System (located in McCracken County), which consists of five

elementary schools and three parochial schools. The system currently has 1724 students enrolled in grades K–6, 888 in junior high school, and 1067 in high school. Paducah annually spends roughly $2390 per student on education. The education system has a current student-to-teacher ratio of 19:1 (KDED 1988).

Higher education is available locally in McCracken County from Paducah Community College, an affiliate of the University of Kentucky Community College System. The school offers courses leading to associate degrees in applied science, arts, and science. Student enrollment in the college was 2005 in 1986 (KDED 1988, p. 30).

The Graves County School System has 2691 students in grades K–6, no middle school, and 1319 in high school. Roughly $1065 per student is spent on education annually. The school system is accredited by the Southern Association of Colleges and Schools (KDC 1980, p. 28).

The Mayfield Independent School System, in Graves County, has a total 4010 student enrollment, with 990 pupils in grades K–6, 344 in junior high school, and 745 in high school. The education expenditure ~ $915 per student annually (KDC 1980, p. 28).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.2 Water supply

The city of Paducah, in McCracken County, recently completed a 0.53-m^3/d (12-Mgd) water treatment plant. The current peak demand is ~0.44-m^3/d (~10 Mgd), giving the plant a 20% excess capacity for future growth. The average daily consumption in Paducah is ~0.38-m^3/d (~6.3 Mgd) (Talbert 1988, p. 76).

The city of Mayfield, in Graves County, has a water treatment capacity of 0.14-m^3/d (3.1-Mgd) and an average daily consumption of 0.06-m^3/d (1.43 Mgd). The peak daily consumption is 0.07-m^3/d (1.6 Mgd), well below the capacity level (KDC 1980, p. 20).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.3 Sewage treatment

The city of Paducah, in McCracken County, is undergoing an extensive plant upgrade and expansion to modernize the facility to meet all expected future state and federal effluent standards. Currently, the city has a 0.39-m^3/d (9-Mgd) plant with an average daily use of 0.32 m^3/d (7.5 Mgd). The plant has ~15% excess capacity future demand. Primary and secondary treatment is used (Talbert 1988, p. 76).

The city of Mayfield, in Graves County, has a sewage treatment capacity of 0.10 m^3/d (2.3 Mgd) and an average daily usage of 0.07 m^3/d (1.6 Mgd). Primary and secondary treatment is used (KDC 1980, p. 22).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.4 Fire protection

The city of Paducah, in McCracken County, has 91 full-time fire fighters on staff. The county has no full-time employees and is staffed by 129 volunteers. The city of Paducah uses a figure of 2.10 fire fighters per 1000 population as a gauge for planning

future fire protection needs. Projections show that by 1990, with an estimated population of 29,234, 61 fire fighters would be needed. That number is substantially exceeded by the current staff of 91 full-time fire fighters (Talbert 1988, p. 109).

The city of Mayfield, in Graves County, has 40 full-time fire fighters and 20 combination fire and rescue volunteers (KDC 1980, p. 26).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.5 Police protection

The city of Paducah Police Department, in McCracken County, has a staff of 65 with 22 patrol cars. The McCracken County Police Department has 19 full-time and three part-time patrol officers and 10 cruisers (KDED 1988, p, 28).

The city of Mayfield, in Graves County, has 18 law enforcement officers and five patrol cars. The Graves County Police Department has seven full-time and five part-time officers with nine patrol cars (KDC 1980, p. 26).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.6 Medical facilities

Paducah serves as the regional medical center for much of the Jackson Purchase Area of Western Kentucky, a large portion of Southern Illinois and Western Tennessee. The medical industry in Paducah is represented by two major hospitals that provide >750 beds, ~300 doctors, 470 registered nurses, and 270 licensed practical nurses. Other facilities in Cracken County include an 80-bed substance abuse center and a mental health center (Talbert 1988, p. 7).

The city of Mayfield, in Graves County, has one hospital with 116 beds and 26 physicians. Also located in Mayfield are three clinics and one mental health center (KDC 1980, p. 32).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.7 Recreation

The following data on recreation are from KDC (1980), KDED (1988), and (see Appendix I: Van Dyke 1990d).

The rural character of Western Kentucky provides many outdoor recreation opportunities for local communities. Hunting and fishing are readily available in the Ballard County Wildlife Management Area, 16 km (10 miles) northwest of the site. Hunted game includes geese, ducks, and deer. Adjacent and just to the north of the PGDP site is the West Kentucky State Wildlife Management Area, which also provides hunting opportunities for geese, ducks, and deer. The Ohio River, within 6 km (4 miles) of the PGDP site, is used for fishing.

The Land Between the Lakes area, 56 km (35 miles) southeast of Paducah, is a major recreation resource. Among its attractions are an outdoor recreation and conservation education center, a buffalo herd, and an educational farm. This area is located on a 6880-ha (170,000-acre) wooded peninsula between Kentucky Lake and Lake Barkley

(reservoirs on the Tennessee River). These lakes are used for fishing, swimming, and boating. Also on Kentucky Lake are the Kentucky Dam Village State Resort Park and Kenlake State Resort Park.

Columbus-Belmont Battlefield State Park is about 40 km (25 miles) southwest of the PGDP site in Carlisle County. Among its attractions are a campground, a historical hiking trail, a Confederate cannon, and a network of earthen trenches.

The city of Paducah, in McCracken County, has a number of recreational facilities and programs. The city park system consists of 15 parks, 13 playgrounds, 3 swimming pools, 20 tennis courts, 4 racquetball courts, 2 football fields, 8 baseball fields, 4 softball fields, and 1 combination softball/baseball field. Bob Noble Park, Paducah's largest park, includes picnic areas, tennis courts, a pool, an amusement park, five baseball diamonds, and a model airplane field. Additional facilities within the Paducah area include movie theaters, bowling centers, and a skating rink. A racetrack, which is open in the summer and fall months, features quarter horse racing and parimutuel betting. The five-eighths-mile oval track features the Anheuser-Busch Bluegrass Futurity for two-year-old American quarter horses. This facility also has simulcast and betting on thoroughbred horse races from Churchhill Downs in Louisville and from the Lexington, Kentucky, racetracks.

The city of Mayfield, in Graves County, has public recreational facilities that include four parks, one minipark, five playgrounds, two tennis courts, seven baseball fields, a football stadium, and numerous nature trails. Also, two golf courses, two swimming pools, and several recreation centers are located in Mayfield. The city is also within driving distance of several large lakes and resort areas.

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.8 Solid and hazardous waste facilities

The city of Paducah, in McCracken County, currently has a 40-ha (100-acre) landfill that is used by and jointly operated by the city and county governments. The landfill has an estimated useful life of 3–5 years [estimated from the current 1.8 km/d (3.9 lb/d) of waste generated per capita] (Talbert 1988, p. 77).

The city of Mayfield, in Graves County, does not have a city-operated waste disposal site. Private refuse collection service is available to manufacturers located in Graves County in the vicinity of Mayfield (KDC 1980, p. 27).

Data for Ballard, Carlisle, Marshall, and Massac counties were requested but have not been received.

10.2.3.9 Emergency preparedness

PGDP has an emergency preparedness coordinator on-site and a comprehensive emergency management plan for the facility. Paducah has a mutual aid agreement with the city, surrounding counties, and the state of Kentucky. This agreement is with rescue squads, fire departments, and sherriffs' departments (see Appendix I: Lasley 1990).

10.2.3.10 Transportation

The PGDP site has access to I-24, ~16 km (10 miles) to the east (see Fig. 10.2-2). The interstate leads southeast to Nashville, Tennessee, and north into southern Illinois. I-57, ~40 km (25 miles) to the west, leads north to Chicago and south to I-55, which leads south to Memphis. PGDP is served by the Paducah and Louisville Railroad. Rail transport

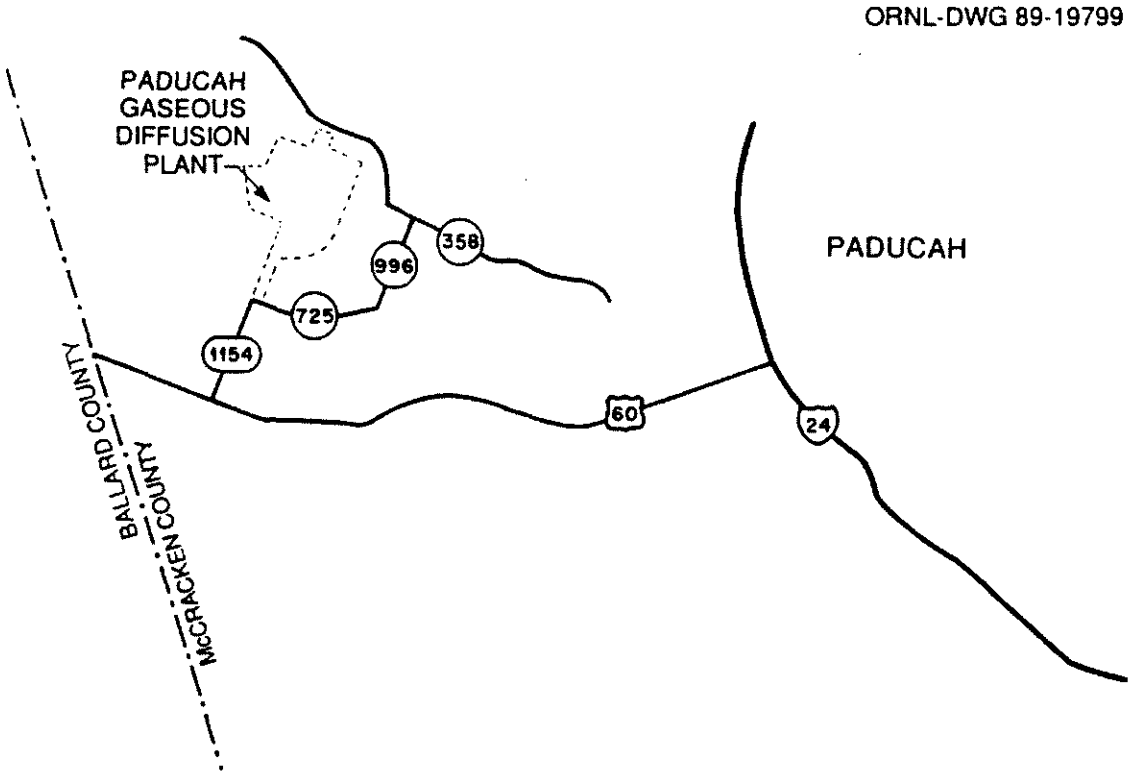

Fig. 10.2-2. Roads with potential traffic increase in vicinity of proposed site.

is used to ship and receive canisters of uranium hexaflouride. Coal for the steam plant is also received by rail. Inland water transportation is available through a terminal on the Tennessee River in Paducah. Barkley Regional Airport, ~8 km (~5 miles) from PGDP, is a commuter airport with a 2000-meter (6500-ft) runway with hub connections to St. Louis, Nashville, and Memphis.

Most of the traffic to and from PGDP travels on U.S. 60, which is oriented east and west, passing through Paducah ~16 km (10 miles) east of the plant. From U.S. 60, Highway 1154 leads ~2 km (1.6 miles) northeast to the PGDP entrance road. Traffic from Paducah also can access the plant via SR 358. Using this route, traffic parallels the plant perimeter heading south off 358 onto Highway 996 then west on 725, which intersects the plant entrance road. Traffic counts taken in 1989 (see Table 10.2-3) on public roads used by PGDP employees indicate that traffic is well under road capacities, and there is little, if any, congestion even during morning and afternoon peaks.

10.2.4 Land Use

The six-county area around the Paducah site is largely (>57%) agricultural (USBC 1989a,b), with predominantly soybean and corn crops. The second most frequent land use in the area is timberland, which accounts for just under 30% of the area. Of the six counties, McCracken County devotes the smallest percentage (74%) to these two purposes. The population of McCracken County, at 60,300, is relatively large in comparison with the other counties in the area. Thus, residential usage is greater than in the other counties. Also located in McCracken County is the 1313-ha (3245-acre) PGDP, which occupies 2% of the county's land (DOE 1982). Table 10.2-4 depicts the number of acres and percentage of total land area devoted to agriculture and timberland.

10.2.5 Economic Structure

PGDP is located in northwestern McCracken County, ~13 km (8 miles) northwest of the city of Paducah. The work force at the facility was about 1400 in November 1989, with an open requisition to hire ~300 additional workers.

The six-county assessment region (see Sect. 2) is dominated by the city of Paducah and McCracken County. The per capita income in the region is below the national average but higher than that of the state of Kentucky (see Table 10.2-5). In 1979 (the last official count), ~13% of persons in the region had incomes below the poverty level. In July 1989, Ballard and Carlisle counties had unemployment rates of ~12%, compared with the six-county average of 7%. Per capita income in the region is expected to increase at an annual rate of 1.6% from 1990 to 2000, which is about the same as is projected for the nation (EISF 1989).

In 1983, manufacturing accounted for 30.4% (see Table 10.2-6) of regional earnings, followed by services (18.4%) and trade (16.4%). Manufacturing is projected to remain the largest source of regional earnings; however, it is projected to account for 27.5% of earnings in 2000. Services are projected to increase to 19.6% of regional earnings by 2000.

Table 10.2-7 indicates the per capita level of county government revenue and taxes. The primary source of property tax is residential and farm property (see Table 10.2-8). The value of DOE's industrial operations in McCracken County is not taxable.

Table 10.2-3. Traffic counts on roads near Paducah Gaseous Diffusion Plant[a]

Location	Afternoon total	Adjusted 24-hour peak	Morning peak
SR 1154 just north of U.S. 60	815	50	90
U.S. 60 just east of SR 1154	6,387	560	710
U.S. 60 west of SR 1154 at Ballard County line	5,237	330	490
Hwy. 358 east of Hwy. 996	2,488	340	320
Hwy. 358 west of Hwy. 996	774	60	90
Hwy. 996 south of Hwy. 358	1,480	120	170
Hwy. 725 just west of Hwy. 996	1,125	140	220

[a]All counts are for 1989. Most peak periods are from 7 to 8 a.m. and 4 to 5 p.m.

Source: G. Mason, Kentucky Department of Highways, Division of Planning, personal communication with J. W. Van Dyke, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 21, 1989. (Personal communications are included in Appendix I: Van Dyke 1990e.)

Table 10.2-4. Agricultural land and timberland in the Paducah area

County	Area (acres)	Farmland (acres)	Farmland (%)	Timber-land (acres)	Timberland (%)
Ballard	162,560	105,236	64.7	49,000[a]	30.1
Carlisle	122,240	84,620	69.2	29,000	23.7
Graves	356,480	220,710	61.9	76,000	21.3
McCracken	160,640	70,148	43.7	49,000[a]	30.5
Marshall	194,560	74,001	38.0	86,000	44.2
Massac, Ill.	154,240	103,802	67.3	34,500	22.4

[a]McCracken and Ballard counties have a combined 98,000 acres of timberland. This figure attributes 50% of that total to each county.

Sources: U.S. Bureau of the Census, *County and City Data Book 1988,* 1988; U.S. Bureau of the Census, *1987 Census of Agriculture*, 1989; R. Green, Kentucky Department of Natural Resources, Frankfort, Ky., personal communication with S. Schexnayder, Oak Ridge National Laboratory, Oak Ridge, Tenn., Jan. 5, 1990; D. Little, Illinois Division of Forestry, Department of Conservation, Springfield, Ill., personal communication with S. Schexnayder, Oak Ridge National Laboratory, Oak Ridge, Tenn., Jan. 5, 1990. (Personal communications are included in Appendix I: Schexnayder 1990g and 1990k.)

Table 10.2-5. Employment and income for counties in the Paducah area

County	1989 labor force	Unemployment (%)	1987 per capita income ($)
Ballard	3,366	11.8	11,408
Carlisle	231	12.3	11,387
Graves	17,075	7.0	12,078
McCracken	11,114	6.1	14,728
Marshall	11,114	6.8	12,109
Massac, Ill.	4,700	10.9	11,153
Region	66,687	7.2	13,016
Kentucky	1,777,564	6.1	11,997
United States	126,238,000	5.3	15,484

Sources: Kentucky County Employment data are from the Kentucky Department of Employment Services; Massac employment data are from Dennis Hoffman, Illinois Department of Employment Security, Centralia, Ill.; per capita income data are from the U.S. Bureau of Economic Analysis.

Table 10.2-6. Percentage of earnings by industry for six counties in the Paducah area (%)

Year	Construction	Manufacturing	Trade	Services	Government	Other
1983	6.3	30.4	16.4	18.5	12.8	15.6
1990	7.4	29.0	15.7	18.5	11.0	18.3
1995	7.4	28.2	15.8	19.3	10.6	18.7
2000	7.4	27.5	15.9	19.6	10.5	19.1

Source: Economic Information Systems Forecasting, OBERS *Projections*, on-line files, Construction Engineering Research Laboratory, Army Corp of Engineering, Champaign, Ill., 1989.

Table 10.2-7. Source of county government revenues in the Paducah area ($)

County	Per capita local tax	Per capita property tax	Per capita general revenue	Per capita intergovernmental revenue
Ballard	122	78	590	420
Carlisle	90	66	580	440
Graves	107	64	520	350
McCracken	206	108	680	360
Marshall	104	67	540	310
Massac, Ill.	298	264	1,060	460

Source: U.S. Bureau of the Census, *County and City Data Book, 1988,* pp. 144, 209, and 222, 1988.

Table 10.2-8. Relative assessed value of taxable property in the Paducah area

County	Per capita estimated 1986 property value ($)	Total assessed value (%)			
		Residential and farm	Industrial and commercial	Personal property	Public utilities
Ballard	18,300	24	31	8	30
Carlisle	11,300	35	58	6	1
Graves	11,700	52	27	21	0
McCracken	14.200	63	5	32	0
Marshall	15,500	61	12	26	1
Massac	16,500	29	13	57	1

Sources: C. M. Straus (ed.), *1988 Kentucky Statistical Abstract,* University of Kentucky, Center for Business and Economic Research, Lexington, 1988; *Illinois Property Tax Statistics 1986*, Illinois Department of Revenue, Springfield, Ill., 1988.

10.2.6 Cultural, Historical, and Archaeological Resources

More than 30 sites in McCracken, Ballard, Carlisle, Graves, Marshall, and Massac (Illinois) counties are eligible for or are listed in the *National Register of Historic Places* [information compiled through February 17, 1988 (see Appendix I: Wolfe 1990b)]. These sites are listed in Appendix H. In addition, hundreds of other archaeological and architectural sites of historic interest are located in these counties (see Appendix I: Wolfe 1990a,c).

10.2.7 Social Structure

The following section briefly reviews the history of PGDP and the relationship among the community, DOE, and the plant managers. A discussion of community response to other DOE proposals and private industries that handle hazardous material is included. A more detailed discussion of these topics is included in Appendix H.

PGDP, the only DOE facility in the Paducah area, is located 16 km (10 miles) west of the city of Paducah, Kentucky, and 6.4 km (4 miles) south of the Ohio River on land transferred to the Atomic Energy Commission from the Kentucky Ordnance works in January 1951 (DOE 1982). The plant was constructed between 1951 and 1954 (DOE 1984). Initial operation began in 1952, and full-scale operation was reached by 1955 (DOE 1982). Prior to plant construction, and to a lesser extent today, the area was primarily agricultural and forest land.

Other industries in the area include Allied Chemicals (Massac County, Illinois), which produces hexafluorocarbons; the TVA Joppa Steam Electric Plant, 21 km (13 miles) northwest of PGDP, which provides power to PGDP (DOE 1982); and a large industrial complex located in Calvert City, Kentucky.

The original manager of PGDP was Union Carbide Nuclear Division, but in 1984 Martin Marietta Energy Systems, Inc., assumed operation of the facility. PGDP is the largest employer in the area and has provided economic stability throughout the Kentucky Purchase Area, the eight Kentucky counties west of the Tennessee River (see Appendix I: Schexnayder 1990e,f,j,m). The economic impact, PDGP's safe operating record, its contribution to community projects, and its public information programs are reasons for the community's continued support of the facility (see Appendix I: Schexnayder 1990d,e,j,l,m,o).

Little or no organized opposition to PGDP operations has arisen. However, environmental issues have been raised by local citizens concerning other facilities in recent years. The Calvert City Industrial Complex, ~20 km southwest of Paducah, was the subject of environmental controversy reported in a 1988 Greenpeace documentary (see Appendix I: Schexnayder 1990l). More recently, the Kentucky Cabinet for Natural Resources issued intent to deny an operating permit to Liquid Waste Disposal, Inc., a hazardous waste incineration facility in Marshall County [*Paducah Sun*, November 5, 1989, p.1; (see Appendix I: Schexnayder 1990m)].

Community officials indicated that these environmental issues are far less important to the public than the issue of continued economic viability of the region. The continued operation of PGDP is considered the top concern of the entire community (see Appendix I; Schexnayder 1990e,o,r).

10.3 PORTSMOUTH

10.3.1 Population

The proposed site is located in Pike County, which has a population of 25,000 (USBC 1988b). Adjacent counties include Jackson, Ross, and Scioto. Communities closest to the site include the cities of Piketon, ~5 km north of the site; Waverly, 20 km north; and the small towns of Wakefield and Jasper, both within 8 km of the site. Other nearby cities include Chillicothe, ~43 km north; Jackson, 29 km east; Portsmouth, 43 km south; and Wellston, 40 km northeast. A map depicting this four-county region and the cities and towns within is included in Fig. 10.3-1.

All four counties experienced population growth in the 1970s, particularly Pike County, where the population increased by almost 20% (see Table 10.3-1). This trend of growth continued into the early 1980s in Pike and Ross counties, while Jackson and Scioto counties began to experience a decline in population. Historical population growth characteristics of the four-county area and the large incorporated areas within each county are presented in Table 10.3-1.

Trends in population change beginning in the 1980s are expected to continue through 2000. The population of Pike County is expected to increase another 20% between 1980 and 2000, while Jackson County is expected to lose 13% of its population. Table 10.3-2 presents population projections through 2000 for the four-county area.

10.3.2 Housing

Housing availability patterns in Pike County have changed since 1980, when the census reported 8.4% vacancy in rental housing and 1% vacancy in housing for sale (USBC 1983). Following the census, the economy has become depressed, while the population increased by almost 10% between 1980 and 1986 (USBC 1988a). The total number of housing units is now ~9000 (see Appendix I: Schexnayder 1990p,s). New units include 2 subsidized rental housing complexes, 20–30 new apartments, and a few owner-occupied units. The economic conditions in the area have caused the vacancy of for-sale units to increase to 5% and the vacancy of rental units to drop to between 2 and 5%. Therefore, 50–120 rental units are available in Pike County (see Appendix I: Schexnayder 1990p,s) and ~100 units for sale (OVRDC 1987). Estimates of available trailer pads range from 60 to 100 (see Appendix I: Schnexnayder 1990p,s).

In Jackson County, rental units, excluding subsidized units, have an occupancy rate approaching 100% (see Appendix I: Schexnayder 1990u,v). However, 250 houses are for sale in Jackson County (OVRDC 1987). Also, 2 trailer courts, each with 20–30 pads, have a combined vacancy of 10 pads (see Appendix I: Schexnayder 1990u).

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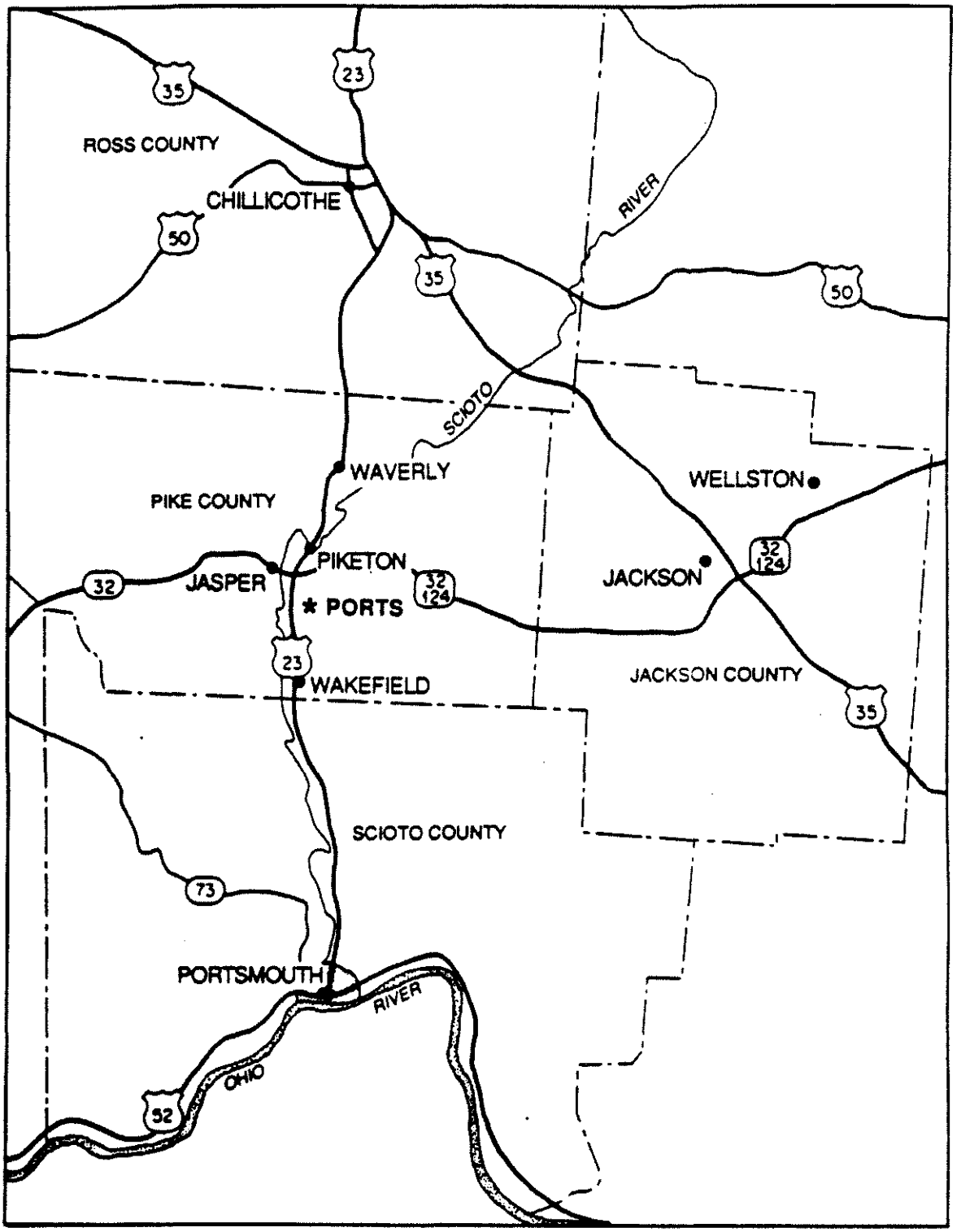


Fig. 10.3-1. Map showing the four-county region and the cities in and near the immediate impact region.

Table 10.3-1. Historical population growth characteristics for counties and principal cities in the Portsmouth area

County City	1970 population	1980 population	1970–1980 change (%)	1986 population	1980–1986 estimated change (%)
Jackson	27,174	30,592	12.6	30,000	–1.9
Jackson	6,843	6,675	–2.4	6,770	1.4
Wellston	5,410	6,016	11.2	6,330	5.2
Pike	19,114	22,802	19.3	25,000	9.6
Piketon	1,347	1,726	28.1	1,690	-2.1
Waverly City	5,082	4,603	–9.4	4,810	4.5
Ross	61,211	65,004	6.2	67,300	3.5
Chillicothe	24,842	23,420	–5.7	23,420	0
Scioto	76,951	84,545	9.9	82,300	–2.7
Portsmouth	27,633	25,943	–6.1	23,070	–11.1

Sources: U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988; U.S. Bureau of the Census, "Characteristics of the Population: Part 15, Illinois, and 19, Kentucky," in *Census of Population: 1970*, Vol 1, 1973.

Table 10.3-2. Population estimates and projections for counties in the Portsmouth area

County	1980[a]	1986[a]	1990[b]	2000[b]	1980–1990 change (%)	1990–2000 change (%)
Jackson	30,592	30,000	28,817	26,797	–5.7	–7.0
Pike	22,802	25,000	25,459	27,158	11.6	6.7
Ross	65,004	67,300	70,791	74,890	8.9	5.8
Scioto	84,545	82,300	83,860	81,773	–0.8	–2.5

[a]*Source:* U.S. Bureau of the Census, *1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, 1988.
[b]*Source:* Ohio Data Users Center, *Ohio County Profiles,* Columbus, Ohio, 1988.

Scioto County has ~12,000 rental units, 600 of which are available. The 3 trailer courts in Scioto County currently have 28 mobile home pads and 5 RV pads available (see Appendix I: Schexnayder 1990h). In addition, ~450 homes are for sale (OVRDC 1987; see Appendix I: Schexnayder 1990h).

No current housing information concerning Ross County is available. For equitable comparison, general housing characteristics from the 1980 census for all four counties are provided in Appendix H.

In Jackson, Pike, and Scioto counties, the 11 hotels and motels have a combined total of ~485 rooms. Of this total, 427 rooms are in Scioto County [PACC(b) n.d.; (see Appendix I: Schexnayder 1990p)]. Occupancy rates vary considerably but average 50% on weekdays and 75% on weekends (see Appendix I: Schexnayder 1990p).

10.3.3 Public Services

10.3.3.1 Public education

The Pike County School System consists of four districts. These districts operate five elementary schools, two junior high schools, and three high schools. Elementary enrollment is 2194, junior high enrollment is 674, and high school enrollment is 953 (total of 3821 pupils). Of the 10 schools in the system, three are currently over capacity and seven are under capacity. Overall, elementary schools are under capacity by 100 students, high schools are under by 150, and the junior high school is under 139 (see Appendix I: PCPS 1989, pp. 2–3).

Actual enrollment for school year 1988–89 in the Waverly City School System, in Pike County, shows 916 students in grades K–5, 423 in grades 6–8, and 605 in grades 9–12 (total 1944 students). Projections indicate that total enrollment in the Waverly City School System will increase to 1947 students in 1989–90, drop to 1932 and 1929 in 1990–91 and 1991–92 respectively, and then increase to 1944 and 1952 in 1992–93 and 1993–94 respectively (WCBE 1989).

Ross County schools consist of six county school districts, one city school district, and two parochial schools. The six county districts have 11 elementary schools, 3 junior high schools, and 6 high schools. Available information indicates that enrollment in the county school districts range from a low of 1162 students in the Adena Local School District to a high of 1370 in the Scioto Valley Local School District, with all others falling within this range (RCPS 1989).

The Chillicothe City School District, in Ross County, has 4040 students enrolled in grades K–12. The district includes six elementary schools, two middle schools, and one high school. Grades K–5 have 2011 students, and grades 6–12 have 2029. Chillicothe has a 1:26 teacher/pupil ratio for grades K–5 and a 1:21 ratio for grades 6–12 (CCSS 1989).

Jackson County has three public school districts. The largest district, Jackson, consists of seven elementary schools and one high school. The high school houses 2000 students, while the seven elementary schools have a combined total of 2870. A building program for the Jackson City School District recommended that two of the elementary schools not be used as education facilities, because the existing buildings are old and in poor condition (see Appendix I: Radabaugh 1989).

The Wellston City School District, in Jackson County, has an enrollment of ~1900 students in one high school, one junior high school, and two elementary schools (*City of Wellston* n.d.).

The Oak Hill Union Local School District, in Jackson County, has an enrollment of 1300 in one high school and five elementary schools. Enrollment in all three Jackson County school districts has declined slightly in recent years. That trend is expected to continue for at least the next few years (see Appendix I: Radabaugh 1989).

Data for Scioto County were requested but have not been received.

10.3.3.2 Water supply

The cities of Jackson, Oak Hill, and Wellston, all in Jackson County, each operates a public water supply system. The Jackson County Water Company purchases water from Jackson and Wellston and supplies water to the village of Coalton (see Appendix I: Radabaugh 1989).

The city of Wellston, in Jackson County, has a water system capacity of 0.18 m^3/s (4.0 Mgd), with an average daily usage of 0.04 m^3/s (0.85 Mgd) (*City of Wellston* n.d.).

Jackson has a treatment capacity of 0.18 m^3/s (4.0 Mgd) and a maximum daily usage of 0.11 m^3/s (2.4 Mgd). Coagulation and filtration are used for treatment (CPCJ n.d.).

Data for Scioto, Pike, and Ross counties were requested but have not been received.

10.3.3.3 Sewage treatment

Major improvements in sewer service have been made in Jackson County over the past ten years. The city of Jackson has a 0.9-m^3/s (2.0-Mgd) wastewater treatment plant completed a few years ago (see Appendix I: Radabaugh 1989). This plant has an average daily flow of 0.07 m^3/s (1.67 Mgd) (CPCJ n.d.).

Wellston and Oak Hill, in Jackson County, will begin major renovations to their wastewater treatment plants within the next year (see Appendix I: Radabaugh 1989). Wellston has a sewage treatment capacity of 0.26 m^3/s (6.0 Mgd). Sludge digestion treatment is used (*City of Wellston* n.d.).

Data for Scioto, Pike, and Ross counties were requested but have not been received.

10.3.3.4 Fire protection

Jackson County is served by nine fire departments. The Jackson city fire department consists of two part-time members and 17 volunteers (CPCJ n.d.).

The city of Wellston, in Jackson County, has a fire department with 25 volunteers and three full-time personnel. The department also has mutual fire protection agreements with ~15 other departments (*City of Wellston* n.d.).

The city of Portsmouth, in Scioto County, has a fire department with of 44 fire fighters. Also in Scioto County, the village of New Boston has a fire department with 11 fire fighters. Scioto County, overall, has 22 volunteer fire departments [PACC(b) n.d.].

Data for Scioto, Pike and Ross counties were requested but have not been received.

10.3.3.5 Police protection

Police protection for Jackson County is provided by the State Highway Patrol, Jackson County Sheriff's Department, and police departments in the cities of Jackson and Wellston. The city of Jackson has 19 full-time employees. Overall, Police protection is generally considered to be adequate (see Appendix I: Radabaugh 1989).

The city of Portsmouth, in Scioto County, has a police department with 44 officers. The Scioto County Sheriff's Department employs 21 deputies. The village of New Boston, also in Scioto County, has 11 officers [PACC(a) n.d.].

Data for Pike County were requested but have not been received.

10.3.3.6 Medical facilities

The only hospital located in Jackson County has 68 beds and 11 physicians. Also located in the county are five clinics, which are operated by area hospitals, and six nursing homes (see Appendix I: Radabaugh 1989).

The city of Wellston, in Jackson County, has one nursing home with 50 beds. Plans are under consideration to convert this nursing home into an adult day care center and construct a new 100-bed nursing home (see Appendix I: Radabaugh 1989).

Three hospitals, with a total of 556 beds, are located in Scioto County, and a retirement center is in Portsmouth. This area has 89 physicians [PACC(a) n.d.].

Data for Pike and Ross counties were requested but have not been received.

10.3.3.7 Recreation

The following data on recreation are from sources listed in PACC(a) n.d. and Appendix I: Adams (1990); Van Dyke (1990a,b); and Radabaugh (1989).

The many lakes and forests of southern Ohio provide numerous opportunities for outdoor recreation in the area surrounding the PORTS site. Hunting, fishing, boating, and swimming are popular activities. The Ohio River, ~35 km (22 miles) south of PORTS, is used for fishing, boating, water skiing, and—to a lesser extent—swimming. The 26,710-ha (66,000-acre) Shawnee State Forest and Park, ~16 km (10 miles) west of the city of Portsmouth, is the largest state park in Ohio. It features camping and has a game management program with squirrel, rabbit, deer, wild turkey, and duck hunting. The park also has five lakes for fishing and swimming—one is stocked with trout.

Two state parks are located in Pike County. Lake White State Park, 16 km (10 miles) north of PORTS, includes 136 water ha (337 water acres) featuring a public boat launch ramp, power and sail boating, water skiing, fishing, and a 50-ft (15-m) beach for swimming. Land totaling 43 ha (107 acres) feature two picnic shelters and 38 primitive campsites (no electricity). Pike Lake State Park, ~20 km (13 miles) northwest of PORTS, has 5.3 water ha (13 water acres) and 243 land ha (600 land acres). It has a 47-m (155-ft) beach for swimming. No power boats are permitted. A group lodge; 25 cabins; and >200 camping sites, 101 of which have electricity. Pike Lake State Park has four hiking trails and is near the 4,856-ha (12,000-acre) Pike State Forest.

Pike County also has two privately owned camping facilities with extensive recreation attractions. Longs Retreat, off SR 124 near Latham, is ~22 km (14 miles) northwest of PORTS. Cave Lake Family Campground is 2 km (1 mile) west of Longs Retreat. These facilities, which cater to family vacations, offer various recreational activities including fishing, swimming, boating, go-carts, and game rooms.

Other state parks in the area include Scioto Trail State Park, ~25 km (16 miles) north of PORTS in Ross County, and Jackson Lake State Park, ~40 km (25 miles) southeast in Jackson County.

Wayne National Forest is east of the city of Portsmouth and south of Jackson Lake State Park. This 72,844-ha (180,000-acre) park includes Vesuvius Recreation Area at Lake Vesuvius, which is developed for camping, hiking, fishing, and horseback riding. The

undeveloped areas of the forest provide opportunities for hunting, primitive camping, and off-trail hiking.

Other recreation opportunities in Pike County include five public tennis courts in Waverly, including the Waverly Golf Club, an 18-hole public golf course 8 km (5 miles) northwest of Waverly. Although the Waverly Swim Club is private, an outdoor swimming pool is open to the public two evenings per week.

Many recreation opportunities are available in the Portsmouth and Chillicothe vicinities. Portsmouth reputedly has one of the largest swimming pools in the nation. Portsmouth also has ten municipal parks, eight public playgrounds, and one baseball and one softball field.

10.3.3.8 Solid and hazardous waste facilities

A landfill, located south of Wellston, currently operates in Jackson County. This landfill has a remaining life expectancy of ~3 years (see Appendix I: Radabaugh 1989).

The city of Wellston, in Jackson County, uses individual contracts negotiated with industrial and commercial firms for waste disposal (*City of Wellston* n.d.).

Data for Pike and Ross counties and for the city of Jackson, in Jackson County, were requested but have not been received.

10.3.3.9 Emergency preparedness

PORTS has an emergency preparedness coordinator on-site and a facility comprehensive emergency management plan. Portsmouth has a mutual aid agreement with the surrounding counties and the state of Ohio. This agreement is with rescue squads, fire departments, and sheriffs' departments (see Appendix I: Lasley 1990).

10.3.3.10 Transportation

The Portsmouth facility has direct access to U.S. 23, a four-lane divided highway that leads north to Chillicothe and Columbus and south to Portsmouth and Huntington, West Virginia. U.S. 23 intersects Ohio SR 32/124 ~3 km (2 miles) north of the PORTS access road. SR 32 is a four-lane divided highway that leads west to Cincinnati and east through Jackson County and onto U.S. 50 near Athens in Southeastern Ohio (see Fig. 10.3-2). The plant ships and receives uranium hexafluoride canisters via Norfolk and Western Railroad. The nearest inland water transportation is the Ohio River, ~40 km (25 miles) to the south. PORTS is relatively isolated from commercial air service. The Port of Columbus International Airport is ~120 km (75 miles) from the plant and, the Cincinatti International Airport ~160 km (100 miles). The Portsmouth Regional Airport, serving chartered aircraft, is ~30 km (19 miles) to the southeast near the small town of Minford, Ohio.

The main access road from the plant feeds onto U.S. 23 via entrance and exit ramps directly west. Another common access to the plant is from Wakefield Mound Road, which is accessed directly from the southwest perimeter of the plant. Wakefield Mound Road is parallel to U.S. 23, which intersects ~5 km (3 miles) south of the main access road. Access to the plant is also available from Big Run Road, which accesses the southeast perimeter of the plant and leads onto Wakefield Mound Road just north of the intersection with U.S. 23. Table 10.3-3 presents various traffic counts. The peak hours for plant traffic are from 7 to 8 a.m. and from 4 to 5 p.m., corresponding with peak traffic counts presented in Table 10.3-3.

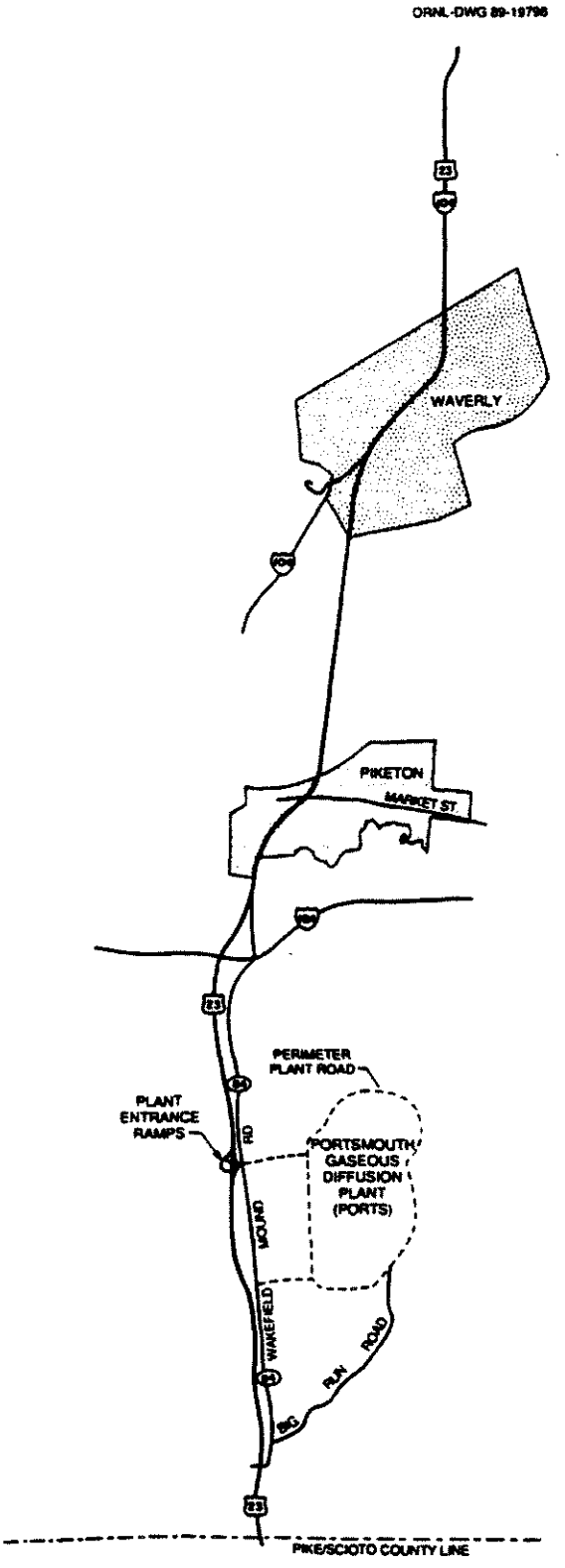


Fig. 10.3-2. Roads with potential traffic increase in vicinity of proposed site.

Table 10.3-3. Traffic counts on roads near Portsmouth Gaseous Diffusion Plant[a]

Location	Adjusted 24-hour total	Morning peak	Afternoon peak
Plant entrance and exit ramps to U.S. 23	3,076	483	469
U.S. 23 at main plant access road (1986)	10,120		
Intersection of U.S. 23 and Wakefield Mound and Ferry Roads (1982)	8,969	963	1,155
U.S. 23 at the Pike and Scioto county line	8,975	876	970
U.S. 23 at Market Street in Piketon	13,100		
U.S. 23 at SR 104 in Waverly	18,220		

[a]Except where noted, traffic counts are for 1985. Peak periods are from 7 to 8 a.m. and 4 to 5 p.m. Peak hour counts were not taken on all roads. *Source:* Ohio Department of Transportation, Bureau of Transportation Technical Services, *Traffic Survey Report of the State Highway System—Western Half,* 1986.

The most recent available peak hour traffic counts in Pike County (1985) on U.S. 23 indicate a B level of service (LOS) during peak hours, which indicates free-flow conditions without traffic congestion. The traffic entering and exiting PORTS at U.S. 23 uses on and off ramps at the main access road. The entrance and exit ramps from PORTS do not experience traffic congestion, even during morning and evening rush hours.

The intersection of Wakefield Mound and Ferry Roads with U.S. 23, ~5 km (3 miles) south of the main plant entrance road, had a significant problem with traffic congestion during the 4 to 5 p.m. rush hour when the most recent hourly traffic count was taken in 1982. Traffic approaching the intersection from the east on Wakefield Mound Road or from the west on Ferry Road must stop for traffic on U.S. 23, which has the right-of-way. The basic problem is caused by traffic attempting east-to-south left turns from Wakefield Mound Road onto U.S. 23. Some of the rush-hour traffic originates at the PORTS plant. The 1982 hourly traffic count reported that ~380 vehicles (PORTS and non-PORTS) made this turn during the 4 to 5 p.m. rush hour. A traffic analysis indicates that this number exceeds, by ~200 vehicles, the intersection's capacity for this specific turning movement during rush hour. This condition indicates an LOS of F, the worst rating, which is associated with extreme delays and congestion.

Current conditions indicate that the Wakefield Mound Road intersection with U.S. 23 is not being used nearly as much as indicated by the traffic count in 1982. The 1982 traffic count probably reflects the higher employment during 1982 at the plant associated with construction of the Gas Centrifuge Enrichment Plant (GCEP) facility at PORTS. However, it should be noted that, in general, traffic from the PORTS plant had an alternative to avoid this congestion by using the main entrance road, which accesses U.S. 23 with ramps. The fact that construction traffic was using the Wakefield Mound Road in spite of significant congestion at the U.S. 23 intersection could reflect that construction workers were required to use specific access roads (see Appendix I: Van Dyke 1990c).

10.3.4 Land Use

The predominant land use in the four-county area surrounding the Portsmouth site is forestland, comprising 54% of the area. Agricultural use, at 41.3%, ranks second. Combined, these two uses account for >95% of the four-county area (OVRDC 1988).

Ross County is the largest of the four counties surrounding the site. Of its 179,278 ha (443,000 acres), >113,718 ha (>281,000 acres), or 63.5%, are used for agriculture, while forests occupy 32.3% of the land. With >3,238 ha (>8,000 acres), 1.86% of the area used for residential purposes, Ross County ranks first of the four counties in the land area devoted to residential usage. Industry occupies <0.79% of the land, while 0.36% is devoted to commercial usage.

Scioto County outranks Ross County in the amount and percentage of land devoted to forest usage but ranks last among the four counties in agricultural land. Of the >115,741-ha (>286,500-acre) area, 72.6% is forestland, while only 36,151 ha (89,330 acres), or 22.6%, are used for agriculture. Residential usage occupies 2,891 ha (7,144 acres), or 1.81%, while commercial and industrial usage each account for ~1,012 ha (~2,500 acres), or 0.6%.

Jackson County, the smallest of the four counties, with only 109,469 ha (270,500 acres), uses >2% of its area, or 2,226 ha (5,500 acres), for residential purposes and almost 4%, or 4,249 ha (10,500 acres), for mines and quarries. Forestland occupies 60,704 ha (>150,000 acres), and agriculture occupies ~40,469 ha (~100,000 acres). Industry and commercial usage combined account for <0.5% of the total area of the county.

Pike County, in which the proposed site is located, uses 60% of its 115,377 ha (285,100 acres) for forestland. The second largest land use, agriculture, occupies ~42,492 ha (~105,000 acres), or 36.7%. Pike County ranks lowest of the four counties in industrial land area usage. Pike County has only 176 ha (436 acres), or 0.15% of its area, devoted to industrial use. Residential usage occupies 1,303 ha (3,220 acres), while commercial usage of 631 ha (1,560 acres) accounts for 0.55% of the area.

10.3.5 Economic Structure

The PORTS facility is located in Pike County, ~14 km (9 miles) south of Waverly, Ohio, and 34 km (21 miles) north of Portsmouth, Ohio. The work force at the facility was ~2350 in November 1989.

In 1985, per capita income in the region was significantly below the average for Ohio and the nation (see Table 10.3-4). In 1979 (the most recent official count), ~16% of persons in the region had incomes below the poverty level. In July 1989, Jackson and Pike counties had unemployment rates of ~12%, compared with the six-county average of 7%. Per capita income in the region is expected to increase at an annual rate of 1.6% from 1990 to 2000, which is about the same as projected for the nation (OBES 1989).

In 1983, manufacturing accounted for 33.7% of regional earnings (see Table 10.3-5), followed by government (19.0%) and services (15.5%). Manufacturing is projected to continue as the largest source of regional earnings, by accounting for ~35% of earnings in 2000. The services category is projected to increase to 18% of regional earnings by 2000, with government earnings falling to 15%.

Table 10.3-6 indicates the per capita level of county government revenue and taxes. The primary source of property tax is residential and farm property (see Table 10.3-7). The value of the DOE Gaseous Diffusion Plant in Pike County is not taxable.

10.3.6 Cultural, Historical, and Archaeological Resources

Nearly 100 sites are listed in the *National Register of Historic Places* in Jackson, Pike, Ross, and Scioto counties. Appendix H includes a list of these sites provided by the Ohio Historic Preservation Office. Prehistoric archaeological sites in the National Register for this area generally are Indian mounds. However, a host of additional archaeological sites in these counties have been identified through an inventory on file at the Ohio Historic Preservation Office (see Appendix I: Wolfe 1990d). Apparently, however, no evidence exists for archaeological materials within the PORTS reservation (ERDA 1977).

10.3.7 Social Structure

The following section briefly reviews the history of PORTS and the relationship among the community, DOE, and the plant managers. A discussion of community response to other DOE proposals and private industries that handle hazardous material is included. A more detailed discussion of these topics is included in Appendix H.

PORTS is one of four DOE plants in Ohio, but the only one in the Portsmouth area. PORTS is located 35 km (22 miles) north of Portsmouth and 3.2 km (2 miles) east of the Scioto River in Pike County. PORTS is capable of producing a full range of enriched uranium. Construction of PORTS began in 1953 (DOE 1984). The plant began

Table 10.3-4. Employment and income for counties in the Portsmouth area

County	1989 labor force	Unemployment (%)	1987 per capita income ($)
Jackson	12,700	10.9	9,786
Pike	9,000	8.2	9,429
Ross	29,200	7.3	11,714
Scioto	29,800	7.1	10,524
4-County Region	80,700	7.8	10,673
Ohio	5,525,600	5.0	14,605
United States	126,238,000	5.3	15,484

Source: Ohio Bureau of Employment Services, *Labor Force Estimates July 1989*; U.S. Bureau of Economic Analysis.

Table 10.3-5. Percentage of earnings by industry for four counties in the Portsmouth area (%)

Year	Construction	Manufacturing	Trade	Services	Government	Other
1983	6.2	33.7	12.6	15.5	19.0	13.1
1990	5.9	35.8	11.7	16.2	14.4	18.3
1995	5.7	35.8	11.6	17.3	15.4	14.2
2000	5.6	35.3	11.6	18.0	15.0	14.2

Source: Economic Information Systems Forecasting, *OBERS Projections,* on-line files, Construction Engineering Research Laboratory, U.S. Army Corp of Engineering, Champaign, Ill., 1989.

Table 10.3-6. Source of county government revenues in the Portsmouth area ($)

County	Per capita local tax	Per capita property tax	Per capita general revenue	Per capita intergovernmental revenue
Jackson	144	140	740	490
Pike	201	197	1,150	730
Ross	309	245	860	440
Scioto	210	165	860	530

Source: U.S. Bureau of the Census, *County and City Data Book, 1988,* pp. 404 and 417, 1988.

Table 10.3-7. Relative assessed value of taxable property in the Portsmouth area

County	Per capita real property 1988 assessed value ($)	Total assessed value (%)		
		Residential	Farm	Commercial and industrial
Jackson	14,300	60	19	21
Pike	12,400	60	27	13
Ross	16,900	59	18	23
Scioto	12,300	67	11	22

Source: Abstracts of Real Property for each county for 1988, Ohio State Tax Equalization Office, n.d.

operation in 1954 and reached full-scale operation early in 1956 (ERDA 1977). Construction of the Gas Centrifuge Enrichment Plant (GCEP) began in 1979 but was halted in 1985 before the plant became fully operational (DOE 1984).

The area surrounding PORTS, prior to its construction, was primarily forest and agricultural land. Steel mills and shoe manufacturers, once mainstays of the local economy, have experienced considerable decline (Schexnayder 1990q). Also, the cancelation of the GCEP facility ended a brief economic boom in the area (see Appendix I: Schexnayder 1990q). Most recently, a local coal company has been experiencing large layoffs, and local small businesses have been closing (see Appendix I: Schexnayder 1990t).

Community officials are pleased with the relationship between the community and PGDP, and they maintain that the relationship has improved since Martin Marietta Energy Systems, Inc., assumed operations (see Appendix I: Schexnayder 1990b,c,i,q). Good rapport has been established as a result of Martin Marietta's (1) providing adequate public information; (2) community involvement such as United Way contributions, providing use of emergency equipment, and having representatives serve on community boards; and 3) ensuring PGDP's safe operating record (see Appendix I: Schexnayder 1990b,c,i,n,q,s,t).

Community support for DOE projects at the site has been demonstrated through the years in various ways including community plans to donate land to DOE, community support at public meetings, and letter-writing campaigns and government resolutions supporting the facility (see Appendix I: Schexnayder 1990b,n,s,t).

Only one instance of organized protest at PORTS was reported by community officials (see Appendix I: Schnexnayder 1990n,s). The protest involved a group of American Indians from outside the community, who staged a sit-in at the gates of PGDP in the late. Only a few local residents joined this antinuclear protest (see Appendix I: Schexnayder 1990n,s). Community members are not, however, complacent about environmental issues. This was evidenced by concern voiced to community leaders when BASF proposed siting a facility in eastern Scioto County (see Appendix I: Schexnayder 1990q). Residents were concerned about the company's record of environmental degradation and labor problems.

Continued DOE presence is considered critical to the future economic viability of the Portsmouth area and is ranked as the top economic priority of the community (see Appendix I: Schexnayder 1990b,c,i,q,t).

10.4 REFERENCES

10.4.1 Oak Ridge

CBER (Center for Business and Economic Research) 1989. *Tennessee Statistical Abstract 1989*, ed. B. B. Vickers and M. A. Wood, College of Business Administration, The University of Tennessee, Knoxville.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, DOE/EA-0106.

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

ETDD (East Tennessee Development District) 1989. *Knox County Economic Statistics*, Knoxville, Tenn.

FHLBB (Federal Home Loan Bank Board) 1985. *Knoxville Tennessee Metropolitan Statistical Area Housing Vacancy Survey.*

Fiedler, G. F., Jr., Ahler, S. R., and Barrington, B. 1977. *Historic Sites Reconnaissance of the Oak Ridge Reservation, Oak Ridge, Tennessee*, ORNL/TM-5811, Oak Ridge National Laboratory, Oak Ridge, Tenn.

KKCMPC (Knoxville-Knox County Metropolitan Planning Commission) 1980a. *Knoxville-Knox County General Plan 2000*, September.

KKCMPC (Knoxville-Knox County Metropolitan Planning Commission) 1980b. *Land Use Study, May 1980*, Knoxville, Tenn.

KKCMPC (Knoxville/Knox County Metropolitan Planning Commission) 1988. *Knox County Schools Population and Enrollment Trends Study*, March.

LPAO (Local Planning Assistance Office) 1987a. *Future Land Use Analysis East Roane County*, Knoxville, Tenn.

LPAO (Local Planning Assistance Office) 1987b. *Use of Land in Lenoir City and Loudon, By Category 1964 and 1987*, Knoxville, Tenn.

LPAO (Local Planning Assistance Office) 1988. *Roane County, Tennessee Economic Development Plan: Strategies for Roane County*, Tennessee Department of Economic and Community Development, Knoxville, Tenn.

OBES (Ohio Bureau of Employment Services) 1989. *Ohio Labor and Market Information, Labor Force Estimates, July.*

ORCP *Oak Ridge Comprehensive Plan Including 1988 Update* 1988. Oak Ridge, Tenn.

TDECD (Tennessee Department of Economic and Community Development) 1989a. *Tennessee Community Data: Harriman, Tennessee*, Knoxville, Tenn.

TDECD (Tennessee Department of Economic and Community Development) 1989b. *Tennessee Community Data: Rockwood, Tennessee*, Knoxville, Tenn.

TDECD (Tennessee Department of Economic and Community Development) 1989c. *Tennessee Community Data: Knoxville, Tennessee*, Knoxville, Tenn.

TDECD (Tennessee Department of Economic and Community Development) 1989d. *Tennessee Community Data: Wartburg, Tennessee*, Knoxville, Tenn.

TDECD (Tennessee Department of Economic and Community Development) 1989e. *Tennessee Community Data: Kingston, Tennessee*, Knoxville, Tenn.

TCECD (Tennessee Department of Economic and Community Development) 1989f. *Tennessee Community Data: Clinton, Tennessee*, Knoxville, Tenn.

TCECD (Tennessee Department of Economic and Community Development) 1989g. *Tennessee Community Data: Oak Ridge, Tennessee*, Knoxville, Tenn.

TDHE (Tennessee Department of Health and Environment) 1986. *The Public Response to MRS*, Nashville, Tenn.

The Oak Ridger 1989. October 25, p. 1.

TSCHS (Tennessee State Center for Health Statistics) 1986. *Population Estimates for the State of Tennessee*, Tennessee Department of Health and Environment, Nashville, Tenn.

TSPO (Tennessee State Planning Office) 1982. *Anderson County Tennessee Comprehensive Plan 1982-1992*, East Tennessee Section, Knoxville, Tenn.

USBC (U.S. Bureau of the Census) 1988a. *East North Central—1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, No. ENC-SC.

USBC (U.S. Bureau of the Census) 1988b. *South—1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, No. S-SC.

USBC (U.S. Bureau of the Census) 1989. *1987 Census of Agriculture,* Geographic Area Series, Part 42, Tennessee.

10.4.2 Paducah

CBER (Center for Business and Economic Research) 1989. *1988 Kentucky Statistical Abstract*, ed. C. M. Straus, College of Business and Economics, University of Kentucky, Lexington.

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site*, DOE/EA-0155.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, DOE/EA-0106.

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

KDC (Kentucky Department of Commerce) 1980. *Industrial Resources, Mayfield.*

KDED (Kentucky Department of Economic Development) 1988. *Resources for Economic Development, Paducah*, Division of Research and Planning in cooperation with the Paducah Area Chamber of Commerce.

PADD (Purchase Area Development District) 1990. *Housing Vacancy Estimates*, compiled by D. Elias, Physical Planning Director, Mayfield, Ky., January 10.

Paducah Sun 1989. "Cabinet Gets an Earful from LWD Supporters," November 5, p. 1.

Talbert, John S., & Associates 1988. *City of Paducah Comprehensive Plan*, Paducah, Ky.

USBC (U.S. Bureau of the Census) 1988a. *East North Central—1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, No. ENC-SC.

USBC (U.S. Bureau of the Census) 1988b. *South—1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, No. S-SC.

10.4.3 Portsmouth

CCSS (Chillicothe City School System) 1989. *Chillicothe City Schools,* Chillicothe, Ohio, September.

City of Wellston, Jackson County, Southeastern Ohio n.d. Pamphlet.

CPCJ n.d. *Community Profile for City of Jackson, Ohio.*

DOE (U.S. Department of Energy) 1982. *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site*, DOE/EA-0155.

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

EISF (Economic Information Systems Forecasting) 1989. *OBERS Projections*, on-line files, Construction Engineering Laboratory, U.S. Army Corp of Engineers, Champaign, Ill.

ERDA (U.S. Energy Research and Development Administration) 1977. *Final Environmental Impact Statement Portsmouth Gaseous Diffusion Plant Site, Piketon, Ohio*, ERDA-1555.

OBES (Ohio Bureau of Employment Services) 1989. *Ohio Labor and Market Information, Labor Force Estimates,* July.

OVRDC (Ohio Valley Regional Development Commission) 1987. *Demographic Profile for the Ohio Counties of: Adams, Jackson, Lawrence, Pike, Ross, and Scioto*, Portsmouth, Ohio.

OVRDC (Ohio Valley Regional Development Commission) 1988. *Overall Economic Development Program*, Portsmouth, Ohio.

PACC(a) (Portsmouth Area Chamber of Commerce) n.d. *Positive on the Portsmouth Area*, pamphlet.

PACC(b) (Portsmouth Area Chamber of Commerce) n.d. *New Resident Guide*, Portsmouth, Ohio.

RCPS (Ross County Public Schools) 1989. *Ross County School Enrollment*, Chillicothe, Ohio, September.

USBC (U.S. Bureau of the Census) 1983. *1980 Census of Population and Housing*, Part 37, Ohio.

USBC (U.S. Bureau of the Census) 1988a. *East North Central—1986 Population and 1985 Per Capita Income Estimates for Counties and Incorporated Places*, Current Population Reports, Series P-26, No. ENC-SC.

WCBE (Waverly City Board of Education) 1989. *Waverly City Schools Enrollment*, Waverly, Ohio, September.

APPENDIX A

Appendix A

AIR QUALITY/METEOROLOGY

Table A.1-1. Frequency distribution, all stability classes, for Tower K (10 m) for the period from January 1, 1986 (00) through December 31, 1986 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	153	94	47	29	13	9	345
NNE	152	133	57	21	6	0	369
NE	134	222	115	45	12	0	528
ENE	92	218	141	39	8	1	499
E	62	67	41	7	0	0	177
ESE	41	47	23	2	1	0	114
SE	57	41	20	1	0	0	119
SSE	55	43	22	4	1	2	127
S	88	51	45	18	9	27	238
SSW	151	138	134	71	59	102	655
SW	198	225	171	103	100	111	908
WSW	228	127	119	64	37	55	630
W	161	96	69	32	20	34	412
WNW	117	59	48	49	41	76	390
NW	129	41	36	51	68	189	514
NNW	147	81	61	51	38	65	443
Total	1965	1683	1149	587	413	671	6468

Table A.1-2. Frequency distribution, all stability classes, for Tower K (60 m) for the period from January 1, 1986 (00) through December 31, 1986 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	40	147	69	62	44	44	406
NNE	37	122	66	46	23	11	305
NE	41	189	135	77	67	75	584
ENE	46	165	171	123	93	113	711
E	43	87	50	15	6	5	206
ESE	27	45	35	10	1	1	119
SE	15	43	23	10	0	0	91
SSE	24	38	29	15	7	3	116
S	25	72	62	21	16	53	249
SSW	34	117	113	94	61	157	576
SW	30	155	206	142	110	190	833
WSW	40	156	151	94	70	89	600
W	43	98	81	52	41	70	385
WNW	48	108	88	41	41	134	460
NW	56	75	56	47	50	232	516
NNW	26	91	50	39	34	71	311
Total	575	1708	1385	888	664	1248	6468

Table A.1-3. Frequency distribution, all stability classes, for Tower K (10 m) for the period from January 1, 1987 (00) through December 31, 1987 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	370	51	18	8	6	9	462
NNE	391	55	22	6	5	0	479
NE	294	135	90	33	6	0	558
ENE	219	130	143	48	7	0	547
E	135	62	27	11	1	0	236
ESE	99	28	16	4	5	0	152
SE	77	24	21	4	3	1	130
SSE	109	31	23	9	2	11	185
S	227	34	23	12	0	8	304
SSW	337	50	48	31	15	30	511
SW	496	87	116	66	22	45	832
WSW	560	72	53	33	29	23	770
W	526	45	46	24	19	37	697
WNW	476	19	32	25	25	50	627
NW	385	30	27	17	27	64	550
NNW	308	40	36	33	14	28	459
Total	5009	893	741	364	186	306	7499

Table A.1-4. Frequency distribution, all stability classes, for Tower K (60 m) for the period from January 1, 1987 (00) through December 31, 1987 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	30	106	59	21	16	28	260
NNE	45	178	60	46	27	18	374
NE	64	286	194	130	65	69	808
ENE	43	218	253	188	139	175	1016
E	24	104	76	38	20	7	269
ESE	25	68	36	24	5	7	165
SE	19	47	48	18	12	8	152
SSE	26	47	52	21	13	16	175
S	20	67	50	38	13	24	212
SSW	20	100	125	91	50	87	473
SW	23	200	242	167	88	180	900
WSW	35	166	169	114	77	102	663
W	26	139	146	70	64	111	556
WNW	34	108	86	73	57	163	521
NW	44	125	77	62	56	195	559
NNW	22	98	83	62	41	90	396
Total	500	2057	1756	1163	743	1280	7499

Table A.1-5. Summary of ambient air monitoring data collected in Anderson County, Tennessee, in 1988

SUSPENDED PARTICULATE (11101) TENNESSEE UNITS: 001 UG/CU METER (25 C)

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	YR	REP ORG	#OBS	MAXIMUM 24-HR VALUES 1ST	2ND	3RD	4TH	ARITH MEAN	GEO MEAN	GEO STD
47-001-0028	1	3		ANDERSON CO	TVA BULL RUN 26 0.5 MI NE	88	006	57	94	92	89	87	44	38	1.7
				NAAQS					260					75	

SULFUR DIOXIDE (42401) TENNESSEE UNITS: 001 UG/CU METER (25 C)

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	YR	REP ORG	#OBS	MAX 24-HR 1ST	2ND	OBS > 365	MAX 3-HR 1ST	2ND	OBS > 1300	MAX 1-HR 1ST	2ND	ARIT MEAN
47-001-0028	1	3		ANDERSON CO	TVA BULL RUN 26__	88	006	7581	97	87	0	482	402	0	807	472	14
47-001-0029	1	3		ANDERSON CO	TVA KINGSTON 13__	88	006	2479	224	97	0	414	413	0	815	697	26?
47-001-1004	1	3	OAK RIDGE	ANDERSON CO	4.3 MI. W OF BULL	88	006	1398	65	65	0	143	134	0	246	199	29?
47-001-1005	1	0	OAK RIDGE	ANDERSON CO	Y-12 PLANT WEST S	88	006	7904	101	73	0	291	188	0	414	356	27
47-001-2004	1	3	OAK RIDGE	ANDERSON CO	Y-12 PLANT	88	032	6507	94	88	0	243	240	0	498	388	38?
				NAAQS					365			1300					80

Source: *Ambient Air Quality Report*, Tennessee Air Pollution Control Division, Nashville, Tenn., 1989.

Table A.2-1. Frequency distribution, all stability classes, for Paducah (10 m) during the period January 1, 1988 (00) through December 31, 1988 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	23	117	77	9	0	0	226
NNE	13	160	102	31	0	0	306
NE	18	102	76	0	0	0	196
ENE	19	233	51	0	0	0	303
E	38	126	10	0	0	0	174
ESE	38	127	11	1	0	0	177
SE	81	176	29	1	0	0	287
SSE	275	198	29	7	1	0	510
S	311	242	73	38	15	2	681
SSW	299	309	85	31	10	4	738
SW	299	267	32	4	0	3	605
WSW	242	175	18	1	0	0	436
W	256	116	12	3	0	0	387
WNW	271	147	18	2	0	0	438
NW	357	309	77	12	0	0	755
NNW	164	185	80	5	0	0	434
Total	2704	2989	780	145	26	9	6653

Validity of Data from 01/01/88(00) - 12/31/88(23)
for TOWER P(10m)

the number of I (invalid) ws or wd data	=	1277
the number of Q (questionable) ws or wd data	=	932
the number of '999' ws or wd data	=	0
the number of I sigma theta data	=	192
the number of Q sigma theta data	=	862
the number of '999' sigma theta data	=	0
the number of 'good' ws and wd data	=	6653
the number of 'good' sigma theta data	=	7708
the total number of data	=	8762
the total number of possible data	=	8784
the percentage of I wd and ws data	=	14.6
the percentage of Q wd and ws data	=	10.6
the percentage of 'good' ws and wd data	=	75.9
the percentage of available 'good' ws and wd data	=	75.7
the percentage of I sigma theta data	=	2.2
the percentage of Q sigma theta data	=	9.8
the percentage of 'good' sigma theta data	=	88.0
the % of available 'good' sigma theta data	=	87.8
the number of calm wind speed data	=	0

Table A.2-2. Frequency distribution, all stability classes, for Paducah (60 m) during the period January 1, 1988 (00) through December 31, 1988 (23)

	Windspeed (m/s)						
Direction	0-2	2-4	4-6	6-8	8-10	> 10	Total
N	83	560	478	158	32	0	1311
NNE	107	533	338	101	13	0	1092
NE	89	315	196	18	0	0	618
ENE	73	270	155	14	0	0	512
E	69	251	192	16	0	0	528
ESE	51	245	168	24	5	1	494
SE	40	163	142	33	7	1	386
SSE	31	152	137	42	9	1	372
S	29	111	124	50	15	9	338
SSW	27	132	186	58	36	23	462
SW	21	126	184	46	1	8	386
WSW	19	105	88	29	1	1	243
W	21	87	86	17	2	0	213
WNW	25	80	57	14	6	1	183
NW	30	105	61	27	7	3	233
NNW	21	82	78	53	3	4	241
Total	736	3317	2670	700	137	52	7612

Validity of Data from 01/01/88(00) - 12/31/88(23)
for TOWER P(60m)

the number of I (invalid) ws or wd data	=	192
the number of Q (questionable) ws or wd data	=	958
the number of '999' ws or wd data	=	0
the number of I sigma theta data	=	192
the number of Q sigma theta data	=	862
the number of '999' sigma theta data	=	0
the number of 'good' ws and wd data	=	7612
the number of 'good' sigma theta data	=	7708
the total number of data	=	8762
the total number of possible data	=	8784
the percentage of I wd and ws data	=	2.2
the percentage of Q wd and ws data	=	10.9
the percentage of 'good' ws and wd data	=	86.9
the percentage of available 'good' ws and wd data	=	86.7
the percentage of I sigma theta data	=	2.2
the percentage of Q sigma theta data	=	9.8
the percentage of 'good' sigma theta data	=	88.0
the % of available 'good' sigma theta data	=	87.8
the number of calm wind speed data	=	0

Table A.2-3. Summary of ambient air monitoring data collected in or near Paducah, Kentucky, from April 1988 to March 1989

PARTICULATE MATTER 10 MICRON (PM10) STATISTICS
UNITS = MICROGRAMS PER CUBIC METER
PADUCAH-CAIRO INTERSTATE AIR QUALITY CONTROL REGION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OBS.	ARITHMETIC MEAN	24-HOUR OBSERVATIONS			
				TIMES > 150	1ST MAX/ DATE	2ND MAX/ DATE	3RD MAX/ DATE
18-2320-004-F02 METHOD(64) (8324) LIVINGSTON CO., LIVINGSTON RALPH BLOODWORTH FARM, OFF KY 453	88/04-89/03	47	28	0	69 88/06/08	66 88/07/08	66 88/07/14

NUMBER OF 24-HOUR AVERAGE CONCENTRATIONS IN RANGES!								
0 TO 25	26 TO 50	51 TO 75	76 TO 100	101 TO 125	126 TO 150	151 TO 175	176 TO 200	OVER 200
23	18	6	0	0	0	0	0	0

TOTAL SUSPENDED PARTICULATES STATISTICS
UNITS = MICROGRAMS PER CUBIC METER
PADUCAH-CAIRO INTERSTATE AIR QUALITY CONTROL REGION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OBS.	ARITHMETIC MEAN	24-HOUR OBSERVATIONS			
				TIMES > 150	1ST MAX/ DATE	2ND MAX/ DATE	3RD MAX/ DATE
18-3180-004-F01 METHOD(91) (8043) PADUCAH, MCCRACKEN PADUCAH MIDDLE SCHOOL 342 LONE OA	88/04-89/03	59	52	0	101 88/06/02	96 88/06/08	95 88/05/21
18-3180-025-F01 METHOD(91) (8307) PADUCAH, MCCRACKEN 1390 IRVIN COBB DRIVE	88/04-89/03	59	55	0	102 88/05/21	102 88/07/08	100 88/06/08

NUMBER OF 24-HOUR AVERAGE CONCENTRATIONS IN RANGES!							
0 TO 50	51 TO 100	101 TO 150	151 TO 200	201 TO 250	251 TO 300	301 TO 400	OVER 400
30	28	1	0	0	0	0	0
29	28	2	0	0	0	0	0

Table A.2-3 (continued)

SULFUR DIOXIDE STATISTICS
UNITS = PARTS PER MILLION
PADUCAH-CAIRO INTERSTATE AIR QUALITY CONTROL REGION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OBS.	ARITHMETIC MEAN	24-HOUR AVERAGES			3-HOUR AVERAGES		
				1ST MAX/ DATE	2ND MAX/ DATE	TIMES > .14	1ST MAX/ DATE/TIME	2ND MAX/ DATE/TIME	TIMES > .50
18-2460-001-F02 METHOD(20) (8046) MCCRACKEN COUNTY, MCCRACKEN WILDLIFE GAME RESERVE KY 358	88/04-89/03	7,998	0.007	0.064 89/02/23	0.043 89/03/09	0	0.235 88/10/19 1100	0.135 89/02/23 0600	0
18-3180-025-F01 METHOD(20) (8307) PADUCAH, MCCRACKEN 1390 IRVIN COBB DRIVE	88/04-89/03	8,437	0.003	0.024 89/02/11	0.021 89/02/28	0	0.076 89/02/11 1300	0.053 89/02/28 1500	0

CARBON MONOXIDE STATISTICS
UNITS = PARTS PER MILLION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OF 8-HOUR AVERAGE CONCENTRATIONS IN RANGES:							
		0 TO 4	5 TO 8	9 TO 12	13 TO 16	17 TO 20	21 TO 24	25 TO 28	OVER 28
18-3180-023-F01 METHOD(11) (8270) PADUCAH, MCCRACKEN CO FEDERAL BLDG 501 BROADWAY	88/04-89/03	8,269	5	0	0	0	0	0	0

OZONE STATISTICS
UNITS = PARTS PER MILLION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OBS.	NO. DAYS IN VIOLATION	FOUR HIGHEST DAILY MAXIMUM HOUR VALUES			
				1ST MAX/ DATE/TIME	2ND MAX/ DATE/TIME	3RD MAX/ DATE/TIME	4TH MAX/ DATE/TIME
072 PADUCAH-CAIRO INTERSTATE							
18-3180-024-F01 METHOD(11) (8280) PADUCAH, MCCRACKEN 2901 POWELL ST. BEHIND JPECC BUILDI	88/04-88/10	4,562	1	0.139 88/06/24 1200	0.122 88/07/08 1300	0.110 88/06/22 1800	0.109 88/08/07 1600

NUMBER OF DAILY MAXIMUM HOUR CONCENTRATIONS IN RANGES:							
0.00 TO 0.04	0.05 TO 0.08	0.09 TO 0.12	0.13 TO 0.16	0.17 TO 0.20	0.21 TO 0.24	0.25 TO 0.28	OVER 0.28
50	125	26	1	0	0	0	0

Table A.2-3 (continued)

NITROGEN DIOXIDE STATISTICS
UNITS = PARTS PER MILLION
PADUCAH-CAIRO INTERSTATE AIR QUALITY CONTROL REGION

SITE AND MONITORING INFORMATION	REPORTING PERIOD FROM - THRU	NUMBER OBS.	ARITHMETIC MEAN	24-HOUR AVERAGES		1-HOUR AVERAGES	
				1ST MAX/ DATE	2ND MAX/ DATE	1ST MAX/ DATE/TIME	2ND MAX/ DATE/TIME
18-3180-024-F01 METHOD(14) (8280) PADUCAH, MCCRACKEN 2901 POWELL ST. BEHIND JPECC BUIL	88/04-89/03	7,739	0.016	0.037 88/06/07	0.036 88/09/22	0.098 88/06/06 2100	0.086 88/09/21 1900

NUMBER OF 1-HOUR AVERAGE CONCENTRATIONS IN RANGES:							
0.00 TO 0.04	0.05 TO 0.08	0.09 TO 0.12	0.13 TO 0.16	0.17 TO 0.20	0.21 TO 0.24	0.25 TO 0.28	OVER 0.28
7,571	167	1	0	0	0	0	0

Source: Ambient Air Quality Summary Statistical Report, Division of Air Quality, Frankfort, Ky., 1989.

Table A.3-1. Portsmouth 40-m joint frequency distribution, 1987

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24	Totals
A	N	0.00047	0.00000	0.00012	0.00000	0.00000	0.00000	0.00059
	NNE	0.00035	0.00083	0.00000	0.00000	0.00000	0.00000	0.00118
	NE	0.00035	0.00213	0.00000	0.00000	0.00000	0.00000	0.00248
	ENE	0.00047	0.00224	0.00012	0.00000	0.00000	0.00000	0.00284
	E	0.00106	0.00319	0.00024	0.00000	0.00000	0.00000	0.00449
	ESE	0.00130	0.00354	0.00047	0.00000	0.00000	0.00000	0.00532
	SE	0.00248	0.00213	0.00000	0.00000	0.00000	0.00000	0.00461
	SSE	0.00354	0.00295	0.00024	0.00000	0.00000	0.00000	0.00673
	S	0.00449	0.00449	0.00024	0.00000	0.00000	0.00024	0.00945
	SSW	0.00662	0.00473	0.00000	0.00000	0.00000	0.00024	0.01158
	SW	0.00780	0.00532	0.00012	0.00000	0.00000	0.00000	0.01323
	WSW	0.00579	0.00543	0.00059	0.00000	0.00000	0.00000	0.01181
	W	0.00473	0.00520	0.00024	0.00012	0.00000	0.00000	0.01028
	WNW	0.00543	0.00343	0.00024	0.00000	0.00000	0.00000	0.00910
	NW	0.00177	0.00343	0.00000	0.00000	0.00000	0.00000	0.00520
	NNW	0.00059	0.00130	0.00000	0.00000	0.00000	0.00000	0.00189
B	N	0.00083	0.00000	0.00012	0.00000	0.00000	0.00000	0.00095
	NNE	0.00024	0.00130	0.00106	0.00000	0.00000	0.00000	0.00260
	NE	0.00071	0.00201	0.00095	0.00000	0.00000	0.00000	0.00366
	ENE	0.00106	0.00272	0.00047	0.00000	0.00000	0.00000	0.00425
	E	0.00130	0.00165	0.00106	0.00000	0.00000	0.00000	0.00402
	ESE	0.00142	0.00307	0.00106	0.00000	0.00000	0.00000	0.00555
	SE	0.00189	0.00165	0.00059	0.00000	0.00000	0.00000	0.00414
	SSE	0.00224	0.00295	0.00024	0.00012	0.00000	0.00000	0.00555
	S	0.00543	0.00579	0.00130	0.00000	0.00000	0.00000	0.01252
	SSW	0.00697	0.00414	0.00071	0.00000	0.00000	0.00000	0.01181
	SW	0.00744	0.01205	0.00106	0.00012	0.00000	0.00000	0.02068
	WSW	0.00721	0.00520	0.00177	0.00012	0.00000	0.00000	0.01430
	W	0.00614	0.00425	0.00295	0.00024	0.00000	0.00000	0.01359
	WNW	0.00508	0.00236	0.00106	0.00000	0.00000	0.00000	0.00851
	NW	0.00189	0.00189	0.00059	0.00000	0.00000	0.00000	0.00437
	NNW	0.00106	0.00118	0.00106	0.00012	0.00000	0.00000	0.00343
C	N	0.00012	0.00024	0.00071	0.00000	0.00000	0.00000	0.00106
	NNE	0.00095	0.00284	0.00201	0.00012	0.00000	0.00000	0.00591
	NE	0.00059	0.00591	0.00130	0.00012	0.00000	0.00000	0.00792
	ENE	0.00083	0.00461	0.00248	0.00000	0.00000	0.00000	0.00792
	E	0.00130	0.00425	0.00236	0.00000	0.00000	0.00000	0.00792
	ESE	0.00154	0.00354	0.00236	0.00047	0.00000	0.00000	0.00792
	SE	0.00059	0.00319	0.00366	0.00035	0.00000	0.00000	0.00780
	SSE	0.00130	0.00366	0.00213	0.00047	0.00012	0.00000	0.00768
	S	0.00402	0.00827	0.00284	0.00071	0.00000	0.00000	0.01583
	SSW	0.00709	0.00922	0.00650	0.00083	0.00000	0.00000	0.02363
	SW	0.00685	0.00650	0.00922	0.00284	0.00012	0.00012	0.02564
	WSW	0.00425	0.00520	0.00851	0.00201	0.00012	0.00000	0.02009
	W	0.00508	0.00402	0.00555	0.00284	0.00012	0.00000	0.01760
	WNW	0.00165	0.00366	0.00449	0.00213	0.00000	0.00000	0.01193
	NW	0.00106	0.00224	0.00378	0.00248	0.00000	0.00000	0.00957
	NNW	0.00071	0.00130	0.00224	0.00035	0.00000	0.00000	0.00461

Table A.3-1 (continued)

Stability Class		WIND SPEED CLASS < 3	3-7	7-12	12-18	18-24	>24	TOTALS
D	N	0.00768	0.00071	0.00402	0.00236	0.00118	0.00000	0.01595
	NNE	0.00189	0.00933	0.00709	0.00201	0.00024	0.00000	0.02056
	NE	0.00106	0.00851	0.00780	0.00083	0.00000	0.00000	0.01819
	ENE	0.00224	0.00567	0.00236	0.00024	0.00000	0.00000	0.01052
	E	0.00343	0.00437	0.00402	0.00095	0.00000	0.00000	0.01276
	ESE	0.00284	0.00248	0.00260	0.00071	0.00000	0.00000	0.00862
	SE	0.00343	0.00414	0.00118	0.00071	0.00000	0.00000	0.00945
	SSE	0.00614	0.00378	0.00331	0.00024	0.00000	0.00000	0.01347
	S	0.00933	0.01548	0.01796	0.00343	0.00024	0.00000	0.04643
	SSW	0.01477	0.01465	0.01430	0.00284	0.00012	0.00047	0.04714
	SW	0.02044	0.01075	0.01536	0.00862	0.00319	0.00130	0.05966
	WSW	0.01536	0.00992	0.01335	0.01087	0.00496	0.00142	0.05588
	W	0.01512	0.00898	0.01548	0.00815	0.00165	0.00000	0.04939
	WNW	0.01548	0.00650	0.00922	0.00638	0.00059	0.00000	0.03816
	NW	0.00402	0.00815	0.01004	0.00721	0.00059	0.00024	0.03025
	NNW	0.00083	0.00307	0.00756	0.00473	0.00035	0.00000	0.01654
E	N	0.00000	0.00059	0.00224	0.00189	0.00000	0.00000	0.00473
	NNE	0.00059	0.00922	0.00709	0.00189	0.00000	0.00000	0.01879
	NE	0.00000	0.00260	0.00071	0.00000	0.00000	0.00000	0.00331
	ENE	0.00035	0.00095	0.00000	0.00000	0.00000	0.00000	0.00130
	E	0.00024	0.00154	0.00106	0.00000	0.00000	0.00000	0.00284
	ESE	0.00035	0.00177	0.00000	0.00000	0.00000	0.00000	0.00213
	SE	0.00059	0.00071	0.00000	0.00000	0.00000	0.00000	0.00130
	SSE	0.00165	0.00319	0.00024	0.00000	0.00000	0.00047	0.00555
	S	0.00165	0.01016	0.00662	0.00095	0.00000	0.00000	0.01938
	SSW	0.00248	0.00827	0.00248	0.00000	0.00000	0.00000	0.01323
	SW	0.00591	0.00414	0.00106	0.00012	0.00000	0.00000	0.01122
	WSW	0.00461	0.00319	0.00142	0.00012	0.00000	0.00000	0.00933
	W	0.00437	0.00248	0.00059	0.00000	0.00000	0.00000	0.00744
	WNW	0.00721	0.00165	0.00035	0.00012	0.00000	0.00000	0.00933
	NW	0.00047	0.00083	0.00035	0.00000	0.00000	0.00000	0.00165
	NNW	0.00000	0.00059	0.00118	0.00035	0.00000	0.00000	0.00213
F	N	0.00532	0.00414	0.00024	0.00000	0.00000	0.00000	0.00969
	NNE	0.00000	0.00071	0.00083	0.00000	0.00000	0.00000	0.00154
	NE	0.00035	0.00000	0.00000	0.00000	0.00000	0.00000	0.00035
	ENE	0.00024	0.00024	0.00000	0.00000	0.00000	0.00000	0.00047
	E	0.00047	0.00012	0.00000	0.00000	0.00000	0.00000	0.00059
	ESE	0.00024	0.00024	0.00000	0.00012	0.00000	0.00012	0.00071
	SE	0.00047	0.00000	0.00000	0.00000	0.00000	0.00000	0.00047
	SSE	0.00035	0.00071	0.00000	0.00000	0.00000	0.00071	0.00177
	S	0.00035	0.00106	0.00095	0.00000	0.00000	0.00012	0.00248
	SSW	0.00095	0.00059	0.00000	0.00000	0.00000	0.00000	0.00154
	SW	0.00083	0.00047	0.00000	0.00000	0.00000	0.00000	0.00130
	WSW	0.00165	0.00024	0.00012	0.00000	0.00000	0.00000	0.00201
	W	0.00177	0.00000	0.00000	0.00000	0.00000	0.00000	0.00177
	WNW	0.00343	0.00035	0.00000	0.00000	0.00000	0.00000	0.00378
	NW	0.00106	0.00000	0.00000	0.00000	0.00000	0.00000	0.00106
	NNW	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012

Table A.3-2. Portsmouth 10-m joint frequency distribution, 1987

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24	Totals
A	N	0.00059	0.00035	0.00000	0.00000	0.00000	0.00000	0.00095
	NNE	0.00059	0.00142	0.00012	0.00000	0.00000	0.00000	0.00213
	NE	0.00142	0.00295	0.00000	0.00000	0.00000	0.00000	0.00437
	ENE	0.00154	0.00307	0.00047	0.00000	0.00000	0.00000	0.00508
	E	0.00154	0.00307	0.00047	0.00000	0.00000	0.00000	0.00508
	ESE	0.00414	0.00543	0.00024	0.00000	0.00000	0.00000	0.00981
	SE	0.00520	0.00319	0.00024	0.00000	0.00000	0.00000	0.00862
	SSE	0.00650	0.00449	0.00012	0.00000	0.00000	0.00000	0.01111
	S	0.00910	0.00922	0.00047	0.00000	0.00000	0.00000	0.01879
	SSW	0.00945	0.00815	0.00035	0.00000	0.00000	0.00000	0.01796
	SW	0.01075	0.01300	0.00130	0.00000	0.00000	0.00000	0.02505
	WSW	0.00922	0.01500	0.00047	0.00000	0.00000	0.00000	0.02469
	W	0.00709	0.01181	0.00095	0.00000	0.00000	0.00000	0.01985
	WNW	0.00567	0.01016	0.00095	0.00000	0.00000	0.00000	0.01678
	NW	0.00331	0.00579	0.00024	0.00000	0.00000	0.00000	0.00933
	NNW	0.00083	0.00201	0.00012	0.00000	0.00000	0.00000	0.00295
B	N	0.00437	0.00047	0.00000	0.00000	0.00000	0.00000	0.00484
	NNE	0.00106	0.00165	0.00142	0.00000	0.00000	0.00000	0.00414
	NE	0.00118	0.00248	0.00012	0.00000	0.00000	0.00000	0.00378
	ENE	0.00154	0.00366	0.00059	0.00000	0.00000	0.00000	0.00579
	E	0.00248	0.00343	0.00059	0.00000	0.00000	0.00000	0.00650
	ESE	0.00177	0.00319	0.00047	0.00000	0.00000	0.00000	0.00543
	SE	0.00354	0.00437	0.00165	0.00000	0.00000	0.00000	0.00957
	SSE	0.00532	0.00402	0.00130	0.00012	0.00000	0.00000	0.01075
	S	0.01229	0.01252	0.00130	0.00000	0.00000	0.00000	0.02611
	SSW	0.01406	0.01371	0.00224	0.00000	0.00000	0.00000	0.03001
	SW	0.01075	0.00874	0.00354	0.00012	0.00012	0.00000	0.02328
	WSW	0.00839	0.00874	0.00437	0.00000	0.00000	0.00000	0.02150
	W	0.00425	0.00378	0.00189	0.00000	0.00000	0.00000	0.00992
	WNW	0.00307	0.00366	0.00284	0.00012	0.00000	0.00000	0.00969
	NW	0.00177	0.00402	0.00177	0.00035	0.00000	0.00000	0.00792
	NNW	0.00083	0.00224	0.00142	0.00000	0.00000	0.00000	0.00449
C	N	0.00000	0.00035	0.00213	0.00035	0.00000	0.00000	0.00284
	NNE	0.00130	0.00354	0.00496	0.00047	0.00000	0.00000	0.01028
	NE	0.00461	0.00851	0.00142	0.00000	0.00000	0.00000	0.01453
	ENE	0.00201	0.00709	0.00366	0.00000	0.00000	0.00000	0.01276
	E	0.00189	0.00555	0.00236	0.00024	0.00000	0.00000	0.01004
	ESE	0.00095	0.00390	0.00059	0.00000	0.00000	0.00000	0.00543
	SE	0.00213	0.00354	0.00213	0.00000	0.00000	0.00000	0.00780
	SSE	0.00366	0.00236	0.00083	0.00000	0.00000	0.00000	0.00685
	S	0.00827	0.00662	0.00189	0.00000	0.00000	0.00000	0.01678
	SSW	0.01016	0.01902	0.00378	0.00012	0.00000	0.00000	0.03308
	SW	0.00343	0.01099	0.00402	0.00083	0.00024	0.00000	0.01949
	WSW	0.00425	0.00945	0.01264	0.00603	0.00095	0.00000	0.03332
	W	0.00213	0.00910	0.00933	0.00307	0.00000	0.00000	0.02363
	WNW	0.00130	0.00792	0.00638	0.00059	0.00000	0.00000	0.01619
	NW	0.00154	0.00532	0.01016	0.00224	0.00024	0.00000	0.01949
	NNW	0.00047	0.00567	0.00957	0.00142	0.00000	0.00000	0.01713

Table A.3-2 (continued)

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24	Totals
D	N	0.00792	0.00035	0.00260	0.00083	0.00000	0.00000	0.01170
	NNE	0.00083	0.00603	0.00685	0.00130	0.00000	0.00000	0.01500
	NE	0.00425	0.01075	0.00414	0.00024	0.00000	0.00000	0.01938
	ENE	0.00165	0.00095	0.00024	0.00000	0.00000	0.00000	0.00284
	E	0.00378	0.00130	0.00071	0.00012	0.00000	0.00000	0.00591
	ESE	0.00567	0.00071	0.00024	0.00000	0.00000	0.00000	0.00662
	SE	0.00827	0.00000	0.00012	0.00000	0.00000	0.00000	0.00839
	SSE	0.02800	0.00012	0.00000	0.00000	0.00000	0.00000	0.02812
	S	0.08247	0.00142	0.00059	0.00012	0.00000	0.00000	0.08459
	SSW	0.03544	0.00319	0.00012	0.00000	0.00000	0.00000	0.03875
	SW	0.01808	0.00035	0.00024	0.00000	0.00000	0.00000	0.01867
	WSW	0.01134	0.00284	0.00059	0.00012	0.00000	0.00000	0.01489
	W	0.00851	0.00118	0.00047	0.00000	0.00012	0.00000	0.01028
	WNW	0.00378	0.00154	0.00035	0.00000	0.00000	0.00000	0.00567
	NW	0.00130	0.00236	0.00106	0.00000	0.00000	0.00000	0.00473
	NNW	0.00012	0.00461	0.00130	0.00035	0.00000	0.00000	0.00638
E	N	0.00000	0.00000	0.00000	0.00000	0.00000	0.00024	0.00024
	NNE	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012
	NE	0.00024	0.00083	0.00047	0.00000	0.00000	0.00000	0.00154
	ENE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	E	0.00035	0.00000	0.00000	0.00000	0.00000	0.00000	0.00035
	ESE	0.00024	0.00000	0.00000	0.00000	0.00000	0.00000	0.00024
	SE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	SSE	0.00024	0.00000	0.00000	0.00000	0.00000	0.00000	0.00024
	S	0.00095	0.00000	0.00000	0.00000	0.00000	0.00000	0.00095
	SSW	0.00047	0.00000	0.00000	0.00000	0.00000	0.00000	0.00047
	SW	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	WSW	0.00012	0.00012	0.00000	0.00000	0.00000	0.00000	0.00024
	W	0.00000	0.00012	0.00000	0.00000	0.00000	0.00000	0.00012
	WNW	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012
	NW	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	NNW	0.00000	0.00024	0.00000	0.00000	0.00000	0.00000	0.00024
F	N	0.00603	0.00733	0.00201	0.00047	0.00000	0.00000	0.01583
	NNE	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012
	NE	0.00024	0.00000	0.00000	0.00000	0.00000	0.00000	0.00024
	ENE	0.00024	0.00000	0.00000	0.00000	0.00000	0.00000	0.00024
	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	ESE	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012
	SE	0.00095	0.00000	0.00000	0.00000	0.00000	0.00000	0.00095
	SSE	0.00402	0.00000	0.00012	0.00000	0.00000	0.00000	0.00414
	S	0.01052	0.00000	0.00177	0.00035	0.00000	0.00012	0.01276
	SSW	0.00437	0.00000	0.00000	0.00000	0.00000	0.00012	0.00449
	SW	0.00106	0.00012	0.00000	0.00000	0.00000	0.00000	0.00118
	WSW	0.00047	0.00012	0.00000	0.00000	0.00000	0.00000	0.00059
	W	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012
	WNW	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	NW	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	NNW	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table A.3-3. Portsmouth 40-m joint frequency distribution, 1988

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24
A	N	.000330	.000496	.000000	.000000	.000000	.000000
	NNE	.001652	.001487	.000330	.000000	.000000	.000000
	NE	.001157	.003305	.000000	.000000	.000000	.000000
	ENE	.002809	.002974	.000330	.000000	.000000	.000000
	E	.002148	.003305	.000165	.000165	.000000	.000000
	ESE	.003800	.003305	.000165	.000000	.000000	.000000
	SE	.004296	.002479	.000330	.000000	.000000	.000000
	SSE	.003139	.003966	.000165	.000000	.000000	.000000
	S	.006444	.006279	.000661	.000000	.000000	.000000
	SSW	.006609	.003139	.000991	.000000	.000000	.000000
	SW	.007105	.005783	.000496	.000165	.000000	.000000
	WSW	.005288	.004461	.000496	.000000	.000000	.000000
	W	.003305	.002313	.000000	.000000	.000000	.000000
	WNW	.002479	.002148	.000330	.000000	.000000	.000000
	NW	.000496	.001652	.000330	.000000	.000000	.000000
	NNW	.000330	.000991	.000496	.000000	.000000	.000000
B	N	.000661	.000000	.000165	.000000	.000000	.000000
	NNE	.001487	.001652	.000991	.000000	.000000	.000000
	NE	.001652	.001652	.000165	.000000	.000000	.000000
	ENE	.003305	.002644	.001157	.000000	.000000	.000000
	E	.001818	.001818	.001322	.000165	.000000	.000000
	ESE	.001983	.001983	.000991	.000165	.000000	.000000
	SE	.002479	.002148	.000000	.000000	.000000	.000000
	SSE	.003635	.001487	.000826	.000000	.000000	.000000
	S	.004957	.003305	.002809	.000330	.000000	.000000
	SSW	.007436	.005288	.001983	.000000	.000000	.000000
	SW	.009418	.004296	.002809	.000330	.000000	.000000
	WSW	.006775	.003470	.001322	.000000	.000000	.000000
	W	.003800	.002313	.001487	.000000	.000000	.000000
	WNW	.001818	.001487	.001322	.000000	.000000	.000000
	NW	.000496	.001652	.002479	.000165	.000000	.000000
	NNW	.000165	.000661	.000496	.000000	.000000	.000000
C	N	.000000	.000330	.000826	.000000	.000000	.000000
	NNE	.000661	.001652	.001652	.000496	.000000	.000000
	NE	.001487	.003800	.001487	.000826	.000000	.000000
	ENE	.002974	.004461	.002148	.001322	.000000	.000000
	E	.002809	.004461	.001487	.000826	.000000	.000000
	ESE	.002479	.002644	.002974	.000496	.000000	.000000
	SE	.001652	.001983	.001487	.000000	.000000	.000000
	SSE	.003800	.002313	.003470	.000496	.000000	.000000
	S	.005783	.006940	.008427	.002644	.000330	.000000
	SSW	.008427	.007931	.006775	.005948	.001652	.000165
	SW	.009914	.004792	.006775	.002148	.000991	.000165
	WSW	.005122	.003470	.005288	.001818	.000330	.000000
	W	.002809	.003635	.005948	.002644	.000330	.000000
	WNW	.001487	.003139	.004131	.001818	.000000	.000000
	NW	.000165	.001983	.002313	.000826	.000000	.000000
	NNW	.000165	.000826	.001652	.000826	.000000	.000000

Table A.3-3 (continued)

Stability Class		WIND SPEED CLASS < 3	3-7	7-12	12-18	18-24	>24
D	N	.003139	.000661	.002313	.002313	.000496	.000000
	NNE	.003139	.007601	.001983	.000661	.000000	.000000
	NE	.003139	.006609	.001487	.000165	.000000	.000000
	ENE	.005783	.003635	.002148	.000165	.000000	.000000
	E	.003139	.003635	.002479	.001322	.000000	.000000
	ESE	.003470	.002974	.001157	.000496	.000000	.000000
	SE	.003800	.003470	.001322	.000000	.000000	.000000
	SSE	.006279	.005618	.009088	.001487	.000000	.000165
	S	.009253	.017350	.033047	.013219	.001487	.000000
	SSW	.013054	.017350	.020324	.012888	.002479	.000000
	SW	.016028	.008923	.017019	.010245	.004131	.000991
	WSW	.015036	.008262	.015202	.016193	.002313	.000661
	W	.008262	.007270	.013054	.006775	.000991	.000000
	WNW	.005122	.007105	.011236	.004461	.000330	.000000
	NW	.001983	.005948	.012888	.003305	.000165	.000000
	NNW	.000661	.001983	.006444	.005288	.000330	.000000
E	N	.000000	.001487	.001983	.000661	.000165	.000000
	NNE	.000991	.007931	.002479	.000330	.000000	.000000
	NE	.000330	.004627	.000661	.000000	.000000	.000000
	ENE	.001652	.003305	.000000	.000000	.000000	.000000
	E	.001322	.001652	.000165	.000000	.000000	.000165
	ESE	.000165	.000826	.000000	.000000	.000000	.000000
	SE	.000496	.000826	.000330	.000000	.000000	.000826
	SSE	.001157	.004131	.001157	.000000	.000000	.000330
	S	.001487	.014045	.007931	.000330	.000000	.000000
	SSW	.000496	.008592	.005618	.000496	.000000	.000000
	SW	.004627	.005453	.002148	.000165	.000000	.000000
	WSW	.004792	.002644	.001652	.000165	.000000	.000000
	W	.001487	.003635	.000496	.000330	.000000	.000000
	WNW	.000165	.001983	.000000	.000000	.000000	.000000
	NW	.000000	.001487	.000991	.000000	.000000	.000000
	NNW	.000165	.000496	.002148	.000000	.000000	.000000
F	N	.004296	.008592	.008923	.000330	.000000	.000000
	NNE	.000000	.001487	.000991	.000165	.000000	.000000
	NE	.000000	.000000	.000000	.000000	.000000	.000000
	ENE	.000000	.000000	.000165	.000000	.000000	.000165
	E	.000165	.000000	.000000	.000000	.000000	.000000
	ESE	.000000	.000165	.000000	.000000	.000000	.000000
	SE	.000000	.000000	.000000	.000000	.000000	.000000
	SSE	.000330	.000330	.000165	.000000	.000000	.000165
	S	.000000	.000330	.000826	.000000	.000000	.000000
	SSW	.000000	.000330	.000000	.000000	.000000	.000000
	SW	.000165	.000496	.000000	.000000	.000000	.000000
	WSW	.000496	.000000	.000000	.000000	.000000	.000000
	W	.000000	.000000	.000000	.000000	.000000	.000000
	WNW	.000000	.000000	.000000	.000000	.000000	.000000
	NW	.000000	.000000	.000000	.000000	.000000	.000000
	NNW	.000000	.000000	.000000	.000000	.000000	.000000

Table A.3-4. Portsmouth 10-m joint frequency distribution, 1988

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24
A	N	.000165	.000496	.000165	.000165	.000000	.000000
	NNE	.000496	.003635	.001818	.000000	.000000	.000000
	NE	.001983	.004461	.000000	.000000	.000000	.000000
	ENE	.003305	.005618	.000165	.000000	.000000	.000000
	E	.004957	.006940	.000991	.000000	.000000	.000000
	ESE	.005288	.007601	.000661	.000000	.000000	.000000
	SE	.005618	.003635	.000165	.000000	.000000	.000000
	SSE	.007931	.005453	.000000	.000000	.000000	.000000
	S	.010905	.010079	.000826	.000000	.000000	.000000
	SSW	.012888	.011071	.002479	.000165	.000000	.000000
	SW	.010905	.012062	.001322	.000000	.000000	.000000
	WSW	.010905	.012558	.001157	.000000	.000000	.000000
	W	.005783	.006114	.000165	.000000	.000000	.000000
	WNW	.006444	.004131	.000661	.000000	.000000	.000000
	NW	.002644	.004627	.001157	.000000	.000000	.000000
	NNW	.000496	.002974	.000000	.000000	.000000	.000000
B	N	.002313	.000661	.001157	.000496	.000000	.000000
	NNE	.002313	.003635	.002313	.000330	.000000	.000000
	NE	.003470	.001652	.001322	.000000	.000000	.000000
	ENE	.003139	.003966	.000991	.000000	.000000	.000000
	E	.002809	.002809	.002974	.000000	.000000	.000000
	ESE	.003966	.002148	.000496	.000000	.000000	.000000
	SE	.004296	.002313	.000330	.000000	.000000	.000000
	SSE	.007270	.004131	.000330	.000000	.000000	.000000
	S	.016193	.018176	.005618	.000000	.000000	.000000
	SSW	.014541	.015202	.009418	.000826	.000000	.000000
	SW	.010410	.010740	.010410	.002313	.000165	.000000
	WSW	.008096	.006444	.004957	.000991	.000000	.000000
	W	.009253	.003305	.003800	.000330	.000000	.000000
	WNW	.003635	.004957	.004131	.000496	.000000	.000000
	NW	.001652	.003305	.002479	.000000	.000000	.000000
	NNW	.001157	.001818	.001652	.000000	.000000	.000000
C	N	.000330	.001487	.001652	.001157	.000000	.000000
	NNE	.002148	.005453	.003470	.000000	.000000	.000000
	NE	.005783	.003966	.000826	.000000	.000000	.000000
	ENE	.001487	.002148	.001983	.000000	.000000	.000000
	E	.003635	.003470	.002148	.000330	.000000	.000000
	ESE	.000661	.002479	.000661	.000000	.000000	.000000
	SE	.001487	.003305	.000661	.000000	.000000	.000000
	SSE	.001983	.003139	.001487	.000000	.000000	.000000
	S	.010410	.010740	.006279	.000661	.000000	.000000
	SSW	.008592	.027594	.012888	.001487	.000000	.000000
	SW	.004957	.014045	.009088	.002809	.000000	.000000
	WSW	.004131	.013219	.015036	.002809	.000661	.000000
	W	.003139	.010905	.018176	.001487	.000330	.000000
	WNW	.001983	.013714	.008427	.001322	.000000	.000000
	NW	.000991	.009584	.009418	.000496	.000000	.000000
	NNW	.000826	.006114	.003966	.000826	.000000	.000000

Table A.3-4 (continued)

Stability Class		WIND SPEED CLASS (in mph) < 3	3-7	7-12	12-18	18-24	> 24
D	N	.006279	.000496	.000496	.000496	.000000	.000000
	NNE	.001487	.002148	.001157	.000165	.000000	.000000
	NE	.004627	.004792	.001157	.000000	.000000	.000000
	ENE	.001983	.001157	.000000	.000000	.000000	.000000
	E	.005948	.000165	.000165	.000000	.000000	.000000
	ESE	.005618	.000496	.000000	.000000	.000000	.000000
	SE	.008757	.000000	.000165	.000000	.000000	.000000
	SSE	.026438	.000496	.000330	.000000	.000000	.000000
	S	.075347	.001157	.000661	.000000	.000000	.000000
	SSW	.026272	.003470	.002148	.000165	.000000	.000000
	SW	.015863	.001652	.000661	.000165	.000000	.000000
	WSW	.012888	.002644	.001157	.000000	.000000	.000000
	W	.012723	.000991	.000991	.000000	.000000	.000000
	WNW	.004627	.001652	.000000	.000000	.000000	.000000
	NW	.001983	.002479	.000826	.000000	.000000	.000000
	NNW	.005122	.007105	.003470	.000165	.000000	.000000
E	N	.000000	.000000	.000000	.000000	.000000	.000000
	NNE	.000000	.000000	.000000	.000000	.000000	.000000
	NE	.000000	.000000	.000000	.000000	.000000	.000000
	ENE	.000000	.000000	.000000	.000000	.000000	.000000
	E	.000000	.000000	.000000	.000000	.000000	.000000
	ESE	.000000	.000000	.000000	.000000	.000000	.000000
	SE	.000000	.000000	.000000	.000000	.000000	.000000
	SSE	.000000	.000000	.000000	.000000	.000000	.000000
	S	.000496	.000000	.000000	.000000	.000000	.000000
	SSW	.000165	.000000	.000000	.000000	.000000	.000000
	SW	.000165	.000000	.000000	.000000	.000000	.000000
	WSW	.000165	.000000	.000000	.000000	.000000	.000000
	W	.000165	.000000	.000000	.000000	.000000	.000000
	WNW	.000165	.000000	.000000	.000000	.000000	.000000
	NW	.000000	.000000	.000000	.000000	.000000	.000000
	NNW	.000330	.000000	.000000	.000000	.000000	.000000
F	N	.000000	.000000	.000000	.000000	.000000	.000165
	NNE	.000000	.000000	.000000	.000000	.000000	.000000
	NE	.000000	.000000	.000000	.000000	.000000	.000000
	ENE	.000000	.000000	.000000	.000000	.000000	.000000
	E	.000000	.000000	.000000	.000000	.000000	.000000
	ESE	.000000	.000000	.000000	.000000	.000000	.000000
	SE	.000000	.000000	.000000	.000000	.000000	.000000
	SSE	.000000	.000000	.000000	.000000	.000000	.000000
	S	.000000	.000000	.000000	.000000	.000000	.000000
	SSW	.000000	.000000	.000000	.000000	.000000	.000000
	SW	.000000	.000000	.000000	.000000	.000000	.000000
	WSW	.000000	.000000	.000000	.000000	.000000	.000000
	W	.000000	.000000	.000000	.000000	.000000	.000000
	WNW	.000000	.000000	.000000	.000000	.000000	.000000
	NW	.000000	.000000	.000000	.000000	.000000	.000000
	NNW	.000000	.000000	.000000	.000000	.000000	.000000

Table A.3-5. Summary of ambient monitoring data collected at Portsmouth, Ohio, in 1987

SITE SUMMARY OF TOTAL PARTICULATES
UNITS: MICROGRAMS/CUBIC METER (25 DEG.C)
JAN 87-DEC 87

STATE/AQCR/COUNTY: AREA	SITE	FED REQ SITE	SIP REQ SITE	YEAR	ANNUAL GEO AVG	TOTAL 24-HR OBS	TOTAL 24-HR OBS>260	TOTAL 24-HR OBS>150	HIGH 24-HR OBS	2ND 24-HR OBS	3RD 24-HR OBS	4TH 24-HR OBS	5TH 24-HR OBS	STD GEO DEV
(36) OHIO														
(103) HUNTINGTON-ASHLAND-PORTSMOUTH-IRONTON INTERSTATE AQCR														
PORTSMOUTH	365620002H01	728 2ND ST PORTSMOUTH												
		Y		87	52.3	60	0	0	139.	116.	115.	111.	98.	1.51
	002H09	728 SECOND STREET												
		Y		87	50.3	251	0	1	162.+	142.	132.	131.	126.	1.63
	003H01	2040 CHARLES STREET												
		Y		87	49.2	56	0	0	139.	102.	102.	99.	94.	1.60
	005H01	422 HARDING AVENUE												
		Y		87	48.7	61	0	0	109.	103.	80.	79.	78.	1.44
	009H01	25TH STREET & ELMWOOD DR.												
		Y		87	38.9	36	0	0	82.	77.	68.	68.	63.	1.45
	013H01	4862 GALLIA ST.PORTSMOUT												
		Y		87	63.5+	59	1	3	276.*	183.+	157.+	146.	137.	1.66

SITE SUMMARY OF SULFUR DIOXIDE
UNITS: MICROGRAMS/CUBIC METER (25 DEG.C)
JAN 87-DEC 87

STATE/AQCR/COUNTY: AREA	SITE	FED REQ SITE	SIP REQ SITE	SMP MTH	YEAR	ANNUAL ARITH AVG	TOTAL OBS	TOTAL 24-HR AVG>365	HIGH 24-HR AVG	2ND 24-HR AVG	3RD 24-HR AVG	TOTAL 3-HR PERIOD >1300	HIGH 3-HR AVG	2ND 3-HR AVG	3RD 3-HR AVG	STD GEO DEV
(36) OHIO																
(103) HUNTINGTON-ASHLAND-PORTSMOUTH-IRONTON INTERSTATE AQCR																
PORTSMOUTH	365620007H01	740 SECOND STREET														
		Y		23	87	35.5	8440	0	201.	159.	150.	0	485.	380.	362.	2.10

****
* '*' = EXCEEDS PRIMARY STANDARD '+' = EXCEEDS SECONDARY STANDARD *.
****

Source: Ohio Environmental Protection Agency, *Ohio Air Quality Report,* Columbus, Ohio, June 12, 1989. pp. 54, 81.

APPENDIX B

Appendix B

GEOLOGY

APPENDIX B. GEOLOGY

Appendix B consists of three maps placed in pockets after Appendix I:

- Fig. B.1. Hydrogeological characterization study, base map, Paducah Gaseous Diffusion Plant, Paducah, Kentucky;
- Fig. B.2. Hydrogeological characterization study, generalized stratigraphic correlation, Profile X–X, Paducah Gaseous Diffusion Plant, Paducah, Kentucky; and
- Fig. B.3. Hydrogeological characterization study, generalized stratigraphic correlation, Profile Y–Y, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.

APPENDIX C

Appendix C

SEISMICITY

APPENDIX C. SEISMICITY

Figure C-1 is a Uniform Building Code (ICBO 1988, p. 178) seismic zone map of the 48 conterminous United States. The Paducah Gaseous Diffusion Plant (PGDP) is located in Seismic Zone 2A, where moderate earthquake damage may be expected. The boundary with Seismic Zone 3 (where major earthquake damage may be expected) is nearby. The Oak Ridge Gaseous Diffusion Plant (ORGDP) is also located in Seismic Zone 2A, but the boundary with Seismic Zone 1 (where only minor earthquake damage may be expected) is nearby. The Portsmouth Gaseous Diffusion Plant (PORTS) is located in Seismic Zone 1. Z-factors in the 1988 *Uniform Building Code* (ICBO 1988, p. 168) seismic design standards (implicitly understood as design EPGAs) are 0.15 in Seismic Zone 2A, where both PGDP and ORGDP are located, and 0.075 in Seismic Zone 1, where PORTS is located.

Figure C-2 is a map of estimated EPGAs in the conterminous states of the United States (FEMA 1988, p. 15) having 10% probabilities of exceedance at least once in 50 years (equivalent to a 475-year return period). The 0.10-g contour is the boundary between Seismic Zones 1 and 2A, as presented in Fig. C-1, and the 0.20-g contour is the boundary between Seismic Zones 2A and 3. The EPGAs having 10% probabilities of exceedance are 0.20 g, 0.10 g, and 0.05 g for PGDP, ORGDP, and PORTS respectively. Thus, seismic-risk estimates (FEMA 1988, p. 15) are significantly greater at PGDP than at ORGDP despite the fact that these two facilities are in the same seismic zone (2A), as shown in Fig. C-1.

Figure C-3 is a seismotectonic map of the midwestern United States showing the relationship between structural features and seismically active regions. Also shown are the locations of ORGDP, PGDP, and PORTS. According to Hadley and Devine (1974, Map MF-620, sheets 1 and 2 combined), only the New Madrid, Shawneetown, and Wabash Valley Fault Zones are clearly "associated with epicentral alinements or distribution in such a way as to suggest that movements on the known faults or closely related faults may have been the source of recorded earthquakes." According to Bollinger and Wheeler (1988, p. 1), earthquake foci are too deep to be associated with decollement faults of the Appalachian fold belt. As shown in Fig. C-3, the Cottage Grove, Rough Creek, Kentucky River, Irvine, and Paint Creek Fault Zones do not appear to be related to modern seismicity.

Table C-1 compares the TERA Corp.'s seismic hazard analysis results for the design of low-, moderate-, and high-hazard facilities at ORGDP, PGDP, and PORTS (DOE 1989, p. 1-2). Although final design peak ground accelerations have not been decided, these results are useful for comparative purposes. The tabulated results in Table C-1 show that seismic hazards are large, intermediate, and low at PGDP, ORGDP, and PORTS respectively.

Table C-2 is the modified Mercalli intensity scale of 1931 as presented by Beavers, Manrod, and Stoddart (1982, pp. 93–99).

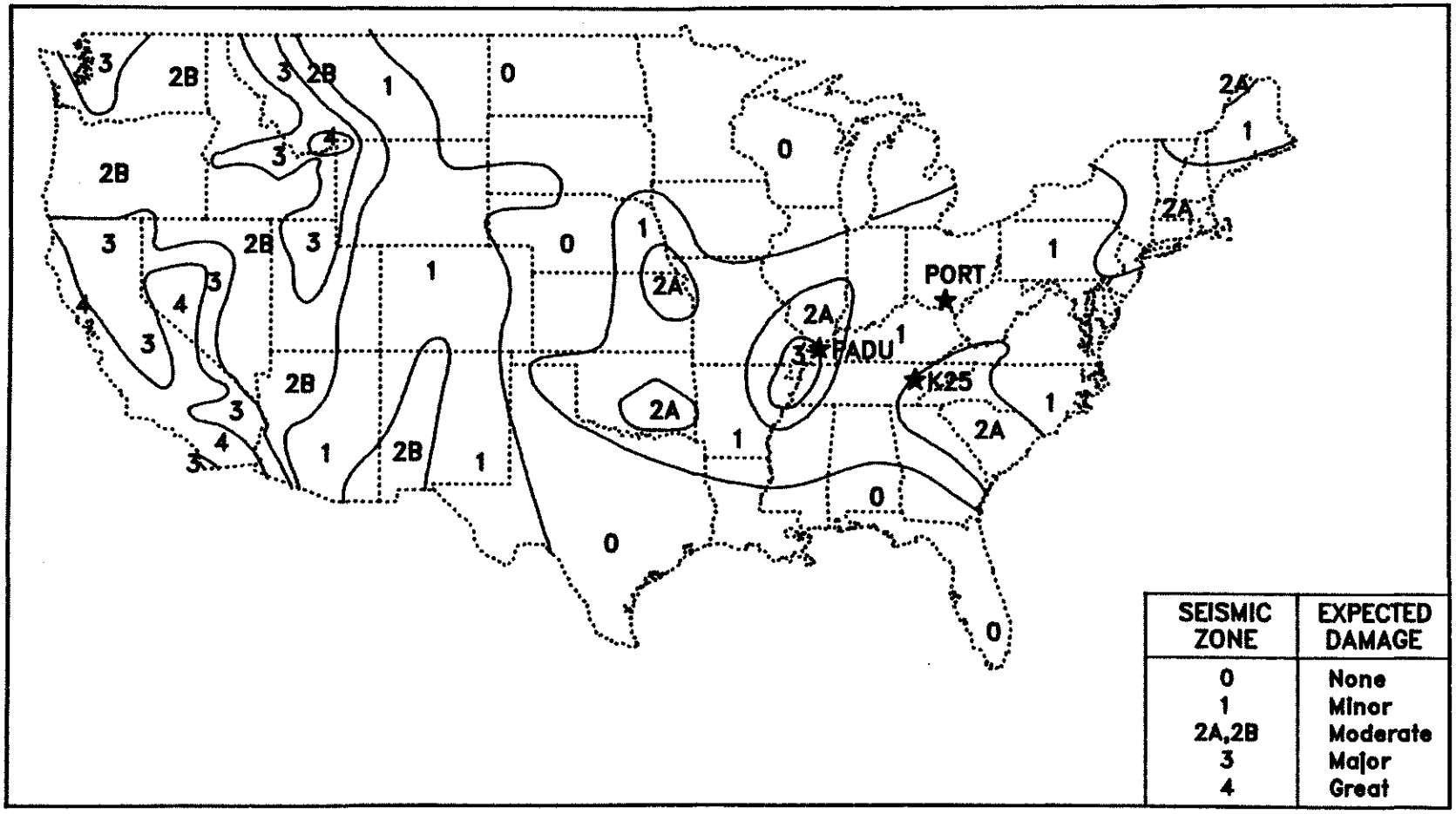
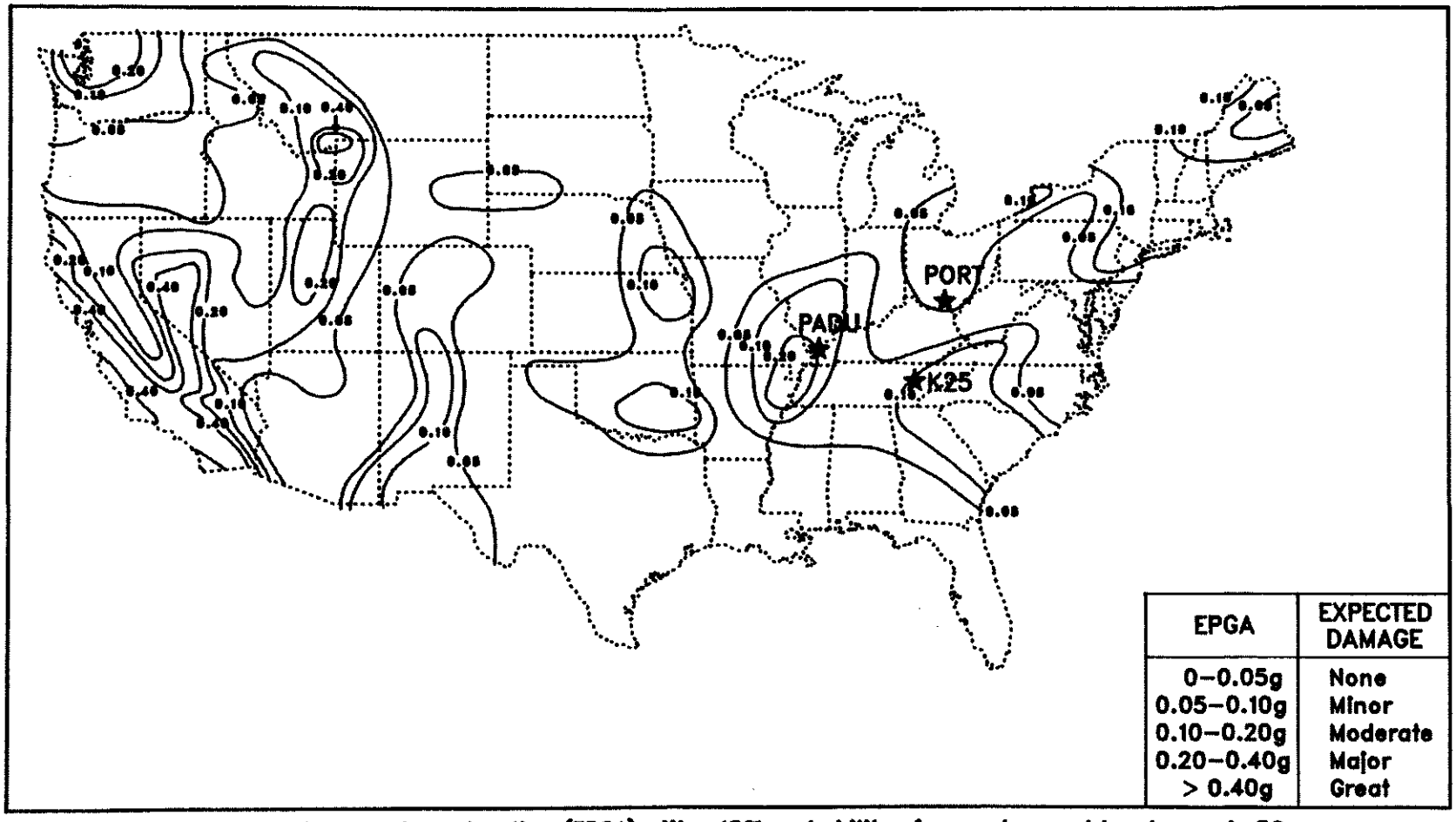


Fig. C–1. Seismic zone map of the 48 conterminous U.S. states. *Source: Uniform Building Code*, International Conference of Building Officials, Whittier, Calif., 1988.



EPGA	EXPECTED DAMAGE
0–0.05g	None
0.05–0.10g	Minor
0.10–0.20g	Moderate
0.20–0.40g	Major
> 0.40g	Great

Fig. C–2. Effective peak ground acceleration (EPGA) with a 10% probability of exceedance at least once in 50 years. *Source*: modified from Federal Emergency Management Agency, *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, Building Seismic Safety Council, Washington, D.C., 1988.

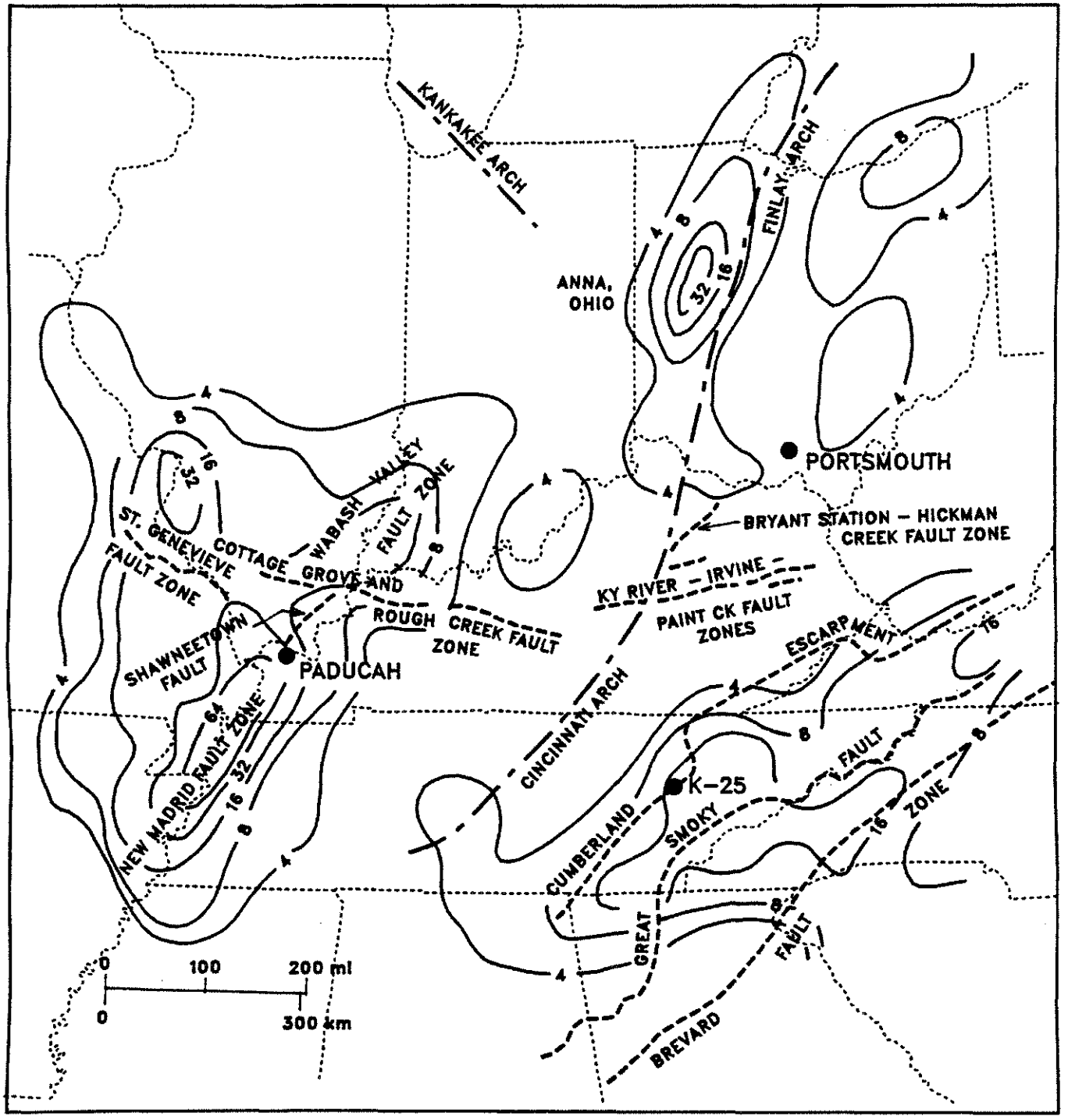


Fig. C–3. Seismotectonic map of the midwestern United States. *Source*: modified after Hadley, J.B. and Devine, J.F., 1974, "Seismotectonic map of the eastern United States," U.S. Geological Survey miscellaneous field investigation, Map MF–620, Denver, Colorado. Contour interval: number of earthquakes with intensities equal to or greater than Mercalli III per 10,000 square kilometers from 1800–1972.

Table C-1. Results of the TERA Corp.'s 1982 seismic hazard analysis for the Oak Ridge Gaseous Diffusion Plant (ORGDP), Paducah Gaseous Diffusion Plant (PGDP), and Portsmouth Gaseous Diffusion Plant (PORTS)

Annual probability of exceedance	Type of facility	Effective peak ground acceleration		
		ORGDP	PGDP	PORTS
2×10^{-3}	Low hazard	0.15	0.33	0.08
1×10^{-3}	Moderate hazard	0.19	0.45	0.11
2×10^{-4}	High hazard	0.32	NA[a]	0.17

[a]NA = not available.

Source: Modified from U.S. Department of Energy, *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, draft, UCRL-15910, Washington, D.C., 1989.

Table C-2. Modified Mercalli intensity scale of 1931

I.
- a. Not felt - or, except rarely under especially favorable circumstances.
  Under certain conditions, at and outside the boundary of the area in which a great shock is felt:
- b. Sometimes birds, animals, reported uneasy or disturbed.
- c. Sometimes dizziness or nausea experienced.
- d. Sometimes trees, structures, liquids, bodies of water, may sway, doors may swing, very slowly.

II.
- a. Felt indoors by few, especially on upper floors, or by sensitive, or nervous persons.
  Also, as in Grade I, but often more noticeably:
- b. Sometimes hanging objects may swing, especially when delicately suspended.
- c. Sometimes trees, structures, liquids, bodies of water, may sway, doors may swing, very slowly.
- d. Sometimes birds, animals, reported uneasy or disturbed.
- e. Sometimes dizziness or nausea experienced.

III.
- a. Felt indoors by several . . .
- b. Motion usually rapid vibration.
- c. Sometimes not recognized to be an earthquake at first.
- d. Duration estimated in some cases.
- e. Vibration like that due to passing of light, or lightly-loaded trucks, or heavy trucks some distance away.
- f. Hanging objects may swing slightly.
- g. Movements may be appreciable on upper levels of tall structures.
- h. Rocked standing motorcars slightly.

IV.
- a. Felt indoors by many, outdoors by few.
- b. Awakened few, especially light sleepers.
- c. Frightened no one, unless apprehensive from previous experience.
- d. Vibration like that due to passing of heavy, or heavily loaded trucks.
- e. Sensation like heavy body striking building, or falling of heavy objects inside.
- f. Rattling of dishes, windows, doors; glassware and crockery clink and clash.
- g. Creaking of walls, frame, especially in the upper range of this grade.
- h. Hanging objects swung, in numerous instances.
- i. Disturbed liquids in open vessels slightly.
- j. Rocked standing motorcars noticeably.

V.
- a. Felt indoors by practically all, outdoors by many or most.
- b. Outdoors direction estimated.
- c. Awakened many, or most.
- d. Frightened few--slight excitement, a few ran outdoors.
- e. Buildings trembled throughout.
- f. Broke dishes, glassware, to some extent.
- g. Cracked windows--in some cases, but not generally.

Table C-2. (continued)

h. Overturned vases, small or unstable objects, in many instances, with occasional fall.
i. Hanging objects, doors, swing generally or considerably.
j. Knocked pictures against walls, or swung them out of place.
k. Opened, or closed, doors, shutters abruptly.
l. Pendulum clocks stopped, started, or ran fast, or slow.
m. Moved small objects, furnishings, the latter to slight extent.
n. Spilled liquids in small amounts from well-filled, open containers.
o. Trees, bushes, shaken slightly.

VI.
a. Felt by all indoors and outdoors.
b. Frightened many, excitement general, some alarm, many ran outdoors.
c. Awakened all.
d. Persons made to move unsteadily.
e. Trees, bushes, shaken slightly to moderately.
f. Liquid set in strong motion.
g. Small bells rang--church, chapel, school, etc.
h. Damage slight in poorly built buildings.
i. Fall of plaster in small amount.
j. Cracked plaster somewhat, especially fine cracks (in) chimneys in some instances.
k. Broke dishes, glassware, in considerable quantity, also some windows.
l. Fall of knickknacks, books, pictures.
m. Overturned furniture in many instances.
n. Moved furnishings of moderately heavy kind.

VII.
a. Frightened all--general alarm, all ran outdoors.
b. Some, or many, found it difficult to stand.
c. Noticed by persons driving motorcars.
d. Trees and bushes shaken moderately to strongly.
e. Waves on ponds, lakes, and running water.
f. Water turbid from mud stirred up.
g. Incaving to some extent of sand or gravel stream banks.
h. Rang large church bells, etc.
i. Suspended objects made to quiver.
j. Damage negligible in buildings of good design and construction.
k. (Damage) slight to moderate in well-built ordinary buildings, considerable in poorly-built or badly-designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc.
l. Cracked chimneys to considerable extent, walls to some extent.
m. Fall of plaster in considerable to large amount, also some stucco.
n. Broke numerous windows, furniture to some extent.
o. Shook down loosened brickwork and tiles.
p. Broke weak chimneys at the roofline (sometimes damaging roofs).
q. Fall of cornices from towers and high buildings.

Table C-2. (continued)

r. Dislodged bricks and stones.
s. Overturned heavy furniture, with damage from breaking.
t. Damage considerable to concrete irrigation ditches.

VIII.
a. Fright general--alarm approaches panic.
b. Disturbed persons driving motorcars.
c. Trees shaken strongly--branches, trunks, broken off, especially palm trees.
d. Ejected sand and mud in small amounts.
e. Changes: temporary, permanent; in flow of springs and wells; dry wells renewed flow; in temperature of spring and well waters.
f. Damage slight in structures (brick) built especially to withstand earthquakes.
g. (Damage) considerable in ordinary substantial buildings, partial collapse; racked, tumbled down, wooden houses in some cases; threw out panel walls in frame structures, broke off decayed piling.
h. Fall of walls.
i. Cracked, broke, solid stone walls seriously. Wet ground to some extent, also ground on steep slopes.
j. Twisting, fall, of chimneys, columns, monuments, also factory stacks, towers.
k. Moved conspicuously, overturned, very heavy furniture.

IX.
a. Panic general.
b. Cracked ground conspicuously.
c. Damage considerable in (masonry) structures built especially to withstand earthquakes.
d. Threw out of plumb some wood frame houses built especially to withstand earthquakes.
e. (Damage) great in substantial (masonry) buildings, some collapse in large part; or wholly shifted frame buildings off foundations, racked frames.
f. (Damage) serious to reservoirs.
g. Underground pipes sometimes broken.

X.
a. Cracked ground, especially when loose and wet, up to widths of several inches; fissures up to a yard in width ran parallel to canal and stream banks.
b. Landslides considerable from river banks and steep coasts.
c. Shifted sand and mud horizontally on beaches and flat land.
d. Changed level of water in wells.
e. Threw water on banks of canals, lakes, rivers, etc.
f. Damage serious to dams, dikes, embankments.
g. (Damage) severe to well-built wooden structures and bridges, some destroyed.
h. Developed dangerous cracks in excellent brick walls.
i. Destroyed most masonry and frame structures, also their foundations.
j. Bent railroad rails slightly.
k. Tore apart, or crushed endwise, pipelines buried in earth.
l. Open cracks and broad wavy folds in cement pavements and asphalt road surfaces.

Table C-2. (continued)

XI.	a.	Disturbances in ground many and widespread, varying with ground material.
	b.	Broad fissures, earth slumps, and land slips in soft, wet ground.
	c.	Ejected water in large amounts charged with sand and mud.
	d.	Caused sea-waves ("tidal" waves) of significant magnitude.
	e.	Damage severe to wood frame structures, especially near shock centers.
	f.	(Damage) great to dams, dikes, embankments, often for long distances.
	g.	Few, if any (masonry), structures remained standing.
	h.	Destroyed large well-built bridges by the wrecking of supporting piers, or pillars.
	i.	Affected yielding wooden bridges less.
	j.	Bent railroad rails greatly, and thrust them endwise.
	k.	Put pipelines buried in earth completely out of service.
XII.	a.	Damage total--practically all works of construction damaged greatly or destroyed.
	b.	Disturbances in ground great and varied, numerous shearing cracks.
	c.	Landslides, falls of rock of significant character, slumping of river banks, etc., numerous and extensive.
	d.	Wrenched loose, tore off, large rock masses.
	e.	Fault slips in firm rock, with notable horizontal and vertical offset displacements.
	f.	Water channels, surface and underground, disturbed and modified greatly.
	g.	Dammed lakes, produced waterfalls, deflected rivers, etc.
	h.	Waves seen on ground surfaces (actually seen, probably, in some cases).
	i.	Distorted lines of sight and level.
	j.	Threw objects upward into the air.

Source: J. E. Beavers, W. E. Manrod, and W. C. Stoddart, *Recommended Seismic Hazard Levels for Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations*, K/BD-1025/R1, Oak Ridge, Tenn., 1982, pp. 93–99.

C.1 REFERENCES

ICBO (International Conference of Building Officials) 1988. *Uniform Building Code*, Whittier, Calif.

FEMA (U.S. Federal Emergency Management Agency) 1988. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, Building Seismic Safety Council, Washington, D.C.

DOE (U.S. Department of Energy) 1989. *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, draft, UCRL-15910, Washington, D.C.

APPENDIX D

Appendix D

SURFACE WATER

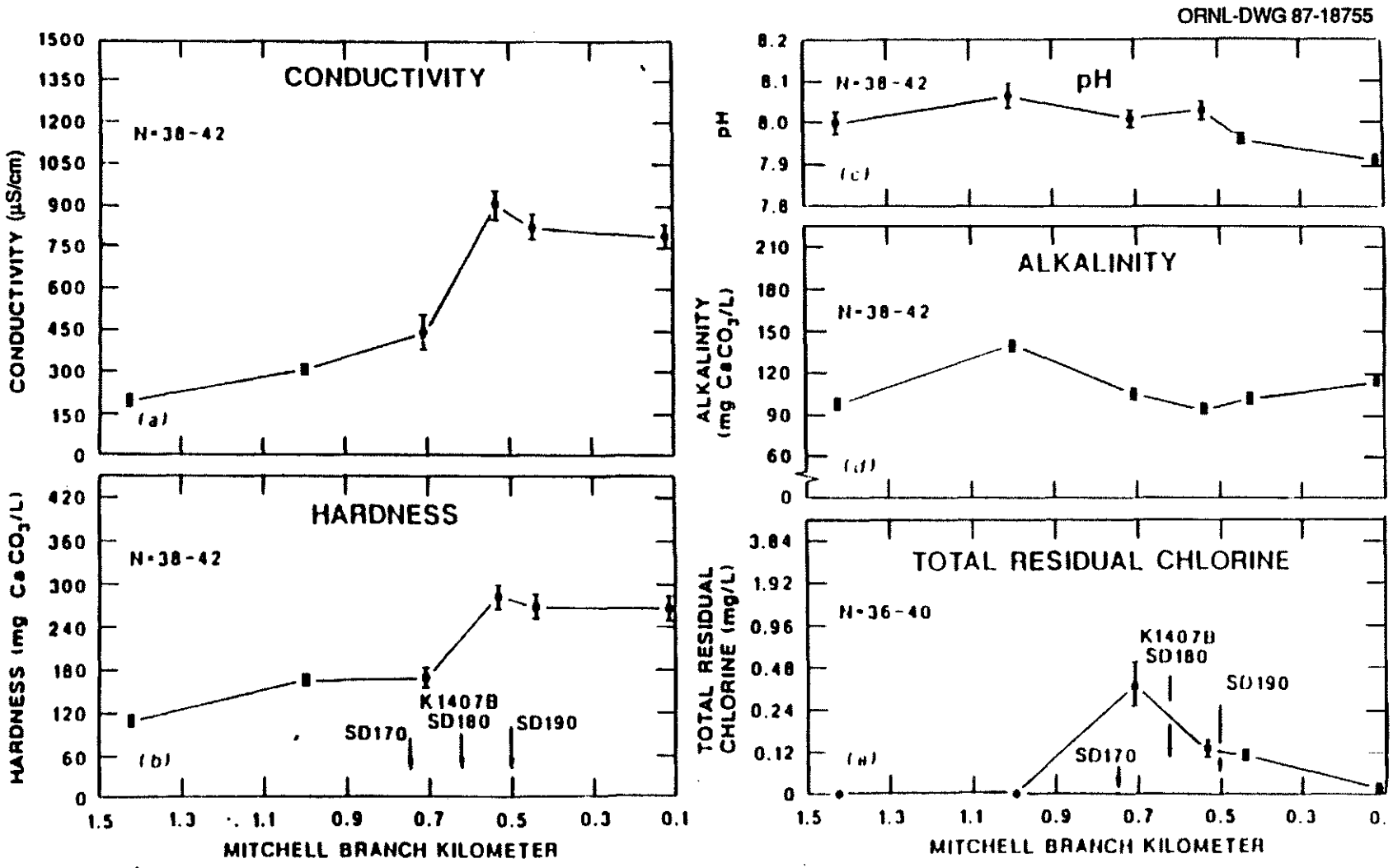


Fig. D.1-1. Mean (±SE) conductivity, hardness, pH, alkalinity, and total residual chlorine vs distance above the mouth of Mitchell Branch; data from all dates combined. *Source:* J. G. Smith et al., *First Annual Report on the ORGDP Biological Monitoring and Abatement Program*, draft, ORNL/TM, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1988, p. 45.

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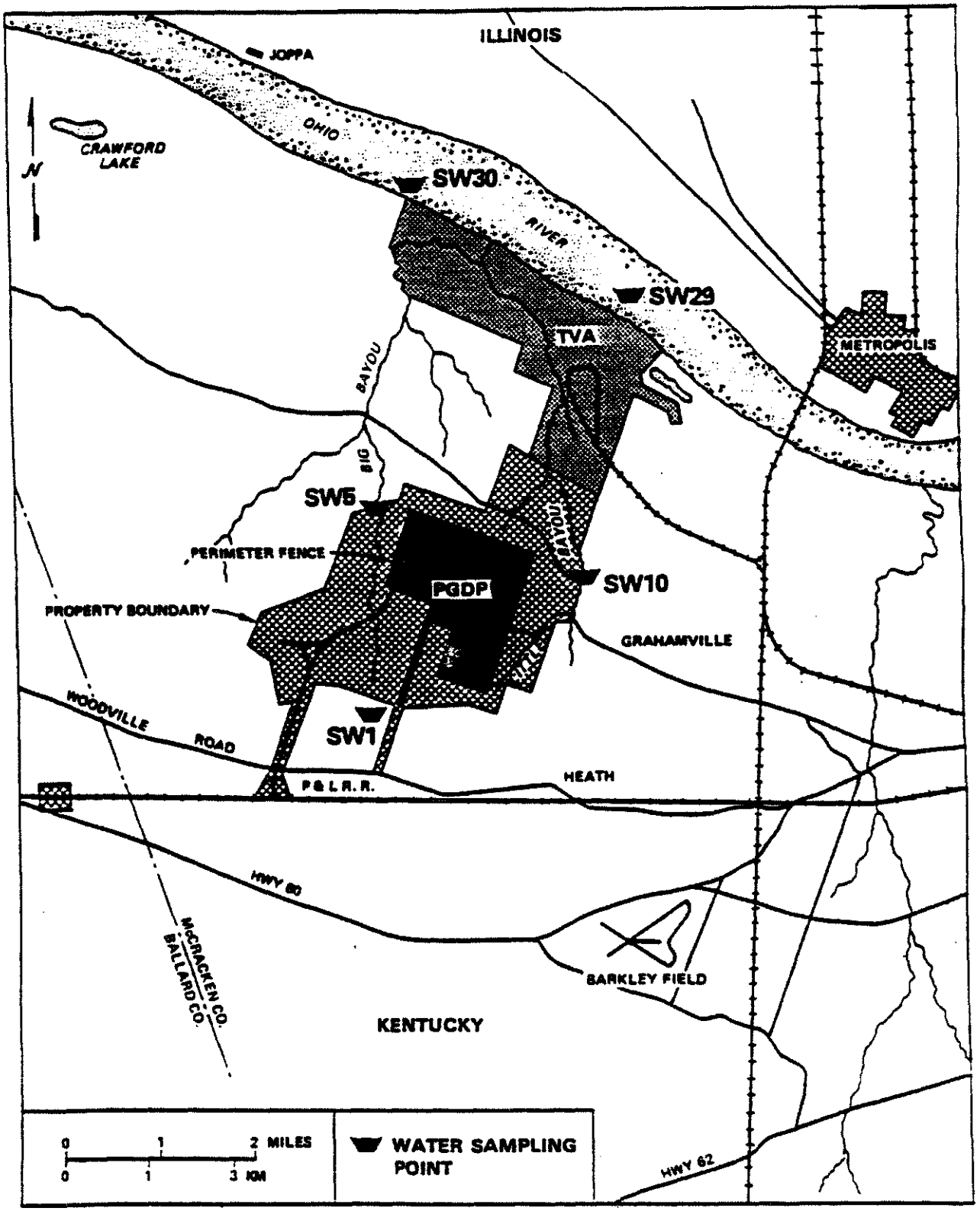

Fig. D.2-1. Surface water characterization monitoring points at the Paducah Gaseous Diffusion Plant. *Source:* J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, p. 25, Fig. 2.2.5.

Table D.1-1. Discharge in cubic feet per second (cfs) for the Clinch River at Melton Hill dam for water year October 1987 to September 1988.[a]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5280	817	1170	817	2180	450	422	400	1520	2810	1850	3000
2	5180	4300	1240	1040	2870	0	400	400	1800	3160	2380	2120
3	3200	3790	733	417	1220	1200	439	400	1720	1300	2120	1650
4	2000	2640	867	2800	1190	822	422	439	1880	1390	2370	2450
5	7680	1690	1250	6820	6450	817	433	422	1400	3100	2780	2920
6	7430	883	417	8370	1580	750	1500	400	1250	3100	3850	2080
7	8400	400	1260	5850	1220	2930	433	433	2250	3590	1100	1170
8	6970	450	2060	2050	5670	2800	1550	417	2570	3280	2230	817
9	5850	394	2100	417	4520	3780	389	600	2670	2150	833	1220
10	417	383	767	450	3100	4230	422	800	3350	2150	3020	1690
11	417	467	400	4580	7100	3230	850	1200	2420	2600	2970	1650
12	2020	2820	417	4930	3530	422	933	1250	2580	2670	2920	1650
13	3770	1200	300	5880	1850	0	855	850	2470	2570	1270	1650
14	6670	817	833	5170	1720	1300	800	894	3420	2450	1250	2020
15	6270	783	800	5820	1670	3280	400	783	4670	4300	3720	2470
16	3870	4100	2600	2450	3600	3080	422	817	4470	1550	3580	2250
17	2130	3630	4420	1520	2230	1600	800	1280	4230	1600	5110	1700
18	1200	5400	4750	5400	1650	1470	833	1190	4280	2150	3160	1570
19	5460	3850	1680	4780	2670	833	800	1200	4420	1540	2170	2000
20	5280	2770	767	10600	1630	700	805	1170	4650	1570	1300	1650
21	6500	400	950	4720	2030	750	739	983	5650	1150	433	1570
22	6600	400	1230	1260	6240	860	850	817	5730	1220	1720	1670
23	4800	417	1200	1280	5100	790	417	3700	3720	417	922	1650
24	367	400	833	383	8020	883	900	372	3270	417	1230	833
25	367	417	600	3080	5240	594	1030	439	7040	833	1220	833
26	400	400	1580	6610	2500	383	1160	467	11700	855	2420	2080
27	450	800	1180	6670	0	383	800	400	6270	2690	3000	1670
28	2790	417	800	5150	500	783	1000	417	9600	3060	2450	1690
29	2340	383	2520	2030	500	800	400	483	10100	2680	2520	3630
30	2430	2320	2070	833	---	861	400	1290	9100	890	1620	1670
31	1280	---	2000	417	---	400	---	1120	---	883	2520	---
TOTAL	117818	47938	43794	112594	87780	41181	21604	25833	130200	64125	70038	55023
MEAN	3801	1598	1413	3632	3027	1328	720	833	4340	2069	2259	1834
MAX	8400	5400	4750	10600	8020	4230	1550	3700	11700	4300	5110	3630
MIN	367	383	300	383	.00	.00	389	372	1250	417	433	817

CAL YR 1987 TOTAL 1635163 MEAN 4480 MAX 13500 MIN 0 Mean :4097 CFSM :1.23 IN :16.64
WTR YR 1988 TOTAL 817928 MEAN 2235 MAX 11700 MIN 0 Mean :2159 CFSM :0.65 IN : 8.79

: Adjusted for change in contents in Norris and Melton Hill lakes.
Note.--Contents (cfs-days) for adjustments furnished by Tennessee Valley Authority.

[a]cfs (cubic feet per second) can be converted to m^3/s (cubic meters per second) by multiplying the given values by 0.02832.

Source: U.S Geological Survey, *Water Resources Data for Tennessee,* Water Data Report TN-88.1, prepared in cooperation with the state of Tennessee and other agencies, 1988, p. 115.

Table D.1-2. Water quality data for the Clinch River at Melton Hill dam for water year October 1987-September 1988.

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE WATER (DEG C)	BARO-METRIC PRES-SURE (MM OF HG)	TUR-BID-ITY (NTU)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)
OCT										
29...	1020	10000	260	8.00	15.0	750	0.90	8.8	89	22
DEC										
08...	1100	3000	268	8.20	12.0	749	2.4	10.0	94	K3
FEB										
18...	1030	4000	255	8.10	8.0	746	2.7	10.9	94	K5
APR										
19...	1200	150	265	8.30	14.0	738	1.3	9.4	94	K3
JUN										
15...	1100	400	270	8.10	20.0	750	2.6	7.5	84	K7
AUG										
25...	1100	200	280	7.80	20.5	741	2.5	6.2	71	K6

DATE	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARD-NESS TOTAL (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM PERCENT	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY WAT DIS TOT IT FIELD MG/L AS CACO3	SULFATE DIS-SOLVED (MG/L AS SO4)
OCT										
29...	31	130	37	10	4.6	7	0.2	1.5	106	23
DEC										
08...	K2	130	34	11	5.4	8	0.2	1.6	112	25
FEB										
18...	K2	140	36	11	6.1	9	0.2	2.3	105	25
APR										
19...	K1	130	36	10	5.7	9	0.2	1.8	107	25
JUN										
15...	K1	140	35	12	6.8	10	0.3	1.8	110	31
AUG										
25...	K9	130	35	11	5.7	8	0.2	1.4	110	28

DATE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
OCT									
29...	3.8	0.10	4.5	152	154	0.21	4100	0.010	0.300
DEC									
08...	5.0	0.30	1.0	152	151	0.21	1230	<0.010	0.100
FEB									
18...	4.7	0.40	2.6	150	155	0.20	1620	<0.010	0.270
APR									
19...	5.0	0.20	1.5	156	151	0.21	63.2	--	--
JUN									
15...	5.7	0.30	2.0	156	161	0.21	168	0.020	0.250
AUG									
25...	5.6	0.10	3.2	161	159	0.22	86.9	0.010	0.470

Table D.1-2 (cont'd)

DATE	NITROGEN, AMMONIA TOTAL (MG/L AS N)	NITROGEN, AMMONIA DISSOLVED (MG/L AS N)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N)	PHOSPHOROUS TOTAL (MG/L AS P)	PHOSPHOROUS DISSOLVED (MG/L AS P)	PHOSPHOROUS ORTHO, DISSOLVED (MG/L AS P)	SEDIMENT, SUSPENDED (MG/L)	SEDIMENT, DISCHARGE, SUSPENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
OCT									
29...	0.030	0.030	0.30	<0.010	<0.010	<0.010	5	135	86
DEC									
08...	<0.010	0.020	0.20	0.020	<0.010	<0.010	7	57	72
FEB									
18...	0.030	<0.010	0.20	0.020	<0.010	<0.010	7	76	75
APR									
19...	--	--	--	--	--	--	5	2.0	63
JUN									
15...	<0.010	0.050	0.30	0.020	<0.010	<0.010	10	11	82
AUG									
25...	0.020	<0.010	0.30	0.030	<0.010	<0.010	14	7.6	58

DATE	ALUMINUM, DISSOLVED (UG/L AS AL)	ARSENIC DISSOLVED (UG/L AS AS)	BARIUM, DISSOLVED (UG/L AS BA)	BERYLLIUM, DISSOLVED (UG/L AS BE)	CADMIUM DISSOLVED (UG/L AS CD)	CHROMIUM, DISSOLVED (UG/L AS CR)	COBALT, DISSOLVED (UG/L AS CO)	COPPER, DISSOLVED (UG/L AS CU)	IRON, DISSOLVED (UG/L AS FE)	LEAD, DISSOLVED (UG/L AS PB)
OCT										
29...	<10	<1	35	<0.5	<1	<1	<3	<1	5	6
FEB										
18...	<10	<1	37	<0.5	2	30	<3	1	7	<5
APR										
19...	<10	<1	33	<0.5	<1	<1	<3	<1	<3	5
JUN										
15...	<10	<1	42	<0.5	3	<1	<3	1	<3	<5

DATE	LITHIUM DISSOLVED (UG/L AS LI)	MANGANESE, DISSOLVED (UG/L AS MN)	MERCURY DISSOLVED (UG/L AS HG)	MOLYBDENUM, DISSOLVED (UG/L AS MO)	NICKEL, DISSOLVED (UG/L AS NI)	SELENIUM, DISSOLVED (UG/L AS SE)	SILVER, DISSOLVED (UG/L AS AG)	STRONTIUM, DISSOLVED (UG/L AS SR)	VANADIUM, DISSOLVED (UG/L AS V)	ZINC, DISSOLVED (UG/L AS ZN)
OCT										
29...	6	<1	<0.1	<10	<1	<1	<1.0	93	<6	5
FEB										
18...	7	3	<0.1	<10	<1	<1	<1.0	96	<6	12
APR										
19...	9	3	<0.1	<10	3	<1	1.0	96	<6	<3
JUN										
15...	10	3	<0.1	<10	<1	<1	<1.0	100	<6	5

Source: U.S Geological Survey, *Water Resources Data for Tennessee,* Water Data Report TN-88.1, prepared in cooperation with the state of Tennessee and other agencies, 1988, pp. 116-7.

Table D.1-3. Mean annual concentration (mg/l) and range (in parentheses) of 19 water quality parameters at six stations on Poplar Creek and the Clinch River. Mean values were calculated from monthly data collected from April 1977 to March 1978. Since less than (<) signs were ignored in these computations, the means are biased and somewhat conservative. An annual mean was reported as 'less than' some table values if more than one-half of the monthly concentrations reported for a parameter were below the detection limit (given in parentheses below the parameter). N/A=no data available.

Parameter	West Fork Poplar Creek (PCM 6.9)[a]	K-1710 (PCM 5.3)[a]	K-1513 (PCM 0.3)[a]	K-1513 (CRM 14.4)[b]	K-901 (CRM 11.6)[b]	Clinch River (CRM 9.8)[b]
Ammonia (NH_3) (0.01,0.2)[c]	<0.10 (<0.01-0.21)	0.13 (<0.01-0.24)	0.14 (<0.01-0.38)	<0.10 (<0.01-0.2)	0.10 (<0.01-<0.2)	<0.10 (<0.01-0.23)
Arsenic (0.01)	<0.01 (<0.01-0.02)	<0.01 (<0.01-0.03)	<0.01 (<0.01-0.02)	<0.01 (<0.01-0.03)	<0.01 (<0.01-0.02)	<0.01 (<0.01-0.03)
Cadmium (0.005)	<0.005 (all <0.005)	<0.005 (<0.005-0.006)	<0.005 (all <0.005)	<0.005 (all <0.005)	<0.005 (all <0.005)	<0.005 (<0.005-0.007)
Chromium, total (0.005)	0.006 (<0.005-0.01)	0.007 (<0.005-0.016)	0.014 (0.008-0.022)	0.007 (<0.005-0.015)	0.007 (<0.005-0.015)	0.005 (<0.005-0.008)
COD (2,5)[d]	8 (<5-13)	7 (<5-14)	10 (<5-14)	5 (<5-10)	6 (<2-13)	5 (<2-10)
Copper (0.005)	0.014 (<0.005-0.048)	0.017 (<0.005-0.059)	0.016 (<0.005-0.08)	0.026 (<0.005-0.029)	0.013 (<0.005-0.06)	0.014 (<0.005-0.073)
Cyanide (0.0005,0.002)[e]	0.0025 (<0.0005-0.013)	0.0021 (0.0006-0.005)	0.0022 (<0.0005-0.005)	0.0016 (<0.0005-0.003)	<0.0019 (<0.0005-0.005)	0.0021 (0.0007-0.005)
Fluoride (0.1)	<0.10 (<0.1-0.13)	0.23 (<0.1-0.44)	0.22 (<0.1-0.4)	<0.11 (<0.1-0.17)	<0.1 (<0.1-0.1)	<0.11 (<0.1-0.2)
Lead (0.005,0.01)[f]	<0.010 (<0.005-0.02)	0.034 (0.006-0.3)	<0.010 (<0.005-0.019)	<0.009 (<0.005-0.014)	<0.010[g] (<0.005-0.02)	<0.010 (<0.005-0.02)
Manganese (0.005)	0.158 (0.019-0.311)	0.080 (0.025-0.198)	0.122 (0.04-0.173)	0.035 (<0.005-0.3)	0.036 (0.01-0.048)	0.063 (0.007-0.28)
Mercury (0.001)	<0.001 (<0.001-0.002)	<0.001 (<0.001-0.001)	<0.001 (<0.001-0.001)	<0.001 (all <0.001)	<0.001 (<0.001-0.001)	<0.001 (<0.001-0.003)
Nickel (0.005)	0.020 (<0.005-0.112)	0.019 (<0.005-0.08)	0.015 (0.002-0.031)	0.011 (<0.005-0.026)	0.013 (<0.005-0.027)	0.009 (<0.005-0.018)
Nitrates (NO_3^-) (0.01)	2.13 (0.04-3.54)	2.68 (0.28-6.20)	3.82 (<0.01-5.49)	2.99 (1.72-4.25)	4.32 (1.45-14.7)	2.54 (0.35-4.96)
pH	N/A	7.0 (6.0-8.3)	7.4 (7.0-8.2)	7.8 (7.1-8.1)	7.4 (6.9-7.8)	N/A
Sodium	4.17 (2.5-5.79)	5.07 (3.02-7.81)	5.89 (1.8-9.64)	3.12 (2.5-3.88)	3.34 (2.68-4.00)	3.19 (1.95-4.2)
Sulfates	43 (25-53)	34 (21-50)	34 (15-45)	23 (14-40)	27 (15-50)	24 (13-45)
Total dissolved solids	189 (40-330)	195 (114-294)	179 (98-244)	160 (118-278)	168[h] (114-202)	159 (90-218)
Total suspended solids (5)	26 (<5-67)	20 (<5-74)	21 (<5-43)	11 (<5-32)	19[h] (<5-74)	16 (<5-34)
Zinc	0.017 (0.005-0.053)	0 025 (0.008-0.051)	0.028 (0.009-0.059)	0.050 (0.016-0.133)	0.020 (0.006-0.05)	0.017 (0.005-0.05)

[a]PCM = Poplar Creek Mile, beginning at the confluence with the Clinch River (PCM = 0) and proceeding upstream.

[b]CRM = Clinch River Mile, beginning at the confluence with the Tennessee River (CRM = 0) and proceeding upstream.

[c]Detection limit was 0.01 mg/liter for April-September, and March samples and 0.2 mg/liter for October-February samples.

[d]Detection limit was 2 mg/liter for April-September samples and 5 mg/liter for October-March samples.

[e]Detection limit was 0.0005 mg/liter for April-September and March samples and 0.002 mg/liter for October-February samples.

[f]Detection limit was 0.005 mg/liter for June, November, and January samples and 0.01 mg/liter for the other nine samples.

[g]n = 11; no value given for May.

[h]n = 1; no value given for August.

Source: J. M. Loar, J. A. Solomon, and G. F. Cada, *Technical Background Information for the ORNL Environmental and Safety Report: Vol. II, A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam,* ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1981, p. 48, Table 1.4-1.

Table D.1-4. Selected water quality parameters for Poplar Creek and East Fork Poplar Creek in the ORGDP vicinity.

DATE	TIME	STREAM-FLOW INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	TEMPER-ATURE WATER (DEG C)	DATE	TIME	STREAM-FLOW INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	TEMPER-ATURE WATER (DEG C)
03538225 - POPLAR CREEK NEAR OAK RIDGE, TN									
OCT					FEB				
08...	1315	7.4	--	12.0	17...	1400	106	--	4.5
NOV					MAR				
09...	1205	7.4	--	12.0	18...	1700	115	--	7.5
DEC					MAY				
16...	1200	29	--	5.0	23...	1250	19	--	19.5
JAN					24...	1015	23	--	18.0
20...	1200	3920	--	9.0	JUL				
20...	1610	3640	--	10.0	05...	1045	6.2	337	21.5
21...	1110	601	--	8.0	AUG				
21...	1410	514	--	8.0	15...	1255	6.4	368	24.5
21...	1645	435	--	8.0	31...	1020	4.5	340	20.0
03538250 - EAST FORK POPLAR CREEK NEAR OAK RIDGE, TN									
NOV					APR				
09...	1355	16	--	14.5	20...	1220	41	--	13.0
DEC					MAY				
16...	1410	20	--	5.0	24...	1300	41	--	19.0
FEB					JUL				
17...	1130	33	--	7.0	26...	1030	17	445	22.0
24...	1435	31	--	8.5					
MAR									
18...	1350	36	--	11.5					

Source: U.S Geological Survey, *Water Resources Data for Tennessee,* Water Data Report TN-88.1, prepared in cooperation with the state of Tennessee and other agencies, 1988, p. 302.

Table D.2-1. Discharge in cubic feet per second (cfs) for the Ohio River at Metropolis, Illinois for water year October 1985 to September 1986.[a]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	95500	206000	611000	142000	206000	507000	196000	99400	158000	108000	67100	56100
2	97700	202000	653000	139000	180000	435000	172000	88900	145000	121000	46400	61800
3	105000	203000	690000	141000	251000	386000	151000	91800	138000	140000	58300	47700
4	91700	222000	714000	142000	303000	350000	140000	91700	110000	175000	66200	52300
5	101000	248000	721000	137000	313000	317000	137000	88700	109000	193000	61300	106000
6	99100	268000	735000	141000	363000	279000	106000	93300	113000	211000	55400	116000
7	98200	297000	782000	145000	444000	247000	89300	87700	136000	216000	42800	119000
8	101000	334000	793000	143000	483000	223000	102000	88200	174000	217000	40000	104000
9	101000	366000	803000	136000	514000	200000	109000	103000	201000	175000	58000	86700
10	90200	381000	791000	128000	540000	194000	113000	111000	281000	129000	60300	68000
11	72200	415000	762000	117000	568000	201000	109000	109000	309000	162000	59600	65200
12	30000	445000	698000	109000	604000	206000	107000	95600	276000	242000	72600	82100
13	46000	462000	616000	109000	618000	230000	106000	96100	255000	108000	76400	90800
14	31000	473000	574000	109000	632000	329000	110000	97600	255000	121000	72000	71800
15	40000	470000	539000	110000	633000	427000	119000	120000	246000	164000	51000	69100
16	37000	475000	535000	109000	620000	476000	112000	176000	240000	184000	55400	73200
17	35000	496000	536000	107000	599000	504000	106000	191000	237000	201000	62800	73400
18	51000	544000	546000	106000	575000	471000	105000	190000	224000	185000	64300	78900
19	34000	572000	561000	107000	566000	546000	107000	169000	190000	154000	73300	77900
20	35000	591000	575000	127000	560000	559000	108000	138000	161000	153000	70400	73200
21	102000	614000	573000	144000	573000	563000	131000	115000	162000	144000	68300	76300
22	174000	646000	537000	180000	574000	553000	148000	114000	154000	127000	63000	78500
23	159000	661000	431000	208000	592000	553000	152000	156000	107000	128000	65400	85600
24	170000	665000	368000	219000	602000	553000	157000	151000	115000	132000	71300	79000
25	237000	539000	325000	244000	583000	517000	160000	162000	98600	111000	57500	85000
26	215000	514000	284000	270000	577000	481000	161000	173000	81700	114000	67800	100000
27	192000	526000	256000	288000	572000	420000	161000	183000	79700	112000	64800	83100
28	161000	528000	236000	304000	557000	339000	163000	179000	57200	89700	60700	81600
29	155000	558000	212000	300000	---	284000	150000	186000	80200	79200	65100	97900
30	187000	588000	181000	278000	---	248000	111000	217000	85200	74700	64900	104000
31	201000	---	167000	252000	---	219000	---	191000	---	74900	54800	---
TOTAL	3344600	13509000	16805000	5191000	14202000	11817000	3898300	4153000	4978600	4545500	1917200	2444200
MEAN	107900	450300	542100	167500	507200	381200	129900	134000	166000	146600	61850	81470
MAX	237000	665000	803000	304000	633000	563000	196000	217000	309000	242000	76400	119000
MIN	30000	202000	167000	106000	180000	194000	89300	87700	57200	74700	40000	47700

CAL YR 1985 TOTAL 105022000 MEAN 287700 MAX 803000 MIN 30000
WTR YR 1986 TOTAL 86805400 MEAN 237800 MAX 803000 MIN 30000

[a]cfs (cubic feet per second) can be converted to m^3/s (cubic meters per second) by multiplying the given value by 0.02832.

Source: U.S Geological Survey, *Water Resources Data for Illinois,* Water Year 1986, Vol. 1, Illinois except Illinois River, Water Data Report 16-86-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., 1986, p. 150.

Table D.2-2. Discharge in cfs for the Ohio River at Metropolis, Illinois for water year October 1986 to September 1987.[1]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	103000	35000	610000	405000	236000	645000	226000	353000	181000	91600	114000	73300
2	99600	31200	584000	345000	258000	698000	268000	337000	145000	78800	133000	58700
3	94300	47000	579000	278000	265000	736000	308000	301000	141000	107000	92800	82200
4	98600	64600	567000	256000	274000	742000	355000	288000	144000	137000	103000	76300
5	124000	70600	534000	246000	289000	707000	364000	238000	146000	174000	129000	63800
6	139000	102000	515000	226000	301000	671000	363000	223000	146000	212000	109000	44800
7	141000	120000	524000	219000	295000	660000	357000	208000	149000	248000	125000	44600
8	158000	144000	540000	209000	292000	652000	347000	200000	130000	279000	120000	49600
9	158000	209000	565000	193000	285000	628000	334000	184000	117000	287000	83900	66100
10	165000	290000	564000	172000	268000	578000	340000	165000	99000	285000	67400	95600
11	148000	344000	584000	147000	248000	507000	364000	148000	122000	269000	84800	105000
12	139000	427000	581000	155000	238000	432000	394000	126000	101000	247000	92400	85600
13	125000	473000	579000	161000	223000	369000	418000	128000	120000	230000	91100	83600
14	117000	484000	592000	165000	212000	337000	452000	111000	140000	215000	88000	61200
15	124000	467000	615000	164000	198000	329000	471000	117000	136000	202000	64700	91300
16	129000	438000	647000	158000	203000	302000	512000	109000	123000	194000	58400	113000
17	123000	392000	652000	141000	204000	264000	561000	84800	113000	190000	67800	110000
18	123000	317000	625000	140000	209000	238000	561000	110000	115000	171000	67600	98200
19	127000	261000	553000	165000	203000	212000	548000	112000	124000	153000	69900	90800
20	98700	233000	444000	221000	215000	200000	544000	107000	103000	127000	71300	99000
21	38500	210000	377000	284000	233000	213000	551000	109000	84500	117000	73800	100000
22	86200	203000	333000	324000	236000	209000	564000	121000	107000	114000	68500	115000
23	60500	187000	282000	367000	250000	196000	567000	127000	133000	98200	80900	121000
24	33200	229000	270000	388000	291000	203000	570000	133000	148000	95700	105000	119000
25	98000	259000	276000	424000	315000	195000	536000	149000	142000	92600	71000	119000
26	93500	264000	282000	430000	359000	180000	473000	154000	135000	78400	57700	95400
27	127000	371000	309000	406000	428000	174000	372000	153000	128000	74600	61300	79600
28	105000	459000	351000	333000	533000	168000	288000	147000	109000	72100	46900	76100
29	70300	542000	393000	282000	---	166000	305000	148000	92200	87900	64300	78800
30	82000	590000	421000	259000	---	162000	341000	177000	100000	98800	71800	73700
31	72500	---	424000	236000	---	181000	---	175000	---	81900	84700	---
TOTAL	3410900	8273400	15182000	7889000	7562000	11954000	12654000	5220800	3773700	4909600	2620800	2571300
MEAN	110000	275800	489700	254500	270100	385600	421800	168400	125800	158400	84540	85710
MAX	168000	590000	652000	430000	533000	742000	570000	353000	181000	287000	133000	121000
MIN	33200	31200	270000	140000	198000	162000	226000	84800	84500	72100	46900	44600

CAL YR 1986 TOTAL 80013100 MEAN 219200 MAX 652000 MIN 31200
WTR YR 1987 TOTAL 86021500 MEAN 235700 MAX 742000 MIN 31200

[1]cfs (cubic feet per second) can be converted to m^3/s by multiplying the given values by 0.02832

Source: U.S Geological Survey, *Water Resources Data for Illinois,* Water Year 1987, Water Data Report IL-87-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., 1987, p. 236.

Table D.2-3. Discharge in cfs for the Ohio River at Metropolis, Illinois for water year October 1987 to September 1988.

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	70700	61100	117000	471000	217000	222000	246000	109000	66100	59200	20600	52300
2	69200	77800	137000	432000	312000	190000	259000	99900	55900	59600	28400	39500
3	65600	69300	148000	393000	422000	170000	262000	103000	56900	60200	42100	35000
4	68000	64500	152000	357000	481000	172000	270000	108000	60100	59900	43700	54100
5	76300	68100	150000	325000	510000	197000	289000	108000	55900	57900	42300	59300
6	89000	65500	144000	302000	540000	248000	338000	104000	63300	56100	54600	55300
7	91200	59700	129000	269000	563000	311000	362000	108000	62200	52500	51500	42400
8	80400	59800	124000	201000	589000	365000	377000	120000	62600	50800	50900	69000
9	71600	74900	116000	126000	583000	420000	395000	140000	65200	49600	43900	67800
10	75100	78200	108000	120000	621000	451000	407000	150000	63600	47800	36400	61500
11	76600	94300	103000	138000	619000	449000	407000	154000	61700	48800	36300	38900
12	81400	94800	101000	129000	400000	394000	403000	157000	59700	50400	44300	26100
13	69100	70600	117000	142000	526000	303000	406000	159000	60000	52800	54700	36700
14	87400	91100	128000	146000	408000	271000	404000	134000	56200	52400	44400	44700
15	68400	89300	138000	130000	328000	276000	369000	120000	55600	52000	44400	52000
16	77900	95400	137000	111000	298000	278000	305000	122000	55900	50200	35600	76900
17	76300	91800	128000	117000	304000	269000	248000	97000	48500	48500	31700	61600
18	61400	96400	124000	130000	301000	265000	224000	79600	49400	50000	50400	41500
19	64100	105000	131000	187000	295000	232000	214000	75900	53900	49800	60000	45500
20	62900	117000	140000	345000	296000	190000	211000	81900	55300	57200	66000	66900
21	53500	87600	141000	534000	276000	176000	206000	96400	56100	106000	64900	90100
22	82700	83100	140000	599000	269000	164000	194000	117000	55400	140000	45900	82700
23	51300	93000	135000	602000	287000	140000	181000	125000	48400	119000	39300	68300
24	62600	88000	166000	572000	313000	147000	171000	139000	46100	82400	47400	71100
25	59200	87700	259000	573000	317000	141000	154000	146000	52800	65700	50400	63000
26	60900	84100	449000	566000	314000	148000	144000	139000	21300	61700	48500	72300
27	63300	77500	557000	539000	291000	161000	145000	129000	44200	81300	50100	79400
28	60300	94200	614000	459000	264000	171000	135000	129000	53500	74700	53200	83600
29	55400	111000	572000	334000	245000	191000	115000	129000	61400	59800	53000	92700
30	53400	125000	479000	253000	---	203000	120000	122000	59100	45800	52200	93500
31	53700	---	466000	206000	---	226000	---	93800	---	43200	54300	---
TOTAL	2138900	2555800	6548000	9808000	11189000	7541000	7961000	3695500	1666100	1945300	1441400	1823700
MEAN	69000	85190	211200	316400	385800	243300	265400	119200	55540	62750	46500	60790
MAX	91200	125000	614000	602000	621000	451000	407000	159000	66100	140000	66000	93500
MIN	51300	59700	101000	111000	217000	140000	115000	75900	21300	43200	20600	26100

CAL YR 1987 TOTAL 70397900 MEAN 192900 MAX 742000 MIN 44600
WTR YR 1988 TOTAL 58313700 MEAN 159300 MAX 621000 MIN 20600

Source: U.S Geological Survey, *Water Resources Data for Illinois,* Water Data Report TL-88-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., 1988, p. 123

Table D.2-4. Water quality parameters measured at discharge point 30 from Big and Little Bayou Creeks to the Ohio River. Location is downstream of the PGDP discharge.[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	pH (units) No. of samples 12			*Dissolved alpha (pCi/L)* No. of samples 12			*Suspended alpha (pCi/L)* No. of samples 12			*Dissolved beta (pCi/L)* No. of samples 12		
January	7.8	7.8	a	2.70	2.70	2.70	6.78	6.78	6.78	3.15	3.15	3.15
February	7.3	7.3	a	1.35	1.35	1.35	10.8	10.8	10.8	31.5	31.5	31.5
March	7.3	7.3	a	4.51	4.51	4.51	9.01	9.01	9.01	9.01	9.01	9.01
April	7.2	7.2	a	4.51	4.51	4.51	1.80	1.80	1.80	−9.01	−9.01	−9.01
May	7.1	7.1	a	6.78	6.78	6.78	12.6	12.6	12.6	58.6	58.6	58.6
June	7.2	7.2	a	0.135	0.135	0.135	11.7	11.7	11.7	−13.5	−13.5	−13.5
July				7.21	7.21	7.21	8.11	8.11	8.11	13.5	13.5	13.5
August	7.1	7.1	a	4.96	4.96	4.96	3.15	3.15	3.15	4.51	4.51	4.51
September	7.5	7.5	a	7.21	7.21	7.21	4.05	4.05	4.05	5.86	5.86	5.86
October	7.8	7.8	a	13.1	13.1	13.1	2.70	2.70	2.70	4.51	4.51	4.51
November	7.6	7.6	a	6.31	6.31	6.31	0.451	0.451	0.451	4.51	4.51	4.51
December	7.4	7.4	a	4.51	4.51	4.51	6.78	6.78	6.78	1.35	1.35	1.35
Annual summary	7.8	7.1	a	13.1	0.135	5.27	12.6	0.451	6.42	58.6	−13.5	8.52
	Suspended beta (pCi/L) No. of samples 12			*Cr^{6+} (mg/L)* No. of samples 12			*Uranium (mg/L)* No. of samples 12			*Fluoride (mg/L)* No. of samples 12		
January	9.01	9.01	9.01	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.11	0.11	0.11
February	76.6	76.6	76.6	0.01	0.01	0.01	0.002	0.002	0.002	0.10	0.10	0.10
March	13.5	13.5	13.5	0.01	0.01	0.01	0.001	0.001	0.001	0.12	0.12	0.12
April	−3.15	−3.15	−3.15	<0.01	<0.01	<0.01	0.001	0.001	0.001	0.12	0.12	0.12
May	13.5	13.5	13.5	0.01	0.01	0.01	0.001	0.001	0.001	0.14	0.14	0.14
June	31.5	31.5	31.5	<0.01	<0.01	<0.01	0.001	0.001	0.001	0.22	0.22	0.22
July	−4.51	−4.51	−4.51	0.01	0.01	0.01	0.002	0.002	0.002	0.15	0.15	0.15
August	31.5	31.5	31.5	<0.01	<0.01	<0.01	0.002	0.002	0.002	0.15	0.15	0.15
September	31.5	31.5	31.5	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.18	0.18	0.18
October	22.5	22.5	22.5	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.21	0.21	0.21
November	13.5	13.5	13.5	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.23	0.23	0.23
December	72.1	72.1	72.1	<0.01	<0.01	<0.01	0.002	0.002	0.002	0.22	0.22	0.22
Annual summary	76.6	−4.50	25.6	0.01	<0.01	<0.01	0.002	<0.001	<0.002	0.23	0.10	0.17
	NO_3-N (mg/L) No. of samples 12			*SO_4 (mg/L)* No. of samples 12			*Cl^- (mg/L)* No. of samples 12					
January	0.5	0.5	0.5	22	22	22	11	11	11			
February	0.6	0.6	0.6	18	18	18	10	10	10			
March	0.8	0.8	0.8	39	39	39	13	13	13			
April	2.7	2.7	2.7	42	42	42	14	14	14			
May	1.2	1.2	1.2	36	36	36	11	11	11			
June	0.9	0.9	0.9	48	48	48	19	19	19			
July	0.4	0.4	0.4	30	30	30	14	14	14			
August	0.4	0.4	0.4	30	30	30	14	14	14			
September	0.1	0.1	0.1	52	52	52	19	19	19			
October	0.3	0.3	0.3	54	54	54	26	26	26			
November	0.5	0.5	0.5	61	61	61	22	22	22			
December	1.7	1.7	1.7	56	56	56	23	23	23			
Annual summary	2.7	0.1	0.9	61	18	40	26	10	16			

[a]Not applicable for pH.

[a]See Figure D.2-1 for location of the sampling site.

Source: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, p. 106.

Table D.2-5. Water quality parameters measured at discharge point 29 on the Ohio River. Location is upstream of the PGDP discharge to the Ohio River.[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	pH (units) No. of samples 11			*Dissolved alpha (pCi/L)* No. of samples 11			*Suspended alpha (pCi/L)* No. of samples 12			*Dissolved beta (pCi/L)* No. of samples 12		
January	7.6	7.6	a	−0.910	−0.910	−0.910	9.01	9.01	9.01	1.35	1.35	1.35
February	7.1	7.1	a	−1.35	−1.35	−1.35	2.70	2.70	2.70	45.1	45.1	45.1
March	7.2	7.2	a	6.31	6.31	6.31	7.21	7.21	7.21	31.5	31.5	31.5
April	7.2	7.2	a	4.51	4.51	4.51	−0.225	−0.225	−0.225	−4.51	−4.51	−4.51
May	7.1	7.1	a	0.451	0.451	0.451	2.70	2.70	2.70	13.5	13.5	13.5
June	7.0	7.0	a	2.25	2.25	2.25	8.11	8.11	8.11	−9.01	−9.01	−9.01
July	7.6	7.6	a	3.15	3.15	3.15	3.15	3.15	3.15	−1.80	−1.80	−1.80
August	7.1	7.1	a	4.96	4.96	4.96	−9.01	−9.01	−9.01	−9.01	−9.01	−9.01
September	7.3	7.3	a	9.46	9.46	9.46	1.80	1.80	1.80	1.35	1.35	1.35
October	7.8	7.8	a	0	0	0	−0.451	−0.451	−0.451	−2.25	−2.25	−2.25
November				6.76	6.76	6.76	0.451	0.451	0.451	27.0	27.0	27.0
December	7.3	7.3	a	−2.70	−2.70	−2.70	2.70	2.70	2.70	−9.01	−9.01	−9.01
Annual summary	7.8	7.0	a	6.76	−2.7	2.99	9.01	−9.01	2.60	45.1	−9.01	8.99
	Suspended beta (pCi/L) No. of samples 12			*Cr^{6+} (mg/L)* No. of samples 11			*Uranium (mg/L)* No. of samples 11			*Fluoride (mg/L)* No. of samples 11		
January	9.01	9.01	9.01	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.12	0.12	0.12
February	167.0	167.0	167.0	<0.01	<0.01	<0.01	0.001	0.001	0.001	0.11	0.11	0.11
March	0.451	0.451	0.451	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.12	0.12	0.12
April	−1.35	−1.35	−1.35	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.11	0.11	0.11
May	−13.5	−13.5	−13.5	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.12	0.12	0.12
June	18.0	18.0	18.0	<0.01	<0.01	<0.01	0.001	0.001	0.001	0.21	0.21	0.21
July	−1.80	−1.80	−1.80	0.03	0.03	0.03	0.001	0.001	0.001	0.25	0.25	0.25
August	−13.5	−13.5	−13.5	<0.01	<0.01	<0.01	0.002	0.002	0.002	0.14	0.14	0.14
September	58.6	58.6	58.6	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.18	0.18	0.18
October	22.5	22.5	22.5	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.21	0.21	0.21
November	49.6	49.6	49.6	<0.01	<0.01	<0.01						
December	31.5	31.5	31.5	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	0.23	0.23	0.23
Annual summary	167.0	−13.5	2.76	0.03	<0.01	<0.01	0.001	<0.001	<0.001	0.25	0.11	0.16
	NO_3-N (mg/L) No. of samples 11			*Sulfate (mg/L)* No. of samples 11			*Chloride (mg/L)* No. of samples 11					
January	0.5	0.5	0.5	20	20	20	11	11	11			
February	0.7	0.7	0.7	16	16	16	10	10	10			
March	0.7	0.7	0.7	28	28	28	11	11	11			
April	3.0	3.0	3.0	42	42	42	13	13	13			
May	0.6	0.6	0.6	29	29	29	10	10	10			
June	0.3	0.3	0.3	38	38	38	16	16	16			
July	2.6	2.6	2.6	26	26	26	11	11	11			
August	0.5	0.5	0.5	29	29	29	13	13	13			
September	<0.1	<0.1	<0.1	47	47	47	19	19	19			
October	0.4	0.4	0.4	52	52	52	26	26	26			
November												
December	1.2	1.2	1.2	59	59	59	25	25	25			
Annual summary	3.0	<0.1	1.0	59	16	35	26	10	15			

[a]Not applicable for pH.

[a]See Figure D.2-1 for location of the sampling site.

Source: J. G. Rogers and D. L. Ashburn, *Environmental Surveillance of the U.S. Department of Energy Paducah Reservation and Surrounding Environs During 1987*, ES/ESH-4/V3, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, p. 107.

Table D.2-6. Water quality data for the Ohio River at Lock and Dam 53 near Grand Chain, Illinois for water year October 1985 to September 1986.

DATE	TIME	AGENCY COLLECTING SAMPLE (CODE NUMBER) (00027)	AGENCY ANALYZING SAMPLE (CODE NUMBER) (00028)	STREAMFLOW, INSTANTANEOUS (CFS) (00061)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH (STANDARD UNITS) (00400)	TEMPERATURE (DEG C) (00010)	TURBIDITY (NTU) (00076)	OXYGEN, DISSOLVED (MG/L) (00300)	OXYGEN DEMAND, CHEMICAL (LOW LEVEL) (MG/L) (00335)	COLIFORM, FECAL, 0.45 UM-MF (COLS./100 ML) (31616)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML) (31625)
OCT												
22...	1200	17002	17002	--	372	7.70	20.0	14	6.4	18	K64	--
22...	1230	----	80010	147000	390	7.60	20.0	15	6.4	--	--	87
DEC												
12...	1200	----	80020	672000	296	8.00	7.0	51	9.2	--	--	150
MAR												
05...	1045	----	80020	302000	324	7.40	6.0	--	11.0	--	--	34
APR												
17...	1110	----	80020	104000	384	8.10	15.0	11	10.6	--	--	K4
MAY												
15...	0900	17002	17002	--	472	8.40	20.0	39	7.1	29	--	--
JUN												
17...	1020	----	80020	236000	340	7.35	26.0	43	6.4	--	--	53
17...	1100	17002	17002	--	340	7.00	24.0	52	6.4	15	K20	--
AUG												
12...	1110	----	80020	73100	340	7.40	27.5	22	7.5	--	--	44

DATE	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARDNESS (MG/L AS CACO3) (00900)	HARDNESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM TOTAL RECOVERABLE (MG/L AS CA) (00916)	CALCIUM DISSOLVED (MG/L AS CA) (00915)	MAGNESIUM, TOTAL RECOVERABLE (MG/L AS MG) (00927)	MAGNESIUM, DISSOLVED (MG/L AS MG) (00925)	SODIUM, TOTAL RECOVERABLE (MG/L AS NA) (00929)	SODIUM, DISSOLVED (MG/L AS NA) (00930)	POTASSIUM, TOTAL RECOVERABLE (MG/L AS K) (00937)	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	ALKALINITY WH WAT TOTAL FIELD MG/L AS CACO3 (00410)
OCT												
22...	--	130	52	35	34	12	12	20	19	2.8	2.6	--
22...	240	130	53	--	34	--	12	--	20	--	2.9	82
DEC												
12...	270	130	44	--	37	--	9.7	--	7.9	--	3.0	91
MAR												
05...	K1000	130	59	--	35	--	9.6	--	13	--	2.1	71
APR												
17...	K3	170	68	--	46	--	13	--	13	--	2.0	101
MAY												
15...	--	230	68	60	57	23	21	12	11	3.0	2.7	--
JUN												
17...	>1000	150	49	--	40	--	11	--	13	--	2.7	95
17...	--	130	43	43	35	12	9.2	12	10	2.8	2.2	--
AUG												
12...	21	130	19	--	37	--	10	--	12	--	2.6	115

Table D.2-6 (cont'd)

DATE	BICARBONATE IT-FLD (MG/L AS HCO3) (99440)	ALKALINITY, CARBONATE IT-FLD (MG/L - CACO3) (99430)	ALKALINITY LAB (MG/L AS CACO3) (90410)	SULFATE DISSOLVED (MG/L AS SO4) (00945)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	FLUORIDE, TOTAL (MG/L AS F) (00951)	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) (70301)	SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (MG/L) (00530)
OCT											
22...	--	--	83	59	27	0.2	--	--	--	--	72
22...	--	--	82	58	26	--	0.2	1.8	222	200	--
DEC											
12...	109	89	80	40	12	--	0.2	7.7	178	180	--
MAR											
05...	83	68	73	54	18	--	0.2	4.9	191	180	--
APR											
17...	123	101	97	62	20	--	0.2	3.2	223	220	--
MAY											
15...	--	--	161	57	16	0.2	--	--	--	--	202
JUN											
17...	117	96	93	50	17	--	0.2	4.2	197	200	--
17...	--	--	82	48	16	0.2	--	--	--	--	127
AUG											
12...	--	--	101	41	16	--	0.2	1.6	193	190	--

DATE	SOLIDS, VOLATILE, SUSPENDED (MG/L) (00535)	NITROGEN, NO2+NO3 TOTAL (MG/L AS N) (00630)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N) (00631)	NITROGEN, AMMONIA TOTAL (MG/L AS N) (00610)	AMMONIA UNIONIZED (MG/L AS N) (00619)	NITROGEN, AMMONIA DISSOLVED (MG/L AS N) (00608)	NITROGEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N) (00625)	NITROGEN, TOTAL (MG/L AS N) (00600)	PHOSPHORUS, TOTAL (MG/L AS P) (00665)	PHOSPHORUS, DISSOLVED (MG/L AS P) (00666)
OCT											
22...	8	0.31	--	<0.10	<0.002	--	--	0.8	1.1	0.13	0.04
22...	--	--	0.42	--	--	0.06	--	0.7	--	0.11	0.06
DEC											
12...	--	--	1.70	0.07	--	0.06	0.83	0.9	--	0.13	--
MAR											
05...	--	--	1.60	0.09	--	0.09	0.91	1.0	--	0.15	0.03
APR											
17...	--	--	1.50	0.03	--	0.04	0.67	0.7	--	0.07	0.02
MAY											
15...	27	2.40	--	<0.10	<0.01	--	--	1.3	3.7	0.24	0.07
JUN											
17...	--	--	2.50	0.03	--	0.05	0.67	0.7	--	0.16	0.05
17...	12	2.30	--	<0.10	<0.001	--	--	0.6	2.9	0.15	0.05
AUG											
12...	--	--	0.77	0.06	--	0.08	0.74	0.8	--	0.11	0.04

DATE	ALUMINUM, TOTAL RECOVERABLE (UG/L AS AL) (01105)	ALUMINUM, DISSOLVED (UG/L AS AL) (01106)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DISSOLVED (UG/L AS AS) (01000)	BARIUM, TOTAL RECOVERABLE (UG/L AS BA) (01007)	BARIUM, DISSOLVED (UG/L AS BA) (01005)	BERYLLIUM, TOTAL RECOVERABLE (UG/L AS BE) (01012)	BERYLLIUM, DISSOLVED (UG/L AS BE) (01010)	BORON, TOTAL RECOVERABLE (UG/L AS B) (01022)	BORON, DISSOLVED (UG/L AS B) (01020)	CADMIUM TOTAL RECOVERABLE (UG/L AS CD) (01027)
OCT											
22...	800	<50	<1	--	50	40	<1.0	<0.5	60	60	<3
22...	--	10	--	1	--	48	--	2	--	--	--
DEC											
12...	--	30	--	<1	--	45	--	<0.5	--	--	--
MAR											
05...	--	--	--	--	--	--	--	--	--	--	--
APR											
17...	--	20	--	<1	--	46	--	<0.5	--	--	--
MAY											
15...	1800	<50	2	--	100	76	<2.0	<1	60	50	<3
JUN											
17...	--	--	--	--	--	--	--	--	--	--	--
17...	2000	<50	2	--	60	38	<1.0	<0.5	<50	<50	<3
AUG											
12...	--	--	--								

Table D.2-6 (cont'd)

DATE	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, TOTAL RECOV-ERABLE (UG/L AS CO) (01037)	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)
OCT											
22...	<3	<5	<5	<5	<5	10	6	1200	<50	<50	<50
22...	2	--	<1	--	<3	--	4	--	12	--	<1
DEC											
12...	<1	--	1	--	<3	--	4	--	33	--	1
MAR											
05...	--	--	--	--	--	--	--	--	--	--	--
APR											
17...	<1	--	2	--	<3	--	1	--	5	--	1
MAY											
15...	<3	<5	<5	<5	<5	18	7	2900	<50	<50	<50
JUN											
17...	--	--	--	--	--	--	--	--	--	--	--
17...	<3	13	<5	5	<5	6	<5	3100	<50	<50	<50
AUG											
12...	--	--	--	--	--	--	--	--	--	--	--

DATE	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG) (01077)	SILVER, DIS-SOLVED (UG/L AS AG) (01075)	STRON-TIUM, TOTAL RECOV-ERABLE (UG/L AS SR) (01082)	STRON-TIUM, DIS-SOLVED (UG/L AS SR) (01080)
OCT											
22...	190	<5	<0.1	--	<5	<5	--	<3	<3	220	220
22...	--	1	--	<0.1	--	1	<1	--	<1	--	210
DEC											
12...	--	11	--	<0.1	--	3	<1	--	<1	--	140
MAR											
05...	--	--	<0.1	--	--	--	--	--	--	--	--
APR											
17...	--	5	<0.1	--	--	1	<1	--	<1	--	190
MAY											
15...	240	<5	<0.1	--	13	<5	--	<3	<3	140	140
JUN											
17...	--	--	--	--	--	--	--	--	--	--	--
17...	180	11	<0.1	--	18	<5	--	<3	<3	190	150
AUG											
12...	--	--	--	--	--	--	--	--	--	--	--

DATE	VANA-DIUM, TOTAL (UG/L AS V) (01087)	VANA-DIUM, DIS-SOLVED (UG/L AS V) (01085)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)	CARBON, ORGANIC TOTAL (MG/L AS C) (00680)	CYANIDE TOTAL (MG/L AS CN) (00720)	PHENOLS TOTAL (UG/L) (32730)	OIL AND GREASE, TOTAL RECOV. GRAVI-METRIC (MG/L) (00556)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT											
22...	<5	<5	<50	<50	--	<0.01	<5	1	--	--	--
22...	--	<6	--	11	--	--	--	--	64	25400	100
DEC											
12...	--	<6	--	6	--	--	--	--	185	336000	100
MAR											
05...	--	--	--	--	--	--	--	--	112	91300	100
APR											
17...	--	<6	--	12	--	--	--	--	23	6460	100
MAY											
15...	8	<5	<50	<50	--	<0.01	<5	1	--	--	--
JUN											
17...	--	--	--	--	--	--	--	--	88	56100	100
17...	6	<5	<50	<50	3.8	<0.01	<5	1	--	--	--
AUG											
12...	--	--	--	--	--	--	--	--	41	8090	100

Source: U.S Geological Survey, *Water Resources Data for Illinois, Water Year 1986, Vol. 1, Illinois except Illinois River Basin,* Water Data Report IL-86.1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., 1986, pp. 155-7.

Table D.2-7. Water quality data for the Ohio River at Lock and Dam 53 near Grand Chain, Illinois for water year October 1986 to September 1987.

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (FT^3/S)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE WATER (DEG C)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	BARO-METRIC PRES-SURE (MM OF HG)	TUR-BID-ITY (NTU)	FECAL COLI-FORM 24-HR MEM.FIL (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
OCT 1986											
29...	1125	70300	320	7.0	17.5	7.9	83	760	15	10	44
DEC											
17...	1130	655000	250	7.4	7.0	13.9	116	755	59	167	630
FEB 1987											
11...	1145	247000	320	7.8	5.5	--	--	757	19	K13	17
APR											
15...	1310	470000	325	7.6	10.0	10.2	92	746	120	24	22
JUN											
16...	1145	122000	360	7.5	28.0	7.6	99	751	14	9	--
AUG											
10...	1100	52800	305	7.3	30.5	--	--	755	3.5	22	29

DATE	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	BICAR-BONATE IT-FLD (MG/L AS HCO3)	CAR-BONATE IT-FLD (MG/L AS CO3)	ALKA-LINITY WH WAT TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)
OCT 1986											
29...	120	35	35	8.7	18	3.0	107	0	89	88	46
DEC											
17...	110	47	31	6.8	7.3	2.3	72	0	60	59	33
FEB 1987											
11...	120	45	34	8.7	12	2.1	93	0	77	76	53
APR											
15...	110	45	30	8.3	13	1.9	78	0	64	64	54
JUN											
16...	150	53	40	11	13	2.2	112	0	91	92	51
AUG											
10...	120	45	35	8.7	13	2.2	95	0	67	78	39

DATE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	ALUM-INUM, DIS-SOLVED (UG/L AS AL)
OCT 1986											
29...	20	0.1	4.1	203	0.71	0.06	0.60	0.06	0.08	0.03	20
DEC											
17...	17	0.1	5.8	124	1.1	0.04	0.70	0.08	0.03	0.04	40
FEB 1987											
11...	18	0.1	5.2	177	1.3	0.14	0.80	0.11	0.02	0.04	--
APR											
15...	18	0.2	5.5	176	1.1	0.04	1.3	0.06	0.03	0.02	60
JUN											
16...	17	0.2	2.8	206	1.9	0.03	1.1	0.15	0.09	0.03	20
AUG											
10...	14	0.2	30	157	0.23	0.03	2.0	0.08	0.03	0.02	--

Table D.2-7 (cont'd)

DATE	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	LITHIUM DIS-SOLVED (UG/L AS LI)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
OCT 1986											
29...	1	44	<0.5	8	<1	<3	3	17	<5	6	12
DEC											
17...	<1	37	<0.5	<1	<1	<3	1	40	<5	7	7
FEB 1987											
11...	--	--	--	--	--	--	--	--	--	--	--
APR											
15...	<1	39	<0.5	2	3	<3	<1	100	<5	10	17
JUN											
16...	<1	46	<0.5	<1	1	<3	3	21	<5	9	5
AUG											
10...	--	--	--	--	--	--	--	--	--	--	--

DATE	MOLYB-DENUM, DIS-SOLVED (UG/L AS MO)	NICKEL, DIS-SOLVED (UG/L AS NI)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	VANA-DIUM, DIS-SOLVED (UG/L AS V)	ZINC, DIS-SOLVED (UG/L AS ZN)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
OCT 1986										
29...	<10	3	<1	<1	180	<6	20	15	2850	100
DEC										
17...	<10	1	<1	<1	130	<6	7	210	371000	--
FEB 1987										
11...	--	--	--	--	--	--	--	47	31300	100
APR										
15...	<10	1	<1	<1	180	<6	17	322	409000	76
JUN										
16...	<10	<1	<1	<1	180	<6	<3	27	8890	81
AUG										
10...	--	--	--	--	--	--	--	22	3140	52

Source: U.S. Geological Survey, *Water Resources Data for Illinois Water Year 1987, Vol. 1, Illinois except Illinois River Basin,* Water Data Report IL-87-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., 1987, pp. 237-8.

Table D.2-8. Water quality data for the Ohio River at Lock and Dam 53 near Grand Chain, Illinois for water year October 1987 to September 1988.

DATE	TIME	AGENCY COLLECTING SAMPLE (CODE NUMBER) (00027)	AGENCY ANALYZING SAMPLE (CODE NUMBER) (00028)	STREAM-FLOW, INSTANTANEOUS (CFS) (00061)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH (STANDARD UNITS) (00400)	TEMPERATURE WATER (DEG C) (00010)	TURBIDITY (FTU) (00076)	OXYGEN, DISSOLVED (MG/L) (00300)	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARDNESS TOTAL (MG/L AS CACO3) (00900)
OCT											
13...	1210	1028	80020	93700	322	7.36	17.0	5.7	8.5	56	110
DEC											
14...	1215	1028	80020	126000	428	7.36	8.0	0.70	11.4	75	150
FEB											
17...	1145	1028	80020	304000	282	7.28	3.0	64	12.5	80	130
APR											
13...	1130	1028	80020	406000	320	7.38	14.0	80	9.7	43	140
JUN											
14...	1105	1028	80020	56200	378	7.40	25.5	2.8	8.5	110	130
AUG											
08...	1130	1028	80020	36900	315	7.26	30.5	5.2	6.0	38	110

DATE	HARDNESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DISSOLVED (MG/L AS CA) (00915)	MAGNESIUM, DISSOLVED (MG/L AS MG) (00925)	SODIUM, DISSOLVED (MG/L AS NA) (00930)	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	ALKALINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	ALKALINITY LAB (MG/L AS CACO3) (90410)	SULFATE DISSOLVED (MG/L AS SO4) (00945)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)
OCT											
13...	44	30	9.3	21	2.8	74	70	54	23	0.30	2.0
DEC											
14...	82	40	12	24	3.0	82	79	76	30	0.20	3.4
FEB											
17...	70	37	8.6	9.5	2.6	60	78	41	13	0.30	6.1
APR											
13...	70	40	9.5	12	2.5	69	84	51	16	0.20	5.0
JUN											
14...	86	34	11	16	1.2	66	78	64	18	0.30	1.0
AUG											
08...	58	29	9.5	17	2.3	68	66	56	18	0.20	0.89

DATE	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) (70301)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N) (00631)	NITROGEN, AMMONIA TOTAL (MG/L AS N) (00610)	NITROGEN, AMMONIA DISSOLVED (MG/L AS N) (00608)	NITROGEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N) (00625)	PHOSPHOROUS TOTAL (MG/L AS P) (00665)	PHOSPHOROUS DISSOLVED (MG/L AS P) (00666)	ALUMINUM, DISSOLVED (UG/L AS AL) (01106)
OCT										
13...	185	186	0.320	0.110	0.090	0.39	0.50	0.360	0.050	10
DEC										
14...	243	235	1.30	0.130	0.120	0.67	0.80	0.120	0.060	<10
FEB										
17...	175	162	1.90	0.150	0.180	1.0	1.2	0.050	0.230	--
APR										
13...	196	184	1.40	0.070	0.050	1.1	1.2	0.470	0.340	30
JUN										
14...	191	174	0.330	0.040	0.060	0.46	0.50	0.040	0.020	<10
AUG										
08...	189	167	0.370	0.080	0.070	0.42	0.50	0.030	<0.010	--

Table D.2-8 (cont'd)

DATE	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE) (01010)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)
OCT										
13...	1	40	<0.5	<1	<1	<3	3	91	18	3
DEC										
14...	1	46	<0.5	<1	2	<3	2	6	<5	6
FEB										
17...	--	--	--	--	--	--	--	--	--	--
APR										
13...	1	38	0.7	<1	<1	<3	6	33	<5	9
JUN										
14...	1	44	<0.5	<1	2	<3	4	<3	<5	1
AUG										
08...	--	--	--	--	--	--	--	--	--	--

DATE	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	SILVER, DIS-SOLVED (UG/L AS AG) (01075)	STRON-TIUM, DIS-SOLVED (UG/L AS SR) (01080)	VANA-DIUM, DIS-SOLVED (UG/L AS V) (01085)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT										
13...	--	<1	<1	<1.0	160	<6	15	18	4650	89
DEC										
14...	--	3	<1	<1.0	210	<6	6	19	6460	93
FEB										
17...	--	--	--	--	--	--	--	162	133000	81
APR										
13...	<0.1	2	<1	<1.0	160	<6	5	195	214000	86
JUN										
14...	<0.1	5	<1	<1.0	170	<6	6	6	910	48
AUG										
08...	--	--	--	--	--	--	--	10	996	65

Source: U.S. Geological Survey, *Water Resources Data for Illinois,* Water Data Report TL-88-1, prepared in cooperation with the state of Illinois and other agencies, Reston, Va., pp. 128-9.

Table D.2-9. Results of water quality and sediment analysis—Big Bayou Creek

Station	Date	Time	Temp. C	Conductivity u mho	Dissolved Oxygen ppm	pH	Oil and Grease % Dry Solids 1	2
1	6/14/79	1400	23.4	167	6.2	7.1	0.008	< 0.005
2	6/14/79	1100	25.0	175	6.6	6.8	0.015	0.007
3	6/13/79	1600	27.5	616	6.6	8.1	< 0.006	< 0.006
4	6/13/79	1330	24.9	605	7.6	7.6	0.008	< 0.006
5	6/13/79	0900	2.14	526	6.2	6.9	< 0.005	0.032

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio, 1979, p. 11.

Table D.2-10. Results of water quality and sediment analyses—Little Bayou Creek

Station	Date	Time	Temp C	Conductivity μ mho	Dissolved Oxygen ppm	pH	Oil and Grease % Dry Solids 1	2
6	6/14/79	0915	20.0	144	3.3	6.8	0.033	0.026
7	6/13/79	1430	24.2	291	7.5	7.5	0.030	0.034
8	6/13/79	1145	21.3	261	6.6	7.0	0.032	0.041
9	6/13/79	1045	20.0	344	6.9	6.5	0.017	0.013

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio, 1979, p. 21.

Table D.3-1. Discharge in cubic feet per second (cfs) for the Scioto River at Higby, Ohio for water year October 1987 to September 1988.[a]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	560	947	1280	1670	1320	2690	3190	1760	885	560	787	752
2	580	1010	973	1620	11600	2480	2930	1680	862	580	1060	607
3	590	798	901	1300	24000	2690	3980	1600	827	560	839	554
4	610	784	876	1210	26600	18100	17100	1500	820	530	812	2080
5	610	784	1040	1260	24300	18800	20200	1460	879	550	830	5250
6	620	784	1050	977	17000	12800	17000	1610	813	540	741	2370
7	640	784	845	736	9590	10200	12900	1970	762	540	790	1650
8	680	784	767	845	6590	9170	12200	1800	748	540	850	1240
9	740	817	737	757	4850	9060	11300	1700	731	530	740	1020
10	780	831	737	751	3890	10500	8900	1460	865	530	636	918
11	768	879	725	697	3540	10800	7040	1680	1030	540	581	843
12	838	878	715	699	3300	8990	5740	1510	818	560	816	816
13	926	901	784	682	3230	6940	4840	1420	737	530	791	2300
14	774	945	873	597	2670	6060	4040	1390	689	493	630	4090
15	730	906	812	663	2760	5300	3550	1350	666	456	626	2530
16	680	1100	812	636	4280	4350	3360	1520	670	445	589	1780
17	660	1040	931	651	4690	3760	2960	1260	665	436	545	1350
18	660	819	834	684	5270	3180	2850	1280	683	430	543	1890
19	680	775	874	940	4910	2950	3000	1190	736	455	568	1560
20	700	789	956	3970	7820	2860	2670	1090	687	1410	708	1060
21	750	772	994	6490	11900	2940	2530	1080	637	3080	1330	945
22	800	772	1090	4340	10400	2690	2300	1140	663	5660	1440	882
23	980	791	961	3130	8680	2680	2370	1110	682	2420	834	902
24	860	788	983	2370	9760	2640	2400	1320	648	2130	754	900
25	800	831	1050	1860	8730	2550	2540	1620	619	2560	1480	880
26	780	862	1340	1580	7300	3270	2150	1530	589	1580	888	772
27	720	1050	1780	1380	4730	5690	1970	1270	565	1190	679	697
28	680	1210	1570	1340	3680	5580	1890	1090	543	1110	584	687
29	740	1110	1330	1190	3180	5030	1830	995	540	926	589	674
30	800	1270	1750	1130	---	4020	1790	922	530	819	856	650
31	760	---	1710	1110	---	3460	---	901	---	756	1200	---
TOTAL	22496	26811	32080	47265	240570	192230	171520	43208	21589	33446	25116	42649
MEAN	726	894	1035	1525	8296	6201	5717	1394	720	1079	810	1422
MAX	980	1270	1780	6490	26600	18800	20200	1970	1030	5660	1480	5250
MIN	560	772	715	597	1320	2480	1790	901	530	430	543	554

CAL YR 1987 TOTAL 1044329 MEAN 2861 MAX 25600 MIN 490
WTR YR 1988 TOTAL 898980 MEAN 2456 MAX 26600 MIN 430

[a]cfs (cubic feet per second) can be converted to m^3/s (cubic meters per second) by multiplying the given values by 0.02832.

Source: U.S. Geological Survey, *Water Resources Data for Ohio: Vol. 1, Ohio River Basin,* Water Data Report OH-88-1, prepared in cooperation with the state of Ohio and other agencies, Reston, Va., 1988, p. 141.

Table D.3-2. Water quality data for the Scioto River at Higby, Ohio for water year October 1987 to September 1988.

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE AIR (DEG C)	TEMPER-ATURE WATER (DEG C)	TUR-BID-ITY (FTU)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
DEC											
21...	1030	948	840	7.8	15.0	6.0	3.1	10.4	86	K11000	120
MAR											
15...	0945	5380	630	8.3	0.5	2.5	31	13.0	99	700	320
JUN											
08...	0915	749	915	8.4	29.0	24.0	11	8.7	109	>50	55
AUG											
11...	1015	588	900	8.7	31.0	28.0	9.3	5.7	75	6000	2300

DATE	HARD-NESS TOTAL (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	BICAR-BONATE IT-FLD (MG/L AS HCO3)	CAR-BONATE IT-FLD (MG/L AS CO3)	ALKA-LINITY WAT WH TOT FET FIELD MG/L AS CACO3	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
DEC											
21...	310	120	81	26	61	6.5	232	0	189	120	95
MAR											
15...	280	130	71	24	22	3.0	181	0	149	86	39
JUN											
08...	330	88	82	30	67	6.4	286	5.0	242	140	72
AUG											
11...	320	58	82	28	68	6.3	322	--	362	150	88

DATE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	PHOS-PHORUS TOTAL (MG/L AS P)	PHOS-PHORUS DIS-SOLVED (MG/L AS P)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P)
DEC											
21...	0.5	4.3	514	0.04	2.5	0.16	0.16	<0.20	0.95	0.91	0.79
MAR											
15...	0.3	6.2	360	0.04	5.9	0.08	0.09	0.90	0.17	0.14	0.15
JUN											
08...	0.8	4.6	563	0.02	1.5	0.01	0.02	0.90	0.62	0.53	0.41
AUG											
11...	0.4	4.0	560	0.02	2.0	<0.01	0.02	1.4	0.60	0.39	0.35

DATE	ALUM-INUM, DIS-SOLVED (UG/L AS AL)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	LITHIUM DIS-SOLVED (UG/L AS LI)
DEC											
21...	30	1	64	<0.5	<1	1	<3	5	49	<5	31
MAR											
15...	20	1	52	<0.5	<1	<1	<3	15	43	<5	9
JUN											
08...	30	2	79	<0.5	1	<1	<3	3	20	<5	15
AUG											
11...	30	3	89	<0.5	<1	<1	<3	5	31	<5	17

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	MOLYB-DENUM, DIS-SOLVED (UG/L AS MO)	NICKEL, DIS-SOLVED (UG/L AS NI)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	VANA-DIUM, DIS-SOLVED (UG/L AS V)	ZINC, DIS-SOLVED (UG/L AS ZN)	SEDI-MENT, SUS-PENDED (MG/L)
DEC										
21...	50	<0.1	<10	5	1	<1.0	1600	<6	21	15
MAR										
15...	10	0.1	<10	<1	<1	<1.0	1200	<6	32	40
JUN										
08...	19	<0.1	20	4	<1	<1.0	1600	<6	9	30
AUG										
11...	12	<0.1	20	5	<1	<1.0	1400	<6	14	--

Source: U.S. Geological Survey, *Water Resources Data for Ohio: Vol. 1, Ohio River Basin,* Water Data Report OH-88-1, prepared in cooperation with the state of Ohio and other agencies, Reston, Va., pp. 142-3.

Table D.3-3. NPDES permits—summary effective April 8, 1985

NPDES outfall description and sample parameters	Required sampling method	Daily average limitation	Daily maximum limitation
Outfall 001 (east drainage ditch)			
Flow	Continuous		
TSS	24-h composite	20 mg/L	30 mg/L
O&G	Grab	10 mg/L	15 mg/L
Temperature	Grab	Monitoring only specified	
TRCL	Grab		0.02 mg/L
pH	Grab	6.5 to 9.0	
Outfall 001A (X-701B pond effluent)			
Flow	Continuous		
Nitrate, as N	24-h composite	Monitoring only specified	
Ammonia, as N	24-h composite	Monitoring only speicifed	
Total Cu	24-h composite	Monitoring only specified	
Total Zn	24-h composite	0.05 kg/d	0.09 kg/d
Total Fe	24-h composite	0.30 kg/d	0.60 kg/d
Total Ni	24-h composite	Monitoring only specified	
Total Cr	24-h composite	0.007 kg/d	0.014 kg/d
Cr^{6+}	24-h composite	Monitoring only specified	
TCE	Grab	Monitoring only specified	
pH	Continuous	Monitoring only specified	
Outfall 002 (X-230K, south pond effluent)			
Flow	Continuous		
TSS	24-h composite	20 mg/L	30 mg/L
TRCL	Grab		0.02 mg/L
O&G	Grab	10 mg/L	15 mg/L
pH	Grab	6.5 to 9.0	
Total Fe	24-h composite	Monitoring only specified	
Total Mn	24-h composite	Monitoring only specified	
Total Cu	24-h composite	Monitoring only specified	
Total Zn	24-h composite	Monitoring only specified	
Total Ni	24-h composite	Monitoring only specified	
Total As	24-h composite	Monitoring only specified	
Outfall 002A (X-621 coal pile runoff treatment plant)			
Flow	Continuous		
TSS	24-h composite		50 mg/L
Total Fe	24-h composite	3.0 mg/L	6.0 mg/L
Total Mn	24-h composite	2.0 mg/L	4.0 mg/L
Total Cu	24-h composite	Monitoring only specified	
Total Zn	24-h composite	Monitoring only specified	
Total Ni	24-h composite	Monitoring only specified	
Total As	24-h composite	Monitoring only specified	
pH	Grab	6.5 to 10.0	

Table D.3-3 (continued)

NPDES outfall description and sample parameters	Required sampling method	Daily average limitation	Daily maximum limitation
Outfall 003 (X-6619 sewage treatment plant)			
Flow	Continuous		
BOD_5	24-h composite	26.3 kg/d	40.0 kg/d
TSS	24-h composite	31.8 kg/d	47.7 kg/d
Fecal coliform/100 mL	Grab		0.5 mg/L
TRCL	24-h composite	Monitoring only specified	
pH	Grab	6.5 to 9.0	
Outfall 003B (biodenitrification plant)			
Flow	Continuous		
Nitrate, as N	24-h composite	11.0 kg/d	13.0 kg/d
Total Cu	24-h composite	0.007 kg/d	0.014 kg/d
Total Zn	24-h composite	0.055 kg/d	0.110 kg/d
Total Fe	24-h composite	0.23 kg/d	0.45 kg/d
Total Ni	24-h composite	0.018 kg/d	0.036 kg/d
pH	Grab	6.5 to 9.0	
Outfall 004 (X-616 chromium treatment plant)			
Flow	Continuous		
TDS	24-h composite	3500 mg/L	4000 mg/L
TSS	24-h composite	75.8 kg/d	113.5 kg/d
Total Zn	24-h composite	1.9 kg/d	3.8 kg/d
Cr^{6+}	24-h composite	0.2 kg/d	0.4 kg/d
Total Cr	24-h composite	1.9 kg/d	3.8 kg/d
Total Fe	24-h composite	3.8 kg/d	5.7 kg/d
Total Cu	24-h composite	1.9 kg/d	3.8 kg/d
TRCL	Grab		0.02 mg/L
TCE	24-h composite		0.001 mg/L
pH	Grab	6.5 to 9.0	
Outfalls 005, 005, 007, and 008 (X-611 sludge lagoons)			
Flow	Estimate		
TSS	Grab	10 mg/L	15 mg/L
pH	Grab	6.5 to 10.0	

Table D.3-3 (continued)

NPDES outfall description and sample parameters	Required sampling method	Daily average limitation	Daily maximum limitation
	Outfall 009 (north holding pond)		
Flow	Weekly measurements		
TSS	Grab	30 mg/L	100 mg/L
O&G	Grab	10 mg/L	15 mg/L
Fluoride	Grab	Monitoring only specified	
TRCL	Grab		0.02 mg/L
pH	Grab	6.5 to 9.0	
	Outfall 009A (fluorine generator cleaning)		
Flow	Batch measurement		
TSS (kg/batch)	24-h composite		0.68
Fluorine (kg/batch)	24-h composite		0.68
	Outfall 010 (west drainage ditch) and Outfall 011 (northeast drainage ditch)		
Flow	Continuous		
O&G	Grab	10 mg/L	15 mg/L
pH	Grab	6.5 to 9.0	
	GCEP NPDES Outfalls		
	Outfall 001 X-2230M pond effluent, Outfall 002 X-2230N pond effluent, and Outfall 003 stormwater runoff, south GCEP site		
Flow	Continuous		
TSS	Grab	30 mg/L	100 mg/L
O&G	Grab	10 mg/L	20 mg/L
pH	Grab	6.5 to 8.5	

Notes: 1. Parameters for which limits are not specified are required to be monitored. Results are to be reported to the U.S. EPA.

2. The pH limitations were removed at outfall 001A. A pH range of 6.5 < pH < 9.0 should be maintained. Continuous pH monitoring data must be reported monthly to the Ohio EPA.

Source: J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs During 1987*, ES/ESH-4/V4, POEF-1180, prepared by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, 1988, pp. 32-34, Table 2.2.1.

APPENDIX E

Appendix E

GROUNDWATER

The Appendix E tables are taken from the following sources unless otherwise noted on the individual tables:

E.1-1 to E.1-4	J. G. Rogers et al, *Oak Ridge Reservation Environmental Report for 1988,* ES/ESH-8/V1 and 2, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., May 1989.
E.2-1 to E.2-13	J. G. Rogers and T. G. Jett, *Paducah Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8V3, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Paducah, Ky., May 1989.
E.3-1 to E.3-29	J. G. Rogers et al, *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988,* ES/ESH-8/V4, POEF-2010, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., and Piketon, Ohio, May 1989.

[Figure E.2-1 is placed in a pocket after Appendix I.]

Fig. E.2-1. Paducah Gaseous Diffusion Plant wells and piezometers.

Table E.1-1. Oak Ridge Gaseous Diffusion Plant groundwater monitoring for 1988

Parameter	Total number of samples	Number of samples > standard	Concentration		Average of samples > detection limit
			Minimum	Maximum	
		K-1407-B pond			
1,1,1-Trichloroethane, μg/L	1	1	210	210	210
1,1-Dichloroethane, μg/L	1	1	370	370	370
1,1-Dichloroethene, μg/L	1	1	180	180	180
1,2-Dichloroethane, μg/L	1	1	10	10	10
Butylbenzylphthalate, μg/L	1	1	23	23	23
Chloride, mg/L	5	2	22	308	180
Di-n-butylphthalate, μg/L	1	1	20	20	20
Iron, mg/L	17	17	0.84	43	10.9
Manganese, mg/L	17	17	0.16	21	8.9
pH	85	14	6.2	7.3	*a*
Sulfate, mg/L	5	1	28	471	182
Trans-1,2-dichloroethene, μg/L	1	1	410	410	410
Trichloroethene, μg/L	1	1	2,100	2,100	2,100
TOX, μg/L	66	66	57	4,520	1,010
Vinyl chloride, μg/L	1	1	48	48	48
		K-1407-C pond			
Cadmium, mg/L	12	1	<0.003	0.017	0.007
Chromium, mg/L	12	1	<0.01	0.35	0.088
Iron, mg/L	19	19	0.91	220	39
Lead, mg/L	12	1	<0.05	0.086	0.086
Manganese, mg/L	19	18	0.017	27	7.1
pH (<6.5)	95	33	5.8	7.2	*a*
Sulfate, mg/L	7	1	4	300	78
TOX, μg/L	76	61	<10	221	<48.5

Table E.1-1 (continued)

Parameter	Total number of samples	Number of samples > standard	Concentration Minimum	Concentration Maximum	Average of samples > detection limit
K-1407 WAG					
1,1-Dichloroethane, μg/L	11	4	2	2,300	1,200
1,1-Dichloroethene, μg/L	11	3	3	890	446
1,2-Dichloroethane, μg/L	11	2	<5	23	22.5
Bis(2-ethylhexyl)phthalate, μg/L	11	3	2	15	15
Cadmium, mg/L	11	1	<0.003	0.013	0.01
Chromium, mg/L	11	2	<0.01	0.14	0.051
Diacetone alcohol,[b] μg/L	8	8	3	15	7.9
Hexamethylcyclotrisiloxane, μg/L	6	6	2	3	2.5
Iron, mg/L	11	10	0.23	78	16
Manganese, mg/L	11	9	0.0083	13	2.5
Methyl benzene, μg/L	6	6	3	7	4.3
Methylene chloride, μg/L	11	1	3	120	120
pH (<6.5)	100	18	5.9	8.1	*a*
Sulfate, mg/L	11	1	4.2	350	94
Tetrachlorobenzene, μg/L	1	1	35	35	35
Tetrachloroethene, μg/L	11	3	2	2,000	1,380
Toluene, μg/L	11	2	<5	8	8
TOX, μg/L	80	80	20	39,110	6,300
Trans-1,2-dichloroethene, μg/L	10	5	3	1,100	25.6
Trichloroethene, μg/L	11	8	4	8,500	2,200
Vinyl chloride, μg/L	11	8	10	350	198
K-1407-C upgradient area					
Alkyl substituted phenol, μg/L	1	1	9	9	9
Alpha activity, pCi/L	3	1	0.189	20	7.06
Bis(2-ethylhexyl)phthalate, μg/L	3	1	<5	19	19
Chromium, mg/L	3	1	<0.01	0.054	<0.054
Diacetone alcohol,[b], μg/L	2	2	4	6	5
Hexamethylcyclotrisiloxane, μg/L	2	2	2	3	2.5
Iron, mg/L	3	2	0.099	5.8	2.7
Manganese, mg/L	3	3	0.18	2.1	0.84
Methyl benzene, μg/L	2	2	3	19	11
Methylene chloride, μg/L	3	1	<5	5	5
Total coliform bacteria, col./100 mL	3	1	<1	2	1.5
TOX, μg/L	24	21	<10	132	28.8
Trichloroethene, μg/L	3	1	<5	32	32

Table E.1-1 (continued)

Parameter	Total number of samples	Number of samples > standard	Concentration Minimum	Concentration Maximum	Average of samples > detection limit
K-1413 WAG					
Acetone,[b] μg/L	5	1	<8	10	8
Cyclohexanol,[b] μg/L	3	3	5	8	6.667
Cyclohexanone,[b] μg/L	3	3	4	4	4
Diacetone alcohol,[b] μg/L	5	5	81	550	210
Iron, mg/L	5	3	0.24	15	7.7
Lead, mg/L	5	1	0.004	0.058	0.019
Managanese, mg/L	5	3	0.017	0.97	0.407
pH (>8.5)	49	1	5.1	9.8	*a*
(<6.5)	49	22	5.1	9.8	*a*
Trichloroethene, μg/L	5	1	3	1,700	1,700
TOX, μg/L	40	35	<10	3,420	449
K-1070 C/D classified burial ground					
1,1,Trichloroethane, μg/L	4	2	7	360	170
1,1,2,2-Tetrachloroethane, μg/L	27	1	<5	6	<6
1,1-Dichloroethane, μg/L	27	4	3	400	190
1,1-Dichloroethene, μg/L	27	2	2	200	130
2-Butanone,[b] μg/L	27	1	<10	33	33
4-Tert-butylphenol, μg/L	1	1	3	3	3
Acetone,[b] μg/L	27	2	3	25	18.5
Alpha activity, pCi/L	27	2	<1	82	11
Aryl hydrocarbon, μg/L	8	8	2	3	2.1
Barium, mg/L	27	1	<0.001	1.2	0.25
Beta activity, pCi/L	27	3	<3	189	31
Bis(2-ethylhexyl)phthalate,μg/L	27	6	1	70	22
Chloride, mg/L	27	2	<1	611	52.6
Chlorinated hydrocarbon, μg/L	3	3	2	61	25
Chromium, mg/L	27	6	<0.01	0.14	0.046
Diacetone alcohol,[b] μg/L	6	6	11	260	119
Dioctyl adipate, μg/L	2	2	8	18	13
Ethane,1,1,2-trichloro-1,2,2-t, μg/L	2	2	5	71	38
Ethane,1,2,-dichloro-1,1,2-tri, μg/L	2	2	17	29	23
Freon 113, μg/L	4	4	2	10	7.2
Iron, mg/L	27	22	0.032	120	22
Lead, mg/L	27	1	<0.004	0.17	0.022
Manganese, mg/L	27	20	0.001	15	1.8
Methylene chloride, μg/L	27	3	1	38	19
pH (>8.5)	200	60	5.4	10.4	*a*
(<6.5)	200	40	5.4	10.4	*a*
Phenol, μg/L	27	1	3	14	14
Phthalate ester, μg/L	1	1	5	5	5
Tetrachloroethene, μg/L	27	8	0.4	260	68.375
Toluene, μg/L	27	1	0.5	22	22
Total xylenes, μg/L	25	1	1	19	19
TOX, μg/L	160	128	<10	15,400	1,180
Trans-1,2-dichloroethene,μg/L	26	3	1	310	250
Trichloroethene, μg/L	27	8	3	2,900	860

Table E.1-1 (continued)

Parameter	Total number of samples	Number of samples > standard	Concentration Minimum	Concentration Maximum	Average of samples > detection limit
K-770 scrap yard					
2-Butanone,[b] μg/L	8	1	<10	69	69
Beta activity, pCi/L	8	4	0.31	1,540	458
Bis(2-ethylhexyl)phthalate, μg/L	8	3	2	100	46
Chlorodifluoromethane, μg/L	1	1	7	7	7
Diacetone alcohol,[b] μg/L	4	4	2	67	19
Dioctyl adipate, μg/L	1	1	31	31	31
Hexamethylcyclotrisiloxane, μg/L	1	1	2	2	2
Iron, mg/L	8	5	0.03	29	5.7
Manganese, mg/L	8	8	0.054	1.7	0.68
pH (<6.5)	80	57	5.3	7.1	*b*
Total coliform bacteria, col./100 mL	8	2	<1	10	4.7
TOX, μg/L	64	61	<10	375	43.7
K-1064-G burn area/peninsula storage					
1,1,2-Trichloroethane, μg/L	7	1	4	16	16
1,1-Dichloroethane, μg/L	7	4	<5	22	18
1,1-Dichloroethene, μg/L	7	3	<5	18	9.4
Alpha activity, pCi/L	7	4	4	220	57
Barium, mg/L	7	1	0.017	1.4	0.24
Beta activity, pCi/L	7	4	12	298	110
Bis(2-ethylhexyl)phthalate, μg/L	7	1	2	75	75
Copper, mg/L	7	1	<0.004	1.9	0.66
Diacetone alcohol,[b], μg/L	3	3	4	120	44
Fluoride, mg/L	7	1	0.2	6.4	1.1
Freon 113, μg/L	3	3	13	42	24
Hexamethylcyclotrisiloxane, μg/L	5	5	2	3	2.6
Iron, mg/L	7	1	0.0056	300	43
Lead, mg/L	7	1	<0.004	0.084	0.019
Manganese, mg/L	7	3	<0.001	5.7	1.1
pH (>8.5)	70	5	5	8.9	*b*
(<6.5)	70	2	5	8.9	*b*
Sulfate, mg/L	7	1	45	256	109
Total coliform bacteria, col./100 mL	7	4	<1	55	18
TOX, μg/L	56	56	10	182	76.2
Trans-1,2-dichloroethene, μg/L	7	2	3	10	10
Trichloroethane, μg/L	2	2	2	9	5.5
Trichloroethene, μg/L	7	2	4	18	17

Table E.1-1 (continued)

Parameter	Total number of samples	Number of samples > standard	Concentration Minimum	Concentration Maximum	Average of samples > detection limit
K-1085 firehouse burn area					
Diacetone alcohol,[b] μg/L	2	2	2	5	3.5
Hexamethylcyclotrisiloxane, μg/L	2	2	2	3	2.5
Iron, mg/L	5	5	0.51	12	4.2
Manganese, mg/L	5	3	0.022	0.76	0.21
Methyl benzene, μg/L	3	3	2	4	3
Methylene chloride, μg/L	5	1	4	8	8
pH (<6.5)	55	2	5.6	7.5	*a*
TOX, μg/L	44	33	<10	98	31
K-1070-A contaminated burial ground					
1,1,1-Trichloroethane, μg/L	9	2	5	3,100	770
1,1,2-Trichloroethane, μg/L	9	3	2	10	7.3
1,1-Dichloroethane, μg/L	9	2	2	57	34
1,1-Dichloroethene, μg/L	9	5	3	1,100	310
2-Butanone,[b] μg/L	9	1	4	12	12
Beta activity, pCi/L	9	6	2	818	354
Carbon tetrachloride, μg/L	9	5	2	110	53
Chromium, mg/L	9	2	<0.01	0.086	0.052
Freon 113, μg/L	1	1	64	64	64
Iron, mg/L	9	5	0.11	93	16
Lead, mg/L	9	2	<0.004	0.14	0.048
Manganese, mg/L	9	4	0.002	3.2	0.49
pH (>8.5)	90	2	5.4	8.7	*a*
(<6.5)	90	12	5.4	8.7	*a*
Phthalate ester, μg/L	1	1	9	9	9
Tetrachloroethene, μg/L	10	3	2	14	10
TOX, μg/L	72	71	<10	7,250	1,470
Trans-1,2-Dichloroethene, μg/L	9	1	1	6	6
Trichloroethane, μg/L	1	1	5	5	5
Trichloroethene, μg/L	9	7	5	1,600	698

Table E.1-1 (continued)

Parameter	Total number of samples	Number of samples > standard	Concentration Minimum	Concentration Maximum	Average of samples > detection limit
K-1070-F old contractors' burial ground					
Benzo(a)anthracene, μg/L	8	1	<5	9	9
Chrysene, μg/L	8	1	<5	11	11
Diacetone alcohol,[a] μg/L	4	4	2	4	2.8
Hexamethylcyclotrisiloxane, μg/L	5	5	2	3	2.4
Iron, mg/L	8	5	0.071	10	2.8
Manganese, mg/L	8	3	0.0043	0.19	0.071
Methyl benzene, μg/L	3	3	2	9	4.3
Methylene chloride, μg/L	8	2	4	12	9.5
pH (>8.5)	64	10	6.6	9.6	*a*
Total coliform bacteria, col./100 mL	8	4	<1	14	11
TOX, μg/L	52	33	<10	96	29
K-1232 treatment unit					
2-Tert-butylphenol, μg/L	1	1	0.7	0.7	0.7
4-Tert-butylphenol, μg/L	1	1	79	79	79
Aryl hydrocarbon, μg/L	5	5	2	4	3.4
Beta activity, pCi/L	12	6	<5	152	73
Bis(2-ethylhexyl)phthalate, μg/L	12	1	2	7	7
Carbon tetrachloride, μg/L	12	2	<5	13	10
Chromium, mg/L	12	1	<0.01	0.14	0.035
Diacetone alcohol,[a] μg/L	4	4	3	77	24
Fluoride, mg/L	12	4	<0.1	11	3.3
Freon 113, μg/L	2	2	6	10	8
Iron, mg/L	12	9	0.0041	120	18
Lead, mg/L	12	2	<0.004	0.23	0.038
Manganese, mg/L	12	10	0.019	3.5	0.74
pH (>8.5)	80	15	5.2	11.8	*a*
(<6.5)	80	25	5.2	11.8	*a*
TOX, μg/L	63	58	<10	2,560	239
Trichloroethene, μg/L	12	8	1	1,900	450
K-1099 Blair Road Quarry					
Hexamethylcyclotrisiloxane, μg/L	1	1	2	2	2
Methyl benzene, μg/L	1	1	22	22	22
Sulfate, mg/L	1	1	266	266	266
Total coliform bacteria, col./100 mL	1	1	4	4	4
TOX, μg/L	8	5	<10	16	14

[a]Not applicable.
[b]Also detected in laboratory blanks.

Table E.1-2. Off-site well water inorganic analyses, October 1988

Parameter	Number of samples	Concentration (mg/L)				Percentage DWL[a]
		Max	Min	Av	Standard error	
Alkalinity	6	240	170	200	11	
Arsenic-GFAA	6	<0.030	<0.0050	<0.018	0.0056	
Barium	6	0.15	0.027	0.079	0.022	7.9
Cadmium	6	<0.0050	<0.0030	<0.0040	0.0004	<40
Chloride IC	6	6.0	1.0	3.4	0.80	1.3
Chromium	6	<0.010	<0.010	<0.010	0	<20
Copper	6	0.040	<0.0040	<0.015	0.0056	<1.5
Dissolved solids	6	290	190	240	15	48
Fluoride IC	6	<1.0	0.10	<0.40	0.14	<20
Iron	6	0.59	0.035	0.17	0.089	57
Iron IC (reanalysis)	1	0.57	0.57	0.57		
Lead-GFAA	6	<0.030	<0.0040	<0.017	0.0058	<34
Lead IC (reanalysis)	1	0.0078	0.0078	0.0078		
Manganese	6	0.025	<0.0010	<0.0076	0.0037	<15
Mercury	6	<0.0010	<0.0002	<0.0006	0.0001	<30
Nitrate	6	2.6	<0.50	<1.1	0.38	<11
Selenium-GFAA	6	<0.030	<0.0050	<0.013	0.0042	<130
Silver	6	0.034	<0.0050	<0.013	0.0051	<27
Sulfate	6	14	1.0	7.0	2.2	2.8
Suspended solids	6	19	<1.0	<4.0	3.0	
Thallium-GFAA	3	<0.010	<0.010	<0.010	0	
Turbidity (NTU)	6	8.6	0.24	3.2	1.5	
Uranium fluorometric	6	<0.0010	<0.0010	<0.0010	0	
Zinc	6	0.15	0.016	0.069	0.023	1.4

[a]Average concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

Table E.1-3. Off-site well water radiochemical analyses, October 1988

Parameter	Number of samples	Concentration (pCi/L)				Percentage DWL[a]
		Max	Min	Av	Standard error	
^{60}Co	6	<7.0	<2.7	<5.3	0.86	
^{137}Cs	6	<2.7	0	<1.4	0.60	
Gross alpha	6	4.9	<2.0	<3.1	0.45	<21
Gross beta	6	17	3.2	10	2.4	
^{99}Tc	6	<460	<14	<240	100	
Total radioactive strontium	6	<8.1	1.0	<5.7	1.5	<72
Total radium	6	<3.2	<2.7	<3.0	0.11	<59
Tritium	6	<3800	<1400	<2600	550	<13

[a]Average concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

Table E.1-4. Off-site well water organic analyses, October 1988

Parameter	Number of samples	Concentration (mg/L)				Percentage DWL[a]
		Max	Min	Av	Standard error	
1,1,1-Trichloroethane	6	<5.0	<5.0	<5.0	0	<2.5
1,1,2,2-Tetrachloroethane	6	<5.0	<5.0	<5.0	0	
1,1,2-Trichloroethane	6	<5.0	<5.0	<5.0	0	
1,1-Dichloroethane	6	<5.0	<5.0	<5.0	0	
1,1-Dichloroethene	6	<5.0	<5.0	<5.0	0	
1,2-Dichloroethane	6	<5.0	<5.0	<5.0	0	<1.0
1,2-Dichloroethene (total)	6	<5.0	<5.0	<5.0	0	
1,2-Dichloropropane	6	<5.0	<5.0	<5.0	0	
2,4,5-T	8	<0.10	<0.10	<0.10	0	
2,4,5-TP (silvex)	8	<0.10	<0.10	<0.10	0	<1.0
2,4-D	8	<1.0	<1.0	<1.0	0	<1.0
2-Butanone	6	<10	<10	<10	0	
2-Hexanone	6	<10	<10	<10	0	
4-Methyl-2-pentanone	6	<10	<10	<10	0	
Acetone	6	<10	<10	<10	0	
Benzene	6	<5.0	<5.0	<5.0	0	<100
Bromodichloromethane	6	<5.0	<5.0	<5.0	0	
Bromoform	6	<5.0	<5.0	<5.0	0	
Bromomethane	6	<10	<10	<10	0	
Carbon disulfide	6	<5.0	<5.0	<5.0	0	
Carbon tetrachloride	6	<5.0	<5.0	<5.0	0	<100
Chlorobenzene	6	<5.0	<5.0	<5.0	0	
Chloroethane	6	<10	<10	<10	0	
Chloroform	5	<5.0	<5.0	<5.0	0	
Chloromethane	6	<10	<10	<10	0	
Dibromochloromethane	6	<5.0	<5.0	<5.0	0	
Endrin	8	<0.10	<0.10	<0.10	0	<50
Ethyl benzene	6	<5.0	<5.0	<5.0	0	
Methoxychlor	8	<0.50	<0.50	<0.50	0	<0.50
Methylene chloride	6	<5.0	<5.0	<5.0	0	
Styrene	6	<5.0	<5.0	<5.0	0	
Tetrachloroethene	6	<5.0	<5.0	<5.0	0	
Toluene	6	<5.0	<5.0	<5.0	0	
Toxaphene	8	<1.0	<1.0	<1.0	0	<20
Trichloroethene	6	<5.0	<5.0	<5.0	0	
Vinyl acetate	6	<10	<10	<10	0	
Vinyl chloride	6	<10	<10	<10	0	
Xylene (total)	6	<5.0	<5.0	<5.0	0	
cis-1,3-Dichloropropene	6	<5.0	<5.0	<5.0	0	
gamma-BHC(Lindane)	8	<0.050	<0.050	<0.050	0	<1.3
trans-1,3-Dichloropropene	6	<5.0	<5.0	<5.0	0	

[a]Average concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

Table E.2-1. References information for monitoring wells and piezometers at the Paducah Gaseous Diffusion Plant

Well	AKA	Monitored Interval	Construction Casing	Construction Screen	Comments	Boring[a]	Reference
1							
7	10	SGS[b]	6" PVC	6" PVC	1	10	Geotek (1980)
8	22	RGA[c]	6" PVC	6" PVC	1	22	Geotek (1980)
9	3(?)	RGA	6" PVC	6" PVC	1	3?	Geotek (1980)
11	2	RGA?	6" PVC	6" PVC	1	2	Geotek (1980)
12	1	RGA	6" PVC	6" PVC	1	1	Geotek (1980)
13	11	SGS?	6" PVC	6" PVC	1	11	Geotek (1980)
14	28	RGA?SFS?	6" PVC	6" PVC	1	28	Geotek (1980)
15	29	RGA	6" PVC	6" PVC	1	29	Geotek (1980)
16	7	SGS	6" PVC	6" PVC	2	7	Geotek (1979)
17	8	RGA	6" PVC	6" PVC	2	8	Geotek (1979)
18	1	SGS	6" PVC	6" PVC	2	1	Geotek (1979)
19	9	RGA	6" PVC	6" PVC	2	9	Geotek (1979)
21							
22							
23	B-1	PCC[d]	1 1/4" GalvS	1 1/4"SS		B-1	Wehran (1981)
24	B-2	PCC	1 1/4" GalvS	1 1/4"SS		B-2	Wehran (1981)
25	B-3	PCC	1 1/4" GalvS	1 1/4"SS		B-3	Wehran (1981)
26	B-3A	RGA	1 1/4" GalvS	1 1/4"SS		B-3A	Wehran (1981)
27	B-4	PCC	1 1/4" GalvS	1 1/4"SS		B-4	Wehran (1981)
38	5P	RGA	4" PVC	4" PVC		5P	PGDP Files
39[e]	3P	RGA	4" PVC	4" PVC		3P	PGDP Files
40[e]	4P	RGA	4" PVC	4" PVC		4P	PGDP Files
41	2P	RGA	4" PVC	4" PVC		2P	PGDP Files
42[e]	N6P	RGA	4" PVC	4" PVC		N6P	PGDP Files
43[e]	N7P	RGA	4" PVC	4" PVC		N7P	PGDP Files
44	1P	RGA	4" PVC	4" PVC		1P	PGDP Files
46	D-5	RGA	4"BkS	4" SS		B-5	D'Appolonia(1983)
47	D-5A	SGS	1.5" GalvS	1.5" SS		B-5	D'Appolonia(1983)
48	D-4	RGA	4"BkS	4" SS		B-4	D'Appolonia(1983)
49	D-4A	SGS	1.5" GalvS	1.5" SS		B-4	D'Appolonia(1983)
50	D-3	RGA	4"BkS	4" SS		B-3	D'Appolonia(1983)
51	D-2	RGA	4"BkS	4" SS		B-2	D'Appolonia(1983)
52	D-10	RGA	4"BkS	4" SS		B-10	D'Appolonia(1983)
53	D-9	RGA	4"BkS	4" SS		B-9	D'Appolonia(1983)
54	D-8	RGA	4"BkS	4" SS		B-8	D'Appolonia(1983)
57	D-1A	SGS	4"BkS	4" SS		B-1	D'Appolonia(1983)
58	D-1B	SGS	1.5" GalvS	1.5" SS		B-1	D'Appolonia(1983)
63		RGA top	2" SS	2" SS		S-2	MCI (1986)
64		SGS	2" SS	2" SS		S-2	MCI (1986)
65		RGA base	2" SS	2" SS		S-2	MCI (1986)
66		RGA top	2" SS	2" SS		S-2,66	MCI (1986)
67		RGA	2" SS	2" SS		67	MCI (1986)
68		RGA base	2" SS	2" SS		S-1	MCI (1986)
69		SGS	2" SS	2" SS		S-1	MCI (1986)
71	70-A	RGA top	2" SS	2" SS		S-1	MCI (1986)
72		RGA	2" PVC	2" PVC		72	EDGe (1987b)
73		RGA	2" PVC	2" PVC		S-3,73	EDGe (1987b)
74		SGS	2" PVC	2" PVC		74	EDGe (1987b)
75		SGS	2" PVC	2" PVC		S-3,75	EDGe (1987b)
76		RGA	2" PVC	2" PVC		S-3,76	EDGe (1987b)
77		RGA	2" PVC	2" PVC		77	EDGe (1987b)
78		RGA	2" PVC	2" PVC		S-3,7	ERC (1989)
79		RGA	6" PVC	6" PVC	3	S-3,79	ERC (1989)
80		RGA	2" PVC	2" PVC		S-3	ERC (1989)
81		RGA	2" PVC	2" PVC		S-3	ERC (1989)
82		SGS	2" PVC	2" PVC		S-3	ERC (1989)
83		SGS	2" PVC	2" PVC		S-3	ERC (1989)
84		RGA top	2" SS	2" SS		86	ERC (1989)
85		SGS	2" SS	2" SS		86	ERC (1989)
86		RGA base	2" SS	2" SS		86	ERC (1989)
87		RGA top	2" SS	2" SS		89	ERC (1989)
88		SGS	2" SS	2" SS		89	ERC (1989)
89		RGA base	2" SS	2" SS		89	ERC (1989)
90		RGA top	2" SS	2" SS		92	ERC (1989)
91		SGS	2" SS	2" SS		92	ERC (1989)
92		RGA base	2" SS	2" SS		92	ERC (1989)
93		RGA top	2" SS	2" SS		95	ERC (1989)
94		SGS	2" SS	2" SS		95	ERC (1989)
95		RGA base	2" SS	2" SS		95	ERC (1989)

Comments:
1 = Annular Space Sandpacked with 2 feet grout at surface
2 = 2 - 3 feet grout seal above monitored interval; sand packed to surface
3 = Wire wrapped screen

Footnotes:

a Notations in this column refer to the boring number located in the cited reference from which lithologic information for the wells is derived. In several instances geologic logs exist for both the well and for an adjacent soil boring.

b SGS = Shallow Groundwater System (sands within Clay Facies)

c RGA = Regional Gravel Aquifer

d PCC = Porters Creek Clay

e Documentation from the driller for wells 38 to 44 is limited. Some evidence suggests that lithologic and depth information for wells 39 and 40 and 42 and 43, respectively, were switched following completion. These well designations represent an attempt to reconcile inconsistencies.

Source: Early, T. O., Sigmon, C. F., and Williams, R. T. 1989. Groundwater Monitoring Plan for the Paducah Gaseous Diffusion Plant. Environmental Sciences Division, Oak Ridge National Laboratory, August 3,

1

Table E.2-2. Background groundwater quality in the vicinity of the Paducah Gaseous Diffusion Plant

Parameters	Well 59 (sampled 10/18/88	Well 60 (sampled 10/18/88	Well 61 (sampled 11/28/89	Well 62 (sampled 10/18/88
Color	5 units	<5 units	5 units	15 units
Conductivity	234 μmho/cm	459 μmho/cm	400 μmho/cm	307 μmho/cm
Cr	<0.05 mg/L	<0.05 mg/L	<0.05 mg/L	<0.05 mg/L
Cu	0.06 mg/L	<0.01 mg/L	<0.01 mg/L	0.02 mg/L
Dissolved alpha	0.7 pCi/L	8.9 pCi/L	0 pCi/L	-3 pCi/L
Dissolved beta	2 pCi/L	-11 pCi/L	8 pCi/L	8 pCi/L
Fe	0.05 mg/L	0.02 mg/L	0.18 mg/L	6.45 mg/L
Fluoride	0.13 mg/L	0.20 mg/L	0.19 mg/L	0.25 mg/L
NO_3-N	3.7 mg/L	3.4 mg/L	2.5 mg/L	<1 mg/L
Ni	<0.05 mg/L	<0.05 mg/L	<0.05 mg/L	<0.05 mg/L
PCB	<0.5 μg/L	<0.5 μg/L	<0.5 μg/L	<0.5 μg/L
Pb	<0.2 mg/L	<0.2 mg/L	<0.2 mg/L	<0.2 mg/L
Sulfate	<5 mg/L	48.0 mg/L	6.0 mg/L	<5 mg/L
Suspended alpha	-1.1 pCi/L	-2.9 pCi/L	-0.7 pCi/L	0.9 pCi/L
Suspended beta	-17 pCi/L	-3 pCi/L	-1 pCi/L	-1 pCi/L
TOC	<1 mg/L	2 mg/L	2 mg/L	2 mg/L
TOX	<5 μg/L	6 μg/L	10 μg/L	<5 μg/L
Triene-H_2O	<1 μg/L	<1 μg/L	<1 μg/L	<1 μg/L
^{99}Tc	<25 pCi/L	<25 pCi/L	<25 pCi/L	<25 pCi/L
Turbidity	1.5 NTU	0.3 NTU	1.6 NTU	11.4 NTU
Uranium	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L
Zn	0.055 mg/L	0.02 mg/L	0.31 mg/L	0.02 mg/L
pH	6.3 units	6.3 units	6.2 units	7.2 units

Source: Unpublished data from Jeffrey W. Douthitt, Martin Marietta Energy Systems, Inc., Paducah, Ky.

Table E.2-3. Constituents in groundwater at the horse barn during 1988
Well 20

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	1/1	92.0	92.0	92.0	NA	NA
Am (pCi/L)	NA[a]/1	−0.4	−0.4	NA	NA	NA
Ba (mg/L)	1/1	0.12	0.12	0.12	NA	NA
Ca (mg/L)	1/1	16.0	16.0	16.0	NA	NA
Chloride (mg/L)	1/1	29.0	29.0	29.0	2	0
^{60}Co (pCi/L)	NA/1	0.4	0.4	NA	3	0
Color (units)	4/4	3.0	8.0	5.0	2	0
Conductivity (μmho/cm)	16/16	299.0	318.0	307.4	NA	NA
Cr (mg/L)	0/4	<0.05	0.05	None	1	0
Cr^{6+} (mg/L)	0/1	<0.01	<0.01	None	NA	NA
Cs (pCi/L)	NA/1	0.2	0.2	NA	3	0
Cu (mg/L)	4/4	0.068	0.210	0.150	2	0
Depth (ft)	NA/2	NA	42.02	NA	NA	NA
Dissolved alpha (pCi/L)	NA/6	−9.9	12.9	NA	1	0
Dissolved beta (pCi/L)	NA/6	11.0	116.0	NA	1	NA
Dissolved solids (mg/L)	1/1	164.0	164.0	164.0	2	0
Fe (mg/L)	4/4	3.23	28.40	11.08	2	4
Fluoride (mg/L)	4/4	0.17	0.18	0.18	1	0
Mg (mg/L)	1/1	7.08	7.08	7.08	NA	NA
Mn (mg/L)	1/1	0.02	0.02	0.02	2	0
NO_3-N (mg/L)	0/4	<1	1.0	None	1	0
Na (mg/L)	1/1	32.0	32.0	32.0	NA	NA
Ni (mg/L)	0/4	<0.05	<0.05	None	NA	NA
PCB (μg/L)	0/4	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/1	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/1	0.2	0.2	NA	1	0
Sulfate (mg/L)	4/4	9.0	14.0	12.50	2	0
Suspended alpha (pCi/L)	NA/6	−5.2	2.7	NA	1	0
Suspended beta (pCi/L)	NA/6	−15.0	5.0	NA	1	NA
TOC (mg/L)	2/16	<1	3.0	1.6	NA	NA
TOX (μg/L)	16/16	14.0	41.0	21.1	NA	NA
Trichloroethylene (μg/L)	5/5	17.0	43.0	26.0	4	5
^{99}Tc (pCi/L)	NA/6	<25	51.0	NA	1	0
Temperature (°F)	NA/1	55.0	55.0	NA	NA	NA
Total Cd (mg/L)	0/1	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/4	<0.2	<0.2	None	1	4
Total Se (mg/L)	0/1	<0.005	<0.005	None	1	0
Turbidity (NTU)	4/4	29.0	87.0	46.25	1	4
Uranium (mg/L)	0/5	<0.001	<0.001	None	NA	NA
Zn (mg/L)	4/4	0.043	0.170	0.111	2	0
pH (units)	NA/16	6.0	6.8	NA	2	10

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-4. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-616 lagoon during 1988
Wells 21 and 22
Units 17 and 18

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	2/2	28.0	354.0	191.0	NA	NA
Am (pCi/L)	NA[a]/2	−0.4	0	NA	NA	NA
Ca (mg/L)	2/2	9.52	29.0	19.3	NA	NA
Chloride (mg/L)	2/2	12.0	20.0	16.0	2	0
^{60}Co (pCi/L)	NA/2	−0.1	0.6	NA	3	0
Color (units)	8/8	3.0	120.0	30.1	2	4
Conductivity (μmho/cm)	32/32	124.4	915.0	507	NA	NA
Cr (mg/L)	3/8	<0.05	0.20	0.12	1	3
Cr^{6+} (mg/L)	0/2	<0.01	<0.01	None	NA	NA
Cs (pCi/L)	NA/2	0	0.3	NA	3	0
Cu (mg/L)	7/8	<0.01	0.11	0.05	2	0
Depth (ft)	NA/8	44.08	49.33	NA	NA	NA
Dissolved alpha (pCi/L)	NA/8	−12.6	36.0	NA	1	2
Dissolved beta (pCi/L)	NA/8	7.0	164.0	NA	1	NA
Dissolved solids (mg/L)	2/2	87.0	504.0	296	2	1
Fe (mg/L)	8/8	0.98	185.0	53.1	2	8
Fluoride (mg/L)	8/8	0.25	0.47	0.36	1	0
Mg (mg/L)	2/2	4.72	13.65	9.19	NA	NA
Mn (mg/L)	2/2	0.35	0.69	0.52	2	2
NO_3-N (mg/L)	0/8	<1	<1	None	1	0
Na (mg/L)	2/2	7.31	123.0	65.2	NA	NA
Ni (mg/L)	6/8	<0.05	4.34	0.92	NA	NA
PCB (μg/L)	0/8	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/2	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/2	0.2	0.3	NA	1	0
Sulfate (mg/L)	8/8	18.0	129.0	54.6	2	0
Suspended alpha (pCi/L)	NA/8	0.7	11.0	NA	1	0
Suspended beta (pCi/L)	NA/8	9.0	81.0	NA	1	NA
TOC (mg/L)	32/32	3.0	9.0	5.2	NA	NA
TOX (μg/L)	32/32	8.0	56.0	29.1	NA	NA
Trichloroethylene (μg/L)	0/6	<1	1.0	None	4	0
^{99}Tc (pCi/L)	NA/6	0	71.0	NA	1	0
Temperature (°F)	NA/2	54.0	58.0	NA	NA	NA
Total Cd (mg/L)	0/2	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/8	<0.2	<0.2	None	1	8
Total Se (mg/L)	0/2	<0.005	<0.005	None	1	0
Turbidity (NTU)	8/8	330.0	3200.0	1340	1	8
Uranium (mg/L)	8/8	0.002	0.014	0.007	NA	NA
Zn (mg/L)	7/8	<0.005	1.080	0.385	2	0
pH (units)	NA/31	6.0	7.60	NA	2	10

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-5. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-404/C-749 burial area during 1988 Wells 46, 48, 50, 51, 67, 2, 3, 4, 5, 6, 47, 49, 57, and 58 Units 2 and 3

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	9/9	60	134.0	81.8	NA	NA
Am (pCi/L)	NA[a]/10	−2.6	1.6	NA	NA	NA
Ca (mg/L)	10/10	10.2	30.9	18	NA	NA
Chloride (mg/L)	8/9	<2	29.0	16	2	0
^{60}Co (pCi/L)	NA/10	−0.3	0.9	NA	3	0
Color (units)	25/25	3.0	300.0	35.8	2	14
Conductivity (μmho/cm)	100/100	153.0	389.0	216	NA	NA
Cr (mg/L)	1/29	0.01	0.08	0.07	1	1
Cr^{6+} (mg/L)	0/9	<0.01	0.01	None	NA	NA
Cs (pCi/L)	NA/10	−1.1	0.6	NA	3	0
Cu (mg/L)	7/29	<0.01	2.48	0.39	2	1
Depth (ft)	NA/21	17.8	64.4	NA	NA	NA
Dissolved alpha (pCi/L)	NA/29	−2.4	70.5	NA	1	8
Dissolved beta (pCi/L)	NA/29	−9.0	177.0	NA	1	NA
Dissolved solids (mg/L)	9/9	96.0	277.0	139	2	0
Fe (mg/L)	28/29	<0.01	55.0	9.9	2	23
Fluoride (mg/L)	23/25	<0.1	0.32	0.2	1	0
Mg (mg/L)	10/10	4.42	15.58	7.2	NA	NA
Mn (mg/L)	8/10	<0.005	1.8	0.51	2	6
NO_3-N (mg/L)	0/25	<1	<1	None	1	0
Na (mg/L)	10/10	11.2	66.4	22.2	NA	NA
Ni (mg/L)	5/29	<0.05	0.08	0.06	NA	NA
PCB (μg/L)	0/28	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/9	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/10	−0.5	0.6	NA	1	0
Sulfate (mg/L)	19/25	<5	50.0	12.6	2	0
Suspended alpha (pCi/L)	NA/29	−1.8	17.3	NA	1	1
Suspended beta (pCi/L)	NA/29	−17.0	203.0	NA	1	NA
TOC (mg/L)	18/104	0.0	8.0	2.3	NA	NA
TOX (μg/L)	70/107	<5	1080	37.3	NA	NA
Trichloroethylene (μg/L)	6/14	<1	31.2	12.9	4	4
^{99}Tc (pCi/L)	NA/13	0.0	133.0	NA	1	0
Temperature (°F)	NA/6	57.0	60.0	NA	NA	NA
Total Cd (mg/L)	0/10	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/29	0.03	<0.2	None	1	28
Total Se (mg/L)	0/10	<0.005	<0.005	None	1	0
Turbidity (NTU)	25/25	0.4	430.0	59.1	1	21
Uranium (mg/L)	7/27	<0.001	0.078	0.04	NA	NA
Zn (mg/L)	21/29	<0.005	0.880	0.12	2	0
pH (units)	NA/105	5.7	7.5	NA	2	77

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-6. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-746-S/C-746-T landfill during 1988 Wells 16, 17, 18, 19, 38, 39, 40, 41, 42, 43, and 44 Units 9 and 10

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	10/10	78.0	680.0	230.0	NA	NA
Am (pCi/L)	NA[a]/10	−0.4	0.4	NA	NA	NA
Ca (mg/L)	10/10	13.9	85.0	37.6	NA	NA
Chloride (mg/L)	21/21	4.0	44.0	27.6	2	0
^{60}Co (pCi/L)	NA/10	−0.6	1.6	NA	3	0
Color (units)	40/40	3.0	13.0	6.7	2	0
Conductivity (μmho/cm)	159/159	227.0	1520.0	620	NA	NA
Cr (mg/L)	0/41	<0.05	<0.05	None	1	0
Cr^{6+} (mg/L)	0/10	<0.01	0.01	None	NA	NA
Cs (pCi/L)	NA/10	−0.4	0.4	NA	3	0
Cu (mg/L)	13/41	<0.01	1.72	0.5	2	2
Depth (ft)	NA/42	10.7	80.2	NA	NA	NA
Dissolved alpha (pCi/L)	NA/41	−9.4	79.7	NA	1	5
Dissolved beta (pCi/L)	NA/41	−8.0	174.0	NA	1	NA
Dissolved solids (mg/L)	10/10	138.0	983.0	411	2	3
Fe (mg/L)	40/41	<0.01	6.25	1.00	2	24
Fluoride (mg/L)	41/41	0.15	1.0	0.33	1	0
Gross alpha (pCi/L)	NA/3	0	2.6	NA	1	0
Gross beta (pCi/L)	NA/3	2.0	14.0	NA	1	NA
Mg (mg/L)	10/10	5.74	51.0	19.8	NA	NA
Mn (mg/L)	7/10	<0.005	2.04	0.304	2	3
NO_3-N (mg/L)	19/40	<1	4.3	1.9	1	0
Na (mg/L)	10/10	21.9	99.0	53.4	NA	NA
Ni (mg/L)	5/41	<0.05	0.22	0.15	NA	NA
PCB (μg/L)	0/42	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/10	<2	<2	None	NA	NA
Radon (pCi/L)	NA/3	211.0	358.0	NA	NA	NA
^{226}Ra (pCi/L)	NA/10	−0.3	0.3	NA	1	0
^{222}Rn (pCi/L)	NA/6	173.0	358.0	NA	NA	NA
Sulfate (mg/L)	40/40	8.0	240.0	69.8	2	0
Suspended alpha (pCi/L)	NA/41	−6.5	5.6	NA	1	0
Suspended beta (pCi/L)	NA/41	−21.0	44.0	NA	1	NA
TOC (mg/L)	82/157	0	29.0	5.2	NA	NA
TOX (μg/L)	167/178	<5	51.0	17.6	NA	NA
Trichloroethylene (μg/L)	34/64	0.0	32.0	10.4	4	18
^{99}Tc (pCi/L)	NA/53	0	25.0	NA	1	0
Temperature (°F)	NA/6	55.0	58.0	NA	NA	NA
Total Cd (mg/L)	0/10	<0.01	<0.01	None	1	0
Total Pb (mg/L)	1/41	<0.2	0.23	0.23	1	41
Total Se (mg/L)	0/10	<0.005	<0.005	None	1	0
Turbidity (NTU)	40/40	0.5	160.0	13.8	1	21
Uranium (mg/L)	9/41	<0.001	0.008	0.005	NA	NA
Zn (mg/L)	17/41	<0.005	3.24	0.54	2	0
pH (units)	NA/158	5.8	7.6	NA	2	100

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-7. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-746 scrap yard during 1988 Wells 63, 64, 65, and 66 Units 7, 12, 13, 14, and 30

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
^{241}Am (pCi/L)	NA[a]/1	0	0	NA	NA	NA
Alkalinity (mg/L as $CaCO_3$)	5/5	68.0	278.0	140.0	NA	NA
Am (pCi/L)	NA/5	−0.3	0.9	NA	NA	NA
Ca (mg/L)	5/5	14.3	34.6	27.7	NA	NA
Chloride (mg/L)	5/5	11.0	33.0	22.0	2	0
^{60}Co (pCi/L)	NA/6	−0.7	0.1	NA	3	0
Color (units)	14/14	3.0	21.0	7.2	2	1
Conductivity (μmho/cm)	53/53	194.0	732.0	344	NA	NA
Cr (mg/L)	0/16	0.01	0.05	None	1	0
Cr^{6+} (mg/L)	0/5	<0.01	<0.01	None	NA	NA
Cs (pCi/L)	NA/5	−1.0	1.3	NA	3	0
^{137}Cs (pCi/L)	NA/1	−0.1	−0.1	NA	NA	NA
Cu (mg/L)	5/16	<0.01	0.02	0.02	2	0
Depth (ft)	NA/11	10.3	84.10	NA	NA	NA
Dissolved alpha (pCi/L)	NA/16	−1.80	111.0	NA	1	6
Dissolved beta (pCi/L)	NA/16	−1.7	2460.0	NA	1	NA
Dissolved solids (mg/L)	5/5	102.0	401.0	235	2	0
Fe (mg/L)	15/16	<0.01	11.55	1.82	2	8
Fluoride (mg/L)	14/14	0.11	0.33	0.17	1	0
Gross alpha (pCi/L)	NA/2	2.69	7.10	NA	1	0
Gross beta (pCi/L)	NA/2	1380	1890.0	NA	1	NA
Mg (mg/L)	5/5	6.40	11.92	8.64	NA	NA
Mn (mg/L)	3/5	<0.005	0.120	0.051	2	1
NO_3-N (mg/L)	7/15	<1	8.3	4.9	1	0
Na (mg/L)	5/5	13.6	49.6	24.7	NA	NA
Ni (mg/L)	7/16	0.04	0.22	0.13	NA	NA
^{237}Np (pCi/L)	NA/2	<1	1.0	NA	NA	NA
PCB (μg/L)	0/16	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/5	<2	<2	None	NA	NA
^{239}Pu (pCi/L)	NA/1	<1	1.0	NA	NA	NA
^{226}Ra (pCi/L)	NA/6	−0.2	0.4	NA	1	0
^{222}Rn (pCi/L)	NA/2	290.0	307.0	NA	NA	NA
Sulfate (mg/L)	15/15	9.0	44.0	16.3	2	0
Suspended alpha (pCi/L)	NA/16	−1.8	22.5	NA	1	1
Suspended beta (pCi/L)	NA/16	−24.0	57.0	NA	1	NA
TOC (mg/L)	8/54	0	8.0	1.9	NA	NA
TOX (μg/L)	36/58	<5	2610.0	875.0	NA	NA
Trichloroethylene (μg/L)	5/11	<1	5900.0	4780.0	4	5
^{99}Tc (pCi/L)	NA/11	0	3200	NA	1	5
Temperature (°F)	NA/4	51.0	58.0	NA	NA	NA
^{230}Th (pCi/L)	NA/1	<1	1.0	NA	NA	NA
Total Cd (mg/L)	0/5	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/16	<0.2	<0.2	None	1	16
Total Se (mg/L)	0/5	<0.005	<0.005	None	1	0
Turbidity (NTU)	15/15	0.4	990.0	119	1	9
Uranium (mg/L)	4/17	<0.001	0.005	0.005	NA	NA
Zn (mg/L)	11/16	<0.005	0.045	0.025	2	0
pH (units)	NA/57	5.8	7.6	NA	2	35

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-8. Constituents in groundwater at Paducah Gaseous Diffusion Plant wells south of C-400 during 1988 Wells 68, 69, and 71

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	2/2	92.0	100.0	96.0	NA	NA
Am (pCi/L)	NA*/2	−0.5	−0.5	NA	NA	NA
Ca (mg/L)	2/2	28.6	29.7	29.2	NA	NA
Chloride (mg/L)	2/2	65.0	123.0	94.0	2	0
^{60}Co (pCi/L)	NA/2	−0.1	0.1	NA	3	0
Color (units)	8/8	3.0	9.0	5.8	2	0
Conductivity (μmho/cm)	32/32	418.0	604.0	498	NA	NA
Cr (mg/L)	3/8	<0.05	0.20	0.13	1	3
Cr^{6+} (mg/L)	0/2	<0.01	<0.01	None	NA	NA
Cs (pCi/L)	NA/2	−0.8	0	NA	3	0
Cu (mg/L)	0/8	<0.01	<0.01	None	2	0
Depth (ft)	NA/6	54.5	95.40	NA	NA	NA
Dissolved alpha (pCi/L)	NA/8	2.6	16.7	NA	1	2
Dissolved beta (pCi/L)	NA/8	18.0	155.0	NA	1	NA
Dissolved solids (mg/L)	2/2	253.0	350.0	302	2	0
Fe (mg/L)	5/8	<0.01	1.56	0.70	2	4
Fluoride (mg/L)	8/8	0.13	0.21	0.16	1	0
Mg (mg/L)	2/2	12.7	13.61	13.2	NA	NA
Mn (mg/L)	2/2	0.015	0.050	0.033	2	0
NO_3-N (mg/L)	4/8	<1	2.0	1.7	1	0
Na (mg/L)	2/2	29.50	61.8	45.7	NA	NA
Ni (mg/L)	3/8	0.02	0.10	0.09	NA	NA
PCB (μg/L)	0/8	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/2	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/2	−0.2	0.5	NA	1	0
Sulfate (mg/L)	8/8	7.0	17.0	11.50	2	0
Suspended alpha (pCi/L)	NA/8	−4.7	40.0	NA	1	1
Suspended beta (pCi/L)	NA/8	−10.0	57.0	NA	1	NA
TOC (mg/L)	6/32	<1	4.0	1.6	NA	NA
TOX (μg/L)	32/32	18.0	57.0	36.6	NA	NA
Trichloroethylene (μg/L)	4/4	4.0	45.0	22.8	4	3
^{99}Tc (pCi/L)	NA/4	0	121.0	NA	1	0
Temperature (°F)	NA/2	58.0	63.0	NA	NA	NA
Total Cd (mg/L)	0/2	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/8	<0.2	<0.2	None	1	8
Total Se (mg/L)	0/2	<0.005	<0.005	None	1	0
Turbidity (NTU)	8/8	0.5	18.0	7.3	1	4
Uranium (mg/L)	0/8	<0.001	<0.001	None	NA	NA
Zn (mg/L)	2/8	<0.005	0.060	0.025	2	0
pH (units)	NA/32	5.5	6.5	NA	2	28

*NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-9. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-404 low-level burial ground during 1988
Unit 3

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Al (mg/L)	5/6	0.1	19.7	7.9	NA[a]	NA
Conductivity (μmho/cm)	12/12	212.0	1340.0	372.6	NA	NA
Cr (mg/L)	0/7	0.02	0.05	None	1	0
Cu (mg/L)	2/7	<0.01	0.03	0.02	2	0
Dissolved As (mg/L)	1/12	<0.005	0.010	0.008	NA	NA
Dissolved Cd (mg/L)	12/12	<0.02	<0.02	None	NA	NA
Dissolved Pb (mg/L)	0/12	<0.2	<0.2	None	NA	NA
Dissolved Se (mg/L)	0/12	<0.005	<0.005	None	NA	NA
Depth (ft)	NA/12	14.64	53.86	NA	NA	NA
Fe (mg/L)	7/7	0.09	30.70	12.07	2	6
Ni (mg/L)	0/7	0.01	0.05	None	NA	NA
^{237}Np (pCi/L)	NA/3	−0.21	0.46	NA	NA	NA
^{239}Pu (pCi/L)	NA/3	0.03	0.04	NA	NA	NA
TOC (mg/L)	9/47	<1	6.0	3.3	NA	NA
TOX (μg/L)	15/47	<5	136.0	57.8	NA	NA
Trichloroethylene (μg/L)	3/12	<1	125.0	58.0	4	3
^{99}Tc (pCi/L)	NA/12	<25	716.0	NA	1	0
Temperature (°F)	NA/12	57.0	66.0	NA	NA	NA
^{230}Th (pCi/L)	NA/3	−0.18	0.25	NA	NA	NA
Total As (mg/L)	7/12	<0.005	0.040	0.013	1	0
Total Cd (mg/L)	8/12	<0.01	0.02	0.02	1	9
Total Pb (mg/L)	0/13	<0.2	<0.2	None	1	13
Total Se (mg/L)	1/12	<0.005	0.008	0.007	1	0
Uranium (mg/L)	2/12	<0.001	0.002	0.002	NA	NA
Zn (mg/L)	6/7	<0.005	0.080	0.034	2	0
pH (units)	NA/12	6.0	7.2	NA	2	7

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-10. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-746-F burial ground during 1988
Wells 52, 53, and 54
Unit 5

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
^{241}Am (pCi/L)	NA[a]/1	0	0	NA	NA	NA
Alkalinity (mg/L as $CaCO_3$)	3/3	68.0	162.0	101	NA	NA
Am (pCi/L)	NA/3	−0.2	0.2	NA	NA	NA
Ca (mg/L)	3/3	12.2	32.7	19.9	NA	NA
Chloride (mg/L)	3/3	7.0	12.0	9.3	2	0
^{60}Co (pCi/L)	NA/4	−0.3	0.2	NA	3	0
Color (units)	12/12	5.0	28.0	13.5	2	4
Conductivity (μmho/cm)	48/48	179.0	340.0	232	NA	NA
Cr (mg/L)	0/12	<0.05	<0.05	None	1	0
Cr^{6+} (mg/L)	0/3	<0.01	<0.01	None	NA	NA
Cs (pCi/L)	NA/3	−1.2	0.3	NA	3	0
^{137}Cs (pCi/L)	NA/1	−0.4	−0.4	NA	NA	NA
Cu (mg/L)	1/12	<0.01	0.015	0.012	2	0
Depth (ft)	NA/9	47	52.8	NA	NA	NA
Dissolved alpha (pCi/L)	NA/12	−1.9	15.8	NA	1	1
Dissolved beta (pCi/L)	NA/12	−21.0	87.0	NA	1	NA
Dissolved solids (mg/L)	3/3	108.0	196.0	141	2	0
Fe (mg/L)	11/12	<0.01	6.55	2.69	2	11
Fluoride (mg/L)	12/12	0.12	0.22	0.16	1	0
Gross alpha (pCi/L)	NA/1	−4.2	−4.2	NA	1	0
Gross beta (pCi/L)	NA/1	−14.0	−14.0	NA	1	NA
Mg (mg/L)	3/3	4.50	9.83	6.66	NA	NA
Mn (mg/L)	3/3	0.03	2.27	0.80	2	2
NO_3-N (mg/L)	0/12	<1	<1	None	1	0
Na (mg/L)	3/3	13.4	17.52	15.07	NA	NA
Ni (mg/L)	0/12	<0.05	<0.05	None	NA	NA
PCB (μg/L)	0/12	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/3	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/4	0.1	0.2	NA	1	0
Sulfate (mg/L)	12/12	6.0	10.0	7.3	2	0
Suspended alpha (pCi/L)	NA/12	−1.8	3.8	NA	1	0
Suspended beta (pCi/L)	NA/12	−10.0	9.0	NA	1	NA
TOC (mg/L)	13/48	0	7.0	2.8	NA	NA
TOX (μg/L)	25/48	<5	15.0	8.1	NA	NA
Trichloroethylene (μg/L)	0/6	<1	<1	None	4	0
^{99}Tc (pCi/L)	NA/7	0	25.0	NA	1	0
Temperature (°F)	NA/3	55.0	58.0	NA	NA	NA
Total Cd (mg/L)	0/3	<0.01	<0.01	None	1	0
Total Pb (mg/L)	0/12	0.02	0.20	None	1	11
Total Se (mg/L)	0/3	<0.005	<0.005	None	1	0
Turbidity (NTU)	12/12	1.5	148.0	23.8	1	7
Uranium (mg/L)	0/13	<0.001	<0.001	None	NA	NA
Zn (mg/L)	7/12	<0.005	0.040	0.026	2	0
pH (units)	NA/48	5.9	7.6	NA	2	32

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-11. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-746-K landfill during 1988 Wells 23, 24, 25, 26, 27, 28, 29, 30, 32, 35, 36, and 37 Unit 8

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Alkalinity (mg/L as $CaCO_3$)	3/3	70.0	498.0	215.3	NA	NA
Am (pCi/L)	NA[a]/3	−0.4	0.9	NA	NA	NA
Ca (mg/L)	4/4	9.85	458.0	139.83	NA	NA
Chloride (mg/L)	4/4	4.0	79.0	26.8	2	0
^{60}Co (pCi/L)	NA/3	0.5	1.5	NA	3	0
Color (units)	3/3	5.0	10.0	6.7	2	0
Conductivity (μmho/cm)	6/6	192.0	2540.0	729	NA	NA
Cr (mg/L)	1/4	<0.05	0.08	0.08	1	1
Cr^{6+} (mg/L)	0/4	<0.01	0.01	None	NA	NA
Cs (pCi/L)	NA/3	−0.1	0.1	NA	3	0
Cu (mg/L)	3/4	<0.01	0.24	0.17	2	0
Depth (ft)	NA/4	11.79	19.25	NA	NA	NA
Dissolved alpha (pCi/L)	NA/4	0	15.0	NA	1	0
Dissolved beta (pCi/L)	NA/4	9.0	36.0	NA	1	NA
Dissolved solids (mg/L)	4/4	97.0	1480	522	2	1
Fe (mg/L)	4/4	1.18	122.0	35.7	2	4
Fluoride (mg/L)	3/3	0.15	0.27	0.190	1	0
M Alkaline (mg/L)	1/1	232.0	232.0	232.0	NA	NA
Mg (mg/L)	4/4	3.0	122.0	43.9	NA	NA
Mn (mg/L)	4/4	0.06	27.60	6.99	2	4
NO_3-N (mg/L)	0/4	<1	1.0	None	1	0
Na (mg/L)	4/4	0.97	110.0	37.81	NA	NA
Ni (mg/L)	1/4	<0.05	0.06	0.06	NA	NA
PCB (μg/L)	0/3	<0.5	<0.5	None	NA	NA
PO_4-P (mg/L)	0/4	<2	<2	None	NA	NA
^{226}Ra (pCi/L)	NA/3	0.2	1.1	NA	1	0
Sulfate (mg/L)	2/4	<5	1200.0	606	2	1
Suspended alpha (pCi/L)	NA/4	−1.4	5.1	NA	1	0
Suspended beta (pCi/L)	NA/4	−3.0	27.0	NA	1	NA
TOC (mg/L)	3/6	0	10.0	6.0	NA	NA
TOX (μg/L)	6/6	9.0	79.0	31.3	NA	NA
Trichloroethylene (μg/L)	0/6	<1	<1	None	4	0
^{99}Tc (pCi/L)	NA/5	<25.0	25.0	NA	1	0
Total Cd (mg/L)	1/4	<0.01	0.12	0.07	1	1
Total Pb (mg/L)	3/4	<0.2	0.86	0.49	1	4
Total Se (mg/L)	0/4	<0.005	<0.005	None	1	0
Turbidity (NTU)	3/3	8.5	325.0	120	1	3
Uranium (mg/L)	2/3	<0.001	0.012	0.008	NA	NA
Zn (mg/L)	4/4	1.42	95.0	51.4	2	3
pH (units)	NA/6	5.9	6.9	NA	2	4

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-12. Constituents in groundwater at the Paducah Gaseous Diffusion Plant C-404 low-level waste burial ground during 1988
Well 79
Unit 3

Parameter	Number detected/ number of samples	Concentration		Average of values above the detection limit	Reference	Number of values exceeding reference
		Min	Max			
Color (units)	1/1	7.0	7.0	7.0	2	0
Conductivity (μmho/cm)	1/1	187.0	187.0	187.0	NA[a]	NA
Cr (mg/L)	0/1	0.006	0.006	None	1	0
Cu (mg/L)	0/1	<0.01	<0.01	None	2	0
Dissolved alpha (pCi/L)	NA/1	3.7	3.7	NA	1	0
Dissolved beta (pCi/L)	NA/1	10.0	10.0	NA	1	NA
Fe (mg/L)	1/1	0.39	0.39	0.39	2	1
Fluoride (mg/L)	1/1	0.16	0.16	0.16	1	0
NO_3-N (mg/L)	0/1	<1	<1	None	1	0
Ni (mg/L)	0/1	<0.006	<0.006	None	NA	NA
PCB (μg/L)	0/1	<0.5	<0.5	None	NA	NA
Sulfate (mg/L)	1/1	9.0	9.0	9.0	2	0
Suspended alpha (pCi/L)	NA/1	0.1	0.1	NA	1	0
Suspended beta (pCi/L)	NA/1	0.3	0.3	NA	1	NA
TOC (mg/L)	0/1	1.0	1.0	None	NA	NA
TOX (μg/L)	0/1	5.0	5.0	None	NA	NA
Trichloroethylene (μg/L)	0/1	<1	<1	None	4	0
^{99}Tc (pCi/L)	NA/1	<25	25.0	NA	1	0
Total Pb (mg/L)	0/1	<0.2	<0.2	None	1	1
Turbidity (NTU)	1/1	0.45	0.45	0.45	1	0
Uranium (mg/L)	0/1	<0.001	<0.001	None	NA	NA
Zn (mg/L)	1/1	0.02	0.02	0.02	2	0
pH (units)	NA/1	5.8	5.8	NA	2	1

[a]NA = not applicable. See Sect. 2.3.7 of Part 1 for clarification of NA entries.

Table E.2-13. 1988 Paducah Gaseous Diffusion Plant groundwater comparison data

Parameter	Applicable value	Reference
Cr	0.05 mg/L	1
Cu	1.0 mg/L	2
Fe	0.3 mg/L	2
Ni	None	NA[a]
Pb	0.05 mg/L	1
Zn	5.0 mg/L	2
Total As	0.05 mg/L	1
Total Cd	0.01 mg/L	1
Total Pb	0.05 mg/L	1
Total Se	0.01 mg/L	1
Dissolved As	None	NA
Dissolved Cd	None	NA
Dissolved Pb	None	NA
Dissolved Se	None	NA
Ca	None	NA
Mg	None	NA
Mn	0.05 mg/L	2
Na	None	NA
Cr^{6+}	None	NA
pH	6.5–8.5 units	2
Temperature	None	NA
Chloride	250 mg/L	2
NO_3-N	10 mg/L	1
SO_4	250 mg/L	2
Turbidity	5 NTU	1
Color	15 units	2
Fluoride	4.0 mg/L	1
Conductivity	None	NA
TOC	None	NA
Dissolved solids	500 mg/L	2
Alkalinity	None	NA
PO_4-P	None	NA
Trichloroethylene	5 μg/L	4
PCB	None	NA
TOX	None	NA
U	None	NA
Am	None	NA
Ra	5 pCi/L	1
Co	10,000 pCI/L	4
Cs	3,000 pCI/L	3
^{99}Tc	900 pCI/L	1
Dissolved alpha	15 pCi/L gross alpha	1
Suspended alpha	15 pCi/L gross alpha	1
Dissolved beta	4 mrem/year gross beta	1
Suspended beta	4 mrem/year gross beta	1
Gross alpha	15 pCi/L	1
Gross beta	4 mrem/year	1

[a]NA = not applicable.

REFERENCES

1. Safe Drinking Water Act—National Primary Drinking Water Regulations, 40 CFR 141, as amended.
2. Safe Drinking Water Act—National Secondary Drinking Water Regulations, 40 CFR 143, as amended.
3. DOE Order 5400.xx—Derived Concentration Guides (DCGs) for Air and Water.
4. National Primary Drinking Water Regulations; Synthetic Organic Chemicals, U.S. EPA, Federal Register, July 8, 1987, pp. 25600–25712

Table E.3-1. Groundwater monitoring parameters and standards at the Portsmouth Gaseous Diffusion Plant

Parameter	Standard	Reference
TOC (mg/L)	None	
TOX (mg/L)	None	
Specific conductance (μmhos/cm)	None	
pH (standard units)	6.5–8.5	40 CFR 143.3
Cl (mg/L)	250 mg/L	40 CFR 143.3
Fe (mg/L)	0.3 mg/L	40 CFR 143.3
Mn (mg/L)	0.05 mg/L	40 CFR 143.3
Na (mg/L)	None	40 CFR 143.3
SO_4 (mg/L)	250 mg/L	40 CFR 143.3
Ba (mg/L)	1.0 mg/L	40 CFR 141.11
Cd (mg/L)	0.010 mg/L	40 CFR 141.11
Cr (mg/L)	0.05 mg/L	40 CFR 141.11
Pb (mg/L)	0.05 mg/L	40 CFR 141.11
α (pCi/L)	15 pCi/L	40 CFR 141.15
β (pCi/L)	4 mrem/year (~1000 pCi/L)	40 CFR 141.16
Tc (pCi/L)	900 pCi/L	EPA-570/9-76-003
Ra (pCi/L)	5 pCi/L	40 CFR 141.15
Trichloroethene (μg/L)	5.0 μg/L	40 CFR 141.62
1,1,1-Trichloroethane (μg/L)	5.0 μg/L	40 CFR 141.62
1,2-Dichloroethane (μg/L)	5.0 μg/L	40 CFR 141.62
1,1-Dichloroethane (μg/L)	7.0 μg/L	40 CFR 141.62

Table E.3-2. X-701B indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos/cm)
			Upgradient	
Av	0.036	1.61	NA[a]	672
Max	0.061	2.15	6.4	903
Min	0.009	1.22	5.6	387
			Downgradient	
Av	113.0	65.30	NA	499
Max	237.0	167.00	7.0	878
Min	0.005	0.75	5.4	168
			Blanks	
Av	0.002	0.07		
Max	0.003	0.15		

[a]NA = not applicable.

Table E.3-3. X-701B groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Chloride (mg/L)	0	47.0	30.0	40.6	35.0	5.0	29.6	19/19		<2
Iron (mg/L)	2	0.35	<0.05	<0.23	<0.05	<0.05	<0.05	2/18	0.09	<0.05
Manganese (mg/L)	15	0.09	<0.03	<0.07	0.34	<0.03	<0.24	16/18		<0.03
Sodium (mg/L)	NA[a]	57.0	41.0	49.3	62.0	13.0	42.4	18/18		<5
Sulfate (mg/L)	10	326.4	100.7	208.4	286.4	25.0	180.9	19/19		<1
Unfiltered										
Iron (mg/L)	10	0.28	<0.05	<0.23	110.0	<0.05	<12.90	12/18		<0.05
Manganese (mg/L)	16	0.09	<0.03	<0.07	2.9	0.13	0.45	17/18		<0.03
Sodium (mg/L)	NA	57.0	41.0	50.0	66.0	14.0	44.6	18/18		<5

[a]NA = not applicable.

Table E.3-4. X-701B site-specific parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Barium (mg/L)	0	*a*		<0.2			<0.2	0/5		<0.2
Cadmium (mg/L)	0			<0.005			<0.005	0/18		<0.005
Chromium (mg/L)	2			<0.03	0.08	<0.03	<0.08	2/5		<0.03
Lead (mg/L)	1	0.16	<0.05	<0.05			<0.05	1/18		<0.05
Unfiltered										
Barium (mg/L)	0			<0.2			<0.2	0/5		<0.2
Cadmium (mg/L)	1			<0.005	0.013	<0.005	<0.005	1/18		<0.005
Chromium (mg/L)	2			<0.03	0.07	<0.03	<0.07	2/5		<0.03
Lead (mg/L)	2			<0.05	0.24	<0.05	<0.05	2/18		<0.05

[a]No data available.

Table E.3-5. X-701B radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	5	19.0	0	14.5	94.0	0	20.8	11/16	10.0	3.7
Total beta (pCi/L)	0	87.0	0	19.2	150.0	0	22.9	12/17	5.0	3.3
Technetium (pCi/L)	0	146.0	0	45.3	825.0	0	118.9	20/22	10.0	7.5
Radium (pCi/L)	0			<5			<5	0/5		<5

Table E.3-6. Well field X-701B halogenated volatile organics data [ppb (μg/L)][a]

Chemical name	Max	Min	Av
Downgradient wells (28 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	28.0	0	2.0
Trans-1,2-dichloroethene	54.0	0	3.3
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	40,800.0	0	1,860.0
Chloroform	2,070.0	0	75.3
Trichlorofluoromethane	4,700.0	0	388
Freon-113	700.0	0	100
1,1,1-Trichloroethane	900.0	0	76.4
Trichloroethene	870,000.0	0	121,000.0
Sample blanks (8 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	36.0	0	6.4
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	1.0	0	0.3

[a]No upgradient wells sampled.

Table E.3-7. X-616 indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos)
Upgradient				
Av	0.06	2.83	NA[a]	2130
Max	0.14	4.79	7.3	3630
Min	0.01	1.23	5.4	1510
Downgradient				
Av	0.06	3.83	NA	3170
Max	0.14	6.35	12.1	4130
Min	0.02	2.35	5.4	728
Blanks				
Av	0.01	0.07		
Max	0.02	0.21		

[a]NA = not applicable.

Table E.3-8. X-616 groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Chloride (mg/L)	31	400	50	239	625	210	349	41/41		<2
Iron (mg/L)	13	0.93	<0.05	<0.41	4.26	<0.05	<0.76	30/65		<0.05
Manganese (mg/L)	38	8.46	<0.03	<3.62	4.80	<0.03	<0.47	42/65		<0.03
Sodium (mg/L)	NA[a]	245	177	212	370	146	261	65/65		<5
Sulfate (mg/L)	40	5350	240	1137.3	2000	391	1140	41/41		<1
Unfiltered										
Iron (mg/L)	54	137	<0.05	<22.2	110	<0.05	<6.42	64/69		<0.05
Manganese (mg/L)	49	8.98	<0.03	<2.82	4.70	<0.03	<0.46	54/69		<0.03
Sodium (mg/L)	NA	250	189	214	390	140	260	69/69		<5

[a]NA = not applicable.

Table E.3-9. X-616 site-specific parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Barium (mg/L)	1	<0.2	<0.2	<0.2	1.2	<0.2	<0.2	1/65		<0.2
Cadmium (mg/L)	21	0.010	<0.005	<0.008	0.014	<0.005	<0.009	55/65		<0.005
Chromium (mg/L)	6	0.04	<0.03	<0.03	0.17	<0.03	<0.03	13/65		<0.03
Lead (mg/L)	39	0.11	<0.05	<0.05	0.20	<0.05	<0.09	39/65		<0.05
Unfiltered										
Barium (mg/L)	1	0.2	<0.2	<0.2	3.6	<0.2	<0.2	7/69		<0.2
Cadmium (mg/L)	30	0.016	<0.005	<0.010	0.024	<0.005	<0.010	59/69		<0.005
Chromium (mg/L)	27	0.36	<0.03	<0.03	1.90	<0.03	<0.37	35/69		<0.03
Lead (mg/L)	46	0.39	<0.05	<0.15	0.73	<0.05	<0.13	46/69	0.08	<0.05

Table E.3-10. X-616 radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	8	41.0	0	8.6	57.0	0	6.3	33/60	18	5.8
Total beta (pCi/L)	0	43.0	0	9.7	43.0	0	10.2	30/62	9	2.0
Technetium (pCi/L)	0	36.0	0	17.1	38.0	0	15.0	58/72	36	13.7
Radium (pCi/L)	0	<5	<5	<5	3	<5	<5	2/48	32	<5

Table E.3-11. X-749 indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos/cm)
			Downgradient	
Av	2.343	3.46	NA[a]	383
Max	3.706	4.96	6.9	453
Min	0.107	0.69	5.7	168
			Blanks	
Av	0.004	0.10		
Max	0.011	0.32		

[a]NA = not applicable.

Table E.3-12. X-749 groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Chloride (mg/L)	0				90.5	30.0	67.3	12/12		<2
Iron (mg/L)	0				0.11	<0.05	<0.08	6/16		<0.05
Manganese (mg/L)	4				0.09	<0.03	<0.07	5/16		<0.03
Sodium (mg/L)	NA[b]				49.0	18.0	38.7	16/16		<5
Sulfate (mg/L)	0				81.9	8.2	32.6	12/12		<1
Unfiltered										
Iron (mg/L)	16				39.0	0.50	4.2	16/16		<0.05
Manganese (mg/L)	5				0.20	<0.03	<0.08	8/16		<0.03
Sodium (mg/L)	NA				49.0	16.0	38.1	16/16		<5

[a]No upgradient wells sampled.
[b]NA = not applicable.

Table E.3-13. X-749 site-specific parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Cadmium (mg/L)	0				0.006	<0.005	<0.005	3/16		<0.005
Lead (mg/L)	4				0.08	<0.05	<0.05	4/16		<0.05
Unfiltered										
Cadmium (mg/L)	0				0.005	<0.005	<0.005	1/16		<0.005
Lead (mg/L)	5				0.08	<0.05	<0.05	5/16		<0.05

[a]No upgradient wells sampled.

Table E.3-14. X-749 radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	7				76.0	0	25.0	10/15	20.0	10.0
Total beta (pCi/L)	0				386.0	0	58.3	10/15	0	0
Technetium (pCi/L)	0				284.0	2.0	54.1	15/15	0	0

[a]No upgradient wells sampled.

Table E.3-15. Well field X-749 halogenated volatile organics data [ppb (μg/L)][a]

Chemical name	Max	Min	Av
Downgradient wells (24 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	1,270.0	33.0	606.2
Trans-1,2-dichloroethene	289.0	0	44.3
1,1-Dichloroethane	1,200.0	0	173.5
1,2-Dichloroethane	47.0	0	2.0
Chloroform	80.0	8.0	30.0
Trichlorofluoromethane	1.0	0	0.1
Freon-113	390.0	16.0	163.0
1,1,1-Trichloroethane	2,490.0	50.0	989.0
Trichloroethene	2,200.0	52.0	915.0
Sample blanks (6 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	6.0	0	2.17
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	0	0	0

[a]No upgradient wells sampled.

Table E.3-16. X-231B indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos/cm)
Upgradient[a]				
Av				
Max				
Min				
Downgradient				
Av	0.102	1.77	NA[b]	1165
Max	0.283	2.47	6.1	1903
Min	0.018	1.20	5.3	508
Blanks				
Av	0.003	0.06		
Max	0.008	0.17		

[a]No upgradient wells sampled.
[b]NA = not applicable.

Table E.3-17. X-231B groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Chloride (mg/L)	0				104.0	46.0	78.4	10/10		<2
Iron (mg/L)	0				0.25	<0.05	<0.14	5/14		<0.05
Manganese (mg/L)	7				0.09	<0.03	<0.05	13/14		<0.03
Sodium (mg/L)	NA[b]				85	34	60	14/14		<5
Sulfate (mg/L)	7				851	142	411	10/10		<1
Unfiltered										
Iron (mg/L)	5				4.60	<0.05	<0.73	12/14	0.23	<0.05
Manganese (mg/L)	9				0.09	<0.03	<0.06	13/14		<0.03
Sodium (mg/L)	NA				85	33	59	14/14		<5

[a]No upgradient wells sampled.
[b]NA = not applicable.

Table E.3-18. X-231B site-specific parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Cadmium (mg/L)	1				0.012	<0.005	<0.009	6/14	0.006	<0.005
Lead (mg/L)	9				0.22	<0.05	<0.13	9/14	0.20	<0.05
Unfiltered										
Cadmium (mg/L)	1				0.011	<0.005	<0.008	6/14	0.005	<0.005
Lead (mg/L)	6				0.26	<0.05	<0.19	6/14	0.23	<0.05

[a]No upgradient wells sampled.

Table E.3-19. X-231B radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient[a]			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	1				26.0	0.0	5.6	4/12	0	0
Total beta (pCi/L)	0				16.0	0.0	5.6	8/12	1	0
Technetium (pCi/L)	0				5.0	0.0	2.3	6/12	1	0

[a]No upgradient wells sampled.

Table E.3-20. Well field X-231B halogenated volatile organics data [ppb (μg/L)][a]

Chemical name	Max	Min	Av
Downgradient wells (28 samples)			
Methylene chloride	28.0	0	6.2
1,1-Dichloroethene	50.0	0	10.2
Trans-1,2-dichloroethene	3.0	0	0.2
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	7.0	0	1.0
Chloroform	3.0	0	0.5
Trichlorofluoromethane	2.0	0	0.1
Freon-113	1.0	0	0.1
1,1,1-Trichloroethane	141.0	0	25.8
Trichloroethene	476.0	2.0	108.8
Sample blanks (6 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	8.0	0	1.67
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	0	0	0

[a]No upgradient wells sampled.

Table E.3-21. X-735 indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos/cm)
Upgradient				
Av	0.009	0.48	NA[a]	82
Max	0.016	0.60	7.2	82
Min	0.002	0.36	7.2	82
Downgradient				
Av	0.005	1.61	NA	362
Max	0.013	3.37	7.1	437
Min	0.001	0.93	5.8	311
Blanks				
Av	0.002	0.10		
Max	0.003	0.24		

[a]NA = not applicable.

Table E.3-22. X-735 groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Chloride (mg/L)	0	<2	<2	<2	27.5	<2	<8.8	9/15		<2
Iron (mg/L)	1	<0.05	<0.05	<0.05	0.79	<0.05	<0.05	1/7		<0.05
Manganese (mg/L)	4	0.05	0.05	0.05	1.35	<0.03	<0.88	4/8		<0.03
Sodium (mg/L)	NA[a]	6	6	6	30	<5	<18	7/8		<5
Sulfate (mg/L)	0	17.7	16.3	17.0	101.4	24.7	53.5	15/15		<1
Unfiltered										
Iron (mg/L)	8	8.46	8.46	8.46	28.30	5.09	17.68	8/8		<0.05
Manganese (mg/L)	7	0.10	0.10	0.10	1.48	0.07	0.59	8/8		<0.03
Sodium (mg/L)	NA	6	6	6	30	<5	<18	7/8		<5

[a]NA = not applicable.

Table E.3-23. X-735 site-specific parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Filtered										
Barium (mg/L)	0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0/8	<0.2	<0.2
Cadmium (mg/L)	0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0/8	<0.005	<0.005
Chromium (mg/L)	0	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0/8	<0.03	<0.03
COD (mg/L)	0	9.7	<5	<5	15.3	<5	<10.7	12/15	10.0	<5
Unfiltered										
Barium (mg/L)	0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0/8	<0.2	<0.2
Cadmium (mg/L)	1	<0.005	<0.005	<0.005	0.012	<0.005	<0.005	1/7	<0.005	<0.005
Chromium (mg/L)	1	<0.03	<0.03	<0.03	0.08	<0.03	<0.03	2/6	<0.03	<0.03

Table E.3-24. X-735 radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	0	0	0	0	1	0	0	1/8		0
Total beta (pCi/L)	0	0	0	0	19	0	7	5/8		0
Technetium (pCi/L)	0	10	10	10	20	0	9	4/8		0
Radium (pCi/L)	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0/11		<5.0

Table E.3-25. Well field X-735 halogenated volatile organics data [ppb (μg/L)]

Chemical name	Max	Min	Av
Sample blanks (4 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	3.0	0	1.5
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	1.0	0	0.5

Table E.3-26. X-734 indicator parameters

	TOX (mg/L)	TOC (mg/L)	pH (standard units)	Specific conductance (μmhos/cm)
Upgradient				
Av	0.009	1.41	NA[a]	538
Max	0.010	1.60	7.2	546
Min	0.008	1.29	7.1	535
Downgradient				
Av	0.016	3.58	NA	939
Max	0.026	4.82	6.2	939
Min	0.006	1.89	6.2	939
Blanks				
Av	0.002	0.10		
Max	0.003	0.24		

[a]NA = not applicable.

Table E.3-27. X-734 groundwater quality parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Chloride (mg/L)	0	24.0	23.0	23.5	14.5	14.5	14.5	3/3		<2
Sulfate (mg/L)	1	146.0	132.0	139.0	326.0	326.0	326.0	3/3		<1

Table E.3-28. X-734 radionuclide parameters

Parameters	No. of values exceeding standard	Upgradient			Downgradient			Number detected/ number of samples	Blanks	
		Max	Min	Av	Max	Min	Av		Max	Av
Total alpha (pCi/L)	0	1	1	1	5	0	3	3/4	0	0
Total beta (pCi/L)	0	6	0	3	17	3	7	6/7	0	0
Technetium (pCi/L)	0	16	0	6	26	14	20	6/7	0	0
Radium (pCi/L)	0			<5			<5	0/6	<5	<5

Table E.3-29. Well field X-734 halogenated volatile organics data [ppb (μg/L)]

Chemical name	Max	Min	Av
Upgradient wells (6 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	0	0	0
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	1.0	0	0.2
Downgradient wells (8 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	1.0	0	0.1
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	1.0	0	0.3
1,1,1-Trichloroethane	0	0	0
Trichloroethene	2.0	0	0.6
Sample blanks (4 samples)			
Methylene chloride	0	0	0
1,1-Dichloroethene	0	0	0
Trans-1,2-dichloroethene	0	0	0
1,1-Dichloroethane	0	0	0
1,2-Dichloroethane	3.0	0	1.5
Chloroform	0	0	0
Trichlorofluoromethane	0	0	0
Freon-113	0	0	0
1,1,1-Trichloroethane	0	0	0
Trichloroethene	1.0	0	0.5

APPENDIX F

Appendix F

TERRESTRIAL ECOLOGY

Table F.1-1. Extent and productivity of major crops and livestock in counties within 8 km (5 miles) of the Oak Ridge Gaseous Diffusion Plant[a]

	Year				
	1978	1982	1985	1987	1988
Number of farms	498	591			
Average size of farms (acres)	125	114			
Percentage of county in farms	27.2	29.5			
Harvested cropland (acres)	11,307	11,889			
Pasture or grazing (acres)	15,558	17,666			
Corn (acres)		1,400	1,500	900	
Corn (bu/acre)		75	86	50	
Burley tobacco (acres)		380	240	235	
Burley tobacco (lb/acre)		1,500	2,000	1,520	
Cattle and calves				16,000	15,000
Dairy cattle				700	700
Hogs and pigs				1,900	1,800

[a]The only county within 8 km of the Oak Ridge Gaseous Diffusion Plant is Roane County, with a land area of 228,300 acres.

Sources: The 1982 and 1987 data for tobacco and corn and the 1987 and 1988 data for cattle, pigs, and dairy cows are taken from *Tennessee Agricultural Statistics,* Tennessee Agriculture Statistics Service, Nashville, Tenn., 1988, pp. 37, 49, 72, 78, and 93. The 1978 data and all other 1982 data are taken from U.S. Department of Commerce, *1982 Census of Agriculture, Vol. 1, Geographic Area Series, Tennessee, State and County Data,* Bureau of the Census, 1984.

Note: To convert acres to hectares, multiply by 0.405. To convert bushels (bu) to cubic meters, multiply by 0.035. To convert pounds (lb) to kilograms, multiply by 0.454.

Table F.2-1. Extent and productivity of major crops and livestock in counties within an 8-km (5-mile) radius of the Paducah Gaseous Diffusion Plant

	Year		
	1978	1982	1987
McCracken County—land area: 160,454 acres			
Number of farms	616	555	
Average size of farms (acres)	126	130	
Percentage of county in farms	48	45	
Harvested cropland (acres)	44,254	45,870	
Pasture or grazing (acres)	10,548	9,056	
Corn (acres)	7,717	8,983	8,000
Corn (bu/acre)	77.5	98.9	100
Soybeans (acres)	26,273	25,285	21,000
Soybeans (bu/acre)	25.9	25.5	20
Wheat (acres)	1,304	6,709	2,500
Wheat (bu/acre)	34.9	37.1	45
Sorghum (acres)	*a*	4,729	1,300
Sorghum (bu/acre)	*a*	58.8	70
Hay (acres)	4,647	3,760	4,500
Hay (tons/acre)	1.7	1.9	1.8
Tobacco (acres)	534	645	350
Tobacco (lb/acre)	2,087	1,960	2,155
Cattle and calves	7,447	6,899	6,900
Dairy cattle	796	674	800
Milk production (lb/cow)	*a*	*a*	11,625
Hogs and pigs	6,812	4,893	4,000
Sheep and lambs	*a*	268	
Horses and ponies	253	293	
Ballard County—land area: 162,515 acres			
Number of farms	641	527	
Average size of farms (acres)	185	211	
Percentage of county in farms	73	69	
Harvested cropland (acres)	96,461	80,133	
Pasture or grazing (acres)	14,375	9,997	
Corn (acres)	14,879	10,318	12,000
Corn (bu/acre)	73	102	109
Soybeans (acres)	49,543	53,994	36,000
Soybeans (bu/acre)	27	26	18
Wheat (acres)	2,439	18,254	12,000

Table F.2-1 (continued)

	Year		
	1978	1982	1987
Wheat (acres)	2,439	18,254	12,000
Wheat (bu/acre)	39	36	50
Sorghum (acres)			6,000
Sorghum (bu/acre)			78
Hay (acres)	5,771	4,384	5,700
Hay (tons/acre)	2.0	2.0	2.1
Tobacco (acres)	1,386	1,325	970
Tobacco (lb/acre)	1,976	2,034	1,980
Cattle and calves	10,771	9,193	8,400
Dairy cattle	1,578	988	1,000
Milk production (lb/cow)			11,300
Hogs and pigs	14,659	13,730	15,500

[a]Data not available.

Sources: Data for 1987 are taken from *Kentucky Agricultural Statistics 1987-1988*, Kentucky Agricultural Statistics Service, U.S. Department of Agriculture National Statistics Service and Kentucky Department of Agriculture, Louisville, Ky., 1988, pp. 24, 26, 30, 32–34, 36, 38, 40, 52, 56, 68. Data for 1978 and 1982 are taken from *1982 Census of Agriculture, Vol. 1, Geographic Area Series, Tennessee, State and County Data,* Bureau of the Census, 1984, pp. 120, 130, 184, 194, 308, 318, 340, 350, 380, 390.

Note: To convert acres to hectares, multiply by 0.405. To convert bushels (bu) to cubic meters, multiply by 0.035. To convert tons/acre to kilograms/hectare, multiply by 2242. To convert pounds (lb) to kilograms, multiply by 0.454.

Table F.2-2. List of vascular plants identified during a 3-day survey of Tennessee Valley Authority land adjacent to the Paducah Gaseous Diffusion Plant

Carya ovata	*Paronychia fastigiata*
Carya tomentosa	*Andropogon sp.*
Carya illinoensis	*Dactylis glomerata*
Polygala curtissii	*Solidago sp.*
Cyperus ovularis	*Platanus occidentalis*
Helenium flexuosum	*Quercus falcata var. pagodaefolia*
Verbena sp.	*Pycnanthemum pilosum*
Eupatorium fistulosum	*Monarda fistulosa*
Cassia fasciculata	*Smilax glauca*
Phlox paniculata	*Prunella vulgaris*
Polygonum persicaria	*Prunus serotina*
Fraxinus americana	*Quercus imbricaria*
Sorghum halepense	*Corylus americana*
Rhus copallina	*Quercus alba*
Robinia pseudo-acacia	*Quercus shumardii*
Festuca elatior	*Ostrya virginiana*
Campsis radicans	*Sabatia angularis*
Lactuca serriola	*Aralia spinosa*
Erigeron canadensis	*Rhexia mariana var. mariana*
Gleditsia triacanthos	*Scutellaria incana var. incana*
Chenopodium sp.	*Hibiscus militaris*
Ambrosia trifida	*Quercus prinus*
Lespedeza cuneata	*Lippia lanceolata*
Eragrostis cilianensis	*Quercus phellos*
Spermacoce glabra	*Pycnanthemum incanum*
Digitaria sanguinalis	*Sassafras albidum*
Quercus stellata	*Ulmus alata*
Lactuca canadensis var. latifolia	*Smilax glauca*
Scutellaria ovata var. ovata	*Nyssa sylvatica*
Eupatorium purpureum	*Lonicera japonica*
Quercus palustris	*Acer rubrum*
Ulmus rubra	*Liquidambar styraciflua*
Acer saccharinum	*Catalpa speciosa*
Asimina triloba	

Source: J. L. Collins, Tennessee Valley Authority, Norris, Tenn., letter to Linda K. Mann, Oak Ridge National Laboratory, Oak Ridge, Tenn., Oct. 30, 1989 (see Appendix I: Collins 1989).

Table F.3-1. Extent and productivity of major crops and livestock in counties within an 8-km (5-mile) radius of Portsmouth Gaseous Diffusion Plant

	Year			
	1978	1982	1986	1987
Pike County—land area: 283,532 acres				
Number of farms	567	521	590	560
Land in farms (acres)	111,483	109,450	111,000	109,000
Percentage of county in farms	39.3	38.6	39.1	38.4
Corn (acres)	13,114	21,428	18,000	15,200
Corn yield (bu/acre)	87.3	88.4	106.6	85.8
Soybeans (acres)	13,347	10,908	10,000	11,600
Soybean yield (bu/acre)	29.1	24.7	40.8	29.6
Wheat (acres)	1,645	3,496	2,100	1,600
Wheat yield (bu/acre)	32.3	38.7	36.0	49.8
Hay (acres)	8,551	7,279	12,400	12,400
Hay yield (tons/acre)	1.83	1.83	2.18	2.77
Burley tobacco (acres)			120	110
Tobacco yield (lb/acre)			1,500	1,480
Cattle and calves			12,000	13,000
Hogs and pigs			7,000	8,000
Scioto County—land area: 292,524 acres				
Number of farms	714	712	710	680
Percentage of county in farms	28.4	25.8	26.0	25.5
Corn (acres)	11,880	12,648	13,200	8,500
Corn yield (bu/acre)	93	91	108	93
Soybeans (acres)			7,200	7,000
Soybean yield (bu/acre)			40.9	29.1
Wheat (acres)	873	1,818	1,000	*a*
Wheat yield (bu/acre)	33	34	30	*a*
Hay (acres)	11,020	8,999	11,400	11,300
Hay yield (tons/acre)	1.9	1.8	2.8	2.2
Burley tobacco (acres)			280	290
Tobacco yield (lb/acre)			1,750	1,690
Cattle and calves			12,000	12,000
Dairy cattle			1,700	1,700
Milk production (million pounds)			24	25

[a]Not reported for acreages less than 1000.

Sources: Data for 1986 and 1987 are taken from *1987 Ohio Agricultural Statistics and Ohio Department of Agriculture Annual Report,* Ohio Agricultural Statistics Service, U.S. Department of Agriculture National Agricultural Statistics Service and Ohio Department of Agriculture, Columbus, Ohio, 1987, pp. 17, 19, 21, 23, 25, 27, 30, 53, and 59. Data for 1978 and 1982 are taken from U.S. Department of Commerce, *1982 Census of Agriculture, Vol. 1, Geographic Area Series, Ohio, State and County Data,* computer database, 1984.

Note: To convert acres to hectares, multiply by 0.405. To convert bushels (bu) to cubic meters, multiply by 0.035. To convert tons/acre to kilograms/hectare, multiply by 2242. To convert pounds (lb) to kilograms, multiply by 0.45

APPENDIX G

Appendix G

AQUATIC ECOLOGY

Table G.1-1. Benthic macroinvertebrate taxa collected from Mitchell Branch, August 1986 through July 1987. An "X" denotes that the taxon was collected at least once in quantitative samples and a "Q" denotes that the taxon was collected in qualitative samples only.

	Site					
Taxon	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Turbellaria						
Planariidae	X		X	X		
Nematoda	X	X	X			
Oligochaeta	X	X	X	X	X	X
Crustacea						
Isopoda	X					
Asellidae						
Asellus	X	X				
Lirceus	X	X			X	
Amphipoda						
Gammaridae	X					
Crangonyx	X	X				
Decapoda	X	X				
Cambaridae						
Cambarus	X	Q				
Orconectes				X		X
Hydracarina					X	
Insecta						
Collembola	X	X	X	X	X	
Entomobryomorpha	X		X		X	X
Symphypleona			X			
Ephemeroptera						
Baetidae	X					
Baetis	X	X	X			
Caenidae						
Caenis				X		
Ephemerellidae	X					
Eurylophella	X					
Ephemeridae						
Ephemera	X					
Leptophlebiidae	X					
Habrophlebiodes	X	X	Q			
Paraleptophlebia	Q					

Table G.1-1 (continued)

Taxon	Site					
	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Coleoptera (cont.)						
Ptilodactylidae						
Anchytarsus bicolor	X					
Staphylinidae			X	X		
Diptera	X					
Ceratopogonidae	X	X	X			
Chaoboridae						
Chaoborus				X	X	Q
Chironomidae						
Tanypodinae	X	X	X			
Larsia		X				
Larsia?	X	X	X			
Natarsia	X	X	X		X	X
Nilotanypus	X				X	
Nilotanypus?	X					
Paramerina	X					
Procladius					X	
Tanypus					X	
Thienemannimyia gp	X	X	X	X		X
Thienemannimyia gp?	X					
Trissopelopia		X	X			
Trissopelopia ogemawi	X		X			
Zavrelimyia	X	X	X			
Zavrelimyia?	X	X				
Diamesinae						
Diamesa		X	X		Q	
Diamesa?			Q			
Orthocladiinae	X	X	X			X
Chaetocladius		X	X		Q	
Chaetocladius?		Q		X		
Corynoneura	X	X	X			
Cricotopus bicinctus gp[a]		X	X	X	X	X
Cricotopus sylvestris gp[a]					X	X
Cricotopus tremulus gp[a]		X	X	X	X	X
Cricotopus/ Orthocladius[a]	X	X	X	X	X	X
Heleniella	X	X				

Table G.1-1 (continued)

Taxon	Site					
	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Hemiptera	Q					
Gerridae	X				X	
Veliidae	X					
Megaloptera						
Corydalidae						
Nigronia fasciatus	X	X	X			
Sialidae						
Sialis	X	X				
Trichoptera	X					
Hydropsychidae						
Cheumatopsyche	X	X	X			
Diplectrona modesta	X		X			
Leptoceridae	X					
Triaenodes	X					
Limnephilidae						
Goera	X					
Hydatophylax	X				Q	
Neophylax	X					
Pycnopsyche	X					
Molannidae						
Molanna	X					
Philopotamidae						
Chimarra	X		X			
Psychomyiidae						
Lype diversa	X					
Lepidoptera	X					
Coleoptera						
Curculionidae	Q					
Dryopidae						
Helichus	X	X				
Dytiscidae						
Hydroporus	X					
Elmidae						
Dubiraphia	X					
Optioservus	X	X	X			
Stenelmis	X	X	X	X		
Hydrophilidae	X					
Berosus					X	

Table G.1-1 (continued)

Taxon	Site					
	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Coleoptera (cont.)						
Ptilodactylidae						
Anchytarsus bicolor	X					
Staphylinidae			X	X		
Diptera	X					
Ceratopogonidae	X	X	X			
Chaoboridae						
Chaoborus				X	X	Q
Chironomidae						
Tanypodinae	X	X	X			
Larsia		X				
Larsia?	X	X	X			
Natarsia	X	X	X		X	X
Nilotanypus	X				X	
Nilotanypus?	X					
Paramerina	X					
Procladius					X	
Tanypus					X	
Thienemannimyia gp	X	X	X	X		X
Thienemannimyia gp?	X					
Trissopelopia		X	X			
Trissopelopia ogemawi	X		X			
Zavrelimyia	X	X	X			
Zavrelimyia?	X	X				
Diamesinae						
Diamesa		X	X		Q	
Diamesa?			Q			
Orthocladiinae	X	X	X			X
Chaetocladius		X	X		Q	
Chaetocladius?		Q		X		
Corynoneura	X	X	X			
Cricotopus bicinctus gp[a]		X	X	X	X	X
Cricotopus sylvestris gp[a]					X	X
Cricotopus tremulus gp[a]		X	X	X	X	X
Cricotopus/ Orthocladius[a]	X	X	X	X	X	X
Heleniella	X	X				

Table G.1-1 (continued)

Taxon	Site					
	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Orthocladiinae (cont.)						
Heterotrissocladius	X					
Hydrobaenus	X					
Limnophyes	X					
Limnophyes?	X					
Nanocladius	X					
Parametriocnemus	X	X	X		X	
Parametriocnemus?	X					
Paraphaenocladius			X			
Psectrocladius	X					
Smittia		X				
Smittia?					Q	
Thienemanniella	X					
Tvetenia	X					
Chironominae						
Chironomini	X					
Chironomus			X			
Cryptochironomus	X	X				X
Cryptotendipes	X					
Dicrotendipes	X	X	X	Q	X	
Endochironomus					X	
Glyptotendipes					X	
Goeldichironomus			X		X	X
Microtendipes	X		X			
Paralauterborniella	X					
Paralauterborniella?	Q					
Paratendipes	X		X	X	X	X
Phaenopsectra	X		X			
Polypedilum	X	X	X		X	X
Stenochironomus		X				
Tanytarsini	X	X	X			
Micropsectra	X					
Paratanytarsus					X	
Rheotanytarsus	X					
Rheotanytarsus?	X		X			
Stempellina	X					
Stempellinella	X	X				
Stempellinella?	X					
Tanytarsus	X	X	X			X
Dolichopodidae	X					
Dixidae						
Dixa	X					

Table G.1-1 (continued)

Taxon	Site					
	MIK 1.43	MIK 0.86	MIK 0.78	MIK 0.71	MIK 0.54	MIK 0.45
Diptera (cont.)						
Empididae						
Hemerodromia	X	X	X	X	X	
Empididae?	X					
Muscidae						X
Sciomyzidae	Q					
Simuliidae	X	X	X	X	X	X
Stratiomyidae		X				
Allognosta	Q					
Stratiomys	Q					
Tabanidae	X		X			X
Tipulidae	X	X	X		X	
Hexatoma	X					
Tipula	X	X	X			
Tipula abdominalis	X		X			
Mollusca						
Gastropoda						
Ancylidae						
Ferrissia	X					
Lymnaeidae			X			
Fossaria						X
Pseudosuccinea columella	Q					
Physidae						
Physella			X	X		
Pelecypoda						
Sphaeriidae						
Pisidium	X					
Sphaerium	X					

[a]Because of the difficulty in reliably distinguishing the species groups within the genera Cricotopus and *Orthocladius*, they were combined into a *Cricotopus/Orthocladius* group for all data analyses.

Source: J. G. Smith et al., *First Annual Report on the ORGDP Biological Monitoring and Abatement Program*, draft, prepared by Oak Ridge National Laboratory for the U.S. Department of Energy, 1988, pp. 81-86, Table 6-1.

Table G.1-2. Mean density, biomass, richness, and diversity of benthic macroinvertebrates in Mitchell Branch, August 1986 through July 1987 (values in parentheses represent ± 1 SE).

Site	Density (no./0.1m^2)	Biomass (mg wet wt/0.1m^2)	Richness (no. of taxa/sample)	Diversity (H')
MIK 1.43	101.1 (18.8)	218.1 (41.1)	20.2 (1.4)	3.52 (0.1)
MIK 0.86	60.7 (25.3)	339.3 (107.1)	6.3 (0.5)	1.69 (0.1)
MIK 0.78	91.9 (60.7)	231.0 (109.3)	5.6 (0.5)	1.52 (0.1)
MIK 0.71	2.0 (0.5)	2.8 (0.9)	1.1 (0.1)	0.24 (0.1)
MIK 0.54	44.3 (23.9)	34.2 (13.3)	2.9 (0.4)	0.91 (0.1)
MIK 0.45	34.5 (9.4)	75.3 (23.1)	2.4 (0.2)	0.60 (0.1)

Source: J. G. Smith et al., *First Annual Report on the ORGDP Biological Monitoring and Abatement Program*, draft, prepared by Oak Ridge National Laboratory for the U.S. Department of Energy, 1988, p. 87, Table 6-2.

Table G.2-1. Diatom species and standing crop (thousand cells) collected from natural substrates in Big Bayou Creek, June 13–14, 1979

Species	Station 1 Replicate 1	Station 1 Replicate 2	Station 1 Replicate 3	Station 2 Replicate 1	Station 2 Replicate 2	Station 2 Replicate 3	Station 1 Replicate 1	Station 1 Replicate 2	Station 1 Replicate 3	Station 4 Replicate 1	Station 4 Replicate 2	Station 4 Replicate 3	Station 5 Replicate 1	Station 5 Replicate 2	Station 5 Replicate 3
Achnanthes lanceolate	48	31	17	1	6							2	1	3	3
A. minutissima	65	95	11	11	191	476	22	48	26	23	7	6	10	148	49
Amphipleura pellucida			1												
Caloneis bacillum													3	9	12
C. op.														3	
Capartogramma crucicula															3
Cyclotella menegheniana				1		6								3	
C. lanceolata			1												
C. prostrata													1	3	3
C. ventricosa		2	6	14	9	31	2	2				1	12	35	15
Eunotia pectinalis			6												
Fragilaria construens	10	68	26	24	37	37	43	5	17	75	3	3	4	12	6
Frustulia vulgaris														3	3
Gomphonema angustatum	2	5	1	10	13	2							4	3	
G. parvulum			1	4	4									9	
Navicula cryptocephala	7			7	2	6					*a*	1	2	15	
N. exigua			1			3		1							
M. minima	10														
M. pelliculosa	19	2		1	9		8	10	21		2	1		9	
M. pygmaea						2									
M. rhyncocephala														23	
M. salinarum v. *intermedia*		2			2										
M. seminulum	2														
M. viridula	2		4	1									13		20
Mitzechia amphibia	2		1												3
M. claueii													1		6
M. dissipata							3	19		13	+			32	
M. filiformis				6											
M. gracilis	2														
M. ignorata					2	6									
M. lineris	2														
M. microcephala				1										3	
M. palea	5	3	4	17	2	12	41	26	200	13	2	32		93	298
M. thermalis													2		3
N. sp.			4												
Pinnularia braunii v. *amphicephala*													9	9	6
P. sp.					2										
Rhoicosphenia curvata	190	24	4		2										
Stephanodiscus astraea								1							
Surirella angustata			2				1			1			1	3	
S. lineris v. *constricta*												1			
S. ovalis													4	6	9
S. ovata															3
S. sp.											+				
Synedra rumpens		2			2	28									
S. ulna			1	1											
Standing crop [individuals/cm^2 (thousands)	372	230	90	101	281	611	119	110	265	125	14	46	68	420	439
Number of species	14	10	17	14	14	11	7	8	4	5	7	7	15	20	16
Species Diversity Index	2.28	2.18	3.23	3.20	1.82	1.37	2.03	2.19	1.18	1.62	1.93	1.48	3.36	1.08	1.93

[a]$\pm$<500 cells/cm^2.

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio 1979, p. 12, Table 3.

Table G.2-2. Summary of benthic macro-invertebrates collected from Big Bayou Creek
(Paducah, Ky., June 16–17, 1979)

Organisms	Station 1	2	3	4	5
DIPTERA					
Chironomidae (larva)	X	X			X
Chironomidae (pupa)	X	X			X
Tipulidae					
Tipula sp.	X				
Simuliidae					
Simulium sp.		X			X
Empididae					X
EPHEMEROPTERA					
Baetidae					
Baetis sp.	X	X			X
Heptogeniidae					
Stenonema sp.	X				
TRICHOPTERA					
Hydropsychidae					
Hydropsyche sp.	X	X			X
Cheumatopsyche sp.	X	X			X
Pupa	X				X
PLECOPTERA					
Perlodidae					
Isoperla sp.	X				
HEMIPTERA					
Naucoridae (?)					X
COLEOPTERA					
Elmidae					
Stenelmis sp.		X			
Chrysomelidae					
Galerucella sp.	X				
OLIGOCHAETA	X				X
ISOPODA					
Asellidae					
Asellus sp.		X			
Total Number of Organisms	116	61	0	0	170
Total Number of Taxa	11	8	0	0	10
Species Diversity Index (pooled data for station)	2.34	2.58	–	–	2.21

← NO ORGANISMS →

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio, 1979, p. 14, Table 4.

Table G.2-3. Fish species collected from Big Bayou, Little Bayou, and West Fork of Massac Creeks, June 13–14, 1979

Species	Big Bayou Creek Station 1	2	3	4	5	Little Bayou Creek Station 6	7	8	9	Massac Creek Station 12
Gizzard shad, *Dorosoma cepedianum*					7				21	
Golden shiner, *Notemigonus crysoleucas*					2	17	2			9
Creek chub, *Semotilus atromaculatus*	28	5	11				13			78
Suckermouth minnow, *Phenacobius mirabilis*										118
Redfin shiner, *Notropis umbratilis cyanocephalus*		26		35			6	10		6
Steelcolor shiner, *Notropis whipplei*			1	1						
Bluntnose minnow, *Pimephales notatus*			9	14			3			
Stoneroller minnow, *Campostoma anomalum*	5	1					1			7
Blackstripe topminnow, *Fundulus notatus*	2	2			1				1	6
Common gambusia, *Gambusia affinis*									1	
Largemouth bass, *Micropterus salmoides*					1			1[a]	1	
Green sunfish, *Lepomis cyanellus*	15	16	2			10	3	1		12
Bluegill, *Lepomis macrochirus*	103	34	12	13	1	2	1	4		1
Orangespotted sunfish, *Lepomis humilis*		5								6
Longear sunfish, *Lepomis megalotis*			1		3					
Pumpkinseed sunfish, *Lepomis gibbus*		1		3						
Total Number of Species	5	8	6	5	6	3	7	4	4	9
Total Number of Individuals	153	90	36	66	15	29	29	16	24	243

(a) Young-of-the-year.

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio, 1979, p. 19, Table 8.

Table G.2-4. Diatom species and standing crops (thousand cells) collected from natural substrates in Little Bayou Creek, June 13–14, 1979

Species	Station 6 Replicate 1	Station 6 Replicate 2	Station 6 Replicate 3	Station 7 Replicate 1	Station 7 Replicate 2	Station 7 Replicate 3	Station 8 Replicate 1	Station 8 Replicate 2	Station 8 Replicate 3	Station 9 Replicate 1	Station 9 Replicate 2	Station 9 Replicate 3
Achnanthes lanceolata					9	3	5	15	13			
A. minutissima		3		24	40	771	110	709	254	3	1	+(a)
Amphora (?)												+
Caloneis bacillum	2	3						2				+
C. sp.	1											
Cyclotella meneghenina								11	1	1	2	4
Cymbella naviculiformis		3										
C. ventricosa	21	44	270		22	26	4	50	9			+
Eunotia pectinalis			3					2				
E. sp.	2	18										
Fragilaria construens	3	2	9	110	22		38		1	119	8	10
Frustulia vulgaris	2		15					2				
Comphonema angustatum	2	3		53					1			+
C. parvulum			3									
Navicula cryptocephala		12			12	62	2	44	7	1	1	
N. exigua								11				
N. pelliculosa			31	22	68	1505		328	20			
N. viridula	1		31			3	1	6	3			
N. sp. 1					28				3	1		
N. sp. 2					12					2		
N. sp. 3						59						
Neidium affine						3		2				
Nitzschia acicularis			15									
N. amphibia		2	3		6	207	6	11	2			
N. Clausii						3						
N. dissipata		3						2				
N. ignorata		2	12		3	3						
N. palea		3	95		3	130		2	2	1	2	3
N. parvula	1											

Source: M. A. Eischen, *Further Aquatic Field Studies at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Draft Final Report, Battelle Columbus Laboratories, Columbus, Ohio, 1979, pp. 22-23, Table 10.

Table G.3-1. Aquatic sampling station locations and descriptions

Station Number	
1	Little Beaver Creek upstream from the Portsmouth facility. Stream lined by a variety of trees providing a canopy. Area sampling consisting of riffle and pool ranging from 3 feet wide in riffle areas to 15-20 feet in pool areas. Riffles shallow with sand, gravel, cobble substrate with occasional rubble and boulder.
2	Little Beaver Creek downstream from plant outfall (water quality monitoring point #11) and settling lake overflow. Sampling collected in an area shaded by sycamores, elms, river birch, wild cherry, and box elder. The stream is approximately 15-20 feet wide. Riffle-pool development with riffle having cobble, rubble over a sand-gravel substrate. Pools are 1-2 feet deep with a large percentage of the bottom composed of exposed bedrock.
3	Little Beaver Creek downstream from the plant site. Stream becomes rather wide about 25-30 feet in riffle and pool area. Pools are deep, 4-6 feet.
4	Big Run Creek downstream from plant site but upstream from Wakefield, Ohio. Banks are lined with occasional trees. Riffle-pool development--riffles 15-20 feet wide, 3-4 inches deep--pools 2-4 feet deep, long and wide.
5	Big Run Creek downstream from plant and Wakefield, Ohio. Riffle with a gravel-cobble substrate were predominant. Very few pool areas present. Sampling areas were approximately 10-15 feet wide located just below bridge.
6	Unnamed tributary of the Scioto River that originates on plant reservation. Very small tributary stream mostly riffle, with large rubble overlying cobble-gravel substrate. Riffles are 2-4 inches deep and pools approximately 6-8 inches deep. Areas sampled had minimal tree cover.
7	Big Beaver Creek above the confluence of Little Beaver Creek. Station was located downstream from a RR bridge. Substrate was rather compacted consisting of gravel, cobble, occasional boulder underlying sand.
8	Big Beaver Creek below the confluence of Little Beaver Creek. Area about 20-30 feet wide and 4-6 feet deep. Very few trees hung directly over this section of the creek providing little shade.

Table G.3-1 (continued)

Station Number	
9	Mainstream of the Scioto River above the confluence of Big Beaver Creek. Depths ranged from approximately 2-1/2 - 3 feet along shorelines to 6-8 feet mid-stream. Substrate consisted of mostly coarse sand with cobble, pebbles, and rocks in mid-stream to clay and fine sand near shore. The east bank had little tree cover.
10	Mainstream of the Scioto River below the confluence of Big Beaver Creek, but above Portsmouth Facility's main outfall. Shade provided by a variety of trees along shore. Depths averaged between 2-3 feet along shore to 8-10 feet mid-stream. Cobble, pebble, gravel and coarse sand made up the bottom mid-stream and coarse sand and clay composed the substrate along the shoreline.
11	Mainstream of the Scioto River approximately 1/4-mile downstream of Portsmouth Facility's main outfall. A gravel, cobble beach is located on the west shore and high banks on the east. Coarse sand, gravel, and cobble substrate was predominant.
12	Main stream of the Scioto River downstream of the confluence of Big Run Creek. Depths ranged from 2 feet along the shoreline to approximately 5 feet mid-stream. Substrate consisted of gravel, sand, pebble in the middle and fine sand and silt with small amount of detritus along shore.

Source: U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, 1977, App. B, pp. B-95 and B-96, Table B.30.

Table G.3-2. Relative abundance of fishes collected from Little Beaver Creek

	Station 1	Station 2	Station 3
Common White Sucker	R	R	R
Carp	-	-	R
Creek Chub	C	R	C
Suckermouth Minnow	R	R	R
Redbelly Dace	C	-	R
Rosefin Shiner	-	-	R
Common Emerald Shiner	-	-	R
Striped Shiner	R	-	A
Spotfin Shiner	-	-	R
Steelcolor Shiner	-	-	R
Silverjaw Minnow	R	R	R
Bluntnose Minnow	C	R	C
Stoneroller Minnow	C	O	A
Yellow Bullhead	-	-	R
Green Sunfish	R	R	-
Bluegill	R	-	R
Longear Sunfish	-	-	R
Orangethroat Darter	C	-	O
Barred Fantail Darter	R	-	R
Total Number of Species	12	7	18

A = Abundant.
C = Common.
O = Occasional.
R = Rare.
- = Not collected.

Source: U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, 1977, App. B, p. B-178, Table B.82.

Table G.3-3. Relative abundance of fishes collected from Big Beaver Creek

	Station 7	Station 8
Gizzard Shad	C	C
Quillback Carpsucker	O	O
Golden Redhorse Sucker	O	O
Silver Redhorse Sucker	R	R
Ohio Spotted Sucker	–	R
Hog Sucker	O	O
Common White Sucker	–	R
Carp	O	O
Creek Chub	R	R
Gravel Chub	–	R
Suckermouth Minnow	O	O
Common Emerald Shiner	A	A
Striped Shiner	O	O
Steelcolor Shiner	R	–
Spotfin Shiner	O	O
Sand Shiner	O	O
Silverjaw Minnow	–	R
Bluntnose Minnow	C	C
Stoneroller Minnow	C	C
Yellow Bullhead	–	R
Blackstripe Topminnow	R	–
Troutperch	O	O
White Crappie	–	R

Table G.3-3 (continued)

	Station 7	Station 8
Black Crappie	R	R
Spotted Bass	C	C
Warmouth Sunfish	R	–
Bluegill	O	O
Orangespotted Sunfish	R	R
Longear Sunfish	C	C
Rock Bass	O	O
Dusky Darter	R	–
Ohio Logperch Darter	R	R
Blackside Darter	R	–
Johnny Darter	R	–
Banded Darter	R	–
Orangethroat Darter	–	R
Barred Fantail Darter	R	–
Total Number of Species	30	29

A = Abundant.
C = Common.
O = Occasional.
R = Rare.
– = Not collected.

Source: U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, 1977, App. B, pp. B-182 and B-183, Table B.84.

Table G.3-4. Relative abundance of fishes collected from Big Run Creek

	Station 4	Station 5
Golden Redhorse Sucker	-	R
Carp	-	R
Creek Chub	A	R
Redbelly Dace	C	-
Rosefin Shiner	-	O
Emerald Shiner	-	R
Striped Shiner	-	A
Steelcolor Shiner	-	R
Spotfin Shiner	-	R
Silverjaw Minnow	-	O
Bluntnose Minnow	-	R
Stoneroller Minnow	C	C
Largemouth Bass	-	R
Green Sunfish	O	R
Bluegill	C	R
Longear Sunfish	-	R
Johnny Darter	-	O
Greenside Darter	-	R
Orangethroat Darter	C	O
Barred Fantail Darter	-	C
Total Number of Species	6	19

A = Abundant.
C = Common.
O = Occasional.
R = Rare.
- = Not collected.

Source: U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, 1977, App. B, p. B-180, Table B.83.

Table G.3-5. Relative abundance of fishes collected from the Scioto River

	Station 9	Station 10	Station 11	Station 12
Longnose Gar	R	R	R	R
Gizzard Shad	A	A	A	A
Bigmouth Buffalofish	–	–	R	–
Smallmouth Buffalofish	O	R	R	–
Quillback Carpsucker	C	C	C	C
Highfin Carpsucker	–	R	–	R
Golden Redhorse Sucker	R	–	–	–
Carp	C	C	C	C
Goldfish	–	–	–	R
Gravel Chub	–	–	–	R
Suckermouth Minnow	R	R	R	O
Redbelly Dace	R	–	–	–
Common Emerald Shiner	A	A	A	A
Striped Shiner	–	R	R	–
Steelcolor Shiner	R	–	R	R
Spotfin Shiner	O	O	O	O
Sand Shiner	R	O	R	O
River Shiner	–	–	–	R
Silverjaw Minnow	–	–	–	R
Bullhead Minnow	–	–	R	R
Bluntnose Minnow	O	O	O	O
Stoneroller Minnow	–	R	R	R

Table G.3-5 (continued)

	Station 9	Station 10	Station 11	Station 12
Channel Catfish	–	O	O	O
Flathead Catfish	R	–	–	–
American Eel	R	–	–	–
White Bass	–	–	R	–
White Crappie	O	O	–	O
Black Crappie	O	O	O	O
Spotted Bass	C	C	C	C
Largemouth Bass	–	–	–	R
Green Sunfish	–	R	R	R
Bluegill	O	O	O	O
Orangespotted Sunfish	R	–	R	R
Longear Sunfish	O	O	O	O
Sauger	R	R	R	–
Yellow Walleye	R	–	–	–
Dusky Darter	R	–	–	–
Freshwater Drum	–	R	–	R
Total Number of Species	24	22	24	27

A = Abundant.
C = Common.
O = Occasional.
R = Rare.
– = Not collected.

Source: U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site,* Vol. 2, 1977, App. B, pp. B-185 and B-186, Table B.85.

APPENDIX H

Appendix H

SOCIOECONOMICS

Appendix H. SOCIOECONOMICS

PROJECT DESCRIPTION

Construction Description

Construction of the AVLIS plant will begin in March 1993 and end in December 1997. The duration of construction is, therefore, 4 years and 9 months. This estimate is the same at both the Oak Ridge and Paducah sites. At Portsmouth, the use of existing Gas Centrifuge Enrichment Plant (GCEP) facilities will reduce the duration of construction by ≈3 months. Because a conceptual design does not exist for the conversion of existing GCEP facilities for AVLIS use, this estimate is not based on detailed analysis of construction. It does, however, take into account that significant modifications of existing facilities will be needed.

Construction Costs

Total construction costs of the AVLIS facility in 1994 dollars is expected to be ≈$1.3 billion for the Oak Ridge and Paducah sites. For Portsmouth, the projected construction cost in 1994 dollars is <$1.2 billion. These figures are derived from 1984 total costs for labor and materials, including a 12% markup for construction management, and then converted to 1994 dollars (by adding 50%). Two segments of on-site construction at Portsmouth are projected to cost 50% of the original estimated cost for labor and materials because of the presence of existing unused facilities built for the GCEP project. The total construction cost and the following breakdown of labor and materials for Portsmouth reflect this change.

Total project costs can be divided into the categories of materials, off-site labor, on-site labor, and construction management costs, all presented here in 1994 dollars. The cost of construction materials is projected to be ≈$874 million at Oak Ridge, the same for Paducah, and $805 million at Portsmouth. Off-site labor will cost ≈$35 million at all sites. On-site labor will cost ≈$273 million at Oak Ridge, the same at Paducah, and $226 million at Portsmouth. These on-site labor figures include the costs of labor management and support personnel located at the construction site. The construction management costs are projected to be ≈$140 million at the Oak Ridge site, the same at the Paducah site, and $127 million at the Portsmouth site. Construction management costs exclude direct payments of salary and benefits to management personnel already accounted for in on-site labor figures but include other indirect costs such as operating fees, overhead, and profit.

Labor Force Estimates

Table H.1 (Oak Ridge and Paducah) and Table H.2 (Portsmouth) show the estimated number of workers by craft during each year of construction. The peak demand for construction workers will occur during the third year of construction at each site, with Paducah and Oak Ridge requiring slightly over 1500 construction workers and Portsmouth requiring slightly under 1300 construction workers. To predict the number of workers who will move to the area as a result of this project, the focus shifts from the size of the overall

Table H.1. Estimated construction work force for AVLIS Project: Oak Ridge and Paducah

	Year 1	Year 2	Year 3	Year 4	Year 5
Construction craft					
Electrician	575	230	920	460	154
Ironworker	128	320	192		
Pipe fitter	141	141	211	141	94
Carpenter	35	35	35	123	164
Operator	63	63	63	13	65
Laborer	36	36	36	36	48
Sheet metal worker	16	63	16	63	
Millwright				66	87
Finisher	2	8	4	3	4
Truck driver	7	7	7	7	10
Painter				6	18
Sprinkler fitter		3	6	5	2
Asbestos worker			13	13	9
Roofer	1	2	2		1
Brick mason	1	1	1		1
Subtotal	1005	909	1506	936	657
Technical field					
Support workers	113	113	113	113	113
Operations worker		20	60	300	900
Total	1118	1042	1679	1349	1670

Table H.2. Estimated construction work force for AVLIS Project: Portsmouth

	Year 1	Year 2	Year 3	Year 4	Year 5
Construction category					
Electrician	527	211	842	421	211
Ironworker	76	190	114		
Pipe fitter	132	132	197	132	132
Carpenter	25	25	25	88	176
Operator	43	43	43	9	68
Laborer	24	24	24	24	48
Sheet metal worker	11	45	11	45	
Millwright				59	118
Finisher	1	4	2	2	3
Truck driver	5	5	5	5	10
Painter				3	14
Sprinkler fitter		2	2	2	2
Asbestos worker			11	11	11
Roofer	1	1	1		1
Brick mason	1	1	1		1
Subtotal	846	683	1278	801	795
Technical field					
Support worker	102	102	102	102	102
Operations worker		20	60	300	900
Total	948	805	1440	1203	1797

work force to the number of workers required in each major craft category. In-migration will be required for those crafts that require large numbers of workers when insufficient numbers of qualified craftsmen are available locally. As shown in Tables H.1 and H.2, electricians are by far the single largest category of workers, with ironworkers, pipe fitters, and carpenters also providing substantial numbers in peak years.

The following procedure was used to derive work force estimates.

1. Begin with adjusted 1984 labor costs used in the 1984 AVLIS plant estimate (presented in 1984 dollars including all markup on labor);
2. Sum the numbers for each major task for each craft to obtain the total adjusted labor cost per craft;
3. Multiply these costs by 0.80 to remove the 20% indirect markup for overhead and profit;
4. Divide the resulting numbers by $15 (the approximate average 1984 hourly construction wage rate, including benefits, for the Oak Ridge area) to obtain the number of work-hours by craft;
5. Divide the resulting numbers by 2000 to obtain the number of work-years by craft;
6. For each craft, multiply the total number of work-years by the estimated percent of this total to be worked each year of the project (see Table H.3).

The total number of workers at the site during each year of construction was determined by adding the number of construction workers, technical support personnel, and operations personnel. These numbers are presented in Tables H.1 and H.2 and compared graphically in Fig. H.1. The following method was used to estimate the number of technical field support workers.

1. Begin with the estimate of costs (for material and labor in 1994 dollars);
2. Multiply 1994 costs by 0.03 to obtain additional cost for technical and field support workers;
3. Multiply this number by 0.80 to remove the 20% indirect markup for overhead and profit;
4. Divide the resulting number by $25 (the estimated average 1994 hourly rate, including benefits, for support staff) to obtain the total number of work-hours. The hourly rate is an average of highly paid engineering personnel and lower paid guards, clerical staff, and maintenance workers;
5. Divide this number by 2000 to obtain the number of work-years;
6. Divide the total number of work-years by 5 to obtain the annual number of technical field support workers, whom we assume will be distributed evenly over the entire 5-year construction period.

Table H.3. Estimated percentage of work within each craft category to be performed during each construction year (%)

Construction category	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Electrician	25	10	40	20	5	100
Ironworker	20	50	30			100
Pipe fitter	20	20	30	20	10	100
Carpenter	10	10	10	35	35	100
Operator	25	25	25	5	20	100
Laborer	20	20	20	20	20	100
Sheet metal worker		10	40	10	40	100
Millwright				50	50	100
Finisher	10	40	20	15	15	100
Truck driver	20	20	20	20	20	100
Painter				30	70	100
Sprinkler fitter		20	40	30	10	100
Asbestos worker			40	40	20	100
Roofer	10	40	40		10	100
Brick mason	10	35	30		25	100

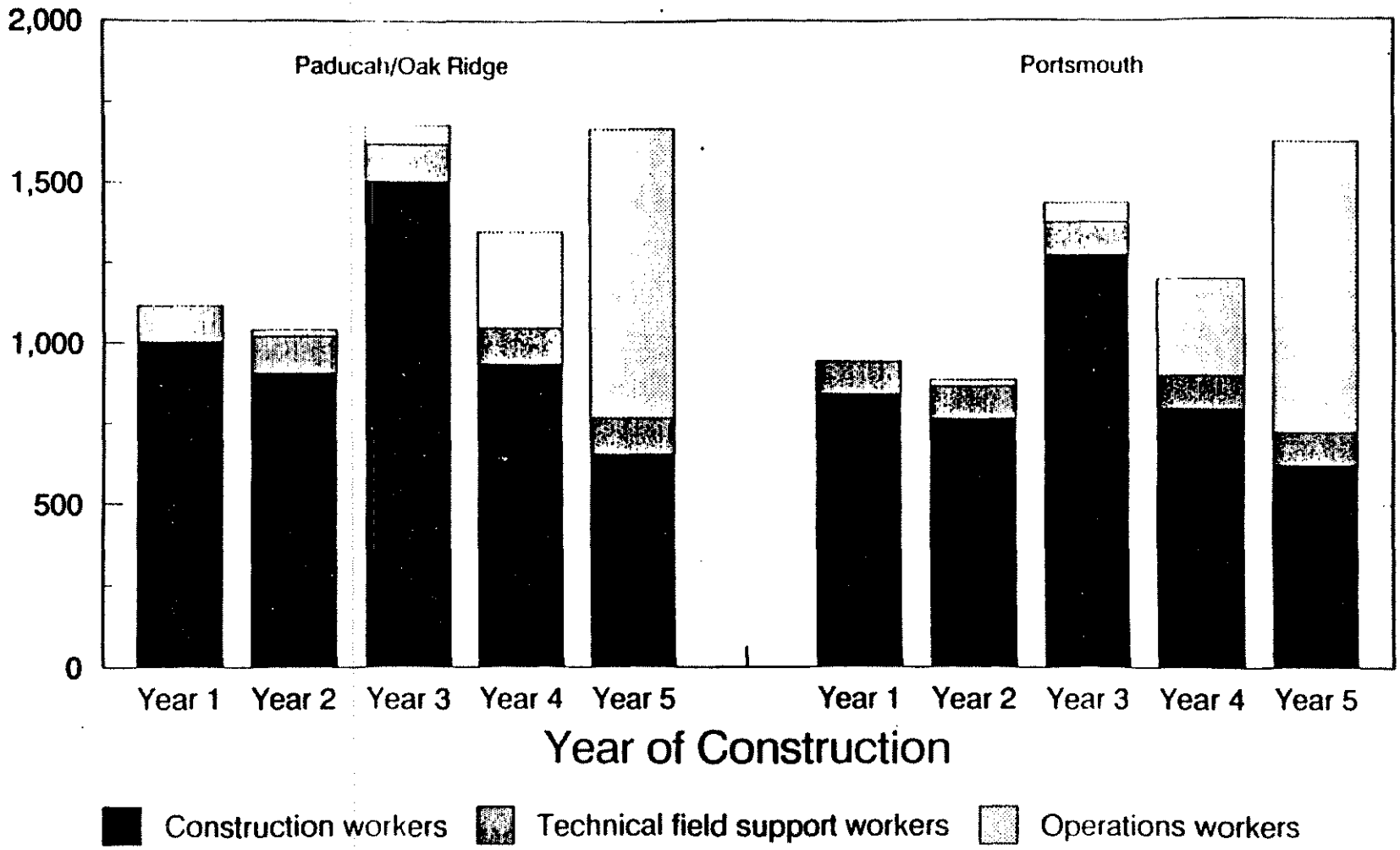

Fig. H.1. Comparison of the total number of workers at the site during each year of construction.

H.1 OAK RIDGE

H.1.1 Population

General population characteristics of each of the five counties neighboring the Oak Ridge site are presented in Tables H.1-1 and H.1-2.

H.1.2 Housing

Vacancy estimates included in Sect. 10.1.2 of this report were based on combined material from a number of sources. Estimates of the total number of units were derived by summing the number of units reported in the 1980 census and the number of housing starts between 1980 and 1988 (ETDD 1989; LPAO 1988). Then the vacancy rates for apartments (ETDD 1988; ETTD 1989) and for houses (FHLB 1985) were multiplied by the existing number of units.

Because some vacancy estimates are based on 1980 census data, housing information from the 1980 census is included in Table H.1-3.

H.1.3 Economic Structure

General economic characteristics for the Oak Ridge area are given in Tables H.1-4 through H.1-7.

Table H.1-1. Age distribution of residents

County	Under 5 years	5 to 14 years	15 to 24 years	25 to 34 years	34 to 44 years	45 to 54 years	55 to 64 years	65 to 74 years	75 years and over
Anderson	6.4	13.9	13.7	17.1	14.4	10.6	11.2	8.2	4.5
Knox	6.3	13.3	18.3	18.3	13.1	9.7	9.2	6.9	4.8
Loudon	6.5	14.8	14.3	15.5	13.8	11.2	10.8	8.2	4.0
Morgan[a]									
Roane	6.6	15.6	13.5	16.5	14.0	11.0	11.0	7.1	4.7

[a]Data for Morgan County are suppressed by U.S. Bureau of the Census.
Source: Data are from *County and City Data Book 1988*, U.S. Bureau of the Census, 1988.

Table H.1-2. Population characteristics

County	Total persons	Percentage		Education	
		White	Other	12 years or more	16 years or more
Anderson	68,800	95.3	4.7	62.2	18.2
Knox	329,500	90.3	9.7	64.4	18.8
Loudon	30,500	98.4	1.6	48.7	6.7
Morgan	16,800	*a*	*a*	40.5	3.9
Roane	49,400	96.2	3.8	54.1	10.6

[a]Data are suppressed by the U.S. Bureau of the Census.
Source: Data are from *County and City Data Book 1988*, U. S. Bureau of the Census, 1988.

Table H.1-3. Oak Ridge area 1980 census housing data

County	Total number housing units	Number owner occupied	Percentage owner occupied	Number renter occupied	Number vacant	
					For sale	For rent
Anderson	25,849	17,667	71.8	6,949	197	486
Knox	125,883	74,565	63.2	43,386	1,315	3,957
Loudon	10,835	8,077	78.5	2,212	68	125
Morgan	5,924	4,327	80.3	1,062	45	103
Roane	18,732	13,229	77.5	3,849	237	487

Source: Data are from *1980 Census of Population and Housing*, U. S. Bureau of the Census, 1988.

Table H.1-4. Employment by occupation Oak Ridge Gaseous Diffusion Plant study area, 1980

	County					
	Anderson	Knox	Loudon	Morgan	Roane	Region
Total employed	28,276	141,632	12,119	5,197	19,301	206,525
Executive, administrative, managerial	2,261	14,530	618	264	1,163	18,836
Professional specialty	4,451	20,444	1,076	369	2,151	28,491
Technicians	2,050	6,076	347	75	816	9,364
Sales	2,243	16,103	822	283	1,427	20,878
Administrative support, clerical	4,162	23,520	1,466	529	2,574	32,251
Private household	204	676	52	19	67	1,018
Protective services	521	1,826	134	163	284	2,928
All other services	2,568	16,272	1,315	447	1,954	22,556
Farming, forestry, fishing	279	1,190	451	144	247	2,311
Precision production craft repair	4,524	16,911	2,064	1,175	3,807	28,481
Machine operators, assemblers, inspectors	2,774	12,077	2,239	973	2,778	20,841
Transportation material moving	996	5,935	729	450	897	9,007
Handlers, cleaners, helpers, laborers	1,243	6,072	1,071	306	1,136	9,563

Source: Data from *Tennessee Statistical Abstract 1989*, The University of Tennessee, Knoxville Center for Business and Economic Research, Table 3-14, Knoxville, Tenn., 1989.

Table H.1-5. FY-1986 operating revenue by source for municipalities in Oak Ridge Gaseous Diffusion Plant study area with 1980 population over 5,000

City	Total	Property tax	Local sales tax	Other local sources	Federal government	State government
Clinton	5,032	982	1,147	1,306	289	1,309
Harriman	6,742	1,358	805	1,233	443	2,904
Knoxville	139,466	34,933	15,981	38,914	12,955	36,684
Lenoir City	5,515	1,137	595	1,098	531	23,155
Oak Ridge	47,661	6,706	2,026	29,237	2,089	7,274
Rockwood	1,655	360	344	425	101	424

Source: Data from *Tennessee Statistical Abstract 1989*, The University of Tennessee, Knoxville Center for Business and Economic Research, Table 15.15, Knoxville, Tenn., 1989.

Table H.1-6. FY-1986 operating expenditures by function for municipalities in Oak Ridge Gaseous Diffusion Plant study area with 1980 population over 5,000

City	Total	General purpose	Schools	Highways and streets	Debt principal	Service interest
Clinton	4,633	1,913	1,778	632	310	0
Harriman	6,868	1,607	4,820	131	183	127
Knoxville	212,534	68,255	66,833	4,520	65,341	7,585
Lenoir City	5,323	1,190	3,620	322	135	56
Oak Ridge	25,203	7,214	14,430	671	2,385	503
Rockwood	1,569	1,139	0	298	71	61

Source: Data from *Tennessee Statistical Abstract 1989*, The University of Tennessee, Knoxville Center for Business and Economic Research, Table 15.16, Knoxville, Tenn., 1989.

Table H.1-7. FY-1986 effective tax rates by class of property for municipalities in Oak Ridge Gasesous Diffusion Plant study area

City	Commercial and industrial real	Residential and farm real	Commercial and industrial personal	Utilities	Weighted average effective rate
Clinton	1.64	1.03	1.23	2.26	1.26
Harriman	1.84	1.15	1.38	2.54	1.44
Knoxville	2.27	1.42	1.7	3.12	1.87
Lenoir City	1.43	0.89	1.07	1.97	1.16
Oak Ridge	1.79	1.12	1.34	2.46	1.38
Rockwood	1.41	0.88	1.06	1.94	1.07

Source: Data from *Tennessee Statistical Abstract 1989*, The University of Tennessee, Knoxville Center for Business and Economic Research, Table 15.18, Knoxville, Tenn., 1989.

H.1.4 Cultural, Historical, and Archaeological Resources

The following are National Register sites for Anderson, Knox, Morgan, Roane, and Loudon counties (provided by the Tennessee Historical Commission).

Anderson County

Norris: *Arnwine Cabin*, SR 61 (3-16-76)
Lake City: *Edwards-Fowler House*, 3.5 miles south of Lake City on Dutch Valley Rd. (5-29-75)
Norris: *Norris District*, town of Norris on U.S. 441 (7-10-75)

Knox County

Knoxville: *Bleak House*, 3148 Kingston Pike (11-08-84)
Knoxville: *Blount, William, Mansion*, 200 West Hill Avenue (10-15-66)
Knoxville: *Boyd–Harvey House*, Harvey Road (11-7-85)
Knoxville vicinity: *Buffat, Alfred, Homestead*, 1 mile north of Knoxville on Love Creek Road (4-1-75)
Knoxville: *Burwell Building Tennessee Theater*, 600 South Gay Street (4-1-82)
Knoxville: *Camp House*, 1306 Broadway, NE (4-24-73)
Knoxville: *Caswell-Taylor House*, 803 North Fourth Street (8-1-86) RN
Mascot: *Chesterfield*, north of Mascot off Old Rutledge Pike (11-16-77)
Knoxville *Commerce Avenue Fire Hall*, 201–5 Commerce Avenue (1977) RN

Concord: *Concord Village Historic District*, roughly bounded by Lakeridge and Third Drives, Spring Street, and the Masonic Hall and Cemetery (10-22-87)
Knoxville: *Cowan, McClung and Company Building*, 500–4 Gay Street (7-12-84)
Knoxville: *Craighead-Jackson House*, 1000 State Street (3-20-73)
Knoxville: *Dulin, H. L., House*, 3100 Kingston Pike (10-15-74)
Knoxville vicinity: *Ebenezer Mill*, Ebenezer Road (6-25-87)
Knoxville: *Fire Station No. 5*, 419 Arthur Street, NW (11-2-78)
Knoxville: *Fort Sanders Historic District*, roughly bounded by White and Grand Avenues and 11th and 19th Streets (9-16-80)
Knoxville: *Fourth and Gill Historic District*, roughly bounded by I-40, Broadway, Central, and Fifth Avenues (04-29-85)
Knoxville: *Gay Street Commercial Historic District*, roughly along Gay Street from Summit Hill Drive to Church Avenue (11-4-86)
Knoxville: *General Building*, 625 Market Street (3-8-88)
Knoxville: *Gibbs, Nicholas, House*, Emory Road (9-9-88)
Knoxville: *Holston National Bank*, 531 South Gay Street (10-2-79)
Knoxville: *Jackson Avenue Warehouse District*, Jackson Avenue (4-11-73); now *Southern Terminal District*
Knoxville: *Jackson Avenue Warehouse District Extension*, 120–24 Jackson Avenue (3-10-75); now *Southern Terminal District*
Knoxville: *Johnson, Andrew, Hotel*, 912 South Gay Street (7-9-80)
Knoxville: *Knollwood*, 6411 Kingston Pike (5-12-75)
Knoxville: *Knox County Courthouse*, Main Avenue and Gay Street (4-24-73)
Knoxville: *Knoxville Business College*, 209 West Church Street (1-27-83)
Knoxville: *Knoxville College Historic District*, 901 College Street, NW (5-1-80)
Knoxville: *Knoxville Iron Foundry Complex-Nail Factory and Warehouse*, 715 Western Avenue, NW (3-25-82)
Knoxville: *Knoxville Post Office*, 501 Main Street (5-31-84)
Knoxville: *Knoxville YMCA Building*, 605 Clinch Avenue (11-17-83)
Knoxville: *Lamar House Hotel*, 803 Gay Street, SW (12-4-75)
Knoxville: *Lebanon-in-the-Fork Presbyterian Church*, Asbury Road (2-18-83) RN
Knoxville: *Louisville and Nashville Freight Depot*, 700 Western Avenue, NW (3-25-82)
Knoxville: *Louisville and Nashville Passenger Station*, 700 Western Avenue, NW (3-25-82)
Knoxville: *Mabry, Joseph Alexander, Jr., House*, 1711 Dandridge Avenue (11-13-89)
Knoxville: *Mall Building*, 1–5 Market Street (8-26-82)
Knoxville: *Marble Springs*, south of Knoxville on Neubert Springs Road (5-6-71)
Knoxville: *Market Square Commercial Historic District*, Market Square Mall (12-20-84)
Knoxville: *McCammon, Samuel, House*, 1715 Riverside Drive (3-1-84)
Knoxville: *Mechanics' Bank and Trust Company Building*, 612 South Gay Street (1-27-83)
Knoxville: *Mechanicsville Historic District*, off SR 62 (7-18-80)
Knoxville: *Medical Arts Building*, 603 Main Street (5-24-84)
Knoxville: *Middlebrook*, 4001 Middlebrook Pike (6-18-74)
Knoxville: *New Salem United Methodist Church*, 2417 Tipton Station Road (8-11-83)
Knoxville: *Old Knoxville City Hall*, Summit Hill Drive (5-31-72)
Knoxville: *Old Post Office Building*, Clinch and Market Streets (3-20-73)
Knoxville: *Ossoli Circle Clubhouse*, 2511 West Cumberland Avenue (3-21-85)
Knoxville: *Park City Junior High School*, 523 Bertrand Street (6-30-83)
Knoxville: *Park, James, House*, 422 West Cumberland Avenue (10-18-72)

Knoxville: *Ramsey House*, southeast of Knoxville on Thorngrove Pike (12-23-69)
Knoxville vicinity: *Riverdale Mill*, Wayland Road and Thorngrove Pike (3-13-87)
Concord: *Russell, Avery, House*, 11409 Kingston Pike (6-5-75)
Knoxville: *Southern Terminal and Warehouse Historic District*, bounded Depot, Central, Sullivan, Vine, and Gay Streets (11-18-85)
Knoxville: *St. John's Lutheran Church*, 544 Broadway, NW (4-4-85)
Knoxville: *Statesview*, ≈10 miles southwest of Knoxville off U.S. 70 (4-24-73)
Knoxville: *Talahi Improvements*, off U.S. 129 (12-26-79)
Knoxville: *Trinity Methodist Episcopal Church*, 416 Lovenia Avenue (8-26-82)
Knoxville: *U. T. Agriculture Farm Mound*, Neyland Drive (3-30-78)
Knoxville: *Westwood*, 3425 Kingston Pike (11-8-84)
Knoxville: *Williams, Col. John, House*, 2325 Dandridge Avenue (12-3-80)
Knoxville: *Zeigler, Isaac, House*, 712 North Fourth Avenue (8-1-86) RN

Morgan County

Rugby: *Rugby Colony*, SR 52 (4-26-72)

Roane County

Oliver Springs: *Colonial Hall*, Spring and Main Streets (9-11-75)
Harriman: *Harriman City Hall*, Roane and Walden Streets (4-16-71)
Kingston: *Morgan, Col. Gideon, House*, 149 Kentucky Street (1-27-83)
Kingston: *Roane County Courthouse*, Kentucky Avenue (7-14-71)
Harriman: *Roane Street Commercial District*, roughly Roane Street between Morgan and Crescent Avenues, NW (6-29-89)
Kingston: *Southwest Point*, 1 mile southwest of Kingston (7-31-72)
Oak Ridge: *X-10 Reactor Oak Ridge National Laboratory*, Oak Ridge National Laboratory (10-15-66)

Loudon County

Loudon: *Blair's Ferry Storehouse*, 800 Main Street (7-14-77)
Loudon: *Bowman House*, east of Loudon on Little River Road (7-8-70)
Lenoir City: *Bussell Island Site*, south of Lenoir City (3-29-78)
Loudon: *Cannon-Calloway House*, west of Loudon off U.S. 11 (7-8-70)
Loudon: *Carmichael Inn*, off U.S. 11 (7-8-70) RN
Loudon: *Cumberland Presbyterian Church of Loudon*, College Street (04-15-82)
Greenback vicinity: *Griffitts, William H., House*, Jackson Ferry-Greenback Road (3-2-89)
Lenoir City: *Lenoir City Company*, Depot Street (03-19-82)
Lenoir: *Lenoir Cotton Mill*, Depot Street (6-18-75)
Loudon: *Lenoir, Albert, House*, west of Loudon on River Road (SR 72) (4-11-73)
Loudon: *Loudon County Courthouse*, Grove and Mulberry Streets (5-28-75)
Loudon: *Mason Place*, 600 Commercial Street (11-27-89)
Greenback: *McCollum Farm*, southwest of Greenback on Morganton Road (4-15-78)
Greenback: *National Campground*, SR 1 (1-7-72)
Loudon: *Robinson Mill*, SR 72 (4-5-84)
Loudon: *Wilson, Orme, and Company Storehouse*, Hackberry Street (2-2-80)

Other sites may have cultural or historical value in the immediate vicinity of ORGDP or in the five-county region of impact. These sites may already have been surveyed in a continuing state-wide effort to conduct a comprehensive inventory of potentially historic properties 50 years of age or older. Information about this survey is available at the Tennessee State Historic Preservation Office in Nashville (see Appendix I: Wolfe 1990e). Information on federal projects is available from Joe Garrison, review and compliance coordinator (telephone 615-742-6758).

H.1.5 Social Structure

The following discussion describes the history of ORGDP and the relationship among the community, DOE, and the plant managers. Also included is a discussion of public response to (1) the gaseous diffusion plants, (2) other DOE proposals or projects in the area, and (3) other industries in the area that handle or process hazardous material.

On the 58-mile^2 (150-km^2) DOE Oak Ridge Reservation, in Roane and Anderson counties, are three facilities originally located there as part of the Manhattan Project: (1) Oak Ridge National Laboratory, a national research and development laboratory; (2) Y-12, a weapons production plant; and (3) Oak Ridge Gaseous Diffusion Plant (DOE 1984). Construction of ORGDP began in 1943, and the plant reached full-scale operation in August 1945 (DOE 1979). Four additional processing buildings were constructed between 1950 and 1954 and were on line by 1956 (DOE 1979; DOE 1984). Gas centrifuge and AVLIS development and testing also have been conducted at ORGDP (DOE 1984).

The relationship between the city of Oak Ridge and the Oak Ridge DOE facilities is unique among the three sites. Prior to the construction of the three plants, the Anderson-Roane county area was a slow-growing agricultural and mining region. In the 1930s, Tennessee Valley Authority (TVA) projects changed the physical contour of the land and brought in workers from throughout the United States. In the 1940s, the federal government cleared the Oak Ridge site to construct the three plants. A city, with various housing types and support services, was constructed to house the workers who were there to take part in building the first atomic bomb. By 1945, 75,000 residents were living in temporary houses, trailers, and dormitories. The common purpose shared by the residents and the strict secrecy concerning their work engendered a strong sense of community and a shared identity (Wolfe 1987a,b). The Atomic Energy Commission relinquished ownership of the city's commercial and residential areas in 1959, and the city—with a population of just over 27,000—was incorporated (ORCP 1988).

The Oak Ridge DOE complex is the dominant industrial employer in the five-county area. Other large industries include Boeing Engineering Company in Oak Ridge, TVA, the Technology Corridor, and Alcoa Industries. TVA offices are located in Knoxville and various power-generating facilities are located throughout the five-county area. The Technology Corridor stretches from Knoxville to Oak Ridge (the Corridor includes the numerous industrial and engineering corporations located between the two cities). Alcoa Industries, although located in Blount County, employs many workers from the area. New industry in the Oak Ridge area includes 40 companies spawned by the environmental cleanup and monitoring projects ongoing at the DOE site (see Appendix I: Morrissey 1990h).

Following World War II, management of ORGDP first was conducted by Union Carbide Nuclear Division. Martin Marietta Energy Systems, Inc., assumed management in 1984. Relations among the community, DOE, and the operating managers have changed

significantly since ORGDP began operation. Because of the Manhattan Project, ORGDP began operation behind a veil of secrecy. Community officials said that DOE's tendency toward secretive operations lingered for years and just recently has begun to change (see Appendix I: Schexnayder 1990m; Morrissey 1990h). The change toward openness is attributed to DOE's realization that local support is necessary to continue operations (see Appendix I: Morrissey 1990d,h); increased community knowledge about activities at DOE facilities; public demands for involvement in decision making and more information (see Appendix I: Schexnayder 1990m; Morrissey 1990h); and media publicity (see Appendix I: Morrissey 1990h). Nevertheless, other community officials think that serious shortcomings remain in the information provided by DOE about its facilities, proposed projects, and environmental problems (see Appendix I: Morrissey 1990a,c,e,f). Another official asserted that the nature of relations among the community, DOE, and its operating managers has been influenced positively by the community's faith in the expertise of the scientific community associated with the facilities; however, as public knowledge increases, negative public reactions may, in turn, increase (see Appendix I: Morrissey 1990b).

Since Oak Ridge's inception, residents and local officials in Oak Ridge and nearby communities have been strongly supportive of DOE operations in the area. Public support is by far the strongest in the city of Oak Ridge. Officials of other cities and counties in the five-county area were unanimous in their support of DOE operations, primarily because of its large economic impact on the region, particularly the 16,000 jobs provided (see Appendix I: Morrissey 1990a,e,i; Schexnayder 1990m).

Community officials are not entirely satisfied, however, with the economic benefit provided to the community (see Appendix I: Morrissey 1990b,d). They argue that private corporations who use government facilities for profit should be taxed. Past attempts to institute such a tax have been construed as a tax on federal property, which is illegal. A new proposal to tax the use of the property will be reviewed in the 1990 session of the Tennessee General Assembly [*The Oak Ridger*, January 7, 1990, p. 1, and January 1, 1990, p. 3; (see Appendix I: Morrissey 1990b)].

The economic viability of the city of Oak Ridge and the immediate area remains largely dependent on DOE presence, although the city has made strong efforts to diversify its economic base. Some progress has been made in the city's recruitment effort, as evidenced by Boeing's operations in Oak Ridge.

Revelations during the 1980s of environmental pollutants from the DOE facilities since their existence has, to some extent, weakened public confidence in DOE, particularly among residents outside Oak Ridge (see Appendix I: Schexnayder 1990m; Morrissey 1990h). In a May 1983 response to an area newspaper's use of the Freedom of Information Act, DOE disclosed that extensive mercury releases had occurred at the Y-12 plant. Subsequent public hearings, media accounts, and a lawsuit filed by a Knoxville environmental group brought negative publicity to Oak Ridge (Marshall 1983). Studies of public responses to the releases have indicated that Oak Ridge residents generally were not concerned about public health threats, although they were concerned about DOE's credibility and its public disclosure policies (Wolfe 1987b).

None of the officials of neighboring towns currently report awareness of specific concerns, controversy, or active opposition among their constituents in relation to ongoing operations at Oak Ridge DOE facilities. However, recent DOE proposals have been met less favorably by community and state officials. The proposed Monitored Retrievable Storage (MRS) facility for high-level radioactive waste was actively opposed by a number of citizen groups and officials in the area outside Oak Ridge (see Appendix I: Morrissey

1990a,h). Opposition was based on questions of need, concerns for health and safety, and concerns about DOE credibility (TDHE 1986). The state executive office and state representatives opposed the MRS facility and finally obtained an injunction in February 1986 to prevent construction of the MRS facility in the Oak Ridge area (BPI 1986).

Other environmental issues have caused mixed response from local citizens in recent years. Knoxville recently experienced controversy about a proposed solid waste incinerator, although the majority of Knoxville residents appear to support the facility (see Appendix I: Morrissey 1990f). In Roane County, near Kingston, a small amount of public opposition surfaced toward the issuance of a Resource Conservation and Recovery Act (RCRA) permit to a privately operated mixed-waste reprocessing facility. Nevertheless, this facility, Diversified Scientific Services, Inc., was issued a permit and is expected to begin operation soon. The International Technology Corporation recently began operations at its toxic waste incinerator at ORGDP, amidst little or no controversy (see Appendix I: Morrissey 1990h). Another facility that reprocesses and transports low-level radioactive waste is in operation by the Scientific Ecology Group, Inc. (SEG). In addition, SEG will soon begin full-scale operation of a low-level radioactive waste incinerator (*The Oak Ridger*, Oct. 25, 1989, p. 1).

H.2 PADUCAH

H.2.1 Population

General population characteristics of each of the six counties neighboring the Paducah site are presented in Tables H.2-1 and H.2-2.

H.2.2 Housing

The following procedure was used to derive the vacancy estimates presented in Sect. 10.2.2. Estimates of the total number of units are derived by adding the number of units reported in the 1980 census to the number of units constructed between 1980 and 1987. Vacancy estimates of rental and for-sale units are provided by the Purchase Area Development District and are based on 1980 census information, knowledge of local housing markets, and information provided by local realtor boards (PADD 1990).

Because some vacancy estimates are based on 1980 census data, housing information from the 1980 census is included in Table H.2-3.

Table H.2-1. Age distribution of residents

County	Under 5 years	5 to 14 years	15 to 24 years	25 to 34 years	34 to 44 years	45 to 54 years	55 to 64 years	65 to 74 years	75 years and over
Ballard[a]									
Carlisle[a]									
Graves	6.0	13.8	14.1	15.0	11.8	9.6	11.1	10.4	8.1
McCracken	6.8	13.8	13.8	16.5	12.5	10.7	10.8	8.6	6.4
Marshall	6.1	12.6	14.5	14.5	14.4	10.8	10.7	10.1	6.4
Massac, Ill.[a]									

[a]Data are suppressed by the U.S. Bureau of the Census. *Source:* Data are from *County and City Data Book 1988*, U.S. Bureau of the Census, 1988.

Table H.2-2. Population characteristics

County	Total Persons	Percentage		Education (%)	
		White	Other	12 years or more	16 years or more
Ballard	8,100	*a*	*a*	53.4	7.7
Carlisle	5,000	*a*	*a*	52.5	4.6
Graves	32,900	95.1	4.9	50.0	7.9
McCracken	60,300	88.9	11.1	62.9	11.5
Marshall	25,800	99.9	0.1	56.4	8.4
Massac, Ill.	14,900	*a*	*a*	53.1	8.4

[a]Data are suppressed by the U.S. Bureau of the Census. *Source:* Data are from *County and City Data Book 1988*, U.S. Bureau of the Census, 1988.

Table H.2-3. Paducah area 1980 census housing data

County	Total housing units	Owner occupied	Percentage		Vacant	
			Owner occupied	Renter occupied	For sale	For rent
Ballard	3,543	2,776	85.0	491	28	53
Carlisle	2,212	1,740	84.5	318	17	29
Graves	13,631	10,143	79.4	2,632	163	205
McCracken	24,797	16,686	71.1	6,773	187	445
Marshall	10,643	8,153	86.5	1,274	157	136
Massac, Ill.	6,217	4,566	79.7	1,165	80	112

Source: Data are from *1980 Census of Population and Housing*, U.S. Bureau of the Census, 1990.

H.2.3 Economic Structure

General economic characteristics of the Paducah area are given in Tables H.2-4 and H.2-5.

H.2.4 Cultural, Historical, and Archaeological Resources

Determining the full extent of cultural, historical, and archaeological resources within the multicounty region of impact would require searching the files maintained at the Kentucky Heritage Council office in Frankfort, Kentucky. In addition to the sites listed on the *National Register of Historic Places* (see below), a host of other archaeological and architectural properties should be considered. For McCracken County alone, >200 archaeological sites are recorded, and even more buildings are recorded (see Appendix I: Wolfe 1990c).

The amount of work involved in producing profile information for an environmental impact statement should be determined to some extent by the expected degree of disturbance. The major question is, "What is the extent of previous disturbance for the particular construction site under consideration?" If the area archaeological and historical sites were already significantly disturbed, then further surveying and recording may not be necessary. If, however, the construction site would disturb such sites, on-site investigation probably would be necessary. In both cases, consultation and concurrence from the State Historic Preservation Officer would be necessary (see Appendix I: Wolfe 1990c).

Table H.2-4. Bonded indebtedness for Kentucky counties in the Paducah Gaseous Diffusion Plant study area, 1987

(values are given in thousands of dollars)

	County	Cities in county	Districts	Special school	Total	Industrial revenue
Ballard	0	10,771	42	1,220	12,033	80,070
Carlisle	408	551	164	1,200	2,323	
Graves	0	1,825	3,933	17,360	23,117	7,925
McCracken	82,370	30,790	3,121	9,930	126,221	6,432
Marshall	3,190	44,905	3,511	4,330	55,936	32,737

Sources: Data are from *1988 Kentucky Statistical Abstract*, Table 86, University of Kentucky, Center for Business and Economic Research, Lexington, 1988.

The following is a list of National Register sites for Ballard, Carlisle, Graves, McCracken, Marshall, and Massac counties. The list was compiled through February 1988; some Massac County information was provided by the Illinois State Historical Library (see Appendix I: Wolfe 1990b).

Ballard County, Kentucky

Lovelaceville vicinity: *Lovelace, Andrew Jr., House*, west of Lovelaceville off U.S. 62 (1-3-78)
Wickliffe: *Wickliffe Site 15 BA 4* (12-08-84Wickliffe, *Ballard County Courthouse*, Fourth and Court Streets (2-27-80)

Carlisle County, Kentucky

Marshall Site, 15 CE 27 (10-29-85)
Turk Site, 15 CE 6 (10-29-85)

Graves County, Kentucky

Fulton vincinity: *Mecham Manor*, 7 miles east of Fulton off KY 116 (12-31-74)
Mayfield: *Wooldridge Monuments*, Maplewood Cemetery (8-11-80)
Mayfield: *U.S. Post Office*, Ninth Street and Broadway (12-02-82)
Mayfield: *Mayfield Downtown Commercial District*, roughly bounded by North, Water, Fifth, and Ninth streets (08-16-84)
Youngblood Site, 15 Gv 26 (2-4-86)

Table H.2-5. Population, income, and poverty rates for Kentucky counties and municipalities in the Paducah Gaseous Diffusion Plant study area

	Population 1986	Per capita income ($) 1985	Poverty rate (%) 1980	Poverty rate (%) 1984
Ballard	8,100	8,147	14.8	17.5
Barlow	720	7,905		
Blandville	100	8,102		
Kevil	340	8,307		
La Center	890	8,375		
Wickliffe	880	8,285		
Carlisle	5,000	7,698	15.7	18.9
Alington	540	7,679		
Bardwell	930	8,295		
Graves	32,900	8,690	13.9	16.7
Mayfield	9,900	9,413		
Water Valley	360	7,857		
Wingo	610	9,733		
McCracken	60,300	9,889	12.9	14.5
Lone Oak	470	9,115		
Paducah	28,370	10,056		
Marshall	25,800	8,846	9.8	12
Benton	3,550	10,139		
Calvert City	2,350	10,645		
Hardin	590	6,547		
Kentucky	3,729,000	8,614	17.6	19.3

Source: Data are from *1988 Kentucky Statistical Abstract*, Tables 60 and 66–68, University of Kentucky, Center for Business and Economic Research, Lexington, 1988.

Marshall County

Benton: *Lemon, James R., House*, 1309 Main Street (8-28-75)
Calverty City: *Oak Hill*, 26 Aspen Street (12-31-74)
Benton vicinity: *Archaeological Site*, 15 M1 109 (01-27-83)
Benton: *Stilley House*, 925 Birch Street (8-19-86)

McCracken County, Kentucky

Paducah: *Angles, The (Quigley-Barkley House)*, Alben W. Barkley Drive near 40th Street (7-19-76)
Paducah: *Grace Episcopal Church*, 820 Broadway (3-16-76)
Paducah: *Hotel Irvin Cobb*, Broadway and Sixth Street (8-24-78)
Paducah: *Paducah Market House District*, Second Street between Broadway and Kentucky Avenue (4-3-78)
Paducah: *Yeiser, Mayor David A., House*, Alben W. Barkley Museum, 533 Madison Street (3-7-73)
Paducah: *Nashville, Chattanooga and St. Louis Railway Office and Freight House*, 300 South Third Street (7-17-79)
Paducah: *St. Francis De Sales Roman Catholic Church*, 116 South Sixth Street (4-16-79)
Paducah: *People's First National Bank and Trust Company Building*, 300 Broadway (8-11-80)
Paducah: *Jefferson Street-Fountain Avenue Residential District*, Jefferson and Madison Streets, Broadway, Fountain Avenue, and Harahan Boulevard (07-14-82)
Paducah: *Paducah Lower Town Neighborhood District*, roughly bounded by Park Avenue, Jefferson, Fifth, and Ninth Streets (03-15-82)
Paducah: *Paducah Downtown Commercial District*, roughly bounded by Seventh, First, Clark, and Monroe Streets (04-20-82)
Paducah: *Anderson, Artelia Hall*, 1400 H.C. Mathis Drive (05-26-83)
Paducah: *Anderson-Smith House*, Lone Oak Road (3-01-84)
Paducah vicinity: *Archeological Site 15McN51* (7-11-85)
Paducah: *Downtown Commercial District (Boundary Increase)*, roughly bounded by First, Clark, Seventh and Monroe Streets (5-2-85)

Massac County, Illinois

Brookport vicinity: *Kincaid Site*, east of Brookport on the Ohio River (10-15-66)
Metropolis: *Curtis, Elijah P., House*, 405 Market Street (6-9-78)
Metropolis vicinity: *Fort Massac Site*, southeast of Metropolis on the Ohio River (7-14-71)
Metropolis: *McCartney Music Hall*, 116–120 East Fourth Street (n.d.)

H.2.5 Social Structure

The following discussion describes the history of PGDP and the relationshiop among the community, DOE, and the plant managers. Also included is a discussion of public response to (1) the gaseous diffusion plant, (2) other DOE proposals for or projects in the area, and (3) other industries in the area that handle or process hazardous material. The Paducah Gaseous Diffusion Plant (PGDP) is the only DOE facility in the Paducah area.

PGDP is located 10 miles (16 km) west of the city of Paducah, Kentucky, and 4 miles (6.4 km) south of the Ohio River on land transferred to the Atomic Energy Commission from the Kentucky Ordnance works in January 1951 (DOE 1982). Plant construction occurred between 1951 and 1954 (DOE 1984). Initial operation began in 1952, and full-scale operation was reached by 1955 (DOE 1982). Before PGDP was constructed, the area was primarily agricultural and forest land—as it is to a lesser extent today.

Other industries in the area include Allied Chemical (Massac County, Illinois), which produces hexafluorocarbons; the TVA Joppa Steam Electric Plant, 13 miles (21 km) northwest of PGDP, which provides power to PGDP (DOE 1982); and a large industrial complex in Calvert City, Kentucky.

The original manager of PGDP was Union Carbide Nuclear Division, but in 1984 Martin Marietta Energy Systems, Inc., assumed operation of the facility. PGDP is the largest employer in the area and has provided economic stability throughout the Kentucky Purchase Area, the eight Kentucky counties west of the Tennessee River (see Appendix I: Schexnayder 1990a,f,j,m). Officials attribute the community's continued support of the facility to the plant's (1) economic importance to the entire Purchase Area; (2) large contributions to community programs such as the United Way; (3) good operating record, particularly safe operation; and (4) public awareness and information programs (see Appendix I: Schexnayder 1990d,e,o,j,l). Community officials reported that the management is forthright and candid and that the community has enjoyed DOE and Martin Marietta's cooperation on community projects such as establishing a 911 emergency telephone system (see Appendix I: Schexnayder 1990j,m). All these elements have contributed to what officials describe as a good working relationship that has extended throughout the four decades of plant construction and operation.

Thus, community awareness and support of PGDP is high, as proven when ≈1400 citizens, all in support of keeping PGDP in operation, attended public hearings when DOE's plans to close one of the uranium enrichment facilities might have affected PGDP (see Appendix I: Schexnayder 1990l). Also, the Purchase Area county governments organized in support of the facility and initiated a campaign to encourage local residents to write letters to state officials, congressmen, and senators (see Appendix I: Schexnayder 1990f,r).

Little or no organized opposition to PGDP has occurred, despite the existence of local environmental groups including Coalition for Health Concerns, Benton, Kentucky; Purchase Area Environmental Forum, Calvert City, Kentucky; Citizens for a Healthy Environment, Smithland, Kentucky; and Association for Concerned Environmentalists, Brookport, Illinois.

Environmental issues have been raised by local citizens in recent years, however. For example, the Calvert City Industrial Complex, ≈20 km west/southwest of Paducah, has been the subject of environmental controversy as evidenced by the 1988 Greenpeace documentary, *Who's Killing Calvert City?* [no mention of any DOE facility was included in the documentary (see Appendix I: Schexnayder 1990l)]. A more recent issue in the area is the licensing of Liquid Waste Disposal, Inc. (LWD), a private industry in Calvert City that employs 300 people. The Kentucky Cabinet for Natural Resources and Environmental Protection has issued intent to deny LWD an operating permit for its hazardous waste incineration facility. The Coalition for Health Concerns supports this decision. Nevertheless, a majority of the 1000 people who attended a public hearing on the licensing issue, many of them employees of LWD, spoke out in favor of licensing [*Paducah Sun* November 5, 1989, p. 1; (see Appendix I: Schexnayder 1990m)].

Community officials indicated that these environmental issues, which are not related to PGDP, have caused less concern within the community than a recent plan to build a prison in Ballard County (see Appendix I: Schexnayder 1990j,o). Furthermore, officials said that environmental issues are far less important to the public than the issue of continued economic viability of the region. The continued operation of PGDP is considered the top concern of the entire community (see Appendix I: Schexnayder 1990e,o,r).

H.3 PORTSMOUTH

H.3.1 Population

General population characteristics of each of the four counties neighboring the Paducah site are presented in Tables H.3-1 and H.3-2.

H.3.2 Housing

Because some vacancy estimates are based on 1980 census data, housing information from the 1980 census is included in Table H.3-3.

H.3.3 Cultural, Historical, and Archaeological Resources

The full extent of cultural, historical, and archaeological resources in the region of impact requires further investigation. For example, most archaeological sites listed in the *National Register of Historical Places* for the impact area are mounds. Additional archaeological sites exist in abundance in the area. Information about such sites is available from an archaeological inventory filed at the Ohio Historic Preservation Office in Columbus. However, a reviewer would have to visit the office in person to study the files because the the staff of that office does not conduct reviews (see Appendix I: Wolfe 1990f).

The amount of work involved in producing profile information for an environmental impact statement should be determined to some extent by the expected degree of disturbance. The major question is, "What is the extent of previous disturbance for the particular construction site under consideration?" If the area archaeological and historical sites have already been destroyed, then further surveying and recording would not be necessary. If, however, the construction site would disturb surface or buried sites, then a plan would have to be developed to determine whether disturbance might occur. In any case, consultation and concurrence from the Ohio Historic Preservation Office would be required (see Appendix I: Wolfe 1990f).

The person to contact for information on federal projects is Catherine Stroup, department head of the Review and Compliance Section, at the Ohio Historic Preservation Office, 1982 Velma Avenue, Columbus, Ohio 43211-2497 (telephone: 614-297-2470).

The following lists the sites recorded in the *National Register of Historic Places* for Pike, Jackson, Ross, and Scioto counties in Ohio (SR indicates state route).

Table H.3-1. Age distribution of residents

County	Under 5 years	5 to 14 years	15 to 24 years	25 to 34 years	34 to 44 years	45 to 54 years	55 to 64 years	65 to 74 years	75 years and over
Jackson	7.6	15.0	14.2	14.4	13.1	9.8	11.1	7.5	5.6
Pike	8.0	17.0	15.4	15.7	12.7	9.4	9.0	7.3	5.5
Ross	7.1	14.8	15.5	16.0	13.8	10.8	10.6	6.8	4.6
Scioto	7.5	16.5	15.2	15.4	12.5	9.5	10.0	7.6	5.9

Source: Data are from *County and City Data Book 1988*, U.S. Bureau of the Census, 1988.

Table H.3-2. Population characteristics

County	Total persons	Percentage		Education (%)	
		White	Other	12 years or more	16 years or more
Jackson	30,000	99.0	1.0	53.9	7.8
Pike	25,000	98.7	1.3	52.3	8.6
Ross	67,300	94.0	6.0	57.3	8.7
Scioto	82,300	96.4	3.6	54.2	7.1

Source: Data are from *County and City Data Book 1988*, U.S. Bureau of the Census, 1988.

Table H.3-3. Portsmouth area 1980 census housing data

County	Total housing units	Owner-occupied units	Percentage		Vacant	
			Owner occupied	Renter occupied	For sale	For rent
Jackson	11,662	8,045	75.1	2,662	217	195
Pike	8,715	5,541	72.0	2,160	47	199
Ross	23,743	15,508	70.4	6,534	206	477
Scioto	31,675	21,292	72.1	8,242	323	542

Source: Data are from *1980 Census of Population and Housing*, U.S. Bureau of the Census, 1988.

Jackson County

Byer: *Byer Covered Bridge*, SR 31 (10-21-75)
Coalton: *Miner's Supply Store*, Main and Second Streets (11-1-77)
Coalton vicinity: *Leo Petroglyph*, northwest of Coalton (11-10-70)
Jackson: *Gibson House*, 187 Main Street (12-5-85)
Jackson vicinity: *Buckeye Furnace*, 10 miles east of Jackson (11-10-70)
Oak Hill: *Oak Hill Welsh Congregational Church*, 412 East Main Street (5-23-78)
Pattonsville vicinity: *Keystone Furnace*, SR 9 (3-18-82)
Petersburg vicinity: *Johnson Road Covered Bridge*, Johnson Road (8-23-84)
Wellston: *Clutts House*, 16 East Broadway Street (11-26-80)
Wellston: *Morgan Mansion*, Broadway and Pennsylvania Avenues (2-16-79)
Wellston vicinity: *Buckeye Furnace Covered Bridge*, 3 miles southeast of Wellston on SR 165 (2-24-75)

Pike County

Jasper: *Jones-Cutler House*, Bridge Street (4-26-76)
Morgantown vicinity: *Eager Inn*, north of Morgantown off SR 772 (11-8-74)
Piketon: *Friendly Grove*, SR 220, east of Piketon (1-26-70)
Piketon: *Piketon Historic District*, bounded by West and Third Streets, U.S. 23, and the Scioto River (2-28-74)
Piketon vicinity: *Piketon Mounds*, south of Piketon (5-2-74)
Piketon vicinity: *Vanmeter Stone House and Outbuildings*, south of Piketon at junction of U.S. 23 and SR 124 (3-31-75)
Wakefield vicinity: *Scioto Township Works I* (10-9-74)
Waverly: *Waverly Canal Historic District*, Walnut, North, Emmitt (U.S. 23), Second, Third, and Fourth Streets between Lock and East (n.d.)

Ross County

Bainbridge: *Harris, Dr. John, Dental School*, Main Street (7-23-73)
Bainbridge vicinity: *Baum, Howard, Site (33 RO 270)* (8-14-86)
Bainbridge vicinity: *Campbell, T. C., Mound*, southwest of Bainbridge (7-15-74)
Bainbridge vicinity: *Seip Earthworks and Dill Mounds District*, U.S. 50, 3 miles east of Bainbridge (8-13-74)
Bourneville vicinity: *Spruce Hill Works* (2-23-72)
Chillicothe: *Adena Mound*, 947–99 Orange Street (6-5-75)
Chillicothe: *Canal Warehouse*, Main and Mulberry Streets (4-24-73)
Chillicothe: *Chillicothe Business District*, roughly bounded by Water, Fourth, Walnut, and Hickory Streets (6-11-79)
Chillicothe: *Chillicothe Water and Power Company Pumping Station*, Enderlin Circle (11-15-79)
Chillicothe: *Chillicothe's Old Residential District*, roughly bounded by Fourth, South Mulberry, South Walnut, and Seventh Streets (11-28-73)
Chillicothe: *Grandview Cemetery*, 240 South Walnut Street (12-19-78)
Chillicothe: *Kendrick-Barrett House*, 475 Western Avenue (11-25-77); demolished/delisted
Chillicothe: *Macomb, Mary Worthington, House*, 490 South Paint Street (4-26-76)
Chillicothe: *Mountain House*, Highland Avenue (12-29-78)
Chillicothe: *Oak Hill*, Dun Road (4-3-73)
Chillicothe: *Renick House, Paint Hill*, 17 Mead Drive (5-9-73)
Chillicothe: *Seip House*, 345 Allen Avenue (5-12-81)
Chillicothe: *Story Mound State Memorial*, east of junction of Cherokee and Delano Streets (3-7-73)
Chillicothe: *Tanglewood*, 177 Belleview Avenue (6-20-79)
Chillicothe: *Vanmeter Church Street House*, 178 Church Street (2-21-79)
Chillicothe vicinity: *Adena*, West Allen Avenue Extension (11-10-70)
Chillicothe vicinity: *Anderson, Levi, House*, west of Chillicothe on Anderson Station Road (12-12-76)
Chillicothe vicinity: *Brown, Austin, Mound*, northwest of Chillicothe (2-15-74)
Chillicothe vicinity: *Cedar-Bank Works* (2-15-74)
Chillicothe vicinity: *Great Seal Park Archeological District*, northeast of Chillicothe (12-2-74)
Chillicothe vicinity: *Higby House*, south of Chillicothe on Three Locks Road (11-29-79)
Chillicothe vicinity: *High Banks Works*, north of Paint Creek (7-16-73)
Chillicothe vicinity: *Highbank Farm*, southeast of Chillicothe on SR 35 (10-20-80)
Chillicothe vicinity: *Hopewell Mound Group*, west of Chillicothe (2-12-74)
Chillicothe vicinity: *Metzger, Charles, Mound*, northwest of Chillicothe (6-18-73)
Chillicothe vicinity: *Mound City Group National Monument*, north of Chillicothe (10-15-66)
Chillicothe vicinity: *Stitt, David, Mound*, north of Chillicothe (11-9-72)
Frankfort: *Frankfort Works Mound*, U.S. 35 (5-17-73)
Hallsville vicinity: *Buchwalter House-Applethorpe Farm*, 292 Whissler Road (5-26-83)
Hopetown: *Wesley Chapel*, off U.S. 23 (2-2-79)
Hopetown vicinity: *Hopeton Earthworks*, north of Chillicothe (10-15-66); NHL (7-19-64)
South Salem: *South Salem Academy*, Church Street (2-23-79)
South Salem vicinity: *Kinzer Mound*, west of South Salem (1-17-74)
South Salem vicinity: *South Salem Covered Bridge*, west of South Salem on Lower Twin Road across Buckskin Creek (3-4-75)

Scioto County

Minford vicinity: *Bennett Schoolhouse Road Covered Bridge*, southeast of Minford (10-11-78)
Otway: *Otway Covered Bridge*, north of SR 348 (5-3-74)
Portsmouth: *All Saints Episcopal Church*, Fourth and Court Streets (3-25-82)
Portsmouth: *Bigelow United Methodist Church*, 415 Washington Street (12-8-87)
Portsmouth: *Boneyfiddle Commercial District*, roughly bounded by Front, Washington, Third, and Scioto Streets (6-6-79)
Portsmouth: *Cunningham–Maier House*, 506 Sixth (12-8-87)
Portsmouth: *Dole-Darrell House*, 322 Market Street (12-8-87)
Portsmouth: *Elden House*, 634 Fourth Street (12-8-87)
Portsmouth: *Evangelical Church of Christ*, 701 Fifth Street (12-8-87)
Portsmouth: *First Presbyterian Church*, 221 Court Street (11-28-73)
Portsmouth: *Gharky, George H., House*, 638 Fourth Street (12-8-87)
Portsmouth: *Greenlawn Cemetery Chapel*, Offnere Street (1-3-80)
Portsmouth: *Horseshoe Mound*, within Mound Park (5-2-74)
Portsmouth: *Hotel Hurth*, 222 Chillicothe Street (7-28-83)
Portsmouth: *Kinney, Aaron, House*, Waller Street (7-2-73)
Portsmouth: *Kinney, Eli, House*, 317 Court Street (3-10-88)
Portsmouth: *Labold House and Gardens*, 633 Fourth Street (12-8-87)
Portsmouth: *Lyric Theater*, 820 Gallia Street (n.d.); demolished/delisted
Portsmouth: *Marsh, Joseph, House*, 701 Market Street (12-8-87)
Portsmouth: *Meyer House*, 309 Washington Street (3-10-88)
Portsmouth: *Newman, William, House*, 716 Second Street (12-8-87)
Portsmouth: *Odd Fellows Hall*, 500–6 Court Street (12-8-87)
Portsmouth: *Peck, Judge William V., House*, 601 Market Street (11-15-79); demolished/delisted
Portsmouth: *Portsmouth Fire Department No. 1*, 642 Seventh Street (12-8-87)
Portsmouth: *Portsmouth Foundry and Machine Works*, 401 Third Street (12-8-87)
Portsmouth: *Purdum-Tracy House*, 626 Fourth Street (12-8-87)
Portsmouth: *Reed, Joseph G., Company*, 700 Second Street (12-8-87)
Portsmouth: *Saint Mary's Roman Catholic Church*, Fifth and Market Streets (8-24-79)
Portsmouth: *Scioto County Courthouse*, bounded by Seventh, Court, Sixth, and Washington Streets (12-8-87)
Portsmouth: *Second Street Historic District*, Second Street (11-30-83)
Portsmouth: *Sixth Street Historic District*, 533, 534, 537, 538, 541, 542, 543, 547, and 548 Sixth Street (3-10-88)
Portsmouth: *Steindam House*, 725 Court Street (12-8-87)
Portsmouth: *Streich Apartments*, 716–22 Washington Street (12-8-87)
Portsmouth vicinity: *Feurt Mounds and Village Site (Boundary Increase)*, north of Portsmouth (1-9-75)
Portsmouth vicinity: *Feurt Mounds and Village Site*, north of Portsmouth (6-18-73)
South Webster: *Tripp-Bauer Building*, 51–53 North Jackson Street (6-9-88)
West Portsmouth vicinity: *Moore, Philip, Stone House*, south of West Portsmouth on SR 23 (10-21-75)
West Portsmouth vicinity: *Tremper Mound and Works*, north of West Portsmouth (12-8-72)

H.3.4 Social Structure

The following discussion describes the history of PORTS and the relationship among the community, DOE, and the plant managers. Also included is a discussion of public response to (1) the gaseous diffusion plant, (2) other DOE proposals for or projects in the area, and (3) other industries in the area that handle or process hazardous material.

The Portsmouth Gaseous Diffusion Plant (PORTS) is one of four DOE plants in Ohio, but the only one in the Portsmouth area. PORTS is located 22 miles (35 km) north of Portsmouth and 2 miles (3.2 km) east of the Scioto River in Pike County. The last of the three DOE uranium enrichment facilities to be constructed, PORTS is capable of producing a full range of enriched uranium. Construction of PORTS began in 1953 (DOE 1984). The plant began operation in 1954 and reached full-scale operation early in 1956 (ERDA 1977). Construction of the Gas Centrifuge Enrichment Plant (GCEP) began in 1979 but was halted in 1985 before the plant became fully operational (DOE 1984).

The area surrounding PORTS, prior to its construction, was primarily forest and agricultural land. Steel and shoe manufacturing were the largest industries in the area.

Industry in the area today is relatively limited because non-DOE industries have experienced considerable decline. In the early 1980s, a large steel mill discontinued operation. Earlier, the strength of the shoe manufacturing industry weakened substantially (see Appendix I: Schexnayder 1990q). Also, the cancelation of the GCEP facility ended a brief economic boom in the area (see Appendix I: Schexnayder 1990q). Most recently, a local coal company has experienced large layoffs, and local small business have closed (see Appendix I: Schexnayder 1990t).

Community officials described the relationship between the community and Martin Marietta Energy Systems, Inc., and DOE as cordial, cooperative, and positive (see Appendix I: Schnexnayder 1990i,q). In fact, they think the relationship has improved in recent years since Martin Marietta Energy Systems, Inc., assumed plant operation from Goodyear Atomic (see Appendix I: Schexnayder 1990b,c). Officials base this observation on the willingness of Martin Marietta Energy Systems, Inc., to provide information about its operations to the community and on its community involvement. Open houses, plant-site tours, news of drills and safety programs, and quick responses to inquiries are offered readily by Martin Marietta Energy Systems, Inc. (see Appendix I: Schexnayder 1990c,i,q,t). Martin Marietta Energy Systems, Inc., and DOE have also established good rapport with the community by (1) contributing to the United Way and other local organizations; (2) providing emergency equipment and assistance to the community when needed; (3) having representatives serve on community boards such as the labor management council; and (4) maintaining a safe operating record (see Appendix I: Schexnayder 1990b,i,n,s).

Community support for DOE projects at the site has been demonstrated consistently since the plant began operation. A mid-1960s proposed DOE project required an additional 2000 acres (809 ha) of land. The local government agreed to buy the land and give it to DOE. Individual community members and various civic and social organizations pledged contributions toward the purchase of this land (see Appendix I: Schexnayder 1990s). Public hearings concerning DOE's plans to close one of its uranium enrichment facilities drew >1000 people in support of continued operation of PORTS (see Appendix I: Schexnayder 1990s). Community officials indicated that payments in lieu of taxes for PORTS are considered acceptable compensation to the communities (see Appendix I: Schexnayder 1990a). Local governments have passed resolutions supporting the GCEP facility (see

Appendix I: Schexnayder 1990b), and county commissioners have organized a letter-writing campaign in support of continued DOE presence in the community. Chambers of Commerce and local government officials have responded immediately to this campaign (see Appendix I: Schexnayder 1990n). Also, radio broadcasts request participation of all community members.

Only one instance of organized protest at PORTS was reported by community officials (see Appendix I: Schexnayder 1990n,s). In the late 1960s or early 1970s, a group of American Indians from outside the local area staged an antinuclear sit-in at the plant gates. Very few local residents joined the protest. Officials maintained that the protest was not against any particular action or incident at PORTS (see Appendix I: Schexnayder 1990n,s). Officials said that some residents, particularly the less informed, were concerned about the safety of the facility when it first began operation in the 1950s (see Appendix I: Schexnayder 1990a,s). Continued safe operation and knowledge about the safety features of the facility have made the residents no longer apprehensive about PORTS. The only other problems associated with PORTS and mentioned by community officials are labor strikes that occurred in the early 1980s (see Appendix I: Schexnayder 1990a).

Community members are not, however, complacent about environmental issues, as evidenced by concern voiced to community leaders when BASF proposed siting a facility in eastern Scioto County (see Appendix I: Schexnayder 1990q). Community members expressed concern about the company's record of environmental degradation and labor problems.

Continued DOE presence in the community is considered critical to the future economic viability of the Portsmouth area (see Appendix I: Schexnayder 1990b,c,q,t). Economic diversity in the area has suffered considerably in recent years. Efforts to attract new industry to the area, including industry to occupy the GCEP facility, have met limited success (see Appendix I: Schexnayder 1990i,q,t). A news article about the proposed AVLIS facility was ranked one of the ten most important articles of the year (see Appendix I: Schexnayder 1990c), and continued operation of PORTS is ranked as the community's first economic priority (see Appendix I: Schexnayder 1990i,t).

H.4 References

H.4.1 Oak Ridge

BPI (Business Publications, Inc.) 1986. *Nuclear Waste News* 6(6), February 13.

DOE (U.S. Department of Energy) 1979. *Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site*, DOE/EA-0106.

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

ETDD (East Tennessee Development District) 1988. *History of Housing Start Data 1980–1986*, Knoxville, Tenn.

ETDD (East Tennessee Development District) 1989. *Knox County Economic Statistics*, Knoxville, Tenn.

FHLB (Federal Home Loan Bank Board) 1985. *Knoxville, Tennessee MSA Housing Vacancy Survey*.

LPAO (Local Planning Assistance Office) 1988. *Roane County, Tennessee, Economic Development Plan: Strategies for Roane County,* Tennessee Department of Economic and Community Development, Knoxville, Tenn.

Marshall, E. 1983. "The 'Lost' Mercury at Oak Ridge," *Science*, 221, 130–32.

ORCP *Oak Ridge Comprehensive Plan Including 1988 Update* 1988. Oak Ridge, Tenn.

TDHE (Tennessee Department of Health and Environment) 1986. *The Public Response to MRS*, Nashville, Tenn.

The Oak Ridger 1989. Oct. 25, p. 1.

The Oak Ridger 1990a. Jan. 1, p. 3.

The Oak Ridger 1990b. Jan. 7, p. 1.

Wolfe, A. 1987a. "Perception of Industrial Risk," pp. 464–71 in *These are Our Voices: The Story of Oak Ridge 1942–1970*, ed. J. Overholt, Children's Museum of Oak Ridge, Oak Ridge, Tenn.

Wolfe, A. 1987b. "Paternalism in Oak Ridge," pp. 500–7 in *These are Our Voices: The Story of Oak Ridge 1942–1970*, ed. J. Overholt, Children's Museum of Oak Ridge, Oak Ridge, Tenn.

H.4.2 Paducah

DOE (U.S. Department of Energy) 1982. *Final Environmental Assessment of the Paducah Gaseous Diffusion Plant Site*, DOE/EA-0155.

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

PADD (Purchase Area Development District) 1990. *Housing Vacancy Estimates*, compiled by D. Elias, Mayfield, Ky., January 10.

Paducah Sun 1989. "Cabinet Gets an Earful from LWD Supporters," November 5, p. 1.

H.4.3 Portsmouth

DOE (U.S. Department of Energy) 1984. *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant*, K/D-5622.

ERDA (U.S. Energy Research and Development Administration) 1977. *Final Environmental Impact Statement Portsmouth Gaseous Diffusion Plant Site, Piketon, Ohio*, ERDA-1555.

Appendix I

PERSONAL COMMUNICATIONS

APPENDIX I. PERSONAL COMMUNICATIONS

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Bunting, Elizabeth B., Tennessee Department of Conservation, 1989 . . . . . I-4
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Hannan, Richard R., Kentucky State Nature Preserves Commission, 1989 . . . . . I-15
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United States Department of the Interior
FISH AND WILDLIFE SERVICE
Post Office Box 845
Cookeville, TN 38503

November 29, 1989

IN REPLY REFER TO
LOG NUMBER 4-C-90-014

Ms. Virginia R. Tolbert, PhD
Environmental Analyses Section
Environmental Sciences Division
Oak Ridge National Laboratory
P. O. Box 2008
Oak Ridge, Tennessee 37831

Dear Ms. Tolbert:

This is in response to your letter of November 6, 1989 regarding the Atomic Vapor Lasar Isotope Separation project with proposed sites at the Paducah Gaseous Diffusion Plant in western Kentucky and the Oak Ridge Gaseous Diffusion Plant in eastern Tennessee.

As requested, we have reviewed the projects with regard to endangered and threatened species. According to our records, the following species may occur in the projects impact areas:

Oak Ridge:
Virginia spirea - Spirea virginiana (PT)
American hart's tongue fern - Phyllitis scolopendrium var. americana (T)
Bachman's sparrow - Aimophila aestivalis (SR)
False foxglove - Aureolaria patula (SR)
Gattinger's lobelia - Lobelia appendiculata var. gattingeri (SR)
Appalachian bugbane - Cimicifuga rubifolia (SR)
Wharton's blackberry - Rubus whartoniae (SR)

Paducah:
Bald eagle - Haliaeetus leucocephalus (E)
Artic peregrine falcon - Falco peregrinus tundrius (E)
Bachman's sparrow - Aimophila aestivalis (SR)
Copperbelly water snake - Nerodia erythrogaster neglecta (SR)

You should assess potential impacts to listed endangered (E) and threatened (T) (PT) species and determine if the project may affect them. A finding of "may affect" may require formal consultation. In addition the status review species (SR), although not now listed or officially proposed for listing as endangered or threatened, are under status review by the Service and may be listed at some time in the future.

Thank you for your interest in protecting our nation's fish and wildlife resources. If we can be of further assistance, please contact us.

Sincerely,

Robert T. Bay

Robert T. Bay
Acting Field Supervisor

JCW/b
xc:
Mr. Robert Hatcher, TWRA, Nashville, TN
Mr. Dan Eager, TDOC, Nashville, TN
Mr. Wayne Davis, KDFWR, Frankfort, KY
Mr. Richard Hannan, KNPC, Frankfort, KY

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

January 31, 1990

V. R. Tolbert

Water Usage from Clinch River

Enclosed is updated information concerning the water usage from the Clinch River. ORGDP withdraws 3.8 CFS at Building K-1513 for sanitary purposes and for the cooling water make-up as well as fire suppression. The K-901 pumping station is no longer used in the daily operation but is in stand by incase needed.

Norman Bowman

N. W. Bowman, K-601, MS 7302 (4-3605) - NoRC

NWB:ljs

Enclosure

cc: W. G. Woods

I-4

TENNESSEE DEPARTMENT OF CONSERVATION
701 BROADWAY
NASHVILLE, TENNESSEE 37219-5237

December 5, 1989

Virginia R. Tolbert, PhD
Oak Ridge National Laboratory
Environmental Analysis Section
Environmental Sciences Division
P. O. Box 2008
Oak Ridge, TN 37831

Re: Information Request
Rare Species Near Oak Ridge
Gaseeous Diffusion Plant

Dear Ms Tolbert:

A list of rare species found in the area delineated by the Elverton and Bethel Valley quadrangle maps is attached. You will find exact locations described by latitude and longitude. To protect these species, we request that you keep exact locations confidential.

If you need further information, please contact me at 615/742-6552.

Sincerely,

Elizabeth B. Bunting

Elizabeth B. Bunting
Environmental Review Coordinator

EBB:bb

Attachment

TENNESSEE VALLEY AUTHORITY
NORRIS, TENNESSEE 37828

November 28, 1989

Ms. Linda Mann
Oak Ridge National Laboratory
Environmental Sciences Division
P.O. Box 2008
Building 1505
Oak Ridge, Tennessee 37831-6038

Dear Linda:

An inventory of the vascular plants of the TVA Shawnee Steam Plant property and adjacent to the Paducah Gaseous Diffusion Plant property is enclosed. This survey was conducted during the 1980 growing season.

If I can be of further assistance, please contact me.

Sincerely,

Joseph L. Collins /cdm

Joseph L. Collins, Botanist
Wildlife and Natural Heritage Resources
Land Resources

Enclosure

Terrestrial Vegetation

The proposed site lies in the Mississippi embayment section of the Western Mesophytic Forest Region according to Braun (1950). This section is an area of coastal plain sediments and is physiographically part of the Mississippi embayment, a northern extension of the Gulf Coastal Plain. The topography of the porposed site shows the strong past influence of the adjacent Ohio River, the area thus characterized by low relief and alluvial soils.

Principle plant communities of the site include row crop fields, old fields, emergent marsh, gum swamp, bottomland hardwood and upland hardwood. The chief row crop is soy bean with a minor area of corn. These fields are kept relatively clear of weeds except prior to cultivation in the spring. At that time the chief plants are buttercups, speedwell, mouse-ear chickweed, dwarf dandelion and hen-bit.

Old fields cover a small percentage of the site. These are mainly sections of the wildlife management area maintained as open habitat. Common in these areas are broom-sedge, blackberry, wild rose, venus's looking-glass, milkweed, panic grass, daisy-fleabane, clover, and hairgrass.

Emergent marsh vegetation includes rushes, sedges, water purslane, frog fruit, and cutgrass. These areas typically have buttonbush and swamp dogwood along their margins.

The gum swamp, occupying 10-20 acres, represents a rare habitat for that section of the U.S. and this particular stands approaches the northern limit of the habitat type. The swamp is composed of gum (Nyssa aquatica L.), scattered cypress overcup oak, willow and swamp cottonwood.

Bottomland hardwood forests on site are mixtures of red maple, hackberry, willow, river birch, box elder, shumard oak and hawthorn, with an understory of saplings, dogwood and possum-haw (swamp holly). Such forests frequently have an abundance of poison ivy as well as virginia creeper, and ferns.

Upland hardwood areas are relatively infrequent on the site. Such areas are characterized by hickories, and several species of oaks. Understory here

Endangered Species

An uncommon species of cottonwood, *Populus heterophylla* L. is found in and around the gum swamp. This species is considered threatened in Kentucky. This species and the swamp habitat on which it depends will be preserved.

APPENDIX I

Carya ovata
Carya tomentosa
Carya illinoensis
Polygala curtissii
Cyperus ovularis
Helenium flexuosum
Verbena sp.
Eupatorium fistulosum
Cassia fasciculata
Phlox paniculata
Polygonum persicaria
Fraxinus americana
Sorghum halepense
Rhus copallina
Robinia pseudo-acacia
Festuca elatior
Campsis radicans
Lactuca serriola
Erigeron canadensis
Gleditsia triacanthos
Chenopodium sp.
Ambrosia trifida
Lespedeza cuneata
Eragrostis cilianensis
Spermacoce glabra
Digitaria sanguinalis
Quercus stellata
Lactuca canadensis var. *latifolia*
Scutellaria ovata var. *ovata*
Eupatorium purpureum
Quercus palustris

Ulmus rubra

Acer saccharinum

Asimina triloba

Paronychia fastigiata

Andropogon sp.

Dactylis glomerata

Solidago sp.

Platanus occidentalis

Quercus falcata var. pagodaefolia

Pycnanthemum pilosum

Monarda fistulosa

Smilax glauca

Prunella vulgaris

Prunus serotina

Quercus imbricaria

Corylus americana

Quercus alba

Quercus shumardii

Ostrya virginiana

Sabatia angularis

Aralia spinosa

Rhexia mariana var. mariana

Scutellaria incana var. incana

Hibiscus militaris

Quercus prinus

Lippia lanceolata

Quercus prinus

Lippia lanceolata

Quercus phellos

Pycnanthemum incanum

Sassafras albidum

Ulmus alata

Smilax glauca

Nyssa sylvatica

Lonicera japonica

Acer rubrum

Liquidambar styraciflua

Catalpa speciosa

Celtis laevigata

PADUCAH GASEOUS DIFFUSION PLANT
ENVIRONMENTAL COMPLIANCE DEPARTMENT
PADUCAH, KENTUCKY
FTS: 355-6113

Date: November 13, 1989

To: Albert, Virginia (Name) O.R. (Location) 624-7288 (Phone No.)

From: Gross, Susan (Name) PGDP (Location) 355-6285 (Phone No.)

This transmittal consists of 4 page(s) "excluding cover sheet"

Remarks:

FAX 624-4946

Dear Ms. Tolbert,

Enclosed is the information you requested concerning storm water runoff at the Paducah Gaseous Diffusion Plant (PGDP). I used National Weather Service rainwater data to estimate the runoff. According to a study conducted at PGDP, normal conditions result in an infiltration of 10%. This implies that 90% of rainwater will be runoff. Also included is a plant map showing the KPDES outfalls. If you have any questions feel free to contact me at FTS 355-6285.

Teresa Gross

Teresa Gross

Environmental Compliance

STORM WATER DISCHARGE FOR 1989
APPROXIMATE MONTHLY TOTALS (Gallons)

Month	Rainwater Runoff		
January	1.75 E+08	175,000,000 ÷ 31 =	5.6 mgd
February	4.40 E+08	440 ÷ 28 =	15 mgd
March	1.77 E+08		5.7 mgd
April	8.41 E+07		2.8 mgd
May	7.69 E+07		2.4 mgd
June	3.04 E+08		1.0 mgd
July	2.33 E+08		7.5 mgd
August	5.94 E+07		1.9 mgd
September	8.71 E+07		2.9 mgd

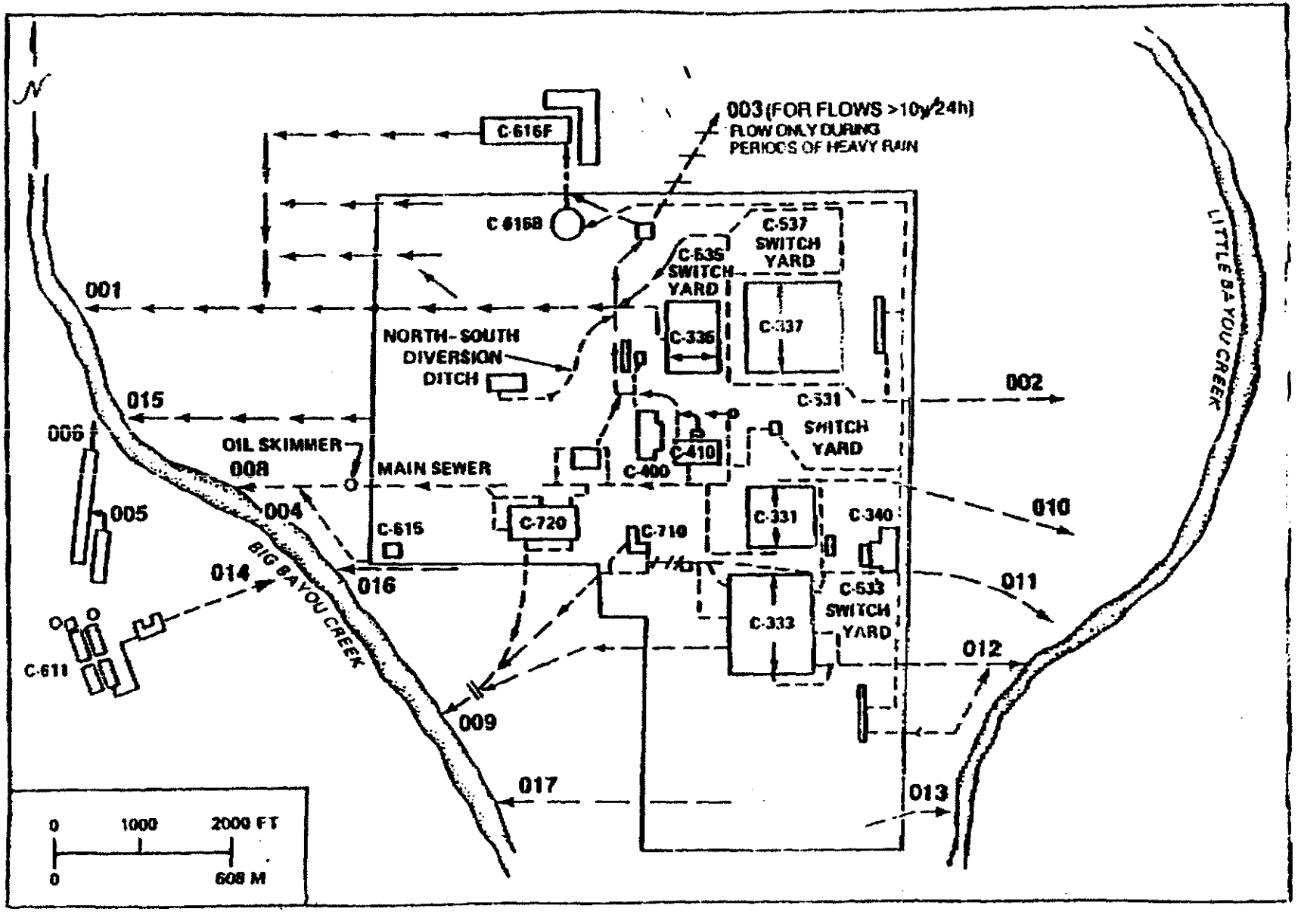
FLOW (Million Gallons per Day)
JANUARY-SEPTEMBER OF 1989

Outfall	Average	
001	1.64	BB
002	0.09	LB
004	0.46	BB
006	0.78	BB
008	0.97	BB
009	0.21	BB
010	0.05	LB
011	0.09	LB
012	0.08	LB
013	1.67	LB
015	0.28	BB
016	0.98	BB
017	0.22	BB

Big Bayou	Little Bayou
4	3
1.64	.09
.46	.05
.78	.09
.97	.08
.21	1.67
.28	1.98
.98	
.22	
5.54 mgd	

these values are an average of a weekly or monthly sample and as such do not accurately reflect the average flow for the outfalls. Teresa Gross PGDP

ORNL-DWG 87-6710R



KPDES outfall locations at PGDP.

RICHARD R. HANNAN
DIRECTOR

WALLACE G. WILKINSON
GOVERNOR

COMMONWEALTH OF KENTUCKY
KENTUCKY STATE NATURE PRESERVES COMMISSION
407 BROADWAY
FRANKFORT, KENTUCKY 40601
(502) 564-2886

November 6, 1989

Virginia R. Tolbert
Environmental Analyses Section
Environmental Sciences Division
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831

Re: Environmental Review of environs surrounding Paducah Gaseous Diffusion Plant for possible AVLIS facility location.

Dear Ms. Tolbert:

This letter is in response to your request of November 1, 1989 for environmental review in the vicinity of the Paducah Gaseous Diffusion Plant in McCracken County, Kentucky for the possible siting of an AVLIS (Atomic Vapor Laser Isotope Separation) facility there. We have reviewed our Natural Heritage Database to determine if any of the rare or endangered species monitored by the Endangered Species Committee of the Kentucky Academy of Science and Kentucky State Nature Preserves Commission (KAS-KSNPC) or unique and sensitive areas occur near the project area. Based on our most current information, we have determined that twenty-four of the species of plants and/or animals that are listed for monitoring by the KAS-KSNPC are known to occur in the vicinity of this project (see attachment).

Some of the species listed in the attachment are found on one or more of three high quality natural areas of great significance in the vicinity. These areas are the Barkley Prairie State Natural Area on the Barkley Airfield, Metropolis Lake State Nature Preserve adjacent to the Tennessee Valley Authority's Shawnee Steam Plant, and the Bayou Creek Ridge State Natural Area on the Tennessee Valley Authority's Shawnee Steam Plant Reservation. Locations of these natural areas are marked on the enclosed map.

Please note that the quantity and quality of data collected by the Kentucky Natural Heritage Program are dependent on the research and observations of many individuals and organizations. In most cases, this information is not the result of comprehensive or site-specific field surveys; many natural areas in Kentucky have never been thoroughly surveyed, and new species of plants and animals are still being discovered. For these reasons, the Kentucky Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of Kentucky. Heritage reports summarize the existing information known to the Kentucky Natural Heritage Program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments.

Thank you for the opportunity to comment on this project. If you have any questions or I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Richard R. Hannan
Director

RRH/BPB

Enclosures

Project: AVLIS facility at Paducah Gaseous Diffusion Plant

SPECIES MONITORED BY THE KENTUCKY ACADEMY OF SCIENCE-KENTUCKY STATE NATURE PRESERVES COMMISSION* AND LOCATED IN THE PROJECT AREA

Species	Latitude Longitude	Status	
		KAS-KSNPC*	USFWS ^
PLANTS			
Carya aquatica Water Hickory	37°08'48" 88°45'54"	Special Concern	--
Muhlenbergia glabriflora Hair grass	37°08'38" 88°45'44"	Special Concern	--
Rudbeckia subtomentosa Sweet coneflower	37°04'06" 88°45'55"	Threatened	--
Scutellaria leonardii Small skullcap	37°05'44" 88°49'01"	Special Concern	--
Silphium laciniatum Compass Plant	37°04'13" 88°50'50"	Special Concern	--
INVERTEBRATES			
Lampsilis orbiculata Pink mucket	37°08'54" 88°44'28"	Endangered	E #
Lampsilis ovata Pocketbook	37°10'26" 88°46'50"	Endangered	--
Orconectes lancifer Crayfish	37°08'48" 88°45'54"	Endangered	--
Plethobasus cooperianus Orange-footed pimpleback	37°08'50" 88°44'20"	Endangered	E #
Plethobasus cyphyus Bullhead	37°08'50" 88°44'20"	Special Concern	--
" "	37°10'26" 88°46'50"	Special Concern	--
Quadrula cylindrica Rabbitsfoot	37°08'52" 88°45'27"	Endangered	C2 #

Project: AVLIS facility at Paducah Gaseous Diffusion Plant

Species	Latitude Longitude	Status KAS-KNPC*	Status USFWS~
VERTEBRATES			
Cycleptus elongatus Blue sucker	37°09'43" 88°46'24"	--	C2 #
Erimyzon sucetta Lake chubsucker	37°09'43" 88°46'24"	Threatened	--
Esox niger Chain pickerel	37°08'42" 88°45'40"	Special Concern	--
Hybognathus hayi Cypress minnow	37°08'42" 88°45'40"	Threatened	--
Ichthyomyzon castaneus Chestnut lamprey	37°08'22" 88°43'47"	Special Concern	--
" "	37°09'43" 88°46'24"	Special Concern	--
Ictiobus niger Black buffalo	37°09'43" 88°46'24"	Special Concern	--
Lepisosteus spatula Alligator gar	37°09'43" 88°46'24"	Endangered	--
Lepomis punctatus Spotted sunfish	37°08'42" 88°45'40"	Threatened	--
Lophodytes cucullatus Hooded Merganser	37°09'43" 88°48'08"	Endangered	--
Nerodia erythrogaster neglecta Copperbelly water snake	37°08'48" 88°45'54"	Special Concern	C2 #
Notropis maculatus Taillight shiner	37°08'42" 88°45'40"	Threatened	--

Project: AVLIS facility at Paducah Gaseous Diffusion Plant

Species	Latitude Longitude	Status	
		KAS-KNPC*	USFWS~
VERTEBRATES cont'd			
Noturus stigmosus Northern madtom	37°09'43" 88°46'24"	Special Concern	--
Vireo bellii Bell's Vireo	37°09'16" 88°47'41"	Special Concern	--
" "	37°07'35" 88°49'05"	Special Concern	--

^ United States Fish and Wildlife Service
# E - Listed as Federally Endangered
# C2 - Federal Candidate for Listing

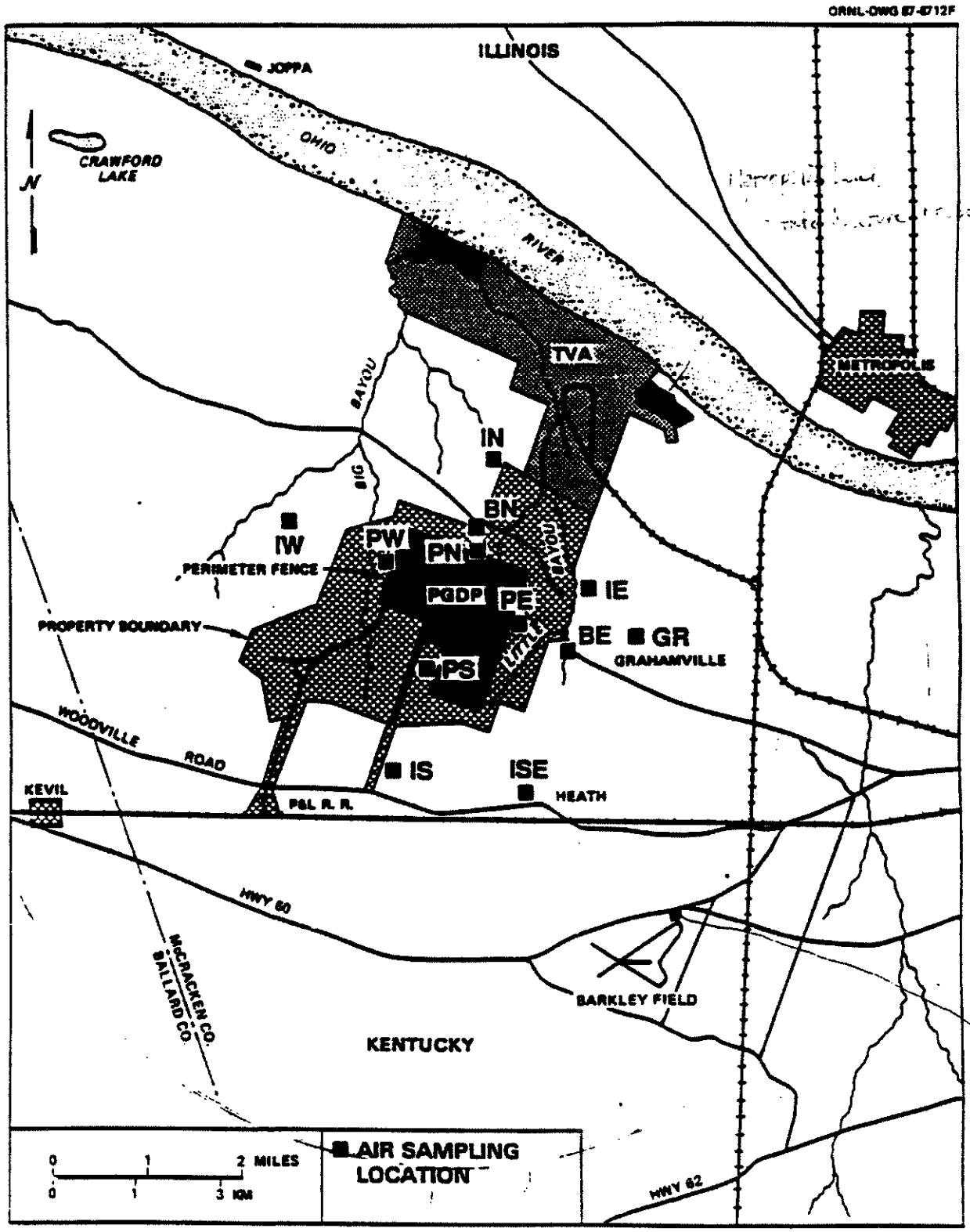


Fig. 2.1.2. Location of air sampling stations at PGDP.

Barkley Prairie ate
Natural tre

OHIO DEPARTMENT OF
NATURAL RESOURCES

Fountain Square
Columbus, Ohio 43224

November 15, 1989

Dr. Virginia R. Tolbert
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831

Dear Dr. Tolbert:

The information you requested for the AVLIS study area is enclosed. The numbers on the list correspond to the numbered locations marked on the accompanying maps. Scientific name, common name and status are given for each species. There are no existing or proposed state nature preserves or scenic rivers in the vicinity of this project area, and we are unaware of any other unique ecological sites within a five mile radius of the Portsmouth Gaseous Diffusion Plant.

Because our inventory program has not surveyed Ohio and relies on information supplied by a number of individuals and organizations, a lack of records for any particular area is not a statement that special plant or animal species are absent from a site.

Please contact me if you have any questions about this information

Sincerely,

Patricia D. Jones

Patricia D. Jones
Data Management Supervisor
Division of Natural Areas and Preserves

PDJ/sl

DIVISION OF NATURAL AREAS AND PRESERVES
OHIO DEPARTMENT OF NATURAL RESOURCES
11/15/89

AVLIS Facility: Portsmouth Gaseous Diffusion Plant

Waverly South Quad

1. Mixed Floodplain Forest Plant Community - wetland, ranked as a locally significant example of this community type.

2. Gratiola viscidula - Short's Hedge-hyssop, P
   Scutellaria integrifolia - Hyssop Skullcap, P

3. Lampropeltis getulus - Black Kingsnake, S

4. Givens Marsh
   Cattail Marsh Plant Community - wetland, ranked as a locally significant example of this community type.
   Vitis labrusca - Northern Fox Grape, P

5. Gratiola viscidula - Short's Hedge-hyssop, P
   Rhexia virginica - Virginia Meadow-beauty, P
   Sagittaria australis - Long-beaked Arrowhead, P

6. Scutellaria integrifolia - Hyssop Skullcap, P

Lucasville Quad

1. Orbexilum pedunculatum - False Scurf-pea, P

2. Turkey Vulture Roost

Wakefield Quad

1. Scioto River near mouth of Starr Hollow

   Fusconaia ebena - Ebony Shell, E
   Lampsilis teres anodontoides - Yellow Sand Shell, OWE
   Plethobasus cyphyus - Bullhead (mollusk), OWE
   Potamilus ohiensis - Fragile Heel-splitter (mollusk), OWE
   Truncilla donaciformis - Fawn's-foot (mollusk), P

2. Graptemys pseudogeographica - False Map Turtle, S

Piketon Quad

1. Truncilla donaciformis - Fawn's-foot (mollusk), P
   Obliquaria reflexa - Three-horned Wartyback (mollusk), T
   Truncilla truncata - Deer-toe (mollusk), T
   Lampsilis teres anodontoides - Yellow Sand Shell, OWE

2. Echinodorus rostratus - Bur-head, E

3. Truncilla donaciformis - Fawn's-foot (mollusk), P
   Obliquaria reflexa - Three-horned Wartyback (mollusk), P

4. Graptemys pseudogeographica - False Map Turtle, S

5. Moxostoma carinatum - River Redhorse, OWS
   Lepisosteus platostomus - Shortnose Gar, OWS
   Hiodon alosoides - Goldeye (fish), OWS

6. Ichthyomyzon unicuspis - Silver Lamprey, OWE

7. Lepisosteus platostomus - Shortnose Gar, OWS

Status Codes

Animals:

1. Ohio Division of Wildlife

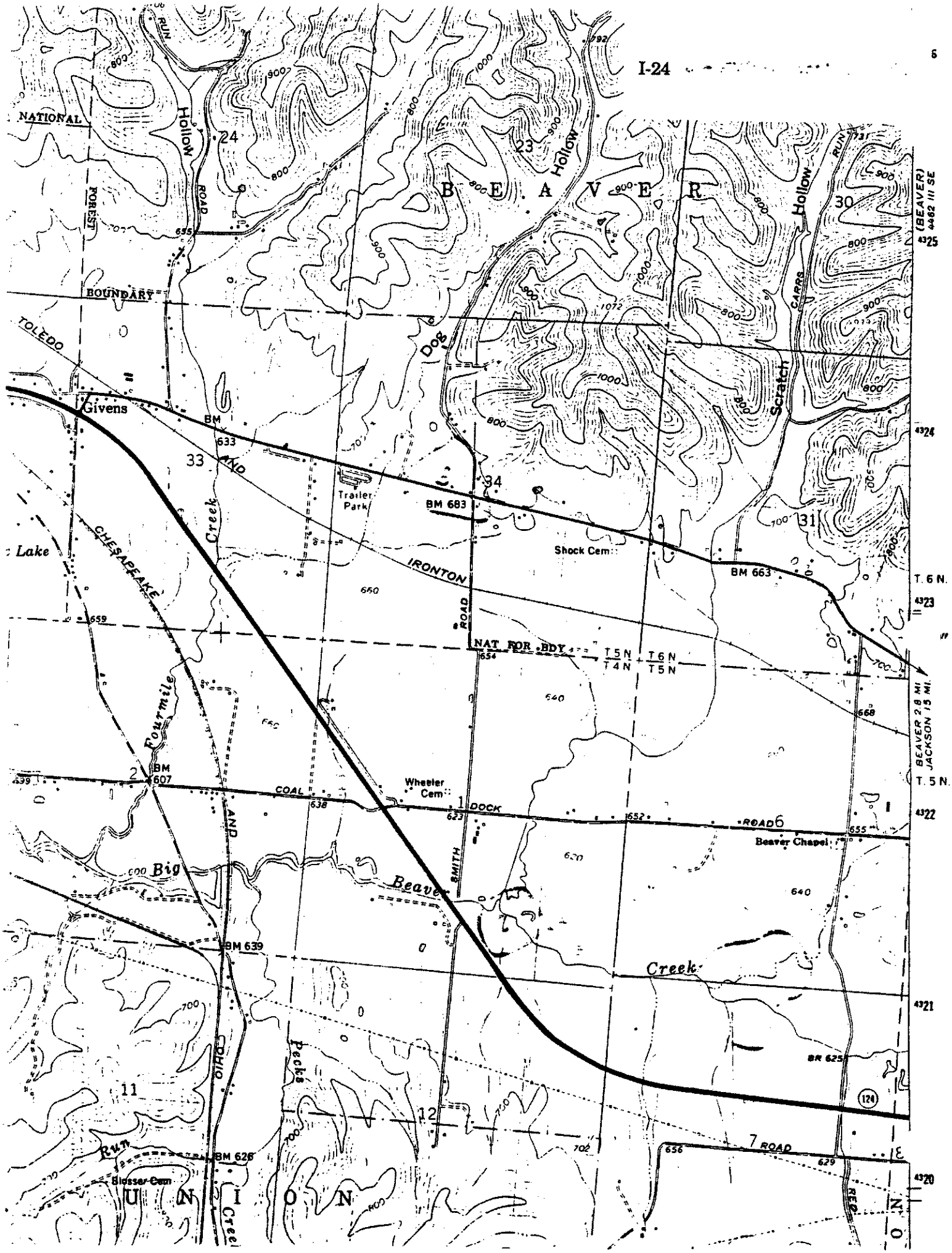
   OWE = State Endangered
   OWS = Special Concern (not a legal designation)

2. Statuses assigned by Division of Natural Areas and Preserves for species with no Division of Wildlife designation.

   E = Endangered (not a legal designation)
   T = Threatened (not a legal designation)
   P = Potentially Threatened (not a legal designation)
   S = Special Interest (not a legal designation)

Plants:

   E = State Endangered
   P = Potentially Threatened (not a legal designation)


NATIONAL
FOREST
BOUNDARY
TOLEDO
Hollow
ROAD
RUN
B E A V E R
Dog
Hollow
Scratch
Hollow
CARRS
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(BEAVER)
4462 III SE
Givens
BM
633
33
34
Trailer
Park
BM 683
Shock Cem
BM 663
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AND
OHIO
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BEAVER 2.8 MI
JACKSON 15 MI.
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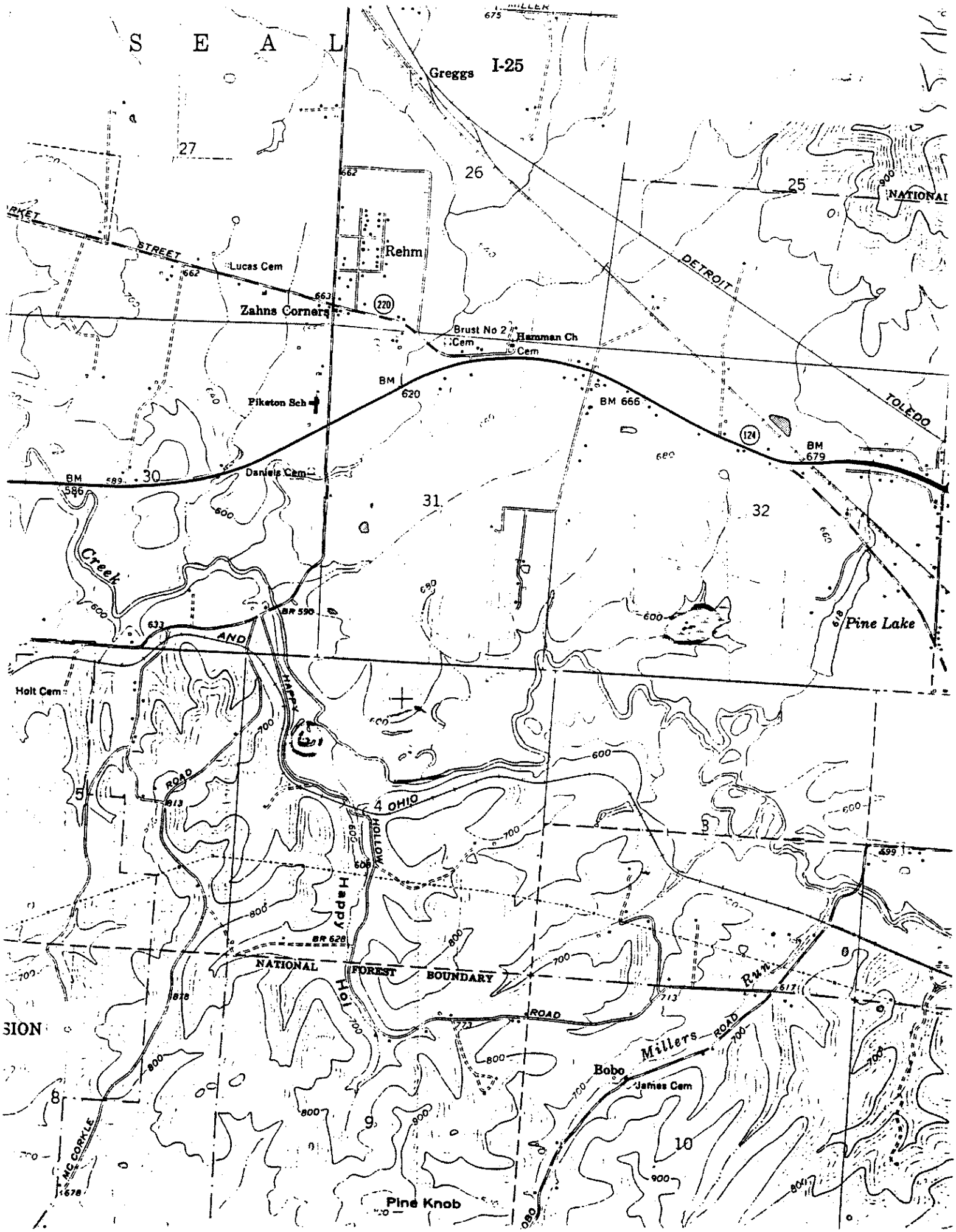
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Holt Cem
HAPPY
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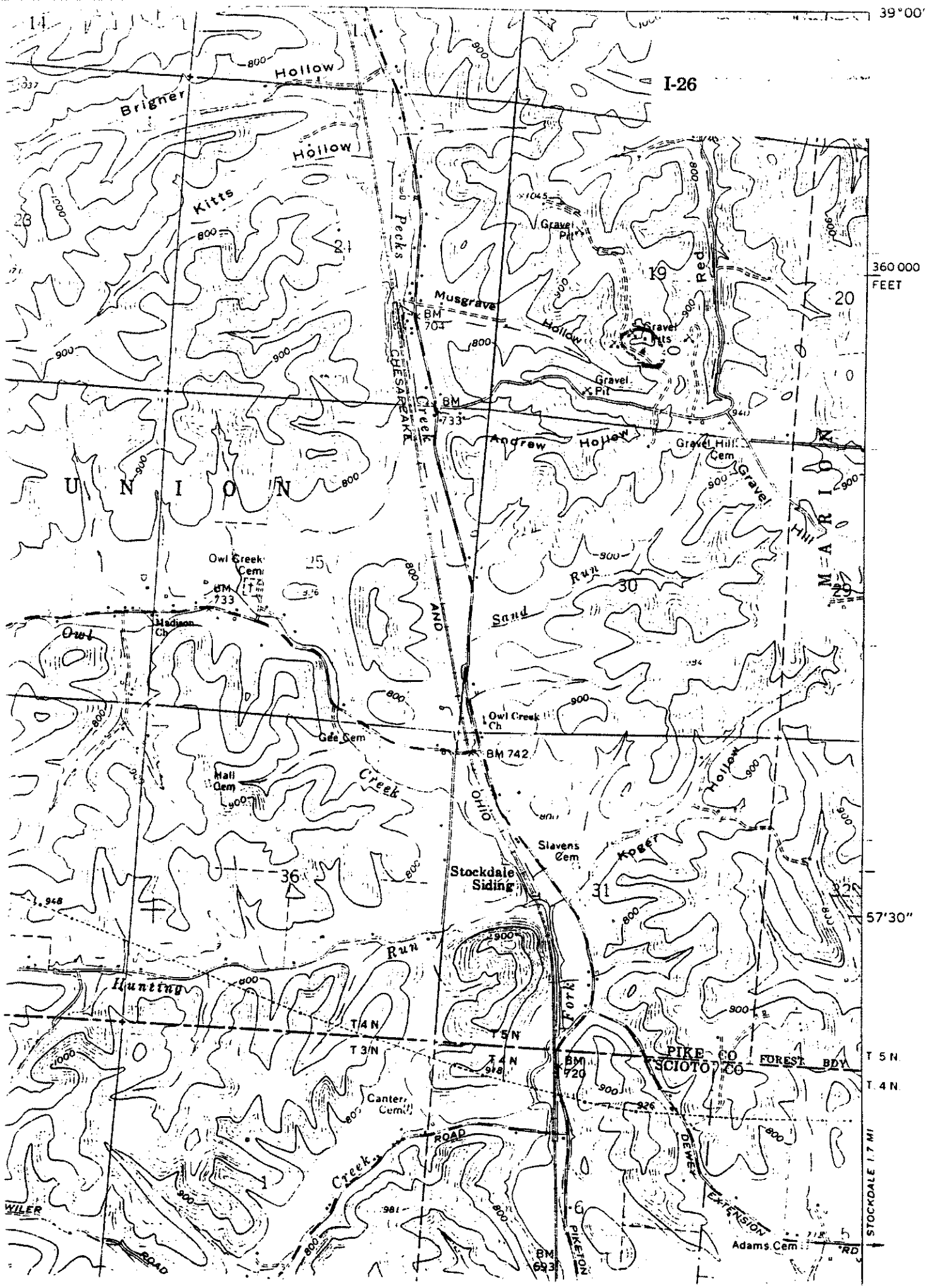
39°00'
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Musgrave Hollow
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Gravel Pit
Red Hollow
Gravel Pits
Gravel Pit
BM 733
Andrew Hollow
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MARION
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BM 733
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Gee Cem
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Creek
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Slavens Cem
Koger Hollow
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T 3 N
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BM 693
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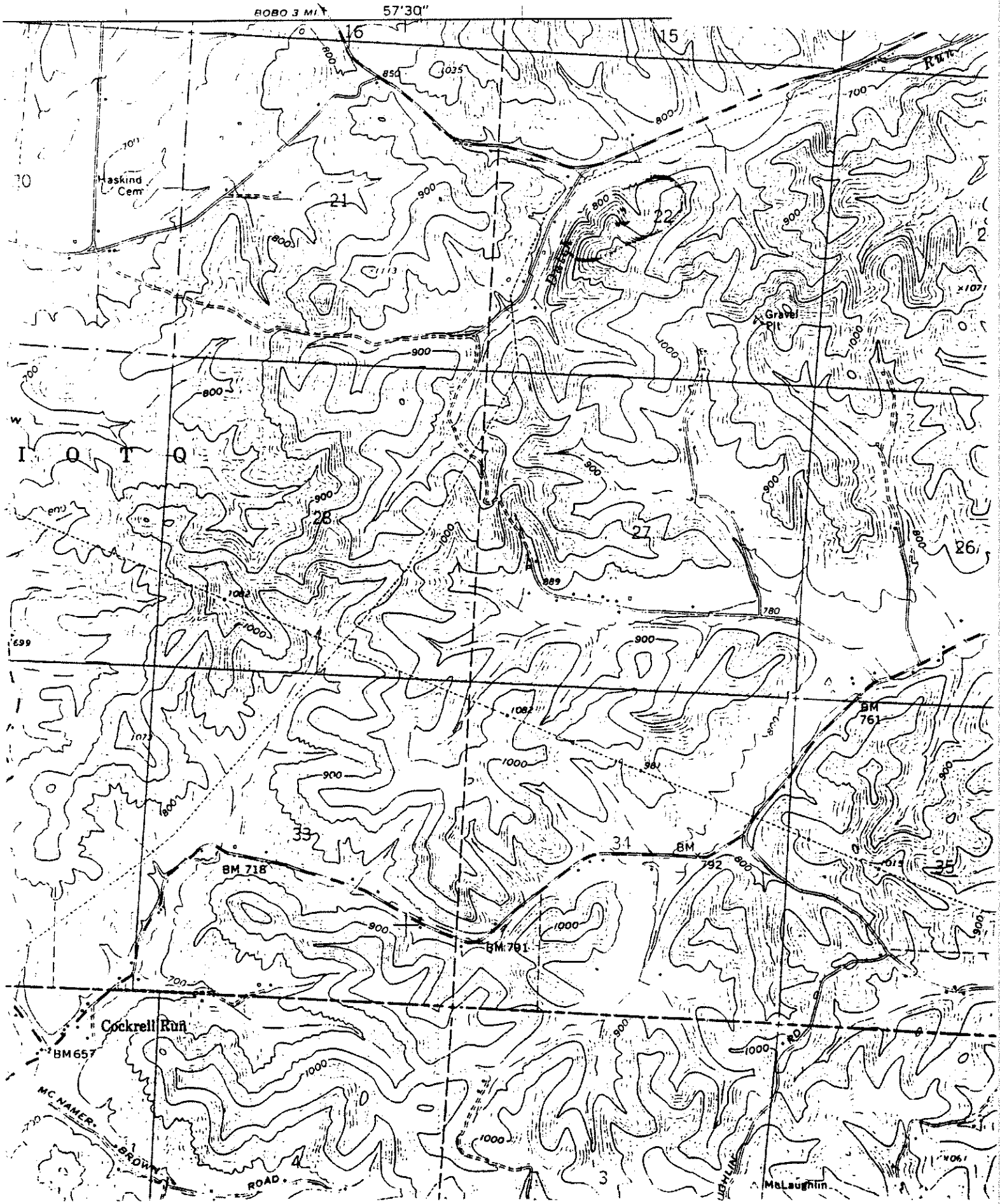
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BM 791
Cockrell Run
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MC NAMER-BROWN ROAD
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McLaughlin

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

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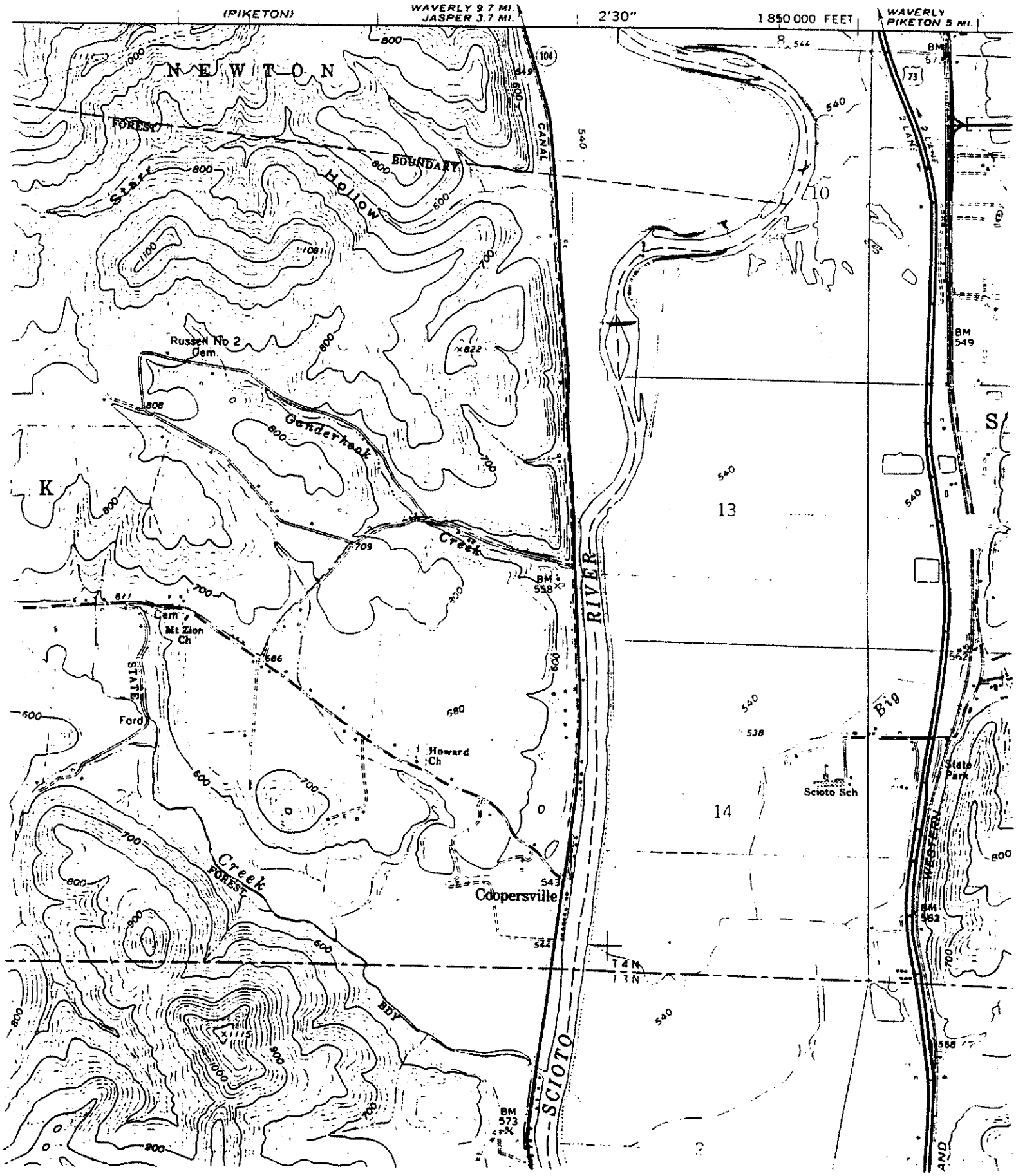

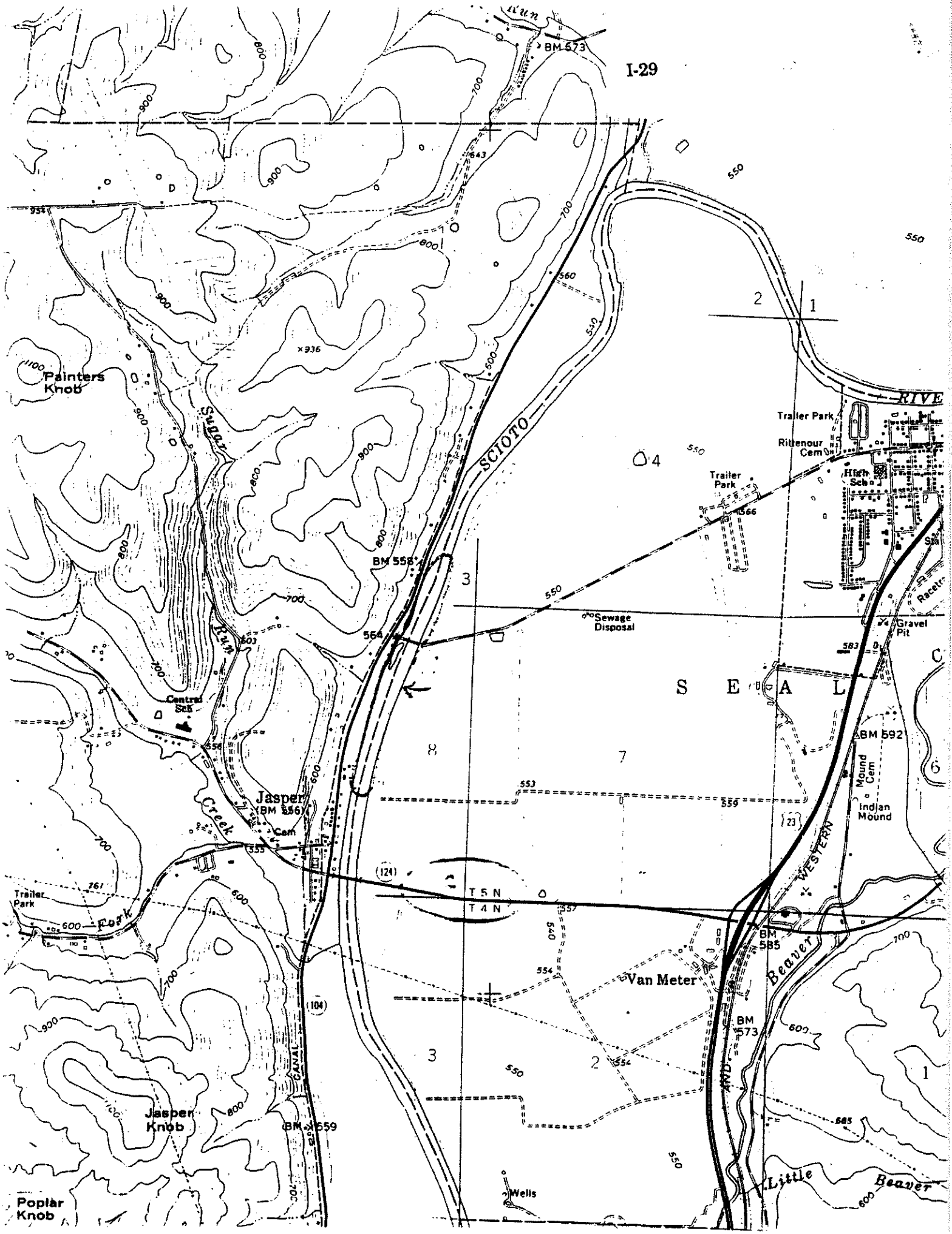
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Jasper (BM 556)
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Creek
Fork
Trailer Park
BM 592
Mound Cem
Indian Mound
WESTERN
T 5 N
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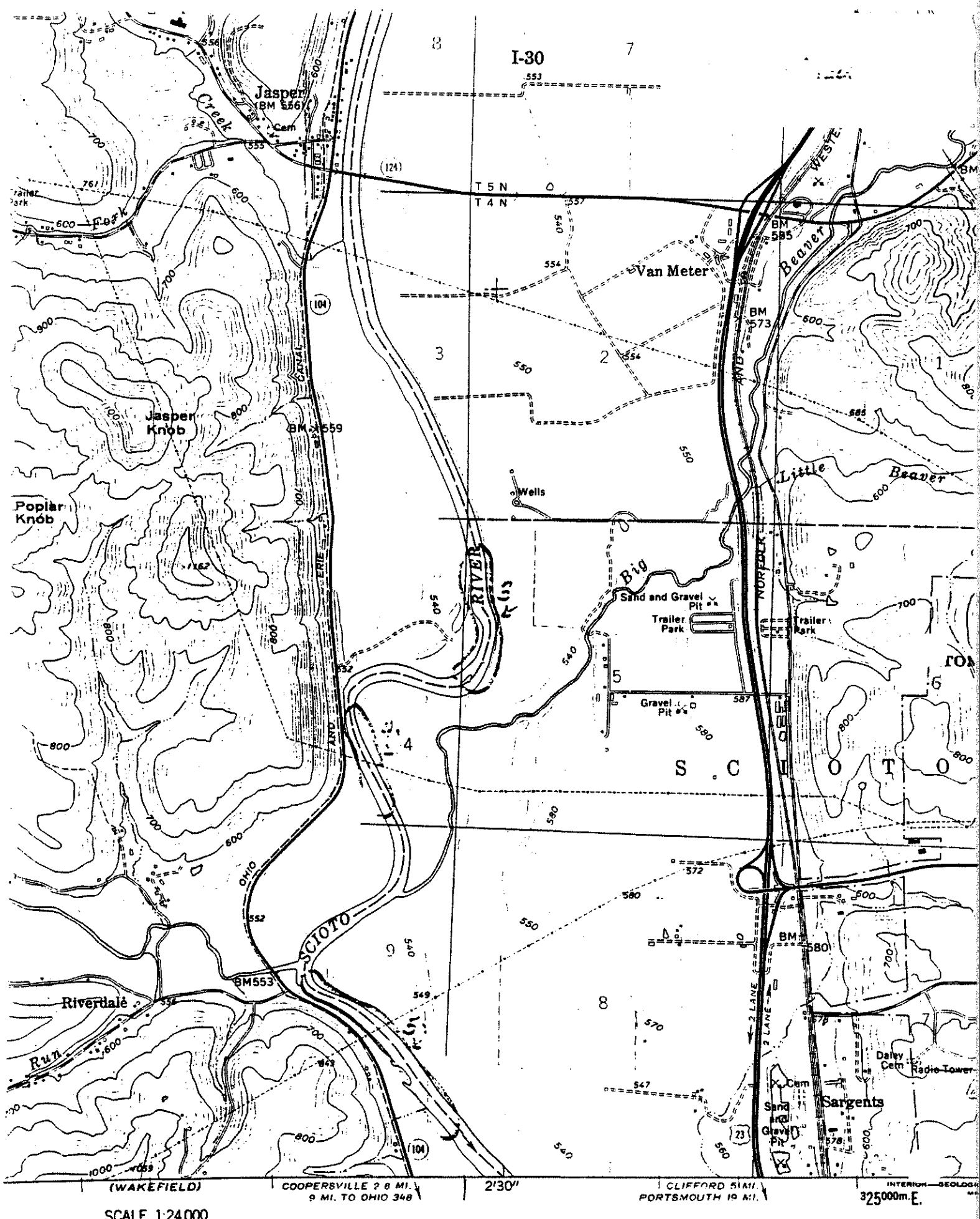
Beaver
Van Meter
BM 573
AND
CANAL
Jasper Knob
BM 559
Wells
Little Beaver
Poplar Knob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Beaver
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BM 559
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Gravel Pit
NORFOLK AND WESTERN
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(WAKEFIELD)
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CLIFFORD 5 MI.
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SCALE 1:24 000
1 MILE
1000 2000 3000 4000 5000 6000 7000 FEET

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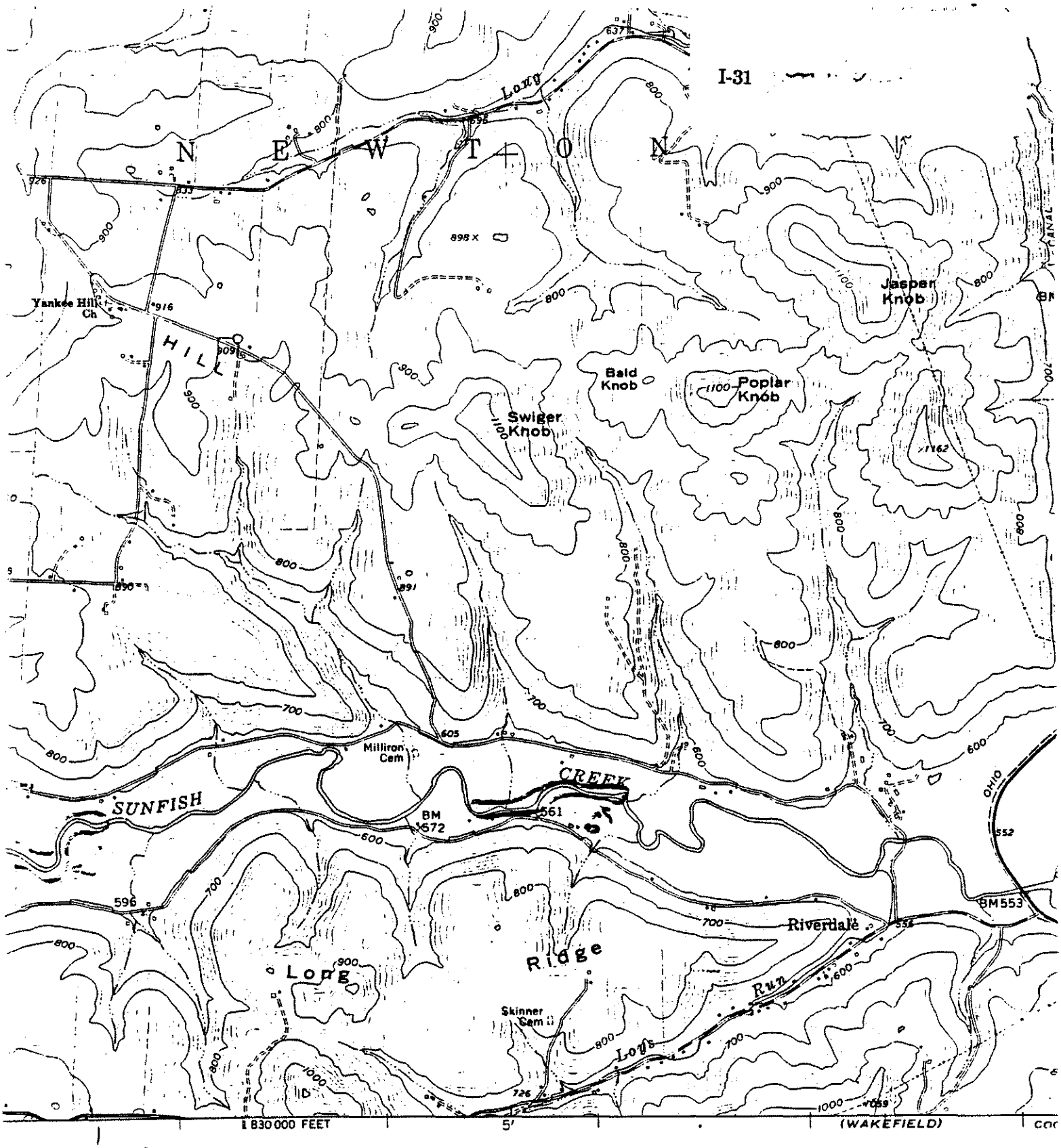

by the Geological Survey

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2°
TRUE NORTH
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DECLINATION, 1961

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STAT

Extinct (O)

Extirpated (X)

Endangered (E)

Threatened (T)

Potentially
Threatened (P)

Special Interest (S)

Legal Animal Endangerment Statuses

Federal (US) E: Endangered
T: Threatened
PE: Proposed Endangered

Ohio (OH) E: State Endangered

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Bivalve Mollusks[1]

	Code No.	DNAP	OH	US
MARGARITANIDAE. Naiad Mollusks				
Cumberlandia monodonta, Spectacle Case	HA 018	X		2
UNIONIDAE. Naiad Mollusks				
Actinonaias ligamentina ligamentina, Mucket	HA 869	X		
Anodonta grandis corpulenta, Stout Floater	HA 845	S		
Arcidens confragosus, Rock Pocketbook	HA 848	X		
Cyprogenia stegaria, Fanshell	HA 868	E	E[2]	PE
Ellipsaria lineolata, Butterfly Shell	HA 873	E	E[2]	
Elliptio crassidens crassidens, Elephant Ear	HA 863	E		
Epioblasma flexuosa, Northern Leaf Shell	HA 890	O		
Epioblasma obliquata obliquata, Purple Cat's Paw Pearly Mussel	HA T21	X		PE
Epioblasma obliquata perobliqua, White Cat's Paw Pearly Mussel	HA T20	E	E[3]	E[4]
Epioblasma personata, Round Snuffbox	HA 889	O		
Epioblasma rangiana, Northern Riffle Shell	HA T18	E	E[5]	2[5]
Epioblasma torulosa torulosa, Tuberculed-blossom Pearly Mussel	HA T19	X		E
Fusconaia ebena, Ebony Shell	HA 855	E		
Fusconaia maculata maculata, Long-solid	HA 856	E	E[6]	
Hemistena lata, Cracking Pearly Mussel	HA 864	X		E[7]
Lampsilis abrupta, Pink Mucket Pearly Mussel	HA 044	E	E[7]	E[7]
Lampsilis ovata, Ridged Pocketbook	HA 887	E	E[8]	
Lampsilis teres anodontoides, Yellow Sand Shell	HA 886	E	E[8]	
Leptodea leptodon, Scale Shell	HA 878	X		2
Ligumia nasuta, Eastern Sand Shell	HA 758	T		
Magnonaias nervosa, Washboard	HA 851	E		
Obliquaria reflexa, Three-horned Wartyback	HA 867	T		
Obovaria olivaria, Hickorynut	HA 874	E		
Obovaria retusa, Ring Pink Mussel	HA 875	X		E
Plethobasus cicatricosus, White Wartyback Pearly Mussel	HA 858	X		E
Plethobasus cyphyus, Bullhead	HA 857	E	E	
Plethobasus striatus, Orange-footed Pearly Mussel	HA 061	X		E[9]
Pleurobema clava, Club Shell	HA 060	E	E	2
Pleurobema cordatum, Ohio Pigtoe	HA 062	E	E	
Pleurobema plenum, Rough Pigtoe	HA 859	X		E
Pleurobema rubrum, Pink Pigtoe	HA 862	E		
Potamilus capax, Fat Pocketbook	HA 882	X		E
Potamilus ohiensis, Fragile Heel-splitter	HA 879	T	E[10]	
Quadrula cylindrica cylindrica, Cob Shell	HA 064	E	E[11]	

	Code No.	DNAP	OH	US
Quadrula fragosa, Winged Maple Leaf	HA 852	O		
Quadrula metanevra, Monkeyface	HA 853	E	E	
Quadrula nodulata, Wartyback	HA 854	E	E	
Simpsonaias ambigua, Salamander Mussel	HA 849	E	E	2
Toxolasma lividus, Little Purple	HA 883	X		2
Truncilla donaciformis, Fawn's-foot	HA 877	P		
Truncilla truncata, Deer-toe	HA 876	T		
Uniomerus tetralasmus, Horn Shell	HA 866	S		
Villosa fabalis, Bean Shell	HA 071	T		2
Villosa lienosa, Little Spectacle Case	HA 885	E		

[1]Nomenclature: Various sources (as interpreted by Dr. David H. Stansberry and G. Thomas Watters, Museum of Zoology, The Ohio State University).

[2]Listed as *Plagiola lineolata*.

[3]Listed as *Epioblasma sulcata perobliqua*.

[4]Listed as *Epioblasma sulcata delicata*.

[5]Listed as *Epioblasma torulosa rangiana*.

[6]Listed as *Fusconaia maculata*.

[7]Listed as *Lampsilis orbiculata*.

[8]Listed as *Lampsilis teres*.

[9]Listed as *Plethobasus cooperianus*.

[10]Listed as *Potamilus laevissimus*.

[11]Listed as *Quadrula cylindrica*.

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Crustaceans

	CODE NO.	DNAP	OH	US
ASELLIDAE. Isopods[1]				
Caecidotea filicispeluncae, Fern Cave Isopod	KA A30	E		2
Caecidotea rotunda, Frost Cave Isopod	KA A31	E		
Cambaridae. Crayfish[1,2]				
Cambarus ortmanni, Cincinnati Crayfish	KG A53	T		
Orconectes propinquus, Great Lakes Crayfish	KG A50		S	
Orconectes sanbornii erismophorus, Crayfish	KG A51	S		
Orconectes sloanii, Sloan's Crayfish	KG A52		T	
Orconectes virilis, Northern Crayfish	KG A54		S	

[1]References:

Bowman, Thomas E. and H.H. Hobbs III. 1983. Caecidotea filicispeluncae, a new troglobitic asellid isopod from Ohio. Proc. Biol. Soc. Washington, 96(3): 693-697.

Bowman, Thomas E. and Julian H. Lewis. 1984. Caecidotea rotunda, a new troglobitic asellid from Indiana and Ohio (Crustacea: Isopods: Asellidae). Proc. Biol. Soc. Washington, 97(2): 425-431.

Jezerinac, Raymond F. 1986. Endangered and threatened crayfishes (Decapoda: Cambaridae) of Ohio. Ohio J. Sci. 86(4): 177-180.

[2]Nomenclature:

Hobbs, Horton H., Jr. 1976. Crayfishes (Astacidae) of North and Middle America. U.S. EPA document. Water Pollution Control Research Series 18050 ELD05/72. 173 pp.

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Fishes[1]

	CODE NO.	DNAP	OH	US
PETROMYZONTIDAE. Lampreys				
Ichthyomyzon bdellium, Ohio Lamprey	AA 667		E	
Ichthyomyzon fossor, Northern Brook Lamprey	AA 610		E	
Ichthyomyzon greeleyi, Mountain Brook Lamprey	AA 668		E	
Ichthyomyzon unicuspis, Silver Lamprey	AA 174		E	
ACIPENSERIDAE. Sturgeons				
Acipenser fulvescens, Lake Sturgeon	AB 073		E	2
Scaphirhynchus platorynchus, Shovelnose Sturgeon	AB 264	X		
POLYODONTIDAE. Paddlefishes				
Polyodon spathula, Paddlefish	AB 259		S	
LEPISOSTEIDAE. Gars				
Lepisosteus oculatus, Spotted Gar	AB 604		E	
Lepisosteus platostomus, Shortnose Gar	AB 606		S	
Lepisosteus spatula, Alligator Gar	AB 178	X		
HIODONTIDAE. Mooneyes				
Hiodon alosoides, Goldeye	AE 156		S	
Hiodon tergisus, Mooneye	AE 157		S	
SALMONIDAE. Trouts				
Coregonus artedii, Cisco	AF 607		E	
Coregonus clupeaformis, Lake Whitefish	AF 608		T	
Salvelinus fontinalis, Brook Trout	AF 261	X[2]		
Salvelinus namaycush, Lake Trout	AF 609	X[2]		
ESOCIDAE. Pikes				
Esox masquinongy masquinongy, Great Lakes Muskellunge	AF 098		E	
CYPRINIDAE. Carps and Minnows				
Clinostomus funduloides, Rosyside Dace	AG 089		T	
Exoglossum laurae, Tonguetied Minnow	AG 146		E	
Hybognathus nuchalis, Mississippi Silvery Minnow	AG 612	X		
Hybopsis aestivalis, Speckled Chub	AG 613		S	
Hybopsis amblops, Bigeye Chub	AG 614	S		
Hybopsis dissimilis, Streamline Chub	AG 161	S		
Notropis anogenus, Pugnose Shiner	AG 617	X		
Notropis ariommus, Popeye Shiner	AG 196		E	
Notropis boops, Bigeye Shiner	AG 199		E	
Notropis buchanani, Ghost Shiner	AG 200	S		
Notropis dorsalis, Bigmouth Shiner	AG 207		T	
Notropis emiliae, Pugnose Minnow	AG 618		E	
Notropis heterodon, Blackchin Shiner	AG 619		E	
Notropis heterolepis, Blacknose Shiner	AG 209		E	
Rhinichthys cataractae, Longnose Dace	AG 579	S		

	CODE NO.	DNAP	OH	US
CATOSTOMIDAE. Suckers				
Catostomus catostomus, Longnose Sucker	AH 085		E	
Cycleptus elongatus, Blue Sucker	AH 092		E	2
Erimyzon sucetta, Lake Chubsucker	AH 621		E	
Lagochila lacera, Harelip Sucker	AH 176	O		
Moxostoma carinatum, River Redhorse	AH 186		S	
Moxostoma valenciennesi, Greater Redhorse	AH 622		E	
ICTALURIDAE. Bullhead Catfishes				
Noturus eleutherus, Mountain Madtom	AJ 223		E	
Noturus stigmosus, Northern Madtom	AJ 231		E	
Noturus trautmani, Scioto Madtom	AJ 623		E	E
APHREDODERIDAE. Pirate Perches				
Aphredoderus sayanus, Pirate Perch	AK 624		E	
GADIDAE. Codfishes				
Lota lota, Burbot	AL 626		T	
CYPRINODONTIDAE. Killifishes				
Fundulus diaphanus menona, Western Banded Killifish	AM 627		E	
PERCIDAE. Perches				
Ammocrypta asprella, Crystal Darter	AT 077	X		2
Ammocrypta pellucida, Eastern Sand Darter	AT 628		S	2
Etheostoma camurum, Bluebreast Darter	AT 629		T	
Etheostoma exile, Iowa Darter	AT 630		S	
Etheostoma maculatum, Spotted Darter	AT 128		E	
Etheostoma tippecanoe, Tippecanoe Darter	AT 141		T	
Percina copelandi, Channel Darter	AT 530		E	
Percina evides, Gilt Darter	AT 243	X		
Percina macrocephala, Longhead Darter	AT 245		E	2
Percina phoxocephala, Slenderhead Darter	AT 248		S	
Percina shumardi, River Darter	AT 249		E	
Stizostedion vitreum glaucum, Blue Pike	AT 269	O		
COTTIDAE. Sculpins				
Cottus ricei, Spoonhead Sculpin	AV 632	X		

[1]Nomenclature (except as noted below): Robbins, C.R., et al. 1980. A list of common and scientific names of fishes from the United States and Canada. 4th ed. Amer. Fish. Soc., Special Publ. No. 12. 174 p.
Subspecies of Esox masquinongy and Fundulus diaphanus: Trautman, M.B. 1981. The fishes of Ohio. rev. ed. Ohio State University Press. 782 p.
[2]Present populations are the result of stocking.

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Amphibians[1]

	CODE NO.	DNAP	OH	US
CRYPTOBRANCHIDAE. Hellbenders				
Cryptobranchus alleganiensis, Hellbender.....	BG 276	T		2
AMBYSTOMATIDAE. Mole Salamanders				
Ambystoma laterale, Blue-spotted Salamander.....	BF 643	E	E	
Ambystoma tigrinum, Tiger Salamander.....	BF 272	P		
PLETHODONTIDAE. Lungless Salamanders				
Aneides aeneus, Green Salamander.....	BL 274	T	E	
Eurycea lucifuga, Cave Salamander.....	BL 283	E	E	
Hemidactylium scutatum, Four-toed Salamander.....	BL 286	P	E	
Plethodon wehrlei, Wehrle's Salamander.....	BL 299	X	E	
Pseudotriton montanus, Mud Salamander.....	BL 589	P		
PELOBATIDAE. Spadefoot Toads				
Scaphiopus holbrooki, Eastern Spadefoot.....	BA 642	E		

[1]Nomenclature (family names): Conant, Roger. 1975. A field guide to the reptiles and amphibians of eastern and central North America, 2nd edition. Houghton Mifflin Co., Boston. 429 p.
Nomenclature (scientific and common names): Collins, Joseph T., James E. Huheey, James L. Knight, and Hobart M. Smith. 1978. Standard common and current scientific names for North American amphibians and reptiles. Society for the Study of Amphibians and Reptiles, Miscellaneous Publications, Herpetological Circular No. 7, 36 p.

November, 1989

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Reptiles[1]

	CODE NO.	DNAP	OH	US
EMYDIDAE. Box and Water Turtles				
Chrysemys scripta, Red-eared Slider	CD 314	T		
Clemmys guttata, Spotted Turtle	CD 592	P	E	
Clemmys insculpta, Wood Turtle	CD 639	S		
Emydoidea blandingi, Blanding's Turtle	CD 641	P		
Graptemys pseudogeographica, False Map Turtle	CD 332	S		
TRIONYCHIDAE. Softshell Turtles				
Trionyx muticus, Smooth Softshell	CG 611	S		
SCINCIDAE. Skinks				
Eumeces anthracinus, Coal Skink	CM 324	E		
Scincella lateralis, Ground Skink	CM 634	S		
COLUBRIDAE. Colubrids				
Clonophis kirtlandi, Kirtland's Snake	CQ M81	S		2
Elaphe vulpina, Eastern Fox Snake	CQ 636	P		
Heterodon platyrhinos, Eastern Hognose Snake	CQ G54	S		
Lampropeltis getulus, Black Kingsnake	CQ 336	S		
Nerodia erythrogaster, Copperbelly Water Snake	CQ 665	E	E[2]	2
Nerodia sipedon insularum, Lake Erie Water Snake	CQ 349	E		2
Opheodrys aestivus, Rough Green Snake	CQ 670	P		
Opheodrys vernalis, Smooth Green Snake	CQ 350	T		
Thamnophis radix, Eastern Plains Garter Snake	CQ 638	E	E	
Virginia valeriae, Eastern Earth Snake	CQ 333	S		
VIPERIDAE. Pit Vipers				
Crotalus horridus, Timber Rattlesnake	CS 593	P		
Sistrurus catenatus, Eastern Massasauga	CS 637	P		2

[1]Nomenclature (family names): Conant, Roger. 1975. A field guide to the reptiles and amphibians of eastern and central North America. 2nd edition. Houghton Mifflin Co., Boston. 42 p.
Nomenclature (scientific and common names): Collins, Joseph T., James E. Huheey, James L. Knight, and Hobart M. Smith. 1978. Standard common and current scientific names for North American amphibians and reptiles. Society for the Study of Amphibians and Reptiles, Miscellaneous Publications, Herpetological Circular No. 7, 36 p.
[2]Listed as *Natrix erythrogaster*, Northern copperbelly.

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Breeding Birds[1]

	CODE NO.	DNAP[2]	OH	US
NONPASSERINE BIRDS				
PHALACROCORACIDAE. Cormorants				
Phalacrocorax auritus, Double-crested Cormorant	DC 422	X		
ARDEIDAE. Herons and Bitterns				
Botaurus lentiginosus, American Bittern	DJ 373	E		
Casmerodius albus, Great Egret	DJ 380	S		
Ixobrychus exilis, Least Bittern	DJ 422	T		
Nycticorax nycticorax, Black-crowned Night-Heron	DJ 360	S		
Nycticorax violaceus, Yellow-crowned Night-Heron	DJ 433	T		
ANATIDAE. Swans, Geese and Ducks				
Anas acuta, Northern Pintail	DD 649	S		
Anas clypeata, Northern Shoveler	DD E46	S		
Anas crecca, Green-winged Teal	DD R64	S		
Anas strepera, Gadwall	DD H31	S		
Aythya americana, Redhead	DD 653	S		
Oxyura jamaicensis, Ruddy Duck	DD 656	S		
CATHARTIDAE. Vultures				
Coragyps atratus, Black Vulture	DE 391	S		
ACCIPITRIDAE. Osprey, Hawks and Harriers				
Accipiter striatus, Sharp-shinned Hawk	DF 362	S	E	
Circus cyaneus, Northern Harrier	DF 388	E		
Elanoides forficatus, American Swallow-tailed Kite	DF 402	X		
Haliaeetus leucocephalus, Bald Eagle	DF 416	E	E	E
Pandion haliaetus, Osprey	DF 435	X		
FALCONIDAE. Falcons				
Falco peregrinus, Peregrine Falcon	DG 408	*	E	E[3]
PHASIANIDAE. Pheasants, Grouse and Quail				
Tympanuchus cupido, Greater Prairie-Chicken	DH 659	X		
RALLIDAE. Rails, Gallinules and Coots				
Porzana carolina, Sora	DM 661	S		
Rallus elegans, King Rail	DM 449	E	E	
Rallus limicola, Virginia Rail	DM 450	S		
GRUIDAE. Cranes				
Grus canadensis, Sandhill Crane	DL 414	X		
CHARADRIIDAE. Plovers and Turnstones				
Charadrius melodus, Piping Plover	DP 385	X	E	E

	CODE NO.	DNAP[2]	OH	US
SCOLOPACIDAE. Sandpipers, Snipe, Woodcock and Phalaropes				
Bartramia longicauda, Upland Sandpiper	DQ 372	T	E	
Gallinago gallinago, Common Snipe	DQ 379	S		
LARIDAE. Gulls and Terns				
Chlidonias niger, Black Tern	DS 673	E		
Sterna hirundo, Common Tern	DS 460	E	E	
COLUMBIDAE. Pigeons and Doves				
Ectopistes migratorius, Passenger Pigeon	D3 P08	O		
PSITTACIDAE. Parrots				
Conuropsis carolinensis, Carolina Parakeet	D5 R66	O		
TYTONIDAE. Barn Owls				
Tyto alba, Common Barn-Owl	DV 466	E		
CAPRIMULGIDAE. Goatsuckers				
Caprimulgus carolinensis, Chuck-will's-widow	DW 678	S		
PICIDAE. Woodpeckers				
Sphyrapicus varius, Yellow-bellied Sapsucker	DY 456	S		
PASSERINE BIRDS				
Hirundinidae. Swallows				
Hirundo pyrrhonota, Cliff Swallow	EB 441	S		
CORVIDAE. Crows and Jays				
Corvus corax, Common Raven	EC 392	X		
TROGLODYTIDAE. Wrens				
Cistothorus platensis, Sedge Wren	EG 389	T		
Thryomanes bewickii, Bewick's Wren	EG 463	E		1
Troglodytes troglodytes, Winter Wren	EG 682	S		
LANIIDAE. Shrikes				
Lanius ludovicianus, Loggerhead Shrike	EK 424	E		2
VIREONIDAE. Vireos				
Vireo solitarius, Solitary Vireo	EL 686	S		
EMBERIZIDAE. Wood Warblers, Sparrows, Meadowlarks and Blackbirds				
PARULINAE. Wood Warblers				
Dendroica kirtlandii, Kirtland's Warbler	EM 396	*	E	E
Dendroica magnolia, Magnolia Warbler	EM 694	S		
Dendroica virens, Black-throated Green Warbler	EM 399	S		

	CODE NO.	DNAP[2]	OH	Ds
Oporornis philadelphia, Mourning Warbler.....	EM 700	X		
Seiurus noveboracensis, Northern Waterthrush.....	EM 699	S		
Vermivora chrysoptera, Golden-winged Warbler.....	EM 687	E		
Wilsonia canadensis, Canada Warbler.....	EM 701	S		
EMBERIZINAE. Sparrows				
Aimophila aestivalis, Bachman's Sparrow.....	EM 364	X		2
Chondestes grammacus, Lark Sparrow.....	EM 387	E		
Junco hyemalis, Dark-eyed Junco.....	EM 423	S		
ICTERINAE. Meadowlarks and Blackbirds				
Sturnella neglecta, Western Meadowlark.....	EM 703	S		

[1]Nomenclature: Thirty-fifth supplement to the American Ornithologist's Union check-list of North American birds. 1985. The Auk 102(3): 680-686.
[2]Refers only to Ohio breeding status.
[3]Listed as Falco peregrinus anatum, American Peregrine Falcon.
*A federal endangered species which migrates through Ohio, but has never been known to nest in the state.

DIVISION OF NATURAL AREAS AND PRESERVES
RARE OHIO ANIMALS

Mammals[1]

	CODE NO.	DNAP	OH	US
SORICIDAE. Shrews				
Sorex hoyi winnemana, Pygmy Shrew	FA 487	S		2
VESPERTILIONIDAE. Vespertilionid Bats				
Myotis leibii, Small-footed Myotis	FD 496	X		2[2]
Myotis sodalis, Indiana Bat	FD 498	E	E	E
Nycticeius humeralis, Evening Bat	FD 598	S		
Plecotus rafinesquii, Rafinesque's Big-eared Bat	FD 506	S		2
LEPORIDAE. Hares and Rabbits				
Lepus americanus, Snowshoe Hare	FF 484	X		
MURIDAE. Rats, Mice and Voles.				
Clethrionomys gapperi, Southern Red-backed Vole	FL 473	E		
Neotoma floridana, Eastern Woodrat	FL 500	E	E	2[3]
Oryzomys palustris, Marsh Rice Rat	FL 603	X		
DIPODIDAE. Birch Mice, Jumping Mice and Jeroboas				
Napaeozapus insignis, Woodland Jumping Mouse	FM 499	S		
ERETHIZONTIDAE. New World Porcupines				
Erethizon dorsatum, Porcupine	FN 475	S		
CANIDAE. Canids				
Canis lupus, Gray Wolf	FP 820	X		E
URSIDAE. Bears				
Ursus americanus, Black Bear	FQ 524	S		
MUSTELIDAE. Mustelids				
Gulo gulo, Wolverine	FS B76	X		
Lutra canadensis, River Otter	FS 485	S	E	
Martes americana, Marten	FS 840	X		
Martes pennanti, Fisher	FS 486	X		
Mustela erminea, Ermine	FS 599	S		
Taxidea taxus, Badger	FS 600	S		
FELIDAE. Cats				
Felis concolor, Eastern Cougar	FT 476	X		E[4]
Lynx canadensis, Lynx	FT 601	X		
Lynx rufus, Bobcat	FT 602	E	E[5]	
CERVIDAE. Deer, Moose, Wapiti and Caribou				
Cervus elaphus, Wapiti	FV M80	X		

	CODE NO.	DNAP	OH	US
BOVIDAE. Bovids				
Bison bison, Bison.....	FX H22	X		

[1]Nomenclature (scientific and most common names): Banks, Richard C., Roy W. McDiarmid, and Alfred L. Gardner. 1987. Checklist of Vertebrates of the United States, the U.S. Territories, and Canada. U.S. Fish and Wildlife Service, Resource Publication 166. 79pp.

[2]Listed as Myotis subulatus leibii, Eastern Small-footed Bat.

[3]Listed as Neotoma floridana magister.

[4]Listed as Felis concolor couguar.

[5]Listed as Felis rufus.

WHAT CAN BE DONE

There are several important actions.

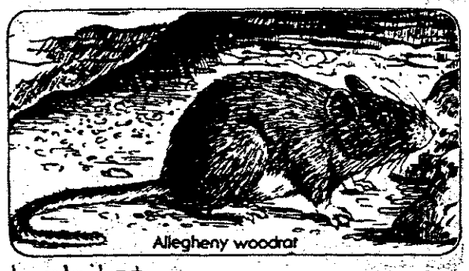
New federal and state laws afford extra protection for endangered animals. In some cases (as with the U.S. Endangered Species Act) the laws protect the animal's habitat as well as the animal itself. Fines and jail sentences penalize the violators of these laws.

Habitat restoration is especially important. In Ohio, major reforestation has allowed reintroduction of animals such as the wild turkey, and in the northern part of the state, control of major wetland areas has greatly benefited waterfowl.

For some species, protection of natural or wild areas is helpful. This may be true for large areas of land (such as with wolf habitat in Minnesota or Alaska) or with smaller areas. In Ohio, most natural areas are small. Protection of these areas is helpful because they often contain the only significant remnants of endangered species habitat left in the state.

New laws are helping to reduce habitat destruction from chemicals and other forms of pollution. It is now illegal to use DDT in the United States except in special, carefully controlled situations, and some progress has been made in cleaning up our waterways and reducing air pollution.

In 1975, the Division of Wildlife initiated a program to work with species on the Ohio endangered list. Animals receiving particular emphasis include the Indiana bat, Allegheny woodrat, bald eagle, common tern, Scioto madtom, blue pike, and eastern plains garter snake.



Allegheny woodrat

These wild animals have been classified as endangered:

Mammals

- River otter, *Lutra c. canadensis*
- Bobcat, *Felis r. rufus*
- *Indiana bat, *Myotis sodalis*
- Allegheny woodrat, *Neotoma floridana magister*

Birds

- *American peregrine falcon, *Falco peregrinus anatum*
- Sharp-shinned hawk, *Accipiter striatus velox*
- *Bald eagle, *Haliaeetus leucocephalus*
- King rail, *Rallus e. elegans*
- *Kirtland's warbler, *Dendroica kirtlandii*
- Upland sandpiper, *Bartramia longicauda*
- Common tern, *Sterna h. hirundo*

Reptiles

- Spotted turtle, *Clemmys guttata*
- Northern copperbelly, *Natrix erythrogaster neglecta*
- Eastern plains garter snake, *Thamnophis r. radix*

Amphibians

- Blue-spotted salamander, *Ambystoma laterale*
- Green salamander, *Aneides aeneus*
- Cave salamander, *Eurycea lucifuga*
- Four-toed salamander, *Hemidactylium scutatum*
- Wehrle's salamander, *Plethodon wehrlei*

Fish

- Ohio lamprey, *Ichthyomyzon bdellium*
- Northern brook lamprey, *Ichthyomyzon fossor*
- Allegheny brook lamprey, *Ichthyomyzon greeleyi*
- Silver lamprey, *Ichthyomyzon unicuspis*
- Lake sturgeon, *Acipenser fulvescens*
- Spotted gar, *Lepisosteus oculatus*
- Cisco, *Coregonus artedii*
- Great Lakes muskellunge, *Esox m. masquinongy*
- Tonguetied minnow, *Exoglossum laurae*
- Popeye shiner, *Notropis ariommus*
- Pugnose minnow, *Notropis emiliae*
- Bigeye shiner, *Notropis boops*
- Blackchin shiner, *Notropis heterodon*
- Blacknose shiner, *Notropis heterolepis*
- Longnose sucker, *Catostomus catostomus*
- Greater redhorse, *Moxostoma valenciennesi*
- Blue sucker, *Cycleptus elongatus*

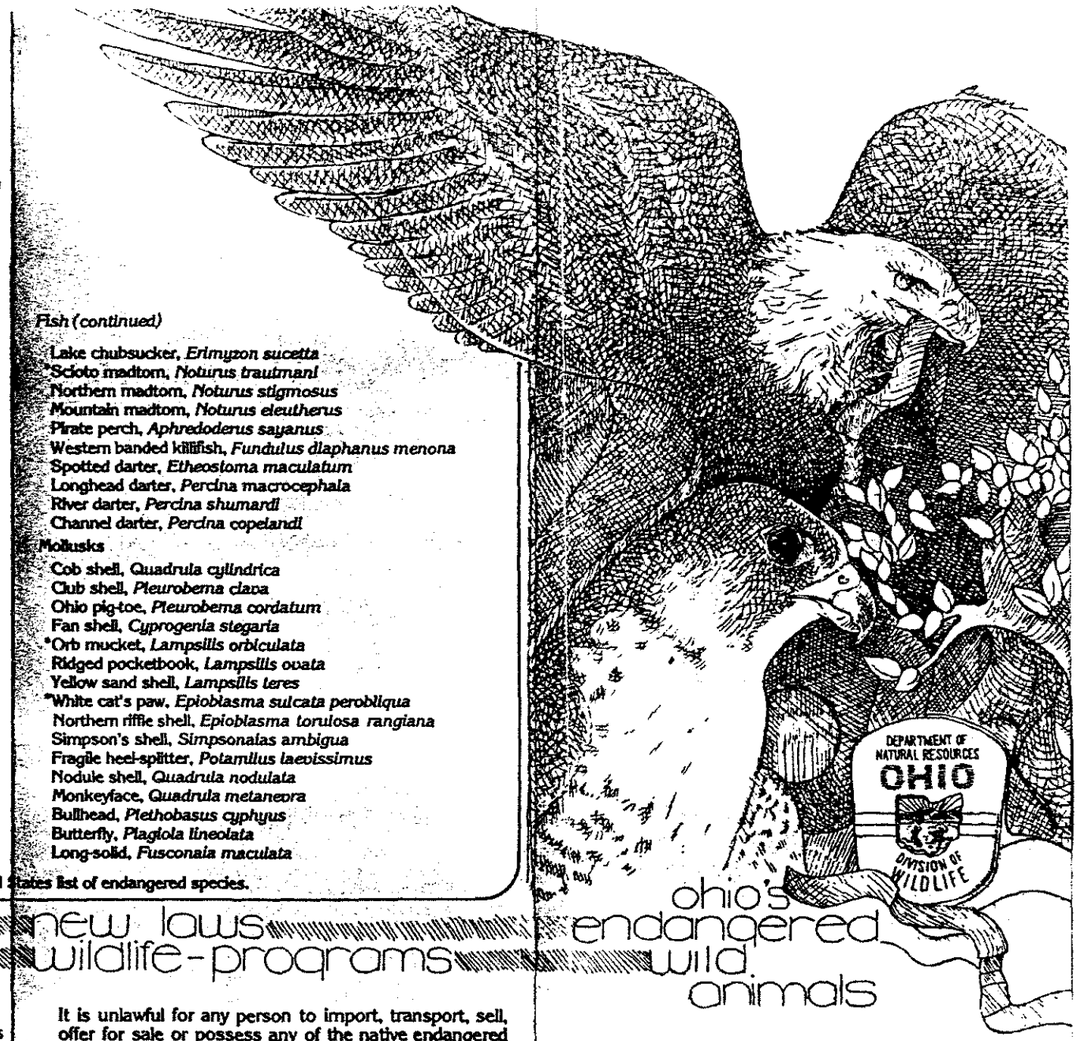
Fish (continued)

- Lake chubsucker, *Erimyzon sucetta*
- *Scioto madtom, *Noturus trautmani*
- Northern madtom, *Noturus stigmosus*
- Mountain madtom, *Noturus eleutherus*
- Pirate perch, *Aphredoderus sayanus*
- Western banded killifish, *Fundulus diaphanus menona*
- Spotted darter, *Etheostoma maculatum*
- Longhead darter, *Percina macrocephala*
- River darter, *Percina shumardi*
- Channel darter, *Percina copelandi*

Mollusks

- Cob shell, *Quadrula cylindrica*
- Club shell, *Pleurobema clava*
- Ohio pig-toe, *Pleurobema cordatum*
- Fan shell, *Cyprogenia stegaria*
- *Orb mucket, *Lampsilis orbiculata*
- Ridged pocketbook, *Lampsilis ovata*
- Yellow sand shell, *Lampsilis teres*
- *White cat's paw, *Epioblasma sulcata perobliqua*
- Northern riffle shell, *Epioblasma torulosa rangiana*
- Simpson's shell, *Simpsonalas ambigua*
- Fragile heel-splitter, *Potamilus laevissimus*
- Nodule shell, *Quadrula nodulata*
- Monkeyface, *Quadrula metanevra*
- Bullhead, *Plethobasus cyphyus*
- Butterfly, *Plagiola lineolata*
- Long-solid, *Fusconaia maculata*

*Animal is also on the United States list of endangered species.



ohio's endangered wild animals

habitat restoration — protection of natural or wild areas — new laws — wildlife-programs

Important sections of the Ohio endangered species law are as follows:

"The Chief of the Division of Wildlife, with the approval of the Wildlife Council, shall adopt and may modify and repeal rules, in accordance with Chapter 119. of the Revised Code, restricting the taking or possession of native species of wild animals, or any eggs or offspring thereof, that he finds to be threatened with statewide extinction. The rules shall identify the common and scientific names of each endangered species and shall be modified from time to time to include all species listed on the United States List of Native Endangered Fish and Wildlife pursuant to the Endangered Species Conservation Act of 1969, 83 Stat. 275, 16 U.S.C. 668cc-3, as amended, and that are native to this state, or that migrate or are otherwise reasonably likely to occur within the state."

"The rules shall provide for the taking of species threatened with statewide extinction, for zoological, educational, and scientific purposes, and for propagation in captivity to preserve the species, under written permits from the Chief. The rules shall in no way restrict the taking or possession of species listed on such United States list for zoological, educational, or scientific purposes, or for propagation in captivity to preserve the species, under a permit or license from the United States or any instrumentality thereof."

"No person shall violate any rule adopted pursuant to this section."

It is unlawful for any person to import, transport, sell, offer for sale or possess any of the native endangered species of wild animals or hides or parts thereof, without first obtaining permission from the Wildlife Chief.

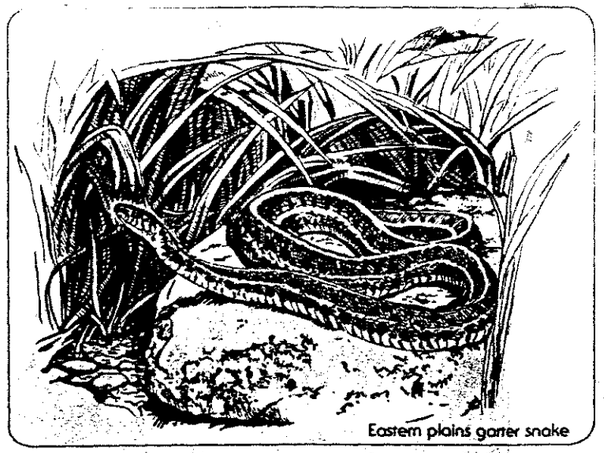
The Division of Wildlife welcomes factual information which tends to support the addition or removal of endangered status for a species. Such information may be submitted at any time to:

Chief, Division of Wildlife
Fountain Square
Columbus, Ohio 43224

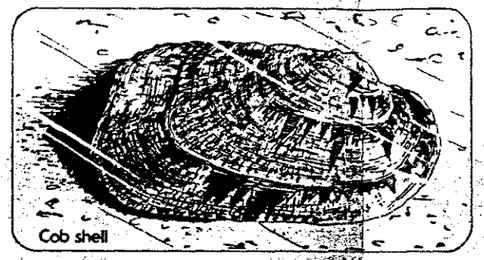
Richard F. Celeste, Governor • Joseph J. Sommer, Director
Clayton H. Lakes, Chief

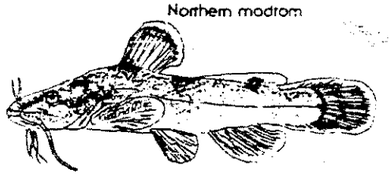
"Naturally OHIO the heart of it all!"

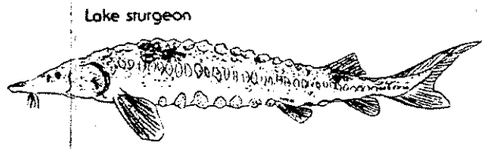
Publication 316 (R487)

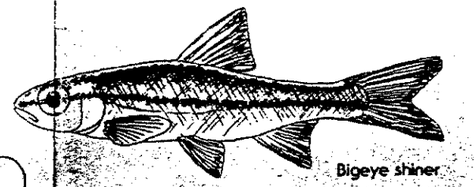

Eastern plains garter snake

The most important problem--
HABITAT DESTRUCTION--
can occur in several ways.


Cob shell


Northern madtom


Lake sturgeon


Bigeye shiner

Sharp-shinned hawk

Animals become endangered for two primary reasons:

1) Their habitat is destroyed, or

2) They are overharvested from the wild because of improper regulations, lack of regulations, or poor enforcement of regulations.

HABITAT DESTRUCTION IS BY FAR THE MOST SERIOUS PROBLEM FACED BY ENDANGERED SPECIES.

It may occur by destroying vast wilderness areas (as happened once in Ohio and is now happening in the Amazon River basin), by polluting the environment with chemicals (such as kepone or DDT), by destroying streams (by construction of dams or choking the waters with silt from erosion), by intruding on animals (such as hibernating bats) that are intolerant of human activity, or by introducing animals or plants in areas where they do not occur naturally (introduction of starlings and house sparrows in the United States has caused serious competition for nesting cavities with native birds such as woodpeckers and bluebirds).

The types of habitat loss most critical in Ohio are:

1. Loss of Ohio's formerly vast forest areas. Land clearing for agriculture and the extensive use of the forest for charcoal in the iron industry were major early causes of forest removal. Recovery of our forest lands has been significant, but recovery of forest wildlife in some cases may not be possible. This is true for species such as mountain lions and timber wolves, which require large areas with little human disturbance.

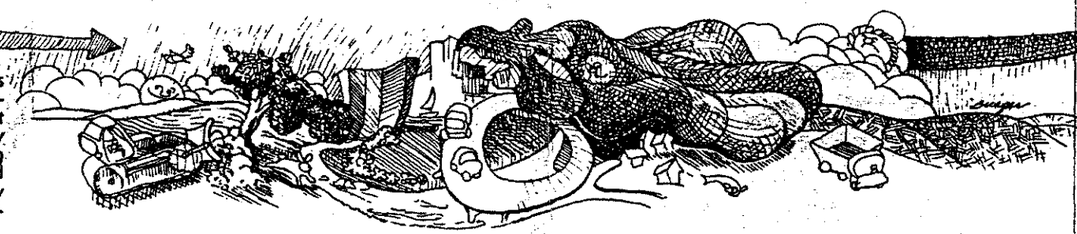
2. Loss of wetland areas and swamp forests, particularly along Lake Erie and in glaciated Ohio. These lands have been drained to convert the land to agricultural production and for residential and urban development. Typical endangered species needing these types of areas are king rails, spotted turtles, and blue-spotted and four-toed salamanders.

3. Contamination by chemicals. Several pesticides such as DDT and dieldrin and industrial chemicals such as polychlorinated biphenyls (PCB's) have been important causes of reproductive failure in Ohio bald eagles. The sharp-shinned hawk is another endangered species affected by these types of chemicals.

4. Damage to natural waters. Most of Ohio's endangered animals are aquatic species. The endangered status of these fish, crayfish and clams is due to:

- Siltation from soil erosion, resulting in loss of clear waters and spawning habitat.
- Construction of dams which halt fish from reaching their upstream spawning areas.
- Degradation of water quality from acid mine drainage, industrial and agricultural discharges, and municipal sewage discharges.
- Loss of aquatic habitat through drainage activities and stream channelization.

When overharvest occurs, it is usually in areas where no government has clear authority (as with whaling in international waters), or it involves animals that were rare to start with. Some animals that are naturally rare are considered valuable, and so there is a strong temptation to harvest as many as can be found. It should be noted here that overharvest does not necessarily mean killing the animal; it may mean removing the animal from the wild and placing it in captivity.



Only a few species in the world are endangered from unregulated harvest, while literally thousands are endangered by habitat destruction.

It is obvious that the most important actions for saving wild animals involve protection and restoration of the animals' habitats.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

6950-H Americana Parkway
Reynoldsburg, OH 43068
614/469-6923

November 21, 1989

Ms. Virginia R. Tolbert
Oak Ridge National Laboratory
P. O. Box 2008
Oak Ridge, TN 37831

Dear Ms, Tolbert:

This responds to your November 6, 1989 letter to Mr. James Engle, Chief of Endangered Species in Twin Cities, Minnesota. Since the proposed site lies in Ohio, Mr. Engle asked that I respond for him regarding threatened or endangered species which may be found at the proposed site of the Atomic Vapor Lasar Isotope Separation project in Pike County, Ohio.

The proposed project lies within the range of the Indiana bat, a Federally listed endangered species. While no winter habitat has been identified in the project area, potential summer habitat for the Indiana bat does exist, primarily along the Scioto River.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Endangered Species Act of 1973, as amended, and are consistent with the intent of the National Environmental Policy Act of 1969 and the U. S. Fish and Wildlife Service's Mitigation Policy.

If you desire additional information, please contact Ken Multerer of my staff at 614-469-6923.

Sincerely,

Ken Multerer

for Kent E. Krounemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Service, Attn: M. Colvin, Columbus, OH
Ohio EPA, Water Quality Monitoring (C. Crook), Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, IN

January 22, 1990

F. C. Kornegay

Emergency Preparedness for AVLIS Report

I appreciate the information you gave me last week. This letter is to confirm our conversation. If you feel there are discrepancies with the summarization of the information below please contact me at 615-574-6582. Thank you again for your help.

Information on Emergency Preparedness at ORGDP, Paducah, and Portsmouth.

ORGDP - Emergency Preparedness Coordinator on-site. Comprehensive Emergency Management Plan for all MMES facilities in state of TN. A mutual aid agreement with other MMES facilities within TN, city of Oak Ridge, surrounding counties, and state of TN. Mutual aid agreement is with rescue squads, fire departments, and sheriff departments. There is an emergency response plan for on-site and transportation accidents involving hazardous and/or radioactive materials.

Paducah - Same as ORGDP, EXCEPT - mutual aid with city of Paducah, surrounding counties, and state of KY.

Portsmouth - Same as ORGDP, EXCEPT - mutual aid agreement with surrounding counties and state of OH.

Darlene Lasley

Darlene Lasley, 4500N, MS-6206, 4-6582

DL:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 17, 1990

Mr. Chuck Northington
Tennessee Division of Air Pollution Control
Customs House, 4th Floor
701 Broadway
Nashville, Tennessee, 37219-5403

Dear Chuck:

This is to confirm our phone conversation today, in which you indicated that the Oak Ridge area (Anderson and Roane Counties) is considered to be in attainment or not classified for criteria air pollutants, except that Roane County was classified as non-attainment for ozone. You also indicated that the Roane County ozone status would be changed shortly to attainment/unclassified.

If the above statements are in error, you may call me at (615) 574-2702 to clarify them.

Sincerely,

Edward Liebsch

Edward Liebsch
Research Associate

EJL:bjs

cc: A. W. Campbell

COPY

EBASCO SERVICES INCORPORATED

225 South Tulane Avenue
Oak Ridge, Tennessee 37930

EBASCO

November 6, 1989
MAM:89-009

Martin Luther
Division of Air Quality
Frankfort Office Park
18 Reilly Road
Frankfort, KY 40601

Dear Marty:

The D.O.E. requires that all phone contacts (no matter how minor the subject) that are used as "personal communication" references in their documents, must be followed up by written confirmation. So by this letter I am confirming that I spoke with you by phone on October 27, 1989 and you basically told me:

> "Presently, McCraken County is classified as attainment for CO, O_3, SO_2 and NO_x. TSP has been classified as non-attainment in the Federal CFR but is classified as 'better than standards' by the State of Kentucky. Ozone monitoring data collected in 1989 may result in eventual reclassification of the county to nonattainment if excessive monitoring levels persist."

Sincerely,

Mark A. Mitckes

COPY

EBASCO SERVICES INCORPORATED

225 South Tulane Avenue
Oak Ridge, Tennessee 37930

EBASCO

November 6, 1989
MAM:89-008

Bill Spires
Division of Air Pollution Control
1800 Water Mark Drive
Columbus, Ohio 44308

Dear Mr. Spires:

The D.O.E. requires that all phone contacts (no matter how minor the subject) that are used as "personal communication" references in their documents, must be followed up by written confirmation. So by this letter I am confirming that I spoke with you by phone on October 27, 1989 and you basically told me that Pike Co., Ohio is presently in attainment status for all criteria air pollutants.

Sincerely,

Mark A. Mitckes

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Gene Aytes
Morgan County Executive
P.O. Box 387
Wartburg, Tennessee 37887

Dear Mr. Aytes:

Thank you for the information you provided on January 5, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* Community awareness of DOE activities is low because not enough information is provided by DOE

* 40% of Morgan County residents work outside of Morgan County; many of these work at the DOE facilities; thus, the economic impact of the DOE facilities is great

* The relationship between the community and DOE and Martin Marietta is good, with the exception of some concern about environmental problems, namely Poplar Creek

* The residents of Morgan County were opposed to siting the MRS facility there

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. David Bolling
Anderson County Executive
Anderson County Courthouse
100 N. Main
Clinton, Tennessee 37716

Dear Mr. Bolling:

Thank you for the information you provided on January 3, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* The community is very aware of the DOE facilities and supportive of them; community members have faith in the scientific expertise of employees there. However, as public knowledge increases, public response may in turn increase.

* In relation to environmental problems at the facilities, the community maintains the attitude that DOE is very capable of dealing with these problems

* The economic impact of the facilities is mostly favorable. However, there is a question of equitable payment by the for-profit operating manager to the community. You are seeking a tax on the use of the facilities.

* Diversification and mitigation is needed to offset the possible impact on defense-related jobs lost as a result of moves toward world peace

If my reiteration of the information you provided is incorrect, please contact me at the above address by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Allen Borden
Director of Economic Development
City of Knoxville
P.O. Box 1631
Knoxville, Tennessee 37901

Dear Mr. Borden:

Thank you for the information you provided on January 22, 1990 about your community and its awareness of and relation to DOE facilities in Oak Ridge. The following is a summary of that information.

* DOE facilities in Oak Ridge are a valuable asset to Knoxville because of 1) large capital investment, 2) the great number of jobs provided, and 3) spinoff industries that have located in Knoxville

* Interaction between the mayor's office and DOE and Martin Marietta has been minimal, but pleasant

* ORNL is making a strong effort to get DOE technology into the private sector

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Jeff Broughton
Oak Ridge City Manager
City of Oak Ridge
P.O. Box 1
Oak Ridge, Tennessee 37831

Dear Mr. Broughton:

Thank you for the information you provided on January 19, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* You did not comment on behalf of the community, but expressed your opinion about the relationship between the community and the DOE facilities

* Relations between DOE and the community has improved in the past 5 years. There is more openness on the part of DOE

* The facilities are the "lifeblood" of the community, namely in terms of economic impact

* There remains some question about the adequacy of financial support ot the community provided by DOE

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mayor Charles Eblen
P.O. Box 427
Lenoir City, Tennessee 37771

Dear Mayor Eblen:

Thank you for the information you provided on January 3, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* Community awareness of DOE facilities is extremely low; DOE should assume the responsibility of informing communities of projects underway

* DOE does serve on union management boards, but generally community involvement is seriosly lacking

* Martin Marietta is the largest employer in the area, though TVA and the industrial park have contributed to economic growth of Lenoir City

* Because they employ many people, the facilities have had a great economic impact on the community

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Dwight Kessel
Knox County Executive
City County Building
Suite 651
Knoxville, Tennessee 37902

Dear Mr. Kessel:

Thank you for the information you provided on January 22, 1990 about your community and its awareness of and relation to DOE facilities in Oak Ridge. The following is a summary of that information.

* 55% of the workforce at the DOE facilities live in Knox County. Thus, there is a large economic impact (though possibly not as great as it once was when community members believed Oak Ridge facilities and Alcoa were the major supporter of the local economy).

* Residents are not well informed about Oak Ridge DOE projects. This is probably a legacy associated with the secrecy of of the Manhattan Project.

* A recent issue in Knox County is the proposed waste incinerator. At least 55% of the people are in support of the incinerator.

* Your office has demonstrated support of DOE proposed projects, such as the breeder reactor and AVLIS, by writing letters officials involved

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. George Miller
Loudon County Executive
P.O. Box 246
Loudon, Tennessee 37774

Dear Mr. Miller:

Thank you for the information you provided on January 4, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* Community support for the MRS project was mixed, while support for the Breeder Reactor was strong

* The relationship between the community and DOE has been good through the years but has recently improved as DOE became more conscientious

* The community maintained a good image of DOE until knowledge of environmental pollutants became widespread.

* Because they employ many people, the facilities have had a great economic impact on the community

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Roy Pruett
Mayor, City of Oak Ridge
P.O. Box 1
Oak Ridge, Tennessee 37831

Dear Mayor Pruett:

Thank you for the information you provided on January 22, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* Several DOE projects have been proposed in recent years. These include CRBRP, MRS, and IT's incinerator.

* Community support, with some exception, has been good for projects (including MRS). However, there is less support outside of Oak Ridge for DOE projects.

* Relations with DOE and operating managers has improved in recent years, namely because of increased communication and because DOE has realized it needs community support to continue operations.

* DOE facilities and projects at these facilities have a positive economic impact, namely in terms of numerous stable jobs and because of spin-off companies (most recently those associated with cleanup projects)

* Oak Ridge is historically dependent on DOE facilities, but the city is seeking greater economic diversity.

If my reiteration of the information you provided is incorrect, please contact me at the above address by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Charles Seviers
City Manager
City Hall
Clinton, Tennessee 37716

Dear Mr. Seviers:

Thank you for the information you provided on January 4, 1990 about your community and its awareness of and relation to the DOE facilities in Oak Ridge. The following is a summary of that information.

* The community of Clinton is strongly supportive of DOE facility operations

* The greatest economic impact of these operations is the jobs they provide

* Relations with DOE and operating managers has been good over the years

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Janice Morrissey

Janice Morrissey

Bldg. 4500N
M.S. 6206

L. RADABAUGH
UILDING AND SUBDIVISION COORDINATOR

ACKSON COUNTY
IVISION OF INSPECTION

ISON PUBLIC HEALTH CENTER
MAIN STREET, ROOM 205
SON, OHIO 45640-1790

286-5630

ITY DIVISION OF INSPECTION

I J. ALLISON HEALTH CENTER

200 Main Street
JACKSON, OHIO 45640

- BUILDING PERMITS
- SUBDIVISIONS
- PLANNING COMMISSION
- SEWER DISTRICTS
- FLOOD INSURANCE PROGRAM

eptember 19, 1989

Mr. Martin Schweitzer
Oak Ridge National Laboratory
Building 4500 N, MS-6206
P.O. Box X
Oak Ridge, Tennessee 37831

Dear Mr. Schweitzer:

Enclosed is information requested by Mr. Jim Salisbury. Since our Comphrehensive Plan and most of our other individual plans and studies are outdated, I have written a brief report of conditions as they currently exist rather than send outdated information. Please contact me if I can be of further assistance.

Sincerely,

Gary L Radabaugh

Gary L. Radabaugh,
Building and Subdivision
Coordinator

GLR/thc

Enclosure

JACKSON COUNTY DIVISION OF INSPECTION

BRINTON J. ALLISON HEALTH CENTER

200 Main Street
JACKSON, OHIO 45640

JACKSON COUNTY, OHIO

Educational Facilities

There are three public school districts within Jackson County. The largest district, the Jackson City Schools, has an enrollment of approximately 2600 in one high school, one middle school, and six elementaries. Dates of construction range from 1912 for Kinnison Elementary to 1957 for Scioto Elementary. Several buildings have had additions constructed since the date of original construction. Pupil capacity per building and classroom is not a problem although some older buildings are considered by school officials to be undesirable due to their age and lack of modern design. A bond issue to construct a new middle school will be voted on in November, 1989.

The Wellston City School District has an enrollment of approximately 1900 in one high school, one junior high and two elementaries. Coalton Elementary built in 1917 is the oldest building in the district and Bundy Elementary built in 1970 is the newest. Additions have been constructed to Coalton Elementary and Wellston High School since the date of original construction. Overcrowding is not a problem, and facilities are generally considered to be adequate. The district has experienced some financial difficulies lately.

The Oak Hill Union Local School District has an enrollment of approximately 1300 in one high school and five elementaries. Central Elementary built in 1901 is the oldest building in the district and Blackfork Elementary built in 1964 is the newest. All buildings except Central and Oak View elementaries have had additions constructed since the date of original construction. Central Elementary is considered to be inadequate and will be closed at the conclusion of the 1989-1990 school year. An addition will be built at Oak View Elementary to accommodate Central students. Overcrowing is not a problem, and other facilities are considered to be adequate.

Enrollment in all three districts has declined slightly in recent years. That trend can be expected to continue for at least the next few years.

In addition to the three districts, other education facilities in or immediately adjacent to Jackson County include the Buckeye Hills Career Center serving high school juniors and seniors who wish to pursue a vocational training program and offering various vocational programs to adults as well. The University of Rio Grande also serves many Jackson County students.

Fire and Police Protection

Jackson County is served by nine fire departments. All fire departments with the exception of Wellston City rely entirely on volunteers. Fire departments are generally adequately equipped to meet the needs of their service areas. However, fire protection in outlaying areas is difficult due to distance from the fire stations and lack of water supply. The State of Ohio Division of Forestry also provides some assistance with control of forest fires.

Police protection for the county is provided by the State Highway Patrol, Jackson County Sheriff's Department, and police departments in the cities of Jackson and Wellston and the villages of Oak Hill and Coalton. Jackson Lake State Park near Oak Hill also employs a park ranger. Police protection is generally considered to be adequate, although financing, particularly of the sheriff's department and the village police departments has been a problem at times. The sheriff's department does not have sufficient deputies to provide 24 hour protection during some week night late hours. Deputies are on call as needed during those times. One major law enforcement problem is the lack of adequate jail space. Planning for a new regional jail is underway among five area counties including Jackson.

Medical

The Oak Hill Community Medical Center is the only hospital in Jackson County. This hospital has 68 beds some of which are for long term care patients. Residents often utilize hospitals in surrounding counties when more specialized care is needed. There are 11 physicians and 10 dentists practicing in the County. There are five clinics operated by area hospitals and there are six nursing homes with a total of 330 beds in the county. Home health care is provided by the county health department, Oak Hill Community Medical Center, and a private home health care company. One nursing home in Wellston is planning to convert their existing 50 bed nursing home into an adult day care center and to construct a new 100 bed nursing home.

Public Services - Portsmouth Site

Solid and Hazard Waste

There is one landfill, located south of Wellston, currently operating in the county. This landfill has a remaining life of approximately three years. Other landfills are located in adjacent counties, but are inconvenient to municipal and private haulers due to the travel time involved. Jackson County is part of a six county solid waste planning district created as a result of a recent state law. The planning committee with the assistance of their consultant will be adopting guidelines for siting of new landfills, recycling programs, and related areas of solid waste management.

Solid waste collection is provided by the cities of Jackson and Wellston and the village of Oak Hill. Oak Hill provides collection service for both the village and a sizeable area around the village. One major private hauler and several smaller private haulers also provide collection service.

There are no hazardous waste disposal facilities in the county. However, there are three industries in the county which produce hazardous wastes as a byproduct of their manufacturing process. These waste are sent to disposal facilites in northern Ohio or out of the state.

Recreation and Parks

Recreational facilities are abundant in Jackson County. State Parks at Jackson Lake and Lake Alma providing fishing, boating, swimming, picnicing and camping. Hunting, hiking and in some areas fishing is provided in the Wayne National Forest, Cooper Hollow Wildlife Area, Richland Furnace State Forest, Liberty Wildlife Area, and Mead Wildlife Area. Lake Katherine Nature Preserve provides fishing, picnicing, hiking and nature interpretation programs. Fishing and picnicing are provided at Hammertown Lake and a limited amount of fishing is allowed at Jisco Lake. Public swimming pools are located in Jackson, Oak Hill, and Wellston and several other pools are operated by private organizations. All four municipalities in the county own one or more public parks. The City of Jackson is planning to develop another park for passive recreational use such as concerts, plays, picnicing, reading, etc.

There are two historical sites in the county, Buckeye Furnace and Leo Petroglyph operated by the Ohio Historical Society, which provide picnic and some hiking trails. There are two golf courses in the county. Recreational facilities provided by the schools are also available on a limited basis for public use.

Public Services - Portsmouth Site

Water and Sewer

Major improvements in water and sewer service have been made in the county over the past ten years. The City of Jackson has a two million gallon per day wastewater treatment plant completed a few years ago to serve the city and a few outlying areas. Wellston and Oak Hill will begin major renovations to their wastewater treatment plants within the next year. Coalton has a wastewater treatment plant and collection system under construction at the present time. The County of Jackson operates a small package plant which serves a 100 bed nursing home and a 63 lot subdivision. About one half the population of the county uses individual sewage disposal systems.

Jackson, Oak Hill, and Wellston all operate public water supply systems. The Jackson County Water Company purchases water from Jackson and Wellston and supplies water to the village of Coalton and an extensive area of the county outside of the municipalities. Rural water companies based in Scioto, Pike, and Gallia County also supply water to some areas of Jackson County. It is estimated that approximately 80% of the population is served by a public water system. The rural water companies are continuing to expand their distribution systems.

Private wells are generally inadequate due to low yield, usually less than three gallons per minute, and poor chemical quality.

Transportation

Jackson County is served by two four lane highways, U.S. Route 35 and State Route 32, as well as eight other state routes. U.S. Route 35 is the most heavily traveled. A U.S. Route 35 bypass of the city of Jackson was completed in 1988. State highways are in good condition, but many county and township roads as well as city and village streets are in need of repair.

The Jackson County Airport located mid-way between Jackson and Oak Hill has a runway capable of accommodating small corporate jets. The runway was resurfaced last year. Financial constraints prevent 24 hour staffing of the airport although it does remain open 24 hours a day. This prevents refueling of planes during off hours unless prior arrangements are made.

The Indiana and Ohio Short Line Railroad provides freight services to all the incorporated communities in the county by means of a spur line which runs from the main line in Vinton County just north of Wellston to Firebrick in Lawrence County south of Oak Hill. Freight traffic has increased on this line since it was acquired from the CSX Corporation a few years ago.

Public Services- Portsmouth Site

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Dr. John R. Allen
County Commissioner
Pike County Courthouse
Waverly, Ohio 45690

Dear Dr. Allen:

Thank you for the information you provided on December 20, 1989 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* The economy created by the numerous jobs provided at the DOE facility offsets the fact that no taxes are paid on the buildings

* There has always been a good relationship between the community, DOE and Martin Marietta

* Any environmental issue associated with the facility died early on because the residents have no concern about the facility, and there has been no opposition to the facility

* Community leaders are working hard to find use for the existing GCEP facility

* You have been on trips to Oak Ridge, Tn. and Washington, D.C. in support of continued DOE operations in the community

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Jim Caldwell
Ross County Commissioner
County Courthouse
2 North Paint St.
Chillicothe, Ohio 45601

Dear Mr. Caldwell:

Thank you for the information you provided on January 2, 1990 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* Community response to DOE projects is positive. The community was disappointed when the GCEP facility was cancelled

* The relationship between the community, DOE and plant operators has always been good, but is even more so with Martin Marietta as operator

* The effects of the facility on Chillicothe is favorable both because of the number and stability of the jobs provided there and because a number of the white collar workers locate in Chillicothe

* Local governments have passed resolutions supporting continued and increased DOE operations in the area

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Steve Carpenter
Managing Editor
Portsmouth Daily Times
637 6th St.
Portsmouth, Ohio 45662

Dear Mr. Carpenter:

Thank you for the information you provided on January 2, 1990 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* There is enthusiastic community support for continued and increased operation at the DOE facility

* The relationship between the community, DOE and Martin Marietta is good. This is partly because Martin Marietta provides adequate information to the community, has safety programs and drills, and contributes to the United Way.

* The community is economically dependent and the facility because of the numerous jobs it provides and the local businesses that are supported indirectly because of them

* A newsroom vote rated the article about the proposed AVLIS facility one of the ten most important of the year

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Judge Foster
c/o Massac County Courthouse
Metropolis, Illinois 62960

Dear Judge Foster:

Thank you for the information you provided on December 19, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* Most residents support the DOE facility at Paducah because it has a large economic impact in terms of the number of jobs it provides

* There has been no environmental protest directed at the Paducah facility nor has anyone complained to you about the facility

* The relationship between Massac County, DOE and Martin Marietta has been good

If my reiteration of the information you provided is incorrect, please contact by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mayor Virgil Gilliam
211 E. Broadway
Mayfield, Kentucky 42066

Dear Mayor Gilliam:

Thank you for the information you provided on December 12, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The economic vitality of the Purchase Area is dependant on the continued operation of the DOE facility at Paducah. Economic contributions to the community include the workers' salaries and charitable contribution to organizations such as United Way

* When DOE planned to close one of its three uranium enrichment facilities, the community showed its support of continued operation by attending public hearings

* The facility is a clean and safe work place, and you are have never received any complaints about it

* The licensing of LWD has caused some controversy lately, but at a recent public hearing the great majority of people there were in favor of licensing the facility

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

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M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Bill Graves
Ballard County Judge Executive
Wickliffe, Kentucky 42087

Dear Mr. Graves:

Thank you for the information you provided on January 11, 1990 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The presence of the facility has helped the economy of the area tremendously. The facility employs 300-400 Ballard County resident and is, thus, particularly important to Ballard County.

* The community supports the facility fully, and there has never been any opposition to the facility

* Ballard County officials have met with McCracken County officials to discuss what they might do to keep the facility operating

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Rich Green
Kentucky Department of Natural Resources
Forestry Division
627 Comanche Trail
Frankfort, Kentucky 40601

Dear Mr. Green:

Thank you for the information you provided about acres of timberland in Kentucky counties. The following is a reiteration of that information to confirm its accuracy.

A 1987 survey revealed that Graves County has 76,000 acres of timberland and Marshall has 86,000. Ballard and McCracken together have 98,000 acres, while Carlisle, Fulton and Hickman together have 85,000 acres of timberland. According to the 1978 survey, Carlisle had approximately 32% of the combined total acres of timberland in Fulton, Hickman and Carlisle Counties. Based on this percentage, it was determined that Carlisle in 1987 has approximately 29,000 acres of timberland.

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
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OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 1, 1990

Ms. Jane Ketz
Scioto County Economic Development Corporation
P.O. Box 509
Portsmouth, Ohio 45662

Dear Ms. Ketz:

Thank you for the information you and Steve Wells provided on January 15 and 22, 1990 concerning housing vacancies in the Portsmouth area. The following is a summary of that information.

* There are a total of 12,022 rental units in Scioto County. Approximately 600 of them are available.

* There are 454 homes for sale.

* There are three trailer courts in the county with a combined total of 33 vacancies--28 for mobile homes and 5 for RVs.

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. John Knauff
Scioto County Commissioner
Scioto County Courthouse
Portsmouth, Ohio 45662

Dear Mr. Knauff:

Thank you for the information you provided on January 2, 1990 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* There is total community support for continued and increased operation at the DOE facility. The public has attended public meetings and demonstrated this support

* The working relationship between the community and DOE and particularly Martin Marietta is excellent. Martin Marietta has made a great effort to inform the community about its operation and to be involved in the community. This is demonstrated through the plant site tours, open houses, equipment loans, and involvement in labor management boards

* Continued operation of the facility is considered the top priority for a stable economy in the area

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
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OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Wayne Lindsey
County Judge's Office
McCracken County Courthouse
Paducah, Kentucky 42001

Dear Mr. Lindsey:

Thank you for the information you provided on December 18, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* Community awareness of the facility is high; most people at least know the basic function of the facility

* Community relations with DOE and Martin Marietta are good as evidenced by the cooperation on establishing a 911 system and plant tours

* Safety issues are minimal and residents have no complaints about the plant's operation. There is much more concern about a small jail proposed in the area

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1990

Mr. Dick Little
Division of Forestry
Illinois Department of Conservation
600 N Grand Ave. W.
Springfield, Illinois 62706

Dear Mr. Little:

Thank you for the information you provided on January 5, 1990 about forest land in Massac County, Illinois. The following is a reiteration of that information.

There are a total of 153,900 acres in Massac County, of which 34,500 are forest land. This includes commercial timber land and reserved forests, i.e., state parks and conservation areas.

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Ms. Shelby Martin
Paducah Chamber of Commerce
P.O. Box 81
Pacucah, Kentucky 42002

Dear Ms. Martin:

Thank you for the information you provided on December 18, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The community strongly supports DOE and Martin Marietta and the continued operation of the gaseous diffusion plant. When DOE planned to close one of its three enrichment plants, 1,400 residents attended a public hearing in support of continued operation of the plant.

* The facility's good operating record is part of the reason for continued community support

* The Chamber reviewed applicants for the plant's operation contract about such things as job security and safety and environmental record

* There have been no complaints or controversy concerning the gaseous diffusion plant. However, the Calvert City industrial complex is the subject of some controversy about producing environmental pollutants. Protest has come from a local group Coalition for Health Concerns and from Greenpeace.

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

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OAK RIDGE NATIONAL LABORATORY
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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Mike Miller
County Judge Executive
Marshall County Courthouse
Benton, Kentucky 42025

Dear Mr. Miller:

Thank you for the information you provided on January 10, 1990 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The entire Purchase Area is affected economically by the DOE facility, namely because of the number of jobs it provides and because it attracts people with hi-tech skills

* The community has expressed much concern about the possiblity of the facility closing

* The plant operators have been and are considered trustworthy

* The licensing of LWD has caused some controversy lately, but at a recent public hearing the great majority of people there were in favor of licensing the facility

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Dave Neal
Jackson County Commissioners
Courthouse, Main St.
Jackson, Ohio 45692

Dear Mr. Neal:

Thank you for the information you provided on January 3, 1990 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* Reuse of the GCEP facilities and reliance on existing support services would save would save a great amount of money

* There is good rapport between the community, DOE and Martin Marietta that Martin Marietta has established by contributions to local organizations and by sharing use of emergency equipment

* Several years ago there was a general anti-nuclear protest staged at the plant by and Indian group; however, there has been no local protest to operation of the DOE facility

* The plant is enormously important to the economy of Jackson as it employs 275-300 people from there

* Support of the facility has been demonstrated by a letter-writing campaign undertaken by community officials

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

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OAK RIDGE NATIONAL LABORATORY
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POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Jim Paxton
Editor
The Paducah Sun
408-12 Kentucky Ave.
Paducah, Kentucky 42001

Dear Mr. Paxton:

Thank you for the information you provided on December 19, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The facility is important to the community because it provides numerous high quality jobs, and keeping the facility operating is an economic priority of the community

* The management is forthright and candid, and the community is well informed about plant operations

* There has been no opposition to or complaints about the facility's operation

* There has been some controversy and opposition by local and national organizations to facilities at the Calvert City industrial complex

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 1, 1990

Mr. Ron Pfeifer
Pike County Office of Community Development
103 E. Third Street
Waverly, Ohio 45690

Dear Mr. Pfeifer:

Thank you for the information you provided on November 8, 1989 concerning housing vacancies in Pike County. The following is a summary of that information.

* There are approximately 9,000 housing units in Pike County

* Occupancy rates of rental housing are approximately 95-98% (this high occupancy may be due in part to the depressed economy which cause more people to rent instead of buy housing)

* There are 3 trailer parks with approximately 20 pads in each

* There are approximately 45 hotel/motel rooms in Pike County. Weekday occupancy is approximately 50%; weekends may be as high as 90% full.

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Mr. Tom Reeder
Portsmouth Area Chamber and Convention Bureau
P.O. Box 509
Portsmouth, Ohio 45662

Dear Mr. Reeder:

Thank you for the information you provided on January 3, 1990 about your community and its awareness of and relation to the DOE facilities in Portsmouth. The following is a summary of that information.

* DOE facilities in the area have had a positive economic impact in terms of employment and job security; however, the community was concerned and the economic growth period associated with the GCEP facility ended when the GCEP was cancelled

* There is a cordial, cooperative, and positive relationship between the community, DOE and Martin Marietta. This relationship has improved recently because of Martin Marietta and DOE efforts to provide more information to the public

* Attempts to diversify the economy of the area have been hampered by the decline of the shoe manufacturing industry and the closure of the steel mill. Thus, the DOE facility remains the life blood of the local economy.

* Citizens expressed concern about environmental and labor practices of BASF when eastern Scioto County was being considered by BASF as a site for a new facility

* Keeping DOE operations at the site viable is a top priority of community leaders

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 31, 1990

Judge Tony Smith
County Judge Executive
Graves County Courthouse
Mayfield, Kentucky 42066

Dear Judge Smith:

Thank you for the information you provided on December 19, 1989 about your community and its awareness of and relation to the DOE facilities in Paducah. The following is a summary of that information.

* The community is strongly supportive of the facility, largely because of the great number of jobs it provides

* The community demonstrated its support of the facility when DOE planned to close one of its three enrichment facilities. Residents attended public hearings and wrote letters in support of continued operation of the facility

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 1, 1990

Mr. Howard Thompson
President
Pike County Chamber of Commerce
P.O. Box 107
Waverly, Ohio 45690

Dear Mr. Thompson:

Thank you for the information you provided on November 8, 1989 and January 3, 1990. During those two phone calls we discussed housing vacancies in Pike County and the community's awareness of and relation to the DOE facility in Pike County. The following is a summary of that information.

* There are approximately 9,000 housing units in Pike County, 200 available rental units and 100 homes for sale. Also, there are approximately 75-100 trailer hookups vacant.

* The community was very aprehensive when DOE planned to close one of its three enrichment facilities. Over 1000 people attended the public meeting in support of continued operation of the facility.

* There has been no protest from within the community to the plant's operation; however, in 1970 (or around that time) a group of individuals from outside the local area staged an anti-nuclear protest at the facility.

* The good operating record of the facility is partly responsible for the community's continued support of the facilty

* Using the GCEP facilities would save a lot on the construction costs of the AVLIS facility

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 1, 1990

Ms. Karen Wyant
Jackson Chamber of Commerce
210 Main St.
Jackson, Ohio 45640

Dear Ms. Wyant:

Thank you for the information you provided on November 8, 1989 and January 3, 1990. During those two phone calls we discussed housing vacancies in Jackson County and the community's awareness of and relation to the DOE facility in Pike County. The following is a summary of that information.

* Occupancy of rental units in Jackson County is almost 100%.

* Community leaders are working hard to find an occupant(s) for the GCEP facilities; the buildings are available for the AVLIS plant and would save a considerable amount of taxpayers' money

* Community civic and social groups are responding to a letter-writing campaign designed to show support of continued DOE operations in the area

* The relationship between the community, DOE and Martin Marietta is good, particularly because the community is kept well informed of activities at the facility

* Recent layoffs at a coal company are associated with the closing of four local businesses; discontinuing operations at the DOE facility would have an enormous negative impact on the local economy

If my reiteration of the information you provided is incorrect, please contact me by February 16, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Steve Alstead
TVA
Norris, Tennessee 37828

Dear Mr. Alstead:

Enclosed please find a copy of a memorandum of conversations from our discussion of January 9, 1990. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME	
9 January 1990		[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
V. R. Tolbert	Steve Alstead
ORNL	TVA
	Norris 37828

SUBJECT:
potential locations of threatened and endangered mollusks in the Clinch River in the DOE GDP vicinity [8km (5mile) radius]

DISCUSSION:
The shiny pigtoe historically occurred in Poplar Cr. records are from 1918 survey. None have been collected in recent years.
Fine-rayed pigtoe also historically occurred in Poplar Cr. none of record since 1918 survey.
Alabama lamp historically occurred in the Emory River. none collected in recent years.
Pink mucket has been collected in the lower Clinch R. in recent years
Spiny riversnail historically occurred in the Clinch R. most recent records are from the 1950s. no specimens have been collected in this area in recent years.
Red-belly dace is found in tributaries to the Clinch R. within the 8km radius of the site.

CONCLUSION OR AGREEMENTS
Alstead will send a copy of his ms. thesis on mollusks in the Clinch R.

DISTRIBUTION:

SIGNED
Virginia R. Tolbert

UCN-693
(1235 6-88)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Bob Currier
Oak Ridge Public Works Department
P.O. Box 1
Oak Ridge, Tennessee 37830

Dear Mr. Currier:

Enclosed please find a copy of a memorandum of conversations from our discussion of October 4, 1989. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME	
4 October 1989		☒ TELEPHONE ☐ PERSONAL

ORIGINATING PARTY	OTHER PARTIES
V. R. Tolbert	Bob Currier
OENL	OR Public Works Dept P.O Box 1
	Oak Ridge 37830

SUBJECT:

type of wastewater treatment used by City of O.R.

DISCUSSION:

waste water treatment at the west-end sewage treatment is tertiary treatment prior to discharge to Poplar Creek.

CONCLUSION OR AGREEMENTS

TRIBUTION:

SIGNED

Virginia R. Tolbert

UCN-693
(1235 6-88)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 378

September 13, 1989

Mr. Dan Eagar
Ecological Services
Department of Conservation
701 Broadway, Customs House
Nashville, Tennessee 37219

Dear Mr. Eagar:

Oak Ridge National Laboratory staff are preparing an Environmental Report for the U.S. Department of Energy for the Atomic Vapor Lasar Isotope Separation (AVLIS) project. One of the proposed sites for the location of this facility is at the Oak Ridge Gaseous Diffusion Plant. The proposel for this site is to construct new facilities to house the AVLIS project. As part of this project, we will be evaluating the potential for effects on important ecological resources within a five-mile radius of the site. Enclosed is a map of the site, including the five-mile radius. We would approciate your assistance in identifying important ecological resources that we should consider within this radius.

If you have questions, please do not hesitate to contact me at the above address or at (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert, PhD
Environmental Analyses Section
Environmental Sciences Division

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Gary Hickman
TVA, Fisheries
Norris, Tennessee 37828

Dear Mr. Hickman:

Enclosed please find a copy of a memorandum of conversations from our discussion of November 1, 1989. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME	
11/1/89	3:15 pm	☒ TELEPHONE ☐ PERSONAL

ORIGINATING PARTY	OTHER PARTIES
V. R. Tolbert	Gary Hickman
ORNL	TVA
	Fisheries Div., Norris, Tn

SUBJECT:

Aquatic resources in the Clinch River below Melton Hill Dam

Verification of continued accuracy of information presented in the US DOE 1979 report (EA)

DISCUSSION:

There have been no surveys of aquatic biota in the Clinch River since the 1978-79 surveys conducted by Loar et al.

Blue gill, largemouth bass, & white crappie are the most abundant species in the river (centrarchid species). Gizzard shad is the most abundant forage species. Rough fish in the ORGDP vicinity are smallmouth buffalo, spotted sucker, carp, & silver redhorse.

TVA fisheries branch will be conducting electroshocking sampling in the Clinch River in the ORGDP vicinity within the next two months. The report from the sampling effort will be available by approximately March.

CONCLUSION OR AGREEMENTS

Hickman will send me a copy of the report when it is completed.

DISTRIBUTION:

SIGNED Virginia R Tolbert

UCN-693
(1235 6-68)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Al Sevi
Operations, Building C400
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001

Dear Mr. Sevi:

Enclosed please find a copy of a memorandum of conservations from our discussion of November 7, 1989. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME	
7 November 1989		☒ TELEPHONE ☐ PERSONAL

ORIGINATING PARTY	OTHER PARTIES
VR Tolbert	Al Sewi FTS 355-6428
ORNL	PGDP Operations
	Bldg. C400 42001

SUBJECT:

water use for PGDP

DISCUSSION:

water withdrawal averages 10 mgd for cooling water makeup
2.5 mgd for sanitary use
~~permitted~~ max. withdrawal would be 30 mgd for cooling & sanitary use
average discharge 0.5 mgd wastewater treatment from cooling tower blowdown
0.3 mgd from sewage treatment
< 1 mgd from once-through cooling & stormwater runoff

CONCLUSION OR AGREEMENTS

DISTRIBUTION:

SIGNED Virginia R. Tolbert

UCN-693
(1235 6-68)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Don Spann
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

Dear Mr. Spann:

Enclosed please find a copy of a memorandum of conversations from our discussion of November 6, 1989. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: 11-6-89

TIME: 10:20 AM

[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
Virginia R. Tolbert	Don Spann 736-5607
ORNL	US Army Corps of Engrs.
	P.O. Box 1070, Nashville, Tn 37202-1070

SUBJECT:

information on Clinch River in ORGDP vicinity

DISCUSSION:

width of Channel in the Clinch River below Melton Hill Dam is maintained at 200' from mile 18 downstream to confluence with the Tenn R. from mile 18 to Melton Hill Dam the channel width is 175'.

the depth of the channel is maintained at 9'-11' at all pool elevations.

average annual water craft for the past three years is:

recreational 55 vessels

commercial 1 vessel

government 4-5 vessels (includes Coast Guard, Corps, TVA)

commercial use was greater prior to closure of the steel mill upstream of Melton Hill Dam.

CONCLUSION OR AGREEMENTS

Copy of this memo will be sent to Mr. Spann for verification

DISTRIBUTION:

SIGNED Virginia R. Tolbert

UCN-693
(1235 6-88)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 29, 1990

Mr. Roger Thomas
Tennessee Valley Authority
Environmental Affairs
3S 161F Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402

Dear Mr. Thomas:

Enclosed please find a copy of a memorandum of conversations from our discussion of November 7, 1989. The information in the enclosed memo is currently being used to prepare background information sections for the three gaseous diffusion plants operated by Martin Marietta Energy Systems and will appear as a technical manuscript. If this memo does not accurately reflect our conservation, I would appreciate receiving a memo from you with the correct information at your earliest convenience.

Thank you for your assistance. If you have questions, please call me at FTS 624-7288 or (615) 574-7288.

Sincerely,

Virginia R. Tolbert

Virginia R. Tolbert
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

VRT:pv

enclosures

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME	
7 November 1989		☒ TELEPHONE ☐ PERSONAL

ORIGINATING PARTY	OTHER PARTIES
V.R. Tolbert	Roger Thomas (615) 751-4426
ORNL	TVA, Office of Power Water Quality
	Chattanooga, Tn.

SUBJECT:

TVA water use at Shawnee Steam Plant, Paducah

DISCUSSION:

Shawnee withdraws an av. of 1585 mgd & discharges an av of ~~1590~~ 1588.9 mgd.

Some of the discharge is to Little Bayou Cr. near the mouth. annual discharge 156,000 gpd of stormwater runoff.

Condenser cooling water discharge is 1588 mgd including stormwater runoff & ash pond discharge.

Atmos. Fluidized Bed ~~Demo. Facility~~ Pilot Plant withdrew from groundwater & discharged to the Ohio River through Shawnee Facility. (not currently in operation)

CONCLUSION OR AGREEMENTS

Roger Thomas
TVA, Environmental Affairs
3S 161F Lookout Place
1101 Market St
Chattanooga, Tn 37402

DISTRIBUTION:

SIGNED Virginia R. Tolbert

UCN-693
(1235 6-88)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 8, 1990

Ms. Brenda Hartley
Pike County Chamber of Commerce
Post Office Box 107
Waverly, Ohio 45690

Dear Ms. Hartley:

I am writing to request confirmation of the accuracy of information you provided in our telephone conversation on January 19, 1990. If there are any errors in my interpretation of what we discussed please let me know, otherwise I will assume that the information below is correct.

In Pike County there are two State Parks. Lake White State Park about 10 miles north of the PORTS (DOE Gaseous Diffusion facility). This park includes 337 water acres featuring a public boat launch ramp, power and sail boating, water skiing, fishing, and a 50-foot swimming beach. There are 107 acres of land with two picnic shelters, and 38 campsites for primitive camping (no electricity).

Pike Lake State Park--about 13 miles northwest of PORTS--has 13 water acres and 600 land acres. It has 155 feet of swimming beach. No power boats are permitted. There are 25 cabins, a group lodge, and over 200 camping sites--101 with electricity. Pike Lake State Park has four hiking trails and is near the 12,000 acre Pike State Forest.

Pike County also has two privately owned camping facilities with extensive recreation attractions. Longs Retreat off SR 124 near Latham is about 14 miles northwest of PORTS. Cave Lake Family Campground is 2 km (1 mile) west of Longs Retreat. These facilities cater to family vacations offering various recreational activities including fishing, swimming, boating, go-carts, and game rooms.

Other recreation opportunities in Pike County include four public tennis courts in Waverly and the Waverly Golf Club, an 18 hole public golf course 8 km (5 miles) northwest of Waverly. The Waverly Swim Club is private but has an outdoor swimming pool that is open to the public two evenings per week.

Given a population of less than 30,000 Pike Count has only limited cultural resources. The Pike County Joint Vocational School offers courses from Shawnee State University which has its main campus in Portsmouth. The Buckeye Community Concerts organization sponsors music concerts four times per year at Waverly High School. The Pike Heritage Museum in Waverly is open nine months per year and has displays that depict Pike County's heritage including life of the local indians.

Sincerely,

James Van Dyke

James Van Dyke

JVD:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 8, 1990

Ms. Ruby Hill
Ironton District Ranger
710 Park Avenue
Ironton, Ohio 45638

Dear Ms. Hill:

I am writing to request confirmation of the accuracy of information you provided in our telephone conversation on January 18, 1990. If there are any errors in my interpretation of what we discussed please let me know, otherwise I will assume that the information below is correct. Also thank you for the additional information you sent to me.

Wayne National Forest is east of the City of Portsmouth and south of Jackson Lake State Park. It takes in 180,000 acres including Vesuvius Recreation Area at Lake Vesuvius which is developed for camping, hiking, fishing, and horseback riding. The undeveloped areas of the Forest provide opportunities for hunting, primitive camping, and off-trail hiking.

Sincerely,

James Van Dyke

James Van Dyke

JVD:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 8, 1990

Martin Marietta
Attention: Mr. Jim Morgan
P.O. Box 628
X-100 Building
MS 1227
Piketon, Ohio 45661

Dear Mr. Morgan:

I am writing to request confirmation of the accuracy of information you provided in our telephone conversation on November 30, 1990. If there are any errors in my interpretation of what we discussed please let me know, otherwise I will assume that the information below is correct.

The traffic entering and exiting the PORTS Plant at U.S. 23 uses on and off ramps at the main access road. The entrance and exit ramps from PORTS do not suffer from congestion including morning and evening rush hours.

The main access road from the Plant feeds onto U.S. highway 23 via entrance and exit ramps directly west of PORTS. Another common access to the plant is from Wakefield Mound Road which is accessed directly from the southwest perimeter of the Plant. Wakefield Mound Road runs parallel to U.S. 23 intersecting it about five km (three miles) south of the main access road. Access to the plant is also available from Big Run Road which accesses the southeast perimeter of the Plant and runs into Wakefield Mound Road just north of the intersection with U.S. 23.

Current conditions indicate that the Wakefield-Mound Road intersection with U.S. 23 is not being used nearly as much as indicated by the traffic count in 1982. The 1982 traffic count probably reflects the large amount of employment during 1982 at the Plant associated with construction of the Gas Centrifuge facility (GCEP) at PORTS. However, it should be noted that, in general, traffic from the PORTS Plant had an alternative to avoid this congestion by using the main entrance road which accesses U.S. 23 with ramps. The fact that construction traffic was using the Wakefield-Mounds Road in spite of significant congestion at the U.S. 23 intersection could reflect that construction workers were required to use specific access roads because of a labor dispute.

Sincerely,

James Van Dyke

James Van Dyke

JVD:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 8, 1990

Paducah Area Chamber of Commerce, Inc.
Ms. Janet Stewart
Post Office Box 810
Paducah, Kentucky 42002-0810

Dear Ms. Stewart:

I am writing to request confirmation of the accuracy of information we discussed in our telephone conversation on January 17, 1990. If there are any errors please let me know, otherwise I will assume that the information below is correct. Also thank you for the additional information you sent to me.

The rural character of Western Kentucky provides many outdoor recreation opportunities for local communities. Hunting and fishing is readily available in the Ballard County Wildlife Management Area 10 miles northwest of the Paducah Gaseous Diffusion Plant (PGDP) site. Game which is hunted includes geese, ducks and deer. Adjacent and just to the north of the PGDP site is the West Kentucky State Wildlife Management Area which also provides hunting opportunities for geese, ducks and deer. The Ohio River, within 6 km (4 miles) of the PGDP site, is utilized for fishing.

Sincerely,

James Van Dyke

James Van Dyke

JVD:mh

Table 4.2

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

December 21, 1989

Mr. George Mason, Administrative Assistant
Division of Planning
Kentucky Department of Highways
Transportation Cabinet
State Office Building
Frankfort, Kentucky 40622

Dear Mr. Mason,

I am writing to request confirmation of the accuracy of traffic counts supplied in a telephone converstions I had with you in November of 1989. If there are any errors with the following traffic counts please let me know otherwise I will assume that the information below is correct. The counts are for 1989 near the U.S. Deparment of Energy Paducah Gaseous Diffusion Plant in McCracken County just west of Paducah. The hourly counts are for the morning and afternoon peaks.

Location	ADT Count	Count	Hourly Time
U.S. 60 west of 1154 at Ballard Co. Line	5,237		
		330	7-8 a.m.
		490	4-5 p.m.
U.S. 60 east of 1154 just east of MacGruder Road	6,387		
		560	7-8 a.m.
		710	4-5 p.m.
Highway 1154 just north of U.S. 60	715		
		50	7-8 a.m.
		90	3-4 p.m.

Mr. George Mason

December 21, 1989

Location	ADT Count	Count	Hourly Time
Highway 725 between 726 and 996	1,125		
		140	7-8 p.m.
		220	4-5 p.m.
Highway 358 east of 996 between Cunningham and Chiles Rds.	2,488		
		340	7-8 a.m.
		320	4-5 p.m.
Highway 996 between 358 and 725 just north of Hall Rd.	1,480		
		120	6-7 a.m.
		170	3-4 p.m.
Highway 358 just west of 996	774		
		60	6-7 a.m.
		90	5-6 p.m.

Sincerely,

James Van Dyke

James Van Dyke

JVD:cjc

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

December 21, 1989

Mr. Buddy McLean, Technician Supervisor
Traffic Engineering
Tennessee Department of Transportation
James K. Polk Building
505 Dedrick Street, Suite 1000
Nashville, Tennessee 37243-0334

Dear Mr. McLean,

I am writing to request confirmation of the accuracy of traffic counts supplied in two telephone converstions I had with you and the Traffic Counts office in November of 1989. If there are any errors with the following traffic counts please let me know otherwise I will assume that the information below is correct. The counts are for State Highway 58 in Roane County in 1989.

Location	ADT Count	Count	Hourly Time	Direction
58 (4 lanes) between SR 327 & SR 95	11,600		24 hour	Both
		642	6-7 a.m.	North
		652	7-8 a.m.	North
		1,158	4-5 p.m.	North
		343	5-6 p.m.	North
		1,154	7-8 a.m.	South
		711	4-5 p.m.	South
58 & 95 just south of intersection with SR 95	9,630		24 hour	Both
		403	7-8 a.m.	Both
		1,215	8-9 a.m.	Both
		612	4-5 p.m.	Both
		1,336	5-6 p.m.	Both

58 just north of I-40	8,900		24 hour	Both
		946	7-8 a.m.	Both
		1,033	4-5 p.m.	Both

Sincerely,

James Van Dyke

James Van Dyke

JVD:cjc

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

2 February 1990

Bill Callahan, Cultural Resources Assistant
Illinois Historic Preservation Agency
Old State Capitol
Springfield, Illinois 62701
217/785-4512

Dear Mr. Callahan:

Thank you very much for the information you gave me about historic preservation during our telephone conversation of 31 January. Summarized below are the main points of our phone conversation.

- Since the proposed project would be built in Kentucky, the effects of altered traffic patterns on known sites in Massac County likely would be the main concern your office would have. In particular, increased traffic for personnel and materials and road realignments could affect existing sites.

- To determine the potential for impacts, it may be necessary to send project plans to your office to comply with the Section 106 review process.

- Massac County is one of the least populated and most economically depressed counties in the state.

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

2 February 1990

George Herman, Head Reference Librarian
Illinois State Historical Library
Old State Capitol
Springfield, Illinois 62701
217/524-6358

Dear Mr. Herman:

Thank you very much for the information you gave me about historic preservation during our telephone conversation of 31 January. Summarized below are the main points of our phone conversation.

- There are three sites listed on the National Register of Historic Places for Massac County. These sites are as follows:

  - Elijah P. Curtis House, 405 Market Street, Metropolis
  - McCartney Music Hall, 116-120 E. Fourth Street, Metropolis
  - Fort Massac State Park

- Other potential contacts are as follows:

  - Ann Swallow, Department of Preservation Services; 217/785-0315
  - Illinois State Museum; 217/782-7386
  - Southern Illinois University in Carbondale
  - public officials in Metropolis

- You will send me some bibliographic materials.

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

31 January 1990

David Pollack, Staff Archaeologist
Kentucky Heritage Council
Capital Plaza Tower
Frankfort, Kentucky 40601
502/564-7005

Dear Mr. Pollack:

Thank you very much for the information you gave me about historic preservation during our telephone conversation of 29 January. Summarized below are the main points of our phone conversation.

- In addition to the sites listed on the National Register for the counties of interest, there is a wealth of additional information available in your office. You indicated that there are over 200 archaeological sites, and even more buildings recorded, in McCracken County alone.

- If the proposed project entails construction on the existing Department of Energy site, the major question to ask is what is the extent of previous disturbance for that particular construction site? From that point, a determination is made regarding how much, if any, surveying and recording is necessary. This is done in consultation with your office.

- A secondary question to consider is if any sites already on the National Register could be affected directly or indirectly by project construction or operation.

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

26 January 1990

Susan Scherff
Review and Compliance Archaeologist
The Ohio Preservation Office
1982 Velma Avenue
Columbus, Ohio 43211-2497
614/297-2470

Dear Ms. Scherff:

Thank you very much for the information you gave me about historic preservation during our telephone conversation today. Summarized below are the main points of that conversation.

- The archaeological inventory and historic survey materials are filed at the Ohio Preservation Office and available for use. Your office, however, does provide reviews for other individuals or agencies.

- The National Register list is virtually useless for archaeological sites, since it includes mainly mounds and not other important sites.

- Section 106 work is routed through your office (Review and Compliance), whether such work pertains to archaeological or historical resources.

- The procedure for a new federal project on an existing plant site like the Portsmouth Gaseous Diffusion Plant is as follows. (1) Determine through site investigation or through the literature (which is available in the Society building) if, prior to construction, archaeological sites were on the surface or were buried. (2) If sites had been destroyed by construction activities, documentation to that effect must be sent to your office for concurrence. (3) If sites are buried beneath existing structures, or if they were not already destroyed, a plan would be necessary to determine if disturbance might occur.

- The Department Head for the Review and Compliance Office is Catherine Stroup.

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

31 January 1990

Richard Tune
Assistant Director for National Register Programs
for the Tennessee Historical Commission
Department of Conservation
701 Broadway
Nashville, Tennessee 37243-0442
615/742-6758

Dear Mr. Tune:

Thank you very much for the information you gave me about historic preservation during our telephone conversation of 26 January. Thank you also for sending the list of sites listed on the National Register. Summarized below are the main points of our phone conversation.

- The sites listed on the National Register are one source of information about historic resources; also to be considered are sites eligible to be listed and sites that are in other ways significant. Information is available in the Nashville office.

- A comprehensive survey and inventory of potentially historic properties throughout the state is underway for sites that are at least 50 years of age. This survey information is available in the Tennessee State Historic Preservation Officer's office.

- The Department of Energy sites have been developed for over forty years. Since the sites are approaching 50 years of age, they may have to be evaluated with regard to their historic importance. The sites may be difficult to evaluate because of the technologies involved and because it is difficult to evaluate the historic importance of war-era structures.

- There may have been a survey conducted on the Oak Ridge site several years ago.

- The person to deal with for federal projects is Joe Garrison, who is the Review and Compliance Coordinator.

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

PIKE COUNTY PUBLIC SCHOOLS

LARRY F. MEREDITH, Ph.D., Superintendent

23365 STATE ROUTE 124 • PIKETON, OHIO PHONE (614) 289-4171 • (614) 289-4112

THE FOLLOWING ARE THE SCHOOLS THAT MAKE UP THE PIKE COUNTY SCHOOL SYSTEM:

		Capacity	
Eastern Local Schools:	Enrollment	Over	Under
Stockdale Elementary	252	X	
Beaver Elementary	479		X .25
Eastern High School	321		X-50
	1052		
Scioto Valley Local Schools:			
Piketon Elementary	472		X-25
Jasper Elementary	408		X-75
Piketon Junior High	235		X-20
Piketon High School	308		X-100
	1423		
Western Local Schools:			
Parker Elementary	583	X	
Western High School	324	X	
	907		
5 elementary schools -2174			
3 HS -453			
2 JH -Middle 474			
Pike County JVS:	439		X-139

HAVE YOU PROJECTIONS FOR NEW BUILDINGS OR EXPANSION OF OLD?

	YES	NO
Eastern		X
Scioto Valley		X
Western	X	
JVS		X

COUNTY BOARD OF EDUCATION

"An Equal Opportunity Employer"

GEORGE MUSTARD, President, Piketon, Ohio
GLEN MUSTARD, Vice President, Piketon, Ohio
HOWARD BOWLES, Latham, Ohio
JAMES C. BEVINS, Stockdale, Ohio
RON PENNINGTON, Beaver, Ohio
JOYCE LEETH, Treasurer

—Our Boys and Girls First—

Public Services - Portsmouth Site

POLICE DEPARTMENT MEMORANDUM

NO. 89-04

DATE: January 23, 1989

TO: Jeffrey J. Broughton, City Manager

FROM: Timothy A. Braaten, Chief of Police

SUBJECT: Monthly Report for December With Year End Data

Calendar year 1988 is at an end and the following report will give an overview of the calendar year as well as the month of December.

- Part I serious crime was up 10% in 1988 with the major increase attributable to aggravated assault, simple assaults and motor vehicle theft.
- Traffic accidents in 1988 totaled 1325 compared to 1326 in 1987. Injury accidents decreased 16% and persons injured in these accidents decreased 13%.
- There was an 11% increase in the issuance of hazardous moving traffic violations along with an 11% increase in the arrest of persons for Part I felonies.
- The crime clearance rates in 1988 were 27% compared to 25% in 1987. This is 5% higher than the national average.

CRIME STATISTICS

The following chart depicts a comparison of Part I serious crime by calendar year. (1986-1988).

OAK RIDGE POLICE DEPARTMENT
POST OFFICE BOX 1
OAK RIDGE, TENNESSEE 37830

SERIOUS PART I CRIMES

CALENDAR YEAR STATISTICS

	January - December		
	1988	1987	1986
MURDER	3	1	0
RAPE	8	7	5
ROBBERY	26	22	16
AGGRAVATED ASSAULT	145	93	55
SIMPLE ASSAULT	67	27	10
BURGLARY	271	268	260
LARCENY	834	830	895
MOTOR VEHICLE THEFT	79	49	47
TOTAL	1433	1297	1288

The 1988 10% Part I Serious Crime increase was 136 crimes more than in 1987. 92 of this 136 crime increase was attributable to the assault category and 30 was motor vehicle thefts. These two categories accounted for the difference between 1987 and 1988 Part I crime statistics.

As you can observe, the major increase in crime is in the category of aggravated and simple assault. These figures have increased by 85% and 75% in the last two calendar years. Notwithstanding the increase in actual numbers, the percentage of the assaults that were cleared by arrests remains extremely high in the 75% to 80% levels. This local clearance rate favorably compares to the national clearance rate for assaults in cities 25,000-49,999 of 56.4%. This increase in assault statistics is definately alarming and the Department is continuing to examine this situation to determine causes.

The other category of serious crime which accounted for a major increase in 1988 statistics was the 30 crime increase in motor vehicle theft. Normally motor vehicle theft is related to the availability of unattended vehicles. Increasing commerce in Oak Ridge and increasing numbers of vehicles moving in and out of our community and being left unattended is always a concern. Some recent coordinated efforts in apprehending area motor vehicle theft rings will hopefully reduce these numbers in 1989.

Part I Serious crime clearance rates increased during 1988 to 27%. 384 of the 1433 crimes were closed by arrest or exceptional means. This is a 5% higher clearance rate than in cities of similar size throughout the country. During these clearances, 378 persons were arrested and charged for Part I criminal offenses.

HISTORICAL PERSPECTIVE

An historical perspective of reported Part I Serious crime is provided on the table below:

YEARS	1980	1981	1982	1983	1984	1985	1986	1987	1988
PART I SERIOUS CRIMES	1747	1483	1520	1572	1267	1175	1288	1297	1433

As you can see, the incidents of Part I Serious crime have fluctuated during the last decade. 1988 was the highest rate recorded in the last five years, however, 1988 was significantly lower than the numbers reported for calendar years 1980-1983. The graph on page 4 illustrates the serious crime comparison of the 80's.

Traffic Related Statistics

In calendar year 1988, Oak Ridge recorded 1355 accidents, which is one accident less than the accidents recorded in 1987. Throughout the decade of the 80's, traffic accidents in Oak Ridge have remained relatively constant. The below table indicates the exact number for each year:

YEARS	1980	1981	1982	1983	1984	1985	1986	1987	1988
NUMBER OF ACCIDENTS	1332	1214	1166	1240	1255	1242	1277	1326	1325

As I'm sure you are aware, the volume of vehicular traffic in Oak Ridge has increased throughout the 80's and as such, motorized travel in Oak Ridge is safer today than in years past. The graph on page 5 illustrates the traffic accidents occurring during the 1980's.

One very significant statistic recorded in 1988 was a 16% decrease in the number of injury accidents. During 1987, 298 of the 1326 accidents or 22.5% of the accidents were injury accidents. This compares to 1988 when injury accidents were down to 257 of the 1325 or 19.4%. In addition to total accidents decreasing, the number of people injured decreased 13% from 440 to 381 persons.

These are very encouraging statistics. The greater the severity of an accident, the greater is the likelihood of personal injuries as well as significant property damage. In order to reduce the severity of accidents and also reduce total numbers of accidents, the City utilizes advancement in traffic engineering, traffic education and traffic enforcement. These three E's are the E's of traffic management. As we move into the decade of the 90's, we need to continuously strive for safer and more convenient traffic movement.

Following is a two-year comparison of important traffic data.

CALENDAR YEAR TRAFFIC ACCIDENT STATISTICS
January and December

	1988	1987	% CHANGE
ACCIDENT TOTAL	1325	1326	
FATAL	4	4	
PERSONAL INJURY	257	298	- 16%
PROPERTY DAMAGE	1063	1024	+ 4%
PEDESTRIAN	4	5	- 20%
PERSONS INJURED	381	440	- 13%
ENFORCEMENT SUMMARY			
HAZARDOUS VIOLATION	3863	3480	+ 11%
D.W.I.	168	175	- 4%
ACCIDENT ARREST AND CITATIONS	718	595	+ 21%

Accident investigation and accident reporting is a major time consumer in the Police Department. It also is one of our primary responsibilities. From accurate and complete reports, we are able to identify engineering needs, educational needs and enforcement demands.

CALLS FOR SERVICES

The City of Oak Ridge continues to experience an increasing number of calls for police services. These services are rendered in a variety of ways and through a variety of personnel. The 1980's has seen these numbers increase significantly.

CALENDAR YEAR CALLS FOR POLICE SERVICES

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988
CALLS FOR SERVICES	20,390	21,057	24,053	22,883	23,799	24,482	24,591	26,182	28,353

This last year calls for services increased by 8%. The 40% increase since 1980 is surprising considering the low growth of population during this time. The graph on page 8 illustrates the increase in calls for services experienced during the 1980's.

ANIMAL CONTROL

1988 calendar year again witnessed a very active year for the Animal Control Shelter. The following statistics illustrate the involvement of City Animal Control personnel and other assisting agencies. Gratitude needs to be expressed for the excellent assistance and cooperation we receive from the Anderson County Humane Society and the area veterinarians.

	CALENDAR YEAR 1988	CALENDAR YEAR 1987
Animal Apprehensions	833	929
Animals Reclaimed	297	210
Animals for disposal	794	910
Animals Adopted	572	584
Bites Reported	48	53
Registrations	72	95
Veterinarian Registrations	3305	3150
Animals Found Dead	302	272
Euthanized	1120	1348
Held for County Animal Control	428	409
Citizen Assists and Complaints	1684	1697
Animals Apprehended with Current registration Tags Attached	8	

As you will note from the top and bottom figures in the calendar year 1988, figures reflect less than 1% of all animal apprehensions are from animals that have up-to-date registration tags attached.

During the first part of 1989, we will be conducting a sample animal census to determine an approximate size of our animal population.

CONCLUSION:

1988 was a busy year. Numerous groups visited the Police Department and many more requested officers to speak to their organizations on topics from personal safety to international drug trafficking.

Numerous officers received specialized training and all officers received refresher training in routine functions and skills essential for the accomplishment of the law enforcement role in a modern society.

Timothy A. Braaten
Chief of Police

TAB:lgw

POLICE

Quality service by quality people for a quality community. This mission statement has come alive and become the driving force as the Oak Ridge Police Department strides forward to meet the peacekeeping and law enforcement needs of citizens and the people who travel within and enjoy our community. Police departments everywhere are charged with preserving the public peace, order and safety. In Oak Ridge, the department is pursuing this common goal with committed police/community teamwork.

The Police Department is comprised of 47 commissioned police officers, 5 civilian Emergency Communications Dispatchers, 4 secretarial and records support personnel and 3 animal control persons. In addition to the more visible law enforcement duties, this compliment of 59 people handle all of the emergency dispatching, records management and animal control functions. In the support role of dispatching, the emergency communications center, located at the Police Department, handled over 150,000 telephone calls for service, information or assistance. Ambulance, fire police and general calls to the City are answered and processed through this center 24 hours a day, 365 days a year.

The Animal Control Section of the Police Department is an essential element in the overall quality of life we enjoy in Oak Ridge. Animal control functions are performed by three persons who effectively manage our domestic and natural animals. In FY 1989,

Animal Control personnel picked up 877 strays and 303 dead animals. 2,177 animals were brought to the animal shelter. Thirteen percent or 275 animals were reclaimed and 28% or 606 animals were sold to new owners.

CRIME REPORTING

During FY 1989, Oak Ridge recorded 1,445 Part I Serious Crimes, which represents a 7% increase over FY 1988. Part I Serious Crimes include murder, rape, robbery, assault, burglary, larceny, and auto theft. The FY year breakdown of these crimes are as follows:

MURDER	0
RAPE	6
ROBBERY	23
AGGRAVATED ASSAULT	122
SIMPLE ASSAULT	114
BURGLARY	233
LARCENY	888
MOTOR VEHICLE THEFT	62
TOTAL	1,445

Considering an estimated population of 30,000 residents, the average citizens of Oak Ridge will be a victim of a serious crime

once every 20.8 years, which is below the national average of once every 17.7 years.

Whenever a perpetrator is identified in a given crime, a crime is considered solved or cleared. In FY 1989, the crime clearance rate for serious crimes was 29.1%, an increase of 3.1% from the previous year. Oak Ridge's clearance rate is 8% higher, or 117 more crimes solved, than the national clearance rate of 21%. During FY 1989, Oak Ridge recorded a daily average of 16.1 traffic and criminal arrests for a total of 5,894 arrests. The Department responded to 32,297 calls for service, a 22.7% increase over the 26,315 recorded last fiscal year.

TRAFFIC ENFORCEMENT

The engineering improvements along the Turnpike and Illinois Avenue have assisted the Police Department in recording a remarkable decrease in the number of vehicle injury accidents and the number of persons injured in these accidents. Notwithstanding an overall 9.1% increase in vehicle accidents, the resulting personal injury accidents decreased from 282 in FY 88 to 218 in FY 89, a decrease of 22.7%. The number of persons injured in these accidents decreased an amazing 27.2%, or 115 fewer personal injuries than the previous year.

DRUG ENFORCEMENT AND DRUG AWARENESS

In response to the increasing drug problem, the Police Department has intensified its drug demand reduction efforts and fine tuned its drug supply interdiction activities.

In demand reduction, the Department continues to be an active partner in the Oak Ridge Community Drug and Alcohol Prevention Network. This intensified effort to promote awareness of the drug and alcohol problem is bringing concerned groups throughout Oak Ridge and Anderson County together to establish a unified and coordinated effort.

Supply interdiction is drug law enforcement. The Department continues to work closely with the Anderson County Judicial District Drug Task Force to interrupt the flow of illegal drugs and illegally obtained legal drugs into and throughout our area. During FY 1989 this effort resulted in the filing of 200 drug charges and the added benefit of initiating charges in 29 other crimes. Drug and alcohol use and abuse contributes to the majority of criminal activity in Oak Ridge and our surrounding area, and as such, drug enforcement activities will continue to be a high priority in Oak Ridge.

In the coming years, it is anticipated these aggressive supply interdiction efforts combined with less demand will provide positive long-term benefits to the community.

MORGAN COUNTY
STUDENT ENROLLMENT

	SCHOOL	ENROLLMENT 9/18/89	PROJECTED* ENROLL.	CAPACITY**
(K-8)	Central Elem.	970		
(K-12)	Coalfield	507		
(K-12)	Oakdale	531		
(K-12)	Sunbright	689		
(9-12)	Central High	473		
(K-8)	Petros-Joyner	200		

* Over the past several years, the enrollment of students in Morgan County has been relatively stable, with a minor decline this year. I ~~have~~ foresee no major indicators in the immediate future which might alter this trend.

** All schools are running at or near capacity with the exception of Petros-Joyner.

Curt Skiles
Attendance Supr.

Morgan County Schools
Allan Nance, Superintendent
P. O. Box 348, 710 Main Street
Wartburg, TN 37887

KNOXVILLE, TN 379
PM
10 OCT
1989

Martin Schweitzer
Oak Ridge National Lab.
Bldg. 4500-N, MS-6206
P.O. Box X
Oak Ridge, TN. 37831

CITY OF
OAK RIDGE

POST OFFICE BOX 1 • OAK RIDGE, TENNESSEE 37831-000

February 6, 1990

Virginia R. Tolbert
Oak Ridge National Laboratory
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036

RE: Wastewater Treatment Plant Operations

Dear Ms. Tolbert,

Thank you for your memo inquiring about the Wastewater Treatment operations for the City Of Oak Ridge.

The Oak Ridge Wastewater Treatment Plant is designed to provide primary, secondary and tertiary treatment, disinfection and post aeration prior to discharge to East Fork Poplar Creek. The primary treatment consist of influent screenings, grit removal and sedimentation. Secondary treatment consist of the activated sludge process. Tertiary treatment facilities consist of dual-media gravity filters. Disinfection is accomplished by the addition of chlorine, and a cascade is provided for post aeration.

Solids handling at the plant consist of air flotation thickening of the waste activated sludge, anaerobic digestion and land application of digested sludge.

The Design Conditions for the Oak Ridge Wastewater Treatment Plant include:

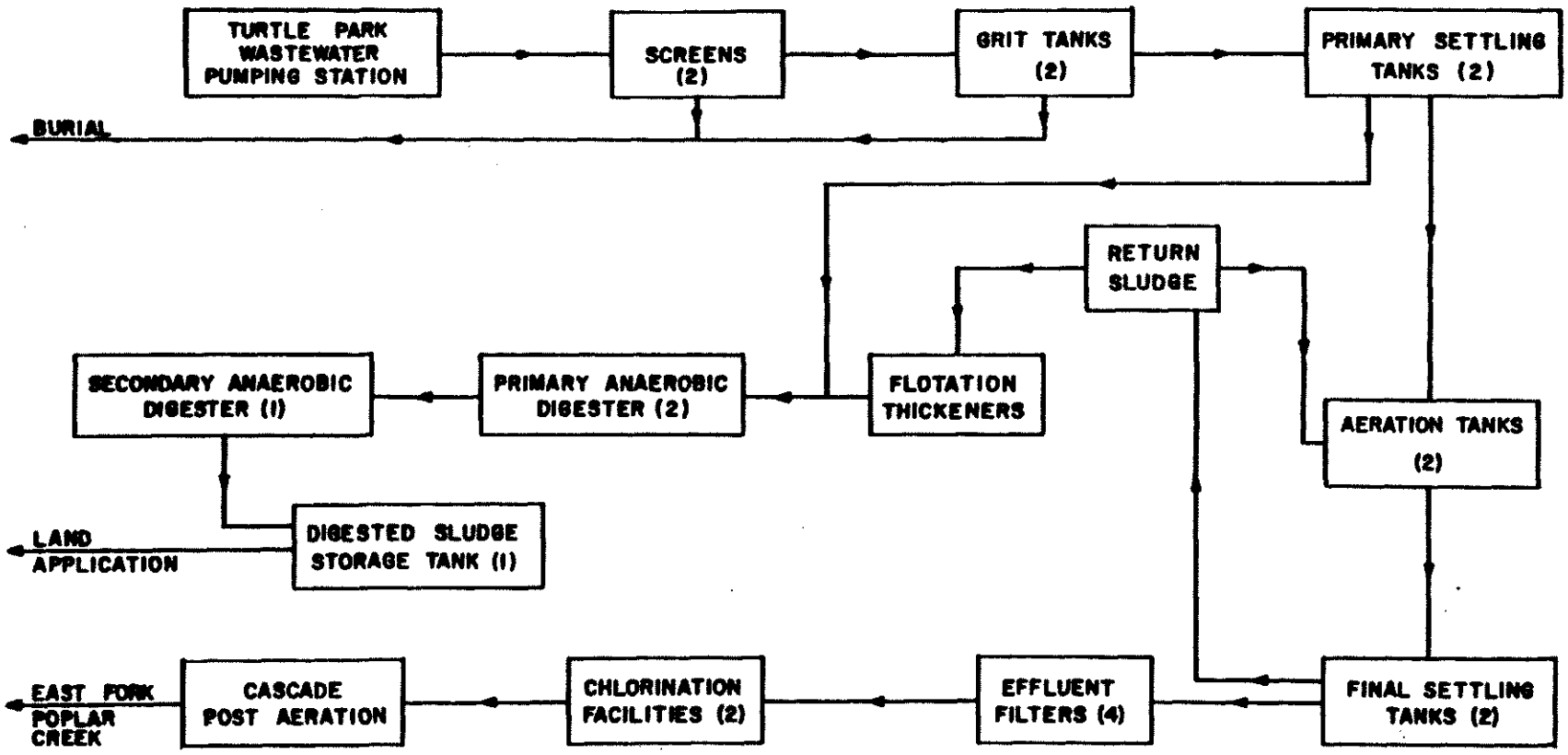
1. Average Daily Flow, MGD	4.66
2. Average Design Flow, MGD	5.87
3. Peak Hydraulic Flow, MGD	13.36
4. BOD/5day, lb/24 hours	8,950
5. suspended solids, lbs/24 Hr.	7,200
6. TKN, lb/24 Hrs.	965

A plant flow pattern is also included for referencing the different sections of the treatment plant.

We hope the above information will assist you in forming the information for the technical manuscript. Please feel free to call me at 482-8342 if you have any questions about the information.

Respectfully Yours,

Jack Robinson, Jr.
Wastewater Treatment Supervisor



PLANT FLOW PATTERN

FIGURE N -1

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 9, 1990

Ms. Connie Walker
Accent 2 Realty
378 E Main St.
Jackson, Ohio 45640

Dear Ms. Walker:

Thank you for the information you provided on November 8, 1989 concerning housing vacancies in Jackson County. The following is a summary of that information.

* There are approximately 250 housing units for sale in the county

* Most rental property in the county is occupied at the present time

* There are two trailer courts with 20-30 pads in each. One maintains close to 100% occupancy, the other is 50-75% full.

If my reiteration of the information you provided is incorrect, please contact me by February 23, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 9, 1990

Ms. Cecil Geitz
Wellston Chamber of Commerce
City Hall
Wellston, Ohio 45692

Dear Ms. Geitz:

Thank you for the information you provided on November 8, 1989 concerning housing vacancies in Jackson County. The following is a summary of that information.

* Rental property in the county maintains 95-98% occupancy, and there are sometimes waiting lists for rental property.

* There is, however, much property for sale (exact amount unknown)

* The local motel, Simms Motel, has approximately 12 rooms.

If my reiteration of the information you provided is incorrect, please contact me by February 23, 1990. Otherwise, I will assume it is correct as stated above. Again, thank you for your assistance.

Sincerely,

Susan M. Schexnayder

Susan M. Schexnayder

Bldg. 4500N
M.S. 6206

RECEIVED FEB - 9 1990

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

26 January 1990

Susan Scherff
Review and Compliance Archaeologist
The Ohio Preservation Office
1982 Velma Avenue
Columbus, Ohio 43211-2497
614/297-2470

Dear Ms. Scherff:

Thank you very much for the information you gave me about historic preservation during our telephone conversation today. Summarized below are the main points of that conversation.

- The archaeological inventory is filed and maintained by the Ohio Historical Society. ~~The archaeological inventory and~~ historic survey materials are filed at the Ohio Preservation Office and available for use. Your office, however, does provide reviews for other individuals or agencies. under the section 106 process.
- The National Register list is virtually useless as a listing of ~~for~~ archaeological sites, since it mainly includes ~~mainly~~ mounds and earthworks. ~~not other important sites~~. Many other important sites have been nominated so do not appear.
- Section 106 work is routed through your office (Review and Compliance), whether such work pertains to archaeological or historical resources.
- The procedure for a new federal project on an existing plant site like the Portsmouth Gaseous Diffusion Plant is as follows. (1) Determine through site investigation or through the literature (which is available in the Society building) if, prior to construction, archaeological sites were on the surface or were buried. (2) If sites had been destroyed by construction activities, documentation to that effect must be sent to your office for concurrence. (3) If sites are buried beneath existing structures, or if they were not already destroyed, a plan would be necessary to determine if disturbance might occur.
- The Department Head for the Review and Compliance Office is Catherine Stroup. Mrs Stroup will be leaving on 9 Mar 90. A new dept. head will be hired

If any of these points are inaccurate, please correct them and mail the corrections to me. If I do not hear from you, I will assume that the information in this letter is accurate.

Thank you for your help.

Sincerely,

Amy K. Wolfe

Amy K. Wolfe

AKW:mh

TENNESSEE VALLEY AUTHORITY
NORRIS, TENNESSEE 37828

FEB 14 1990

Ms. Virginia R. Tolbert
Oak Ridge National Laboratory
Environmental Analysis Section
Environmental Sciences Division
Building 1505, MS 6036
Oak Ridge, TN 37831

Dear Ms. Tolbert:

In response to your January 29 letter concerning our November 1, 1989, phone conversation, there are a couple of changes which need to be made in your memorandum of conversation. First, I am sending you a copy of a report written by Saylor and Tomljanovich in 1983 concerning sauger spawning below Melton Hill Dam as updated work since Loar et al. in 1978-79. Secondly, the tailwater fish population is dominated by gizzard shad, bluegill, redear sunfish, largemouth bass, yellow bass, yellow perch, quillback, carp, spotted sucker, and black redhorse in approximate order of abundance. Other species often encountered include: sauger, white and black crappie, channel and flathead catfish, skipjack herring, golden redhorse, freshwater drum, threadfin shad, spotfin shiner, white bass, redbreast sunfish, longnose gar, striped bass, smallmouth bass, and rock bass. The TVA report on fall 1989 samples noted as being available by March will not be completed until April or May 1990.

Thanks for the opportunity to review your memorandum of conversation covering our November 1 discussion. If you have additional questions, please call me at 632-1791.

Sincerely,

Gary D. Hickman

Gary D. Hickman, Unit Supervisor
Aquatic Biology Department
Water Resources

Enclosure

INTERNAL DISTRIBUTION

1. G. E. Butterworth
2. D. G. Jernigan
3. B. D. Lasley
4. M. A. Mitckes
5. L. K. Mann
6–7. R. E. Saylor
8. S. M. Schexnayder
9. M. Schweitzer
10. W. P. Staub
11. V. R. Tolbert
12. J. W. Van Dyke
13. J. P. Witherspoon
14. A. K. Wolfe
15. J. B. Cannon
16. L. N. McCold
17–20. M. O. Dixon
21. D. E. Reichle
22. J. G. Rogers
23. R. B. Shelton
24. Central Research Library
25. Document Reference Section
26–27. Laboratory Records (2)
28. Laboratory Records—Record Copy

EXTERNAL DISTRIBUTION

29. S. Coker, ERC Environmental and Energy Service Co., 800 Oak Ridge Turnpike, Suite 103A, Oak Ridge, TN 37830
30. E. P. Larson, Paducah Gaseous Diffusion Plant, P.O. Box 1410, Paducah, KY 47001
31. J. Morgan, Portsmouth Gaseous Diffusion Plant, P.O. Box 628, Piketon, OH 45661
32. Office of Assistant Manager for Energy Research and Development, DOE-ORO, P.O. Box 2001, Oak Ridge, TN 37831-8600

33-34. OSTI, U.S. Department of Energy, P.O. Box 62, Oak Ridge, TN 37831

35. B. Sigmon, SAIC, P.O. Box 2501, Oak Ridge, TN 37830

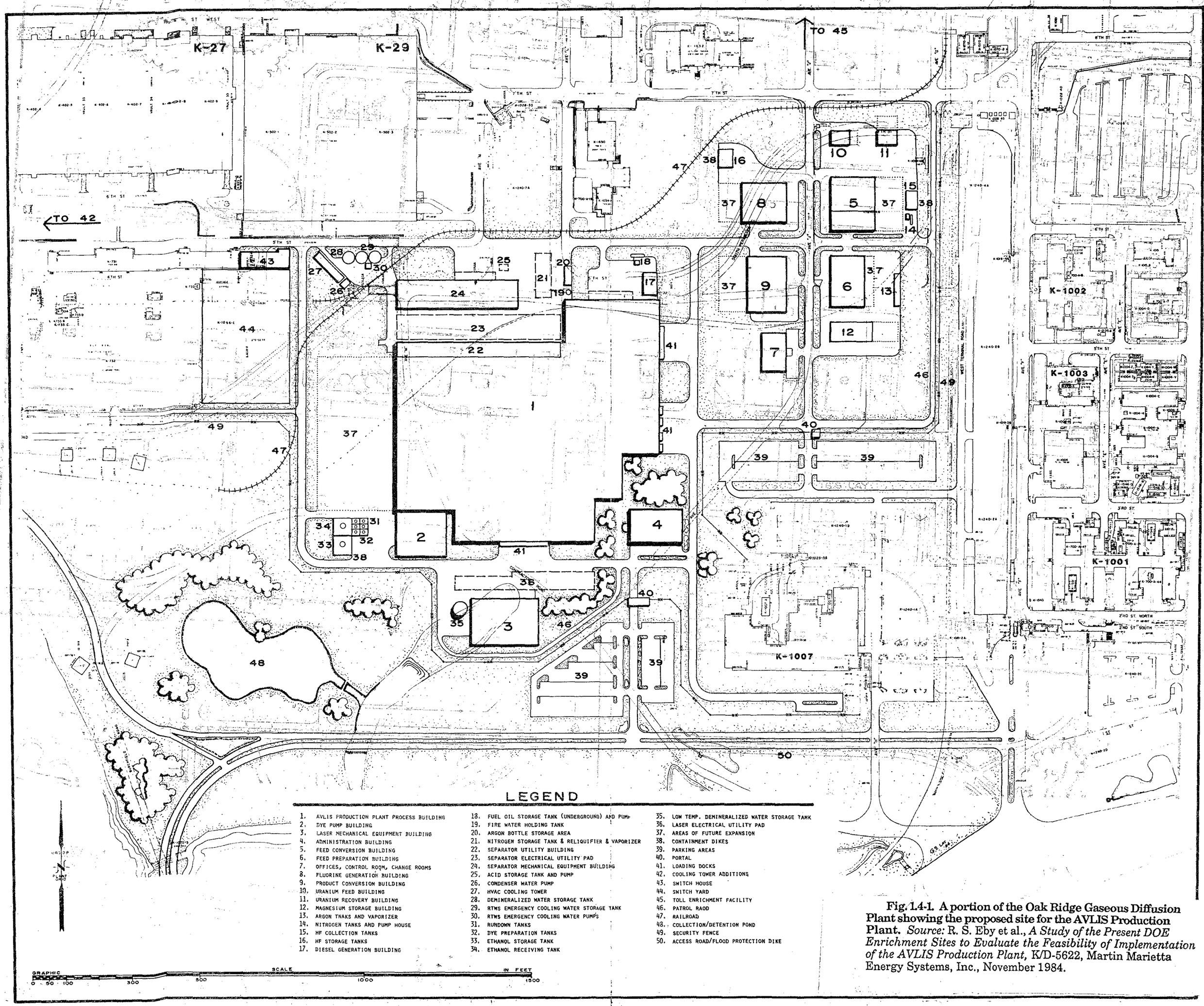


Fig. 1.4-1. A portion of the Oak Ridge Gaseous Diffusion Plant showing the proposed site for the AVLIS Production Plant. *Source:* R. S. Eby et al., *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant,* K/D-5622, Martin Marietta Energy Systems, Inc., November 1984.

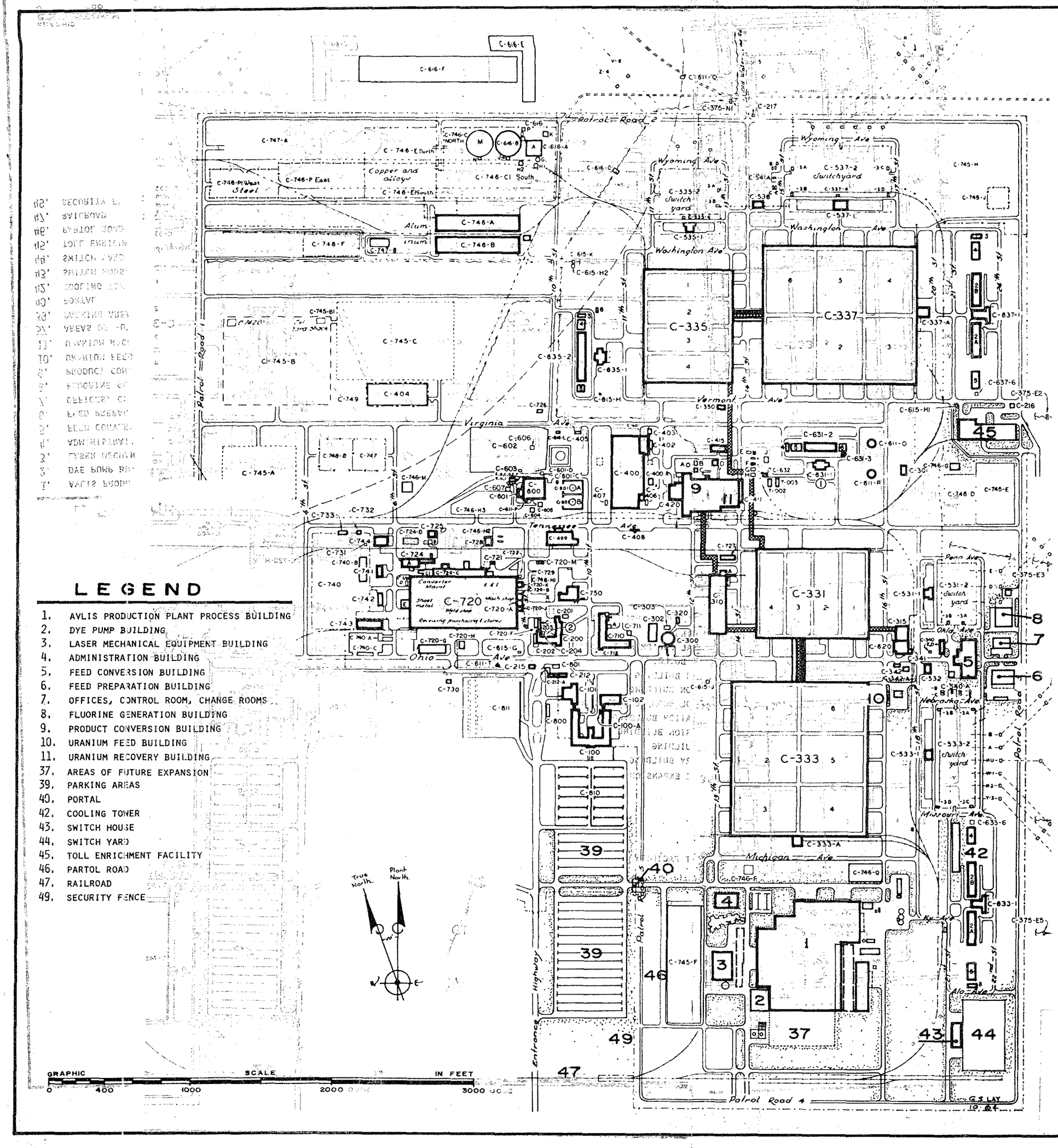


Fig. 1.4-2. A portion of the Paducah Gaseous Diffusion Plant showing the proposed site for the AVLIS Production Plant. *Source:* R. S. Eby et al., *A Study of the Present DOE Enrichment Sites to Evaluate the Feasibility of Implementation of the AVLIS Production Plant,* K/D-5622, Martin Marietta Energy Systems, Inc., November 1984.

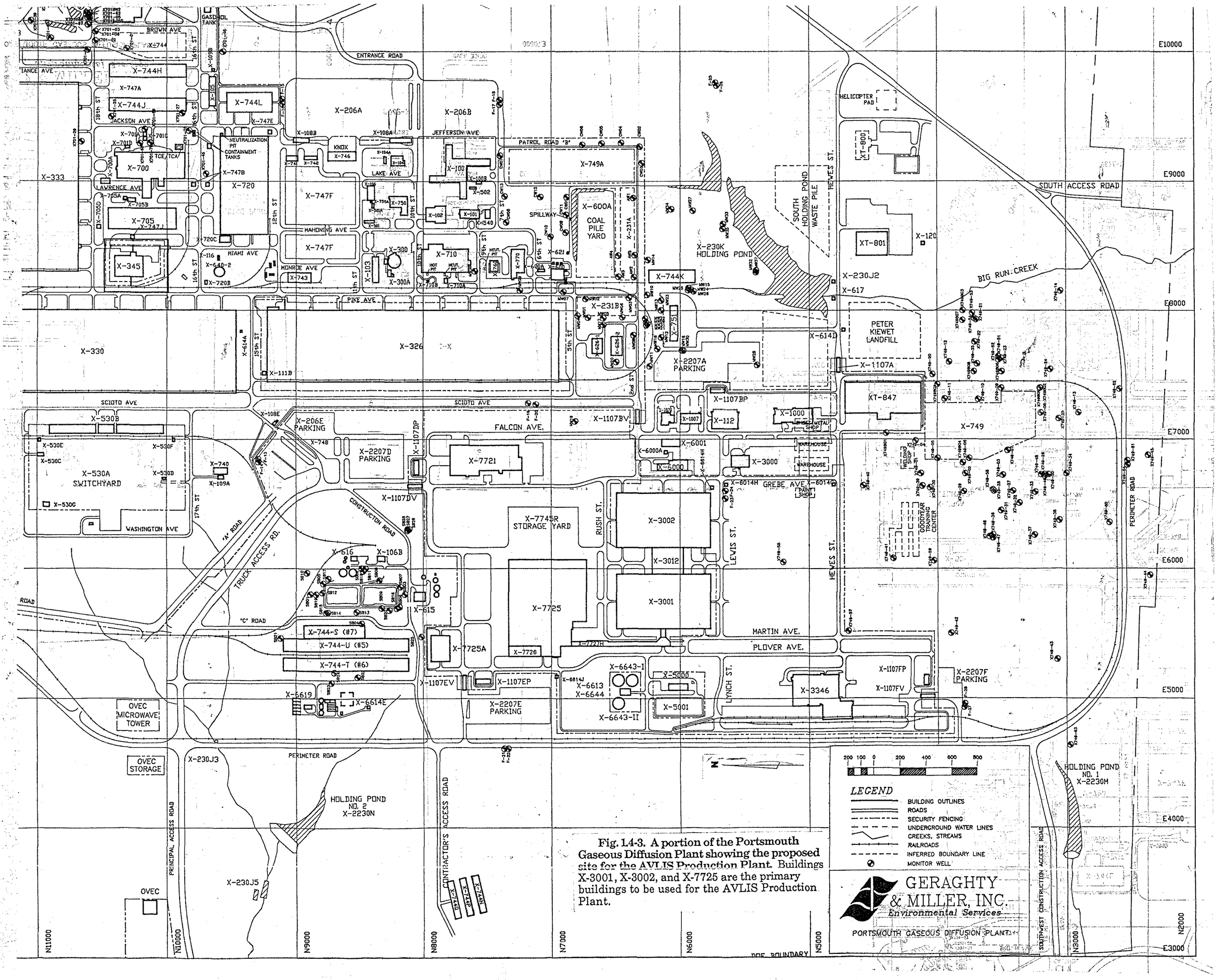


Fig. 1.4-3. A portion of the Portsmouth Gaseous Diffusion Plant showing the proposed site for the AVLIS Production Plant. Buildings X-3001, X-3002, and X-7725 are the primary buildings to be used for the AVLIS Production Plant.

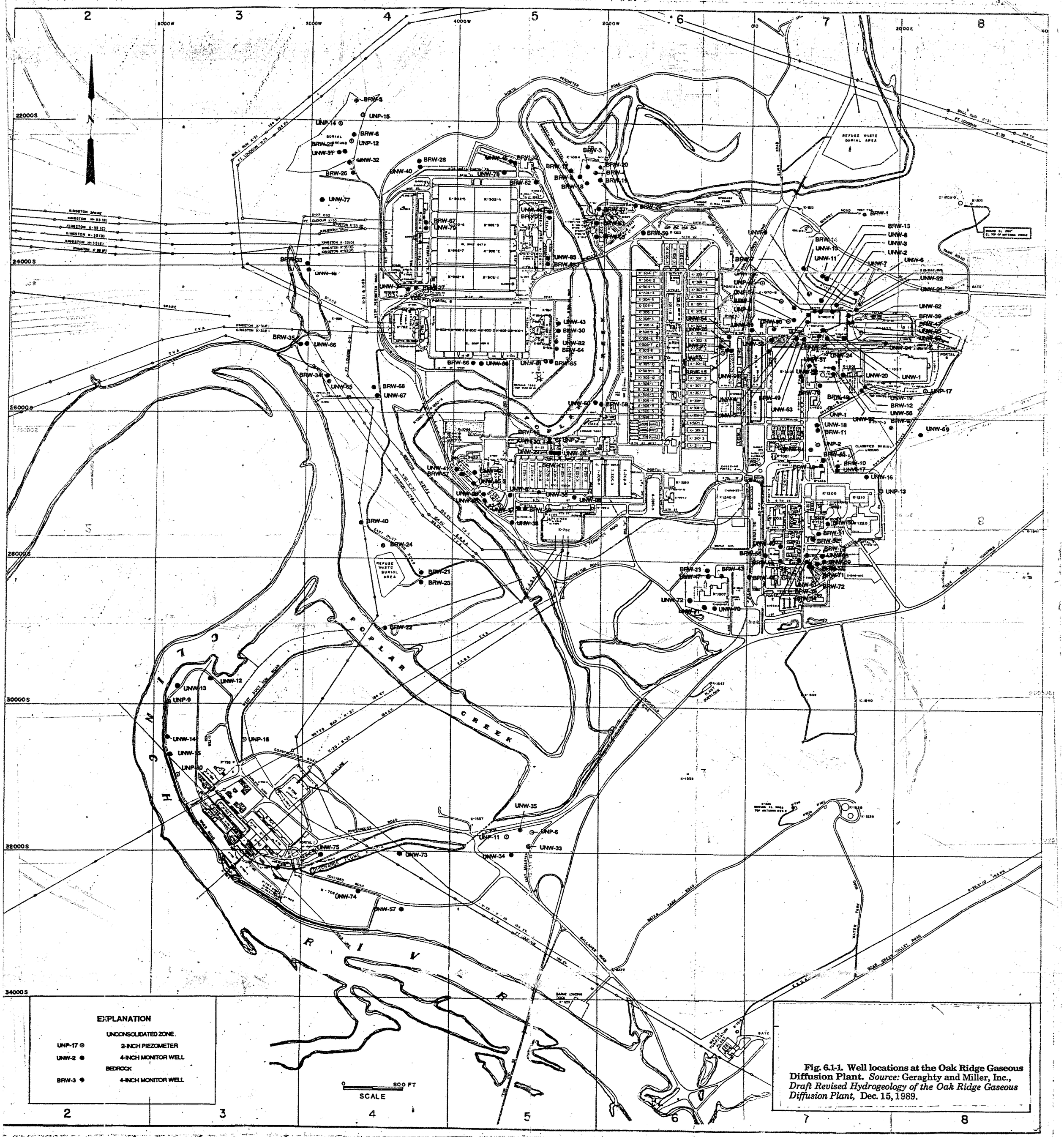
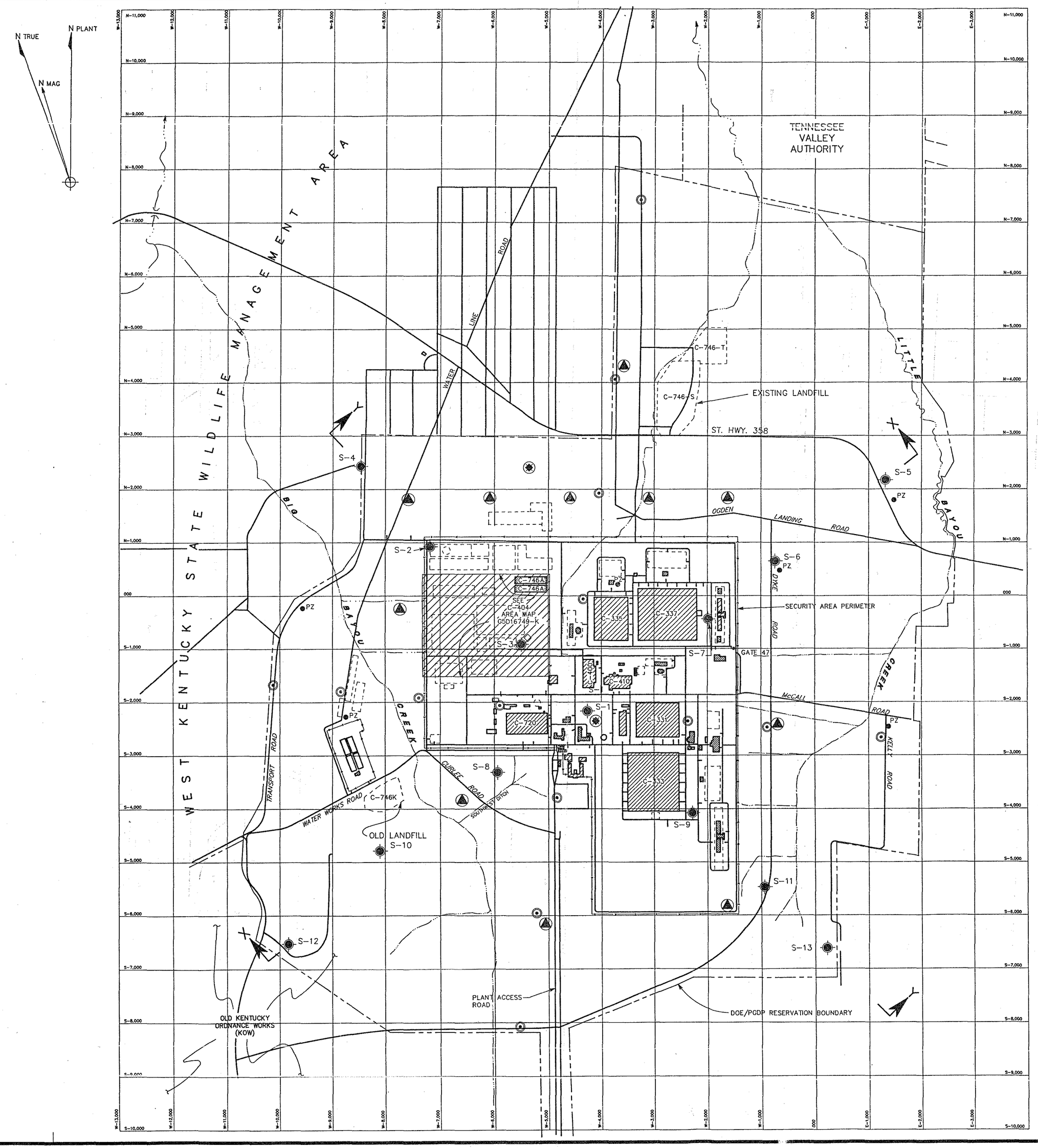


Fig. 6.1-1. Well locations at the Oak Ridge Gaseous Diffusion Plant. *Source:* Geraghty and Miller, Inc., *Draft Revised Hydrogeology of the Oak Ridge Gaseous Diffusion Plant,* Dec. 15, 1989.



LEGEND

- EXISTING DEEP SAMPLE BORINGS
- PROPOSED DEEP SAMPLE BORING
- PROFILE LIMITS
- PROPOSED MONITORING WELL STATION (EACH LOCATION CONSISTS OF A SINGLE WELL OR A CLUSTER OF WELLS DEPENDING ON THICKNESS AND DEPTH OF TARGETED HYDROLOGIC UNITS) THESE LOCATIONS ARE MODIFIED FROM THOSE PROPOSED IN MARCH 1987
- PZ PROPOSED PERMANENT PIEZOMETER LOCATIONS
- PROPOSED PHASE 3 PUMP TEST LOCATIONS

NOTES

1. THIS DRAWING IS PART OF A TECHNICAL REPORT OF ACTIVITIES ASSOCIATED WITH GROUND WATER MONITORING/PHASE 2 FPSC AZ-011 AND SHOULD ONLY BE USED IN CONJUNCTION WITH THE COMPLETE REPORT.
2. AT THE DIRECTION OF MARTIN MARIETTA ENERGY SYSTEMS NUMEROUS COMPONENTS OF THE GROUND WATER MONITORING PLAN (EDGe MARCH 26, 1987) HAVE BEEN MODIFIED IN RESPONSE TO ANALYSIS OF INFORMATION OBTAINED DURING THE PHASE 2 INVESTIGATION. THESE MODIFICATIONS ARE DISCUSSED AND SUMMARIZED IN THE REPORT TEXT.
3. THIS BASE MAP IS ADAPTED FROM MULTIPLE DRAWINGS SUPPLIED BY MARTIN MARIETTA ENERGY SYSTEMS IN ADDITION TO THE JOPPA QUADRANGLE AND HEATH QUADRANGLE (1:24000) PUBLISHED BY THE U.S. GEOLOGICAL SURVEY AND IS INTENDED FOR GENERAL REFERENCE ONLY. FOR PRECISE LOCATION OF FEATURES REFER TO LARGER SCALE MAPS AND/OR FEATURE COORDINATES.

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ESO 16749/GROUND WATER MONITORING PHASE 2
DEPARTMENT OF ENERGY
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY

Fig. B.1. Hydrogeological characterization study, base map, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.

SCALE: 1" = 1000'	DR RAC	CHK WM	REV MM

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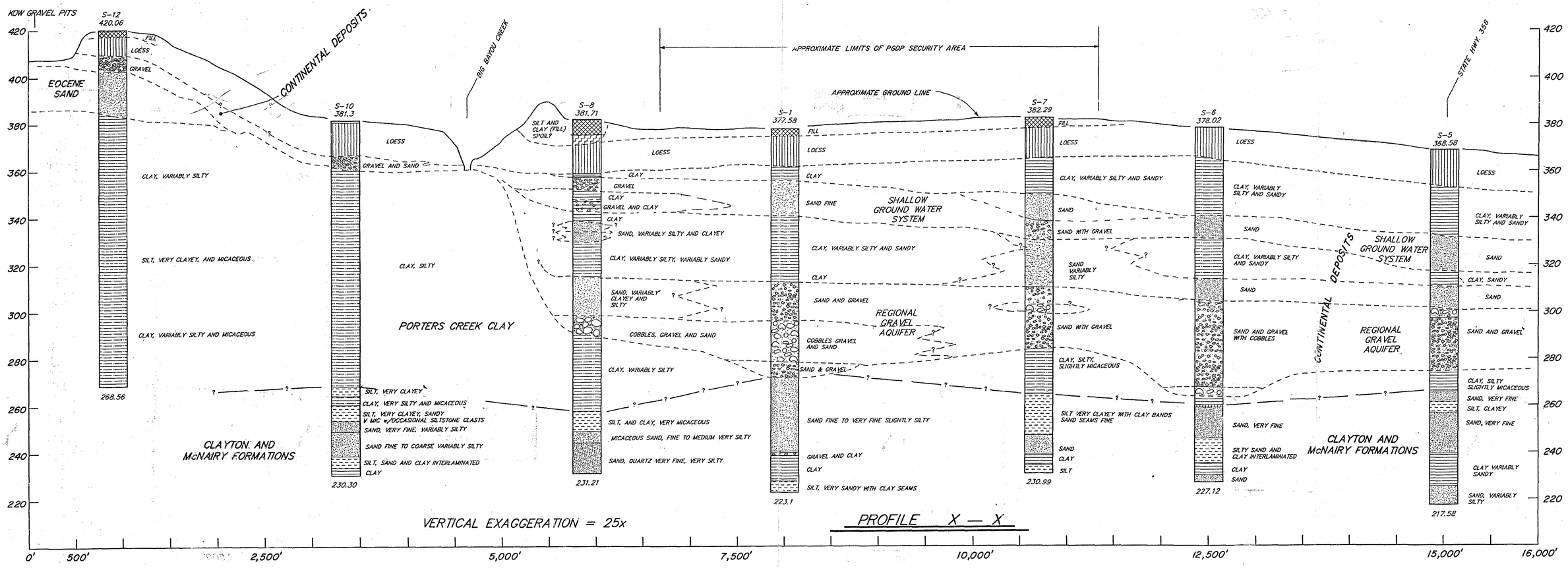
PROJ: X619112	DATE: 05/08/89	G5D16749-B



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ESO 16749 GROUND WATER MONITORING PHASE 2
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PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY

Fig. B.2. Hydrogeological characterization study, generalized stratigraphic correlation, Profile X-X, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.

SCALE: AS SHOWN	DR RAC	CHK WSA	REV VWM

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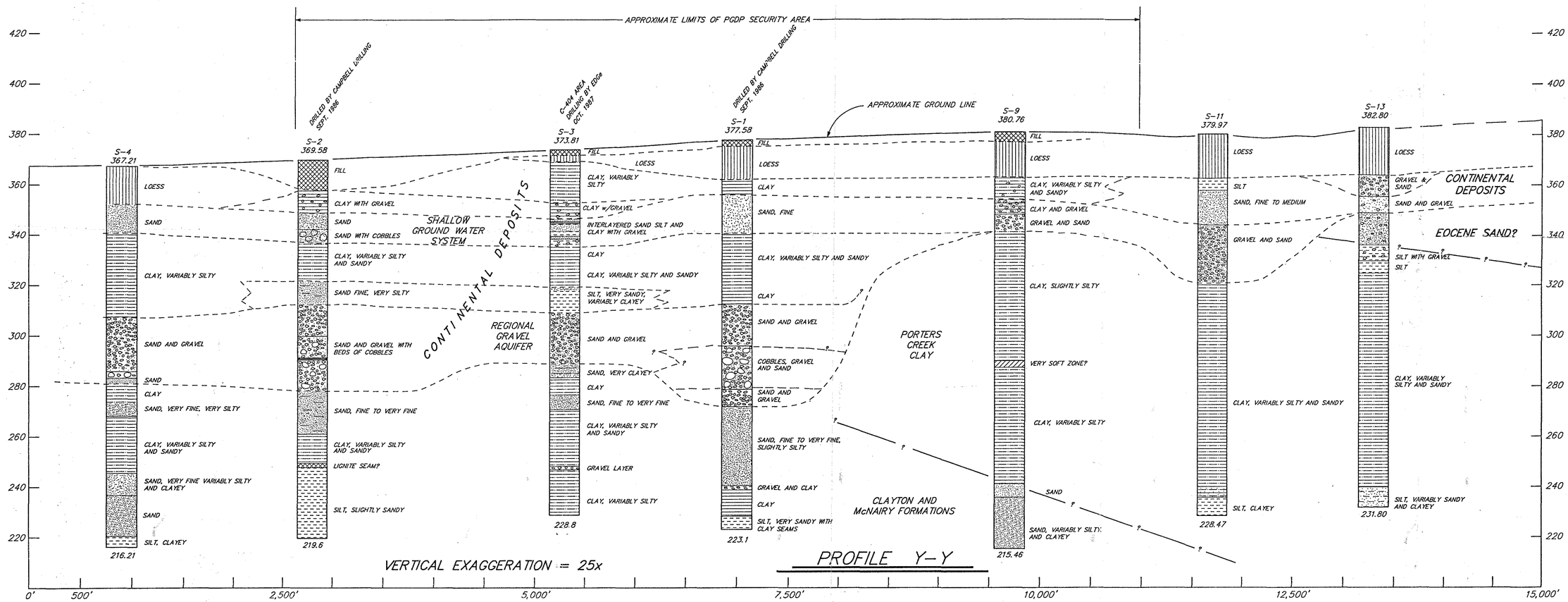

NOTES

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ESO 16749/GROUND WATER MONITORING PHASE 2
DEPARTMENT OF ENERGY
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY

Fig. B.3. Hydrogeological characterization study, generalized stratigraphic correlation, Profile Y-Y, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.

SCALE: AS SHOWN	RAC	WSA	VWMS

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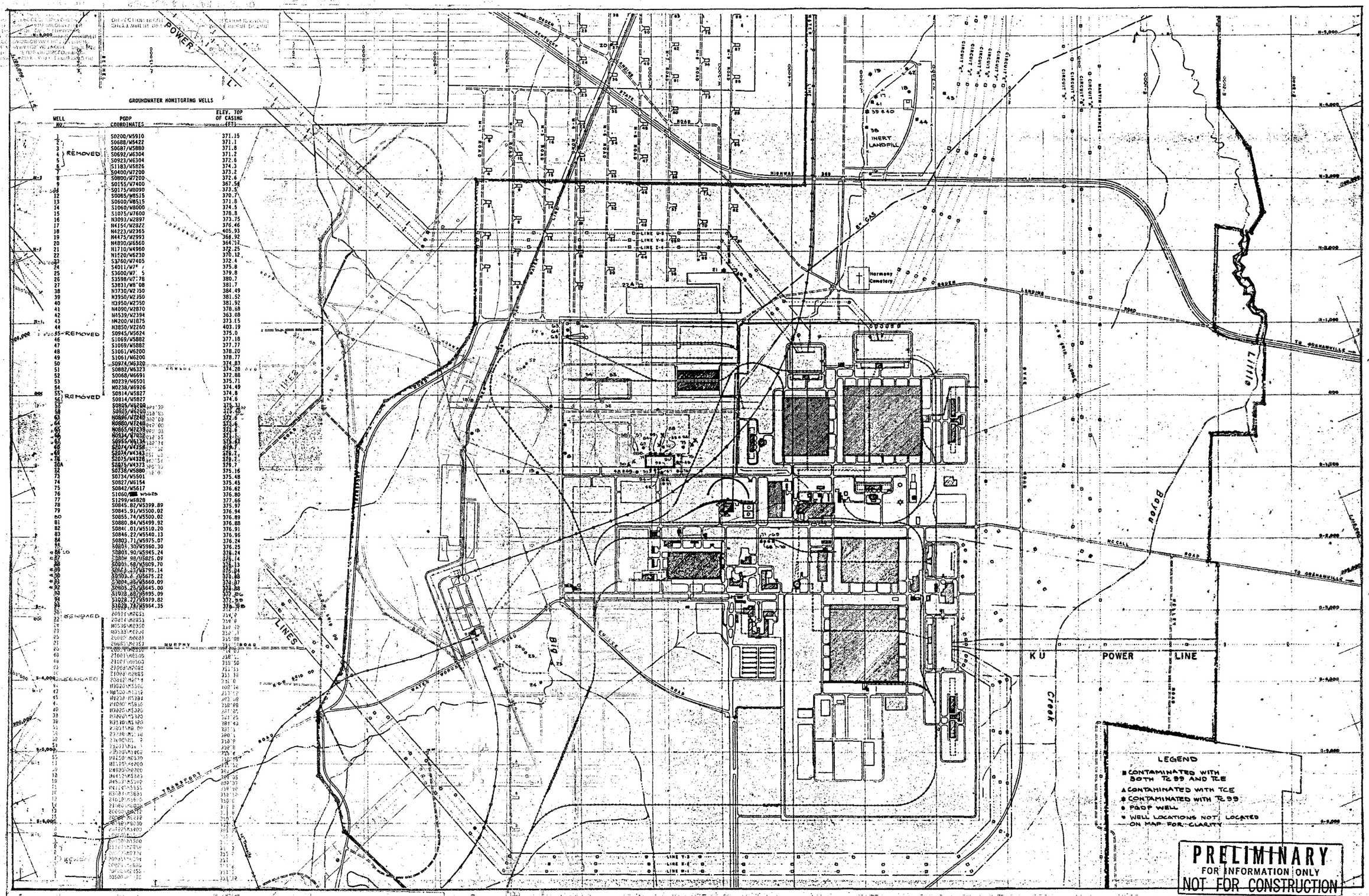

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Fig. E.2-1. Paducah Gaseous Diffusion Plant wells and piezometers.

PGDP WELLS & PIEZOMETER

1	48	49	50	PLANT	BLDG	FL	SHT.	OF
3	C	G	T	PGDP	AREA			

SCALE NONE | ID 16924 | G5E 16924 | A

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