# Argonne National Laboratory-East

# Site Environmental Report
## for Calendar Year 1999

ANL-00/2

By N. W. Golchert and R. G. Kolzow

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ANL-00/2

# ARGONNE NATIONAL LABORATORY-EAST SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1999

by

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**Environment, Safety and Health Division**

**September 2000**


**ARGONNE NATIONAL LABORATORY**
**9700 South Cass Avenue**
**Argonne, Illinois 60439**

**Preceding Report in This Series: ANL-99/3**

# PREFACE

This Site Environmental Report (SER) was prepared by the Environment, Safety and Health (ESH) Division at Argonne National Laboratory-East (ANL-E) for the U.S. Department of Energy. The results of the environmental monitoring program and an assessment of the impact of site operations on the environment and the public are presented in this publication. This SER and those for recent years are available on the Internet at http://www.anl.gov/ESH/anleser/1999.

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# PREFACE

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|---|---|
| **ACM** | Asbestos-Containing Material |
| **AEA** | Atomic Energy Act of 1954 |
| **ANL-E** | Argonne National Laboratory-East |
| **AOC** | Area of Concern |
| **APS** | Advanced Photon Source |
| **$BOD_5$** | Biochemical Oxygen Demand |
| **CAA** | Clean Air Act |
| **CAAPP** | Clean Air Act Permit Program |
| **CAP-88** | Clean Air Act Assessment Package-1988 |
| **CEDE** | Committed Effective Dose Equivalent |
| **CERCLA** | Comprehensive Environmental Response, Compensation and Liability Act |
| **CFR** | Code of Federal Regulations |
| **CLP** | Contract Laboratory Program |
| **COD** | Chemical Oxygen Demand |
| **COE** | U.S. Army Corps of Engineers |
| **CP-5** | Chicago Pile-Five |
| **CRMP** | Cultural Resources Management Plan |
| **CWA** | Clean Water Act |
| **CY** | Calendar Year |
| **D&D** | Decontamination and Decommissioning |
| **DCG** | Derived Concentration Guide |
| **DMR** | Discharge Monitoring Report |
| **DOE** | U.S. Department of Energy |
| **DPCHD** | DuPage County Health Department |
| **EA** | Environmental Assessment |
| **EIS** | Environmental Impact Statement |
| **EML** | Environmental Measurements Laboratory |
| **EMS** | Environmental Protection Data Management System |
| **ENE** | East-Northeast |
| **EPA** | U.S. Environmental Protection Agency |
| **EPCRA** | Emergency Planning and Community Right to Know Act |
| **ERMS** | Emissions Reduction Market System |
| **ESA** | Endangered Species Act |
| **ESH** | Environment, Safety and Health |
| **ESH-ASCL** | Environment, Safety and Health/Analytical Services, Chemical Laboratory |
| **ESH-ASRL** | Environment, Safety and Health/Analytical Services, Radiochemistry Laboratory |
| **FFCA** | Federal Facility Compliance Act |
| **FWS** | U.S. Fish and Wildlife Service |
| **FY** | Fiscal Year |
| **HSWA** | Hazardous and Solid Waste Amendments |
| **IAC** | *Illinois Administrative Code* |
| **ICRP** | International Commission on Radiological Protection |

| | |
|---|---|
| **IDNS** | Illinois Department of Nuclear Safety |
| **IDPH** | Illinois Department of Public Health |
| **IEPA** | Illinois Environmental Protection Agency |
| **IHPA** | Illinois Historic Preservation Agency |
| **IPNS** | Intense Pulsed Neutron Source |
| **ISM** | Integrated Safety Management |
| **LEPC** | Local Emergency Planning Committee |
| **LLW** | Low-Level Radioactive Waste |
| **MSDS** | Material Safety Data Sheet |
| **MW** | Mixed Waste |
| **MY** | Model Year |
| **NBL** | New Brunswick Laboratory |
| **NEPA** | National Environmental Policy Act |
| **NESHAP** | National Emission Standards for Hazardous Air Pollutants |
| **NHPA** | National Historic Preservation Act |
| **NIST** | National Institute of Standards and Technology |
| **NMOC** | Nonmethane Organic Compounds |
| **NPDES** | National Pollutant Discharge Elimination System |
| **NPL** | National Priority List |
| **NRHP** | National Register of Historical Places |
| **O&M** | Operation and Maintenance |
| **PBT** | Persistent, Bioaccumulative Toxic |
| **PCB** | Polychlorinated Biphenyl |
| **PFS** | Plant Facilities and Services |
| **PQL** | Practical Quantification Limit |
| **PSTP** | Proposed Site Treatment Plan |
| **QA** | Quality Assurance |
| **QAP** | Quality Assurance Program |
| **RCRA** | Resource Conservation and Recovery Act |
| **SARA** | Superfund Amendments and Reauthorization Act |
| **SDWA** | Safe Drinking Water Act |
| **SER** | Site Environmental Report |
| **SOP** | Standard Operating Procedure |
| **SIP** | Site Implementation Plan |
| **SSI** | Site Screening Investigation |
| **SVOC** | Semivolatile Organic Compound |
| **SWMU** | Solid Waste Management Unit |
| **SWPPP** | Storm Water Pollution Prevention Plan |
| **TDS** | Total Dissolved Solids |
| **TLD** | Thermoluminescent Dosimeter |
| **TOC** | Total Organic Carbon |
| **TOX** | Total Organic Halogen |
| **TRI** | Toxic Release Inventory |
| **TRU** | Transuranic |

| | |
|---|---|
| **TSCA** | Toxic Substances Control Act |
| **TSS** | Total Suspended Solids |
| **UST** | Underground Storage Tank |
| **VOC** | Volatile Organic Compound |
| **WIPP** | Waste Isolation Pilot Plant |
| **WMO** | Waste Management Operations |
| **WM&PP** | Waste Minimization and Pollution Prevention |
| **WQS** | Water Quality Standard |
| **WTP** | Wastewater Treatment Plant |

# ABSTRACT

This report discusses the results of the environmental protection program at Argonne National Laboratory-East (ANL-E) for 1999. To evaluate the effects of ANL-E operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the ANL-E site were analyzed and compared with applicable guidelines and standards. A variety of radionuclides were measured in air, surface water, on-site groundwater, and bottom sediment samples. In addition, chemical constituents in surface water, groundwater, and ANL-E effluent water were analyzed. External penetrating radiation doses were measured, and the potential for radiation exposure to off-site population groups was estimated. Results are interpreted in terms of the origin of the radioactive and chemical substances (i.e., natural, fallout, ANL-E, and other) and are compared with applicable environmental quality standards. A U.S. Department of Energy dose calculation methodology, based on International Commission on Radiological Protection recommendations and the U.S. Environmental Protection Agency's CAP-88 (Clean Air Act Assessment Package-1988) computer code, was used in preparing this report. The status of ANL-E environmental protection activities with respect to the various laws and regulations that govern waste handling and disposal is discussed, along with the progress of environmental corrective actions and restoration projects.

This report summarizes the ongoing environmental protection program conducted by Argonne National Laboratory-East (ANL-E) in 1999. It includes descriptions of the site, ANL-E missions and programs, the status of compliance with environmental regulations, environmental protection and restoration activities, and the environmental surveillance program. The surveillance program conducts regular monitoring for radiation, radioactive materials, and nonradiological constituents on the ANL-E site and in the surrounding region. These activities document compliance with appropriate standards and permit limits, identify trends, provide information to the public, and contribute to a better understanding of ANL-E's impact on the environment. The surveillance program supports the ANL-E policy of protecting the public, employees, and the environment from harm that could be caused by ANL-E activities and of reducing environmental impacts to the greatest degree practicable.

## Compliance Summary

Radionuclide emissions, the management of asbestos, and conventional air pollutants from ANL-E facilities are regulated under the Clean Air Act (CAA). A number of airborne radiological emission points at ANL-E are subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for radionuclide releases from U.S. Department of Energy (DOE) facilities (*Code of Federal Regulations*, Title 40, Part 61, Subpart H [40 CFR Part 61, Subpart H]). All such air emission sources were evaluated to ensure that these requirements are being addressed properly. The ANL-E individual off-site dose required to be reported by U.S. Environmental Protection Agency (EPA) regulations in 1999 was 0.0043 mrem/yr. This is 0.04% of the 10 mrem/yr standard. This dose does not include contributions from radon-220 and radon-222 emissions, as required by the regulations.

At ANL-E, asbestos-containing material (ACM) frequently is encountered during maintenance or renovation of existing facilities and equipment. Asbestos is removed and disposed of in strict accordance with NESHAP, Toxic Substances Control Act (TSCA), and Occupational Safety and Health Administration worker protection standards. Approximately 170 $m^3$ (6,000 $ft^3$) of ACM was removed and disposed of at off-site landfills in Illinois during 1999.

The ANL-E site contains several sources of conventional air pollutants. The steam plant and fuel dispensing facilities operate continuously and are the only significant sources of continuous air pollutants. The emergency generators at the Advanced Photon Source (APS) and the engine test facility are also significant sources, when operational. The air pollution control operating permit for the steam plant requires continuous opacity and sulfur dioxide monitoring of the smoke stack from Boiler No. 5, the only boiler equipped to burn coal. Low-sulfur coal was burned as the fuel for the steam plant for five months during 1999, whereas natural gas was used as the fuel at that boiler for the other seven months of the year. During the period coal was burned, which occurred during colder

weather to supplement the other gas-fired boilers, one exceedance for opacity was observed on April 15, 1999, due to torn filters and a leaking gasket.

The goals of the Clean Water Act are achieved primarily through the National Pollutant Discharge Elimination System (NPDES) permit program. The federal government has delegated implementation of the NPDES program to the State of Illinois. The renewal of the ANL-E NPDES permit, effective October 30, 1994, increased the number of monitored discharge points from 9 to 28. The permit was modified on August 24, 1995, to increase temporarily to July 1, 1999, some discharge limits during the three-year compliance schedule imposed to achieve final limits. During 1999, only eight exceedances of the NPDES permit limits were reported out of approximately 1,600 measurements. An application to renew the existing permit was submitted timely to the Illinois Environmental Protection Agency (IEPA) during December 1998. The IEPA did not act to review the permit renewal application in 1999, and, therefore, as provided for in the IEPA regulations, ANL-E continues to operate under the 1994 permits, as modified, until a renewal permit is issued.

ANL-E was granted interim status under the Resource Conservation and Recovery Act (RCRA) upon submitting a Part A Permit application in 1980. The IEPA issued a RCRA Part B Permit on September 30, 1997, which became effective on November 4, 1997. The permit addresses 25 hazardous waste treatment and storage facilities and establishes corrective action procedures and requirements for 49 Solid Waste Management Units (SWMUs) and 3 Areas of Concern. Since the issuance of the permit, two additional SWMUs have been added to the permit.

ANL-E has prepared and implemented a sitewide underground storage tank (UST) compliance plan. Thirty-nine tanks have been removed over the past several years. The ANL-E site contains 19 USTs that are in compliance with UST regulations. One UST used for fuel oil storage was removed during 1999.

The only TSCA-regulated compounds in significant quantities at ANL-E are polychlorinated biphenyls (PCBs) contained in electrical capacitors, power suppliers, and small transformers. All pole-mounted transformers and circuit breakers containing PCBs were replaced or retrofilled with non-PCB oil. All removal and disposal activities were conducted by licensed contractors specializing in such operations. PCB-contaminated sludge from the ANL-E wastewater treatment plant was characterized, containerized, and stored during 1994. The ANL-E PCB Item Inventory Program was initiated in 1995 to identify all suspect PCB-containing items.

DOE implementation of National Environmental Policy Act (NEPA) requirements has undergone significant changes since 1992. In 1999, most NEPA project reviews submitted to DOE for review and approval were determined to be categorical exclusions. Two Environmental Assessment (EA) addendums, addressing the 319 Landfill Remediation-Drainage Reroute and the Boiler House SWMU Sampling and Remediation activities, respectively, were completed in 1999.

The ANL-E Environmental Management Plan identifies funding needs for on-site rehabilitation projects, environmental restoration projects, and waste management activities. The rehabilitation projects concentrate on upgrading or replacing existing treatment facilities. ANL-E environmental restoration activities consist of projects that assess and clean up inactive waste sites. These include two inactive landfills, three French drains (i.e., dry wells used to dispose of liquid chemicals), two inactive wastewater treatment facilities, and a number of areas that may have been contaminated with small amounts of hazardous chemicals.

On-going compliance issues at ANL-E during 1999 were effluent concentrations of total dissolved solids (TDS) and total suspended solids (TSS) in excess of NPDES permit effluent limits; elevated levels of some routine indicator parameters in the groundwater at the sanitary landfill; and cleanup of environmental contamination caused by previous activities on the ANL-E site.

## Environmental Surveillance Program

Airborne emissions of radioactive materials from ANL-E were monitored during 1999. The effective dose equivalents were estimated at the site perimeter and to the maximally exposed member of the public with the EPA's CAP-88 (CAA Assessment Package-1988) computer code. The estimated maximum perimeter dose was 0.063 mrem/yr in the southwest direction, while the estimated maximum dose to a member of the public was 0.015 mrem/yr. This is 0.015% of the DOE radiation protection standard of 100 mrem/yr for all pathways. Approximately 65% of this estimated dose is due to the release of 193 Ci of radon-220 in 1999. If the contribution of radon-220 is excluded from reporting, as required by 40 CFR Part 61, Subpart H, the estimated dose to the maximally exposed individual would be 0.0043 mrem/yr. The estimated population dose from releases to the approximately eight million people living within 80 km (50 mi) of the site was 0.97 man-rem.

Ambient air monitoring was conducted for total alpha activity, total beta activity, strontium-90, isotopic thorium, isotopic uranium, and plutonium-239 at the ANL-E site perimeter and at off-site locations. No statistically significant difference was identified between samples collected at the ANL-E perimeter and samples collected off site. Monitoring was not conducted for hazardous chemical constituents in ambient air.

The only detectable radionuclides and chemical pollutants in surface water due to ANL-E releases was in Sawmill Creek below the wastewater discharge point. At various times, measurable levels of hydrogen-3, strontium-90, plutonium-239, and americium-241 were detected. Of these radionuclides, the maximum annual release was 0.68 Ci of hydrogen-3. The hydrogen-3 was added to the wastewater as part of normal ANL-E operations. The dose to a hypothetical individual using water from Sawmill Creek as his or her sole source of drinking water would be 0.047 mrem/yr. However, no one uses this water for drinking, and dilution by the Des Plaines River reduces the

concentrations of the measured radionuclides to levels below their respective detection limits downstream from ANL-E at Lemont. Sawmill Creek also is monitored for nonradiological constituents to demonstrate compliance with State of Illinois water quality standards. Iron and copper occasionally were detected above the standards.

Sediment samples were collected from Sawmill Creek, above, at, and below the point of wastewater treatment plant effluent discharge. Elevated levels of plutonium-239 (up to 0.362 pCi/g) and americium-241 (up to 0.118 pCi/g) were detected in the sediment below the outfall and are attributed to past ANL-E releases.

Dose rates from penetrating radiation (gamma-rays) were measured at 17 perimeter and on-site locations and at five off-site locations in 1999 using thermoluminescent dosimeters. The off-site results averaged 80 ± 4 mrem/yr, which is consistent with the long-term average. Above-background doses occurred at one perimeter location and were due to ANL-E operations. At the south fence, radiation from a temporary storage facility for radioactive waste resulted in an average dose of 105 ± 21 mrem/yr for 1999. The estimated dose from penetrating radiation to the nearest resident south of the site was < 0.01 mrem/yr.

The potential radiation doses to members of the public from ANL-E operations during 1999 were estimated by combining the exposure from inhalation, ingestion, and direct radiation pathways. The inhalation pathway dominates. The highest estimated dose was approximately 0.076 mrem/yr to individuals living 500 m (1,640 ft) north of the site if they were outdoors at that location during the entire year. Estimated doses from other pathways at this location were small. The doses from ANL-E operations are well within all applicable standards and are insignificant when compared with doses received by the public from natural radiation (≈300 mrem/yr) or other sources, for example, medical x-rays and consumer products (≈60 mrem/yr).

Radiological and chemical constituents in the groundwater were monitored in several areas of the ANL-E site in 1999. The former ANL-E domestic water supply is monitored by collecting quarterly samples from the three inactive supply wells. All results were less than the limits established by the Safe Drinking Water Act, except for elevated levels of TDS.

Ten monitoring wells screened in the glacial till and two in the dolomite were sampled quarterly at the 317 and 319 Areas and analyzed for radiological, volatile organic, semivolatile, PCB, and pesticide and herbicide constituents. The major organic contaminants detected were carbon tetrachloride, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethane, and tetrachloroethene. Measurable levels of hydrogen-3, strontium-90, and cesium-137 were present in several of the wells. Remediation continued in this area using phytoremediation to remove volatile organic compounds (VOCs) and hydrogen-3 from groundwater.

Three monitoring wells are screened in the glacial till and one in the dolomite adjacent to the CP-5 reactor. These wells were sampled quarterly, and samples were analyzed for selected radionuclides, metals, VOCs, semivolatile organic compounds (SVOCs), pesticides, herbicides, and PCBs. Measurable levels of hydrogen-3 and strontium-90 were detected regularly, while cesium-137 was detected occasionally. Low levels of trichlorofluoromethane were detected, in addition to a few metals.

Thirteen monitoring wells at the 800 Area sanitary landfill were sampled on a quarterly basis and analyzed for metals, cyanide, phenols, total organic carbon, total organic halogens, VOCs, semivolatiles, PCBs, pesticides and herbicides, and hydrogen-3. An additional 13 wells were added under a Supplemental Permit issued June 16, 1999. Levels above Illinois Class I Groundwater Quality Standards for chloride, iron, lead, manganese, and TDS were found in some wells. Above-background levels of hydrogen-3 were detected in several of the wells.

An extensive quality assurance program is maintained to cover all aspects of the environmental surveillance sampling and analysis programs. Approved documents are in place, along with supporting standard operating procedures. Newly collected data were compared with recent results and historical data to ensure that deviations from previous conditions were identified and evaluated promptly. Samples at all locations were collected using well-established and documented procedures to ensure consistency. Samples were analyzed by documented standard analytical procedures. Data quality was verified by a continuing program of analytical laboratory quality control, participation in interlaboratory cross-checks, and replicate sampling and analysis. Data were managed and tracked by a dedicated computerized data management system that assigns unique sample numbers, schedules collection and analysis, checks status, and prepares tables and information for the annual report.

ANL-E maintains a documented environmental management system that identifies responsibilities for environmental activities. ANL-E is committed to implementing that system in accordance with environmental policy.

# 1. INTRODUCTION

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## 1.1. General

This annual report for 1999 on the Argonne National Laboratory-East (ANL-E) environmental protection program was prepared to inform the U.S. Department of Energy (DOE), environmental agencies, and the public about the levels of radioactive and chemical pollutants in the vicinity of ANL-E, and the amounts, if any, added to the environment by ANL-E operations. It also summarizes the compliance of ANL-E operations with applicable environmental laws and regulations and highlights significant accomplishments and problems related to environmental protection. The report was prepared in accordance with the guidelines of DOE Orders 5400.1[1] and 231.1[2] and supplemental DOE guidance.

ANL-E conducts an environmental surveillance program on and near the site to determine the identity, magnitude, and origin of radioactive and chemical substances in the environment. The detection of any releases of such materials to the environment from ANL-E operations is of special interest, because one important function of this program is verification of the adequacy of the site's pollution control systems.

ANL-E is a DOE research and development laboratory with several principal objectives. It conducts a broad program of research in the basic energy and related sciences (i.e., physical, chemical, material, computer, nuclear, biomedical, and environmental) and serves as an important engineering center for the study of nuclear and nonnuclear energy sources. Energy-related research projects conducted during 1999 included safety studies for light-water reactors; high-temperature superconductivity experiments; development of electrochemical energy sources, including fuel cells and batteries for vehicles and for energy storage; evaluation of heat exchangers for the recovery of waste heat from engines; and clean, efficient transportation.

Other areas of research are basic biological research, heavy-ion research into the properties of super-heavy elements, fundamental coal chemistry studies, the immobilization of radioactive waste products for safe disposal, fundamental studies of advanced computers, and the development of "chips" for the rapid assay of gene composition. Environmental research studies include the biological activity of energy-related mutagens and carcinogens; characterization and monitoring of energy-related pollutants; and new technologies for cleaning up environmental contaminants. A significant number of these laboratory studies require the controlled use of radioactive and chemically toxic substances.

The principal radiological facilities at ANL-E are the Advanced Photon Source (APS); a superconducting heavy-ion linear accelerator (Argonne Tandem Linac Accelerating System [ATLAS]); a 22-MeV pulsed electron linac; several other charged-particle accelerators (principally of the Van de Graaff and Dynamitron types); a large fast neutron source (Intense Pulsed Neutron Source [IPNS]) in which high-energy protons strike a uranium target to produce neutrons; chemical and metallurgical laboratories; and several hot cells and laboratories designed for work with

multicurie quantities of the actinide elements and with irradiated reactor fuel materials. The DOE New Brunswick Laboratory (NBL), a safeguards plutonium and uranium measurements and analytical chemistry laboratory, is located on the ANL-E site.

The principal nonnuclear activities at ANL-E in 1999 that could have measurable impacts on the environment include the use of a coal-fired boiler (No. 5) and the use of chlorine for water treatment.

## 1.2. Description of Site

ANL-E occupies the central 607 ha (1,500 acres) of a 1,514-ha (3,740-acre) tract in DuPage County. The site is 43 km (27 mi) southwest of downtown Chicago and 39 km (24 mi) west of Lake Michigan. It is north of the Des Plaines River Valley, south of Interstate Highway 55 (I-55), and west of Illinois Highway 83. Figures 1.1 and 1.2 are maps of the site, the surrounding area, and sampling locations of the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the ANL-E site before it was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreational area, nature preserve, and demonstration forest. In this report, facilities are identified by the alphanumeric designations in Figure 1.1 to facilitate their location.

The terrain of ANL-E is gently rolling, partially wooded, former prairie and farmland. The grounds contain a number of small ponds and streams. The principal stream is Sawmill Creek, which runs through the site in a southerly direction and enters the Des Plaines River about 2.1 km (1.3 mi) southeast of the center of the site. The land is drained primarily by Sawmill Creek, although the extreme southern portion drains directly into the Des Plaines River, which flows along the southern boundary of the forest preserve. This river flows southwest until it joins the Kankakee River about 48 km (30 mi) southwest of ANL-E to form the Illinois River.

The largest topographical feature of the area is the Des Plaines River valley, which is about 1.6 km (1 mi) wide. This valley contains the river, the Chicago Sanitary and Ship Canal, and the Illinois and Michigan Canal. The elevation of the channel surface of these waterways is 180 m (578 ft) above sea level. The bluffs that form the southern border of the site rise from the river channel at slope angles of 15 to 60$^{o}$ and reach an average elevation of 200 m (650 ft) above sea level at the top. The land then slopes gradually upward and reaches the average site elevation of 220 m (725 ft) above sea level at 915 m (3,000 ft) from the bluffs. Several large ravines oriented in a north-south direction are located in the southern portion of the site. The bluffs and ravines generally are forested with mature deciduous trees. The remaining portion of the site changes in elevation by no more than 7.6 m (25 ft) in a horizontal distance of 150 m (500 ft). The Chicago District Pipe Line Co. and the Burlington Northern Santa Fe Railroad have rights-of-way in the southern portion of the forest preserve.

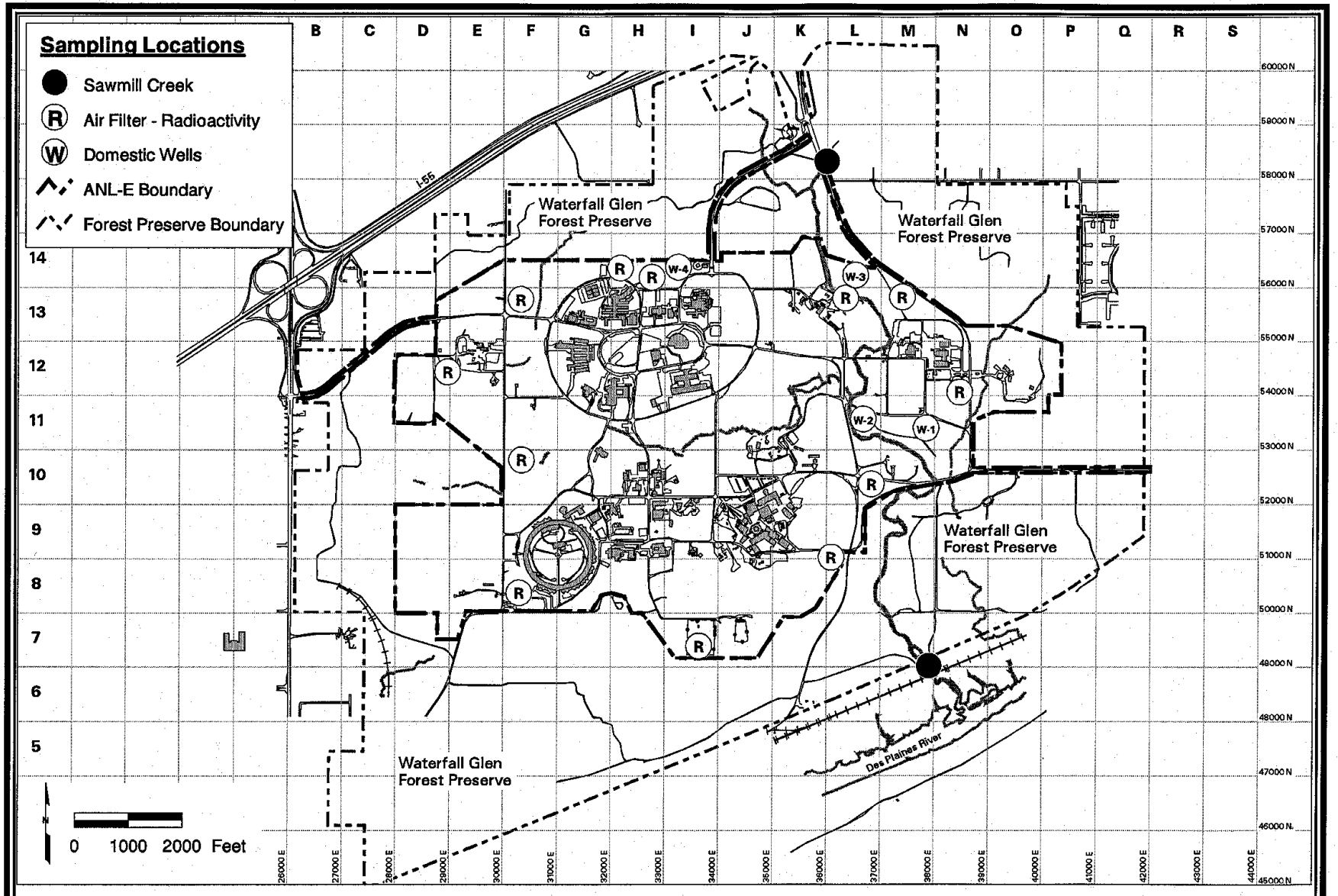


**Figure 1.1** Sampling Locations at Argonne National Laboratory-East

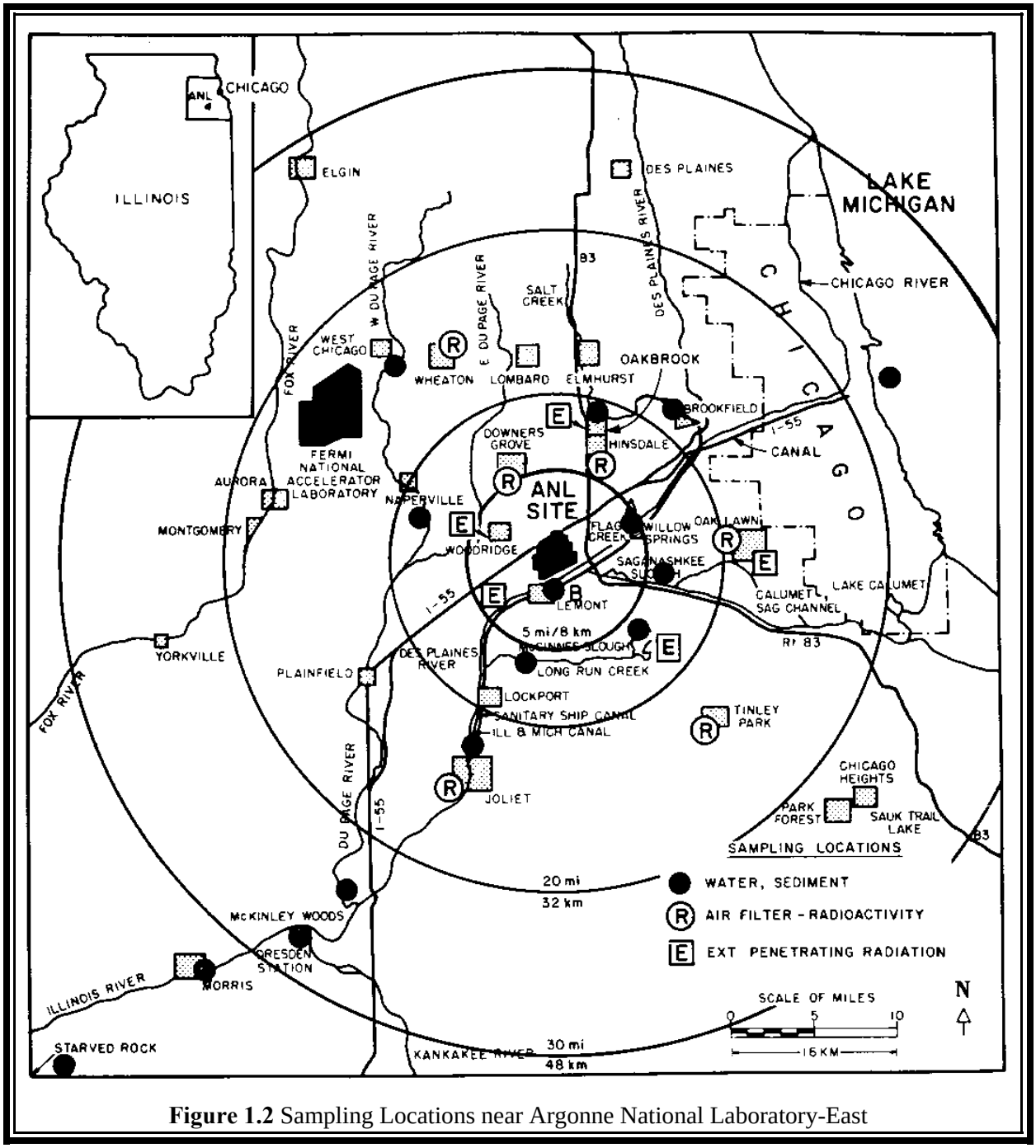


**Figure 1.2** Sampling Locations near Argonne National Laboratory-East

## 1.3. Population

The area around ANL-E has experienced a large population growth in the past 30 years. Large areas of farmland have been converted into housing. Table 1.1 gives the directional and annular 80-km (50-mi) population distribution for the area, which is used to derive the population dose calculations presented later in this report. The population distribution, centered on the Chicago Pile-5 (CP-5) reactor (Location 9G in Figure 1.1), was prepared by the Risk Assessment and Safety Evaluation Group of the Environmental Assessment Division at ANL-E and represents projections to 1997, on the basis of 1990 census data.

## 1.4. Climatology

The climate of the area is representative of the upper Mississippi Valley, as moderated by Lake Michigan. Summaries of the meteorological data collected on the site from 1950 to 1964 are available[3] and provide a historical sample of the climatic conditions. The most important meteorological parameters for the purposes of this report are wind direction, wind speed, temperature, and precipitation. The wind data are used to select air sampling locations and distances from sources and to calculate radiation doses from air emissions. Temperature and precipitation data are useful in interpreting some of the monitoring results. The 1999 data were obtained from the on-site ANL-E meteorological station. The 1999 average monthly and annual wind rose at the 60-m (200-ft) level is shown in Figure 1.3. The wind rose is a polar coordinate plot in which the lengths of the radii represent the percentage frequency of wind speeds in classes of 2.01 – 6 m/s (4.5 – 13.4 mph), 6.01 – 10 m/s (13.4 – 22.4 mph), and greater than 10.01 m/s (22.4 mph). The number in the center of the wind rose represents the percentage of observations of wind speed less than 2 m/s (4.5 mph) in all directions. The direction of the radii from the center represents the direction from which the wind blows. Sixteen radii are shown on each plot at 22.5$^{o}$ intervals; each radius represents the average wind speed for the direction covering 11.25$^{o}$ on either side of the radius.

The annual average wind rose for 1999 is consistent with the long-term average wind direction, which usually varies from the west to south, but with a significant northeast component. Table 1.2 gives 1999 precipitation and temperature data. The monthly precipitation data for 1999 showed a few differences from the average. The early part of the year had less precipitation than normal while the spring was wetter than the average. The annual average was very similar to the long-term average. The temperatures are generally higher when compared with the long-term averages.

**TABLE 1.1**

Population Distribution in the Vicinity of ANL-E, 1997

| | Miles[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Direction | 0 – 1 | 1 – 2 | 2 – 3 | 3 – 4 | 4 – 5 | 5 – 10 | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 |
| N | 0 | 1,120 | 2,884 | 6,245 | 8,613 | 46,331 | 174,570 | 345,014 | 212,982 | 261,504 |
| NNE | 0 | 898 | 3,573 | 6,846 | 7,168 | 44,197 | 287,496 | 463,950 | 95,266 | 2,047 |
| NE | 0 | 748 | 2,203 | 2,255 | 2,125 | 42,131 | 642,743 | 930,802 | 0 | 0 |
| ENE | 0 | 333 | 1,057 | 1,615 | 1,989 | 33,508 | 569,089 | 180,886 | 0 | 0 |
| E | 0 | 335 | 985 | 954 | 462 | 41,692 | 463,141 | 206,619 | 9,217 | 26,320 |
| ESE | 0 | 373 | 882 | 1,161 | 541 | 19,213 | 199,976 | 291,723 | 230,482 | 87,179 |
| SE | 0 | 468 | 900 | 1,192 | 1,109 | 22,696 | 131,492 | 120,061 | 34,063 | 17,926 |
| SSE | 0 | 521 | 900 | 937 | 1,418 | 14,904 | 40,179 | 12,562 | 11,807 | 15,974 |
| S | 0 | 543 | 900 | 1,007 | 1,275 | 6,807 | 28,223 | 6,226 | 36,775 | 37,107 |
| SSW | 0 | 497 | 740 | 898 | 1,063 | 18,028 | 91,686 | 17,430 | 16,371 | 6,348 |
| SW | 0 | 353 | 594 | 637 | 647 | 9,521 | 48,150 | 11,398 | 16,652 | 6,793 |
| WSW | 0 | 333 | 394 | 984 | 2,742 | 9,950 | 11,068 | 5,649 | 8,196 | 14,320 |
| W | 0 | 370 | 2,964 | 7,810 | 9,200 | 30,181 | 65,457 | 20,082 | 16,193 | 5,718 |
| WNW | 0 | 1,022 | 3,573 | 7,777 | 6,817 | 52,201 | 138,763 | 34,280 | 8,780 | 53,815 |
| NW | 0 | 1,361 | 2,793 | 7,075 | 8,755 | 46,680 | 83,890 | 101,417 | 24,562 | 17,492 |
| NNW | 0 | 1,361 | 2,756 | 5,798 | 9,150 | 40,435 | 200,789 | 268,137 | 144,672 | 113,070 |
| Total | 0 | 10,636 | 28,098 | 53,191 | 63,074 | 478,475 | 3,176,712 | 3,016,236 | 866,018 | 665,613 |
| Cumulative total[b] | 0 | 10,636 | 38,734 | 91,925 | 154,999 | 633,474 | 3,810,186 | 6,826,422 | 7,692,440 | 8,358,053 |

[a] To convert from miles to kilometers, multiply by 1.6.

[b] Cumulative total = the total of this sector plus the totals of all previous sectors.

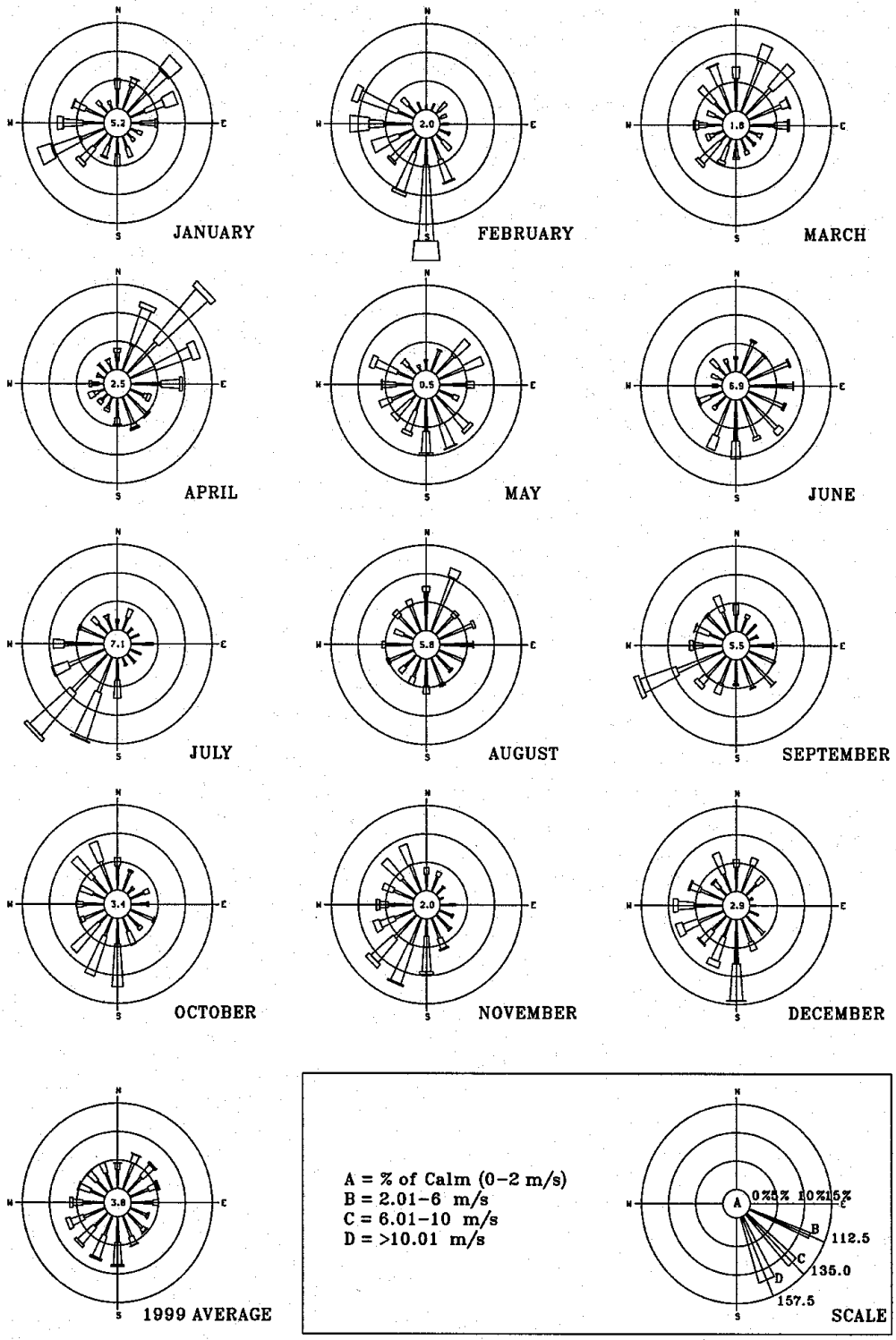


**Figure 1.3** Monthly and Annual Wind Roses at Argonne National Laboratory-East, 1999

**TABLE 1.2**

ANL-E Weather Summary, 1999

| Month | Average Precipitation (cm) | | | Average Temperature (°C) | | |
|---|---|---|---|---|---|---|
| | ANL-E 1999 | ANL-E Historical[a] | Historical[b] | ANL-E 1999 | ANL-E Historical[a] | Historical[b] |
| January | 2.53 | 3.61 | 4.06 | -5.8 | -5.9 | -5.9 |
| February | 1.22 | 3.38 | 3.33 | 2.6 | -3.7 | -3.3 |
| March | 2.77 | 5.56 | 6.58 | 1.8 | 0.6 | 2.2 |
| April | 18.59 | 9.14 | 9.30 | 10.7 | 8.3 | 9.3 |
| May | 14.96 | 7.82 | 8.00 | 17.1 | 14.5 | 15.1 |
| June | 9.14 | 9.47 | 10.36 | 21.2 | 19.7 | 20.3 |
| July | 5.43 | 10.97 | 9.22 | 25.5 | 21.7 | 22.8 |
| August | 7.98 | 8.71 | 8.97 | 21.2 | 20.9 | 22.2 |
| September | 8.31 | 7.14 | 8.51 | 17.9 | 16.8 | 18.2 |
| October | 2.16 | 6.58 | 5.79 | 11.7 | 11.4 | 11.9 |
| November | 2.24 | 4.37 | 5.23 | 7.7 | 2.9 | 4.3 |
| December | 6.08 | 3.20 | 5.33 | -1.1 | -4.2 | -2.4 |
| Total | 81.41 | 79.95 | 84.68 | | | |

[a] ANL-E data obtained from Reference 3.

[b] Data obtained from the National Oceanic and Atmospheric Administration for the weather station at O'Hare International Airport. The average is for the years 1951–1980.

## 1.5. Geology

The geology of the ANL-E area consists of about 30 m (100 ft) of glacial till on top of bedrock, which is Niagaran and Alexandrian dolomite, underlain by shale and older dolomites and sandstones of Ordovician and Cambrian age. The beds are nearly horizontal, although the top of the dolomite may not be horizontal. Niagaran and Alexandrian dolomite is approximately 60 m (200 ft) thick and widely used in DuPage County as a source of groundwater. The shale separating the upper dolomite aquifer from the underlying sandstone and dolomite aquifers retards the hydraulic connection between them. The lower aquifer has a much lower piezometric level and does not appear to be affected by pumpage from the overlying bedrock.

The southern boundary of ANL-E follows the escarpment of a broad valley, which is now occupied by the Des Plaines River and the Chicago Sanitary and Ship Canal. This valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 to 14,000 years ago. The soils on

the site were derived from glacial till over the past 12,000 years and are primarily of the Morley series, that is, moderately well-drained upland soils with a slope ranging from 2 to 20%. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial till. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. These soils are well suited to growing crops if good erosion control practices are used. The remaining soils along creeks, intermittent streams, bottomlands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic-matter content, and a large water capacity.

## 1.6. Seismicity

No tectonic features within 135 km (62 mi) of ANL-E are known to be seismically active. The longest of these features is the Sandwich Fault. Smaller local features are the Des Plaines disturbance, a few faults in the Chicago area, and a fault of apparently Cambrian age.

Although a few minor earthquakes have occurred in northern Illinois, none have been positively associated with particular tectonic features. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the earth's crust in response to glacial loading and unloading, rather than by motion along crustal plate boundaries.

Several areas of considerable seismic activity are located at moderate distances (i.e., hundreds of kilometers) from ANL-E. These areas include the New Madrid Fault zone (southeast Missouri) in the St. Louis area, the Wabash Valley Fault zone along the southern Illinois-Indiana border, and the Anna region of western Ohio. Although high-intensity earthquakes have occurred along the New Madrid Fault zone, their relationship to plate motions remains speculative at this time.

According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the ANL-E area may exceed 10% of gravity (the approximate threshold of major damage) once in approximately 600 years, with an error range of -250 to +450 years.

## 1.7. Hydrology

Up until 1997, most groundwater supplies in the ANL-E area were derived from the Niagaran, and to some extent, the Alexandrian dolomite bedrock. Dolomite well yields are variable, but many approach 3,028 L/min (800 gal/min). In DuPage County, groundwater pumpage over the past 100 years has led to severe overdraft; in northeastern Illinois, the piezometric surface has been

lowered in areas of heavy pumping. Delivery of Lake Michigan water to the major suburban areas is expected to relieve this problem. Because the cones of depression of ANL-E wells do not extend beyond the site and adjacent forest preserve, ANL-E water use does not affect neighboring communities. With the acquisition of Lake Michigan water in 1997, the recovery of the dolomite water table is being measured.

Two principal aquifers are used as water supplies in the vicinity of ANL-E. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the ANL-E area and has a piezometric surface between 15 and 30 m (50 and 100 ft) below the ground surface for much of the site. The lower aquifer is Galesville sandstone, which lies between 150 and 450 m (500 and 1,500 ft) below the surface. Maquoketa shale separates the upper dolomite aquifer from the underlying sandstone aquifer. This shale retards the hydraulic connection between the two aquifers.

## 1.8. Water and Land Use

Sawmill Creek flows through the eastern portion of the site. This stream originates north of the site, flows through the property in a southerly direction, and discharges into the Des Plaines River. Two small streams, one originating on site and the other just off site, which enter the site from the western boundary, combine to form Freund Brook, which discharges into Sawmill Creek. Along the southern margin of the property, the terrain slopes abruptly downward forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge some site drainage into the Des Plaines River. In addition to the streams, various ponds and cattail marshes are present on the site. A network of ditches and culverts transports surface runoff toward the smaller streams.

The greater portion of the ANL-E site is drained by Freund Brook. Two intermittent branches of Freund Brook flow from west to east, drain the interior portion of the site, and ultimately discharge into Sawmill Creek. The larger, south branch originates in a marsh adjacent to the western boundary line of the site. It traverses wooded terrain for a distance of about 2 km (1.5 mi) before discharging into the Lower Freund Pond. The upper Freund Brook branch also discharges into the Lower Freund Pond.

Residential and commercial development in the area have resulted in the collection and channeling of runoff water into Sawmill Creek. Treated sanitary and laboratory wastewater from ANL-E are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 1999, this effluent averaged 2.9 million L/day (0.78 million gal/day), which is slightly higher than the averages for the last few years. The combined ANL-E effluent consisted of 49% laboratory wastewater and 51% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 32 million L/day (8.5 million gal/day) during 1999.

Sawmill Creek and the Des Plaines River above Joliet, about 21 km (13 mi) southwest of ANL-E, receive very little recreational or industrial use. A few people fish in these waters downstream of ANL-E, and some duck hunting takes place on the Des Plaines River. Water from the Chicago Sanitary and Ship Canal is used by ANL-E for cooling towers and by others for industrial purposes, such as hydroelectric generators and condensers, and for irrigation at the state prison near Joliet. ANL-E usage is approximately 1.1 million L/day (290,000 gal/day). The canal, which receives Chicago Metropolitan Sanitary District effluent water, is used for industrial transportation and some recreational boating. Near Joliet, the river and canal combine into one waterway, which continues until it joins the Kankakee River to form the Illinois River about 48 km (30 mi) southwest of ANL-E. The Dresden Nuclear Power Station complex is located at the confluence of the Kankakee, Des Plaines, and Illinois Rivers. This station uses water from the Kankakee River for cooling and discharges the water into the Illinois River. The first downstream location where water is used as a community water supply system is at Peoria, which is on the Illinois River about 240 km (150 mi) downstream of ANL-E. In the vicinity of ANL-E, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near ANL-E is the Waterfall Glen Forest Preserve, which surrounds the site (see Section 1.2 and Figure 1.1). The area is used for hiking, skiing, and horseback riding. Sawmill Creek flows south through the eastern portion of the preserve on its way to the Des Plaines River. Several large forest preserves of the Forest Preserve District of Cook County are located east and southeast of ANL-E and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs (shown in Figure 1.2), as well as other smaller lakes. These areas are used for picnicking, boating, fishing, and hiking. A small park located in the eastern portion of the ANL-E site (Location 12-0 in Figure 1.1) is for the use of ANL-E and DOE employees. A local municipality has use of the park for athletic events.

## 1.9. Vegetation

ANL-E lies within the Prairie Peninsula of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tall-grass prairie occurring in glaciated portions of Illinois, northwest Indiana, southern Wisconsin, and sections of other states. Much of the natural vegetation of this area has been modified by clearing and tillage. Forests in the ANL-E region, which are predominantly oak and hickory, are somewhat limited to slopes of shallow, ill-defined ravines or low morainal ridges. Gently rolling to flat intervening areas between ridges and ravines were predominantly occupied by prairie before their use for agriculture. The prevailing successional trend on these areas, in the absence of cultivation, is toward oak-hickory forest. Forest dominated by sugar maple, red oak, and basswood may occupy more pronounced slopes. Poorly drained areas, streamside communities, and floodplains may support forests dominated by silver maple, elm, and cottonwood.

Early photographs of the site indicate that most of the land that ANL-E now occupies was actively farmed. About 75% was plowed field and 25% was pasture, open oak woodlots, and oak forests. Starting in 1953 and continuing for three seasons, some of the formerly cultivated fields were planted with jack, white, and red pine trees. Other fields are dominated by bluegrass.

The deciduous forests on the remainder of the site are dominated by various species of oak, generally as large, old, widely spaced trees, which often do not form a complete canopy. Their large low branches indicate that they probably matured in the open, rather than in a dense forest. Other upland tree species include hickory, hawthorn, cherry, and ash.

DOE and ANL-E belong to Chicago Wilderness, a partnership of more than 100 public and private organizations that have joined forces to protect, restore, and manage 81,000 ha (200,000 acres) of natural areas in the Chicago metropolitan region. Several activities are planned or are in progress to enhance oak woodland, savanna, wetland, and prairie habitats on the approximately 285 ha (700 acres) undeveloped at the ANL-E site.

## 1.10. Fauna

Terrestrial vertebrates that are commonly observed or likely to occur on the site include about 5 species of amphibians, 7 of reptiles, 40 of summer resident birds, and 25 of mammals. More than a hundred other bird species can be found in the area during migration or winter, but they do not nest on the site or in the surrounding region. An unusual species on the ANL-E site is the fallow deer, a European species that was introduced to the area by a private landowner prior to government acquisition of the property in 1947. A population of native white-tailed deer also inhabits the ANL-E site. The white-tailed and fallow deer populations are each maintained at a target density of 20 deer/mi$^2$ under an ongoing deer management program. Terrestrial invertebrate species and plants also reside on the ANL-E site.

Freund Brook crosses the center of the site but is impounded by a beaver dam in this area. The gradient of the stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Primary production in the stream is limited by shading, but diatoms and some filamentous algae are common. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consist primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures. Other aquatic habitats on the ANL-E site include additional beaver ponds, artificial ponds, ditches, and Sawmill Creek.

The biotic community of Sawmill Creek is relatively impoverished, which reflects the creek's high silt load, steep gradient, and historic release of sewage effluent from the Marion Brook sewage treatment plant north of the site. The fauna consists primarily of blackflies, midges, isopods,

flatworms, segmented worms, and creek chubs. A few species of minnows, sunfishes, and catfish are also present. Clean-water invertebrates, such as mayflies and stoneflies, are rare or absent. Fish species that have been recorded in ANL-E aquatic habitats include black bullhead, bluegill, creek chub, golden shiner, goldfish, green sunfish, largemouth bass, stoneroller, and orange-spotted sunfish.

The U.S. Fish and Wildlife Service (FWS) has rated the Des Plaines River system, including ANL-E streams, as "poor" in terms of the fish species present because of domestic and industrial pollution and stream modification.

## 1.11. Archaeology

ANL-E, which is located in the Illinois and Michigan Canal National Heritage Corridor, is situated in an area known to have a long and complex cultural history. All periods listed in the cultural chronology of Illinois, with the exception of the earliest period (Paleo-Indian), have been documented in the ANL-E area either by professional cultural resource investigators or through interviews of local artifact collectors by ANL-E staff. A variety of site types, including mounds, quarries, lithis workshops, and habitation sites, have been reported by amateurs within a 25-km (16-mi) radius.

Forty-six archaeological sites have been recorded at ANL-E. These sites include prehistoric chert quarries, special purpose camps, base camps, and historical farmsteads. The range of human occupation spans several time periods (Early Archaic through Mississippian Prehistoric to Historical). Three sites have been determined to be eligible for the National Register for Historic Places (NRHP); 20 sites have been determined to be ineligible; and 23 sites have not been evaluated for eligibility.

## 1.12. Endangered Species

No federally listed threatened or endangered species are known to occur on the ANL-E site, and no critical habitat of federally listed species exists on the site. Three federally listed endangered species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the ANL-E property or are known to occur in the area.

The Hine's emerald dragonfly (*Somatochlora hineana*), federally and state listed as endangered, occurs in locations with calcaerous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federally and state listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. An unconfirmed capture of an Indiana bat

(*Myotis sodalis*), which is federally and state listed as endangered, indicates that this species may occur in the area. Additional state-listed species that occur in the area include the following:

- Endangered
  - Black-crowned night heron (*Nycticorax nycticorax*)
  - Great egret (*Casmerodius alba*)
  - Pied-billed grebe (*Podilymbus podiceps*)
  - Red-shouldered hawk (*Buteo lineatus*)
  - River otter (*Lutra canadensis*)
  - Rough marsh cress (*Rorippa islandica* var. *hispida*)
  - Slender sandwort (*Arenaria patula*)
  - White lady's slipper (*Cypripedium candidum*)

- Threatened
  - Early fen sedge (*Carex crawei*)
  - Kirtland's snake (*Clonophis kirtlandi*)
  - Marsh speedwell (*Veronica scutellata*)

Of these, rough marsh cress, Kirtland's snake, pied-billed grebe, great egret, black-crowned night heron, and red-shouldered hawk have been observed on ANL-E property.