

Site Environmental Report

for Calendar Year 2005

Environment, Safety, and Health/Quality Assurance Oversight Division



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Argonne National Laboratory Site Environmental Report for Calendar Year 2005

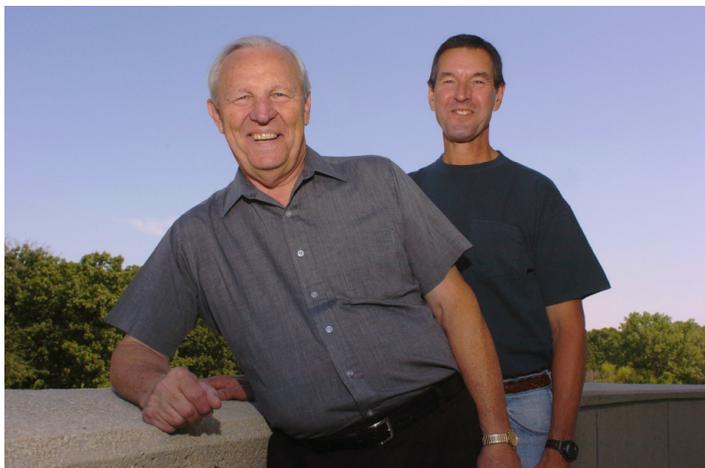
Preceding Report in This Series: ANL-05/02

by
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This Site Environmental Report (SER) was prepared by the Environment, Safety, and Health/Quality Assurance Oversight (EQO) Division at Argonne National Laboratory for the U.S. Department of Energy (DOE). 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/>.



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ACM	Asbestos-Containing Material
AEA	Atomic Energy Act of 1954
AEM-X	Argonne Equipment and Materials Exchange
AGHCF	Alpha-Gamma Hot Cell Facility
ALARA	As Low As Reasonably Achievable
Argonne	Argonne National Laboratory
AOC	Area of Concern
APS	Advanced Photon Source
ATLAS	Argonne Tandem Linac Accelerating System
ATSR	Argonne Thermal Source Reactor
BAT	Best Available Technology
BCG	Biota Concentration Guide
BOD₅	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	<i>Code of Federal Regulations</i>
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
D&D	Decontamination and Decommissioning
DCA	1,1-Dichloroethane
DCG	Derived Concentration Guide
DD/DH	Division Directors/Department Heads
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DOE-ASO	DOE Argonne Site Office
E2	Energy Efficiency
EA	Environmental Assessment
EBWR	Experimental Boiling Water Reactor
ECR	Environmental Compliance Representative
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement
EMS	Environmental Management System
ENE	East-Northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency

ACRONYMS

EPCRA	Emergency Planning and Community Right to Know Act
EQO	Environment, Safety, and Health/Quality Assurance Oversight
EQO-AS	EQO, Analytical Services
EQO-OCC	EQO Oversight Coordinating Committee
ERP	Environmental Remediation Program
ESA	Endangered Species Act of 1973
ES&H	Environment, Safety, and Health
FFCA	Federal Facility Compliance Act of 1992
FY	Fiscal Year
GMZ	Groundwater Management Zone
GRO	Groundwater Remediation Objective
HAP	Hazardous Air Pollutant
HEPA	High-Efficiency Particulate Air
HSWA	Hazardous and Solid Waste Amendments of 1984
HTRL	Howard T. Ricketts Laboratory
HVEM	High-Voltage Electron Microscopy
IAC	<i>Illinois Administrative Code</i>
ICRP	International Commission on Radiological Protection
IDNS	Illinois Department of Nuclear Safety
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois Historic Preservation Agency
IPNS	Intense Pulsed Neutron Source
ISMS	Integrated Safety Management System
LC₅₀	Median Lethal Concentration
LEPC	Local Emergency Planning Committee
LLW	Low-Level Radioactive Waste
LTS	Long-Term Stewardship
LWTP	Laboratory Wastewater Treatment Plant
MACT	Maximum Achievable Control Technology
MAPEP	Mixed Analyte Performance Evaluation Program
MSDS	Material Safety Data Sheet
MY	Model Year
NBL	New Brunswick Laboratory
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHPA	National Historic Preservation Act of 1966
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System

NPL	National Priority List
NRHP	<i>National Register of Historic Places</i>
P2	Pollution Prevention
PA	Preliminary Assessment
PBT	Persistent, Bioaccumulative Toxic
PCB	Polychlorinated Biphenyl
PFS	Plant Facilities and Services
PPOA	Pollution Prevention Opportunity Assessment
PQL	Practical Quantification Limit
PSTP	Proposed Site Treatment Plan
PWA	Process Waste Assessment
QA	Quality Assurance
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RFI	RCRA Facility Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act of 1974
SER	Site Environmental Report
SERC	State Emergency Response Commission
SHPO	State Historic Preservation Office
SIP	Site Implementation Plan
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SSI	Site Screening Investigation
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWPPC	Storm Water Pollution Prevention Committee
SWPPP	Storm Water Pollution Prevention Plan
SWTP	Sanitary Wastewater Treatment Plant
TCA	1,1,1-Trichloroethane
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogen
TRC	Total Residual Chlorine
TRI	Toxic Release Inventory
TRU	Transuranic Waste
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids

ACRONYMS

USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound
WM	Waste Minimization
WMO	Waste Management Operations
WQS	Water Quality Standard
WTP	Wastewater Treatment Plant
ZPR	Zero Power Reactor

This report discusses the accomplishments of the environmental protection program at Argonne National Laboratory for calendar year 2005. The status of Argonne environmental protection activities with respect to compliance with the various laws and regulations is discussed, along with the progress of environmental corrective actions and restoration projects. To evaluate the effects of Argonne operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the Argonne 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 Argonne 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, Argonne, 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.

ABSTRACT

This report summarizes the ongoing environmental protection program activities conducted by Argonne National Laboratory in calendar year 2005. It includes descriptions of the site, Argonne missions and programs, the status of compliance with environmental regulations, environmental protection and restoration activities, and the environmental surveillance program. Members of the surveillance program regularly conduct monitoring for radiation, radioactive materials, and nonradiological constituents on the Argonne 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 Argonne's impact on the environment. The surveillance program supports the Argonne policy of protecting the public, employees, and the environment from harm that may result from Argonne activities, while reducing environmental impacts to the greatest degree practicable.

Executive Order 13148 and U.S. Department of Energy (DOE) Order 450.1 require that an Environmental Management System (EMS) be implemented at Argonne by December 31, 2005. The DOE EMS Implementation Assessment Team conducted its visit November 14–18, 2005. The team issued its report on December 16, 2005, and the DOE Argonne Site Office (DOE-ASO) manager certified that the EMS had been implemented on December 22, 2005. Part of the implementation of EMS was the integration of EMS into the Integrated Safety Management System (ISMS).

Compliance Summary

Radionuclide emissions, the management of asbestos, and conventional air pollutants from Argonne facilities are regulated under the Clean Air Act (CAA). A number of airborne radiological emission points at Argonne are subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for radionuclide releases from DOE facilities (Title 40, Part 61, Subpart H, of the *Code of Federal Regulations* [40 CFR Part 61, Subpart H]). All such air emission sources were evaluated to ensure that these requirements are being addressed properly. The estimated hypothetical individual off-site radiation dose from Argonne activities required to be reported by U.S. Environmental Protection Agency (EPA) regulations for 2005 was 0.034 mrem/yr. This is 0.4% of the 10 mrem/yr standard. This dose does not include contributions from radon-220 and radon-222 emissions, which are exempted in the regulations.

At Argonne, 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 and Occupational Safety and Health Administration worker protection standards. Approximately 79.5 m³ (2,806 ft³) of ACM was removed and disposed of at off-site landfills in Illinois during 2005.

The Argonne site contains 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 and the engine test facility are also significant sources, when in operation. The Illinois Environmental Protection Agency (IEPA) issued the final Argonne Clean Air Act Permit Program (CAAPP) permit in April 2001. All previous air operating permits (with the exception of the open burning permits)

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were incorporated into this sitewide permit for all emission sources and activities. The Argonne CAAPP Title V permit requires continuous opacity and sulfur dioxide monitoring of the steam plant smoke stack from Boiler No. 5, the only boiler equipped to burn coal. Low-sulfur coal was burned in Boiler No. 5 for 4 months during 2005. During the period coal was burned, which occurred during colder weather to supplement the other gas-fired boilers, no exceedances were recorded.

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. An application to renew the existing permit was submitted to the IEPA during December 1998. The IEPA reissued the permit effective September 1, 2005. During 2005, 15 exceedances of NPDES permit limits were reported out of approximately 1,600 measurements.

Argonne 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 24 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 (AOCs). Since the issuance of the permit, three additional AOCs have been added to the permit. By September 30, 2003, all planned remediation work was completed. However, ongoing activities are being conducted at five SWMUs and two AOCs. These seven units require monitoring as part of the Argonne Long-Term Stewardship Program.

Argonne has prepared and implemented a sitewide underground storage tank (UST) compliance plan. The Argonne site contains 13 USTs, which are in compliance with UST regulations.

The only Toxic Substances Control Act-regulated compounds present in significant quantities at Argonne are polychlorinated biphenyls (PCBs) contained in electrical capacitors, power supplies, and small transformers. The Argonne PCB Item Inventory Program was initiated in 1995 to identify all suspect PCB-containing items. All pole-mounted transformers and circuit breakers containing PCBs have been replaced or retrofilled with non-PCB oil. All removal and disposal activities were conducted by licensed contractors specializing in such operations. During 2005, no radioactive PCB-contaminated articles, sludge, debris, or oil were shipped off-site for disposal, leaving 2,056 lb (262 gal) in storage.

In 2005, most projects requiring National Environmental Policy Act (NEPA) assessment were determined to be Categorical Exclusions. One Environmental Assessment (EA) was completed for the decontamination and decommissioning of the Zero Power Reactor.

Ongoing compliance issues at Argonne during 2005 were concentrations of total dissolved solids and total residual chlorine in excess of NPDES permit effluent limits and elevated levels of some routine indicator parameters in the groundwater at the former sanitary landfill.

Environmental Surveillance Program

Airborne emissions of radioactive materials from Argonne were monitored during 2005. The effective dose equivalents were estimated at the site perimeter and to a hypothetical maximally exposed member of the public by using the EPA's CAP-88 (CAA Assessment Package-1988) computer code. The estimated maximum perimeter dose from airborne releases was 0.38 mrem/yr in the east direction, while the estimated maximum dose to a member of the public was 0.036 mrem/yr. This latter value is 0.04% of the DOE radiation protection standard of 100 mrem/yr for all pathways. If the contribution of radon-220 is excluded from reporting, as required by 40 CFR Part 61, Subpart H, the estimated dose to a maximally exposed member of the public would remain 0.034 mrem/yr. The estimated population dose from releases to the approximately nine million people living within 80 km (50 mi) of the site was 2.74 person-rem.

Monitoring of particulates in ambient air was conducted for total alpha activity, total beta activity, and gamma-ray emitters at the Argonne site perimeter and at off-site locations. No statistically significant difference was identified between samples collected at the Argonne 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 Argonne releases were 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 0.07 Ci of hydrogen-3. The other radionuclides released totaled less than 0.001 Ci. The hydrogen-3 was added to the wastewater as part of normal Argonne operations. The dose to a hypothetical individual using water from Sawmill Creek as his or her sole source of drinking water would be 0.018 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 Argonne at Lemont. Sawmill Creek also is monitored for nonradiological constituents to demonstrate compliance with State of Illinois water quality standards. No parameters were detected above the limits established by 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 0.05 pCi/g) and americium-241 (up to 0.01 pCi/g) were detected in the sediment below the outfall and are attributed to past Argonne releases.

Dose rates from penetrating radiation (gamma rays) were measured at 17 perimeter and on-site locations and at 5 off-site locations in 2005 using thermoluminescent dosimeters. The off-site results averaged 87 ± 3 mrem/yr, which is similar to the long-term average dose. Above-background doses occurred at one perimeter location and were due to Argonne operations. At the south fence, radiation from a temporary storage facility for radioactive waste resulted in an average dose of 94 ± 5 mrem/yr for 2005, although no one occupies this area. The estimated dose from penetrating radiation to the nearest resident south of the site was less than 0.01 mrem/yr.

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The potential radiation doses to members of the public from all sources and pathways due to Argonne operations during 2005 were estimated by combining the exposures from inhalation, ingestion, and direct radiation pathways. The inhalation pathway would be primary. The highest estimated dose was approximately 0.055 mrem/yr to a hypothetical individual living east of the site, assuming he or she was outdoors at that location during the entire year and drinking Sawmill Creek water. Estimated doses from other pathways were not significant by comparison. The doses from Argonne 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 Argonne site in 2005. The former Argonne domestic water supply is monitored by collecting quarterly samples from the three inactive supply wells. All results from water supply wells were less than the limits established by the Safe Drinking Water Act.

Ten monitoring wells screened in glacial drift and two in dolomite were sampled quarterly at the 317 and 319 Areas and analyzed for radiological, volatile organic, semivolatile, PCB, pesticide, and herbicide constituents. The major organic contaminants detected were 1,4-dioxane, 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethene. Measurable levels of hydrogen-3 and strontium-90 were present in several of the wells. Remediation continued in these areas using phytoremediation and groundwater extraction to remove volatile organic compounds (VOCs) and hydrogen-3 from groundwater.

Nine monitoring wells are screened in the glacial drift and one in the dolomite adjacent to the Chicago Pile-Five reactor. These wells were sampled quarterly, and samples were analyzed for selected radionuclides and metals. Elevated levels of hydrogen-3 and strontium-90 were detected regularly.

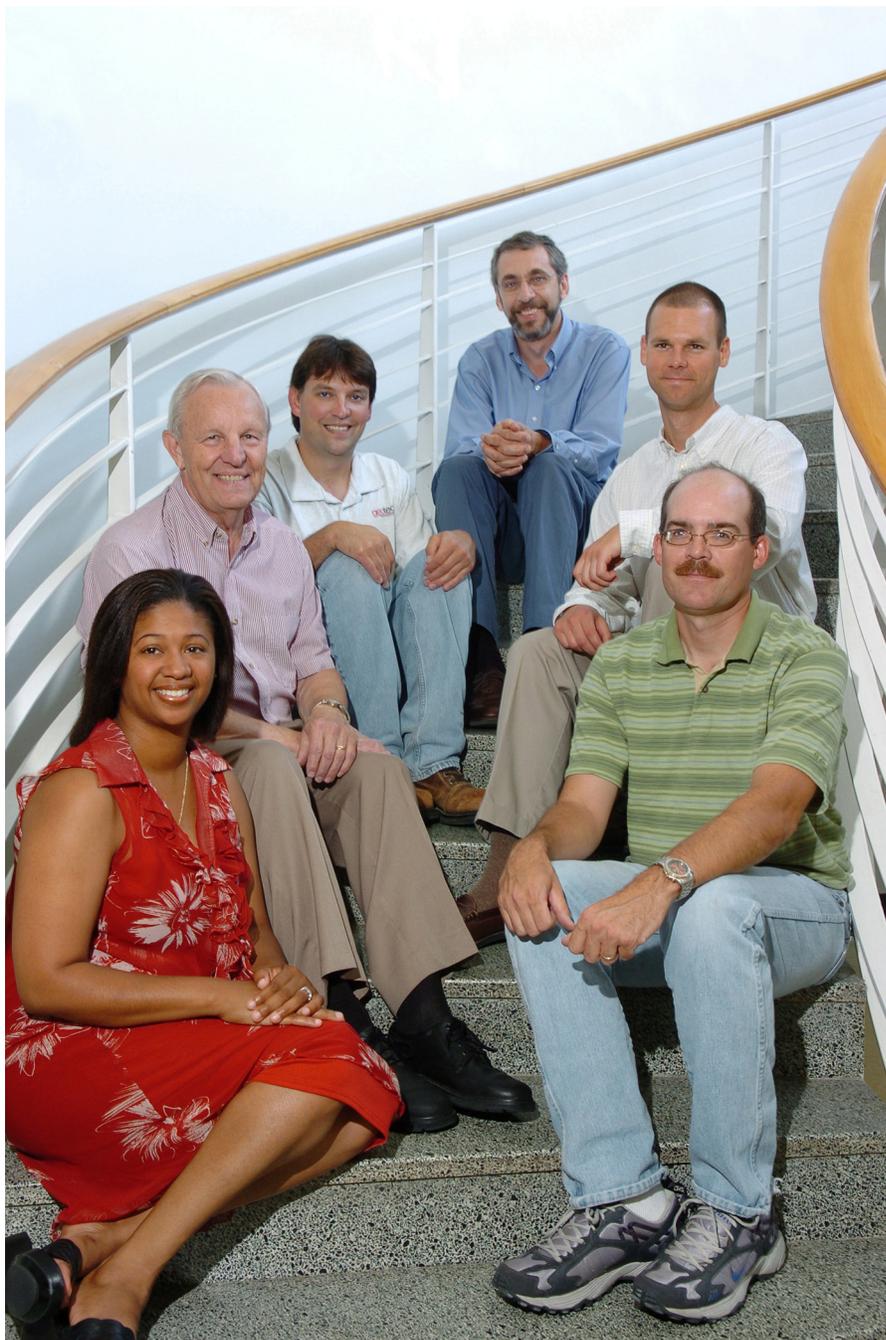
Twenty-six monitoring wells at the 800 Area Landfill were sampled on a quarterly basis and analyzed for metals, cyanide, phenols, total organic carbon, total organic halogens, VOCs, semivolatile organic compounds (SVOCs), PCBs, pesticides, herbicides, and hydrogen-3. As in previous years, levels exceeding background concentrations for ammonia, chloride, iron, lead, manganese, sulfate, total organic carbon, and total dissolved solids (TDS) were found in some wells. Above-background levels of hydrogen-3 were detected in several of the wells, with concentrations up to 362 pCi/L.

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 means of 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 this annual report.

EXECUTIVE SUMMARY

1. INTRODUCTION



1. INTRODUCTION

1.1. General

This annual report for calendar year 2005 of the Argonne National Laboratory 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 Argonne and the amounts, if any, added to the environment by Argonne operations. It also summarizes the compliance of Argonne operations with applicable environmental laws and regulations and highlights significant accomplishments and issues related to environmental protection and remediation. The report was prepared in accordance with the guidelines of DOE Orders 450.1¹ and 231.1A² and supplemental DOE guidance.

Argonne 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 Argonne operations is of special interest, because one important function of this program is verification of the adequacy of the site's pollution control systems.

Argonne is a DOE research and development (R&D) 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 2005 included safety studies for light-water reactors; high-temperature superconductivity experiments; development of electrochemical energy sources, including fuel cells and batteries for vehicles and energy storage; and studies to promote clean, efficient transportation.

Other R&D areas include basic biological research, heavy-ion research into the properties of super-heavy elements, the immobilization of radioactive waste products for safe disposal, fundamental studies of advanced computers, and the development of advanced computing technologies. 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 Argonne 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 plutonium and uranium measurements and analytical chemistry laboratory, is located on the Argonne site.

1. INTRODUCTION

The principal nonnuclear activities at Argonne in 2005 that could have measurable impacts on the environment include the use of a coal-fired boiler (No. 5) and the discharge of wastewater from various sources.

1.2. Description of Site

Argonne 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 and the surrounding area that show sampling locations associated with the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the Argonne 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 Argonne 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 Argonne 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° 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).

1.3. Population

The area around Argonne has experienced significant population growth in the past 30 years as 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 Intense Pulsed Neutron Source (IPNS) (Location 9J in Figure 1.1), was prepared

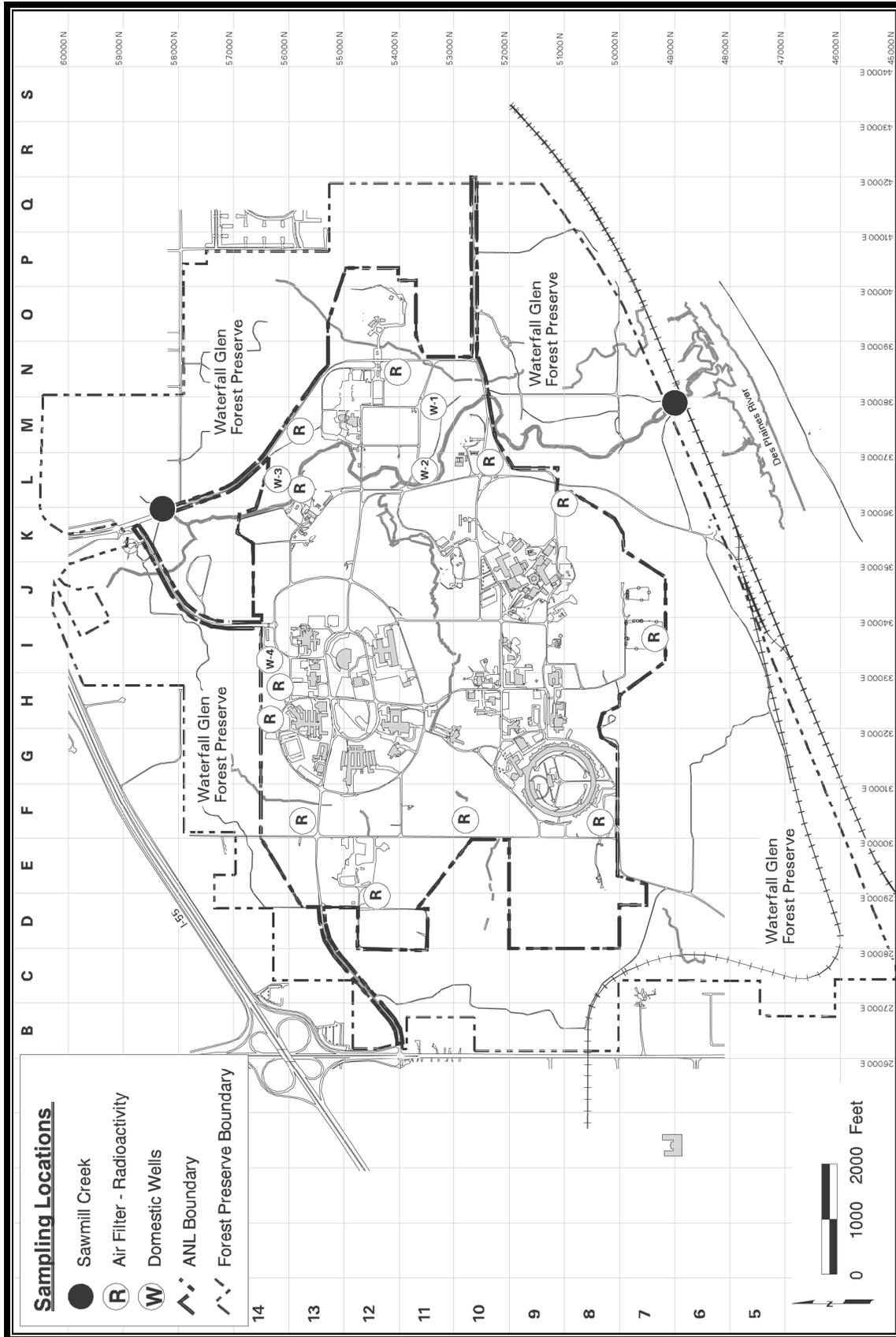


FIGURE 1.1 Sampling Locations at Argonne National Laboratory

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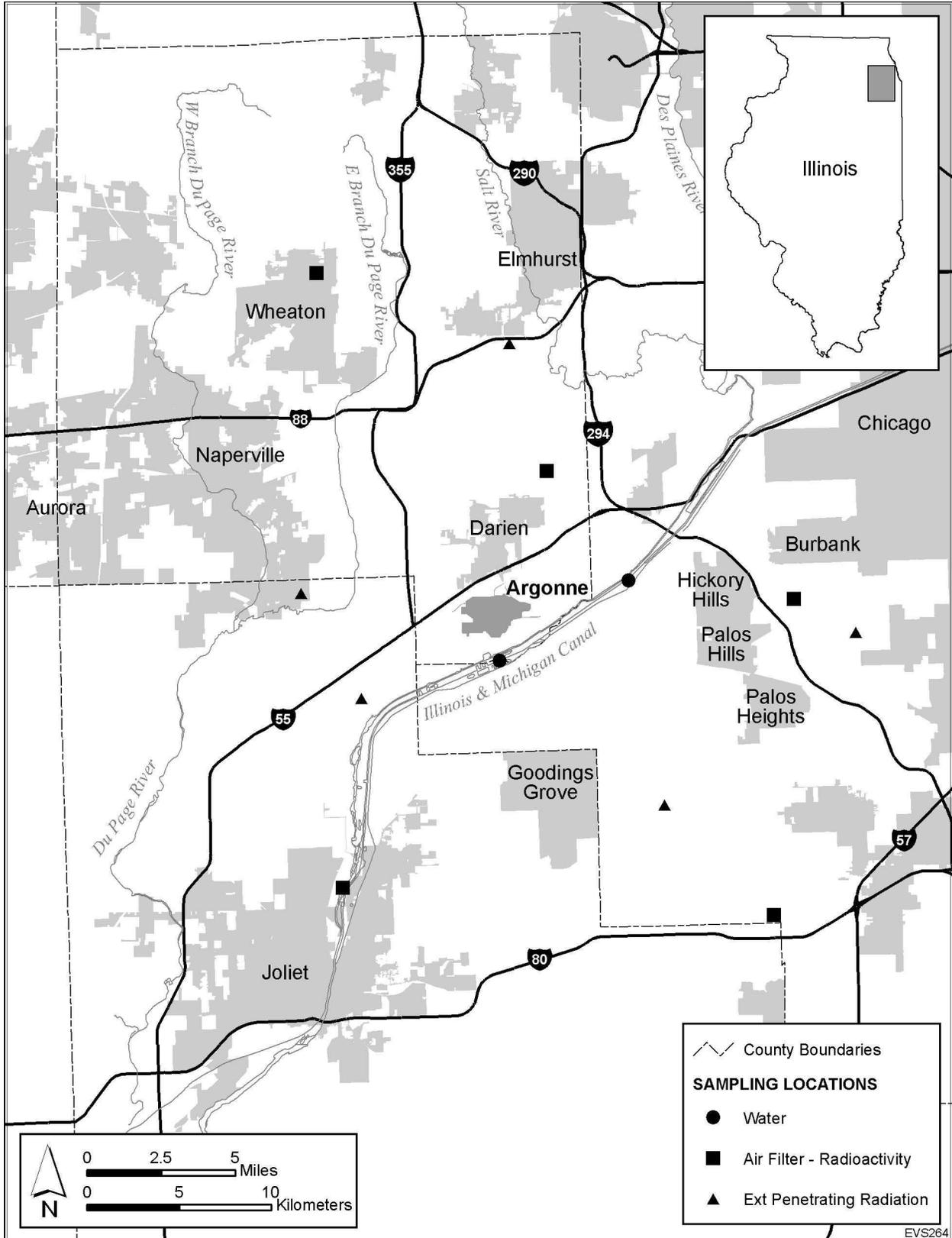


FIGURE 1.2 Sampling Locations near Argonne National Laboratory

TABLE 1.1
Population Distribution in the Vicinity of Argonne, 2005

Direction	Miles ^a									
	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10 - 20	20 - 30	30 - 40	40 - 50
N	0	1,260	3,745	6,359	9,913	47,865	187,957	350,601	235,346	314,363
NNE	0	585	4,226	6,133	6,337	41,311	30,0391	488,056	106,733	1,177
NE	0	816	2,064	2,198	1,876	42,287	706,197	958,769	0	0
ENE	0	1,005	1,307	2,349	1,974	33,622	618,433	190,117	0	0
E	0	1,069	554	363	383	42,134	463,231	215,304	9,899	27,578
ESE	0	424	267	368	505	18,327	188,712	294,596	224,205	95,839
SE	0	193	269	456	939	23,793	111,879	101,003	32,401	17,261
SSE	0	406	396	1,004	1,448	10,466	43,222	1,873	13,635	16,443
S	0	582	2,280	2,129	1,399	9,998	37,982	3,641	36,598	37,792
SSW	0	484	2,307	2,621	1,047	22,183	108,907	14,750	16,781	7,838
SW	0	173	590	342	10	18,024	81,243	14,503	18,929	7,564
WSW	0	129	127	559	3,112	21,066	29,434	7,213	9,429	11,717
W	0	147	567	7,818	10,530	46,610	100,304	30,268	19,165	7,087
WNW	0	500	863	2,973	4,708	46,580	162,138	44,204	8,317	62,884
NW	0	687	2,377	7,248	7,979	47,247	86,635	130,674	27,822	21,825
NNW	0	1,074	2,700	6,124	9,714	34,933	222,946	267,024	183,404	138,432
Total	0	9,534	24,639	49,044	61,874	506,446	3,449,611	3,112,596	942,664	767,800
Cumulative totals ^b	0	9,534	34,173	83,217	145,091	651,537	4,101,148	7,213,744	8,156,408	8,924,208

^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.

1. INTRODUCTION

by the Risk Assessment and Safety Evaluation Group of the Environmental Science Division at Argonne and represents projections to 2005 on the basis of 2000 census data.

1.4. Climatology

The climate of the area is representative of the upper Mississippi Valley, as moderated by Lake Michigan. 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 2005 data were obtained from the on-site Argonne meteorological station. The 2005 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 to 6 m/s (4.5 to 13.4 mph), 6.01 to 10 m/s (13.4 to 22.4 mph), and greater than 10.01 m/s (22.4 mph). The number in the center of each wind rose represents the percentage of observations of wind speed less than 2 m/s (4.5 mph) in all directions. The directions of the radii from the center represent the directions from which the wind blows. Sixteen radii are shown on each plot at 22.5° intervals; each radius represents the average wind speed for the direction covering 11.25° on either side of the radius. The annual average wind rose for 2005 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 2005 precipitation and temperature data. The monthly precipitation data for 2005 shows significant differences from the Argonne historical average. For example, January was above the monthly average, while April through October were below the average. The annual total was 30% below the annual average for the Argonne data. The monthly temperatures were generally higher during the summer months when compared with the long-term monthly average. The 2005 annual monthly average was 8% higher than the long-term annual average. The climatology information was provided by the Atmospheric Research Section of the Environmental Research Division.

1.5. Geology

The geology of the Argonne area consists of about 30 m (100 ft) of glacial drift on top of nearly horizontal bedrock consisting of Niagaran and Alexandrian dolomite underlain by shale and older dolomites and sandstones of Ordovician and Cambrian age. The glacial drift sequence is composed of the Wadsworth and Lemont Formations. Both are dominated by fine-grained drift units but also contain sandy, gravelly, or silty interbeds. Niagaran and Alexandrian dolomite is approximately 60 m (200 ft) thick but has an irregular, eroded upper surface.

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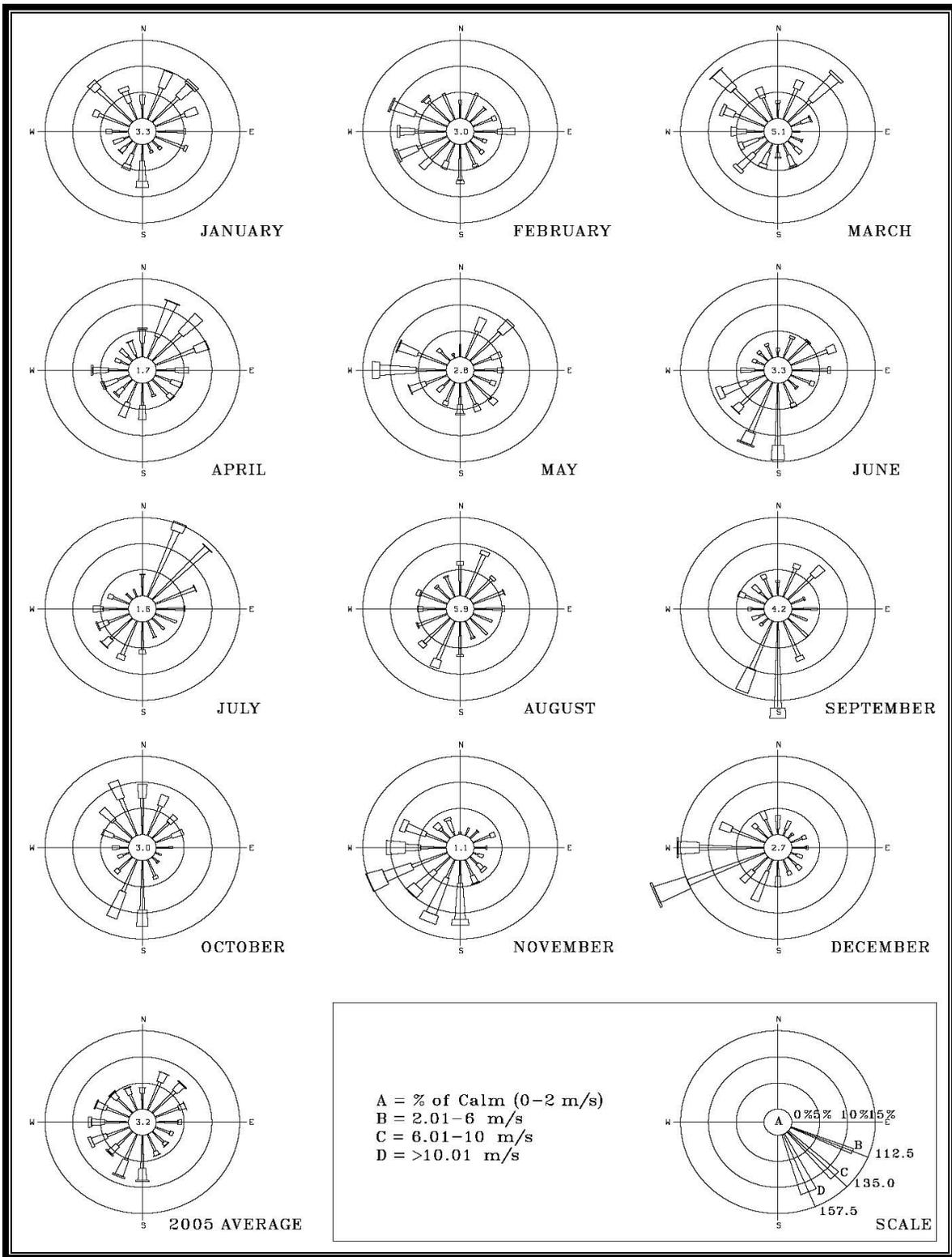


FIGURE 1.3 Monthly and Annual Wind Roses at Argonne National Laboratory, 2005

1. INTRODUCTION

TABLE 1.2

Argonne Weather Summary, 2005

Month	Precipitation (cm)		Temperature (°C)		
	Argonne 2005	Argonne Historical ^a	Argonne 2005	Argonne Historical ^a	
January	12.62	4.29	-4.3	-4.7	
February	5.64	4.19	0.1	-1.9	
March	5.53	6.05	1.7	3.1	
April	5.74	8.34	11.5	9.4	
May	4.70	9.69	14.3	14.0	
June	3.70	8.52	23.6	20.7	
July	6.94	10.55	24.2	23.1	
August	3.33	10.34	23.8	22.1	
September	6.63	8.28	21.1	18.2	
October	1.01	8.07	12.9	11.4	
November	6.30	8.87	5.5	4.4	
December	<u>3.71</u>	<u>4.58</u>	<u>-5.2</u>	<u>-2.9</u>	
Total	65.85	91.57	Monthly Average	10.8	10.0

^a Averages were obtained from the Argonne meteorological tower by using data from the last 23 years (1983–2005).

The southern boundary of Argonne follows the bluff 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 drift 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 drift. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. 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 Argonne are known to be seismically active. The longest inactive local feature 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 Argonne. 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 Argonne 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. Groundwater Hydrology

Two principal aquifers are used as water supplies in the vicinity of Argonne. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the Argonne 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.

Up until 1997, most groundwater supplies in the Argonne 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. Argonne now obtains all of its domestic water from the City of Chicago water system.

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 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

1. INTRODUCTION

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 Argonne 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 originates within the central part of the site and 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 Argonne are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 2005, this effluent averaged 2.80 million L/day (0.75 million gal/day), which is below the averages for the last few years. The combined Argonne effluent consisted of 62% laboratory wastewater and 38% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 15 million L/day (4.1 million gal/day) during 2005.

Sawmill Creek and the Des Plaines River upstream of Joliet, about 21 km (13 mi) southwest of Argonne, receive very little recreational or industrial use. A few people fish in these waters downstream of Argonne, and some duck hunting takes place on the Des Plaines River. Water from the Chicago Sanitary and Ship Canal is used by Argonne for cooling towers and by others for industrial purposes, such as hydroelectric generators and condensers. Argonne usage is approximately 1.9 million L/day (0.5 million 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 Argonne. 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 Argonne. In the vicinity of Argonne, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near Argonne 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, biking, 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 Argonne and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs, 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 Argonne site (Location 12O in Figure 1.1) is for use by Argonne and DOE employees. A local municipality also has use of the park for athletic events. The park also contains a day-care center for children of Argonne and DOE employees.

1.9. Vegetation

Argonne 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 Argonne 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 in 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. Figure 1.4 shows the vegetation communities.

Early photographs of the site indicate that most of the land that Argonne 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 Argonne are members of the Chicago Wilderness Coalition, a partnership of more than 170 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) that remain undeveloped at the Argonne 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 100 other bird species can be found in the area during migration or winter; however, they do not nest on the site or in the surrounding region. An unusual species on the Argonne 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 Argonne site. The white-tailed and fallow deer populations are each maintained at a target density of 15 deer/mi² under an ongoing deer management program.

1. INTRODUCTION

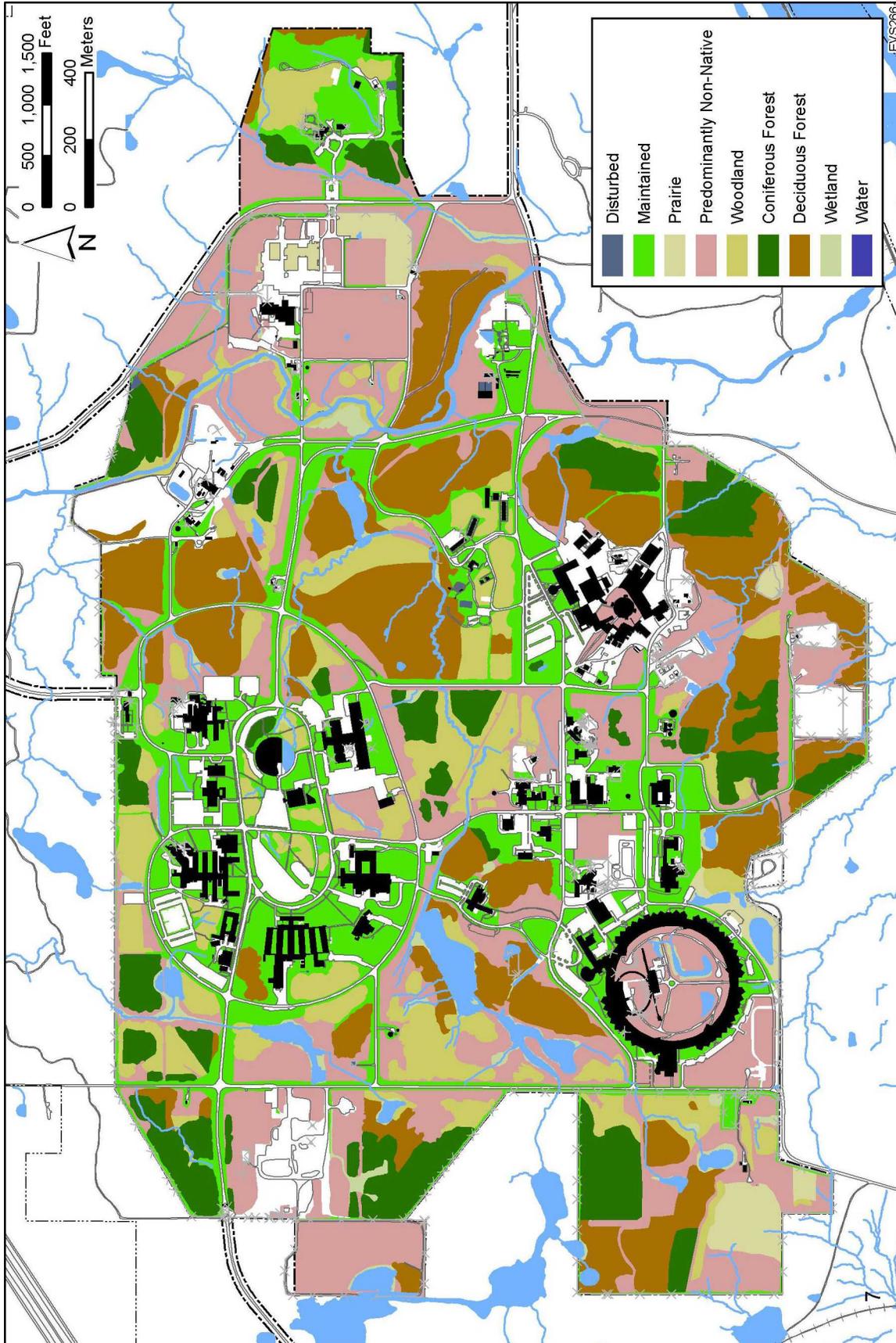


FIGURE 1.4 Argonne Vegetation Communities

Freund Brook crosses the center of the site. 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 Argonne site include 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 Argonne 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 (USFWS) has rated the Des Plaines River system, including Argonne streams, as "poor" in terms of the fish species present because of domestic and industrial pollution and stream modification.

1.11. Cultural Resources

Argonne, 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 Argonne area either by professional cultural resource investigators or through interviews of local artifact collectors by Argonne staff. A variety of site types, including mounds, quarries, lithic workshops, and habitation sites, have been reported by amateurs within a 25-km (16-mi) radius.

Forty-six archaeological sites have been recorded at Argonne. 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). Four sites have been determined to be eligible for the *National Register of Historic Places* (NRHP); 21 sites have been determined to be ineligible; and 21 sites have not been evaluated for eligibility.

Cultural resources also include historic structures. Historic property surveys over the past several years identified two areas at Argonne, the 200 Area campus and the 300 Area reactor development buildings, that are eligible for listing in the NRHP as historic districts, as well as several buildings that are individually eligible for listing in the NRHP.

1. INTRODUCTION

1.12. Endangered Species

No federally listed threatened or endangered species are known to occur on the Argonne site, and no critical habitat of federally listed species exists on the site. Three federally listed endangered species and one federally listed threatened species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the Argonne 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 calcareous 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. The federally listed threatened lakeside daisy (*Hymenoxys herbacea*) has a planted population in Waterfall Glen Forest Preserve. Additional state-listed species that occur in the area are identified in Section 2.10. Of these, Kirtland's snake, pied-billed grebe, black-crowned night heron, brown creeper, and red-shouldered hawk have been observed on Argonne property.

2. COMPLIANCE SUMMARY



2. COMPLIANCE SUMMARY

Argonne is a government-owned, contractor-operated R&D facility that is subject to environmental statutes and regulations administered by the U.S. Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), the U.S. Army Corps of Engineers (COE), and the State Fire Marshal, as well as to numerous DOE Orders and Executive Orders (EOs). The status of Argonne during 2005 with regard to these authorities is discussed in this chapter.

The Atomic Energy Act was promulgated to assure the proper management of radioactive materials. Under the act, DOE regulates the control of radioactive materials under its authority. Sections of the act authorize DOE to set radiation protection standards for itself and its contractors. Accordingly, DOE promulgated a series of regulations (e.g., 10 CFR 820, 10 CFR 830, and 10 CFR 835), DOE Order 435.1, and DOE Order 5400.5 to protect public health and the environment from potential risks associated with radioactive materials. This Site Environmental Report (SER) is used to demonstrate compliance with these regulations and orders.

Argonne has made a commitment to comply with all applicable environmental requirements, as described in the following statement in the Argonne Policy Manual:

The policy of Argonne National Laboratory is that its activities are to be conducted in such a manner that worker and public health and safety and protection of the environment are given the highest priority. The Laboratory will comply with all applicable federal and state health, safety, and environmental laws, regulations, and orders, so as to protect the health and safety of workers and the public and to minimize accidental damage to property.

2.1. Clean Air Act

The Clean Air Act (CAA) is a federal statute that sets emission limits for air pollutants and determines emission limits and operating criteria for certain hazardous air pollutants (HAPs). The program for compliance with the requirements of the CAA is implemented by individual states through a Site Implementation Plan (SIP) that describes how that state will ensure compliance with the air quality standards for stationary sources.

Under Title V of the Clean Air Act Amendments of 1990, Argonne submitted a Clean Air Act Permit Program (CAAPP) application to the IEPA for a sitewide, federally enforceable operating permit to cover emissions of all regulated air pollutants at the facility. The finalized CAAPP Title V permit was issued on April 3, 2001. This permit supersedes the prior individual state air pollution control permits, with two exceptions for prior open-burning permits. The open-burning permits are renewed each year. Argonne meets the definition of a major source because of potential emissions of oxides of nitrogen in excess of 90.72 t/yr (100 tons/yr), carbon monoxide in excess of 90.72 t/yr (100 tons/yr), and sulfur dioxide in excess of 90.72 t/yr (100 tons/yr) at the Building 108 central heating plant.

2. COMPLIANCE SUMMARY

On October 26, 2004, Argonne received a renewal notice from the IEPA notifying the Laboratory that a permit renewal application was due no later than nine months prior to expiration of the CAAPP permit (April 3, 2006). Argonne began preparation of the permit renewal application in the fall of 2004. The CAAPP permit renewal application was submitted to IEPA on April 15, 2005, and received a completeness determination on April 21. Three revisions to the application were submitted to IEPA between September and December 2005. On December 21, 2005, IEPA issued the draft CAAPP permit. Argonne had raised a number of significant concerns in its comments on the draft permit, and these will need to be addressed with IEPA in early 2006.

Facilities subject to Title V must characterize emissions of all regulated air pollutants, not only those that qualify as major sources. In addition to oxides of nitrogen and sulfur dioxide, Argonne also must evaluate emissions of carbon monoxide, particulates, volatile organic compounds (VOCs), HAPs (a list of 188 chemicals, including radionuclides), and ozone-depleting substances. The air pollution control permit program requires that facilities pay annual fees on the basis of the total amount of regulated air pollutants (except carbon monoxide) they are allowed to emit.

The Argonne site contains a large number of air emission point sources. The vast majority are laboratory ventilation systems that are exempt from state permitting requirements, except for those systems emitting radionuclides. In 2005, there was one construction permit issued for the Building 315 Zero Power Reactor (ZPR) decontamination and decommissioning (D&D) project.

2.1.1. National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAP) constitute a body of federal regulations that set forth emissions limits and other requirements, such as monitoring, recordkeeping, and operational and reporting requirements, for activities generating emissions of certain HAPs. The only standards affecting Argonne operations are those for asbestos and radionuclides. By the time of the issuance of the sitewide Argonne Title V permit, the IEPA had issued a total of 23 air pollution control permits to Argonne for NESHAP sources. All Argonne operating NESHAP permits were incorporated into the sitewide Argonne Title V permit.

2.1.1.1. Asbestos Emissions

Many buildings on the Argonne site contain large amounts of asbestos-containing material (ACM), such as thermal system insulation around pipes and tanks, spray-applied surfacing material for fireproofing, floor tile, and asbestos-cement (Transite) panels. This material is removed as necessary during renovations or maintenance of equipment and facilities. The removal and disposal of this material are governed by the asbestos NESHAP.

Argonne maintains an asbestos abatement program designed to ensure compliance with these and other regulatory requirements. In general, ACM is removed from buildings either by

2. COMPLIANCE SUMMARY

specially trained Argonne crews (for small-scale, short-duration projects) or by outside contractors (for large-scale insulation removal projects). All removal work is performed in accordance with both NESHAP and Occupational Safety and Health Administration requirements governing worker safety at ACM removal sites.

Approximately 79.5 m³ (2,806 ft³) of ACM was generated from Argonne asbestos removal projects during 2005. The 95 small removal projects that were completed generated 27.0 m³ (952 ft³) of ACM waste. Thirteen large removal projects generated the remaining 52.5 m³ (1,854 ft³) of ACM waste. Table 2.1 provides asbestos abatement information for the large removal projects. The IEPA was notified during December 2005 that no more than 71 m³ (2,500 ft³) of ACM waste is expected to be generated from small-scale projects during 2006.

A separate portion of the asbestos removal standards contains requirements for disposing of ACM. Off-site shipments are to be accompanied by completed shipping manifests. Until closure of the Argonne landfill in September 1992, asbestos from small-scale projects was disposed of on-site in a designated location within the 800 Area Landfill.

2.1.1.2. Radionuclide Emissions

The NESHAP standard for radionuclide emissions from DOE facilities (Title 40, Part 61, Subpart H, of the *Code of Federal Regulations* [40 CFR Part 61, Subpart H]) establishes the emission limits for the release of radionuclides other than radon to the air and the corresponding requirements for monitoring, reporting, and recordkeeping. A number of emissions points at Argonne are subject to these requirements and are operated in compliance with them. These points include ventilation systems for hot cell facilities for storage and handling of radioactive materials (Building 212), ventilation systems for particle accelerators (Building 375, IPNS facility, and the Building 411 APS linac), and several ventilation systems associated with the Building 350 NBL. In addition, many ventilation systems and fume hoods are used occasionally for processing small quantities of radioactive materials.

The amount of radioactive material released to the atmosphere from Argonne emission sources is extremely small, thereby contributing little to the off-site dose. The maximum off-site dose to a member of the general public for 2005 was 0.034 mrem, which is less than 0.4% of the 10 mrem/yr EPA standard. Section 4.8.1 contains a more detailed discussion of these emission points and compliance with the standard.

2.1.2. Conventional Air Pollutants

The Argonne site contains a number of sources of conventional air pollutants, including a steam plant, gasoline and ethanol/gasoline blend fuel-dispensing facilities, two alkali metal reaction booths, two dust collection systems, the engine test facility, a number of diesel generators, and fire training activities. These facilities are operated and the associated activities are conducted in compliance with applicable regulations and permit conditions.

2. COMPLIANCE SUMMARY

TABLE 2.1

Large-Scale Asbestos Abatement Projects DOE/IEPA Notification, 2005

Completion Date	Asbestos Abatement Contractor	Notification Quantity			Material	Building	Disposal Quantity (ft ³)	Landfill
		ft	ft ²	ft ³				
1/14/2005	Argonne PFS ^a Waste Management Operations (WMO)	0	300	0	Floor Tile and Mastic	308	13	Environtech ^b
2/18/2005	Argonne PFS WMO	0	830	0	Floor Tile and Mastic	315	48	Environtech
2/25/2005	Argonne PFS WMO	0	225	0	Floor Tile and Mastic	205	16	Environtech
3/18/2005	Argonne PFS WMO	0	2,570	0	Floor Tile and Mastic	200	116	Environtech
4/22/2005	Argonne PFS WMO	0	800	0	Floor Tile and Mastic	212	45	Environtech
4/29/2005	Argonne PFS WMO	180	380	0	Floor Tile Mastic Pipe Insulation	202	272	Environtech
5/7/2005	Argonne PFS WMO	400	25	0	Pipe and HVAC Insulation	205	308	Environtech
5/14/2005	Argonne PFS WMO	0	450	0	Floor Tile and Mastic	362	42	Environtech
7/29/2005	Argonne PFS WMO	10	2,040	0	Transite, Gaskets Pipe Insulation	377B	810	Environtech
8/26/2005	Argonne PFS WMO	0	1,400	0	Floor Tile and Mastic	362	104	Environtech
8/26/2005	Environmental Cleansing Corporation	0	0	100	Roofing tar	325C	Not Applicable ^c	Environtech
10/20/2005	Argonne PFS WMO	0	2,680	0	Floor Tile and Mastic	301	48	Environtech ^d
11/16/2005	Argonne PFS WMO	0	220	0	Floor Tile and Mastic	205	16	Environtech ^d
11/19/2005	Argonne PFS WMO	0	380	0	Floor Tile and Mastic	362	16	Environtech ^d

^a PFS = Plant Facilities and Services (Argonne division).

^b Environtech Landfill, Morris, IL.

^c Not applicable, tar is exempt from NESHAP disposal requirements.

^d On-site pending disposal to Environtech.

2. COMPLIANCE SUMMARY

The Title V permit requires continuous opacity and sulfur dioxide monitoring of the smoke stack from Boiler No. 5, the only one of the five boilers at the steam plant that is equipped to burn coal. The permit requires submission of a quarterly report listing any exceedances beyond emission limits for this boiler (30% opacity averaged over 6 minutes and 0.82 kg [1.8 lb] of sulfur dioxide per million Btu averaged over a 1-hour period). Table 2.2 gives the hours that Boiler No. 5 operated on low-sulfur coal during 2005, as well as the amount of low-sulfur coal burned. There were no exceedances at Boiler No. 5 in 2005.

An annual compliance certification must be submitted to the IEPA and EPA each May 1 for the previous calendar year, detailing any deviations from the Title V permit and subsequent corrective actions. During 2005, there was one deviation from the Title V permit. In October 2005, a contractor working on the roof of Building 208 inadvertently cut into a pipe covering that was found to contain asbestos. Failure to have an enclosure when handling asbestos that can be emitted to the environment is a violation of 35 IAC Part 228, and constituted a deviation under Section 9 of the CAAPP permit.

Landfill gas monitoring is conducted quarterly at the 800 Area Landfill via 3 gas wells placed into the waste area and 10 gas wells at the perimeter of the landfill. Figure 2.1 shows their locations. In addition to the wells, ambient air is sampled in two nearby buildings and at three open-air locations to assess the presence of methane. The gas monitoring near the landfill determines whether methane is migrating from the landfill. Results indicate that methane is being generated. No migration of this compound was noted in 2005.

The fuel-dispensing facility is the Building 46, Grounds and Transportation. Except for ethanol vapors from alternate-fuel usage, this facility has VOC emissions typical of any commercial gasoline service station.

Pursuant to *Illinois Administrative Code*, Title 35, Part 254 (35 IAC Part 254), Argonne submits an emissions report to the IEPA each May 1 for the previous year. The summary for 2005 is presented in Table 2.3.

2.1.3. Clean Fuel Fleet Program

Although reporting requirements for the Clean Fuel Fleet Program are still in effect under the CAA and 35 IAC Part 241, IEPA indicated that it no longer wanted reports to be filed for

TABLE 2.2

Boiler No. 5 Operation, 2005		
Month	Operated (hours)	Low-Sulfur Coal Burned (tons)
January	744.0	2,161.2
February	522.0	1,534.9
March	36.0	106.3
April	0	0
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	0
December	81.0	243.8
Total	1,383.0	4,046.2

2. COMPLIANCE SUMMARY

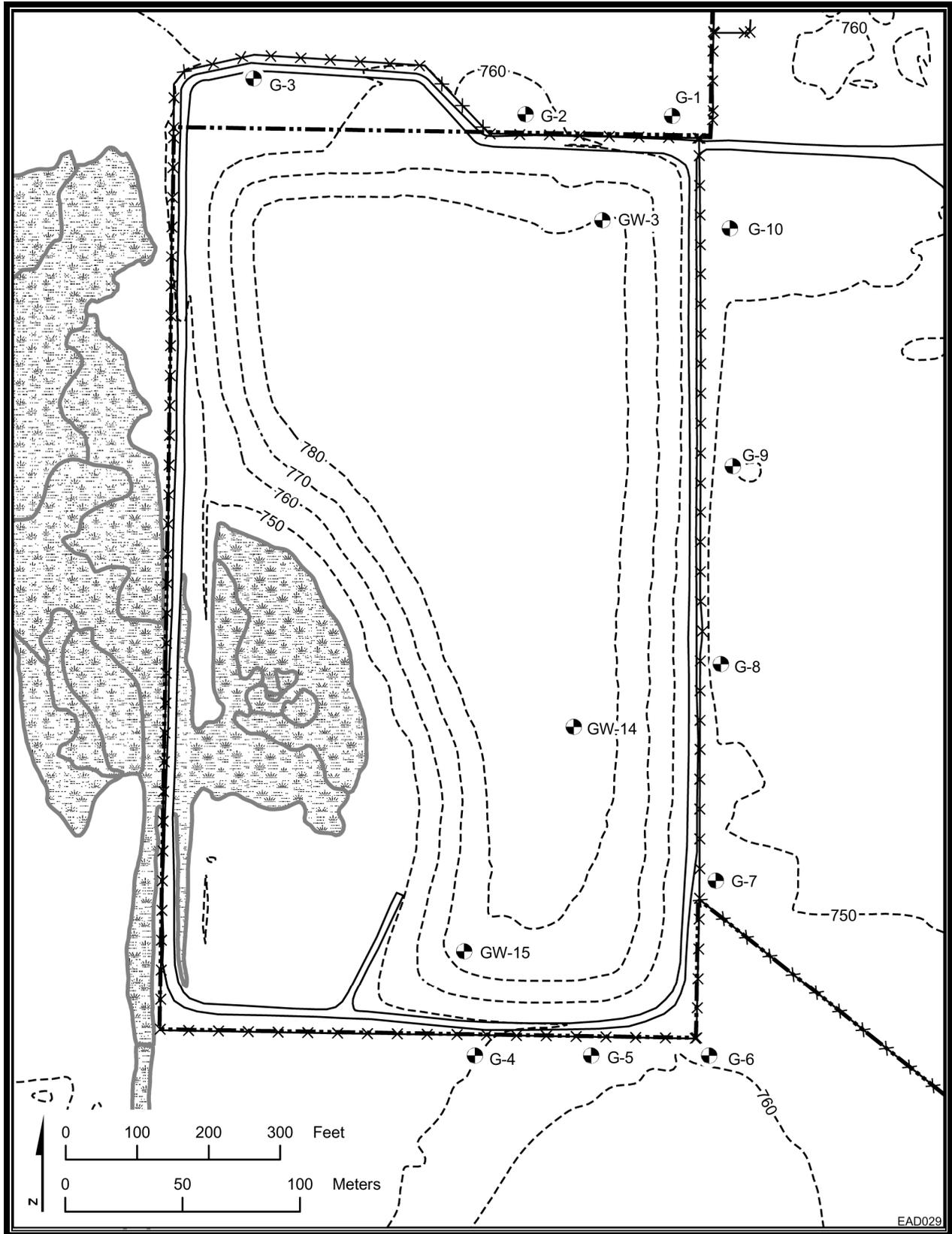


FIGURE 2.1 800 Area Landfill Gas Monitoring Wells

2. COMPLIANCE SUMMARY

TABLE 2.3

2005 Annual Emissions Report: Emissions Summary^a

Building No. and Source	CO	NO _x	PM/PM ₁₀	PM _{2.5} ^b	SO ₂	VOM	HAP ^c	NH ₃ ^b
46: Ethanol/gasoline	_d	–	–	–	–	1	–	–
46: 10,000 gal gasoline	–	–	–	–	–	12	–	–
108: Boiler 1	15,192	50,640	552	344	110	258	–	89
108: Boiler 2	3,868	12,895	141	88	28	66	–	23
108: Boiler 3	11,561	38,536	420	262	84	196	–	68
108: Boiler 4	11,574	38,579	421	262	84	196	–	68
108: Boiler 5 (coal-fired)	21,040	44,500	316	130	121,431	147	5,463	2
108: Boiler 5 (gas-fired)	13,929	20,260	507	315	101	236	–	81
108: Sulfuric acid tank ^e	–	–	–	–	–	–	–	–
200: Peak-shaving generator	55	241	7	7	23	7	–	1
200: M-Wing hot cells (R) ^f	–	–	–	–	–	–	–	–
202: Peak-shaving generator	53	233	7	7	22	7	–	1
206: Alkali reaction booth (R) ^f	–	–	0	–	–	–	–	–
208: Surface preparation facility	–	0	–	–	–	–	0	–
212: Alpha-Gamma Hot Cell (R) ^f	–	–	–	–	–	–	–	–
212: Building exhausts ^e	–	–	–	–	–	–	–	–
301: Hot Cell D&D project (R) ^f	–	–	–	–	–	–	–	–
303: Mixed waste storage (R) ^f	–	–	–	–	–	–	–	–
306: Building vents (R) ^f	–	–	<1	–	–	–	–	–
306: Bulking sheds ^f	–	–	1	1	–	257	9	–
306: Vial crusher/chemical photooxidation unit (R) ^f	–	–	–	–	–	1	–	–
308: Alkali reaction booth ^e	–	–	–	–	–	–	–	–
315: MACE project (R) ^f	160	–	–	–	–	–	–	–
330: CP-5 D&D project (R) ^f	–	–	–	–	–	–	–	–
331: Rad waste storage (R) ^f	–	–	–	–	–	–	–	–
350: NBL Pu/U hoods (R) ^f	–	–	–	–	–	–	–	–
363: Central Shop dust collector ^e	–	–	–	–	–	–	–	–
368: Woodshop dust collector ^e	–	–	–	–	–	–	–	–
370: Alkali reaction booth ^e	–	–	–	–	–	–	–	–
375: Intense Pulsed Neutron Source (R) ^f	–	–	–	–	–	–	–	–
400: APS facility (R) ^f	–	55	–	–	–	–	–	–
400: APS generator, Caterpillar (1 unit)	460	2,395	86	86	198	65	–	2
400: APS generator, Kohler (2 units)	1,902	2,566	100	100	527	91	–	1
595: Lab Wastewater Plant (R) ^f	–	–	–	–	–	648	0	–
Lab rad hoods (R) ^f	–	–	–	–	–	–	–	–
PCB tank cleanout	–	–	–	–	–	0	–	–
Torch cut lead-based paint ^e	–	–	–	–	–	–	–	–
Transportation research facility	9,295	5,213	368	367	332	814	–	–
WMO portable HEPA - (6) (R) ^f	–	–	<1	–	–	–	–	–
Total (lb/yr)	89,090	216,113	2,925	1,966	122,940	3,002	5,472	334
Total (tons/yr)	44.54	108.06	1.46	0.98	61.47	1.50	2.74	0.17
CAAPP permit limit (tons/yr)	(237.60)^g	639.10	66.02	–	332.20	18.65	10.00	–

Footnotes on next page.

2. COMPLIANCE SUMMARY

TABLE 2.3 (Cont.)

- ^a Abbreviations: APS = Advanced Photon Source; CAAPP = Clean Air Act Permit Program; CP-5 = Chicago Pile-Five reactor; CO = carbon monoxide; D&D = decontamination and decommissioning; HAP = hazardous air pollutant; HEPA = high-efficiency particulate air; MACE = melt attack and coolability experiment; NBL = New Brunswick Laboratory; NH₃ = ammonia; NO_x = oxides of nitrogen; PCB = polychlorinated biphenyl; PM = particulate matter; PM₁₀ = particulate matter less than 10 microns; PM_{2.5} = particulate matter less than 2.5 microns; Pu = plutonium; SO₂ = sulfur dioxide; U = uranium; VOM = volatile organic material; and WMO = Waste Management Operations.
- ^b As of 2003, emissions of PM_{2.5} and a precursor, ammonia (NH₃), must be included.
- ^c These compounds are HAPs, but are not classified as VOMs or particulates.
- ^d A dash indicates that the pollutant is not permitted from that particular unit (or it is classified as an insignificant activity); a zero means that the source is permitted for emissions of that pollutant but that there were no emissions for the year.
- ^e These sources have been designated as insignificant in the CAAPP.
- ^f (R) = radionuclide source regulated by NESHAP (40 CFR Part 61, Subpart H).
- ^g Not a permit limit, but the maximum potential emission level for CO.

model year (MY) 2005 (September 1, 2004–August 31, 2005) vehicles because all current model year vehicles meet clean fuel fleet standards. Because the requirements are still in effect, in lieu of a report, Argonne submitted a letter on September 28, 2005, to IEPA certifying that all vehicles acquired in MY 2005 meet federal emission standards.

2.2. Clean Water Act

The Clean Water Act (CWA) was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972 and was modified substantially by the Water Quality Act of 1987. Section 101 of the CWA provides for the restoration and maintenance of water quality in all waters throughout the country, with the ultimate goal of “fishable and swimmable” water quality. The act established the National Pollutant Discharge Elimination System (NPDES) permitting system, which is the regulatory mechanism designed to achieve this goal. The authority to implement the NPDES program has been delegated to those states, including Illinois, that have developed a program substantially the same and at least as stringent as the federal NPDES program.

The 1987 amendments to the CWA significantly changed the thrust of regulatory activities. Greater emphasis is placed on monitoring and control of toxic constituents in wastewater, the permitting of outfalls composed entirely of storm water, and the imposition of regulations governing sewage sludge disposal. These changes in the NPDES program resulted in much stricter discharge limits in the 1990s and greatly expanded the number of chemical constituents monitored in the effluent.

2.2.1. Wastewater Discharge Permitting

The NPDES permitting process administered by the IEPA is the primary tool for enforcing the requirements of the NPDES program. Before wastewater can be discharged to any receiving stream, each wastewater discharge point (outfall) must be characterized and described in a permit application. The IEPA then issues a permit that, for each outfall, contains numeric limits and monitoring frequencies on certain pollutants likely to be present and sets forth a number of additional specific and general requirements, including sampling and analysis schedules and reporting and recordkeeping requirements. NPDES permits are effective for 5 years and must be renewed by the submission of a permit application at least 180 days prior to the expiration of the existing permit.

Wastewater discharge at Argonne is permitted by NPDES Permit No. IL 0034592. This permit was renewed during 1994 (effective October 30, 1994), modified in 1995 (effective August 24, 1995), and was to expire on July 1, 1999. An application to renew the existing permit was submitted in a timely manner to the IEPA on December 28, 1998. In 2001, a previously unknown storm water discharge point was discovered and characterized. On February 12, 2002, Argonne submitted a supplementary permit application covering this outfall and an oil water separator for Building 376, along with comments regarding the preliminary draft NPDES permit.

Just prior to the end of 2002, the IEPA issued the “Final Draft Permit” for public comment. Argonne sent comments to the IEPA in January 2003 covering the “Final Draft Permit” and several provisions Argonne had requested previously. During 2004 through to early 2005, the IEPA had not acted on these or any other comments, and Argonne continued to operate, as provided for in the IEPA regulations, under the existing permit issued in 1994 until the IEPA issued a renewal permit effective September 1, 2005.

Wastewater at Argonne is generated by a number of activities and consists of sanitary wastewater (from restrooms, cafeteria sinks and sinks in certain buildings and laboratories, and steam boiler blowdown), laboratory wastewater (from laboratory sinks and floor drains in most buildings), and storm water. Water softener regenerant from boiler house activities is discharged into the DuPage County sewer system. Cooling water and cooling tower blowdown are discharged into storm water ditches that are monitored as part of the NPDES permit. The permit authorizes the release of wastewater from 42 separate outfalls, most of which discharge directly or indirectly into Sawmill Creek. Two of the outfalls are internal sampling points that combine to form the main wastewater outfall, Outfall 001. Table 2.4 lists these outfalls; Figure 2.2 shows the outfall locations for the old permit and Figure 5.3 shows the outfall locations for the new permit.

2.2.1.1. NPDES Permit Activities

Total dissolved solids (TDS) analyses results historically have demonstrated an annual cycle, culminating in periodic discharge limit violations occurring in the winter at Outfall 001. Investigations into the causes of the heightened TDS concentration during winter have focused on three sources of increased TDS contribution during the winter months: (1) increased boiler activity with its associated increase in high TDS wastewater (i.e., boiler blowdown), (2) salt

2. COMPLIANCE SUMMARY

TABLE 2.4

Characterization of NPDES Outfalls at Argonne, 2005

New Outfall Number	Old Outfall Number	Description	Average Flow ^a
A01	001A	Sanitary Treatment Plant	0.289
B01	001B	Laboratory Treatment Plant	0.461
001	001	Combined outfall	0.750
A03 ^b	003A	Swimming pool	0.0
B03	003B	300 Area (condensate)	0.11
C03	003C	Building 205 footing tile drainage	0.014
D03/E03	003D/003E	Steam trench drainage (condensate)	0.008/0.0
F03	003F	Building 201 fire pond overflow storm water	0.016
G03	003G	North Building 201 storm sewer (condensate)	0.011
H03	003H	Building 212 cooling tower blowdown	<0.001
I03	003I	Buildings 200 and 211 cooling tower blowdown	0.007
J03	003J	Building 213 and Building 213 parking lot storm water	0.003
K03 ^c	–	Storm water, APS	Storm water only
L03 ^c	–	Storm water, APS	Storm water only
M03 ^c	–	Storm water, APS	Storm water only
N03 ^c	–	Storm water, 212 East	Storm water only
004	004	Building 203 cooling tower and Building 221 footing drainage and storm water	0.014
A05	005A	Westgate Road storm water	Storm water only
B05	005B	800 Area east storm water	Storm water only
C05	005C	Building 200 West	0.008
D05	005D	Storm water	Storm water only
E05	005E	Building 203 west footing drainage and condensate	0.001
006	006	Cooling tower blowdown and storm water	0.033
007	007	Domestic cooling water for compressor and storm water	0.003
008	008	Transportation and grounds storm water	0.001
010 ^b	010	Coal pile runoff emergency overflow	Storm water only
011	011	North fence line marsh storm discharge	Storm water only
012	012	100 Area storm water discharge	Storm water only
013	013	Southeast 100 Area storm water	Storm water only
014	014	Northern East Area storm water discharge	Storm water only
A15, B15	105A&B	Building 40 storm water discharge	Storm water only
A16, B16	106A&B	Southern East Area storm water discharge	Storm water only
018	018	Eastern 300 Area storm water and cooling water	0.008
020	020	Shooting range storm water discharge	Storm water only
021	021	319 Landfill and Northeast 317 Area	<0.01
A22	022A	Southern 317 Area	<0.001
B22	022B	Western 317 Area	<0.01
023	023	Southern and Eastern 800 Area Landfill storm water runoff	<0.02
114 ^b	–	Northern and Western 800 Area Landfill storm water runoff	<0.001
025	025	314, 315, and 316 cooling water, eastern and southern APS area	0.004
026	026	Water Treatment Plant and storm water	0.006
027 ^c	–	CNM ^d fire suppression system water and storm water	Storm water only

Footnotes on next page.

2. COMPLIANCE SUMMARY

TABLE 2.4 (Cont.)

- ^a Flow is measured in million gallons per day, except for outfalls with storm water only.
- ^b Outfall removed from September 1, 2005, NPDES permit.
- ^c Outfall added by September 1, 2005, NPDES permit.
- ^d CNM = Center for Nanoscale Materials.

usage in the boiler house area that drains to the boiler house pond, and (3) road salt used sitewide for melting snow. To deal effectively with the boiler house area problems, the boiler house equalization pond was routed to DuPage County for periodic discharge of up to 215,517 L/day (57,000 gal/day).

To accomplish this, in 2000, Argonne completed an application to DuPage County to allow the discharge of this wastewater under the existing permit with the county. An application was also sent to the IEPA. Historically, all wastewater in the equalization pond was directed to the Sanitary Wastewater Treatment Plant (SWTP). This permit application was acted upon by the IEPA, and a new permit was issued in 2001 covering this discharge. Redirection of the equalization pond wastewater to DuPage County is intended to be accomplished only during the heating season in late fall and winter. This was begun in a testing mode late in 2001, and then put into service in the spring of 2002. Experience to date seems to indicate that this action has reduced TDS concentrations at the Wastewater Treatment Plant (WTP) during the heating season.

The Laboratory submitted an application to modify the NPDES permit (IL0034592) in order to include the Howard T. Ricketts Laboratory (HTRL) wastewater discharge to the Laboratory's wastewater treatment plants, as well as other changes to the permit. The complete modification included:

1. Addition of the HTRL wastewater with high biochemical oxygen demand (BOD₅) to the Sanitary Wastewater Treatment Plant;
2. Addition of the non-BOD₅ laboratory wastewater to the Laboratory Wastewater Treatment Plant (LWTP);
3. Addition of a new storm water outfall for the HTRL – Outfall 028;
4. Addition of a phosphorous discharge limit to the LWTP to enable acceptance of phosphorous-containing wastewater;
5. Request for a change in status for Outfall 108 in order to allow receipt of air compressor condensation wastewater.

This modification package was sent to the DOE Argonne Site Office (DOE-ASO) on November 11, 2005, which sent it on to the IEPA on November 22, 2005. The IEPA had not acted on the application by the end of the calendar year.

2. COMPLIANCE SUMMARY

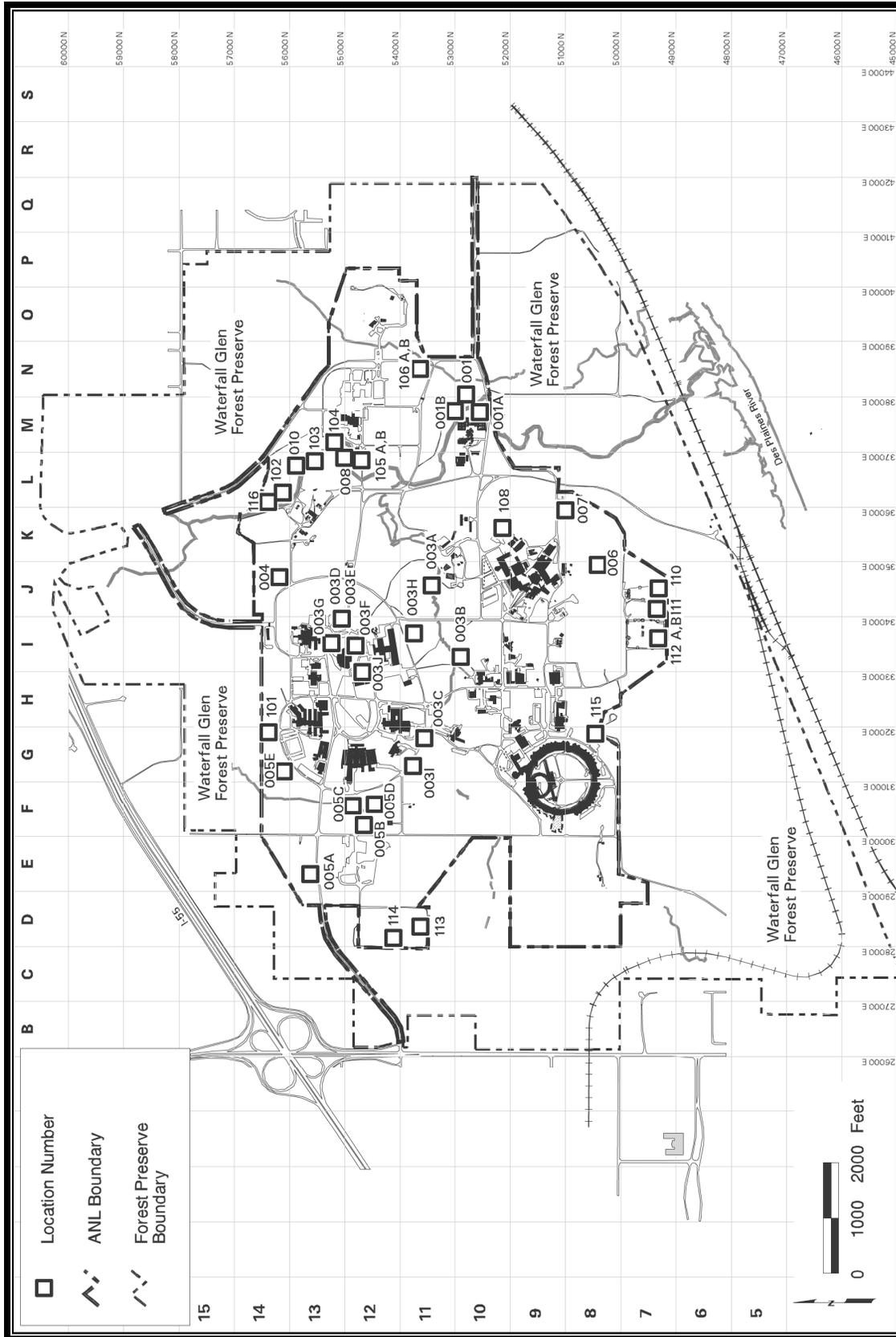


FIGURE 2.2 NPDES Outfall Locations

2.2.1.2. Compliance with NPDES Permit

Wastewater is treated at Argonne in two independent treatment systems, the sanitary system and the laboratory system. The sanitary wastewater collection and treatment system collects wastewater from sanitation facilities, the cafeteria, office buildings, and other portions of the site that do not contain radioactive or hazardous materials. This wastewater is treated in a biological wastewater treatment system consisting of primary clarifiers, trickling filters, secondary clarifiers, and slow sand filters. Wastewater generated during research-related activities, including those that utilize radioactive materials, generally flows to a series of retention tanks located in each building that are pumped to the laboratory wastewater sewer after radiological analysis and release certification. Treatment in the LWTP consists primarily of aeration, solids-contactor clarification, and pH adjustment. Additional steps can be added, including powdered-activated carbon addition for organic removal, alum addition, and polymer addition or adjustment, if analysis demonstrates that any of these are required.

Figure 2.3 shows the two wastewater treatment systems that are located adjacent to each other. The volume of wastewater discharged from these facilities in 2005 averaged 1.10 million L/day (0.289 million gal/day) for the sanitary wastewater and 1.76 million L/day (0.461 million gal/day) for the laboratory process wastewater.

Results of the routine monitoring required by the NPDES permit are submitted monthly to the IEPA in a Discharge Monitoring Report (DMR). As required by the permit, any exceedance of permit limits or conditions is reported by telephone to the IEPA within 24 hours, and a written explanation of the exceedance is submitted with each DMR. During 2005, there were 15 exceedances of NPDES permit limits out of approximately 1,700 measurements. The September 1, 2005, NPDES permit placed additional limits for total residual chlorine (TRC – Outfalls H03, J03, 004, E05, 006, and 025), total suspended solids (TSS – Outfalls B03, D03, E03, and H03), and total dissolved solids (TDS – Outfalls H03, J03, 006, and 025). Five exceedances of the TRC limit were noted at Outfall 025 once the NPDES permit became effective. All five of the TRC violations at Outfall 025 were in excess of the provisions made in 40 CFR 123.45 (a)(2)(ii). Therefore these discharges will result in the Laboratory receiving a Violation Letter from IEPA. In order to remove the offending discharge(s) from the outfall and end the series of violations, the Laboratory organized an investigation for the sources, and shortly after the last violation (October 10, 2005), the source was discovered and stopped. There have been no violations of the TRC limit at this outfall since that time. One TRC exceedance was noted at Outfall H03 during this time period. Three exceedances of the TDS limit were noted at Outfall 001, one TDS exceedance was noted at Outfall H03, and one TDS exceedance was noted at Outfall J03. These TDS exceedances are attributed to road salt associated with snowmelt. One TSS exceedance was noted at Outfall H03, and one TSS exceedance was noted at Outfall 004. The TSS exceedances appear to be related to excessive biological growth in the slow-moving streams during the drought experienced throughout 2005. Figure 2.4 presents the data for the total number of permit limit exceedances each year over the past 16 years.

2. COMPLIANCE SUMMARY

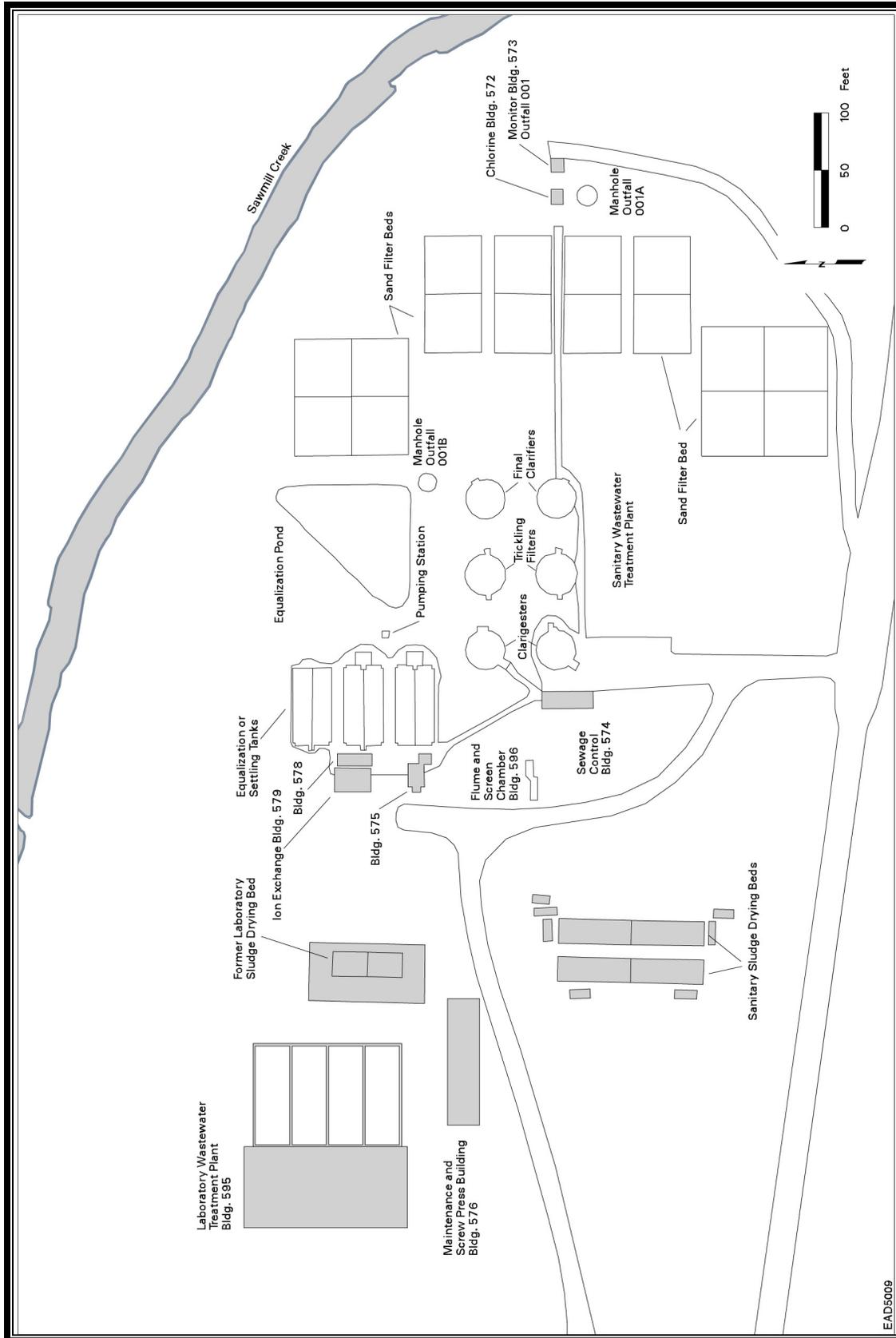


FIGURE 2.3 Argonne Wastewater Treatment Plant

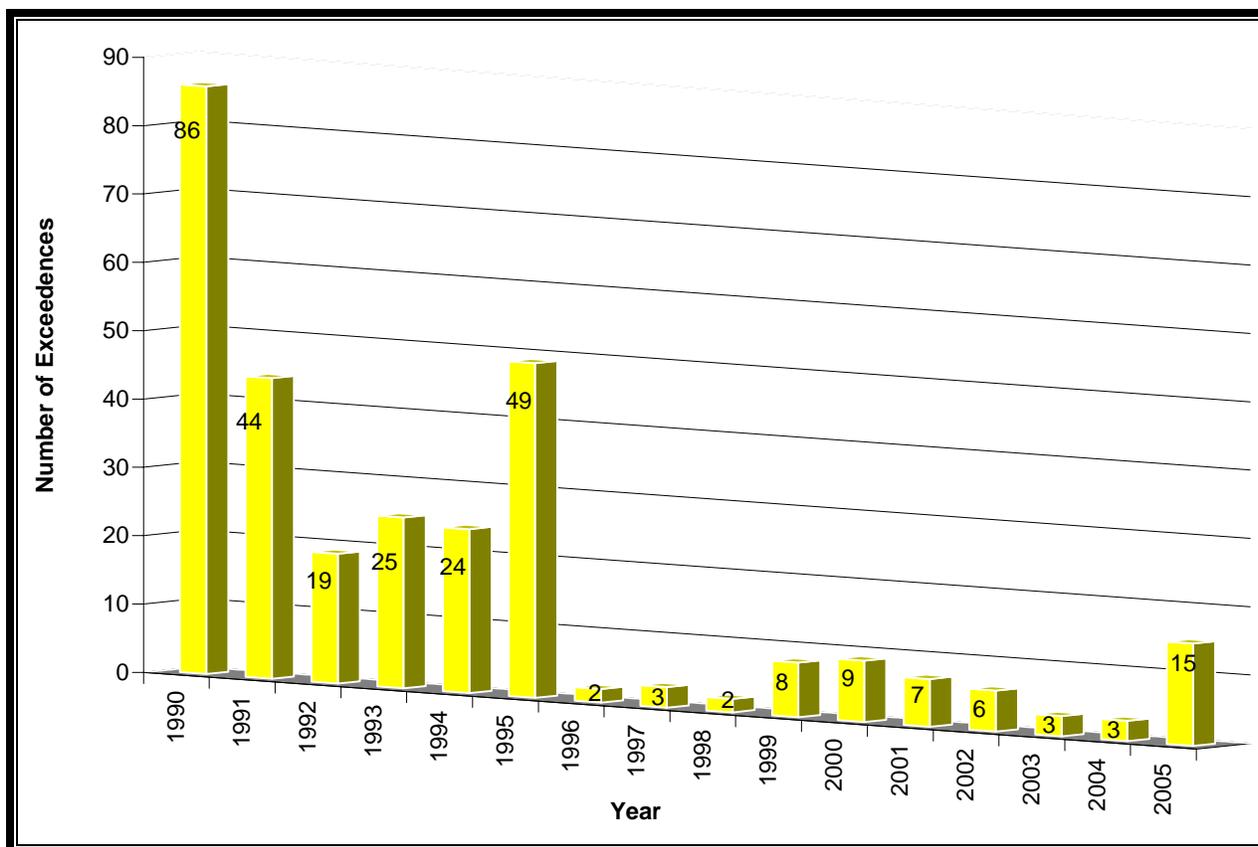


FIGURE 2.4 Total Number of NPDES Exceedances, 1990 to 2005

2.2.1.3. Priority Pollutant Analysis and Biological Toxicity Testing

The NPDES permit requires semiannual testing of Outfall B01, the LWTP outfall, and annually at Outfall 021 for all the priority pollutants — 124 metals and organic compounds identified by the IEPA as being of particular concern. No discharge occurred at Outfall 021 during September through December, the effective period of the new permit. During 2005, the B01 sampling was conducted in June and December. Results were similar to past years. Organic compound concentrations were very low. Chloroform (2 µg/L and 3 µg/L, respectively) was detected in both the June and December samples as was bromodichloromethane (1 µg/L and 3 µg/L, respectively). Dibromochloromethane (4 µg/L) was detected in the December sample. It is suspected that the chloroform, dibromochloromethane, and bromodichloromethane result from the contact of chlorinated water with organic chemicals and residues from cooling tower biocide treatment chemicals. All semivolatile concentrations were below the detection limits. Low concentrations of zinc (0.11 mg/L) were detected at levels well below the corresponding effluent limit (see Table 5.9). These findings are discussed further in Chapter 5.

In addition to the priority pollutant analysis, the permit required annual biological toxicity testing of the combined effluent stream, Outfall 001. This testing was conducted June 13 through June 17, 2005. The data indicate that the effluent was not acutely toxic to either the fathead

2. COMPLIANCE SUMMARY

minnow or the water flea. Data from the past 10 years suggest that cessation of chlorination of Argonne effluent can be correlated with a beneficial effect on aquatic life in the receiving streams.

Special Condition No. 9 of the 1994 NPDES permit requires annual aquatic toxicity testing of Outfalls 003H, 003I, 003J, 004, 006, and 115 during the months of July and August. The samples were collected July 25 through July 29, 2005, and August 22 through August 26, 2005. The 2005 results were similar to the 2004 results with the exception of Outfall 004 during August. A review of the July data indicates that Outfalls 003H, 003I, 003J, and 006 exhibited no toxicity for either the water flea or the fathead minnow. Outfall 004 was acutely toxic to the fathead minnow but not to the water flea. Outfall 115 was acutely toxic to the water flea but not to the fathead minnow. The toxicant was unidentified, but may have been chlorinated drinking water. The August data indicate that Outfalls 003H, 003I, 003J, 004, and 006 were not acutely toxic for either the water flea or the fathead minnow. Outfall 115 was acutely toxic to the water flea. The toxicant was potable water.

The acute toxicity observed at these outfalls is believed to be related primarily to residual chlorine levels in the domestic water, some of which is discharged to the outfalls. Chlorine levels that are necessary to protect the water distribution system are high enough to cause measurable acute toxic effects in these tests. Another source of halogen compounds identified earlier is discharged cooling water containing water treatment chemicals used in various cooling towers throughout the site. Steps are being taken to redirect these nonstorm wastewater discharges into Argonne's sewer systems to reduce the toxicity problems at these outfalls.

2.2.1.4. Storm Water Regulations

In November 1990, the EPA promulgated regulations governing the permitting and discharge of storm water from industrial sites. The Argonne site contains a large number of small-scale operations that are considered industrial activities under these regulations and, thus, are subject to these requirements. An extensive storm water characterization and permitting program was initiated in 1991 and continues as required in the present NPDES permit; Argonne's NPDES permit includes both industrial and stormwater discharges to surface water.

The NPDES permit was reissued on July 28, 2005, and became effective September 1, 2005. As a portion of the effective permit, there are special conditions that include a number of requirements that the Laboratory must fulfill, including monitoring, reporting, and investigations that are additional to the permit requirements, but carry the full authority of the permit with them. One of these requirements, Special Condition 9, requires the Laboratory to maintain its existing Storm Water Pollution Prevention Plan (SWPPP), as well as to modify it as necessary to continue compliance with all provisions of the regulations regarding storm water. Special Condition 9 continues to require Argonne to inspect and report annually on the effectiveness of the sitewide SWPPP. In 2005, the annual inspection was completed and a report was submitted to the IEPA in November. The Storm Water Pollution Prevention Committee (SWPPC) noted that the SWPPP was still in need of rewriting, and this is scheduled for completion in August of 2006.

2.2.2. NPDES Inspections and Audits

The IEPA conducted a compliance inspection on November 16, 2005. No issues were identified.

2.2.3. General Effluent and Stream Quality Standards

In addition to specific NPDES permit conditions, Argonne discharges are required to comply with general effluent limits contained in 35 IAC Part 304. Also, wastewater discharges must be of sufficient quality to ensure that Sawmill Creek complies with IEPA General Use Water Quality Standards (WQSs) found in 35 IAC Part 302, Subpart B. Chapter 5 of this report, which presents the results of the routine environmental monitoring program, also describes the general effluent limits and WQSs applicable to the outfalls and discusses compliance with these standards.

2.2.4. Spill Prevention Control and Countermeasures Plan

Argonne maintains a Spill Prevention Control and Countermeasures (SPCC) Plan as required by the CWA and EPA regulations at 40 CFR Part 112. This plan describes the planning, design features, and response measures that are in place to prevent oil or oil products from being released to navigable waters of the United States. Persons with specific duties and responsibilities in such situations are identified, as are reporting and recordkeeping requirements mandated by the regulations. Regular training is conducted on implementation of this plan. No reportable spills occurred in 2005 that required activation of the SPCC Plan.

The SPCC Plan was revised and certified in December 2004. Among the new requirements are secondary containment for all oil storage containers 55-gallons or greater, tank integrity testing, and additional training. The EPA extended the deadline for amending and implementing the revised SPCC Plan to October 31, 2007.

2.2.5. Clean Water Action Plan

The Clean Water Action Plan Program, instituted in 1998, constitutes a voluntary commitment by federal agencies to work cooperatively to improve water quality in the United States. The approach is for federal agencies to form partnerships to identify watersheds with the most critical water quality problems. The goals of the plan are to establish initiatives to reduce public health threats, improve stewardship of natural resources, strengthen control of polluted runoff, and make water quality information more accessible to the public.

Although no formal plans related to this initiative have been established at Argonne, several activities have been undertaken to support this initiative. Argonne has worked with the IEPA to reduce or eliminate surface water discharges of regulated pollutants. Special focus has been on exceedances of NPDES permit parameter limits. Past upgrades to the Argonne physical

2. COMPLIANCE SUMMARY

plant included acquisition of Lake Michigan water to replace dolomite well water as the source of domestic water. Lake Michigan water has a much lower TDS content than dolomite water, and the use of Lake Michigan water has reduced the amounts of TDS and copper that are discharged (water with lower TDS levels is less aggressive at dissolving copper from piping). The rehabilitation of the SWTP resulted in compliance with the ammonia-nitrogen limit. The upgrade of the LWTP also was completed, which gives Argonne a number of options for treating various waste streams, such as coal pile runoff and laboratory sink discharge, more effectively.

The Clean Water Action Plan included a strategy to achieve a net national increase of 100,000 wetland acres per year by 2005. Argonne is contributing to this effort by increasing the size of an existing wetland by up to 3 ha (6 acres). This wetland restoration effort is discussed further in Section 2.13.

2.3. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) and its implementing regulations are intended to ensure that facilities that treat, store, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 (HSWA) created a set of restrictions on land disposal of hazardous waste. In addition, the HSWA also require that releases of hazardous waste or hazardous constituents from any Solid Waste Management Unit (SWMU) at a RCRA-permitted facility be remediated, regardless of when the waste was placed in the unit or whether the unit originally was intended as a waste disposal unit. The RCRA program includes regulations governing management of underground storage tanks (USTs) containing hazardous materials or petroleum products. The IEPA has been authorized to administer most aspects of the RCRA program in Illinois. The IEPA issued a RCRA Part B permit to Argonne and DOE on September 30, 1997. The permit became effective on November 4, 1997. The permit has been modified eight times. Table 2.5 presents a summary of the RCRA Part B permit modifications.

The Argonne Environmental Remediation Program (ERP) was designed to achieve compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. The corrective action portion of the RCRA Part B permit provides the primary regulatory vehicle. This program was completed on September 30, 2003. However, seven SWMUs could not be remediated to No Further Action (NFA). The long-term monitoring of these inactive waste sites has been incorporated into the Argonne Long-Term Stewardship (LTS) Program. Quarterly reports are transmitted to the IEPA for these inactive sites. The LTS Program is described in greater detail in Chapter 6.

Also, one new SWMU and one new Area of Concern (AOC) have been identified since the ERP was completed. Argonne sent a notice about SWMU No. 746 (Building 300 Floor Drains) to DOE in July 2004. The IEPA added this SWMU to the Argonne corrective action program in March 2005. Argonne sent a notice about AOC-J (lead in soil near water towers) to DOE in November 2004. The IEPA added this AOC to the Argonne corrective action program

2. COMPLIANCE SUMMARY

TABLE 2.5

Summary of Modifications to the RCRA Part B Permit

Modification Application Number	Purpose	IEPA Approval Date
1	Allows Argonne to accept the ash from the incineration of Argonne generated mixed waste at the DOE-owned Waste Experimental Reduction Facility in Idaho, in the event that it cannot be disposed of otherwise.	February 1999
2	(1) Allows use of Building 303 to store surplus chemicals; (2) updates the operating procedures for the Building 308 Alkali Metal Passivation Booth, and (3) updates the RCRA Contingency Plan.	August 2000
3	One Class 1 Modification and one Class 2 Modification allow Argonne to (1) change the name of the DOE signatory authorized to sign documents related to the Argonne RCRA Part B permit, and (2) use a concrete pad at Building 331 for the storage of solid radioactive and mixed waste.	January 2001
4	Class 1 Modification allows Argonne to update the RCRA Contingency Plan.	February 2002
5	Class 1 Modification allows Argonne to change the name of the Argonne signatory authorized to sign documents related to the Argonne RCRA Part B permit.	March 2002
6	(1) Update the RCRA Contingency Plan, and (2) allow Argonne to receive seven drums of defense contact-handled mixed transuranic waste from the Missouri University Research Reactor facility in Columbia, Missouri. At Argonne, the drums will be characterized and certified for disposal and shipped to the Waste Isolation Pilot Plant located in Carlsbad, New Mexico. (3) Approve design and equipment changes to the permitted Building 306 Metal Precipitation/Filtration Treatment Unit.	November 2002
7	(1) Remove references to the Facility 317 Concrete Storage Pad, and (2) remove condition regarding the management of seven 55-gallon drums of contact-handled transuranic mixed waste from the Missouri University Research Reactor facility.	August 2003
8	Allow for some waste management operational changes. Also, the application has been updated to agree with the permit.	September 2004

2. COMPLIANCE SUMMARY

in February 2005. Since the ERP was ended, the new SWMU and AOC are being investigated by Argonne's Plant Facilities and Services (PFS) Division.

2.3.1. Hazardous Waste Generation, Storage, Treatment, and Disposal

The nature of the research activities conducted at Argonne results in the generation of small quantities of a large number of waste chemicals. Many of these materials are classified as hazardous waste under RCRA. Argonne has 24 Hazardous Waste Management Units: 16 container storage units (IEPA approved closure of Building 329 in March 2005, and the building has since been demolished), 1 tank storage unit, 4 miscellaneous treatment units, and 3 tank chemical treatment units. Table 2.6 provides descriptions of all of the units. Closure reports for Building 325C East and West and the Dry Ice Pellet Decontamination Unit were submitted to IEPA for review and approval in December and April 2005, respectively. When the IEPA approves the closure, there will be 14 container storage areas, 1 tank storage unit, and 6 treatment units. Figure 2.5 shows the locations of the major active hazardous waste treatment, storage, and disposal areas at Argonne.

Argonne prepares an annual Hazardous Waste Report. The report is submitted to the IEPA by March 1 of each year and describes the activity of the previous year. It is a summation of all RCRA waste activities, including generation, storage, and treatment. The report describing such activities during 2005 was submitted to the IEPA. The RCRA-permitted storage facilities, designed and operated in compliance with RCRA requirements, allow for accumulation and storage of waste pending off-site disposal. Argonne's on-site permitted treatment facilities address a small number of hazardous wastes generated by Argonne operations. Off-site treatment and disposal take place at approved hazardous waste treatment and disposal facilities. Hazardous wastes that were generated, disposed of, or recycled during 2005 are described in Table 2.7.

2.3.2. Hazardous Waste Treatability Studies

The IEPA requires Argonne to submit a report by March 15 of each year that estimates the number of hazardous waste treatability studies and the amount of waste expected to be used in the studies during the current year. One treatability study was conducted during 2005, Passivation of Lithium Metal Waste Contaminated with Transuranic Radionuclides.

Argonne initiated the study in September 2005. The treatability study involved placement of lithium metal waste into a compatible container. The waste was safely immersed in an aqueous solution to react the alkali metal. This took place in a well-ventilated hood equipped with a high-efficiency particulate air (HEPA) filtration system to remove any radionuclides associated with particulates that became airborne. The reaction rate between the waste and the aqueous solution was controlled by managing the rate at which the waste was added to the aqueous solution. The waste was added to the aqueous solution until all of the lithium was reacted. Thus, the reactive characteristic was removed. Once the reaction was complete, the resulting aqueous solution was neutralized and solidified with a polymer absorbent and managed

2. COMPLIANCE SUMMARY

TABLE 2.6

Permitted Hazardous Waste Treatment and Storage Facilities, 2005

Description	Location	Purpose
<i>Storage</i>		
Concrete Storage Pad	Building 331	Storage of solid radioactive waste and solid mixed waste (MW) in the form of steel-encased lead shielding containers and containerized solid MW.
Container Storage Area	Building 325C, East (closure report submitted to IEPA in December 2005)	Storage of liquid and solid bulk or lab-packed flammable and reactive hazardous waste and solid and liquid bulk polychlorinated biphenyls (PCBs) and miscellaneous PCB units.
	Building 325C, West (closure report submitted to IEPA in December 2005)	Storage of bulk and lab-packed liquid flammable hazardous waste.
	Building 303 Mixed Waste Storage Facility	Storage of containers of ignitable, corrosive, oxidizing, reactive, solid hazardous, radiological, or MW.
	Building 331 Radioactive Waste Storage Facility	Storage of containers of flammable, toxic, corrosive, oxidizing hazardous, radiological, or MW.
Dry Mixed Waste Storage Area	Building 374A	Storage of solid MW and radioactively contaminated lead bricks.
Portable Storage Units (4)	Building 306	Storage of hazardous, radiological, or MW (3 of 4 units).
		Bulking operations to consolidate and reduce the volume of lab-packed waste in containers (1 of 4 units).
Tank Storage	Building 306	Storage of corrosive and toxic mixed waste and radiological liquid wastes (4,000 gal; currently not used).
Mixed Waste Storage	Building 306 – Storage Room A-142	Storage of ignitable MW.
	Building 306 – Storage Room A-150	Storage of solid and liquid MW.
	Building 306 – Storage Room C-131	Storage of ignitable, corrosive, and reactive hazardous waste.

2. COMPLIANCE SUMMARY

TABLE 2.6 (Cont.)

Description	Location	Purpose
	Building 306 – Storage Room C-157	Storage of corrosive and oxidizer MW.
	Building 306 – Storage Room D-001	Storage of solid MW containing toxic metal constituents.
<i>Treatment</i>		
Alkali Metal Passivation Booth	Building 206	Destruction of water reactive alkali metals possibly contaminated with radionuclides.
Alkali Metal Passivation Booth	Building 308	Destruction of water reactive alkali metals.
Chemical/Photooxidation Unit	Building 306	Treatment of ignitable liquid MW containing organic contaminants.
Dry Ice Pellet Decontamination Unit (closure report submitted to IEPA in April 2005)	317 Area	Treatment of solid MW having radionuclide and/or RCRA metal surface contamination.
Low-Level Radioactive Waste (LLW) Neutralization/Precipitation System	Building 306	Treatment of aqueous, corrosive LLW, some of which is contaminated with heavy metals.
Mixed Waste Immobilization/Macroencapsulation Unit	Building 306	Treatment of solid, semisolid, and organic liquid MW containing RCRA metals.
Transuranic (TRU) Neutralization/Precipitation Treatment Unit	Building 306	Treatment of corrosive, aqueous MW containing TRU radionuclides and RCRA metals.

as nonhazardous radioactive waste. The waste was packaged and is being prepared for disposal at an off-site facility. A total of 10.4 kilograms (23 lb) was treated during 2005. The study was completed in October 2005.

2.3.3. Mixed Waste Generation, Storage, Treatment, and Disposal

A small number of hazardous wastes that Argonne generates also exhibit radioactivity, thereby making them “mixed waste.” The hazardous component of mixed waste is subject to RCRA regulations, while the radioactive component is subject to regulation under the Atomic Energy Act of 1954 (AEA) as implemented by DOE orders. Accordingly, facilities storing or disposing of mixed waste must comply with both DOE requirements and RCRA permitting and

2. COMPLIANCE SUMMARY

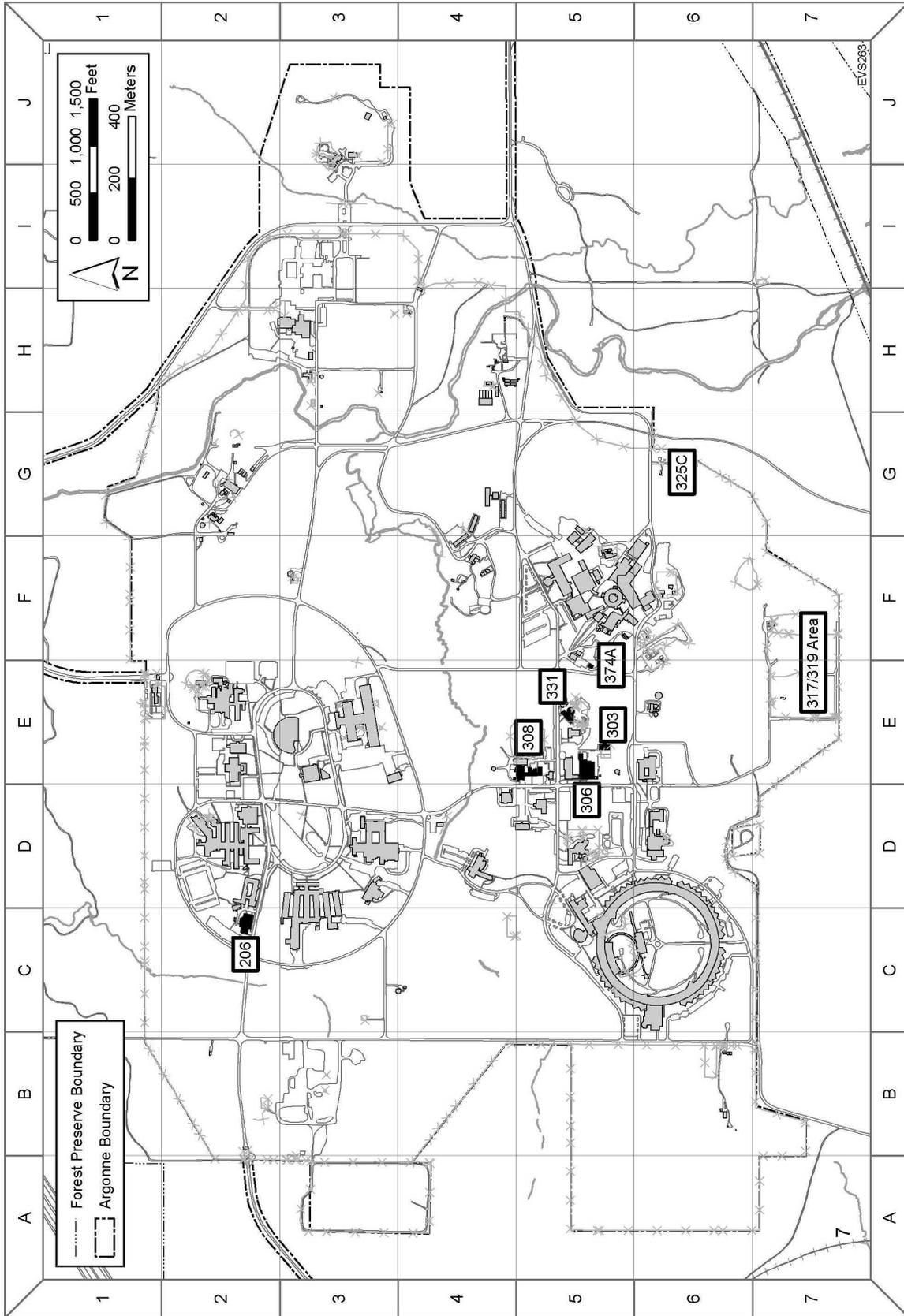


FIGURE 2.5 Major Treatment, Storage, and/or Disposal Areas at Argonne

2. COMPLIANCE SUMMARY

TABLE 2.7

Hazardous Waste Generation, Treatment, Disposal, or Recycle, 2005		
Waste	Volume (gal) ^a	Weight (lb)
<i>Generated and Disposed of or Recycled</i>		
Aerosol cans	85	228
Brake cleaner fluid ^b	8	67
Bulked laboratory solvents	605	3,722
Cadmium contaminated debris	55	220
Caustic solutions with heavy metals	165	1,000
Coal combustion samples	250	500
Compressed gases	21	33
Cutting oils with lead and solvents	110	1,016
Diesel fuel contaminated debris	30	120
Electropolishing solutions	425	3,300
Immersion cleaner fluid	26	217
Labpacks of liquid chemicals	920	7,363
Labpacks of solid chemicals	315	1,257
Lead-contaminated debris	745	3,725
Oil-based paint	30	332
Solvent contaminated debris	85	340
Used oil – hazardous	165	1,035
Zirconium metal shavings	30	270
<i>Universal Hazardous Waste</i>		
Mercury-containing lamps ^b	7,800	7,800
Lead-acid batteries ^b	750	7,500
Other batteries ^b	210	2,100

^a In accordance with RCRA regulations, waste amounts are reported in units of gallons, regardless of the physical form of the waste.

^b Recycled waste.

facility standards. Argonne generates several types of mixed waste, including acids, solvents, and sludges and debris contaminated with radionuclides. The RCRA Part B permit provides for on-site treatment in five mixed-waste treatment systems. These systems include neutralization of low-level radioactive waste (LLW) and transuranic (TRU) corrosive aqueous waste and the stabilization of sludge and soil. In addition, during 2005, some of the mixed waste was sent off-site to Envirocare of Utah, Inc., Salt Lake City, Utah, a commercial treatment and disposal facility. Table 2.8 lists the mixed waste generated, stored, treated on-site, or shipped off-site for disposal in 2005.

2. COMPLIANCE SUMMARY

TABLE 2.8

Mixed Waste Generation, Treatment, Storage, and Disposal, 2005

Waste	Volume (gal)	Weight (lb)
<i>Generated</i>		
MW acidic solutions	90	810
MW acidic solutions with heavy metals	31	279
MW aqueous solutions with heavy metals	470	4,230
MW debris with elemental mercury	8	32
MW flammable liquids	175	1,225
MW debris with heavy metals	2,990	29,900
MW sludge with heavy metals	227	2,270
MW uranyl nitrate	19	380
TRU acids with heavy metals	31	279
<i>Shipped for Treatment/Disposal</i>		
MW debris with heavy metals	7,565	75,650
MW lead articles	120	10,800
MW soil with heavy metals	10	90
<i>Treated</i>		
MW acidic solutions with heavy metals	142	1,278
MW acidic solutions	80	720
MW aqueous with heavy metals	60	540
TRU lithium metal with plutonium	20	200
<i>In Storage</i>		
MW acidic solutions	170	1,530
MW acidic solutions with heavy metals	646	5,814
MW alkali metals	276	2,208
MW aqueous solutions with heavy metals	187	1,683
MW debris with elemental mercury	113	11,187
MW flammable liquids	583	4,081
MW inorganic nitrates	338	6,760
MW debris with heavy metals	3,631	36,310
MW debris with volatile organics	98	392
MW lead articles	3,230	290,700
MW sludges with heavy metals	1,293	12,930
MW soil with heavy metals	354	3,186
TRU acids with heavy metals	533	4,797
TRU lead	55	4,950

2. COMPLIANCE SUMMARY

2.3.4. Federal Facility Compliance Act Activities

The Federal Facility Compliance Act of 1992 (FFCA) amended RCRA to clarify the application of its requirements and sanctions to federal facilities to allow treatment of mixed waste. The FFCA also requires that DOE prepare mixed-waste treatment plans for DOE facilities that store or generate mixed waste. The Proposed Site Treatment Plan (PSTP) for mixed waste generated at Argonne was submitted to the IEPA and the Illinois Department of Nuclear Safety (IDNS) in March 1995. Mixed waste at Argonne has been managed in accordance with the PSTP since October 1995. Argonne's RCRA Part B permit provides for on-site treatment of certain mixed waste as required by the PSTP.

During 2005, Argonne completed the treatment milestone for the lithium metal with plutonium waste streams. During 2006, Argonne will continue to address treatment of lower-volume waste streams. The goal is to complete treatment of all stored mixed waste by late 2006. There are two remaining mixed-waste streams to treat under the PSTP.

2.3.5. RCRA Inspections: Hazardous Waste

A RCRA compliance inspection was conducted by EPA Region V on July 20 and 21, 2005. EPA Region V reviewed pertinent documentation, such as inspection records; the contingency, waste analysis, and closure plans; training records; and annual reports. All permitted storage and treatment units were inspected. The EPA determined that Argonne provided an exemplary waste management program and is in compliance with RCRA regulations.

2.3.6. Underground Storage Tanks

The Argonne site currently contains 13 USTs. Seven of the existing tanks are being used to store fuel oil for emergency generators. The Argonne Service Station, Building 300, was closed on November 30, 2004. Three fuel USTs and one waste oil UST were removed from Building 300 in September 2005. The 20-Day and 45-Day Reports were submitted to the IEPA in October and December. The on-site maintenance facility (Building 46) uses underground tanks to store diesel, gasoline, used oil, antifreeze, and an ethanol/gasoline blend. On June 13, 2003, the Illinois State Fire Marshal certified that the USTs at Argonne are in compliance with the regulations. Argonne compliance staff conducted a compliance assessment in February and March 2005. Compliance issues were identified for follow up by the responsible staff.

2.4. Solid Waste Disposal

In September 1992, Argonne ceased operation of its 800 Area Landfill, which had begun operating in 1966. The IEPA issued the original operating permit in 1981 in accordance with 35 IAC Part 807 and several subsequent supplemental permits. On March 25, 2003, the IEPA

2. COMPLIANCE SUMMARY

determined that the postclosure care of the 800 Area Landfill would be carried out under the corrective action provisions (Section V) of Argonne's RCRA Part B permit.

Groundwater Quality Standards of some routine indicator parameters have been consistently exceeded. Exceedances occur primarily in shallow, perched pockets of groundwater in the glacial drift that is not in direct communication with the deeper dolomite bedrock aquifer. To aid in the determination of the nature and extent of these exceedances, in 1999, additional groundwater monitoring wells were installed around the landfill. Hydrogen-3 has been measured in several wells at the 800 Area Landfill at concentrations ranging from <100 pCi/L to 362 pCi/L. The 800 Area Landfill groundwater monitoring program is discussed in detail in Section 6.3.

Argonne generates a large volume and variety of nonhazardous special wastes. Some otherwise special waste, such as sanitary sewage sludge, is certified to the IEPA as "nonspecial waste" pursuant to IEPA regulations. Table 2.9 gives the nonhazardous special and nonspecial wastes generated, stored, disposed of, or recycled during 2005. All nonhazardous special and nonspecial wastes generated at Argonne in 2005 were disposed of at permitted off-site special waste landfills. The IEPA began requiring annual nonhazardous special waste reporting in 1991. The report is required to be submitted by February 1 of each year to describe the activity of the previous year. It is a summation of all manifested nonhazardous and polychlorinated biphenyl (PCB) wastes shipped out of state.

Argonne also periodically generates radioactive waste containing other regulated materials. Table 2.9 lists the quantities of such waste stored on-site or disposed of off-site.

2.5. National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established a national environmental policy that promotes consideration of environmental impacts in federal or federally sponsored projects. NEPA requires that the environmental impacts of proposed actions with potentially significant effects be considered in an Environmental Assessment (EA) or Environmental Impact Statement (EIS). DOE has promulgated regulations in Title 10, Part 1021, of the *Code of Federal Regulations* (10 CFR Part 1021) that list classes of actions that ordinarily require those levels of documentation or that are categorically excluded from further NEPA review. No Environmental Impact Statements (EISs) were prepared during 2005. One EA was completed in 2005 for the D&D of the Zero Power Reactor, which resulted in a Finding of No Significant Impact.

2.6. Safe Drinking Water Act

The Safe Drinking Water Act of 1974 (SDWA) established a program to ensure that public drinking water supplies are free of potentially harmful materials. This mandate is carried out through the institution of national drinking water quality standards, such as Maximum

2. COMPLIANCE SUMMARY

TABLE 2.9

Generation, Storage, Disposal, or Recycling of Special and Nonspecial Waste, 2005

Waste	Volume	Weight (lb)
<i>Nonhazardous Special Waste Disposal</i>		
Antifreeze	400 gal	3,300
Medical waste	113 ft ³	480
Nonhazardous brine solution	4,200 gal	38,580
Nonhazardous liquid chemicals	1,155 gal	7,980
Nonhazardous potash solution	2,600 gal	23,900
Nonhazardous solid chemicals	1,670 gal	6,850
Petroleum naphtha ^a (parts washers)	1,236 gal	8,283
Used oil ^a	3,235 gal	23,483
<i>Certified Nonspecial Waste Disposal</i>		
Nonspecial fly ash	1,242 yd ³	1,049,500
Nonspecial laboratory sewage sludge	90 yd ³	180,000
<i>Toxic Substances Control Act (TSCA)</i>		
<i>Special Waste Disposal</i>		
Asbestos	225 yd ³	225,000
PCBs	525 gal	3,695
<i>Materials Recycled</i>		
Sanitary sewage sludge ^a	95,000 gal	798,000
<i>TSCA Mixed Waste in Storage</i>		
Radioactive PCB sludge and debris	172 gal	1,376
Radioactive PCB articles	50 gal	400
Radioactive PCB oil	40 gal	280

^a Recycled waste.

Contaminant Levels and Maximum Contaminant Level Goals, as well as through the imposition of wellhead protection requirements, monitoring requirements, treatment standards, and regulation of underground injection activities. The regulations implementing the SDWA in 40 CFR Parts 141–143 establish Primary and Secondary National Drinking Water Regulations that set forth requirements to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

2.6.1. Applicability to Argonne

In January 1997, Argonne incorporated Lake Michigan water as its domestic source water, thereby replacing the dolomite groundwater that formerly constituted its source of drinking water. Because the Lake Michigan water is purchased from the DuPage County Water Commission, Argonne is now a customer, rather than a supplier, of water. Consequently, on January 23, 1997, the DuPage County Health Department notified DOE that the federal and state monitoring requirements applicable to a “non-transient, non-community” public water supply were no longer applicable. Nevertheless, Argonne voluntarily provides to on-site personnel the Consumer Confidence Report on drinking water quality that Argonne receives as a customer of the DuPage County Water Commission. The annual report indicates that all measured contaminants meet the drinking water standards.

2.6.2. Water Supply Monitoring

During 2005, Argonne continued an informational monitoring program at the previously used dolomite domestic wells; quarterly samples were analyzed for radionuclides and VOCs. No radionuclides or VOCs were detected.

2.7. Federal Insecticide, Fungicide, and Rodenticide Act

During 2005, all exterior pesticides and herbicides at Argonne were applied by a licensed contractor who provides the chemicals used and removes any unused portions. Argonne coordinates the contractor’s activities and ensures that the chemicals are EPA-approved, that they are used properly, and that any unused chemicals are removed from the site by the contractor.

In addition, routine applications of pesticides are performed within buildings, as needed. Indoor pesticide applications are provided by Illinois Department of Public Health-licensed contractors under the direction of Plant Facilities and Services (PFS)-Custodial Services or on-site contractors, depending on the building involved. The indoor applications involve EPA “Restricted Use” products.

In 2005, approximately 35,321 L (9,295 gal) of commercial-grade herbicide was applied throughout the Argonne site. Fertilizer with weed control is included in the quantity of herbicide.

2.8. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) addresses the cleanup of hazardous waste disposal sites and the response to hazardous substance spills. Under CERCLA, the EPA collects site data regarding sites subject to CERCLA action through generation of a Preliminary Assessment (PA) report, followed by a Site

2. COMPLIANCE SUMMARY

Screening Investigation (SSI). Sites then are ranked, on the basis of the data collected, according to their potential for affecting human health or causing environmental damage. The sites with the highest rankings are placed on the National Priority List (NPL) and are subject to mandatory cleanup actions. No Argonne sites are included in the NPL.

On December 21, 1999, the EPA published interim guidance redefining “federally permitted releases” under CERCLA. This action may have a significant impact on Argonne with respect to what types of air emissions will need to be reported under Section 101(10)(H) of CERCLA. The guidance provides an extremely narrow definition of how CERCLA substances released into the air would be exempted from reporting as a federally permitted release. On April 17, 2002, additional guidance was published by EPA and the interim guidance was withdrawn. While the final guidance generally regarded emissions covered by CAA permits as federally permitted, there remains some ambiguity in the interpretation and the guidance is not considered a regulation.

2.8.1. Emergency Planning and Community Right to Know Act (Superfund Amendments and Reauthorization Act, Title III)

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) amendments to CERCLA is the Emergency Planning and Community Right to Know Act (EPCRA), a freestanding provision. EPCRA requires providing federal, state, and local emergency planning authorities information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including providing responses to emergency situations involving hazardous materials. Under EPCRA, Argonne has been required to submit reports pursuant to Sections 302, 304, 311, 312, and 313, which are discussed in the following paragraphs. Table 2.10 gives Argonne’s status in regard to EPCRA.

Section 302 of SARA Title III, Planning Notification, addresses notifying and updating the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission (SERC) as to the presence of extremely hazardous substances (EHSs) at Argonne, including laboratory usage, that exceed any EHS threshold planning quantity. The Section 302 information for 2005 was transmitted to the LEPC and SERC during June, October, and December of 2005.

Section 304 of SARA Title III, Extremely Hazardous Substances Release Notification, requires that the LEPC and state emergency management agencies be notified of accidental or unplanned releases of Section 302 hazardous substances to the environment. Also, the National Response Center is notified if a release exceeds the CERCLA Reportable Quantity for that particular hazardous substance. The procedures for notification are described in the Argonne Emergency Plan Implementing Procedures. There were no incidents requiring notification during 2005.

Under SARA Title III, Section 311, Material Data Safety Sheet (MSDS)/Chemical Inventory, Argonne is required to provide applicable emergency response agencies with MSDSs, or a list of MSDSs, for each hazardous chemical stored on-site. The 2005 information was

2. COMPLIANCE SUMMARY

TABLE 2.10

Status of EPCRA Reporting, 2005

EPCRA Section	Description of Reporting	Status
Section 302	Planning notification	Required
Section 304	EHS release notification	Not required in 2005
Section 311–312	Material Safety Data Sheet chemical inventory	Required
Section 313	Toxic Release Inventory reporting	Required

transmitted to the LEPC and the Illinois Emergency Management Agency during June, October, and December of 2005.

Pursuant to EPCRA Section 312, Argonne is required to report certain information regarding inventories and the locations of hazardous chemicals to state and local emergency authorities upon request. Petroleum products need to be reported. However, chemicals used in research laboratories under the direct supervision of a technically qualified individual are exempt from reporting. The report on Section 312 (Tier 2) information for 2005 was provided to DOE during February 2006. Table 2.11 lists the hazardous chemicals reported.

Section 313 of SARA Title III, Toxic Release Inventory (TRI) Reporting, requires facilities to prepare an annual report entitled “Toxic Chemical Release Inventory, Form R,” if annual usage of listed toxic chemicals exceed certain thresholds. Argonne is not within the range of Standard Industrial Codes specified in the statute. Argonne reports this information, however, because DOE, which is subject to EO 13148, “Greening the Government through Leadership in Environmental Management” (April 21, 2000), directs Argonne to do so. No reports were filed from 1997 to 2000, because no listed chemicals were used in amounts that exceeded reporting thresholds. However, new requirements regarding a class of TRI compounds called persistent, bioaccumulative toxics (PBTs) came into effect in 2000. As a result, Argonne filed one report under Section 313 in 2005 for activities in 2004 for lead. Use of lead included machining of various types of lead articles in excess of the 45-kg (100-lb) reporting threshold.

2.9. Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted to require chemical manufacturers and processors to develop adequate data on the health and environmental effects of their chemical substances. The EPA has promulgated regulations to implement the provisions of TSCA. These regulations are found in CFR Title 40, “Protection of the Environment, Chapter I: Environmental Protection Agency, Subchapter R – Toxic Substances Control Act.” These regulations provide specific authorizations and prohibitions on the manufacturing, processing, and distribution in commerce of designated chemicals. The principal impact of these

2. COMPLIANCE SUMMARY

TABLE 2.11

Argonne, SARA, Title III, Section 312, Chemical List, 2005

Compound	Physical Hazard			Health Hazard	
	Fire	Pressure	Reactivity	Acute	Chronic
Ethanol/gasoline	X	– ^a	–	X	–
Aluminum sulfate	–	–	–	X	–
Diesel fuel/heating oil	X	–	–	–	–
Gasoline	X	–	–	X	–
Mepiquat chloride	–	–	–	X	–
Mepiquat pentaborate	–	–	–	X	–
Optibor® boric acids	–	–	–	X	–
Sulfuric acid	–	–	–	X	–

^a A dash indicates that the compound does not fall within the particular hazard class.

regulations at the Argonne site concerns the handling of asbestos and PCBs. Suspect PCB-containing items that are subject to this act are identified through the Argonne PCB Item Inventory Program.

2.9.1. PCBs in Use at Argonne

PCB items in use or in storage for reuse are tracked by the Argonne PCB Item Inventory Program. All PCB items identified by the PCB Item Inventory Program have been labeled appropriately with a unique number for inventory and tracking purposes. These items are included in the Argonne Annual PCB Report, which describes the location, quantity, manufacturer, and unique identification number for all PCBs on-site. This report is not submitted to regulatory agencies, but is kept on file at Argonne. The Annual PCB Report for 2005 was completed on June 29, 2006. The PCBs in use at Argonne are contained in capacitors and power supplies. Waste Management Operations (WMO) processes PCB-contaminated equipment and oil for disposal. The regulations governing the use and disposal of PCBs can be found in 40 CFR Part 761.

2.9.2. Disposal of PCBs

Disposal of PCBs from Argonne operations includes materials lab-packed and bulked and aggregated solids shipped off-site through WMO. This includes PCB-containing materials that also contain radioactive substances known as TSCA mixed waste. Table 2.9 contains the amount of PCBs and PCB-contaminated materials and TSCA mixed waste in storage and shipped by Argonne during 2005.

Several years ago, contamination from historical PCB spills resulted in the generation of sludge contaminated by both PCBs and low-level radioactivity from the building retention tanks and holding tanks at the laboratory WTP. During 2005, no radioactive PCB-contaminated sludge and debris were shipped off-site for disposal. Radioactive PCB-contaminated sludge, debris, articles or oil in storage totaled 1,002 L (262 gal).

2.10. Endangered Species Act

The Endangered Species Act of 1973 (ESA) is federal legislation designed to protect plant and animal resources from the adverse effects of development. To comply with the ESA, federal agencies are required to assess the area of a proposed project to determine whether it contains any threatened or endangered species, or critical habitat of such species.

At Argonne, the applicable requirements of the ESA are identified and satisfied through the NEPA project review process. All proposed projects must provide a statement describing the potential impact to threatened or endangered species and critical habitat. This statement is included in the general Environmental Review Form. If the potential exists for an adverse impact, this impact will be assessed further and will be evaluated through consultation with the USFWS, and, if necessary, the preparation of a more detailed NEPA document, such as an EA or EIS. Where appropriate, this information is shared with affected state and federal stakeholders, so that potential adverse impacts are assessed fully and any steps to minimize these impacts can be identified.

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

The Hine's emerald dragonfly (*Somatochlora hineana*), federally and state listed as endangered, occurs in locations with calcareous 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. The federally listed threatened and state-listed endangered lakeside daisy (*Tetranervis herbacea*) has a planted population in Waterfall Glen Forest Preserve.

Other federally listed species could occur in the Argonne area as extremely rare nonbreeders during migration or in winter. These include the bald eagle (*Haliaeetus leucocephalus*), federally and state listed as threatened; piping plover (*Charadrius melodus*), federally and state listed as endangered; and least tern (*Sterna antillarum*), federally and state listed as endangered.

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Although state-listed species that occur in the area are not covered by the ESA, the following state-listed species are evaluated in the NEPA process:

- Endangered
 - Black-crowned night heron (*Nycticorax nycticorax*)
 - Butler’s quillwort (*Isoetes butleri*)
 - Osprey (*Pandion haliaetus*)
 - Tuckerman’s sedge (*Carex tuckermanii*)
- Threatened
 - Blanding’s turtle (*Emydoidea blandingii*)
 - Kirtland’s snake (*Clonophis kirtlandi*)
 - Marsh speedwell (*Veronica scutellata*)
 - Shadbush (*Amelanchier interior*)
 - Slender sandwort (*Minuartia patula*)
 - White lady’s slipper (*Cypripedium candidum*)

Of these, Kirtland’s snake and black-crowned night heron have been observed on Argonne property. Impacts to these species also would be assessed during the NEPA process.

2.11. National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA), as amended, requires federal agencies to assess the impact of proposed projects on historic or culturally important sites, structures, or objects within the sites of proposed projects. It further requires federal agencies to assess all archaeological sites, historic buildings, and objects on such sites to determine whether any qualify for inclusion in the NRHP. The act also requires federal agencies to consult with the State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation, as appropriate, when determining if proposed actions would adversely affect properties that are eligible for listing on the NRHP.

The NHPA is implemented at Argonne through the NEPA review process, as well as through the Argonne digging permit process. All proposed actions must consider the potential impact to historic or culturally important properties or artifacts and document this consideration on the Environmental Review Form. Prior to disturbing the soil, an Argonne digging permit must be obtained from the PFS Division. This permit must be signed by the designated permit reviewer after verifying the location of nearby archaeological sites and documenting the fact that no significant cultural resources would be affected. If the proposed site has not been surveyed for the presence of historic properties, a cultural resources survey is conducted by qualified personnel, and any artifacts found are documented and carefully removed. At Argonne, DOE consults with the Illinois SHPO through the Illinois Historic Preservation Agency (IHPA) and the Advisory Council on Historic Preservation, as appropriate, if proposed actions would adversely affect properties eligible for listing on the NRHP.

2. COMPLIANCE SUMMARY

In fall 2001, DOE entered into a programmatic agreement with the IHPA and the Advisory Council on Historic Preservation for management of cultural resources at Argonne. This agreement streamlines compliance with the NHPA by allowing standard mitigation measures and by excluding from Section 106 review certain categories of activities that are unlikely to adversely affect historic structures. The Cultural Resources Management Plan (CRMP) was completed, provided to DOE in 2005, and forwarded to the SHPO for approval/concurrence.

Cultural resources include both historic structures and archaeological sites. Phase I archaeological surveys have been completed for the entire Argonne facility, and 46 archaeological sites have been recorded. Three of the sites are eligible for the NRHP. Twenty-two sites have been determined to be ineligible, and 21 recorded sites have not yet been formally evaluated for eligibility. An excavation was conducted in August 2003 north of the Advanced Photon Source (APS) ring to reevaluate the eligibility of a farmstead site. A final determination was made in 2005, which found the site to be ineligible for listing. Some of the areas surveyed previously may require additional survey documentation due to insufficient coverage and coordination.

In fall 2001, Argonne completed a two-phased Sitewide Historic Property Inventory. The historic context portions of this inventory add significantly to the nuclear energy and nuclear science portions of the DOE Cold War story. On the basis of inventory reports, DOE determined that two areas — the Main Campus District (also known as the 200 Area) and the Freund Estate District — are eligible for listing on the NRHP as historic districts and that seven buildings are individually eligible for listing on the NRHP. In addition to the special facilities that were identified as part of the D&D program, including the decommissioned reactors CP-5, Argonne Thermal Source Reactor (ATSR) (removed), Experimental Boiling Water Reactor (EBWR) (removed), and Zero Power Reactors (ZPRs) VI and IX, the survey also identified the Alpha-Gamma Hot Cell Facility (AGHCF) and High-Voltage Electron Microscopy (HVEM) microscope.

The 200 Area Historic District includes six scientific buildings: Buildings 200, 202, 203, 205, 206, and 211. These buildings were identified on the basis of their contribution in association with advancements in nuclear research and the development of nuclear power reactors (Criterion A), and for the engineering and design value of each as a unique specialized and cohesive scientific facility (Criterion C). The Freund Estate District includes five facilities: the former Freund Lodge (Building 600), the pool (603), bathhouse (604), pavilion (606), and tennis courts (616). All are eligible for listing under Criterion B, on the basis of their association with an important local personality, Erwin O. Freund.

Buildings 200 (M-Wing), 203, 205, 212, 350, and Buildings 315/316 of the 314/315/316 complex are the seven buildings that are eligible for individual listing. In addition to these seven active Argonne facilities, three other buildings — Buildings 301, 330, and 331 — were found to be eligible, but subsequently have been mitigated by recordation for disposal. Building 203 is significant because of its association with a Nobel Prize winner, Maria Goeppert-Mayer. In January 2002, the IHPA concurred with the results of the sitewide survey regarding the eligible districts and facilities. Argonne is developing management plans to augment the

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procedural mechanisms identified in the programmatic agreement and CRMP. Argonne also conducted Historic American Building Survey/Historic American Engineering Record documentation of ZPRs VI and IX as part of the D&D process for the reactors.

2.12. Floodplain Management

Federal policy on managing floodplains is contained in EO 11988, “Floodplain Management” (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE’s implementation of this Executive Order. The EO requires federal facilities to avoid, to the extent possible, adverse impacts associated with the occupancy and modifications of floodplains. To construct a project in a floodplain, DOE must demonstrate that there is no reasonable alternative to the floodplain location.

The Argonne site is located approximately 46 m (150 ft) above the nearest large body of water (Des Plaines River); thus, it is not subject to major flooding. The 100- and 500-year floodplains are limited to low-lying areas of the site near Sawmill Creek, Freund Brook, Wards Creek, and other small streams and associated wetlands and low-lying areas. These areas are delineated in Argonne’s site development plan, and are contained within areas designated as conservation use, not intended for development. No significant structures are located in these areas, although an existing pumping station for securing canal water as a cooling tower feedstock is situated in the floodplain of the Des Plaines River south of the site. To ensure that these areas are not adversely affected, new facility construction is not permitted within these areas, unless there is no practical alternative. Any impacts to floodplains would be fully assessed in a floodplain assessment, and, as appropriate, documented in the NEPA documents prepared for a proposed project.

2.13. Protection of Wetlands

Federal policy on wetland protection is contained in EO 11990, “Protection of Wetlands” (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE’s implementation of this EO. The EO requires federal agencies to identify potential impacts to wetlands resulting from proposed activities and to minimize these impacts. Where impacts cannot be avoided, mitigating action must be taken by repairing the damage or replacing the wetlands with an equal or greater amount of a man-made wetland as much like the original wetland as possible.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. The U.S. Army Corps of Engineers (COE) administers this program. Activities regulated under this program include disturbance of wetlands for development projects, infrastructure improvements, and conversion of wetlands to uplands for farming and forestry. The COE uses a permit system to identify and enforce wetland mitigation efforts.

2. COMPLIANCE SUMMARY

Argonne completed a sitewide wetland delineation in 1993. All wetlands present on-site were identified and mapped following the 1987 U.S. Army *Corps of Engineers Wetlands Delineation Manual*.³ The delineation map shows the areal extent of all wetlands present at Argonne down to 500 m² (1/8th acre). Thirty-five individual wetland areas were identified; their total area is approximately 20 ha (50 acres). The larger wetlands are illustrated in Figure 1.4.

In February 1989, the COE issued a permit to DOE under Section 404 of the CWA, addressing the construction of the APS facility at Argonne. The permit was required because construction of the APS involved the filling of three small wetland areas, known as Wetlands A, B, and E, which totaled 0.7 ha (1.8 acres) in size. Issuance of the permit was contingent upon approval of a mitigation plan submitted to the COE by DOE. The plan outlined procedures for the construction of a new wetland area, Wetland R, and also identified actions to be taken to avoid impacts to a fourth wetland, Wetland C, just under 0.4 ha (1 acre), during APS construction activities. The expansion of Wetland R resulted in the creation of a wetland bank.

During October 1996, the COE inspected Wetlands C and R and determined that they were no longer being managed in accordance with the original APS construction permit. The deficiencies noted were excessively dry soil conditions in Wetland C, caused by altered hydrology, and a poor quality biological community in Wetland R. In response to this finding, Argonne prepared a management plan for Wetland R in January 1997 and began investigating the cause of the problems with Wetland C. The COE verbally agreed with these response actions. Implementation of the plan began in 1997.

Mitigative actions for Wetland R, as described in the 1997 management plan, involved improving the mix of vegetation through controlled burns, herbicide application, and planting of desirable plants. Controlled burns were completed in 1997, March 2000, March 2001, April 2002, and April 2005. Planting, herbiciding, and monitoring of the wetland continued in 2005. Due to a severe drought in 2005, the wetland contained no water until July 14, 2005.

2.14. Wildlife Management and Related Monitoring

DOE manages the numbers of white-tailed and fallow deer at the site through an interagency agreement with the U.S. Department of Agriculture. DOE began the deer management program in 1995 to alleviate traffic safety hazards and ecological damage caused by extremely high deer densities. More than 600 deer were removed in the winter of 1995 to 1996, and more than 80 deer were removed the following winter to achieve target densities of 20 deer/mi² for each species. Smaller numbers of deer have been removed each year since 1997.

DOE lowered its target density for white-tailed deer to 15 deer/mi² in 2001 to better achieve its objectives of reducing deer and vehicle collisions, allowing oak trees to regenerate, and allowing deer-sensitive herbaceous species to recover.

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DOE and the Forest Preserve District of DuPage County coordinate deer management efforts in order to preserve and enhance biodiversity at Argonne and the surrounding Waterfall Glen Forest Preserve.

2.14.1. Deer Population Monitoring

The deer population is monitored frequently by spotlight survey to meet the requirements of Deer Population Control Permits and to aid in making deer management decisions. Nineteen white-tailed deer were removed in 2005.

2.14.2. Deer Health Monitoring

The health of the white-tailed deer herd is evaluated by assessing the deer that are removed each year for mean live and dressed weights and the amounts of fat stored in various organs. The health of the white-tailed deer herd has been improving since the deer management program began in 1995.

2.14.3. Deer Tissue Monitoring

Samples taken from the muscles of deer are analyzed periodically for radionuclides to verify that deer meat donated to charity does not pose a radiological health hazard. Samples sent to the IDNS radiochemistry laboratory in November 2005 were analyzed for gamma-ray-emitting radionuclides and hydrogen-3. Naturally occurring potassium-40 (at background levels) was the only gamma-ray-emitting radionuclide identified. Hydrogen-3 was not detected in any sample.

2.14.4. Vegetation Damage

Woodland vegetation is monitored periodically to determine the effects of browsing by deer on woody vegetation and to assess forest health. This monitoring is conducted to meet conditions of Deer Population Control Permits and to help make deer and habitat management decisions. DOE changed its vegetation monitoring protocol in the fall of 2000 to better gauge overall forest health. The new protocol is an adapted form of the Illinois Forest Watch Monitoring Manual issued by the Illinois Department of Natural Resources. It calls for fall surveys of woody vegetation and spring surveys of herbaceous vegetation and tree seedlings. Data collected in two sampling plots from 2000 through 2005 indicate limited success in recovery of deer-sensitive herbaceous species. Oak seedlings were identified for the first time in Spring 2004 and again in Spring 2005.

2.15. Current Issues and Actions

The purpose of this section is to summarize the most important issues related to environmental protection encountered during 2005. Table 2.12 lists all water effluent exceedances reported during 2005. Exceedances of the NPDES wastewater discharge limits and Ground Water Quality Standards at the 800 Area Landfill Area are discussed in Chapters 5 and 6, respectively.

2.15.1. Clean Water Act — NPDES

As in previous years, Argonne exceeded NPDES permit limits in 2005 (see Table 2.12). In past years, the TDS concentration was the most persistent exceedance of the NPDES permit limits. The limit for TDS was exceeded five times at the WTP discharge point Outfall 001 (3), Outfall H03 (1), and Outfall J03 (1). Road salt runoff associated with snowmelt appears to be the main contributor to high TDS concentrations. The limit for total residual chlorine, effective September 1, 2005, was exceeded six times at various outfalls and were due to the discharge of potable water. Corrective actions were completed.

TABLE 2.12

Summary of 2005 Water Effluent Exceedances

Date	Outfall	Parameter	Assessment
February 1	001	TDS	Road salt associated with melting snow
February 15	001	TDS	Road salt associated with melting snow
June 14	004	TSS	Biological growth due to lack of precipitation
July 5	001	Copper	Copper cleaning operations
August 2	001	Copper	Copper cleaning operations
September 6 ^a	025	TRC	Discharge of potable water
September 12	025	TRC	Discharge of potable water
September 12	H03	TRC	Discharge of potable water and cooling tower blowdown
September 21	H03	TSS	Biological growth due to low precipitation
September 26	H03	TDS	Cooling tower flushing
September 26	025	TRC	Discharge of potable water
October 3	025	TRC	Discharge of potable water
October 10	025	TRC	Discharge of potable water
December 8	J03	TDS	Road salt associated with melting snow
December 27	001	TDS	Road salt associated with melting snow

^a New NPDES permit effective date September 1, 2005.

2. COMPLIANCE SUMMARY

Argonne has had occasional positive toxicity test results at several outfalls. These appear to be due to residual chlorine from the discharge of chlorinated drinking water into these outfalls and from cooling tower blowdown that may contain antifouling agents. Many of these discharges have been redirected into the sewer system to be processed at the WTP.

2.15.2. Solid Waste Disposal

The IEPA-approved 800 Area Landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some inorganic parameters consistently are being exceeded in several wells. The 1999 expansion of the groundwater monitoring well network is providing additional information about the nature of these exceedances. Additional information about the source and extent of these exceedances is needed before a plan of action to resolve the issue can be formulated. Hydrogen-3 concentrations in a few of the 800 Area Landfill wells were evaluated. Most concentrations were below the hydrogen-3 detection limit; a few wells, however, contained hydrogen-3 levels just above the detection limit, primarily in the south and southeast direction from the landfill. Hydrogen-3 concentrations in wells on the west and north side of the landfill were below the detection limit on all of the samples reviewed. On the basis of historical analytical data from the perimeter monitoring wells, it appears that any potential for hydrogen-3 to migrate to the northwest and west and impact the water supplies of residents in those directions is extremely low. The groundwater monitoring program is discussed in detail in Section 6.3.

2.15.3. Long-Term Stewardship Activities

Remediation of waste management units was completed in 2003. During 2005, the long-term operation, maintenance, and monitoring of these sites, recognized as Argonne's LTS Program, were incorporated, in their entirety, into Argonne's environmental monitoring and surveillance program. Ongoing activities during 2005 are described in detail in Chapter 6.

2.15.4. CP-5 Monitoring

Elevated levels of hydrogen-3 in CP-5 Monitoring Well 330031R (up to 45,000 pCi/L) were measured in quarterly groundwater samples after the original well was removed and the well replaced with a new well screened at a lower depth. Although the hydrogen-3 concentrations are decreasing, plans have been established to expand monitoring activities in this area to attempt to determine the source and extent of the hydrogen-3 distribution.

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2.16. Environmental Permits

Table 2.13 lists all the environmental permits in effect at the end of 2005. Other portions of this chapter discuss special requirements of these permits and compliance with those requirements.

TABLE 2.13

Argonne Environmental Permits in Effect December 31, 2005

Type	Subject of Permit	Site Location	Issued	Expiration Date
Air	Title V – Argonne	Sitewide	04/03/01	04/03/06
Air	Open-Burning Permit – Fire Dept. ^a	333	04/19/05	04/18/06
Air	Open Burning – Vegetation	Sitewide	01/30/05	01/29/06
Hazardous waste	RCRA Part B	Sitewide	09/30/97	11/04/07
Miscellaneous	Nuisance Wildlife Control	Sitewide	01/31/05	01/31/06
Water	Discharge to DuPage County Public Works	100 Area	08/10/01	— ^b
Water	Lime Sludge Application – Land Application	Sitewide	10/01/02	09/30/07
Water	NPDES Permitted Outfalls	Sitewide	09/01/05	08/31/10

^a This unit has been designated as an insignificant source in the Argonne Title V permit.

^b The permit continues to be in effect until revised.

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DOE Order 450.1, "Environmental Protection Program," was issued on January 15, 2003, to implement the requirements in EO 13148. The objective of DOE Order 450.1 is to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources potentially impacted by operations. Through these practices, DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements. This objective must be accomplished by implementing EMSs at DOE sites. These EMSs must be part of Integrated Safety Management Systems (ISMSs). The requirements of EO 13148 and DOE Order 450.1 are imposed on the contractors by the Contractors Requirements Document of DOE Order 450.1.

3.1. Argonne Environmental Management System

DOE and Argonne policies require that all operations be conducted in compliance with applicable environmental statutes, regulations, and standards, and that environmental obligations be carried out consistently across all operations and organizations. Protection of the environment and human health and safety are given high priority. A number of programs and organizations exist at Argonne to ensure compliance with these authorities and to monitor and minimize the impact of Argonne operations on the environment.

As part of its commitment to environmentally responsible operations, Argonne has established an Environmental Management System (EMS). An EMS ensures that environmental issues are systematically identified, controlled, and monitored and provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement.

3.1.1. Argonne's EMS Approach

The Argonne approach to EMS was to prepare an Environmental Management System Description Document that described the elements identified in DOE Order 450.1. The EMS document was structured to mirror the organizational structure of the Argonne ISMS in order to demonstrate integration between the two documents. DOE-ASO approved the Argonne EMS on July 14, 2003. A critical component of the EMS is the identification of environmental aspects, which are those activities and operations at Argonne that have the potential to impact the environment. Examples of environmental aspects include waste generation, air emissions, liquid effluents, consumption of natural resources, and disturbance to endangered species/protected habitats. A training course was prepared and implemented on January 24, 2004, that provided information on DOE Order 450.1, EO 13148, and the Argonne EMS. The course is part of the implementation process for the Argonne EMS.

As part of the annual review and revision of the EMS in 2004, a new section was added to establish a process for the annual preparation of objectives and targets for the following year. Through the achievement of the objectives and targets, Argonne addresses its significant aspects, including its compliance, mission, and reduction of its environmental risk. To be confident that the objectives and targets will be effective in addressing the significant environmental aspects, it

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is important that they be systematically established, periodically reviewed, and reconsidered within the management review process. Incorporation of the process into the EMS institutionalizes the annual preparation of objectives and targets.

The main effort during 2005 was to conduct EMS activities directed toward the certification of the EMS implementation by December 31, 2005. In June 2005, the annual review and revision of the EMS Description Document was completed. This revision included the addition of sections on several environmental aspects that were identified in DOE guidance documents issued early in 2005 to support DOE Order 450.1. Along with the review and revision of the EMS, objectives and targets for FY2006 were developed and incorporated into the revised EMS. The FY2006 objectives and targets were submitted to DOE-ASO on July 13, 2005, to complete Contract Performance Measure 1–5.

In July 2005, Argonne established an independent review team, as recommended in DOE G450.1-1, to evaluate the completeness of the Argonne EMS. The team used Attachment 3, “Elements of an ISMS/EMS,” from the DOE guide to determine any gaps in the Argonne EMS. The team report was provided on August 19, 2005, and offered a number of comments and identified areas that could be improved in the Argonne EMS. The comments were addressed and a revised Argonne EMS was prepared and transmitted to DOE-ASO on September 14, 2005, along with other material, indicating that Argonne had implemented its EMS and was in conformance with the EMS requirements in DOE Order 450.1.

In parallel with the above, a number of activities were conducted to implement the EMS and inform the Argonne population of the roles and responsibilities associated with the implementation of the EMS. The EMS was initially announced by a division directors and department heads (DD/DH) letter from the Laboratory Director. To support the information deployment, a training program (ESH-300) was created which covered Executive Order 13148, DOE Order 450.1, and the Argonne EMS. Completion of this course is required of all managers; Environmental Compliance Representatives (ECRs); Environment, Safety, and Health (ES&H) Coordinators, and NEPA owners. In addition, information was presented in the *Argonne News*, via a poster on habitat restoration, and presentations to the ECRs, the Pollution Prevention Committee, the Habitat Restoration Committee, the EQO Oversight Coordinating Committee (EQO-OCC), the DD/DH lunch, and the Community Leaders Roundtable. Individual meetings were held with managers and supervisors to discuss details of EMS related to their organizations. The DOE EMS Implementation Assessment Team conducted its visit November 14–18, 2005. The team issued its report on December 16, 2005, and the DOE-ASO manager certified that the Argonne EMS had been implemented on December 22, 2005.

3.1.2. Compliance with EO 13148

Argonne continues to support DOE in meeting its responsibilities for compliance and reporting required by EO 13148. Quarterly reports provided to DOE describe Argonne’s progress toward reaching the goal of preparing and implementing an EMS by December 31, 2005. During 2005, Argonne reported to DOE the completion of several milestones for EMS implementation.

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3.2. EMS Components

The Argonne EMS covers a number of elements that are identified in DOE Order 450.1. These elements are also similar to the topics covered in ISO 14001. A number of the most critical elements are discussed below.

3.2.1. Environmental Policy

Within the Argonne ES&H policy, Argonne has established an environmental protection policy. This policy applies to all Argonne activities that could or do have an impact on the environment or on compliance with environmental regulations. The policy states that “Argonne activities (including experiments, facility operations, construction activities, and other activities) will be conducted in an environmentally safe and sound manner and consistent with Argonne permits. To support this policy, Argonne is committed to leadership in environmental management by integrating environmental accountability into day-to-day activities and into long-term planning processes.”

3.2.2. Environmental Aspects and Impacts

When operations have an environmental aspect, Argonne implements the EMS to minimize or eliminate any potential impact. Argonne evaluates its operations, identifies aspects of its operations that can impact the environment, and determines which of those impacts are significant. The environmental aspects addressed in the Argonne EMS are air emissions, water effluents, drinking water, waste management, waste minimization/pollution prevention, floodplain/wetlands, endangered species, habitat restoration, wildland fire management, wildlife management, pesticide management, cultural resources management, PCB management, management of TSCA chemicals, UST management, EPCRA reporting, and long-term stewardship. Regulatory responsibilities as well as organizational roles and responsibilities are delineated in the EMS to address the management of the aspects and impacts.

3.2.3. Objectives and Targets

The objectives describe Argonne’s goals for environmental performance. The objectives are a set of measurable or qualitative goals concerning how Argonne will address each environmental aspect. Targets are specific and measurable interim steps that the organization takes to obtain the objective. Typically, objectives are broken down into more specific subordinate targets.

The process for the establishment of the objectives and targets is part of the annual management review of the EMS document. Each year, typically in July, the EMS is reviewed and the objectives evaluated for relevance, while targets are revised to reflect the next set of targets

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established for continuous improvement in that area. A subject matter expert is assigned to each environmental aspect; that person is responsible for administering that area and for the creation and annual updates of the objectives and targets. In July 2005, Argonne generated the FY2006 objectives and targets. A listing of the FY2006 objectives and targets can be found in the Argonne EMS Description Document.

3.2.4. Waste Minimization and Pollution Prevention

During 2005, Argonne continued its pollution prevention and waste minimization efforts. Argonne implements a sitewide Pollution Prevention/Waste Minimization (P2/WM) Program in accordance with DOE Order 450.1, and site-specific P2 performance measures. The P2 program tracks the generation of waste and recycle material at Argonne and monitors the progress with regard to performance measures.

Argonne management fosters a work environment that promotes the development and implementation of P2 activities. Argonne management has established a P2 policy statement and constituted a requirement that all new project reviews include the use of a P2 review checklist. In addition, Argonne uses the ISMSs to promote and institutionalize P2 strategies across the Argonne site.

3.2.4.1. P2 Assessments and Reviews

Historically, those involved in the Argonne P2 program have identified, developed, and performed Pollution Prevention Opportunity Assessments (PPOAs). PPOAs are reviews of programs, projects, and activities to determine what changes can be made to reduce or eliminate pollution. During 2005, the following were performed:

- Remanufactured paint,
- Obsolete video cassette tapes and containers,
- Silver recovery from microfilm,
- Fiberglass underground storage tank recycling, and
- Steel counting vault.

During 2005, the Electronic Equipment Recycling Program shipped approximately 50 t (55 tons) of excess computers, monitors, and printers to Fermilab, which works with a demanufacturer that disassembles the equipment to recycle the useful materials. Transferring this material generated a cost savings for Argonne of approximately \$20,000. During 2005, the Battery Recycling Program was available to all of the buildings at Argonne and diverted 1,864 kg (4,100 lb) of routinely used batteries from the Argonne waste stream. The batteries are sent to a facility that recovers metals that can be reused as a secondary raw material.

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3.2.4.2. Waste Reduction and Recycling

Argonne's comprehensive solid waste recycling program effectively recycles/reduces the following waste/materials: surplus laboratory chemicals, mixed office paper, cardboard, aluminum, glass, metals, toner cartridges, construction and demolition debris, fly ash, coal fines, sanitary waste sludge, lead, lead-acid batteries, transparencies, fluorescent light bulbs, computers, and electronic equipment.

Argonne continues to utilize programs, such as the Argonne Chemical Exchange System and the Surplus Office Supply Exchange, that allow employees and contractors to minimize waste and reuse available materials. Argonne expanded this reuse opportunity with the development of the Argonne Equipment and Materials Exchange (AEM-X). The AEM-X program was developed to assist Argonne employees in recycling and reusing surplus equipment, supplies, and materials by promoting the availability or need for items via the Argonne e-mail system. These programs are in need of upgrade and revitalization.

3.2.4.3. Affirmative Procurement Program (EO 13101)

Argonne's commitment to environmental quality, as demonstrated by the purchase of environmentally preferable products, has resulted in an award-winning Affirmative Procurement Program. These efforts have made it easier for employees to purchase recycled-content products, made it less difficult to track purchases, and heightened the overall awareness level for buying recycled items. In 2005, the Affirmative Procurement purchases were 89% of purchases containing recycled products.

In 2005, Argonne reduced all of its waste streams — routine LLW, mixed waste, hazardous waste, TSCA waste, and solid waste — as compared to 2004 and recycled solid waste material at a level of 45%. Argonne tracks, reviews, and assesses (by using PPOAs) the hazardous and radioactive waste streams in an effort to identify alternatives to disposal (e.g., segregation, treatment, reuse, and recycling) for these materials/waste.

3.2.4.4. Sustainable Design

Sustainable design and environmentally preferable building materials and construction methods are included in all phases of project design.

3.2.5. Environmental Training

Argonne has a comprehensive training program that includes mechanisms to identify, track, and document training requirements for every employee. Environmental protection training for Argonne personnel is provided primarily by the EQO Training Section, although some training may be delivered by subject-matter experts from other organizations. Personnel training addresses various requirements, such as those contained in DOE orders, or EPA and

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U.S. Department of Transportation regulations, in addition to specifying Argonne requirements. Required training is identified by a Job Hazards Checklist form that is completed by every employee and is reviewed by each employee's supervisor.

Designation of training and records of training are managed through the Training Management System, an on-line computer-based system that tracks the training status of each employee. Environmental protection training courses and course descriptions are listed in the Training Course Catalog available from divisional training management system representatives, the EQO Training Section, or Human Resources.

3.2.6. Assessment Programs

In line with the principles of integrated safety management, line management is responsible for internal self-assessments. This process focuses on the activities of an individual organization and is intended to stimulate continuous improvement. The results are reported to those who have the authority and responsibility for the organization's performance. At the beginning of the calendar year, each organization develops an agenda of activities to be reviewed. A schedule is prepared and assignments are made to manage the organization's self-assessment program. The Argonne-wide results and conclusions of the assessment programs are summarized by line management and submitted to the Director of EQO. The actual performance during the year is monitored by the line organization as well as by the oversight organization assisting senior management in fulfilling its oversight responsibilities.

3.2.7. Ecological Restoration Program

DOE and Argonne recognize the importance of enhancing and preserving biodiversity and have committed to supporting the Biodiversity Recovery Plan prepared by the Chicago Wilderness partnership organizations. Ongoing ecological restoration activities include enhancing oak woodland, savanna, wetland, and prairie habitats in the undeveloped areas on the Argonne site. Six acres (2.4 ha) of vacant land that formerly was occupied by Quonset huts has been converted to prairie. Controlled burns and hand clearing of invasive shrubs are restoring sunlight to oak woodlands, so that native flowers and grasses can grow. The upland area around a site wetland has been planted with prairie species to cleanse water feeding the wetland. The area surrounding a man-made pond outside the main administration building is being used to demonstrate the use of native plants for landscaping after invasive weedy plants were removed and replaced by native species.

3.3. Environmental Support Programs

Argonne established a number of environmental support programs to support the implementation of the EMS and enhance the management of the various environmental aspects.

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3.3.1. Environmental Monitoring and Surveillance Program

As required by DOE Orders 450.1 and 231.1A, supplemental DOE guidance, and permit conditions, Argonne conducts a routine environmental monitoring program designed to determine the effects of Argonne operations on the environment surrounding the site. The program involves collection of environmental media samples — air, surface water, groundwater, and sediment — in addition to direct radiation measurements and analysis of those radiological and chemical parameters known to be used or generated at Argonne. The potential dose to members of the public is estimated from radiological releases, and chemical concentrations are compared with regulatory limits. The results are compiled, and a number of reports (including this Argonne Site Environmental Report [SER]) are prepared. In 2005, a total of 2,227 samples were collected and 28,800 analytical results were generated. A discussion of the rationale for sampling and analyses for each media is presented in the Argonne Environmental Monitoring Plan.

3.3.2. Long-Term Stewardship Program

By September 30, 2003, Argonne had completed all corrective actions required by the IEPA. The remediation work on all units listed in the RCRA Part B permit — 49 SWMUs and 6 Areas of Concern (AOCs) — was completed. Argonne also completed three voluntary cleanup projects. However, 5 SWMUs and 2 AOCs were not able to be cleaned up sufficiently to meet the IEPA groundwater/soil cleanup standards. These seven locations and maintenance procedures for the remediation systems that were established by the remediation program were incorporated into the Argonne Long-Term Stewardship (LTS) Program.

During 2005, members of the LTS Program conducted quarterly groundwater monitoring of water from wells in the 317/319/ENE (East-Northeast) Area and the 800 Area Landfill. The samples were analyzed for the parameters identified in IEPA permits or in response letters. The results were reported quarterly to the IEPA and summarized in Chapter 6. Maintenance activities included well cleaning, servicing of pumps and compressors, and grass mowing. Argonne scientific staff continue to study the VOC decomposition process within the trees at the phytoremediation plantation.

3.3.3. Site Environmental Performance Measures Program

Effective FY1995, the Prime Contract between DOE and The University of Chicago to operate Argonne made provisions for a fee based on the performance of various research and operations activities, including ES&H and Projects and Infrastructure Management performance. Performance objectives and supporting metrics have been developed as a part of the contract and for determining the performance fee. At the end of the performance period, a rating (outstanding, excellent, good, or marginal) is assigned to each set of activities subject to the evaluation process. These ratings are part of the basis for the performance fee.

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For the period of the performance-based contract of October 1, 2004 to September 30, 2005, the environmental measures were included in two categories: (1) ES&H and (2) Projects and Infrastructure Management. The ratings for the measures in these categories directly affected the performance fee. The environmental measures and their corresponding ratings include the following:

- Develop comprehensive FY2006 EMS objectives and targets (Outstanding);
- Complete FY2005 Land Management and Habitat Restoration Work Plan activities (Outstanding);
- Reduce waste generation for the following routine waste streams: TSCA-regulated waste, hazardous waste, hazardous and radioactive mixed waste, low-level radioactive waste, and sanitary waste (Outstanding);
- Conduct waste minimization pollution prevention opportunity assessments and provide implementation action plan to DOE (Outstanding);
- Achieve FY2005 targets against Old Waste Disposition Plan (Outstanding);
- Number of reportable unpermitted releases at Argonne and Argonne-West (Outstanding);
- Cumulative costs from incidents resulting in environmental cleanup or remediation at Argonne and Argonne-West (Outstanding);
- Quarters with air effluent violation at Argonne boiler house (Outstanding);
- Number of water effluent violations at Argonne (Outstanding); and
- Enforcement action at Argonne not withdrawn by regulator (Outstanding).

The overall rating for the environmental performance measures, based on a rollup of the individual performance ratings during the contract period, was Outstanding.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION



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4.1. Description of Monitoring Program

The radioactivity of the environment around Argonne in 2005 was determined by measuring radionuclide concentrations in air, surface water, subsurface water, and sediment, and by measuring the external photon penetrating radiation and potential neutron exposure. Sample collections and measurements were made at the site perimeter and off-site for comparative purposes. Some on-site results are also reported when they are useful in interpreting perimeter and off-site results.

Because radioactivity is primarily transported by air and water, the sample collection program concentrates on these media. In addition, samples of materials from the streambeds also are analyzed. The program follows the guidance provided in the DOE Environmental Regulatory Guide.⁴ The results of radioactivity measurements are expressed in terms of pCi/L for water, fCi/m³ for air, and pCi/g and fCi/g for bottom sediment. Penetrating radiation measurements are reported in units of mrem/yr, and population dose is reported in units of person-rems.

DOE has provided guidance⁵ for effective dose equivalent calculations for members of the public based on International Commission on Radiological Protection (ICRP) Publications 26 and 30.^{6,7} Those procedures have been used in preparing this report. The methodology requires that three components be calculated: (1) the committed effective dose equivalent (CEDE) from all sources of ingestion, (2) the CEDE from inhalation, and (3) the direct effective dose equivalent from external radiation. These three components were summed for comparison with the DOE effective dose equivalent limits for environmental exposure. The guidance requires that sufficient data on exposure to radionuclide sources be available to ensure that at least 90% of the total CEDE is accounted. The primary radiation dose limit for members of the public is 100 mrem/yr. The effective dose equivalents for members of the public from all routine DOE operations (natural background and medical exposures excluded) shall not exceed 100 mrem/yr and must adhere to the as-low-as-reasonably-achievable (ALARA) process or be as far below the limits as is practical, taking into account social, economic, technical, practical, and public policy considerations. Routine DOE operations are normally planned operations and exclude actual or potential accidental or unplanned releases.

The measured or calculated environmental radionuclide concentrations were converted to a 50-year CEDE with the use of the CEDE conversion factors⁸ and were compared with the annual dose limits for uncontrolled areas. The CEDEs were calculated from the DOE Derived Concentration Guides (DCGs)⁵ for members of the public on the basis of a radiation dose of 100 mrem/yr. The numerical values of the CEDE conversion factors used in this report are provided later in this chapter (Table 4.24). Occasionally, other standards are used, and their sources are identified in the text.

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4.2. Air

The radioactive content of particles in the air was determined by collecting and analyzing air filter samples. The sampling locations are shown in Figures 1.1 and 1.2. Argonne uses continuously operating air samplers to collect samples for the measurement of concentrations of airborne particles contaminated by radionuclides. Currently, nonradiological air contaminants in ambient air are not monitored. Particle samplers are placed at 12 locations around the Argonne perimeter and at 5 off-site locations approximately 8 km (5 mi) from Argonne, to determine the ambient or background concentrations. Samples were collected at the site perimeter to determine whether a statistically significant difference exists between perimeter measurements and measurements taken from samples collected at various off-site locations. The off-site samples establish the local background concentrations of naturally occurring or ubiquitous man-made radionuclides, such as from nuclear weapons testing fallout. Higher levels of radioactivity in the air measured at the site perimeter may indicate radioactivity releases from Argonne, provided that the perimeter sample results are greater than the background sample results by an amount greater than the relative error of the measurement. The relative error is a result of natural variation in background concentrations as well as sampling and measurement error. This relative error is typically 5 to 20% of the measurement value for most of the analyses, but approaches 100% at values near the detection limit of the instrument.

Airborne particle samples for measurement of total alpha, total beta, and gamma-ray emitters are collected continuously at 12 perimeter locations and at 5 off-site locations on glass fiber filter media. Average flow rates on the air samplers are about 70 m³/h (2,472 ft³/h). Filters are changed weekly. Argonne staff change the filters on perimeter samplers, and the filters on off-site samplers are changed and mailed to Argonne by cooperating local agencies. The sampling units are serviced every six months, and the flow meters are recalibrated annually.

At the time of sample collection, the date and time when sampling was begun and the date and time when sample collection was completed are recorded on a label attached to the sample container. The samples are then transported to Argonne, where this information is then transferred to the Environmental Protection Data Management System.

Each air filter sample collected for alpha, beta, and gamma-ray analyses is cut in half. Half of each sample for any calendar week is combined with all other perimeter samples from that week and packaged for gamma-ray spectrometry. A similar package is prepared for the off-site filters for each week. A 5-cm (2-in.) circle is cut from the other half of the filter, mounted in a 5-cm (2-in.) low-lip stainless steel planchet, and counted to determine alpha and beta activity. The remainder of the filter is saved.

Stack monitoring is conducted continuously at four locations (see Section 4.8.1), those emission points that have a probability of releasing measurable concentrations of radionuclides. The results of these measurements are used to estimate the annual off-site dose using the required EPA CAP-88 (Clean Air Act Assessment Package-1988)⁹ atmospheric dispersion computer code and dose conversion method.

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Table 4.1 summarizes the monthly total alpha and beta activities for the individual weekly sample analyses. These measurements were made in low-background gas-flow proportional counters, and the counting efficiencies used to convert counting rates to disintegration rates were those measured for a 0.30-MeV beta and a 5.5-MeV alpha on filter paper. The results were obtained by measuring the samples at least four days after they were collected to avoid counting the natural activity due to short-lived radon and thoron decay products. This activity is normally present in air and disappears within four days by radioactive decay. The average concentrations of gamma-ray emitters, as determined by gamma-ray spectrometry performed on composite weekly samples, are given in Table 4.2. The gamma-ray detector is a shielded germanium diode calibrated for each gamma-ray-emitting nuclide measured.

Comparison of perimeter to off-site alpha and beta concentrations over the past several years shows that the perimeter results are consistently lower. This was most pronounced this year, particularly during the summer months. An investigation of this difference showed that there was significantly less particulate material collected on the perimeter air filters. In addition, the off-site samples would occasionally not be changed on the weekly schedule and run for two weeks. These samples would have a significant amount of particulate material on the filter. The differences in concentration appear to be a function of the mass of material on the filter, which is probably related to the location of the air sampler. The perimeter samplers are sited in grassy, open areas, away from buildings, roads, and other sources of airborne particulate material. The off-site samplers are located within municipal complexes, within secured locations, and are typically exposed to higher levels of airborne particulate material, especially resuspended soil, which contains naturally occurring radionuclides.

The perimeter beta activity averaged 17 fCi/m^3 , which is similar to the average value for the past 5 years. The gamma-ray emitters listed in Table 4.2 are those that have been present in the air for past years and are of natural origin. The beryllium-7 concentration increases in the spring, which indicates its stratospheric origin. The concentration of lead-210 in the air is due to the radioactive decay of gaseous radon-222 and is similar to the concentration last year. The annual average radiation measurements for the on-site samples were less than the off-site samples, as discussed above.

The annual average alpha and beta activities since 1985 are displayed in Figure 4.1. The elevated beta activity in 1986 was due to fallout from the Chernobyl incident. If the radionuclides attributed to the Chernobyl incident are subtracted from the annual beta average of 40 fCi/m^3 , the net would be 27 fCi/m^3 , very similar to the averages of the other years. Figure 4.2 presents the annual average concentrations of the two major gamma-ray-emitting radionuclides in air. The annual average beryllium-7 concentrations have decreased regularly since 1987, reached a minimum in 1991, increased until 1996, and have now decreased. The changes in the beryllium-7 air concentrations have been observed worldwide by the DOE Environmental Measurements Laboratory's Surface Air Sampling Program and are attributed to changes in solar activity.¹⁰

The major airborne effluents released at Argonne during 2005 are listed by location in Table 4.3. Figure 4.3 shows the annual releases of the major sources since 1985. The radon-220 releases from Building 200, due to radioactive contamination from the "proof-of-breeding"

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

TABLE 4.1

Total Alpha and Beta Activities in Air Filter Samples, 2005
(Concentrations in fCi/m³)

Month	Location	No. of Samples	Alpha Activity			Beta Activity		
			Avg.	Min.	Max.	Avg.	Min.	Max.
January	Perimeter	47	1.59	0.30	5.46	19.88	2.16	40.37
	Off-Site	19	3.47	0.26	9.75	35.42	0.82	71.46
February	Perimeter	48	1.19	0.64	2.29	18.99	15.17	27.84
	Off-Site	12	2.05	1.11	3.90	28.18	19.26	37.22
March	Perimeter	60	1.12	0.40	2.05	14.51	9.61	21.43
	Off-Site	16	1.77	0.54	2.83	18.35	6.97	27.00
April	Perimeter	48	1.39	0.81	2.49	14.30	7.79	21.74
	Off-Site	8	1.58	0.60	2.84	16.36	7.26	22.81
May	Perimeter	45	1.22	0.63	1.94	13.08	6.70	19.98
	Off-Site	12	1.62	0.57	2.97	14.59	8.89	22.95
June	Perimeter	57	1.09	0.25	2.54	13.38	3.60	32.47
	Off-Site	15	1.83	0.52	3.78	20.50	11.07	44.87
July	Perimeter	48	1.05	0.38	2.08	15.37	7.25	29.11
	Off-Site	11	1.98	0.42	4.18	23.00	12.69	38.52
August	Perimeter	59	1.19	0.09	2.86	19.40	1.99	33.45
	Off-Site	13	2.03	0.87	3.53	25.34	12.64	36.00
September	Perimeter	47	1.38	0.37	2.49	22.55	10.82	44.19
	Off-Site	10	2.15	1.31	3.84	27.22	16.73	49.95
October	Perimeter	48	0.84	0.22	1.63	13.23	5.37	25.04
	Off-Site	10	1.75	0.80	2.79	16.08	8.98	23.33
November	Perimeter	60	1.31	0.09	3.35	18.19	6.30	39.58
	Off-Site	10	2.51	1.47	3.49	23.78	11.67	38.24
December	Perimeter	48	1.36	0.62	3.20	22.32	9.10	46.71
	Off-Site	8	3.47	1.03	7.30	29.36	12.55	57.24
Annual Summary	Perimeter	615	1.22 ± 0.3	0.09	5.46	17.06 ± 4.1	1.99	46.70
	Off-Site	144	2.21 ± 0.5	0.26	9.75	23.70 ± 6.5	0.82	71.46

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TABLE 4.2

Gamma-Ray Activity in Air Filter Samples, 2005
(Concentrations in fCi/m³)

Month	Location	Beryllium-7	Lead-210
January	Perimeter	65	17
	Off-Site	73	25
February	Perimeter	69	16
	Off-Site	80	18
March	Perimeter	103	12
	Off-Site	89	10
April	Perimeter	112	9
	Off-Site	102	8
May	Perimeter	92	10
	Off-Site	87	9
June	Perimeter	84	10
	Off-Site	89	13
July	Perimeter	92	12
	Off-Site	88	13
August	Perimeter	80	16
	Off-Site	83	18
September	Perimeter	87	18
	Off-Site	89	21
October	Perimeter	53	10
	Off-Site	55	11
November	Perimeter	58	14
	Off-Site	60	17
December	Perimeter	29	23
	Off-Site	30	18
Annual Summary	Perimeter	78 ± 11	14
	Off-Site	77 ± 11	15
Dose (mrem)	Perimeter	(0.00019)	(1.60)
	Off-Site	(0.00019)	(1.71)

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

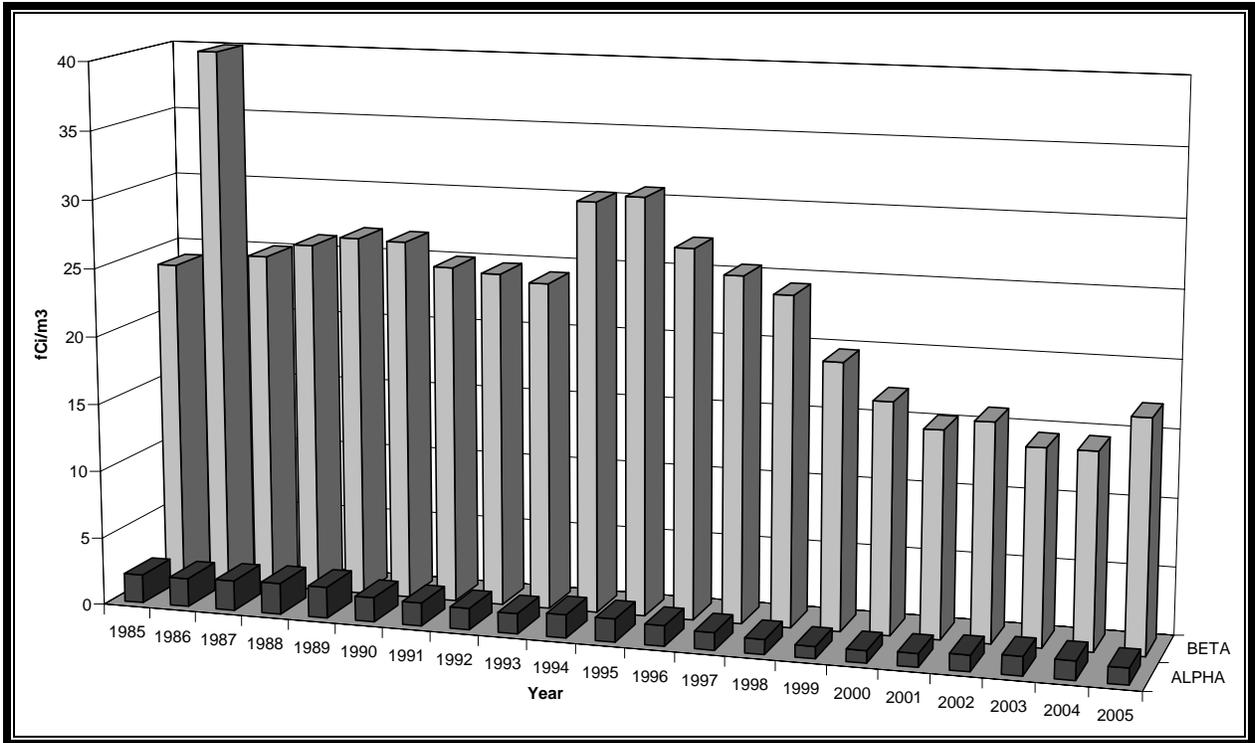


FIGURE 4.1 Comparison of Total Alpha and Beta Activities in Air Filter Samples



FIGURE 4.2 Comparison of Gamma-Ray Activity in Air Filter Samples

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

TABLE 4.3

Summary of Airborne Radioactive Emissions from Argonne Facilities, 2005

Building	Nuclide	Half-Life	Amount Released (Ci)	Amount Released (Bq)
200	Radon-220	56 s	30	1.1×10^{12}
212 (Alpha-Gamma Hot Cell Facility)	Hydrogen-3 (tritiated water vapor [HTO])	12.3 yr	6.0	2.2×10^{11}
	Hydrogen-3 (tritiated hydrogen gas [HT])	12.3 yr	15.8	5.8×10^{11}
	Krypton-85	10.7 yr	1.9	7.0×10^{10}
	Radon-220	56 s	0.3	1.1×10^{10}
350 (NBL)	Uranium-234	2.4×10^5 yr	2.5×10^{-5}	9.2×10^5
	Uranium-238	4.5×10^9 yr	2.5×10^{-5}	9.2×10^5
	Neptunium-237	2.1×10^6 yr	1.4×10^{-11}	5.2×10^1
	Plutonium-239	2.4×10^4 yr	3.9×10^{-6}	1.4×10^5
	Plutonium-240	6.6×10^4 yr	2.0×10^{-6}	7.4×10^4
	Americium-241	433 yr	2.6×10^{-10}	9.6×10^2
375 (IPNS)	Carbon-11	20 min	1,535.4	5.7×10^{13}
	Argon-41	1.8 h	36.8	1.4×10^{11}
411/415 (APS)	Carbon-11	20 min	0.14	5.2×10^9
	Nitrogen-13	10 min	10.32	3.8×10^{11}
	Oxygen-15	122 s	1.12	4.1×10^{10}

program conducted in the mid-1980s, have been greatly reduced. The hydrogen-3 emitted from Building 212 is from hydrogen-3 recovery studies, while short-lived neutron activation products are emitted from the IPNS and APS. In addition to the radionuclides listed in Table 4.3, several other fission products also were released in millicurie or smaller amounts. The quantities listed in Table 4.3 were measured by on-line stack monitors in the exhaust systems of the buildings, except those for Buildings 350 and 411.

Phytoremediation is being applied to the 317/319 Area to complete the cleanup of the groundwater in the area, which was contaminated in the past by the disposal of liquid wastes to the soil in the French drains. Phytoremediation is a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soil, degrade volatile organic constituents, and transpire water vapor to the atmosphere. The system consists of planting shallow-rooted willow and special deep-rooted poplar trees. A mixture of grasses and legumes are also planted around the trees to address shallow soil contamination and to prevent soil erosion. Approximately 800 trees were planted in the fall of 1999.

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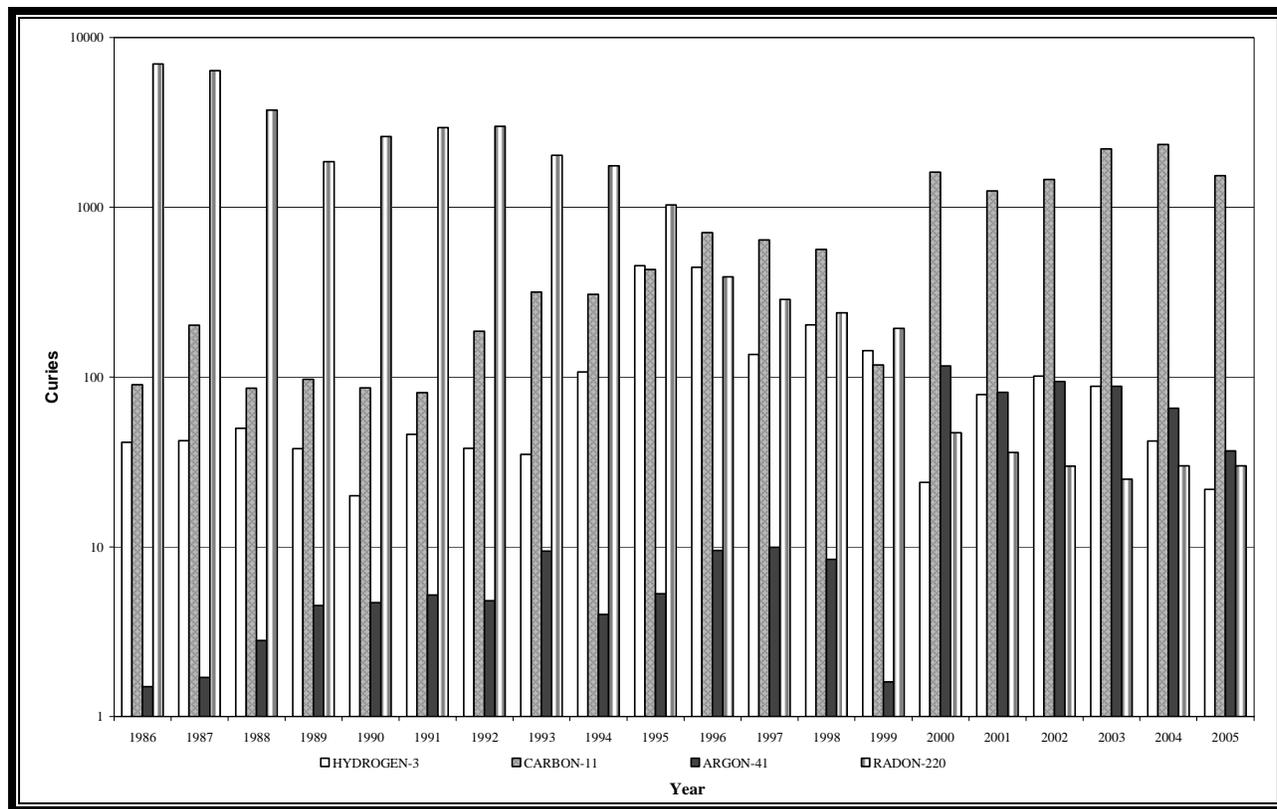


FIGURE 4.3 Selected Airborne Radionuclide Emissions

One of the major groundwater contaminants in the 317/319 Area is hydrogen-3, as tritiated water. The phytoremediation process will translocate the hydrogen-3 from the groundwater to the air as water vapor. Since the hydrogen-3 is released over an area of approximately 2 ha (5.5 acres), traditional point source monitoring for airborne hydrogen-3 water vapor is of little value to determine the quantity of hydrogen-3 released to the air. The annual inventory of hydrogen-3 released to the air can be estimated from the hydrogen-3 content of the groundwater and the extraction rate at which various aged trees remove groundwater. On the basis of the age and type of tree, estimates are available on the average consumption rate of groundwater per tree per month of the growing season. For this estimate, it is assumed that all of the groundwater that is extracted is transpired.

Quarterly monitoring is conducted at the 18 wells that are within the phytoremediation plantation. The average hydrogen-3 concentration for 2005 for all the wells was 459 pCi/L. The annual amount of hydrogen-3 released is then the product of the annual volume of water released for all 800 trees multiplied by the hydrogen-3 concentration in the groundwater. For 2005, the total hydrogen-3 released was 0.008 Ci. Applying the CAP-88 code,⁹ an estimate of the annual dose to the maximally exposed individual was 0.0000001 mrem. This estimated dose is extremely small compared with the 10-mrem annual dose limit of NESHAP.

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4.3. Surface Water

All water samples collected in the monitoring program were acidified to 0.1N with nitric acid and filtered immediately after collection. Total nonvolatile alpha and beta activities were determined by counting the residue remaining after evaporation of the water and then applying weight-dependent counting efficiency corrections determined for plutonium-239 (for alpha activity) and thallium-204 (for beta activity) to obtain disintegration rates. Hydrogen-3 was measured from a separate aliquot. This activity does not appear in the results for total nonvolatile beta activity. Analyses for the radionuclides were performed by specific radiochemical separations followed by appropriate counting. One-liter aliquots were used for all analyses except for hydrogen-3 and the transuranium nuclides. Hydrogen-3 analyses were performed by liquid scintillation counting of 9 mL (0.03 oz) of a distilled sample in a nonhazardous cocktail. Analyses for transuranium nuclides were performed on 10-L (3-gal) samples with chemical separation methods followed by alpha spectrometry. Plutonium-236 was used to determine the yields of plutonium and neptunium, which were separated from the sample together. A group separation of a fraction containing the transplutonium elements was monitored for recovery with an americium-243 tracer. Isotopic uranium concentrations were determined by alpha spectrometry by using uranium-236 as an isotopic tracer.

Liquid wastewater from buildings or facilities that use or process radioactive materials is collected in retention tanks. When a tank is full, it is sampled and analyzed for alpha and beta radioactivity. If the radioactivity exceeds the release limits, the tank is processed by evaporation and the residue is disposed of as solid LLW. If the radioactivity is below the release limits, the wastewater is conveyed to the laboratory WTP in dedicated pipes to waste storage tanks. At the influent to the WTP, all effluent wastewater is screened for gamma-ray radioactivity. The release limits are based on the DCGs for plutonium-239 (0.03 pCi/mL) for alpha activity and for strontium-90 (1.0 pCi/mL) for beta activity. These radionuclides were selected because of their potential for release and their conservative allowable limits in the environment. The effluent monitoring program documents that no liquid releases above the DCGs have occurred and reinforces demonstration of compliance with the use of best available technology (BAT) as required by DOE Order 5400.5.⁵

Another component of the radiological effluent monitoring program is the radiological analysis of the main water treatment plant discharge (Outfall 001). Metals have been analyzed at this location for a number of years (see Table 5.8). The same radiological constituents that are determined in Sawmill Creek are also analyzed at this location. Samples are collected daily, and equal portions are combined for each week and analyzed to obtain an average weekly concentration. Table 4.4 gives the results for 2005. The results show that the radionuclides hydrogen-3 and possibly strontium-90 detected in the effluent water can be attributed to Argonne operations. However, analysis of the Argonne domestic water, which is obtained from Lake Michigan, indicates strontium-90 at about 0.4 pCi/L. This was confirmed by the direct analysis of Lake Michigan water. The concentrations are very low and a small fraction of the DOE limits. These findings reinforce Argonne compliance with DOE Order 5400.5 for use of BAT for releases of liquid effluents. To estimate the total annual quantity of each radionuclide

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TABLE 4.4

Radionuclides in Effluents from the Argonne Wastewater Treatment Plant, 2005

Activity	No. of Samples	Concentrations in pCi/L			Dose (mrem)		
		Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	52	0.7 ± 0.4	<0.1	2.5	— ^a	—	—
Beta	52	14 ± 1	8.4	55.3	—	—	—
Hydrogen-3	52	<100	<100	151	<0.0046	<0.0046	0.0069
Strontium-90	52	0.40 ± 0.04	0.31	0.64	0.039	0.030	0.062
Cesium-137	52	<2.0	<2.0	<2.0	<0.07	<0.07	<0.07
Uranium-234	52	0.268 ± 0.045	0.09	1.16	0.051	0.017	0.221
Uranium-238	52	0.234 ± 0.040	0.06	0.98	0.039	0.010	0.163
Neptunium-237	52	<0.0010	<0.0010	0.0026	<0.0028	<0.0028	0.0073
Plutonium-238	52	<0.0010	<0.0010	0.0074	<0.0028	<0.0028	0.0207
Plutonium-239	52	0.0056	<0.0010	0.2327	0.0174	<0.0031	0.7214
Americium-241	52	<0.0010	<0.0010	0.0024	<0.0033	<0.0033	0.0079
Curium-242 and/or Californium-252	52	<0.0010	<0.0010	<0.0010	<0.0007	<0.0007	<0.0007
Curium-244 and/or Californium-249	52	<0.0010	<0.0010	<0.0010	<0.0034	<0.0034	<0.0034

^a A dash indicates no CEDEs for alpha and beta.

released to the environment, the product of the annual average concentration and the annual volume of water discharged (1.02×10^9 L) is computed. These results are given in Table 4.5.

Argonne wastewater is discharged into Sawmill Creek (Location 7M in Figure 1.1). The creek runs through the Argonne grounds, drains surface water from much of the site, and flows into the Des Plaines River about 500 m (1,600 ft) downstream from the Argonne wastewater outfall. Sawmill Creek was sampled upstream from the Argonne site and downstream from the wastewater discharge point to determine whether radioactivity was added to the stream by Argonne wastewater or surface drainage. The sampling locations are shown in Figure 1.1. Daily samples were collected below the wastewater outfall. Equal portions of the daily samples collected each week were combined and analyzed to obtain an average weekly concentration.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

Samples were collected upstream of the site once a month and were analyzed for the same radionuclides measured in the below-outfall samples.

Table 4.6 gives the annual summaries of the results obtained for Sawmill Creek. Comparison of the results and 95% confidence levels of the averages for the two sampling locations shows that the following radionuclides found in the creek water can be attributed to Argonne operations: hydrogen-3, strontium-90, neptunium-237, plutonium-238, plutonium-239, americium-241, and curium-244 and/or californium-249. The concentrations of all these nuclides are low and at a small fraction of DOE concentration limits. In Sawmill Creek, below the Argonne outfall, the annual average concentrations of most measured radionuclides were similar to recent annual averages. All annual averages were well below the applicable DOE standards.

On the basis of the results of the Storm Water Characterization Study (see Section 2.2.2), two perimeter surface water locations were identified that contained measurable levels of radionuclides. They were south of the 319 Area, Location 7J, and south of the 800 Area Landfill, Location 11D (see Figure 1.1). Samples were scheduled to be collected quarterly and analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. The results are presented in Table 4.7.

The source of the radionuclides at Location 7J appears to be leachate from the 319 Area Landfill. A subsurface barrier wall and leachate collection system were constructed south of the 319 Landfill in November 1995 and became operational in 1996. Since the construction and operation of the leachate collection system, radionuclide concentrations in surface water at Location 7J have decreased substantially. The hydrogen-3 at Location 11D is probably also from the leachate; the decrease in the concentration from earlier years is due to the completion of the clay cap on the 800 Area Landfill in the fall of 1993.

One of the Argonne waste management locations is within the 398A fenced area (Location 8J in Figure 1.1). Surface water drainage from this area is collected in a small pond at the south (downgradient) end of the 398A area. To evaluate whether any radionuclides are being transported by storm water flow through the 398A area, quarterly sampling is conducted from the 398A pond and analyzed for hydrogen-3 and gamma-ray-emitting radionuclides. All hydrogen-3 results were below the detection limit of 100 pCi/L, and gamma-ray spectrometric analysis did not detect any radionuclides associated with Argonne activities above the detection limit of 2 pCi/L.

Because Sawmill Creek empties into the Des Plaines River, data on the radioactivity in this river is important in assessing the contribution of Argonne wastewater to environmental radioactivity. The Des Plaines River was sampled twice a month below and once a month above the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Table 4.8 gives the annual summaries of the results obtained for

TABLE 4.5

Total Radioactivity Released, 2005	
Radionuclide	WTP Outfall (Ci)
Hydrogen-3	0.07
Strontium-90	0.0004
Plutonium-239	<0.0001
Americium-241	<0.0001
Total	0.07

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

TABLE 4.6

Radionuclides in Sawmill Creek Water, 2005

Activity	Location ^a	No. of Samples	Concentrations (pCi/L)			Dose (mrem)		
			Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha (nonvolatile)	16K	12	0.99 ± 0.60	0.32	1.80	– ^b	–	–
	7M	52	0.70 ± 0.43	<0.10	2.31	–	–	–
Beta (nonvolatile)	16K	12	10.6 ± 0.35	3.93	56.7	–	–	–
	7M	52	12.9 ± 0.36	6.87	56.9	–	–	–
Hydrogen-3	16K	12	<100	<100	<100	<0.0046	<0.0046	<0.0046
	7M	52	<100	<100	164	<0.0046	<0.0046	0.0075
Strontium-90	16K	12	<0.25	<0.25	0.30	<0.024	<0.024	0.029
	7M	51	0.35 ± 0.04	<0.25	0.52	0.034	<0.024	0.050
Cesium-137	16K	12	<2.0	<2.0	<2.0	<0.07	<0.07	<0.07
	7M	52	<2.0	<2.0	<2.0	<0.07	<0.07	<0.07
Uranium-234	16K	12	0.588 ± 0.069	0.166	1.09	0.121	0.034	0.225
	7M	52	0.310 ± 0.047	0.082	0.76	0.064	0.017	0.157
Uranium-238	16K	12	0.564 ± 0.067	0.180	1.05	0.093	0.030	0.173
	7M	52	0.275 ± 0.042	0.065	0.70	0.045	0.011	0.115
Neptunium-237	16K	12	<0.0010	<0.0010	<0.0010	<0.0028	<0.0028	<0.0028
	7M	52	<0.0010	<0.0010	0.0047	<0.0028	<0.0028	0.0132
Plutonium-238	16K	12	<0.0010	<0.0010	0.0027	<0.0028	<0.0028	0.0076
	7M	52	0.0014	<0.0010	0.0246	0.0039	<0.0028	0.0689
Plutonium-239	16K	12	0.0014	<0.0010	0.0126	0.0043	<0.0031	0.0391
	7M	52	0.0159	<0.0010	0.7830	0.0493	<0.0031	2.4273
Americium-241	16K	12	<0.0010	<0.0010	<0.0010	<0.0033	<0.0033	<0.0033
	7M	50	<0.0010	<0.0010	0.0033	<0.0033	<0.0033	0.0109
Curium-242 and/or Californium-252	16K	12	<0.0010	<0.0010	0.0016	<0.0007	<0.0007	0.0011
	7M	50	<0.0010	<0.0010	<0.0010	<0.0007	<0.0007	<0.0007
Curium-244 and/or Californium-249	16K	12	<0.0010	<0.0010	<0.0010	<0.0034	<0.0034	<0.0034
	7M	50	<0.0010	<0.0010	<0.0010	<0.0034	<0.0034	<0.0034

^a Location 16K is upstream from the Argonne site, and location 7M is downstream from the Argonne wastewater outfall.

^b A dash indicates no CEDEs for alpha and beta.

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TABLE 4.7

Radionuclides in Storm Water Outfalls, 2005
(concentrations in pCi/L)

Date Collected	Location 7J Hydrogen-3	Location 7J Strontium-90	Location 7J Cesium-137	Location 11D Hydrogen-3
January 13	<100	0.36	<2	147
April 22	<100	0.54	<2	<100
August	Dry	Dry	Dry	Dry
November	Dry	Dry	Dry	Dry

these two locations. The average nonvolatile alpha, beta, and uranium concentrations in the river were very similar to past averages and remained in the normal range. Results were similar above and below the creek for all radionuclides, because the activity in Sawmill Creek was reduced by dilution to the point that it was not detectable in the Des Plaines River.

4.4. Bottom Sediment

The radioactive content of bottom sediment was measured in Sawmill Creek. A grab sample technique was used to obtain bottom sediments. After drying, grinding, and mixing portions of each of the bottom sediment samples, the samples were analyzed by the methods previously described for air filter residues. The plutonium and americium were separated from the same 10-g (0.35-oz) aliquot of sediment. Results are given in terms of the oven-dried (110°C [230°F]) weight.

A set of sediment samples was collected on August 31, 2005, from the Sawmill Creek bed, above, at the outfall, and at several locations below the point at which Argonne discharges its treated wastewater (Location 7M in Figure 1.1). The results, as listed in Table 4.9, show that the concentrations in the samples collected above the outfall at Location 7M are similar to those of the off-site samples collected in past years.¹¹ The plutonium, americium, and cesium-137 concentrations are elevated below the outfall, which indicates that their origin is in Argonne wastewater. Plutonium results varied widely among locations and were strongly dependent on the retentiveness of the sediment material. The changes in concentrations of these nuclides with time and location indicate that the sediment material in this area has a dynamic nature.

4.5. External Penetrating Gamma Radiation

Levels of external penetrating gamma radiation at and in the vicinity of the Argonne site were measured with aluminum oxide thermoluminescent dosimeter (TLD) chips provided and read by a commercial vendor. Each measurement reported represents the average of two chips exposed in the same packet. Dosimeters were exposed at 17 locations at the site boundary and on

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

TABLE 4.8

Radionuclides in Des Plaines River Water, 2005

Activity	Location ^a	No. of Samples	Concentrations (pCi/L)			Dose (mrem)		
			Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha (nonvolatile)	A	12	1.2 ± 0.5	0.35	2.5	– ^b	–	–
	B	24	1.4 ± 0.5	0.09	5.4	–	–	–
Beta (nonvolatile)	A	12	18 ± 1	10	61	–	–	–
	B	24	16 ± 2	9	60	–	–	–
Hydrogen-3	A	12	<100	<100	<100	<0.0046	<0.0046	<0.0046
	B	24	<100	<100	316	<0.0046	<0.0046	0.0145
Strontium-90	A	12	<0.25	<0.25	0.27	<0.024	<0.024	0.026
	B	24	<0.25	<0.25	0.27	<0.024	<0.024	0.026
Uranium-234	A	12	0.452 ± 0.054	0.181	0.850	0.086	0.034	0.161
	B	24	0.432 ± 0.057	0.117	0.863	0.082	0.022	0.164
Uranium-238	A	12	0.389 ± 0.049	0.101	0.716	0.065	0.017	0.119
	B	24	0.363 ± 0.051	0.093	0.744	0.061	0.016	0.124
Neptunium-237	A	12	<0.0010	<0.0010	<0.0010	<0.0028	<0.0028	<0.0028
	B	12	<0.0010	<0.0010	<0.0010	<0.0028	<0.0028	<0.0028
Plutonium-238	A	12	0.0014	<0.0010	0.0069	0.0039	<0.0028	0.0193
	B	12	<0.0010	<0.0010	0.0039	<0.0028	<0.0028	0.0109
Plutonium-239	A	12	<0.0010	<0.0010	<0.0010	<0.0031	<0.0031	<0.0031
	B	12	<0.0010	<0.0010	0.0045	<0.0031	<0.0031	0.0140
Americium-241	A	12	<0.0010	<0.0010	<0.0010	<0.0033	<0.0033	<0.0033
	B	12	<0.0010	<0.0010	<0.0010	<0.0033	<0.0033	<0.0033
Curium-242 and/or Californium-252	A	12	<0.0010	<0.0010	<0.0010	<0.0007	<0.0007	<0.0007
	B	12	<0.0010	<0.0010	<0.0010	<0.0007	<0.0007	<0.0007
Curium-244 and/or Californium-249	A	12	<0.0010	<0.0010	<0.0010	<0.0034	<0.0034	<0.0034
	B	12	<0.0010	<0.0010	<0.0010	<0.0034	<0.0034	<0.0034

^a Location A, near Willow Springs, is upstream; location B, near Lemont, is downstream from the mouth of Sawmill Creek. See Figure 1.2.

^b A dash indicates no CEDEs for alpha and beta.

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TABLE 4.9
Radionuclides in Bottom Sediment, 2005

Location	Concentration (pCi/g)							Concentration (fCi/g)		
	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232	Plutonium-238	Plutonium-239	Americium-241		
Sawmill Creek 25 m above outfall	7.08 ± 0.33	<0.01	0.55 ± 0.04	0.34 ± 0.03	0.32 ± 0.05	0.20 ± 0.20	0.27 ± 0.23	0.57 ± 0.41		
Sawmill Creek at outfall	5.78 ± 0.31	<0.01	0.40 ± 0.03	0.25 ± 0.02	0.24 ± 0.05	1.72 ± 0.57	2.82 ± 0.71	0.57 ± 0.39		
Sawmill Creek 50 m below outfall	7.77 ± 0.35	0.02 ± 0.01	0.54 ± 0.04	0.36 ± 0.03	0.32 ± 0.05	0.33 ± 0.28	2.82 ± 0.69	0.98 ± 0.55		
Sawmill Creek 100 m below outfall	12.2 ± 0.42	0.22 ± 0.02	0.84 ± 0.05	0.60 ± 0.03	0.56 ± 0.06	2.70 ± 0.79	52.6 ± 4.43	9.41 ± 1.69		
Sawmill Creek at Des Plaines River	15.0 ± 0.46	0.12 ± 0.02	0.86 ± 0.05	0.76 ± 0.03	0.68 ± 0.06	0.64 ± 0.32	9.50 ± 1.24	3.57 ± 0.97		

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the site. Readings were also taken at five off-site locations (Figure 1.2) for comparative purposes. Three locations were added to the network in 1999 to monitor radioactive waste management activities. They are east of Building 306 (Location 9/10I), south of Building 331 (Location 9H/I), and next to the 398A radioactive waste storage area (Location 9J).

The results are summarized in Tables 4.10 and 4.11, and the site boundary and on-site readings are shown in Figure 4.4. Measurements were taken during the four successive exposure periods shown in the tables, and the results were calculated in terms of annual dose for ease in comparing measurements made for different elapsed times. The uncertainty of the averages given in the tables is the 95% confidence limit calculated from the standard deviation of the average.

The off-site results averaged 87 ± 3 mrem/yr and were slightly lower than last year's off-site average of 98 ± 8 mrem/yr.¹² To compare boundary results for individual sampling periods, the standard deviation of the 20 individual off-site results is useful. This value is 9 mrem/yr; thus, individual results in the range of 87 ± 18 mrem/yr may be considered to be the average natural background with a 95% probability.

The site boundary at Location 7I had dose rates above the average background. This was the result of radiation from Argonne's 317 Area in the northern half of grid 7I. In the past, waste was packaged and temporarily stored in this area before removal for permanent disposal off-site. In 2005, the dose at this perimeter fence location was 94 ± 5 mrem/yr. Approximately 300 m (960 ft) south of the fence in grid 6I, the measured dose is 92 ± 5 mrem/yr, which is within the normal background range.

In the past, an elevated on-site dose had been measured at Location 9H, next to the CP-5 reactor, where irradiated hardware from the reactor was stored. During the past few years, considerable cleanup of the CP-5 reactor yard has occurred as part of the CP-5 reactor D&D project. The dose at Location 9H decreased from about 1,200 mrem/yr in 1989 to 87 mrem/yr in 2005.

TABLE 4.10

Environmental Penetrating Radiation at Off-Site Locations, 2005

Location	Dose Rate (mrem/yr)				Average
	Period of Measurement				
	Jan. 4–April 1	April 1–July 1	July 1–Oct. 3	Oct. 3–Jan. 2	
Lemont	83	86	88	96	88 ± 5
Oak Brook	92	84	75	91	86 ± 8
Orland Park	105	– ^a	61	94	87 ± 23
Woodridge	90	86	86	100	90 ± 7
Willow Springs	83	80	85	97	86 ± 8
Average	91 ± 10	84 ± 4	79 ± 14	96 ± 4	87 ± 3

^a A dash indicates that the sample was lost.

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TABLE 4.11

Environmental Penetrating Radiation at Argonne, 2005

Location ^a	Dose Rate (mrem/yr) Period of Measurement				Average
	Jan. 4–April 1	April 1–July 1	July 1–Oct. 2	Oct. 2–Jan. 2	
14G – Boundary	96	96	101	108	100 ± 6
14I – Boundary	72	81	80	99	83 ± 11
14L – Boundary	86	90	79	97	88 ± 8
6I – 200 m N of Quarry Road	90	88	90	99	92 ± 5
7I – Center, Waste Storage Area Facility 317	– ^b	144	150	172	155 ± 15
7I – Boundary	89	94	92	101	94 ± 5
8H – Boundary	89	86	88	100	91 ± 6
8H – 65 m S of Building 316	93	91	87	101	93 ± 6
8H – 200 m NW of Waste Storage Area (Heliport)	102	87	91	103	96 ± 8
8H – Boundary, Center, St. Patrick Cemetary	89	89	90	97	92 ± 4
9H – 50 m SE of CP-5	83	81	83	99	87 ± 8
9H/I – 50 m E of Building 331	499	1,576	619	355	762 ± 553
9/10I – E of D306	339	436	350	476	400 ± 67
9/10I – 65 m NE of Building 350 230 m NE of Building 316	87	53	69	91	75 ± 18
9/10E/F – Boundary	87	86	99	106	95 ± 10
9J – 50 m W of 398A Area	467	490	421	635	503 ± 93
10/11K – Lodging Facilities	81	68	81	89	80 ± 9

^a See Figure 1.1.

^b A dash indicates that the sample was lost.

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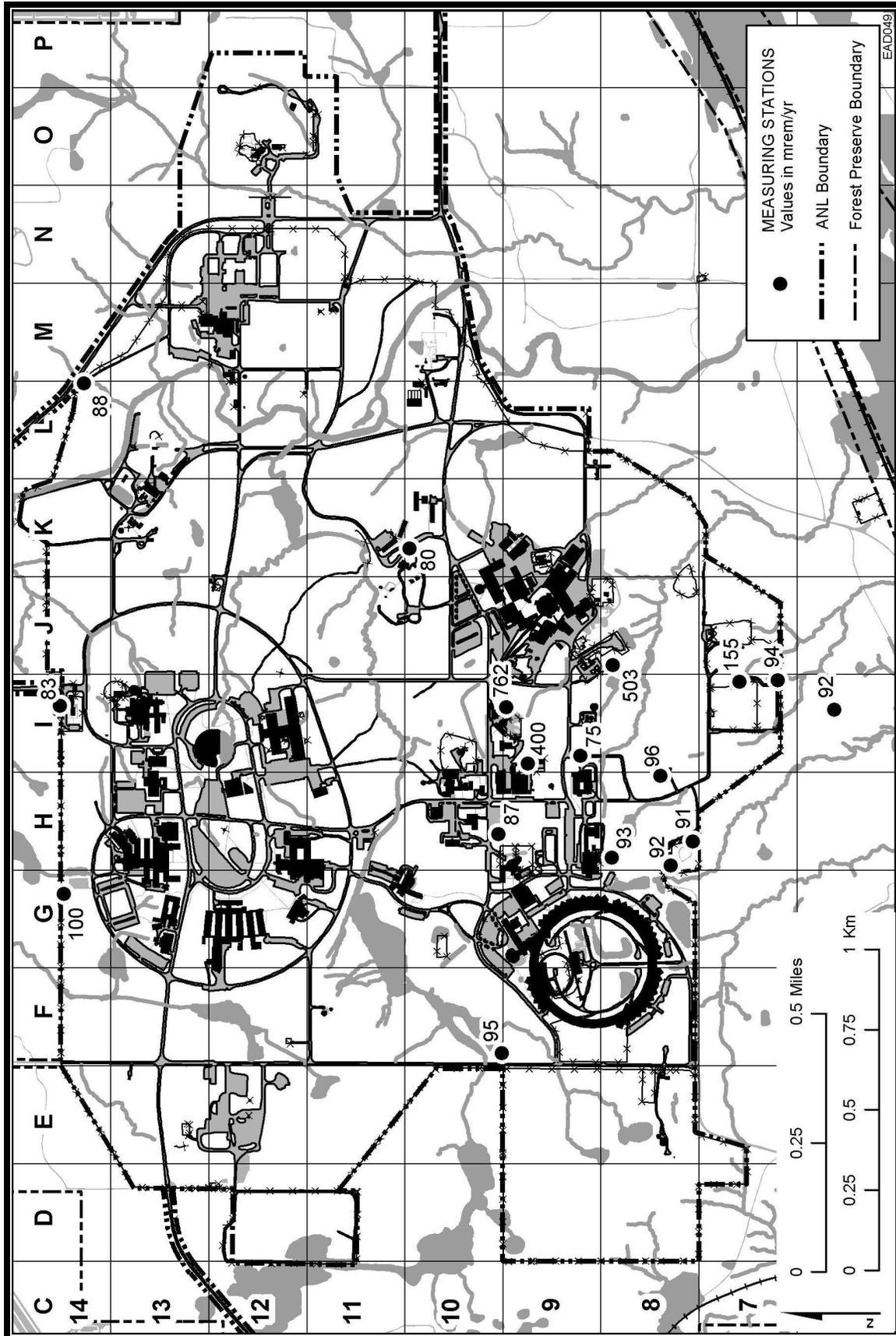


FIGURE 4.4 Penetrating Radiation Measurements at the Argonne Site, 2005

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Three new locations were added to monitor radioactive waste facilities and areas. Significant movement of radioactive waste took place, principally waste from the D&D activities and the relocation of radioactive waste from the 317 Area to the 398A Area. Some waste is repacked in Building 306 (Location 9/10I). The dose from these operations was above normal background levels. The elevated dose levels in the 398A Area (Location 9J) are from waste relocated from the 317 Area, historic waste, and D&D waste temporarily stored pending shipment. The Building 331 yard (Location 9H/I) is being used as a staging area to load trucks for shipment off-site. A number of radioactive waste shipments were made during 2005, as reflected by the elevated dose rates. The 398A Area was also used as a staging area to load trucks for shipment off-site. Depending on the number of shipments, the dose rates will vary from quarter to quarter.

4.6. Neutron Monitoring

An environmental fast neutron monitoring program was first established in 2002 at IPNS. Although Argonne does not have any operating nuclear reactors, several facilities produce fast neutrons and have the potential to release these to the environment. To estimate the dose to the environment during normal operation of these facilities, one of the facilities, the IPNS, was selected for monitoring.

The IPNS produces up to several hundred MeV neutrons for experimental work. Pulses of high-energy protons from an accelerator system are directed by magnets contained in a heavily shielded beamline enclosure into the target area. The target consists of depleted uranium discs contained within stainless-steel housing. The target is cooled by water. The neutron-generating facilities and target support systems are encased within a biological shield that provides structural support and shielding of steel and concrete. Air emissions from this facility are discussed in Section 4.8.1.

Beginning in January 2002, four environmental neutron monitors were obtained from a commercial vendor and placed at locations that were most likely to result in neutron dose. A fifth dosimeter was placed at an off-site location to monitor background neutron dose in areas unaffected by Argonne operations. The neutron dosimeters were changed quarterly. The results are given in Table 4.12 and shown in Figure 4.5.

The results are expressed in units of dose (mrem) for the time the dosimeter was in the field. Therefore, the annual dose is the sum of the individual measurements. Because IPNS does not operate continuously, there may be time periods of up to a month when the system is not generating neutrons. The monitored locations are outside but near the facility. Although these areas are not continuously occupied, measurements in 2005 indicated the potential for neutron dose. Any nearby workers would receive a significantly lower dose, and the dose to the fence line is estimated to be less than 0.01 mrem.

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TABLE 4.12

Fast Neutron Dose at Argonne, 2005
(dose in mrem)

Location	Period of Measurement				Total
	Jan. 5–April 1	April 1–July 1	July 1–Oct. 3	Oct 3.–Jan. 2	
<i>On-Site</i>					
60 m NE of Bldg. 375	20	30	30	40	120
30 m NW of Bldg. 375	30	30	<1	40	100
45 m SW of Bldg. 375	20	30	<1	20	70
60 m S of Bldg. 375	<1	<1	<1	<1	<1
50 m ENE of ATLAS	<1	<1	<1	<1	<1
60 m NNE of ATLAS	– ^a	<1	<1	<1	<1
80 m NW of ATLAS	<1	<1	<1	<1	<1
120 m WNW of ATLAS	<1	<1	<1	<1	<1
<i>Off-Site</i>					
Woodridge	<1	<1	<1	<1	<1

^a The dash indicates that the sample was lost.

Beginning in January 2003, a set of four fast neutron dosimeters was placed around the ATLAS facility (location 13H in Figure 1.1). ATLAS is the world's first superconducting accelerator for projectiles heavier than electrons. It has the capability of producing heavy-ion beams from hydrogen to uranium, to energies as high as 17 MeV per nucleon. Because of the many and varied types of experiments that are conducted at ATLAS, the potential exists for the production of fast neutrons.

The four neutron dosimeters were placed at various distances east, north, and west of the ATLAS facility. The dosimeters were changed on the same schedule as the IPNS dosimeters. The results are shown in Table 4.12. No fast neutron dose was measurable at any of the ATLAS dosimeter locations. This program will be continued.

4.7. Compliance with DOE Order 435.1

DOE Order 435.1, "Radioactive Waste Management," requires that an environmental monitoring and surveillance program be conducted to determine any releases or migration from LLW treatment, storage, or disposal sites. Compliance with these requirements is an integral part of the Argonne sitewide monitoring and surveillance program. Waste management operations in general are covered by relying on the perimeter air monitoring network and monitoring of the liquid effluent streams and Sawmill Creek.

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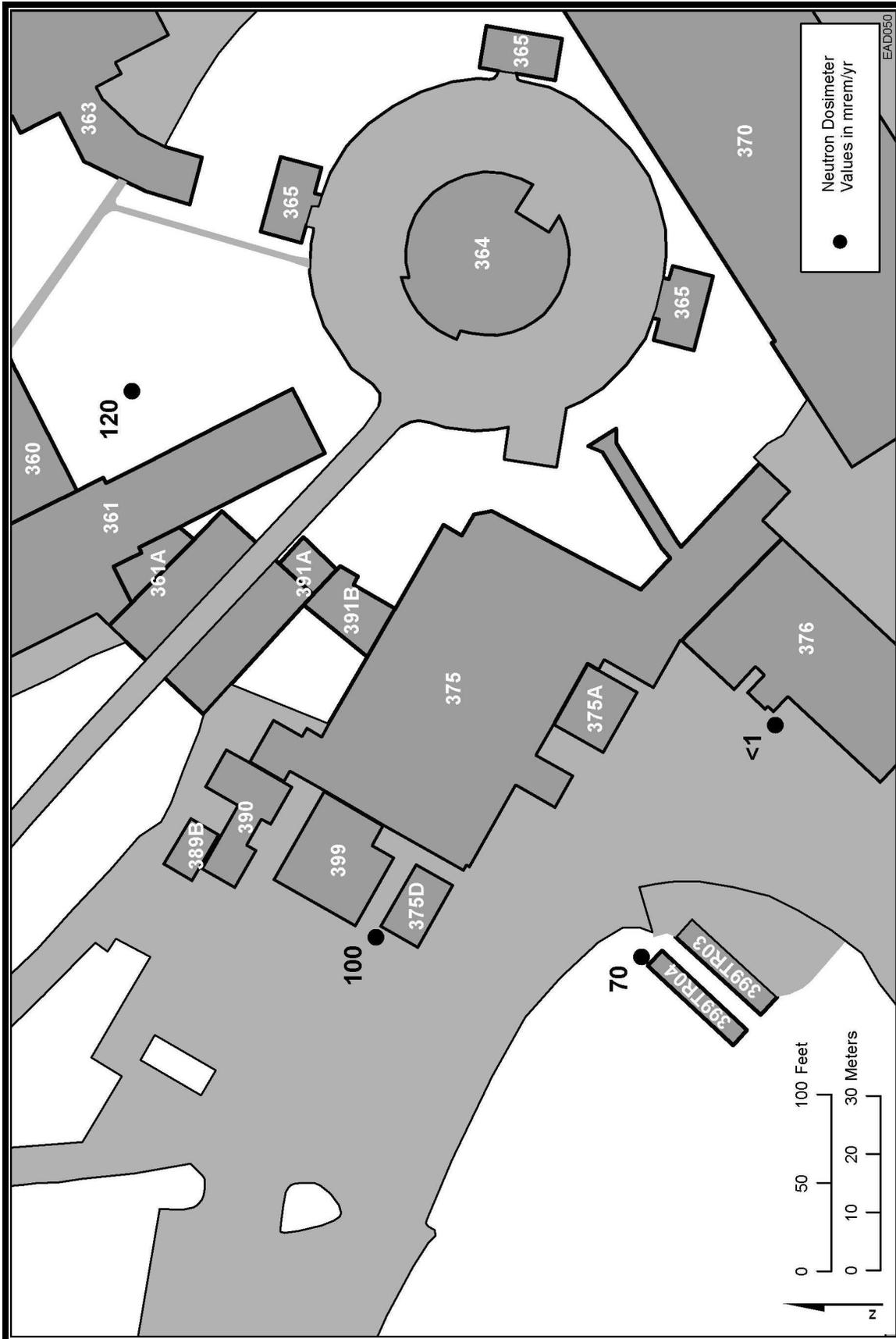


FIGURE 4.5 Neutron Dose Measurements, 2005

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Of particular interest is monitoring of the waste management activities conducted in the 317 Area. These include air particulate monitoring for total alpha, total beta, and gamma-ray emitters; direct radiation measurements with TLDs; surface water discharges for hydrogen-3 and gamma-ray emitters; and subsurface water samples at all monitoring wells with analyses for hydrogen-3, strontium-90, and gamma-ray emitters, plus selected monitoring for VOCs. Direct radiation measurements are also conducted at other waste management areas: Building 306, Building 331, and the 398A Area. The results are presented here and in Chapter 6 of this report.

During 2005, Argonne did not release any property containing residual radioactive material for recycle or reuse. All property that contained residual radioactivity was disposed in a low-level radioactive disposal site.

4.8. Estimates of Potential Radiation Doses

The radiation doses at the site boundary and off the site that could have been received by the public from radioactive materials and radiation leaving the site were calculated. Calculations were performed for three exposure pathways — airborne, water, and direct radiation from external sources.

4.8.1. Airborne Pathway

DOE facilities with airborne releases of radioactive materials are subject to 40 CFR Part 61, Subpart H,¹³ which requires the use of the EPA's CAP-88 code⁹ to calculate the dose for radionuclides released to the air and to demonstrate compliance with the regulation. The dose limit applicable for 2005 for the air pathway is a 10-mrem/yr effective dose equivalent. The CAP-88 computer code uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released to the air from stacks or area sources. For 2005, doses were calculated for hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 plus daughters, and a number of actinide radionuclides. The annual releases are those listed in Table 4.3. Separate calculations were performed for each of the five release points. The wind speed and direction data shown in Figure 1.3 were used for these calculations. In the past, the wind stability classes had been determined by the temperature differences between the 10-m (33-ft) and 60-m (197-ft) levels. To improve the determination of stability levels, the categories were obtained from daytime measurements of solar radiation and nighttime measurements of the standard deviation of the horizontal wind speed. Doses were calculated for an area extending out to 80 km (50 mi) from Argonne. The population distribution of the 16 compass segments and 10 distance increments given in Table 1.1 was used. The dose rate was calculated at the midpoint of each interval and integrated over the entire area to give the annual population cumulative dose.

Distances from the specific facilities that exhaust radiological airborne emissions (see Table 4.3) to the fence line (perimeter) and nearest resident were determined in the 16 compass segments. Calculations also were performed to evaluate the major airborne pathways — ingestion, inhalation, and immersion — both at the point of maximum perimeter

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exposure and to the maximally exposed resident. The perimeter and resident doses and the maximum doses are listed, respectively, for releases from Buildings 200 (Tables 4.13 and 4.14), Building 212 (Tables 4.15 and 4.16), Building 350 (Tables 4.17 and 4.18), Building 375 (Tables 4.19 and 4.20), and Building 411/415 (APS) (Tables 4.21 and 4.22). The doses given in these tables are the committed whole body effective dose equivalents.

A significant D&D program was completed in 1995 for the M-Wing hot cells in Building 200, which constituted the source of the radon-220 emissions. Cleanup of the major source of the radon-220, cell M-1, resulted in a decrease of radon-220 emissions from 3,000 Ci in 1992 to 193 Ci in 1999. The radon-220 emissions were reduced further in 1999, to the present 30 Ci, because of the termination of the nuclear medical program that separates radium-224 from the thorium-228 parent and continued D&D of other cells. Also, the hydrogen-3 recovery program in Building 205 was terminated, and final cleanup of the area was completed in July 2003.

The doses from each of the CAP-88 dose assessments were combined on the basis of the assumption that the IPNS is the central emission point for the site. The 16 compass directions

TABLE 4.13

Radiological Airborne Releases from Building 200, 2005

Direction	Distance to Perimeter (m)	Dose ^a (mrem/yr)	Distance to Nearest Resident (m)	Dose ^a (mrem/yr)
N	500	8.0×10^{-3}	1,000	2.1×10^{-3}
NNE	600	6.0×10^{-3}	1,100	1.9×10^{-3}
NE	750	3.1×10^{-3}	2,600	3.0×10^{-4}
ENE	1,700	5.8×10^{-4}	3,100	2.0×10^{-4}
E	2,400	3.4×10^{-4}	3,500	1.8×10^{-4}
ESE	2,200	3.5×10^{-4}	3,600	1.5×10^{-4}
SE	2,100	3.5×10^{-4}	4,000	1.2×10^{-4}
SSE	2,000	3.8×10^{-4}	4,000	1.2×10^{-4}
S	1,500	3.1×10^{-4}	4,000	6.2×10^{-5}
SSW	1,000	1.7×10^{-3}	2,500	3.3×10^{-4}
SW	800	3.6×10^{-3}	2,200	7.0×10^{-4}
WSW	1,100	1.3×10^{-3}	1,500	7.2×10^{-4}
W	750	1.6×10^{-3}	1,500	4.4×10^{-4}
WNW	800	1.2×10^{-3}	1,300	4.8×10^{-4}
NW	600	2.0×10^{-3}	1,100	6.2×10^{-4}
NNW	600	3.7×10^{-3}	800	2.2×10^{-3}

^a Source term: radon-220 = 30 Ci (plus daughters).

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TABLE 4.14

Maximum Perimeter and Individual Doses
from Building 200 Air Emissions, 2005
(dose in mrem/yr)

Pathway	Perimeter (500 m N)	Individual (800 m NNW)
Ingestion	1.2×10^{-14}	3.9×10^{-15}
Inhalation	7.9×10^{-3}	2.2×10^{-3}
Air immersion	5.3×10^{-5}	1.3×10^{-5}
Ground surface	3.9×10^{-6}	1.3×10^{-6}
Total	8.0×10^{-3}	2.2×10^{-3}
<i>Radionuclide</i>		
Thallium-208	4.6×10^{-5}	1.1×10^{-5}
Bismuth-212	9.5×10^{-4}	3.0×10^{-4}
Lead-212	4.8×10^{-3}	1.6×10^{-3}
Radon-220	2.2×10^{-3}	3.1×10^{-4}
Total	8.0×10^{-3}	2.2×10^{-3}

from IPNS were established for each perimeter and actual resident location. The five individual building assessments were then overlaid on the IPNS grid, and the estimated dose was summed according to which values fell within the IPNS segments. This approach provides an estimated dose to an actual individual and is not just the sum of the maximum doses from the individual building runs.

The highest perimeter dose was in the east direction, with a maximum value of 0.38 mrem/yr (Location 9L in Figure 1.1). Essentially all of this dose can be attributed to air immersion of carbon-11 from the IPNS facility. The maximum perimeter dose is lower than last year due to reduced carbon-11 emissions from the IPNS. The programmatic need for continued operation of the facility will result in continued releases of carbon-11.

The full-time resident who would receive the largest annual dose (0.036 mrem/yr), if he or she were outdoors during the entire year, is located approximately 2.5 km (1.6 mi) east of the IPNS facility. The major contributor to the whole body dose is the air immersion dose from carbon-11 (0.033 mrem/yr). Releases of radon-220 plus daughters contribute less than 1% of the resident dose. If radon-220 plus daughters were excluded from the calculation, the NESHAP reportable dose to the maximally exposed individual would be 0.034 mrem/yr.

The individual doses to the maximally exposed member of the public and the maximum fence line dose are shown in Figure 4.6. The decreases in individual and population doses from

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TABLE 4.15

Radiological Airborne Releases from Building 212, 2005

Direction	Distance to Perimeter (m)	Dose ^a (mrem/yr)	Distance to Nearest Resident (m)	Dose ^a (mrem/yr)
N	800	1.1×10^{-3}	2,000	2.6×10^{-4}
NNE	1,000	7.9×10^{-4}	2,500	1.8×10^{-4}
NE	1,300	4.1×10^{-4}	2,000	2.0×10^{-4}
ENE	1,500	2.9×10^{-4}	2,500	1.3×10^{-4}
E	1,600	2.8×10^{-4}	2,800	1.1×10^{-4}
ESE	1,200	4.1×10^{-4}	2,500	1.2×10^{-4}
SE	1,400	2.9×10^{-4}	3,500	6.6×10^{-5}
SSE	1,400	2.9×10^{-4}	4,500	4.5×10^{-5}
S	1,500	1.2×10^{-4}	5,000	2.0×10^{-5}
SSW	1,600	3.0×10^{-4}	5,000	4.9×10^{-5}
SW	1,400	5.7×10^{-4}	2,400	2.7×10^{-4}
WSW	1,300	3.7×10^{-4}	2,300	1.5×10^{-4}
W	1,700	1.5×10^{-4}	2,200	1.0×10^{-4}
WNW	1,500	1.6×10^{-4}	2,000	9.9×10^{-5}
NW	1,300	1.9×10^{-4}	2,000	9.2×10^{-5}
NNW	1,000	5.4×10^{-4}	2,000	1.8×10^{-4}

^a Source terms: hydrogen-3 = 15.8 Ci (HT = gaseous tritium)
hydrogen-3 = 6.0 Ci (HTO = tritiated water vapor)
krypton-85 = 1.9 Ci
antimony-125 = 2.0×10^{-7} Ci
iodine-125 = 3.0×10^{-7} Ci
iodine-129 = 5.3×10^{-6} Ci
radon-220 = 0.3 Ci

1988 to 1999 are due in part to the decrease of radon-220 emissions as a result of the cleanup of the Building 200 M-Wing hot cells. The increase from 1999 to 2004 is principally due to increased emissions from the IPNS as a result of increased operating time.

The population data in Table 1.1 were used to calculate the cumulative population dose from airborne radioactive effluents from Argonne operations. The results are given in Table 4.23, along with the natural external radiation dose. The natural radiation dose listed is the product of the 80-km (50-mi) population and the natural radiation dose of 300 mrem/yr.¹⁴ It is assumed that this dose is representative of the entire area within an 80-km (50-mi) radius. The population dose resulting from Argonne operations since 1987 is shown in Figure 4.7.

The potential radiation exposures by the inhalation pathways also were calculated by the methodology specified in DOE Order 5400.5.⁵ The total quantity for each radionuclide inhaled,

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TABLE 4.16

Maximum Perimeter and Individual Doses
from Building 212 Air Emissions, 2005
(dose in mrem/yr)

Pathway	Perimeter (800 m N)	Individual (2,400 m SW)
Ingestion	2.7×10^{-4}	6.4×10^{-5}
Inhalation	8.4×10^{-4}	2.0×10^{-4}
Air immersion	4.7×10^{-7}	2.5×10^{-7}
Ground surface	9.2×10^{-6}	1.3×10^{-6}
Total	1.1×10^{-3}	2.7×10^{-4}
<i>Radionuclide</i>		
Hydrogen-3	1.1×10^{-3}	2.7×10^{-4}
Krypton-85	1.2×10^{-6}	3.0×10^{-7}
Antimony-125	4.5×10^{-7}	1.2×10^{-8}
Iodine-125	3.0×10^{-8}	4.2×10^{-9}
Iodine-129	1.7×10^{-5}	2.4×10^{-6}
Radon	5.2×10^{-6}	2.2×10^{-8}
Total	1.1×10^{-3}	2.7×10^{-4}

in microcuries (μCi), is calculated by multiplying the annual average air concentrations by the general public breathing rate of $8,400 \text{ m}^3/\text{yr}$.¹⁵ This annual intake is then multiplied by the CEDE conversion factor for the appropriate lung retention class.⁵ The CEDE conversion factors are in units of $\text{rem}/\mu\text{Ci}$, and this calculation gives the 50-year CEDE. Table 4.24 lists the applicable CEDE factors.

The calculated doses in Tables 4.1 and 4.2 were derived by using this procedure. Because they are all essentially at perimeter locations, these doses represent the fence-line values for those radionuclides measured. These doses are the same as the off-site measurements and represent the ambient dose for the area from these nuclides. No doses were calculated for the total alpha and total beta measurements because the guidance does not provide CEDE conversion factors for such measurements.

An evaluation was conducted of potential sensitive receptors of Argonne airborne releases, including children at the Argonne Child Development Center (Location 120 in Figure 1.1). The airborne dose from Argonne is estimated to be about 0.10 mrem/yr at this location. This assumes full-time, outdoor exposure. Assuming that the children are present about 8 hours per day, 5 days per week, the actual dose is closer to 0.03 mrem/yr . Additional potential sensitive receptors are located at the Darien school on 91st Street, west of Route 83. The estimated full-time outdoor dose at this location is about 0.01 mrem/yr . Again, assuming that the

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TABLE 4.17

Radiological Airborne Releases from Building 350, 2005

Direction	Distance to Perimeter (m)	Dose ^a (mrem/yr)	Distance to Nearest Resident (m)	Dose ^a (mrem/yr)
N	1,700	6.3×10^{-4}	2,200	4.3×10^{-4}
NNE	1,800	5.9×10^{-4}	3,200	2.5×10^{-4}
NE	2,200	3.4×10^{-4}	3,100	2.0×10^{-4}
ENE	2,000	3.6×10^{-4}	3,100	1.8×10^{-4}
E	1,700	4.8×10^{-4}	2,500	2.1×10^{-4}
ESE	900	1.0×10^{-3}	3,000	1.9×10^{-4}
SE	900	9.3×10^{-4}	3,000	2.0×10^{-4}
SSE	700	1.2×10^{-3}	2,700	1.9×10^{-4}
S	600	5.0×10^{-4}	2,700	9.2×10^{-5}
SSW	400	1.8×10^{-3}	2,500	2.9×10^{-4}
SW	600	2.0×10^{-3}	2,700	3.7×10^{-4}
WSW	800	1.2×10^{-3}	2,100	3.3×10^{-4}
W	900	6.1×10^{-4}	2,200	1.9×10^{-4}
WNW	1,000	4.5×10^{-4}	2,100	1.7×10^{-4}
NW	1,900	2.0×10^{-4}	2,400	1.4×10^{-4}
NNW	1,900	3.7×10^{-4}	2,200	3.0×10^{-4}

^a Source terms: neptunium-237 = 1.4×10^{-11} Ci
 uranium-234 = 2.5×10^{-5} Ci
 uranium-238 = 2.5×10^{-5} Ci
 plutonium-239 = 3.9×10^{-6} Ci
 plutonium-240 = 2.0×10^{-6} Ci
 americium-241 = 2.6×10^{-10} Ci

children are only present at this location 6 hours per day, 5 days per week, and for 35 weeks a year, the actual dose is closer to 0.001 mrem/yr.

4.8.2. Water Pathway

Following the methodology outlined in DOE Order 5400.5,⁵ the annual intake of radionuclides (in μCi) ingested with water is obtained by multiplying the concentration of radionuclides in microcuries per milliliter ($\mu\text{Ci/mL}$) by the average annual water consumption of a member of the general public (7.3×10^5 mL). This annual intake is then multiplied by the CEDE conversion factor for ingestion (Table 4.24) to obtain the dose received in that year. This procedure was carried out for all radionuclides, and the individual results were summed to obtain the total ingestion dose.

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TABLE 4.18

Maximum Perimeter and Individual Doses
from Building 350 Air Emissions, 2005
(dose in mrem/yr)

Pathway	Perimeter (600 m SW)	Individual (2,200 m N)
Ingestion	1.6×10^{-5}	3.6×10^{-6}
Inhalation	2.0×10^{-3}	4.3×10^{-4}
Air immersion	1.0×10^{-12}	2.2×10^{-13}
Ground surface	2.2×10^{-7}	4.9×10^{-8}
Total	2.0×10^{-3}	4.3×10^{-4}
<i>Radionuclide</i>		
Neptunium-237	1.6×10^{-9}	3.6×10^{-10}
Uranium-234	7.9×10^{-4}	1.7×10^{-4}
Uranium-238	7.0×10^{-4}	1.5×10^{-4}
Plutonium-239	3.2×10^{-4}	7.0×10^{-5}
Plutonium-240	1.6×10^{-4}	3.6×10^{-5}
Americium-241	3.4×10^{-8}	7.4×10^{-9}
Total	2.0×10^{-3}	4.3×10^{-4}

The only significant location where radionuclides attributable to Argonne operations could be found in off-site water was Sawmill Creek below the wastewater outfall (see Table 4.6). Although this water is not used for drinking purposes, the 50-year effective dose equivalent was calculated for a hypothetical individual ingesting water at the radionuclide concentrations measured at that location. Those radionuclides added to Sawmill Creek by Argonne wastewater, their net average concentrations in the creek, and the corresponding dose rates (if water at these concentrations was used as the sole water supply by an individual for an entire year) are given in Table 4.25. The dose rates were all well below the standards for the general population. It should be emphasized that Sawmill Creek is not used for drinking, swimming, or boating. Inspection of the area shows that there are fish in the stream; however, they do not constitute a significant source of food for any individual. Figure 4.8 is a plot since 1986 showing the estimated dose a hypothetical individual would receive if ingesting Sawmill Creek water.

As indicated in Table 4.6, occasional Sawmill Creek samples (fewer than 10%) contained traces of cesium-137, plutonium-238, curium-242 and 244, or californium-249 and 252; however, the averages were only slightly greater than the detection limit. The annual dose to an individual consuming water at these concentrations can be calculated with the same method used for those radionuclides more commonly found in creek water; this method of averaging,

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TABLE 4.19

Radiological Airborne Releases from Building 375 (IPNS), 2005

Direction	Distance to Perimeter (m)	Dose ^a (mrem/yr)	Distance to Nearest Resident (m)	Dose ^a (mrem/yr)
N	1,600	8.7×10^{-2}	3,200	2.3×10^{-2}
NNE	1,700	9.4×10^{-2}	3,100	2.7×10^{-2}
NE	1,700	7.4×10^{-2}	2,700	2.8×10^{-2}
ENE	1,500	7.5×10^{-2}	2,500	2.9×10^{-2}
E	600	3.8×10^{-1}	2,500	3.4×10^{-2}
ESE	600	3.5×10^{-1}	2,500	2.8×10^{-2}
SE	600	3.1×10^{-1}	2,500	2.5×10^{-2}
SSE	600	3.1×10^{-1}	3,000	1.7×10^{-2}
S	800	8.7×10^{-2}	3,000	8.6×10^{-3}
SSW	800	2.4×10^{-1}	3,500	1.6×10^{-2}
SW	800	3.2×10^{-1}	4,000	1.4×10^{-2}
WSW	1,500	7.2×10^{-2}	2,700	2.4×10^{-2}
W	2,200	2.4×10^{-2}	2,700	1.4×10^{-2}
WNW	1,500	3.8×10^{-2}	2,600	1.3×10^{-2}
NW	2,200	1.7×10^{-2}	2,500	1.3×10^{-2}
NNW	1,800	4.8×10^{-2}	2,200	3.3×10^{-2}

^a Source terms: carbon-11 = 1,535.4 Ci
argon-41 = 36.8 Ci

however, probably overestimates the true concentration. Annual doses range from 3×10^{-4} to 6×10^{-6} mrem/yr for these radionuclides.

Sawmill Creek flows into the Des Plaines River. The flow rate of Sawmill Creek (see Section 1.6) is about 0.28 m³/s (10 ft³/s). The flow rate of the Des Plaines River in the vicinity of Argonne is about 25 m³/s (900 ft³/s). Applying this ratio to the concentration of radionuclides in Sawmill Creek listed in Table 4.25, the dose to a hypothetical individual ingesting water from the Des Plaines River at Lemont would be about 0.0002 mrem/yr. Significant additional dilution occurs farther downstream. Very few people, either directly or indirectly, use the Des Plaines River as a source of drinking water. If 100 people used Des Plaines River water at the hypothetical concentration at Lemont, the estimated population dose would be about 10⁻⁵ person-rem.

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TABLE 4.20

Maximum Perimeter and Individual Doses from
Building 375 (IPNS) Air Emissions, 2005
(dose in mrem/yr)

Pathway	Perimeter (600 m E)	Individual (2,400 m E)
Ingestion	— ^a	—
Inhalation	1.6×10^{-2}	1.5×10^{-3}
Air immersion	3.5×10^{-1}	3.1×10^{-2}
Ground surface	1.4×10^{-2}	1.5×10^{-3}
Total	3.8×10^{-1}	3.4×10^{-2}
<i>Radionuclide</i>		
Carbon-11	3.7×10^{-1}	3.3×10^{-2}
Argon-41	1.1×10^{-2}	1.2×10^{-3}
Total	3.8×10^{-1}	3.4×10^{-2}

^a A dash indicates no exposure by this pathway.

4.8.3. Biota Dose Assessment

DOE Order 5400.5⁵ requires an evaluation of the dose to aquatic organisms from liquid effluents. The dose limit is 1 rad/day, or 365 rad/yr. The location that could result in the highest dose to aquatic organisms is in Sawmill Creek downstream of the point where Argonne discharges its treated wastewater. Inspection of the creek at this location indicates the presence of small bluegill and carp (about 100 g [4 oz] each). The aquatic dose assessment of these species was conducted by using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.¹⁶ The assessment used the general screening approach, which compares maximum water and sediment radionuclide concentrations with biota concentration guides (BCGs). Maximum water concentrations for hydrogen-3, strontium-90, plutonium-239, and americium-241 were obtained from Table 4.6, while maximum sediment concentrations for cesium-137, plutonium-239, and americium-241 were obtained from Table 4.9. Summing the ratios of their respective BCGs for each radionuclide resulted in a dose estimate of 0.0056 rad/yr to aquatic biota. This is well below the 365 rad/yr limit in DOE Order 5400.5 and demonstrates compliance with the limit.

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TABLE 4.21

Radiological Airborne Releases from Building 411/415 (APS), 2005

Direction	Distance to Perimeter (m)	Dose ^a (mrem/yr)	Distance to Nearest Resident (m)	Dose ^a (mrem/yr)
N	1,500	5.5×10^{-4}	2,000	3.0×10^{-4}
NNE	1,600	5.4×10^{-4}	2,100	3.1×10^{-4}
NE	2,200	2.2×10^{-4}	3,100	1.0×10^{-4}
ENE	2,500	1.5×10^{-4}	3,300	8.2×10^{-5}
E	1,600	4.2×10^{-4}	3,400	8.3×10^{-5}
ESE	1,500	4.2×10^{-4}	3,500	6.7×10^{-5}
SE	400	4.7×10^{-3}	3,000	8.0×10^{-5}
SSE	400	4.7×10^{-3}	3,000	7.9×10^{-5}
S	350	2.5×10^{-3}	2,500	5.9×10^{-5}
SSW	400	5.9×10^{-3}	2,800	1.1×10^{-4}
SW	550	4.2×10^{-3}	3,000	1.1×10^{-4}
WSW	800	1.4×10^{-3}	1,400	4.7×10^{-4}
W	800	8.8×10^{-4}	1,500	2.4×10^{-4}
WNW	500	1.8×10^{-3}	1,400	2.4×10^{-4}
NW	350	3.4×10^{-3}	1,600	1.7×10^{-4}
NNW	1,500	3.7×10^{-4}	2,000	2.0×10^{-4}

^a Source terms: carbon-11 = 0.14 Ci (estimated)
nitrogen-13 = 10.32 Ci (estimated)
oxygen-15 = 1.12 Ci (estimated)

4.8.4. External Direct Radiation Pathway

The TLD measurements given in Section 4.5 were used to calculate the radiation dose from external sources. Above-background doses attributable to Argonne operations were found at the southern boundary near the Waste Storage Facility (Location 7I).

At Location 7I, the fence-line dose from Argonne was 94 ± 5 mrem/yr. Approximately 300 m (960 ft) south of the fence line (grid 6I), the measured dose was 92 ± 5 mrem/yr, essentially the same as the off-site average (87 ± 3 mrem/yr). No individuals live in this area. The closest residents are about 1.6 km (1 mi) south of the fence line. At this distance, the calculated dose rate from the Waste Storage Facility would be 0.001 mrem/yr, if the energy of the radiation was that of a 0.66-MeV cesium-137 gamma ray, and approximately 0.003 mrem/yr, if the energy was that of a 1.33-MeV cobalt-60 gamma ray.

At the fence line, where higher doses were measured, the land is wooded and unoccupied. All of these dose calculations are based on full-time, outdoor exposure. Actual exposures to individuals would be substantially less because some of the individuals are indoors (which

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TABLE 4.22

Maximum Perimeter and Individual Doses
from Building 411/415 (APS) Air Emissions, 2005
(dose in mrem/yr)

Pathway	Perimeter (400 m SSW)	Individual (1,400 m WSW)
Ingestion	— ^a	—
Inhalation	1.7×10^{-4}	1.4×10^{-5}
Air immersion	5.6×10^{-3}	4.5×10^{-4}
Ground surface	1.0×10^{-4}	9.5×10^{-6}
Total	5.8×10^{-3}	4.7×10^{-4}
<i>Radionuclide</i>		
Carbon-11	8.0×10^{-5}	7.5×10^{-6}
Nitrogen-13	5.4×10^{-3}	4.5×10^{-4}
Oxygen-15	3.8×10^{-4}	1.5×10^{-6}
Total	5.8×10^{-3}	4.7×10^{-4}

^a A dash indicates no exposure by this pathway.

provides shielding) or away from their dwellings for part of the time. In addition to the permanent resident in the area, occasionally visitors may conduct activities around Argonne that could result in exposure to radiation from this site. Examples of these activities could be cross-country skiing, horseback riding, or running in the fire lane next to the perimeter fence. If the individual spent 10 minutes per week adjacent to the 317 Area, the dose would be 0.001 mrem/yr at the 317 Area fence (Location 7I) from Argonne operations.

4.8.5. Dose Summary

The total effective dose equivalent received by off-site residents during 2005 was a combination of the individual doses received through the separate pathways. Radionuclides that contributed through the air pathway are hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 (plus daughters), and actinides. The highest dose was approximately 0.036 mrem/yr to individuals living east of the site if they were outdoors at that location during the entire year. The total annual population dose to the entire area within an 80-km (50-mi) radius was 2.74 person-rem. The dose pathways are presented in Table 4.26 and are compared with the applicable standards.

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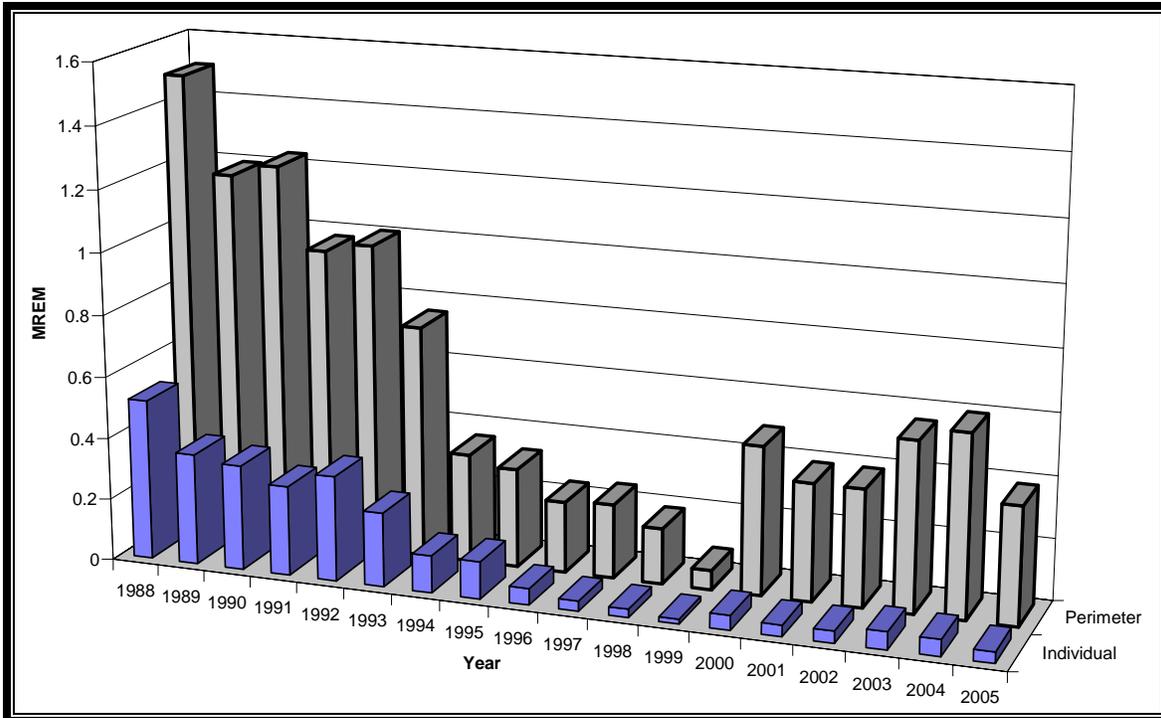


FIGURE 4.6 Individual and Perimeter Doses from Airborne Radioactive Emissions

TABLE 4.23

Population Dose within 80 km
(50 mi), 2005

Radionuclide	Person-rem
Hydrogen-3	0.07
Carbon-11	2.05
Nitrogen-13	0.02
Oxygen-15	<0.01
Argon-41	0.44
Krypton-85	<0.01
Antimony-125	<0.01
Iodine-125	<0.01
Iodine-129	<0.01
Uranium-234	0.06
Uranium-238	0.06
Neptunium-237	<0.01
Plutonium-239	0.03
Plutonium-240	0.01
Americium-241	<0.01
Total	2.74
Natural	2.7×10^6

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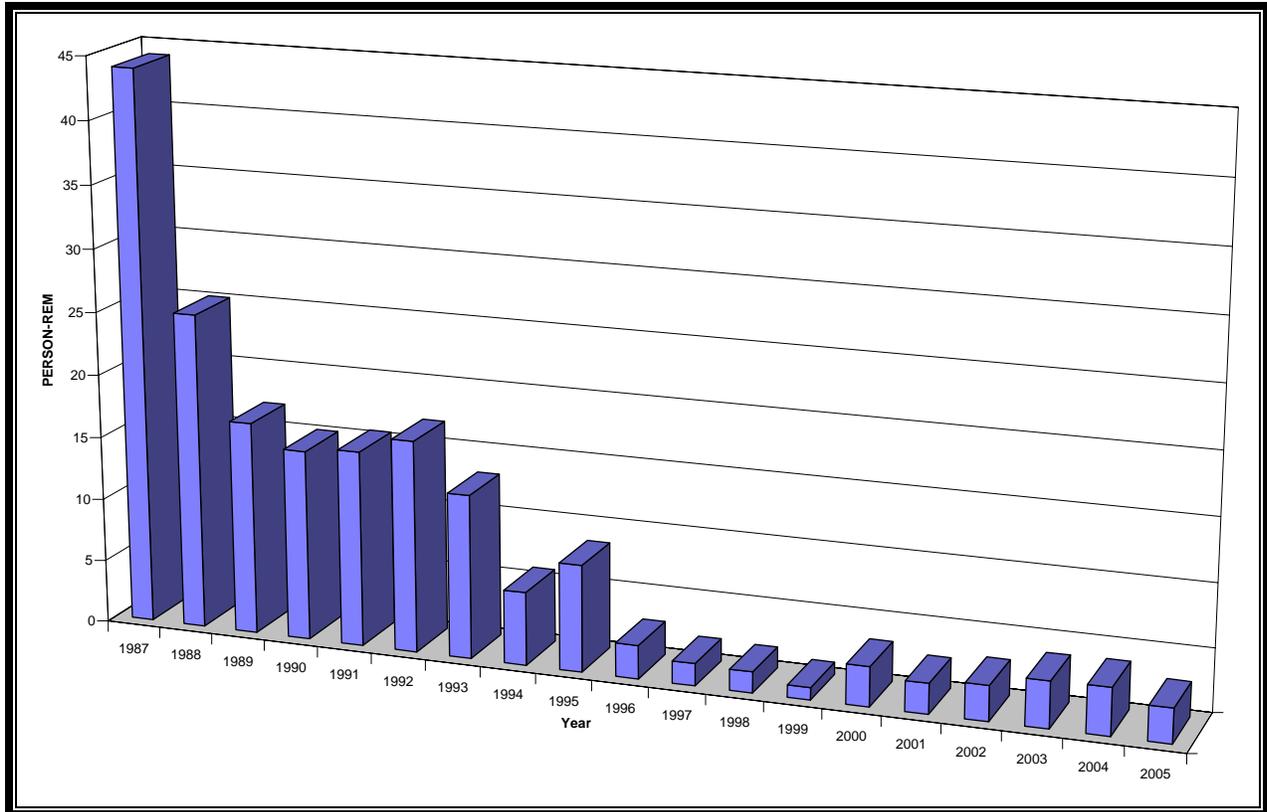


FIGURE 4.7 Population Dose from Airborne Radioactive Emissions

To receive the hypothetical maximum public dose, an individual would need to live at the point of maximum air and direct radiation exposure and use only water from Sawmill Creek below the Argonne wastewater discharge. This is a very conservative and unlikely situation. To put the hypothetical maximum individual dose from all pathways of 0.055 mrem/yr attributable to Argonne operations into perspective, comparisons can be made with annual average doses (360 mrem) from natural or accepted sources of radiation received by an average American who could be living anywhere in the United States. These values are listed in Table 4.27. These site-related doses are in addition to the background doses. The magnitude of the doses received from Argonne operations is insignificant compared with these sources. Therefore, the monitoring program results establish that the radioactive emissions from Argonne are very low and do not endanger the health or safety of those living in the vicinity of the site.

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TABLE 4.24

50-Year Committed Effective Dose
Equivalent (CEDE) Conversion Factors
(rem/ μ Ci)

Nuclide	Ingestion	Inhalation
Hydrogen-3	6.3×10^{-5}	9.6×10^{-5}
Beryllium-7	- ^a	2.7×10^{-4}
Carbon-11	-	8.0×10^{-6}
Strontium-90	0.13	1.32
Cesium-137	0.05	0.032
Lead-210	-	13.2
Radium-226	1.1	-
Thorium-228	-	310
Thorium-230	-	260
Thorium-232	-	1,100
Uranium-234	0.26	130
Uranium-235	0.25	120
Uranium-238	0.23	120
Neptunium-237	3.9	-
Plutonium-238	3.8	-
Plutonium-239	4.3	330
Americium-241	4.5	-
Curium-242	0.11	-
Curium-244	2.3	-
Californium-249	4.6	-
Californium-252	0.94	-

^a A dash indicates that a value is not required.

TABLE 4.25

Radionuclide Concentrations and Dose Estimates
for Sawmill Creek Water, 2005

Radionuclide	Total Released (Ci)	Net Avg. Concentration (pCi/L)	Dose (mrem)
Hydrogen-3	0.07	36	0.0017
Strontium-90	0.0004	0.16	0.015
Plutonium-239	<0.0001	0.0004	0.0014
Americium-241	<0.0001	0.0001	0.00005
Total	0.07		0.018

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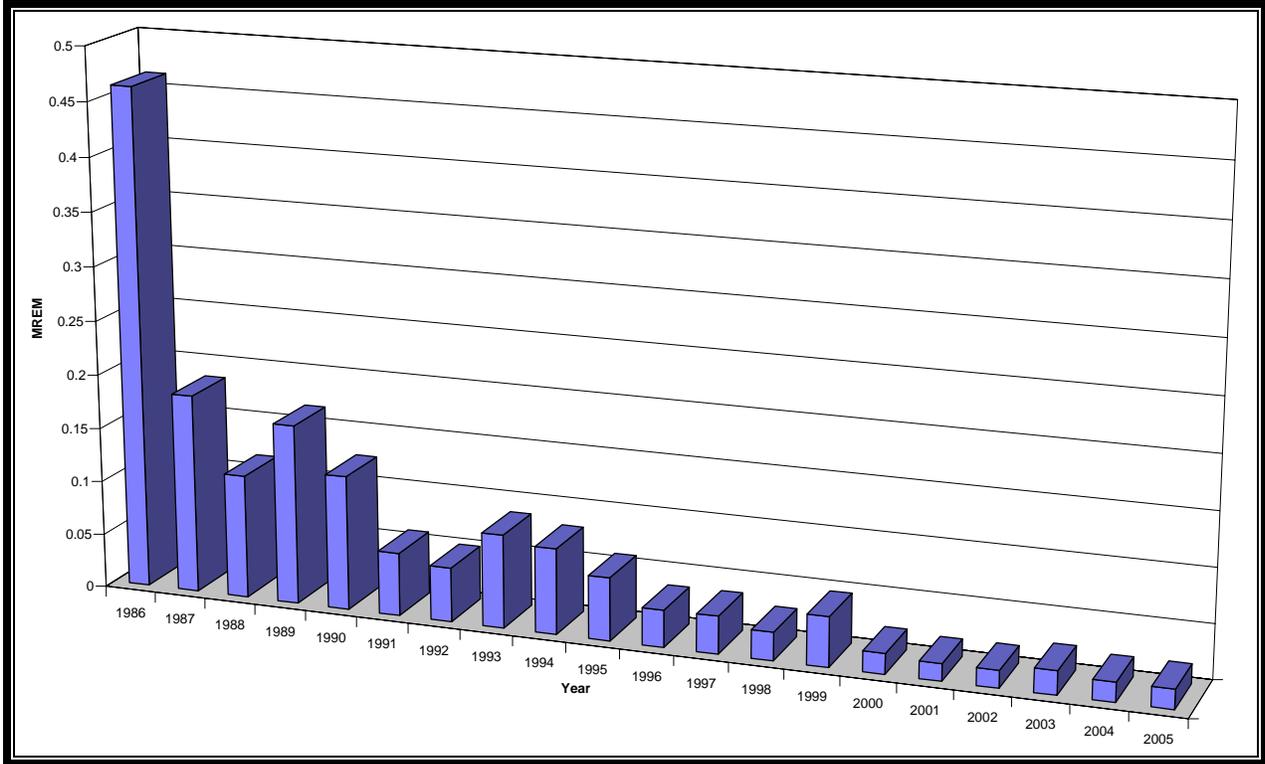


FIGURE 4.8 Comparison of Dose Estimate from Ingestion of Sawmill Creek Water

TABLE 4.26

Summary of the Estimated Dose to a Hypothetical Individual, 2005 (mrem/yr)

Pathway	Argonne Estimate	Applicable Standard
Air total	0.036	10 (EPA)
Water	0.018	4 (EPA) ^a
Direct radiation	0.001	25 (NRC)
Maximum dose	0.055	100 (DOE)

^a The 4-mrem/yr EPA value is not an applicable standard, since it applies to community water systems.¹⁷ It is used here for illustrative purposes.

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TABLE 4.27

Annual Average Dose Equivalent
in the U.S. Population^a

Source	Dose (mrem)
Natural	
Radon	200
Internal (potassium-40 and radium-226)	39
Cosmic	28
Terrestrial	28
Medical/dental	
Diagnostic x-rays	39
Nuclear medicine	14
Consumer products	
Domestic water supplies, building materials, etc.	10
Occupational (medical radiology, industrial radiography, research, etc.)	1
Nuclear fuel cycle	<1
Fallout	<1
Other miscellaneous sources	<1
Total	360

^a National Council on Radiation Protection and
Measurements Report No. 93.¹⁴

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5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION



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The nonradiological monitoring program primarily involves the collection and analysis of surface water and groundwater samples from numerous locations throughout the site. The amount of nonradiological pollutants released to the air from Argonne is small (see Table 2.3), except for the conventional air pollutants emitted from the boiler house while burning coal. This unit is equipped with dedicated monitoring equipment for sulfur dioxide and opacity while burning coal. No exceedances were noted during 2005 over a period of 1,383 hours of coal-burning operation of Boiler No. 5, the coal-burning boiler (see Section 2.1.2). No other air monitoring for nonradiological pollutants is performed, except for landfill gas monitoring (see Section 2.1.2).

Surface water samples for nonradiological chemical analyses are collected from NPDES-permitted outfalls and Sawmill Creek.¹⁸ Analyses conducted on the samples from the NPDES outfalls vary, depending on the permit-mandated monitoring requirements for each outfall. The results of the analyses are compared with the permit limits for each outfall to determine whether they comply with the permit. In addition to being published in this report, the NPDES monitoring results are transmitted monthly to the IEPA in an official DMR.

In addition to the permit-required monitoring, other analyses are conducted on samples collected from the combined wastewater outfall (NPDES Outfall 001) to provide a more complete evaluation of the impact of the wastewater on the environment. Water samples from Sawmill Creek are also collected and analyzed for a number of inorganic constituents. The results of these additional analyses of the main outfall and receiving streams are then compared with IEPA General Effluent Standards and Stream Quality Standards listed in IAC, Title 35, Subtitle C, Chapter I.¹⁹

5.1. National Pollutant Discharge Elimination System Monitoring Results

5.1.1. Influent Monitoring

Since initial monitoring in 1989, analyses of the laboratory wastewater influent have shown the presence of a variety of VOCs with variable concentrations. Although disposing of waste chemicals into the drain is not authorized, residual VOCs are released to the laboratory sewer from laboratory-related activities such as rinsing glassware. Also, VOCs are known to be discharged into the laboratory sewer from the 317/319 Lift Station, which pumps contaminated groundwater generated by Argonne's RCRA corrective actions. Table 5.1 gives the results of the analysis of laboratory wastewater influent.

The 2005 results for laboratory influent wastewater are quite similar to those from 1997 through 2004 with the exception of high levels of ethanol for seven months. Table 5.1 gives the 2005 results for ethanol and the most common compounds detected. Bromoform, bromodichloromethane, chloroform, and dibromochloromethane are halomethanes that are

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TABLE 5.1

Laboratory Influent Wastewater, 2005
(concentrations in $\mu\text{g/L}$)

Month	Acetone	Chloroform	Bromodi- chloroethane	Dibromo- chloromethane	Bromoform	Ethanol
January	24	8	2	1	— ^a	204
February	—	3	2	1	—	—
March	8	14	1	1	—	10,634
April	20	14	2	1	—	1,119
May	—	4	3	2	2	—
June	19	5	7	6	3	—
July	20	5	3	1	—	593
August	—	4	1	—	—	157
September	47	3	2	1	1	4,427
October	17	2	2	2	—	192
November	10	2	2	3	2	—
December	31	4	6	8	3	—
Average	22	6	3	2	<2	2,475

^a A dash indicates that the concentration was less than the detection limit.

produced as the result of contact of the chlorinated water supply with organic chemicals. Research activity may account for the presence of other volatiles.

Ethanol was detected in seven samples, and levels ranged up to 10,634 $\mu\text{g/L}$. Acetone was detected in nine samples, and levels ranged up to 47 $\mu\text{g/L}$. Infrequent trace levels of other chemicals — that is, 2-butanone, acetaldehyde, ethyl acetate, and ethyl ether — were also noted but not shown in Table 5.1.

Figures 5.1 and 5.2 present comparisons of the 1992 through 2005 laboratory influent wastewater results for the two more common VOCs, acetone and chloroform. The presence of high levels of ethanol and acetone is likely due to laboratory activities such as rinsing glassware. Disposing of hazardous chemicals down laboratory drains is not authorized at Argonne. Argonne conducts a waste generator education program as part of its site safety awareness training program, in which proper handling and disposal of chemicals are explained. However, normal use of certain chemicals, such as acetone and ethanol, often results in the discharge of small amounts into the sewer. The decrease in influent concentrations of acetone and chloroform over the past several years shows the effectiveness of educational efforts related to waste disposal and pollution prevention.

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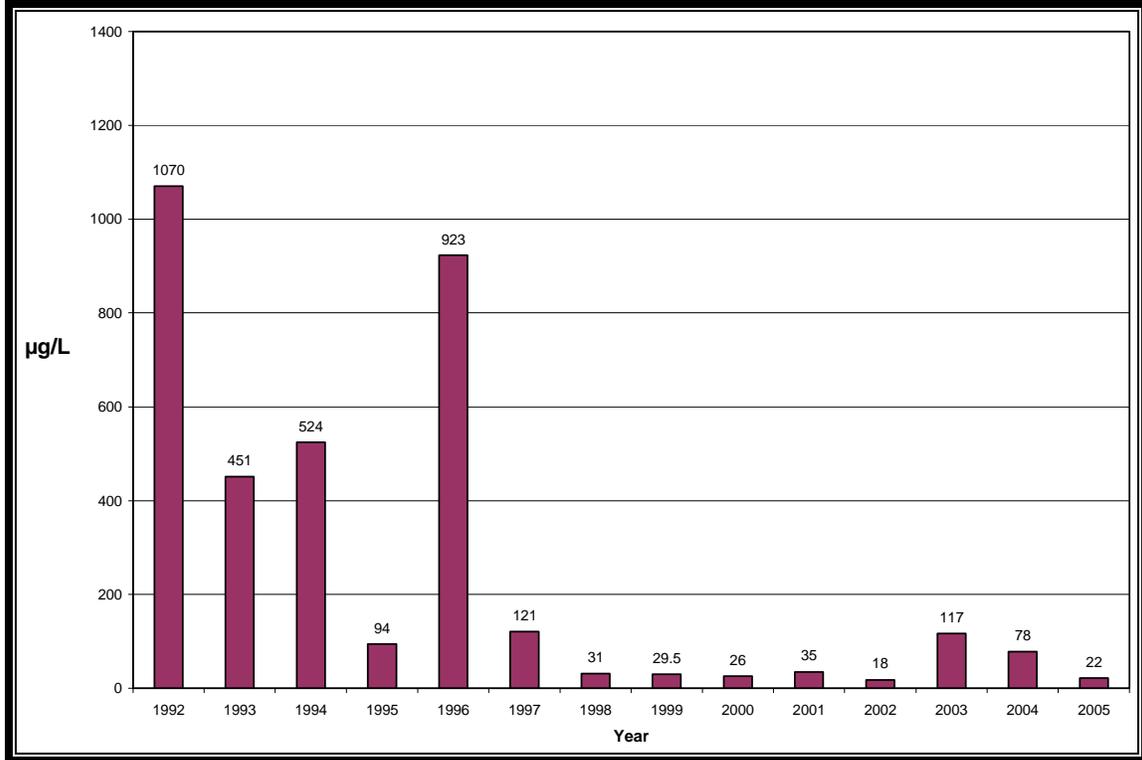


FIGURE 5.1 Average Acetone Levels in Laboratory Influent Wastewater, 1992 to 2005

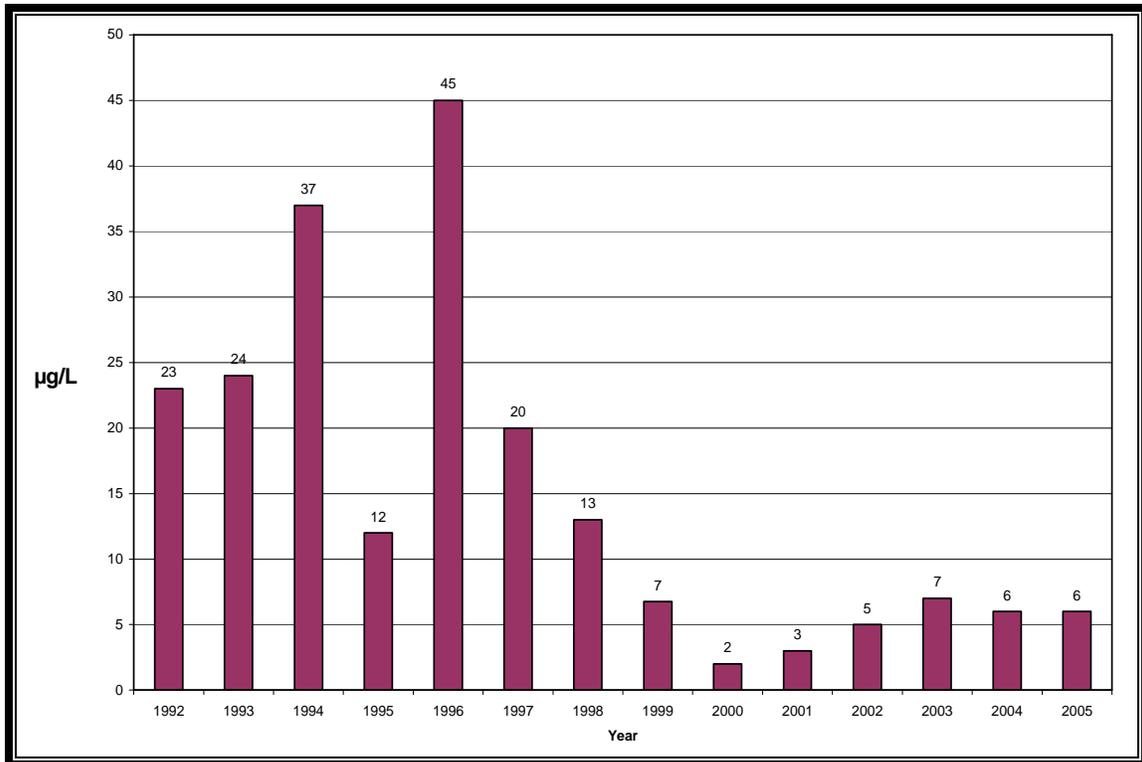


FIGURE 5.2 Average Chloroform Levels in Laboratory Influent Wastewater, 1992 to 2005

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5.1.2. Effluent Monitoring

Section 2.2 of Chapter 2 describes the outfalls on the Argonne site. Table 2.5 lists all of the outfalls. In general, the outfalls fall into two groups: those that have some type of process wastewater discharge and those that contain only storm water runoff following a rain event. The sampling requirements of the process wastewater outfalls (24) depend on the nature of the activity generating the wastewater. This section discusses those requirements and the results of the monitoring. The storm water outfalls (18) are listed in the permit, but they do not require routine monitoring of the discharges.

Effluent samples are collected from Argonne point-source discharges (outfalls) as specified by the NPDES permit. The permit specifies the frequency of sample collection and the specific parameters to be monitored for each individual outfall. Sample collection, preservation, holding times, and analytical methods are specified by the EPA as codified in 40 CFR Part 136, Tables 1B and 2.²⁰

The new NPDES outfall locations are shown in Figure 5.3, while the old NPDES outfall locations are shown in Figure 2.2. Outfalls A01 and B01, the two internal monitoring points representing the effluent from the sanitary system and laboratory system, respectively, are both located at the WTP. Their flows combine to form Outfall 001, which also is located at the treatment facility. The combined stream flows through an outfall pipe that discharges into Sawmill Creek approximately 1,100 m (3,500 ft) south of the treatment plant.

In addition to the main wastewater outfalls, a small amount of process wastewater, primarily cooling tower blowdown and cooling water, is discharged directly to small streams and ditches throughout the site. This wastewater does not contain significant amounts of contaminants and does not require treatment before discharge. These discharge points are included in the site NPDES permit as separate regulated outfalls. Most of the cooling tower-associated discharges have been rerouted to the Argonne sewer system.

5.1.2.1. Sample Collection

All samples are collected in specially cleaned and labeled bottles with appropriate preservatives added. Custody seals and chain-of-custody sheets also are used. All samples are analyzed within the required holding time. Samples are collected at Locations A01, B01, and 001 on a weekly basis, consistent with permit requirements. Similarly, samples are collected at the other locations in accordance with the NPDES permit.

5.1.2.2. Sample Analyses — NPDES

NPDES sample analyses were performed in accordance with standard operating procedures (SOPs) that were issued as controlled documents. These SOPs cite protocols that can be found in 40 CFR Part 136, “Test Procedures for the Analysis of Pollutants under the Clean

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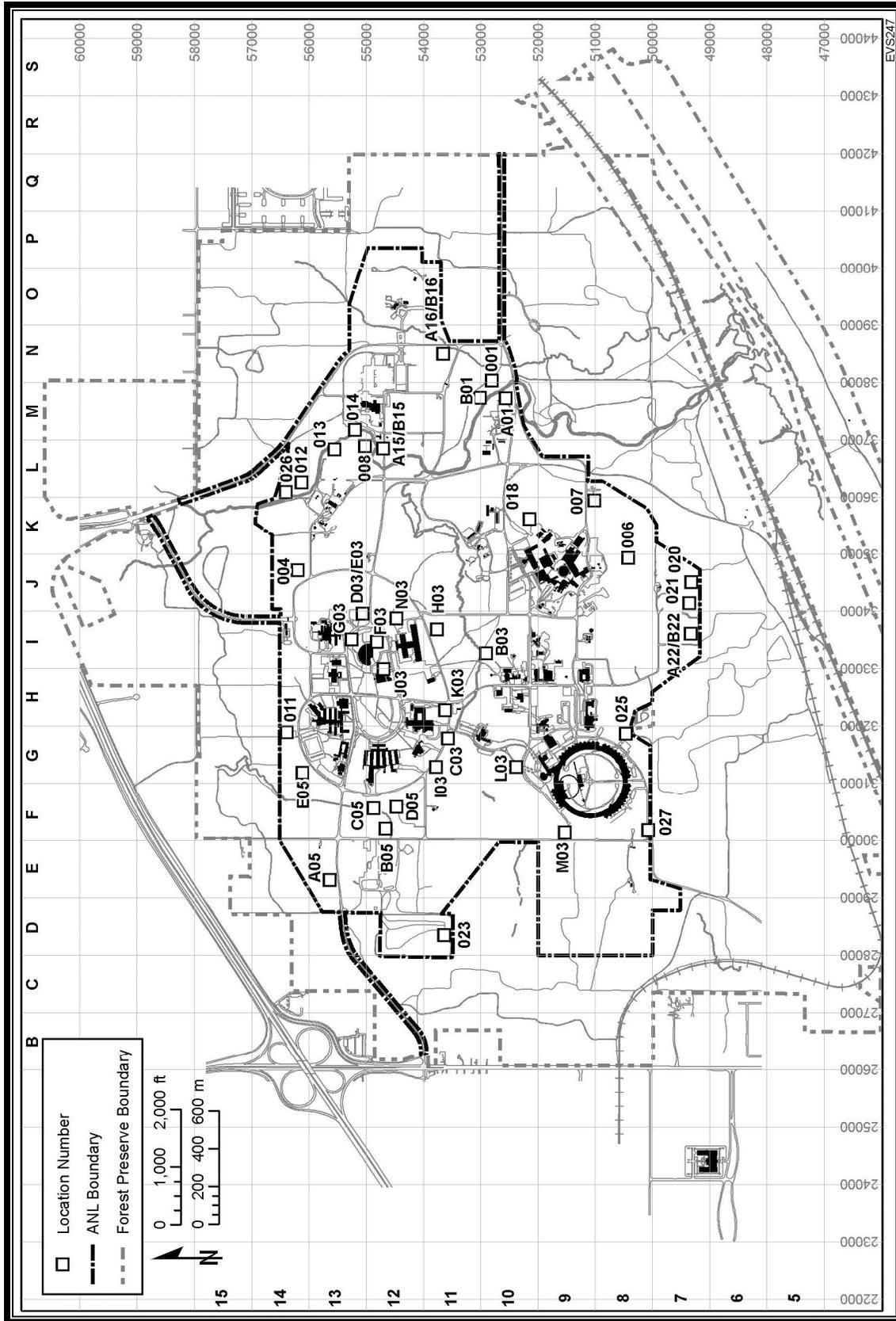


FIGURE 5.3 New NPDES Outfall Locations

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

Water Act.”²⁰ Six metal analyses were performed by using inductively coupled plasma atomic emission spectroscopy. Mercury was determined by cold vapor atomic absorption or atomic fluorescence spectroscopy, depending on the level required at the outfall. Hexavalent chromium determination and chemical oxygen demand (COD) were performed by using a colorimetric technique. Biochemical oxygen demand (BOD₅) was determined by using a dissolved oxygen probe. TSS, TDS, and oils and grease were determined gravimetrically. Sulfate and chloride, determined by ultraviolet (UV)/visible spectrometry, was performed by using a turbidimetric technique. Ammonia nitrogen was determined by distillation, followed by an ion-selective electrode measurement. VOC concentrations were determined by using a purge-and-trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. The PCB Aroclor-1260[®] concentrations were determined by solvent extraction, followed by gas chromatography-electron capture detection. Beta radioactivity was performed by using a gas flow proportional counting technique. Hydrogen-3 concentrations were determined by distillation, followed by a beta liquid scintillation counting technique.

NPDES Outfall B01 is sampled and analyzed semiannually for priority pollutant compounds. VOCs were determined by using a purge-and-trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. Semivolatile organic compounds (SVOCs) were determined by solvent extraction, followed by gas chromatography-mass spectroscopy detection. PCBs and pesticides were determined by solvent extraction, followed by gas chromatography-electron capture detection. Thirteen metals were determined by graphite furnace atomic absorption and inductively coupled plasma atomic emission spectroscopy. Cyanide and phenol were determined by distillation, followed by a spectrophotometric measurement.

NPDES Outfall 001 is sampled and analyzed annually during June for acute aquatic toxicity parameters. Under the terms of the October 30, 1994, NPDES permit, NPDES Outfalls H03, I03, J03, 004, 006, and 025 were tested in July and August for acute aquatic toxicity. An off-site contract laboratory performs the sample collection and analyses. The testing is performed by diluting a series of Argonne effluent samples with Sawmill Creek receiving water, into which species of fish and invertebrates are introduced. Survival is measured over two to four days, and statistically significant mortality is reported as a function of effluent concentration. Under the Special Conditions of the September 1, 2005, NPDES permit, Argonne is required to develop a biomonitoring plan to address the sources and remedies for observed toxicity in the effluent from Outfalls J03, 006, and 025. Argonne’s biomonitoring plan was submitted to IEPA on October 31, 2005, and was subsequently approved by IEPA December 8, 2005.

5.1.2.3. Results

During 2005, approximately 98% of all NPDES analyses were in compliance with their applicable permit limits. Specific limit exceedances are discussed later in this section, as well as in Chapter 2. A discussion of the analytical results for the major outfalls follows.

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5.1.2.4. Wastewater Treatment Facility Outfalls

Outfall A01. This outfall consists of treated sanitary wastewater. Until fall of 2001, it also consisted of various wastewater streams from the boiler house area, including coal pile storm water runoff. These wastewater streams are now directed to the DuPage County system. The effectiveness of the sanitary wastewater treatment systems is evaluated by weekly monitoring for BOD₅, pH, and TSS. The limits for BOD₅ are a monthly average of 10 mg/L and a maximum value of 20 mg/L. The permit limits for TSS are a maximum concentration of 24 mg/L and a monthly average of 12 mg/L. The pH must range between values of 6 and 9. No limits were exceeded during 2005.

The September 1, 2005, permit requires weekly monitoring for total copper, iron, manganese, and zinc. Chromium, lead, and oil and grease were removed from the weekly requirement by the new permit. Table 5.2 gives the effluent limits for these parameters and monitoring results. Two limits are listed; one is a maximum limit for any single sample, and the other is for the average of all samples collected during the month. The constituents in Table 5.2 are present in the coal pile runoff. As of fall 2001, coal pile runoff is discharged to the laboratory sewage system. No limits were exceeded during 2005.

Outfall B01. This outfall consists of processed wastewater from the laboratory wastewater system and the coal pile runoff. The permit requires that weekly samples be collected and analyzed for BOD₅, TSS, iron, zinc, oil and grease, mercury, pH, and COD. Table 5.3 gives the effluent limits for these parameters and monitoring results.

TABLE 5.2

Outfall A01 Effluent Limits and Monitoring Results, 2005
(concentrations in mg/L)

Constituent	Minimum	Average	Maximum	Average Limit	Maximum Limit
BOD ₅	1	2	3	10	20
TSS	1	2	3	12	24
Chromium ^a	– ^b	<0.015	<0.015	1.0	2.0
Copper	<0.021	<0.021	0.018	0.50	1.0
Iron	<0.019	0.046	0.068	2.0	4.0
Lead ^a	–	<0.10	<0.10	0.20	0.40
Manganese	<0.010	<0.013	0.021	1.0	2.0
Zinc	0.063	0.081	0.134	1.0	2.0
Oil and grease ^a	–	<5.0	<5.0	15.0	30.0

^a Parameter deleted by September 1, 2005, NPDES permit.

^b A dash indicates that there is no minimum value.

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TABLE 5.3

Outfall B01 Effluent Limits and Monitoring Results, 2005
(concentrations in mg/L)

Constituent	Minimum	Average	Maximum	Average Limit	Maximum Limit
COD	– ^a	<20	21	– ^b	– ^b
Mercury	– ^a	<0.0002	<0.0002	0.003	0.006
BOD ₅	1	2	3	10	10
TSS	2	3	5	12	24
Iron ^c	<0.027	0.059	0.129	– ^b	– ^b
Zinc ^c	0.064	0.099	0.166	1	2
Oil and grease ^c	– ^a	<5	<5	15	30

^a A dash indicates that there is no minimum value.

^b Monitor only.

^c Parameter added by September 1, 2005, NPDES permit.

The limits established for BOD₅ are a daily maximum of 20 mg/L and a 30-day average of 10 mg/L. The permit also contains BOD₅ mass loading limits of 52 kg/day (114 lb/day) as a daily maximum and 26 kg/day (57 lb/day) as a 30-day average. The mass loading represents the weight of material discharged per day and is a function of concentration and flow. The daily maximum concentration limit for TSS is 24 mg/L; the 30-day average is 12 mg/L. The TSS mass loading limits are 62 maximum and 31 average kg/day (136 and 68 lb/day), respectively. No limits were exceeded during 2005.

The daily maximum concentration limit for mercury is 0.006 mg/L; the 30-day average is 0.003 mg/L. The corresponding loading values are 0.02 kg/day (0.034 lb/day) and 0.01 kg/day (0.017 lb/day), respectively. No exceedances of the mercury loading and concentration limits were noted during 2005. The values obtained in 2005 were all less than 0.0002 mg/L.

No concentration limits have been established for COD. The once-per-week grab samples give a rough indication of the organic and inorganic oxygen-consuming contents of this effluent stream. The values obtained in 2005 ranged from less than 20 to 21 mg/L.

Zinc, oil and grease, and iron (total) were parameters added to the monitoring requirements at Outfall B01 by the September 1, 2005, NPDES permit. The daily maximum limit for zinc is 2.0 mg/L; the 30-day average is 1.0 mg/L. The corresponding loading values are 3.46 kg/day (7.6 lb/day) and 1.73 kg/day (3.8 lb/day), respectively. The daily maximum limit for oil and grease is 30 mg/L; the 30-day average is 15 mg/L. The corresponding loading values are 52.5 kg/day (115.1 lb/day) and 26.2 kg/day (57.5 lb/day), respectively. Iron is monitor only. No zinc or oil and grease limits were exceeded in 2005.

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

A special condition at Location B01 requires monitoring for the 124 priority pollutants listed in the permit during the months of June and December. The June sampling is to be conducted at the same time that aquatic toxicity testing of Outfall 001 is conducted. Samples were collected on June 19, 2005, and December 6, 2005, and analyzed within the required holding times.

Analysis of these samples indicated that very small amounts of a few chemicals were present. The results for SVOCs, PCBs, and pesticides were all less than the detection limits. Very low levels of zinc (0.11 mg/L) were noted in the June and December samples. The samples contained some VOCs at very low levels. The majority of compounds detected were halomethanes, which are found in chlorinated drinking water. Table 5.4 lists the concentrations of volatile organics identified in these samples. Currently, no permit limits or effluent standards are available for these compounds for comparison with these results.

Outfall 001. After the treatment processes, the effluents from both the laboratory and sanitary WTP are combined to form one point-source discharge. The combined effluent flows through a 1,100-m (3,500-ft) outfall pipe where it is eventually discharged into Sawmill Creek.

Samples of the combined effluent are collected weekly or monthly as grab samples or 24-hour composite samples as specified in the NPDES permit. The samples are analyzed for a variety of metals, ammonia nitrogen, chlorides, sulfates, TDS, pH, and beta radioactivity. The permit requires analysis of the combined effluent once a week for TDS, chloride, and sulfate. Table 5.5 gives the results, limits, and number of exceedances.

Three exceedances of the TDS limit were noted during 2005. The elevated TDS levels occurred during the period of heavy snowmelt and the TDS exceedances are believed to be related to the combination of reduced flows and increases in TDS concentrations from road salt infiltration/inflow into the sanitary sewer system associated with snowmelt. For the past several years, chemical analysis for chloride has indicated a close relationship between TDS levels and chloride levels. Figure 5.4 shows the results of TDS and chloride analyses for 1995 through 2005. Elevated TDS levels prior to 1997 are attributed to high TDS levels (800 mg/L) in Argonne's domestic source water (i.e., groundwater, at that time).

In 1997, Lake Michigan water, which is characterized by low TDS levels (200 to 400 mg/L), became Argonne's domestic source water. Figure 5.5 shows that average TDS levels at Outfall 001 have substantially decreased since the introduction of Lake Michigan water.

TABLE 5.4

Outfall B01 Effluent Priority Pollutant
Monitoring Results, 2005
(concentrations in $\mu\text{g/L}$)

Compound	Concentration in June Sample	Concentration in December Sample
Bromodichloromethane	1	3
Bromoform	<1	2
Chloroform	2	3
Dibromochloromethane	<1	4

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.5

Outfall 001 Monitoring Results and Effluent Limits, 2005
(concentrations in mg/L)

Constituent	Minimum	Average	Maximum	Limit	Exceedances
Chloride	88	200	468	500	0
Copper	<0.015	<0.023	0.0685	0.051	2
TDS	539	748	1,077	1,000	3
Ammonia nitrogen	<0.05	0.26	2.7	10.0 (Nov.–March) 3.0 (April–Oct.)	0
Sulfate	66	108	165	500	0
Manganese	<0.010	<0.014	0.039	1.0	0
Zinc	0.036	0.081	0.187	1.0	0
Mercury ^a	NA ^b	NA	NA	NA	NA

^a Effective September 1, 2005, mercury is sampled 1 per month until 12 samples have been collected; after which IEPA will make a determination on further sampling frequency and discharge limits, if appropriate.

^b NA = not applicable.

The permit requires that a biological toxicity screening test be performed on wastewater from Outfall 001 in June of each year. The toxicity testing is run on two trophic levels of aquatic species for acute toxicity. The 2005 testing was conducted on samples collected June 13 through 17. The water flea (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*) were used.

No toxicity was observed to the fathead minnow or to the water flea. The concentration of wastewater that produces 50% mortality in the test population (i.e., the median lethal concentration [LC₅₀]) for both species is greater than 100%; that is, the pure, undiluted effluent is not toxic to these species. Tables 5.6 and 5.7 summarize the results of the toxicity tests from 2000 to 2005.

The permit also requires that weekly pH, ammonia nitrogen, copper, dissolved iron, manganese, and zinc measurements be made. Monthly monitoring for lead, hexavalent and trivalent chromium, and beta radioactivity is required. Two exceedances of copper were noted in July and August 2005. The source of copper was identified as a metal cleaning operation, and corrective action was taken to prevent further exceedances. In addition to the outfalls at the WTP, a number of other outfalls are monitored. The sampling requirements and effluent limits for these outfalls are described in Table 5.8.

Special Condition No. 9 of the October 30, 1994, NPDES permit requires acute toxicity testing of the effluent from Outfalls H03, I03, J03, 004, 006, and 025. The testing is performed on the fathead minnow and the water flea. The testing is performed during the months of July and August. These outfalls were sampled during the periods of July 25 to 29, and August 22 to 26, 2005. The results are summarized in Tables 5.6 and 5.7. The results are discussed by month below.

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

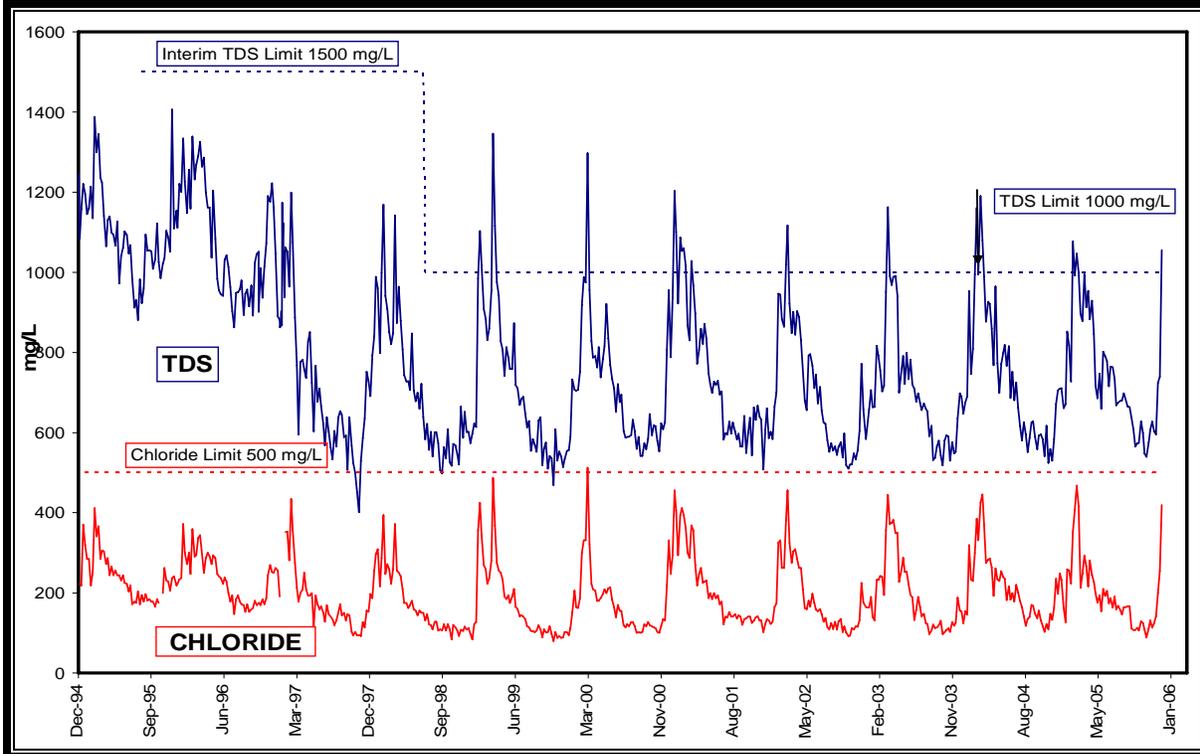


FIGURE 5.4 Total Dissolved Solids and Chloride in Outfall 001 Water, 1995 to 2005

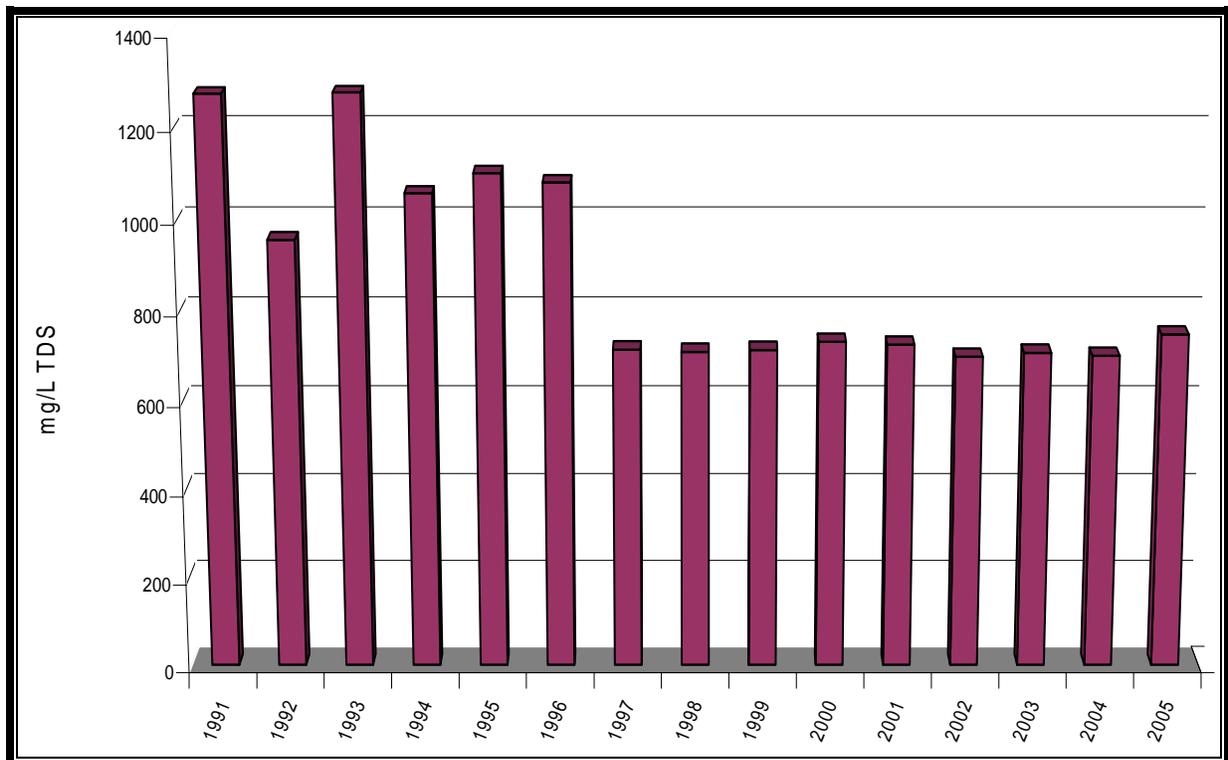


FIGURE 5.5 Average TDS Concentrations at NPDES Outfall 001, 1991 to 2005

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.6
Water Flea, 48-Hour Acute Toxicity Results — LC₅₀, 2000 to 2005

NPDES Outfall	2000 (%)			2001 (%)			2002 (%)			2003 (%)			2004 (%)			2005 (%)		
	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August		
	001	100	NA ^a	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	
003H	100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
003I	>100	>100	71^b	>100	>100	88	>100	82	>100	>100	>100	>100	>100	>100	>100	>100		
003J	>100	< 20	< 20	>100	< 20	< 20	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
004	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
006	>100	30	40	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
115	29	< 20	64	>100	>100	>100	57	>100	>100	>100	34	>100	20	>100	62	47		

^a NA = not applicable.

^b Bold type indicates acute toxicity.

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TABLE 5.7
Fathead Minnow, 96-Hour Acute Toxicity Results — LC₅₀, 2000 to 2005

NPDES Outfall	2000 (%)			2001 (%)			2002 (%)			2003 (%)			2004 (%)			2005 (%)		
	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August	June/ July	August		
	001	>100	NA ^a	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	
003H	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
003I	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
003J	>100	40^b	<20	>100	30	45	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
004	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	88	>100		
006	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		
115	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100		

^a NA = not applicable.

^b Bold type indicates acute toxicity.

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.8

Summary of Monitored NPDES Outfalls, 2005

Discharge Location	No. of Samples	Permit Constituent	Limit		No. Exceeding Limit
			30-Day Average (mg/L)	Daily Maximum (mg/L)	
A03 ^a	0	Flow	None		0
		pH	6-9		0
		TSS	15	30	0
		TRC ^b	0.05		0
B03	12	Flow	None		0
		pH	6-9		0
		Temperature	<1.7°C rise		0
		TSS ^c	Monitor only		NA ^d
C03	12	Flow	None		0
		pH	6-9		0
D03	12	Flow	None		0
		pH	6-9		0
		Temperature	<1.7°C rise		0
		TSS ^c	Monitor only		NA
E03	0	Flow	None		0
		pH	6-9		0
		Temperature	<1.7°C rise		0
		TSS ^c	Monitor only		NA
F03 ^a	6	Flow	None		0
		pH	6-9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
G03	8	Flow	None		0
		pH	6-9		0
		Temperature	<1.7°C rise		0
H03	12	Flow	None		0
		pH	6-9		0
		Temperature	<1.7°C rise		0
		TDS	1,000 ^c		1
		TSS ^c	15	30	1
		TRC ^c	0.011	0.019	1

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TABLE 5.8 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit		No. Exceeding Limit
			30-Day Average (mg/L)	Daily Maximum (mg/L)	
I03 ^a	8	Flow		None	0
		pH		6–9	0
		Temperature		<2.8°C rise	0
		TDS		Monitor only	NA
		Oil and grease		Monitor only	NA
J03	11	Flow		None	0
		pH		6–9	0
		Temperature		<1.7°C rise	0
		TDS		1,000 ^c	1
		TRC ^c	0.011	0.019	0
004	12	Flow		None	0
		pH		6–9	0
		TSS	15	30	1
		TRC ^c	0.011	0.019	0
A05 ^e	0	Flow		None	0
		Iron (total)		Monitor only	NA
		Iron (dissolved)		Monitor only	NA
B05 ^e	0	Flow		None	0
		Iron (total)		Monitor only	NA
		Iron (dissolved)		Monitor only	NA
		Oil and grease		Monitor only	NA
C05	12	Flow		None	0
	12	pH		6–9	0
	12	Temperature		<1.7°C rise	0
	8	Oil and grease ^f		Monitor only	NA
E05	9	Flow		None	0
		pH		6–9	0
		Temperature ^c		<1.7°C rise	0
		TRC ^c	0.011	0.019	0
006	12	Flow		None	0
		pH		6–9	0
		TSS	15	30	0
		TDS		1,000 ^c	NA
		Temperature		<1.7°C rise	0
		TRC ^c	0.011	0.019	0
		Phenols ^c		0.01	0

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.8 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit		No. Exceeding Limit
			30-Day Average (mg/L)	Daily Maximum (mg/L)	
007	12	Flow		None	0
	12	pH		6-9	0
	12	Temperature		<1.7°C rise	0
	26	TRC ^f		0.05	0
	8	Oil and grease ^f		Monitor only	NA
008	5	Flow		None	0
		pH		6-9	0
		VOC(3) ^c		Monitor only	NA
010 ^a	0	Flow		None	0
		pH		6-9	0
		TSS	15	30	0
		Iron (total)	2	4	0
		Iron (dissolved)		1.0	0
		Lead		0.1	0
		Zinc		1.0	0
		Manganese		1.0	0
		Hexavalent chromium	0.011	0.016	0
		Trivalent chromium	0.519	2.0	0
		Copper	0.031	0.051	0
		Oil and grease	15	30	0
		108 ^a	8	Flow	
pH				6-9	0
Temperature				<2.8°C rise	0
020 ^e	0	Flow		None	NA
		COD		Monitor Only	0
021	1	Flow		None	0
		Hydrogen-3		Monitor only	NA
		Iron ^c		Monitor only	NA
		Priority pollutants ^c		Monitor only	NA
A22	1	Flow		None	0
		Hydrogen-3		Monitor only	NA
B22	1	Flow		None	0
		Hydrogen-3		Monitor only	NA

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.8 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit		No. Exceeding Limit
			30-Day Average (mg/L)	Daily Maximum (mg/L)	
023	3	Flow		None	0
		Hydrogen-3		Monitor only	NA
		PCB-1260 ^f		Monitor only	NA
		Lead, ^f copper, nickel, ^f zinc ^f		Monitor only	NA
114 ^a	3	Flow		None	0
		Hydrogen-3		Monitor only	NA
		PCB-1260		Monitor only	NA
		Lead, copper, nickel, zinc		Monitor only	NA
025	12	Flow		None	0
		pH		6–9	0
		Temperature		<1.7°C rise	0
		TDS		1,000 ^c	0
		TRC ^c	0.011	0.019	5
116 ^a	8	Flow		None	0
		pH		6–9	0
		TRC		0.05	0

^a Monitoring of outfall deleted from final NPDES permit, effective September 1, 2005.

^b TRC = total residual chlorine.

^c Parameter and/or limit added by final NPDES permit, effective September 1, 2005.

^d NA = not applicable.

^e Monitoring of outfall added by final NPDES permit, effective September 1, 2005.

^f Monitoring of parameters deleted from final NPDES permit, effective September 1, 2005.

July 2005 — Effluents from Outfalls H03, I03, J03, and 006 exhibited no acute toxicity. Outfall 004 was acutely toxic to fathead minnows with a LC₅₀ value of 88%, but not toxic toward the water flea. Outfall 025 was acutely toxic toward the water flea with an LC₅₀ value of 62%. The toxicity levels at Outfall 025 toward the water flea were similar to those observed in July 2002 and July 2004. The toxicant at Outfalls 004 and 025 was unidentified.

August 2005 — Effluents from Outfalls H03, I03, J03, 004, and 006 were not acutely toxic toward the water flea and fathead minnows. Effluent from Outfall 025 was acutely toxic

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

toward the water flea with an LC₅₀ value of 47%, but not toward fathead minnows. The toxicant at Outfall 025 was identified as potable water.

5.2. Additional Effluent Monitoring

To characterize the wastewater from the Argonne site more fully, composite samples of the combined effluent from the WTP were collected each week and analyzed for the constituents shown in Table 5.9. The results were then compared with IEPA General Effluent Limits found in 35 IAC, Subtitle C, Part 304.²¹

5.2.1. Sample Collection

Samples for analysis of inorganic constituents were collected daily from Outfall 001 located at the WTP by using a refrigerated time-proportional sampler. A portion of the sample was transferred to a clean bottle, a security seal was affixed, and chain of custody was maintained. Five daily samples were composited on an equal-volume basis to produce a weekly sample that was then analyzed. Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed using cold vapor atomic absorption spectroscopy, and fluoride was determined by a specific-ion electrode.

5.2.2. Results

Table 5.9 gives the results for 2005. None of the annual average results exceeded General Effluent Limits.²¹

5.3. Sawmill Creek

Sawmill Creek is a small natural stream that is fed primarily by storm water runoff. During periods of low precipitation, the creek above Argonne has a very low flow. At these times, a major portion of the water in Sawmill Creek south of the site consists of Argonne wastewater and discharges to assorted storm drains. To determine the impact Argonne wastewaters have on Sawmill Creek, samples of the creek downstream of all Argonne discharge points were collected and analyzed. The results were then compared with IEPA General Use Water Quality Standards found in 35 IAC, Subtitle C, Part 302.²²

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

TABLE 5.9

Chemical Constituents in Effluents from the Argonne
Wastewater Treatment Plant, 2005

Constituent	No. of Samples	Concentration (mg/L)			
		Average	Minimum	Maximum	Limit
Arsenic	52	<0.003	<0.003	0.0037	0.25
Barium	52	0.021	0.015	0.032	2.0
Beryllium	52			<0.0002 ^a	– ^b
Cadmium	52	<0.0002	<0.0002	0.0005	0.15
Chromium	52			<0.043	1.0
Cobalt	52			<0.017	–
Copper	52	0.017	<0.015	0.021	0.5
Fluoride	52	1.16	0.68	1.42	15.0
Iron	52	0.029	<0.021	0.074	2.0
Lead	52			<0.002	0.2
Manganese	52	0.012	<0.010	0.046	1.0
Mercury	52			<0.0002	0.0005
Nickel	52			<0.035	1.0
Silver	52			<0.001	0.1
Thallium	52			<0.002	–
Vanadium	52			<0.053	–
Zinc	52	0.080	0.043	0.172	1.0
pH	52	NA ^c	6.69	7.70	6.0–9.0

^a If all values were less than the detection limit for a constituent, only the detection limit value is given.

^b A dash indicates that there is no effluent limit for this constituent.

^c NA = not applicable.

5.3.1. Sample Collection

A time-proportional sampler was used to collect a daily sample at a point well downstream of the combined wastewater discharge point where thorough mixing of the Argonne effluent and Sawmill Creek water is assured. Samples were collected in precleaned, labeled bottles and security seals were used. After pH measurement, the daily samples were acidified and then combined into equal-volume weekly composites and analyzed for the same set of inorganic constituents as those in Table 5.10.

Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed with cold vapor atomic absorption spectroscopy. Fluoride was determined by a specific-ion electrode.

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5.3.2. Results

The results obtained for 2005 are shown in Table 5.10. None of the annual average results exceeded General Use Water Quality Standards.²²

TABLE 5.10

Chemical Constituents in Sawmill Creek, Location 7M,^a 2005

Constituent	No. of Samples	Concentrations (mg/L)			
		Average	Minimum	Maximum	Limit
Arsenic	52	<0.003	<0.003	0.005	0.36 ^b
Barium	52	0.026	0.016	0.051	5.0
Beryllium	52			<0.0002 ^c	— ^d
Cadmium	52	<0.0002	<0.0002	0.0004	0.03
Chromium	52			<0.043	3.6
Cobalt	52			<0.017	—
Copper	52			<0.021	0.041 ^b
Fluoride	52	0.985	0.424	1.41	1.4
Iron	52	0.038	<0.021	0.094	1.0
Lead	52			<0.002	0.3 ^b
Manganese	52	0.014	<0.010	0.033	1.0
Mercury	52	<0.0002	<0.0002	0.0002	0.0026 ^b
Nickel	52			<0.035	1.0
Silver	52			<0.001	0.005
Thallium	52			<0.002	—
Vanadium	52			<0.053	—
Zinc	52	0.059	0.017	0.150	1.0
pH	52	NA ^e	6.28	7.77	6.5–9.0

^a Location 7M is 15 m (50 ft) downstream from the Argonne wastewater outfall.

^b The acute standard for the chemical constituent is listed.

^c If all values were less than the detection limit for a constituent, only the detection limit is given.

^d A dash indicates that there is no effluent limit for this constituent.

^e NA = not applicable.

6. GROUNDWATER PROTECTION



6. GROUNDWATER PROTECTION

6. GROUNDWATER PROTECTION

The groundwater below the Argonne site is monitored through the collection and analysis of samples obtained from the former on-site water supply wells, from a series of groundwater monitoring wells located near several sites that have the potential for affecting groundwater, and from other monitoring wells on and off the Argonne site. Regulations establishing comprehensive WQSs for the protection of groundwater have been enacted: IEPA Groundwater Quality Standards, 35 IAC, Subtitle F, Part 620.²³ In addition, demonstration of compliance with the groundwater protection requirements in DOE Order 450.1,¹ as related to sitewide characterization studies and monitoring well requirements, is presented in this chapter. The permit for the 800 Area Landfill requires a groundwater monitoring program. The program was initiated in July 1992. Information generated by this program is also included in this report.

6.1. Former Potable Water System

Domestic water for Argonne was supplied by four wells (see Section 1.7 and Table 6.1) until early 1997, when Lake Michigan water was obtained. The well locations are shown in Figure 1.1. Lake Michigan water was obtained to provide better-quality drinking water. The dolomite water from the on-site wells had deteriorated in quality. The TDS content of the supply water was approaching 800 mg/L, which made it difficult to consistently meet the 1,000-mg/L TDS discharge limit at NPDES Outfall 001. Lake Michigan water has a TDS range of approximately 200 to 400 mg/L. In addition, Lake Michigan water is lower in bicarbonate, which makes it less corrosive on the piping system. The former potable wells, however, are maintained as a backup in the case of a loss of Lake Michigan water.

6.1.1. Informational Monitoring

Samples were collected quarterly at the wellhead, except at Well 2, which is no longer operational. The samples were analyzed to determine the presence of several types of radioactive constituents and VOCs in Argonne groundwater. Samples from each well were tested for total alpha, total beta, hydrogen-3, and strontium-90. Samples also were analyzed annually for isotopic uranium. Alpha and beta radioactivity were determined by using a gas-flow-proportional counting technique. Hydrogen-3 was determined by means of distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by means of ion-exchange separations followed by proportional counting. Uranium was analyzed by using ion-exchange separations followed by alpha spectrometry. The results are presented in Table 6.2.

VOC samples were collected quarterly, analyzed for SDWA volatile compounds, and quantified by EPA Method 524.2,²⁴ which includes purge-and-trap pretreatment, followed by gas chromatography-mass spectroscopy detection. The reporting limit is the practical quantification limit (PQL), which is defined as 10 times the method detection limit.

All radiological results were within their normal range of concentrations as compared with previous results. No VOCs were detected.

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TABLE 6.1

Argonne Former Water Supply Wells

Well No.	Location	Well Elevation (m AMSL) ^a	Bedrock Elevation (m AMSL)	Well Depth (m bgs) ^b	Inner Diameter (m)	Year Drilled
1	Building 31	204.5	184.4	86.6	0.30	1948
2 ^c	Building 32	202.4	183.2	91.4	0.30	1948
3	Building 163	210.0	182.9	96.9	0.30	1955
4	Building 264	218.2	181.4	103.6	0.36	1959

^a AMSL = above mean sea level.

^b bgs = below ground surface.

^c Well not operational.

6.1.2. Dolomite Well Monitoring

Past analytical data were used to track the presence of hydrogen-3 in Argonne domestic Well 1 and at a lower concentration in Well 2. It is speculated that the source of the hydrogen-3 was liquid waste placed in an unlined holding pond in the wastewater treatment area (Location 10M in Figure 1.1) in the 1950s. The hydrogen-3 as tritiated water appeared to have migrated through the glacial drift to the dolomite aquifer and was drawn into the wells. Well 1, which is about 200 m (650 ft) north of the wastewater treatment area, had higher hydrogen-3 concentrations than Well 2, which is about 300 m (1,000 ft) from the treatment area. Hydrogen-3 is only occasionally identified at concentrations just above the detection limit because of dilution and radioactive decay. Although the normal subsurface water flow gradient is toward the south-southeast, the cone of depression created by pumping these wells while they were still in use would overpower the normal flow pattern.

With the conversion of local well water to Lake Michigan water in early 1997, the water table elevations began to recover. Argonne was concerned that the direction of subsurface migration of radionuclides, particularly hydrogen-3, could change because of the lack of the influence of pumping. Because hydrogen-3 from the 570 Area Pond was already known to have migrated to the dolomite, a monitoring network of three Argonne and seven forest preserve wells was established to monitor the magnitude and direction of hydrogen-3 movement in this area. The well locations are shown in Figure 6.1. Samples were collected quarterly and analyzed for hydrogen-3. Table 6.3 shows the results for 2005. Hydrogen-3 was noted at very low levels in a few wells.

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TABLE 6.2

Radioactivity in Argonne Former Water Supply Wells, 2005
(concentrations in pCi/L)

Type of Activity	Location	No. of Samples	Average	Minimum	Maximum
Alpha	Well 1	4	2.7	2.1	3.6
	Well 3	4	1.9	1.6	2.1
	Well 4	4	3.9	2.9	5.5
Beta	Well 1	4	7.0	6.4	7.6
	Well 3	4	9.3	8.7	9.9
	Well 4	4	10.7	9.9	11.6
Hydrogen-3	Well 1	4	— ^a	—	<100
	Well 3	4	—	—	<100
	Well 4	4	—	—	<100
Strontium-90	Well 1	4	—	—	<0.25
	Well 3	4	—	—	<0.25
	Well 4	4	—	—	<0.25
Uranium-234	Well 1	1	—	—	0.48
	Well 3	1	—	—	0.20
	Well 4	1	—	—	0.18
Uranium-235	Well 1	1	—	—	0.02
	Well 3	1	—	—	<0.01
	Well 4	1	—	—	<0.01
Uranium-238	Well 1	1	—	—	0.32
	Well 3	1	—	—	0.13
	Well 4	1	—	—	0.08

^a A dash indicates that for a single result, the value is placed in the maximum column.

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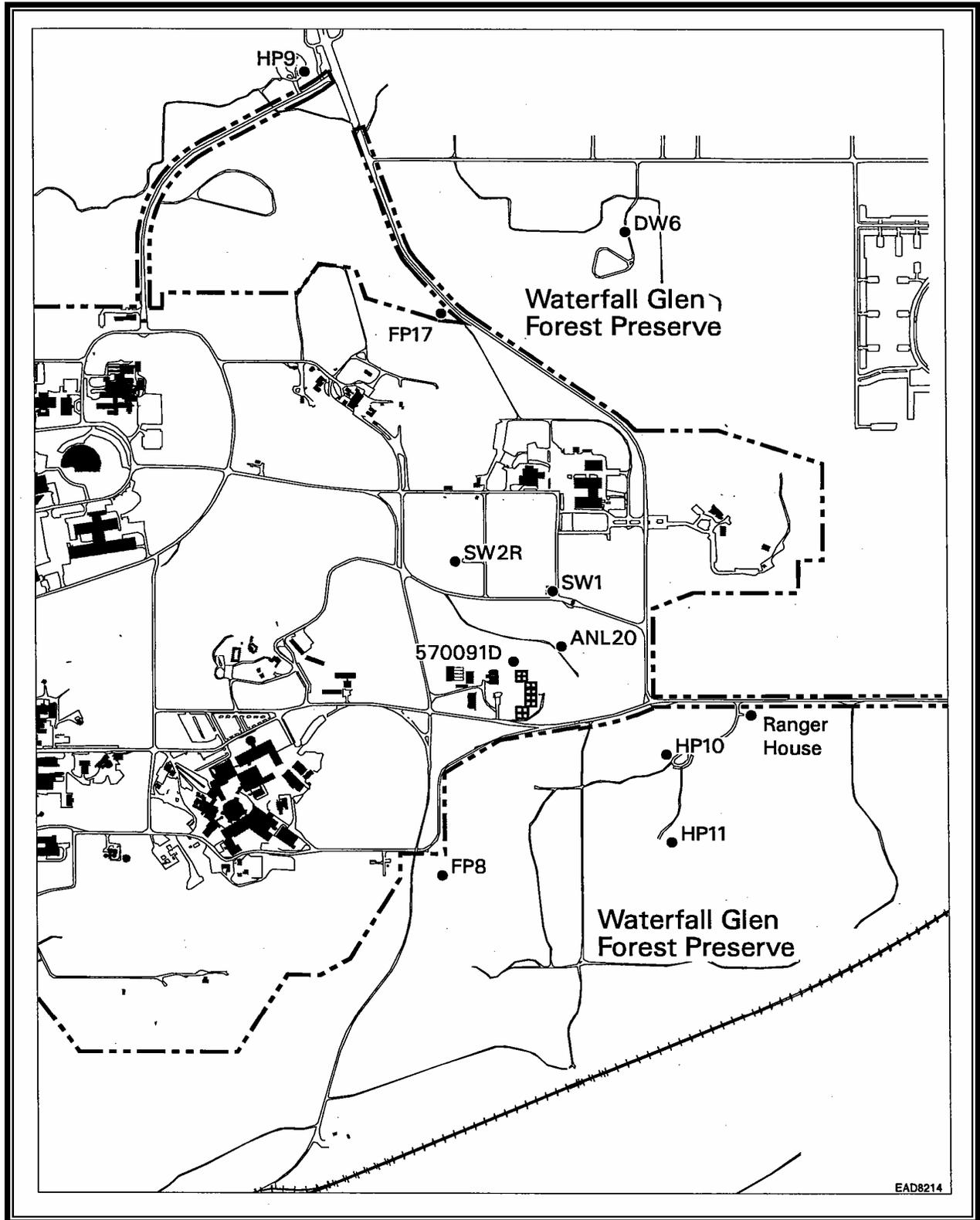


FIGURE 6.1 East Area/Forest Preserve Monitoring Wells

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TABLE 6.3

Hydrogen-3 in Dolomite Wells, 2005
(concentrations in pCi/L)

Well	Date Collected			
	Feb. 16	May 3	Aug. 10	Dec. 9
Waterfall Glen				
DW 6	138	<100	<100	<100
HP 9	104	<100	<100	<100
HP 10	123	<100	<100	<100
HP 11	<100	<100	<100	<100
FP 8	<100	<100	<100	<100
FP 17	104	<100	<100	<100
Ranger house	<100	<100	102	<100
Argonne				
5700910	217	<100	115	<100
ANL-20	<100	<100	128	<100
SW2R	<100	<100	<100	<100
Trip blank	<100	<100	<100	<100

6.2. Groundwater Monitoring at 317/319/ENE Landfill Areas

Argonne has occupied its current site since 1948. Since that time, waste generated by Argonne was placed in a number of on-site disposal units. These ranged from ditches filled with construction and demolition debris during the 1950s to a former sanitary landfill used for nonhazardous solid waste disposal until September 1992. Several of these units contain significant amounts of hazardous materials and, therefore, represent a potential threat to the environment. Groundwater below these sites is monitored routinely to assess the amount and nature of hazardous chemical releases from these units. Routinely monitored sites include the sanitary landfill in the 800 Area and the 317/319 ENE Area, which consists of seven separate SWMUs located within a small geographical area. The site of the CP-5 reactor is also monitored to determine whether any radionuclides are being released from this unit. To aid the reader, results presented in the well tables that exceed State of Illinois' Class I Groundwater Quality Standards are in bold type.

Argonne achieved compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites as of September 30, 2003. However, five SWMUs and two AOCs could not be remediated to free release status and continue to be monitored as part of the LTS Program (refer to Chapter 3). LTS areas that continue to be routinely monitored for groundwater releases include the 317 and 319 Areas (Sections 6.2.3 and 6.2.4), ENE Landfill Area (Section 6.2.5), off-site seeps (Section 6.2.6) and GMZ Area (Section 6.2.7). During 2004, data from the LTS Program were

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integrated with those from the Argonne Sitewide Environmental Groundwater Monitoring and Surveillance Program.

6.2.1. 317/319 Area

The 317/319 Area contains seven separate current or former units that have been used in the past for handling or disposal of various types of waste. The 317 Area is currently an active radioactive waste processing and storage area. It includes the North Vault, an in-ground storage vault that was emptied in May 2001 and has remained empty since. In the past, the 317 Area was used for disposal of various liquid chemical wastes in a unit known as a French drain. The drain consisted of a shallow trench filled with gravel into which an unknown quantity of liquid wastes was poured. This unit operated during the late 1950s. Because of these past disposal practices, there is a region of contaminated soil in the north half of the 317 Area. The contaminants are primarily VOCs such as cleaning solvents. The groundwater below this area also contains concentrations of these chemicals. General features in the 317/319 Area are identified in Figure 6.2.

The groundwater below the 317/319 Area exists in several shallow sand and gravel units up to 6 m (20 ft) thick within the glacial drift, as well as in the upper portions of the dolomite bedrock. There are no known consumers of this groundwater downgradient of the Argonne site.

The 319 Area contains an inactive landfill that was used for disposal of a variety of solid wastes generated on-site prior to 1969. It was not intended for disposal of radioactive waste; however, a small amount of radioactive material was detected during sampling activities completed several years ago. The only radionuclide found to be migrating from the landfill is hydrogen-3, although strontium-90 was noted during one quarter in a well south of the 319 Area. The 319 waste burial area consists of two distinct segments: the waste mound, where the bulk of the waste was buried, and an adjacent burial trench, which contains a much smaller amount of mostly inert waste. This landfill also contains a French drain that was used for several years after the French drain in the 317 Area was closed. The presence of liquid chemical wastes from the French drain, as well as the presence of hydrogen-3 in the waste mound, have resulted in the generation of a plume of contaminated groundwater extending from the waste mound to the south about 200 m (600 ft).

During late 1996, a series of small natural groundwater discharge points (groundwater seeps) was discovered approximately 183 m (600 ft) south of the 319 Area. Two of these seeps were found to contain low levels of three VOCs. These two seeps and one additional seep, which normally does not contain VOCs, were found to contain hydrogen-3 at concentrations below all applicable standards. Since their discovery, these seeps have been monitored on a regular basis (see Section 6.2.6). A characterization study was completed in 1998 to identify the source and migration pathways for the hydrogen-3 and VOCs. The hydrogen-3 appears to be emanating from the 319 Landfill and is likely an extension of the on-site hydrogen-3 plume, albeit at much lower concentrations than those measured on-site. The source of VOCs was not clearly discerned, although it is likely that they also emanated from some past waste disposal activities in the 319 or

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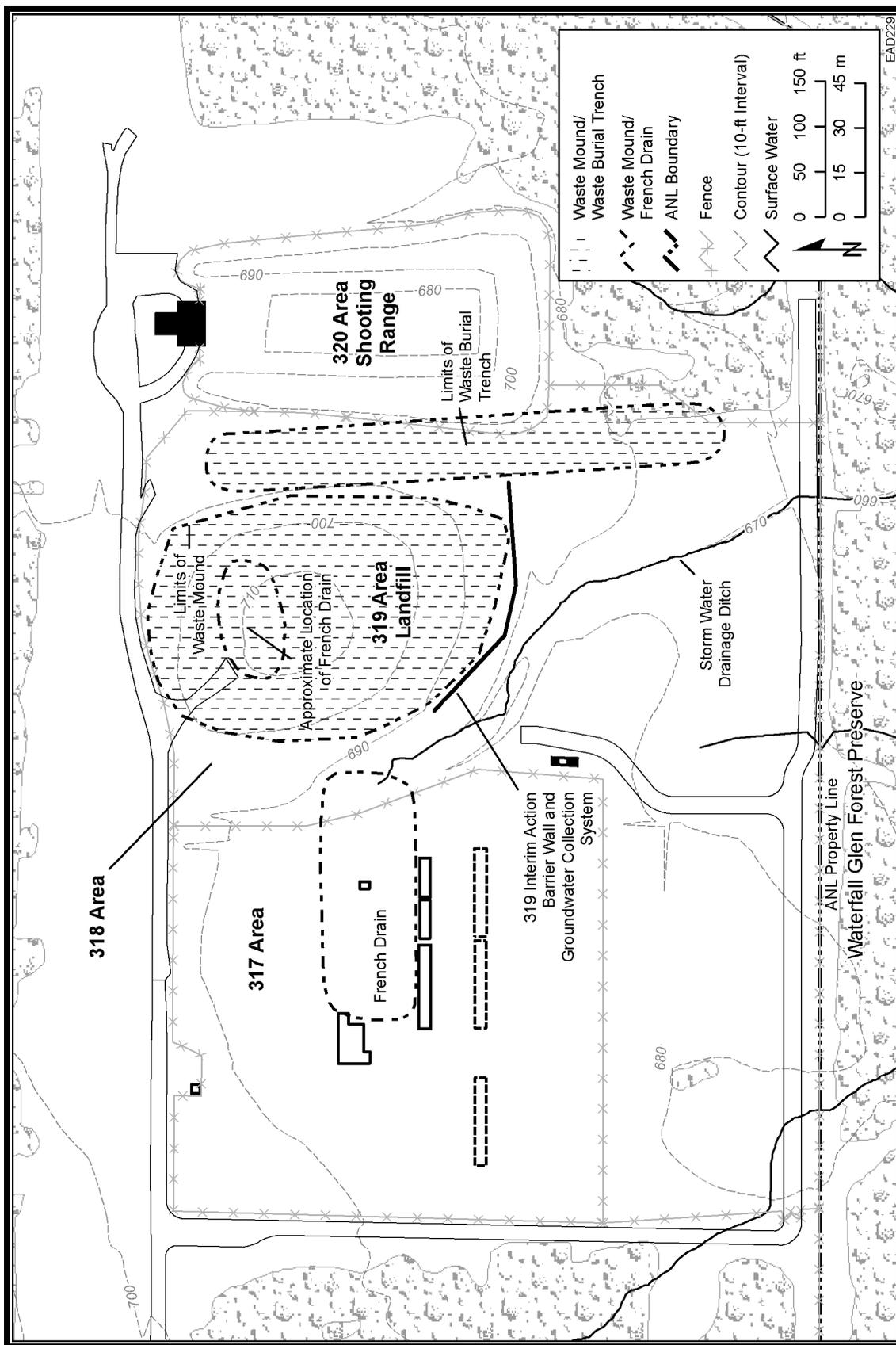


FIGURE 6.2 Locations of Components within the 317/319/ENE Area

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317 Area. The known extent of contaminated groundwater covers much of the area from the 317 French Drain and 319 Landfill, southeast of the seeps.

Cleanup of the 317/ 319 Area has been under way since the late 1980s. The cleanup has been carried out as a series of interrelated actions that ultimately removed or contained the contaminants so that they will no longer migrate away from the waste disposal units. Several remedial actions are already in place and functioning as designed. These actions include a leachate and groundwater collection system for the 319 Landfill, capping of the 319 Landfill, demolition of five waste storage vaults contaminated with radioactive materials, sealing of an underground drainage system, installation of 15 groundwater extraction wells south of the 317 Area, construction of a concrete cover over a region containing buried compressed gas cylinders containing residual gases (318 Area), treatment of highly contaminated soil near the former French drain, and phytoremediation of residual soil and groundwater contamination. Sampling and analysis of groundwater and surface water are ongoing as part of the LTS Program and routine environmental monitoring program.

The North Vault was repaired because Argonne has decided to continue storing waste in the vault. Part of the north wall of the vault was rebuilt, and new roof covers were fabricated.

In 1999, the IEPA approved the installation of a phytoremediation system in the 317 Area. Phytoremediation involves the use of trees to remove contaminated groundwater by evapotranspiration and to degrade contaminants in soil and groundwater. A dense planting of willow trees in the vicinity of the 317 French Drain and a larger planting of hybrid poplar trees downgradient of the 317 French Drain and the former 319 Landfill are in place and will be monitored over the next several years for their ability to remediate those areas.

The results of the required routine monitoring of the groundwater collection systems in the 317 and 319 Areas, the phytoremediation system, and the monitoring of the off-site groundwater seeps continue to be transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports. The data from this monitoring are too voluminous to include in this report; however, the general conclusions are discussed below as part of the Argonne LTS Program (see Sections 6.2.3 through 6.2.7).

6.2.2. Groundwater Monitoring at the 317/319 Area

Groundwater monitoring in the 317/319 Area as part of the sitewide monitoring and surveillance program has been conducted since 1986. Wells 319011, 317021, and 319031 were installed in September 1986; Well 317061 was originally installed in August 1987 but replaced in May 2000; Wells 317101 and 317111 were installed in September 1988; and Wells 319032 and 317052 were installed in June 1989 (Figure 6.3). These wells were all completed in the glacial drift. Wells 317121D and 319131D were installed in November 1989 and reach the dolomite aquifer at about 20 m (64 ft) below the surface.

Wells 317101 and 317111 are upgradient of the 317 Area, and Well 319011 is upgradient of the 319 Area Landfill. A sand lens present at 5 to 8 m (15 to 25 ft) is monitored at

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Wells 317052, 319031, 319032, and 317021. Groundwater in the dolomite bedrock aquifer is monitored at Wells 317121D and 319131D. Table 6.4 lists well data for these areas. These wells are not used to monitor the progress of the remediation systems, but rather serve the 317 and 319 Areas as a whole. In addition to wells in this area, two manholes associated with the vault sewer system were monitored on a monthly basis. Figure 6.3 shows the locations of the manholes.

The LTS Program involves the collection of groundwater data from an extensive network of wells located throughout the 317/319 Area. These data are transmitted to the IEPA quarterly and are summarized in Sections 6.2.3 through 6.2.7. To monitor the performance of the various remedial actions constructed in the 317 and 319 Areas, samples are collected on a quarterly basis. The purpose of this monitoring is to track the movement of contaminated groundwater and to determine the rate at which contaminant levels are decreasing. Monitoring results in 2005 indicate that the two groundwater collection systems south of the 319 Landfill and the 317 Area are effectively preventing off-site migration of contaminated groundwater. The analysis of groundwater samples for contaminants reveals that high concentrations of VOCs are present in groundwater in the immediate vicinity of the former 317 Area French Drain. Concentrations of up to 415,000 µg/L of chlorinated VOCs (i.e., carbon tetrachloride) were detected. However, at the Argonne fence line, near the groundwater collection wells, the level of contamination is much lower; the highest concentration noted in 2005 was 314 µg/L of 1,1,1-trichloroethane (TCA). This groundwater is being collected by the extraction system so that it does not migrate off-site.

Plant tissue monitoring at the phytoremediation system site indicates that the trees are indeed taking up the organic materials and breaking them down. The effect of the trees on groundwater movement was also measured; however, the trees are not full grown, so their effect was not great enough to be easily measured. Long-term monitoring of this system will determine its effectiveness at removing groundwater and degrading contaminants.

6.2.2.1. Sample Collection

The monitoring wells are sampled by using the protocol listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.²⁵ The volume of water in the casing is determined by measuring the water depth from the surface and the depth to the bottom of the well. The latter measurement also determines whether siltation has occurred, which might restrict water movement in the screened area. For those wells in the glacial drift that do not recharge rapidly, the well is emptied, and the volume of water removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled, following recovery, by bailing with a dedicated Teflon[®] bailer. The field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured statically. For those wells in the porous, saturated zone that recharges rapidly, three well volumes are purged by using dedicated submersible pumps, while the field parameters are measured continuously. Field parameters stabilize quickly in these wells. In the case of the dolomite wells, samples are collected as soon as these readings stabilize. Samples for VOCs, SVOCs, PCBs and pesticides, metals, nonmetals, and radionuclide analysis are collected in that order. The samples are placed in precleaned bottles, labeled, and preserved.

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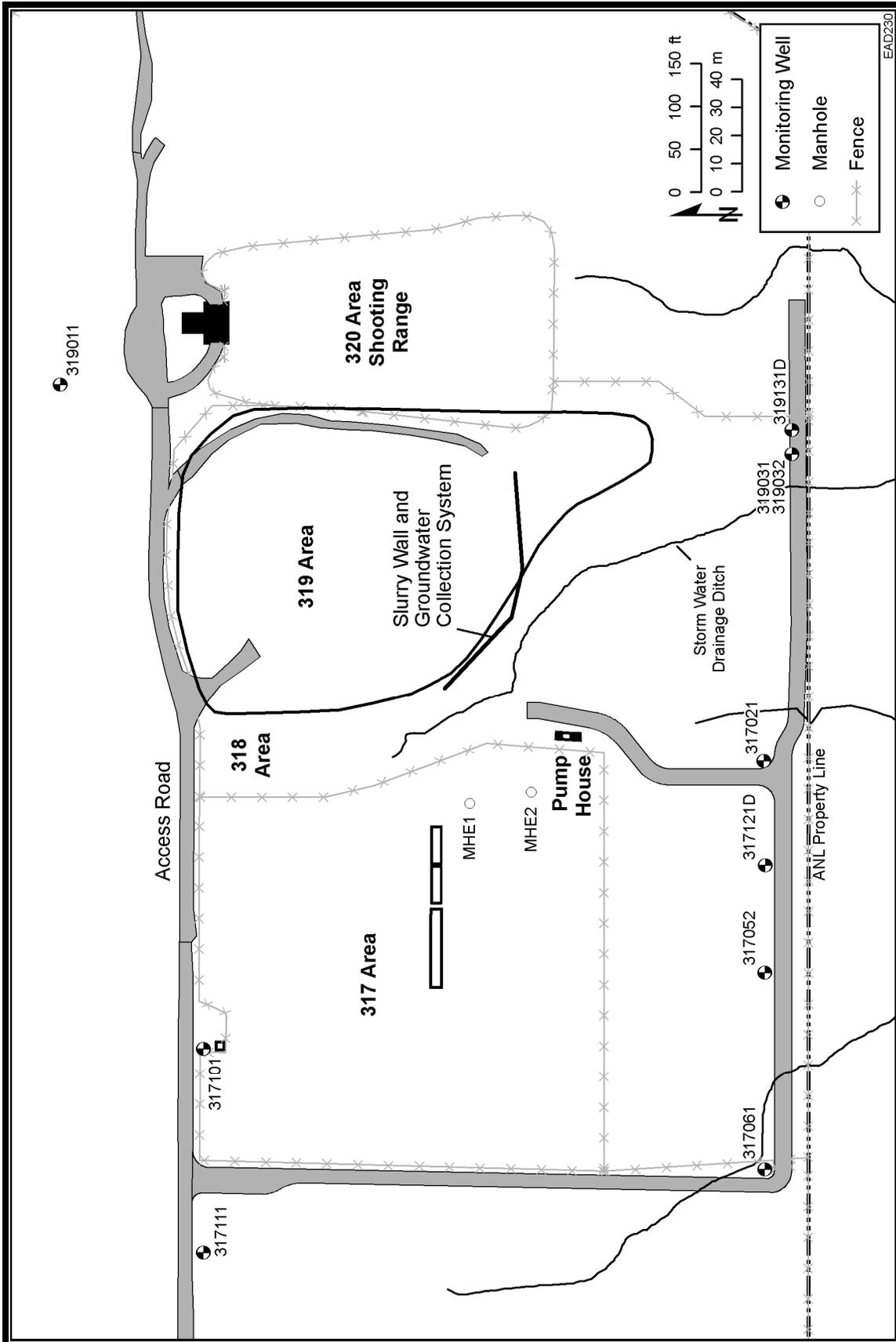


FIGURE 6.3 Monitoring and Characterization Wells in the 317/319 Area, 2005

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TABLE 6.4

Groundwater Monitoring Wells: 317/319 Area

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^a	Date Drilled
319011	12.19	209.8	199.1–197.6	0.05/PVC	9/86
317021	12.19	209.2	198.5–197.0	0.05/PVC	9/86
319031	12.50	204.3	194.8–191.8	0.05/PVC	9/86
319032	7.62	204.3	198.2–196.7	0.05/PVC	6/89
317052	4.27	208.3	207.1–204.0	0.05/PVC	6/89
317061 ^b	10.36	207.6	197.3–199.7	0.05/PVC	5/00
317101	11.89	211.0	202.2–199.1	0.05/PVC	9/88
317111	11.89	210.3	201.4–198.4	0.05/PVC	9/88
317121D ^c	24.08	207.6	185.0–183.5	0.15/CS	11/89
319131D	21.03	203.5	184.0–182.5	0.15/CS	11/89

^a Inner diameter (m)/well material (PVC = polyvinyl chloride; CS = carbon steel).

^b Well was replaced when original well was damaged and became inoperable.

^c Wells identified by a “D” are deeper wells monitoring the dolomite bedrock aquifer.

During each sampling event, one well is selected for replicate sampling. An effort is made to vary this selection so that replicates are obtained at every well over time. In addition, a field blank is also prepared.

6.2.2.2. Sample Analyses — 317/319 Area

Groundwater chemical analyses in the 317/319 Area were performed using SOPs that were written, reviewed, and issued as controlled documents by members of EQO, Analytical Services (EQO-AS). These SOPs reference protocols in EPA-SW-846.²⁶ Fifteen metals were routinely measured using inductively coupled plasma atomic emission spectrometry and graphite furnace atomic absorption spectroscopy. Mercury was determined by using cold vapor atomic absorption spectroscopy. Chloride was determined by means of UV/Vis spectrometry. VOCs were determined by using a purge-and-trap sample pretreatment followed by gas chromatography-mass spectrometry detection. SVOCs were determined by means of solvent extraction followed by gas chromatography-mass spectrometry detection. PCBs and pesticides were determined by using solvent extraction followed by gas chromatography-electron capture detection.

Groundwater radiological analyses for the 317/319 Area were performed by using SOPs that were written, reviewed, and issued as controlled documents by members of EQO-AS. Cesium-137 was determined by using gamma-ray spectrometry. Hydrogen-3 was determined by using distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by means of ion-exchange separation followed by a proportional counting technique.

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6.2.2.3. Results of Analyses

Descriptions of each well, the field parameters measured during sample collection, and the results of chemical and radiological analyses of samples from the wells in the 317/319 Area are contained in Tables 6.5 through 6.14. All radiological and inorganic analytical results are provided in these tables. The analytical methods used for organic compounds could identify and quantify all compounds contained in the Contract Laboratory Program (CLP) Target Compound List. However, the vast majority of these compounds were not detected in the samples. To simplify the format of these tables, those results less than the detection limit are not included. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 5 µg/L.

Field Parameters. The purging of wells to produce water representative of the groundwater being studied was followed by measuring the field parameters. For the wells reported in this study, temperature, pH, redox potential, and specific conductance remained fairly constant after two well volumes were removed. On the basis of this information, sampling was conducted after the removal of three well volumes. The field parameters listed in the tables are the final readings obtained at the time of sampling. Wells 319011, 317021, 317061, 317111, 319031, and 319131D usually dry up after one well volume is removed. Therefore, field parameters were measured on one well volume. Wells 317021, 317052, and 319032 were dry during sampling for one quarter. As in past years, conductivity was elevated in Wells 317101 and 317111. This is probably related to the fact that chloride levels in these two wells are elevated. Both wells are located near a road that is salted during the winter.

Inorganic Parameters. Argonne chose a conservative approach for evaluating the monitoring results by selecting as the standard of comparison the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 31 IAC, Section 620.410. The standards are presented in Tables 6.15 and 6.16. The groundwater that is mentioned is not used as a source of domestic water supply. In 2005, all samples for metals analyses were field-filtered prior to preservation with acid (a requirement for the IEPA-approved groundwater monitoring program at the 800 Area Landfill, Section 6.3.2.3).

As noted in previous years, no elevated levels, with respect to the WQS for inorganics, were noted with the exception of pH during the first three quarters at dolomite Well 317121D and chloride at Wells 317101 and 317111. Historically, elevated pH values at Well 317121D have been reported. Chloride levels in these wells ranged from 181 to 610 mg/L and may be due to road salt usage near the wells. Barium was noted each quarter at very low levels in each of the wells. Barium levels ranged from 0.03 to 0.11 mg/L. Elevated manganese was noted in Wells 317052, 317061, 317101, 317111, and 319011. Low levels of zinc were noted at least one quarter in all wells. Zinc levels ranged from less than 0.008 to 0.15 mg/L. Similar to past years, arsenic was noted three quarters in Well 317061 at levels ranging from 0.009 to 0.014 mg/L.

Organic Parameters. Low VOC levels were noted in Wells 317021, 317061, 317101, 317121D, 319031, and 319032. Well 317021 continues to show persistent but very low levels of TCA and 1,1-dichloroethane (DCA). Low levels of TCA were also noted in Wells 317061,

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TABLE 6.5

Groundwater Monitoring Results, 300 Area Well 317021, 2005

Parameter	Unit	Date of Sampling		
		Mar. 14	May 18	Aug. 31
Water elevation ^a	m	201.18	202.80	199.67
Temperature	°C	10.5	11.7	12.7
pH	pH	7.68	7.24	7.40
Redox	mV	-25	-11	-39
Conductivity	µmhos/cm	718	696	752
Chloride ^b	mg/L	13	24	43
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.042	0.040	0.040
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.079	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.042	0.042
Cesium-137	pCi/L	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	146
Strontium-90	pCi/L	<0.25	<0.25	<0.25
1,1,1-Trichloroethane	µg/L	3	4	3
1,1-Dichloroethane	µg/L	<1	1	2

^a Well point elevation = 197.44 m (AMSL); ground surface elevation = 209.16 m (AMSL); casing material = PVC.

^b Filtered sample.

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TABLE 6.6

Groundwater Monitoring Results, 300 Area Well 317052, 2005

Parameter	Unit	Date of Sampling		
		Mar. 14	May 18	Aug. 30
Water elevation ^a	m	206.30	205.51	204.51
Temperature	°C	7.5	10.6	15.9
pH	pH	7.19	7.13	7.02
Redox	mV	-1	-3	-10
Conductivity	µmhos/cm	758	784	934
Chloride ^b	mg/L	35	30	33
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.045	0.041	0.078
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	0.081	0.141
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.039	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.045	0.048
Cesium-137	pCi/L	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	152
Strontium-90	pCi/L	<0.25	<0.25	<0.25

^a Well point elevation = 204.53 m (AMSL); ground surface elevation = 208.18 m (AMSL); casing material = PVC.

^b Filtered sample.

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TABLE 6.7

Groundwater Monitoring Results, 300 Area Well 317061, 2005

Parameter	Unit	Date of Sampling			
		Mar. 14	May 24	Aug. 30	Dec. 12
Water elevation ^a	m	199.68	200.07	198.28	198.14
Temperature	°C	9.7	12.3	12.5	9.5
pH	pH	7.12	7.64	7.14	7.46
Redox	mV	1	-36	-21	-16
Conductivity	µmhos/cm	821	893	823	1,120
Chloride ^b	mg/L	44	57	20	64
Arsenic ^b	mg/L	0.014	0.009	0.013	<0.003
Barium ^b	mg/L	0.062	0.061	0.059	0.088
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	0.053	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.017	0.015	0.014	0.065
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.0675	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.040	0.039	<0.008
Cesium-137	pCi/L	<2.0	2.0	<2.0	<2.0
Hydrogen-3	pCi/L	115	<100	<100	270
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25
1,1,1-Trichloroethane	µg/L	<1	<1	46	<1
1,1-Dichloroethane	µg/L	<1	<1	6	<1
1,1-Dichloroethene	µg/L	<1	<1	2	<1
Trichloroethene	µg/L	<1	<1	12	<1

^a Well point elevation = 197.68 m (AMSL); ground surface elevation = 207.57 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.8

Groundwater Monitoring Results, 300 Area Well 317101, 2005

Parameter	Unit	Date of Sampling			
		Mar. 9	May 24	Aug. 30	Dec. 12
Water elevation ^a	m	204.04	204.29	202.62	201.85
Temperature	°C	10.2	14.5	12.9	11.3
pH	pH	7.21	6.32	7.07	7.41
Redox	mV	2	33	-16	-6
Conductivity	µmhos/cm	2,310	2,310	1,488	1,541
Chloride ^b	mg/L	610	561	315	270
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.113	0.096	0.067	0.061
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.039	<0.010	0.022	0.027
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.042	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.060	0.051	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	<100	<100
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25
n-Hexane	µg/L	<1	<1	2	<1

^a Well point elevation = 198.66 m (AMSL); ground surface elevation = 211.01 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.9

Groundwater Monitoring Results, 300 Area Well 317111, 2005

Parameter	Unit	Date of Sampling			
		Mar. 9	May 24	Sept. 1	Dec. 12
Water elevation ^a	m	204.35	204.61	202.77	201.96
Temperature	°C	9.3	14.0	11.9	9.2
pH	pH	7.24	7.35	7.08	6.97
Redox	mV	0	-23	-21	4
Conductivity	µmhos/cm	1,160	1,148	1,063	1,304
Chloride ^b	mg/L	201	181	183	209
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.089	0.082	0.084	0.103
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.040	0.030	0.016	0.099
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.048	0.048	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	<100	<100
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25

^a Well point elevation = 198.37 m (AMSL); ground surface elevation = 210.25 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.10

Groundwater Monitoring Results, 300 Area Well 317121D, 2005

Parameter	Unit	Date of Sampling				
		Mar. 14	May 18	Aug. 31	Nov. 7	Nov. 7
Water elevation ^a	m	186.75	186.81	186.65	186.57	186.57
Temperature	°C	9.9	12.2	14.0	11.5	11.5
pH	pH	9.09	10.21	9.72	7.23	7.23
Redox	mV	-105	-175	-173	-16	-16
Conductivity	µmhos/cm	512	424	397	935	935
Chloride ^b	mg/L	56	68	64	79	77
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.071	0.051	0.032	0.058	0.056
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010	0.014	0.014
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.041	0.014	<0.008	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	227	336	246	114	<100
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25	<0.25
1,4-Dioxane	µg/L	<1	15	17	3	3

^a Well point elevation = 183.49 m (AMSL); ground surface elevation = 207.57 m (AMSL); casing material = steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.11

Groundwater Monitoring Results, 300 Area Well 319011, 2005

Parameter	Unit	Date of Sampling			
		Mar. 9	May 25	Sept. 1	Dec. 12
Water elevation ^a	m	202.05	203.92	202.50	199.29
Temperature	°C	10.0	11.1	13.7	8.8
pH	pH	7.69	7.15	7.26	7.37
Redox	mV	-28	-14	-34	-18
Conductivity	µmhos/cm	745	768	808	925
Chloride ^b	mg/L	33	40	37	38
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.038	0.039	0.038	0.039
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.054	0.030	0.051	0.015
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.041	0.039	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	<100	<100
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25

^a Well point elevation = 197.51 m (AMSL); ground surface elevation = 209.80 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.12

Groundwater Monitoring Results, 300 Area Well 319031, 2005

Parameter	Unit	Date of Sampling	
		Mar. 14	May 25
Water elevation ^a	m	193.21	193.21
Temperature	°C	7.9	11.4
pH	pH	7.45	7.23
Redox	mV	-16	-16
Conductivity	µmhos/cm	746	801
Chloride ^b	mg/L	26	24
Arsenic ^b	mg/L	<0.003	<0.003
Barium ^b	mg/L	0.050	0.047
Beryllium ^b	mg/L	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002
Nickel ^b	mg/L	0.045	<0.035
Silver ^b	mg/L	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053
Zinc ^b	mg/L	0.115	0.149
Cesium-137	pCi/L	<2.0	<2.0
Hydrogen-3	pCi/L	464	383
Strontium-90	pCi/L	<0.25	0.26
1,1,1-Trichloroethane	µg/L	2	3
Trichloroethene	µg/L	2	3
Trichlorofluoromethane	µg/L	<1	1

^a Well point elevation = 191.78 m (AMSL); ground surface elevation = 204.28 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.13

Groundwater Monitoring Results, 300 Area Well 319032, 2005

Parameter	Unit	Date of Sampling		
		Mar. 14	May 25	Aug. 31
Water elevation ^a	m	198.80	198.47	197.62
Temperature	°C	9.2	11.5	12.6
pH	pH	7.39	7.31	7.05
Redox	mV	-11	-18	-18
Conductivity	µmhos/cm	770	803	870
Chloride ^b	mg/L	15	16	16
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.070	0.068	0.069
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	0.0003
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.069	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.046	0.046
Cesium-137	pCi/L	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	278	226	296
Strontium-90	pCi/L	<0.25	<0.25	<0.25
1,1,1-Trichloroethane	µg/L	1	2	<1
1,4-Dioxane	µg/L	38	<1	39
1,1-Dichloroethane	µg/L	<1	1	<1

^a Well point elevation = 196.66 m (AMSL); ground surface elevation = 204.28 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.14

Groundwater Monitoring Results, 300 Area Well 319131D, 2005

Parameter	Unit	Date of Sampling			
		Mar. 14	May 18	Aug. 31	Oct. 26
Water elevation ^a	m	185.03	185.02	184.65	184.55
Temperature	°C	10.1	12.3	12.8	10.8
pH	pH	7.44	7.28	7.03	7.08
Redox	mV	-18	-13	-17	-3
Conductivity	µmhos/cm	718	861	900	1,105
Chloride ^b	mg/L	53	55	63	73
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.074	0.072	0.073	0.074
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.085	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.050	0.049	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	916	921	1,129	973
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25
1,4-Dioxane	µg/L	<1	1	<1	1

^a Well point elevation = 182.77 m (AMSL); ground surface elevation = 203.55 m (AMSL); casing material = steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.15

Illinois Class I Groundwater
Quality Standards: Inorganics
(concentrations in mg/L, except
radionuclides and pH)

Constituent	Standard
Antimony	0.006
Arsenic	0.05
Barium	2
Beryllium	0.004
Boron	2
Cadmium	0.005
Chloride	200
Chromium	0.1
Cobalt	1
Copper	0.65
Cyanide	0.2
Fluoride	4
Iron	5
Lead	0.0075
Manganese	0.15
Mercury	0.002
Nickel	0.1
Nitrate, as N	10
Radium-226	20 pCi/L
Radium-228	20 pCi/L
Selenium	0.05
Silver	0.05
Sulfate	400
Thallium	0.002
TDS	1,200
Zinc	5
pH	6.5–9.0

319031, and 319032. TCA levels ranged from less than 1.0 to 46 µg/L. 1,4-dioxane was noted in Well 319131D (two quarters), 319032 (two quarters), and 317121D (three quarters); 1,4-dioxane levels ranged from less than 1.0 to 39 µg/L. Trichloroethene was noted each quarter sampled in Well 319031 and 317061 (one quarter). It should be noted that monitoring conducted as part of the LTS Program, described in Sections 6.2.3 and 6.2.4, routinely detects orders of magnitude higher concentrations of VOCs than those described above (see Table 6.19); many results are well in excess of WQSS. These samples are collected near areas where waste was placed in the ground and where active remediation was conducted. Higher concentrations at these locations are expected at this point in time.

6. GROUNDWATER PROTECTION

TABLE 6.16

Illinois Class I Groundwater Quality Standards: Organics
(concentrations in mg/L)

Constituent	Standard	Constituent	Standard
Alachlor	0.002	1,1-Dichloroethene	0.007
Aldicarb	0.003	cis-1,2-Dichloroethylene	0.07
Atrazine	0.003	trans-1,2-Dichloroethylene	0.1
Benzene	0.005	1,2-Dichloropropane	0.005
Benzo(a)pyrene	0.0002	Ethylbenzene	0.7
Carbofuran	0.04	Methoxychlor	0.04
Carbon tetrachloride	0.005	Monochlorobenzene	0.1
Chlordane	0.002	Pentachlorophenol	0.001
Dalapon	0.2	Phenols	0.1
Dichloromethane	0.005	Picloram	0.5
Di(2-ethylhexyl)phthalate	0.006	PCBs (decachlorobiphenyl)	0.0005
Dinoseb	0.007	Simazine	0.004
Endothall	0.1	Styrene	0.1
Endrin	0.002	2,4,5-TP (Silvex)	0.05
Ethylene dibromide	0.00005	Tetrachloroethylene	0.005
Heptachlor	0.0004	Toluene	1
Heptachlor epoxide	0.0002	Toxaphene	0.003
Hexachlorocyclopentadiene	0.05	1,1,1-Trichloroethane	0.2
Lindane	0.0002	1,1,2-Trichloroethane	0.0005
2,4-D	0.07	1,2,4-Trichlorobenzene	0.07
o-Dichlorobenzene	0.6	Trichloroethylene	0.005
p-Dichlorobenzene	0.075	Vinyl chloride	0.002
1,2-Dibromo-3-chloropropane	0.0002	Xylenes	10
1,2-Dichloroethane	0.005		

Once during the year, the wells were sampled and analyzed for SVOCs, PCBs, pesticides, and herbicides. None of these parameters were found in 2005.

Figure 6.4 shows selected VOC results for Well 317021 since 1988. The major components are TCA and DCA; the latter can be a decomposition product of TCA. As shown in Figure 6.4, the concentrations roughly parallel each other, and the levels are consistent until 1991, at which time a trend of increasing, then decreasing, concentrations can be observed. Since early 1998, the level of contamination has dropped dramatically. The well is immediately below a former discharge line that was known to be contaminated from leaks in the system. The sewer line was permanently closed in 1986 and sealed in 1997. A groundwater collection system was installed in the vicinity of this well in late 1997.

Manholes E1 and E2 in the 317 Area were sampled monthly and analyzed for VOCs. The results are presented in Table 6.17. Contributions of groundwater into Manholes E1 and E2 include a quarterly average of 985 L/day (259 gal/day) from the 319 Area groundwater collection

6. GROUNDWATER PROTECTION

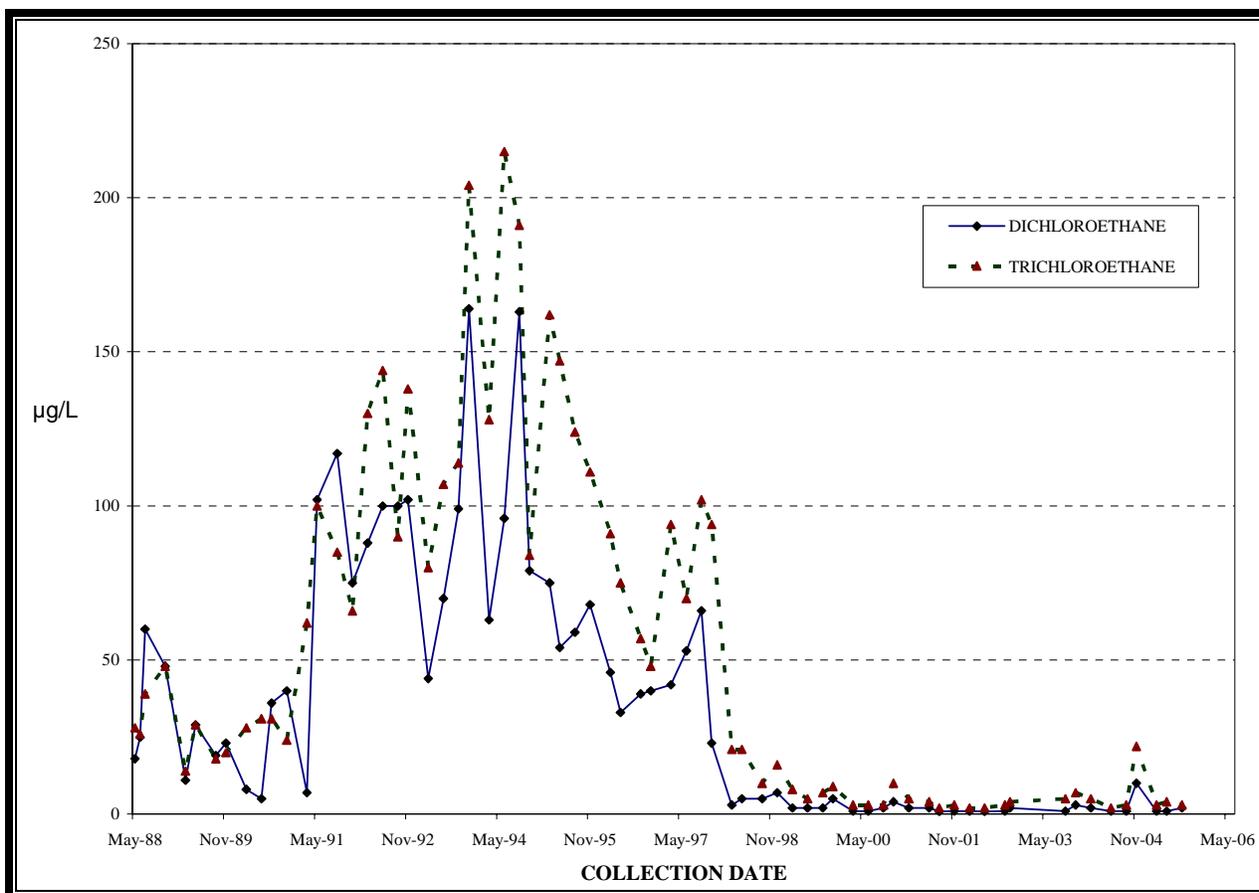


FIGURE 6.4 Concentrations of 1,1-Dichloroethane and 1,1,1-Trichloroethane in Well 317021

system, a quarterly average of 20,783 L/day (5,467 gal/day) from the 317 Area groundwater collection system, and groundwater from existing 317 Area foundation drains around the storage vault.

Manhole 1E receives water from the 317 Area foundation drains around the storage vault. The combined flow of water from the 317 Area groundwater collection system and the 319 Area groundwater collection system is pumped to Manhole 2E. Prior to 2005, flows from both areas had decreased since 1999. The 319 Area decrease can be mainly attributed to a considerable drop in groundwater extraction rates due to the addition of the 319 Landfill cap installed during summer 1999. Flows from the 317 Area are influenced by the increased uptake of groundwater by the phytoremediation system and changes in seasonal precipitation. Based on quarterly averages, the increase in 317 Area flow from previous years can be mainly attributed to heavy precipitation during the winter months in the form of rain versus snow, allowing for increased infiltration into the ground. The high-density polyethylene liner over the 319 Landfill appears to be successfully reducing water movement throughout the southern end of the 319 Area.

6. GROUNDWATER PROTECTION

TABLE 6.17

Volatile Organic Compounds in the 317 Area: Manholes E1 and E2, 2005
(concentrations in $\mu\text{g/L}$)

Month Collected	Chloroform		Tetra-chloroethene		Trichloro-ethene		cis-1,2-Dichloro-ethane		1,1-Dichloro-ethane		Carbon Tetrachloride		1,1,1-Trichloro-ethane	
	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2
Jan.	62	2	4	1	11	5	2	1	48	3	18	20	27	30
Feb.	110	13	9	2	18	7	5	2	101	10	14	17	20	23
March	39	34	3	5	16	13	3	3	42	46	23	22	31	29
April	625	509	60	72	33	20	26	20	985	836	8	6	11	8
May	996	221	30	33	45	10	22	9	1,940	438	11	5	19	8
June	858	28	33	4	46	5	20	1	1,592	44	8	9	13	17
July	435	19	54	104	27	4	19	12	457	26	6	1	8	1
Aug.	138	1	21	5	32	2	10	1	103	1	4	2	6	5
Sept.	191	5	17	8	31	2	9	1	167	5	3	1	3	2
Oct.	204	22	20	19	22	3	7	2	195	9	2	1	2	1
Nov.	124	36	28	8	28	6	15	5	54	2	6	3	3	1
Dec.	264	9	45	10	96	2	38	2	226	4	3	1	2	1

In general, annual average VOC concentrations in Manholes E1 and E2 increased from levels noted in previous years and may be due to the lack of precipitation (see Figure 6.5). A soil remediation project conducted in 1998 resulted in the removal of approximately 80% of the VOCs from several locations within the 317 French Drain Area. As previously mentioned, the addition of the 319 Landfill cap in summer 1999 has decreased leachate production in this area and has resulted in a substantial decrease in the amount of water pumped to Manhole E2 from the 319 Area groundwater collection system. These activities probably account for the decrease in VOC concentrations in Manhole E2 from levels noted up to 2003 (see Figure 6.5). Decreases in VOC concentrations in Manhole 1E may be associated with the substantial increase of groundwater extraction from the 317 Area groundwater collection system, as well as the removal of contaminated groundwater by evapotranspiration and contaminant degradation in the soil. Figures 6.6 to 6.12 compare the major VOC concentrations in Manholes E1 and E2. The TCA and DCA levels in both manholes parallel each other (see Figures 6.11 and 6.12). Monthly VOC concentrations are precipitation-dependent — that is, increased concentrations are indicative of drier periods.

Radioactive Constituents. Samples collected quarterly from the monitoring wells in the 317 and 319 Areas were analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. The results are presented in Tables 6.5 to 6.14. Evidence of possible off-site migration of radionuclides is noted by the low concentrations of hydrogen-3 in wells located near the south perimeter fence in the 317/319 Area. Well 317101 is at the north perimeter of the 317 Area, and no hydrogen-3 was noted. The wells near the south perimeter fence that contained hydrogen-3 include 317061 (two quarters); 317021 and 317052 (two quarters); 317121D (four quarters); and 319031, 319032, and 319131D (four quarters). Hydrogen-3 levels in these wells ranged from less

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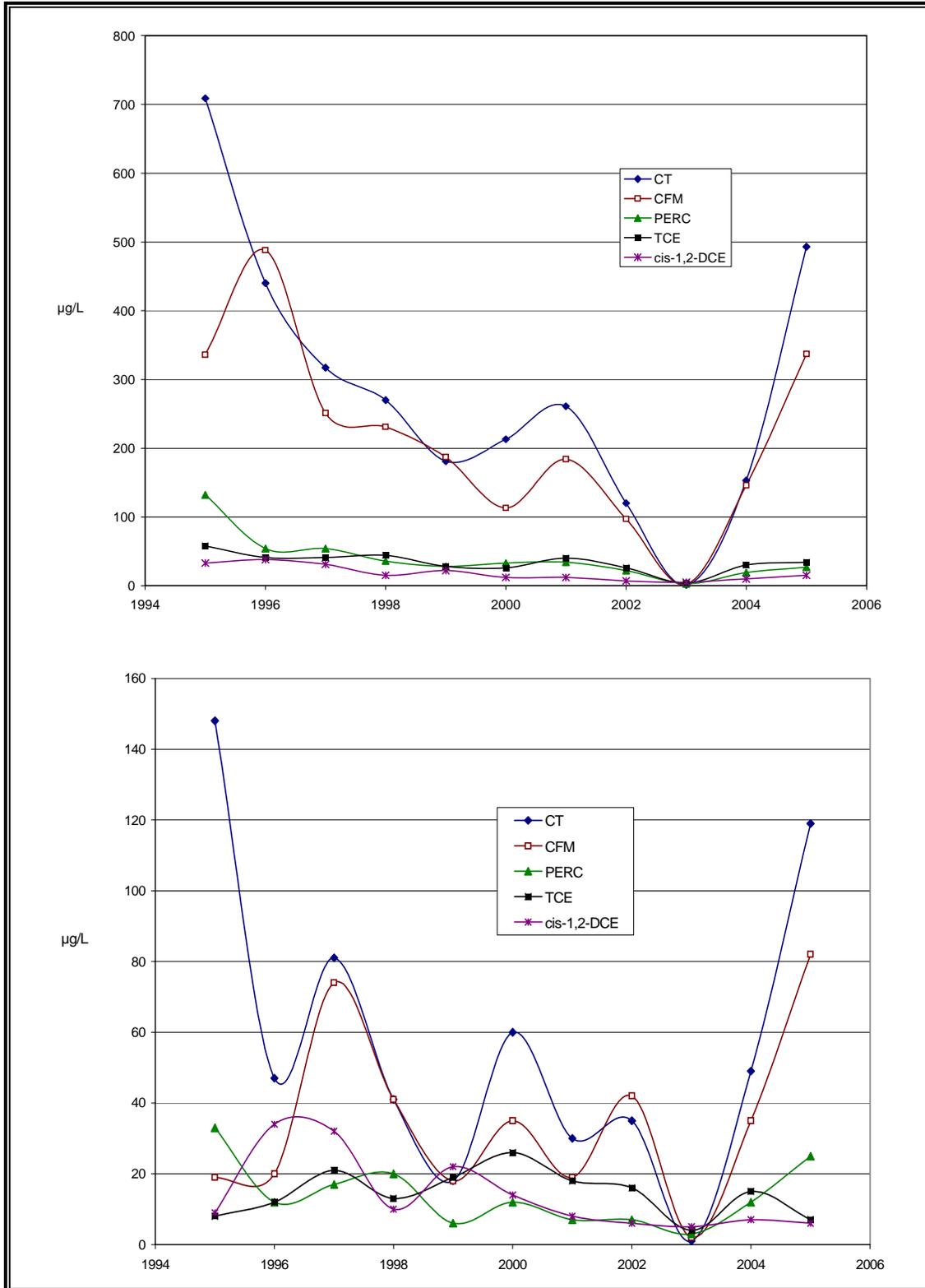


FIGURE 6.5 Manholes E1 and E2 Annual Average Groundwater Concentrations, 1995 to 2005

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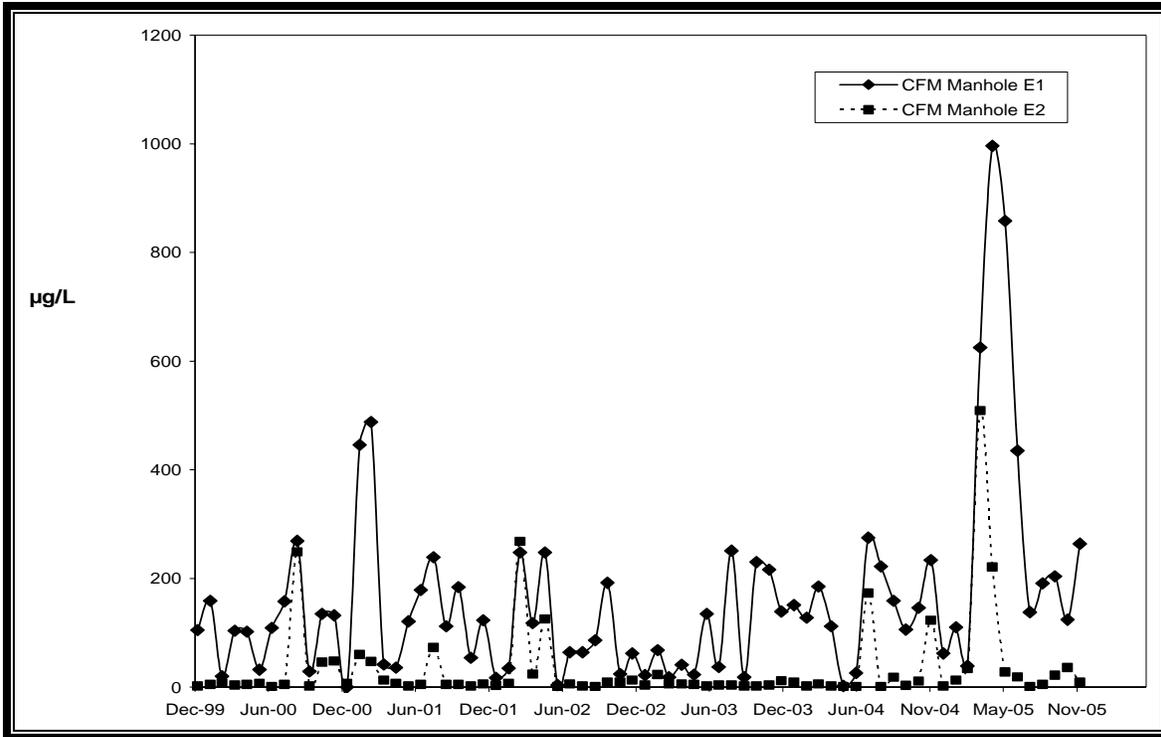


FIGURE 6.6 Manholes E1 and E2 Chloroform Levels, 2000 to 2005

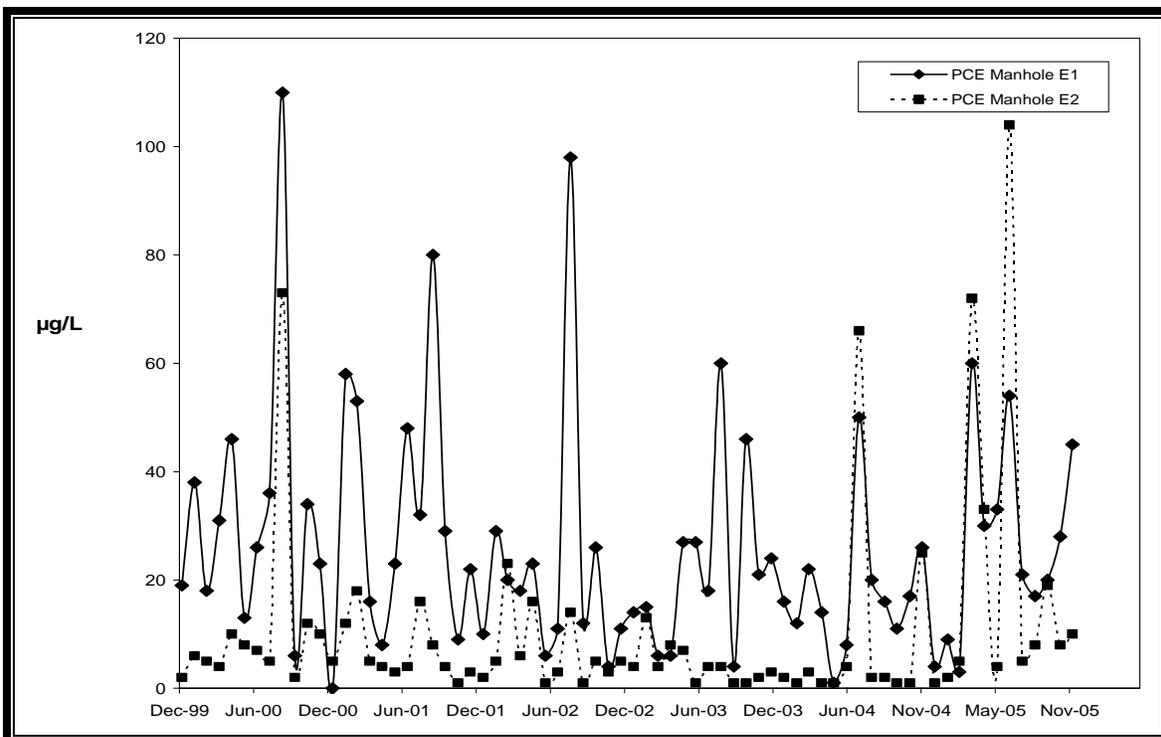


FIGURE 6.7 Manholes E1 and E2 Tetrachloroethene Levels, 2000 to 2005

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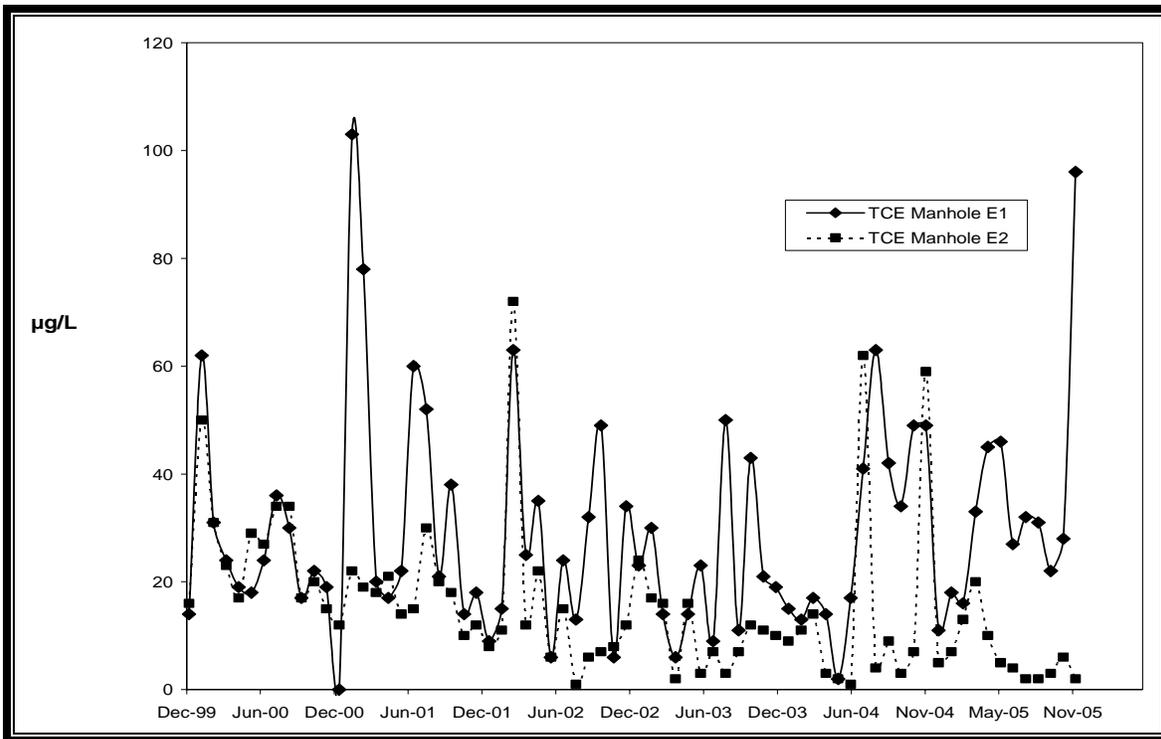


FIGURE 6.8 Manholes E1 and E2 Trichloroethene Levels, 2000 to 2005

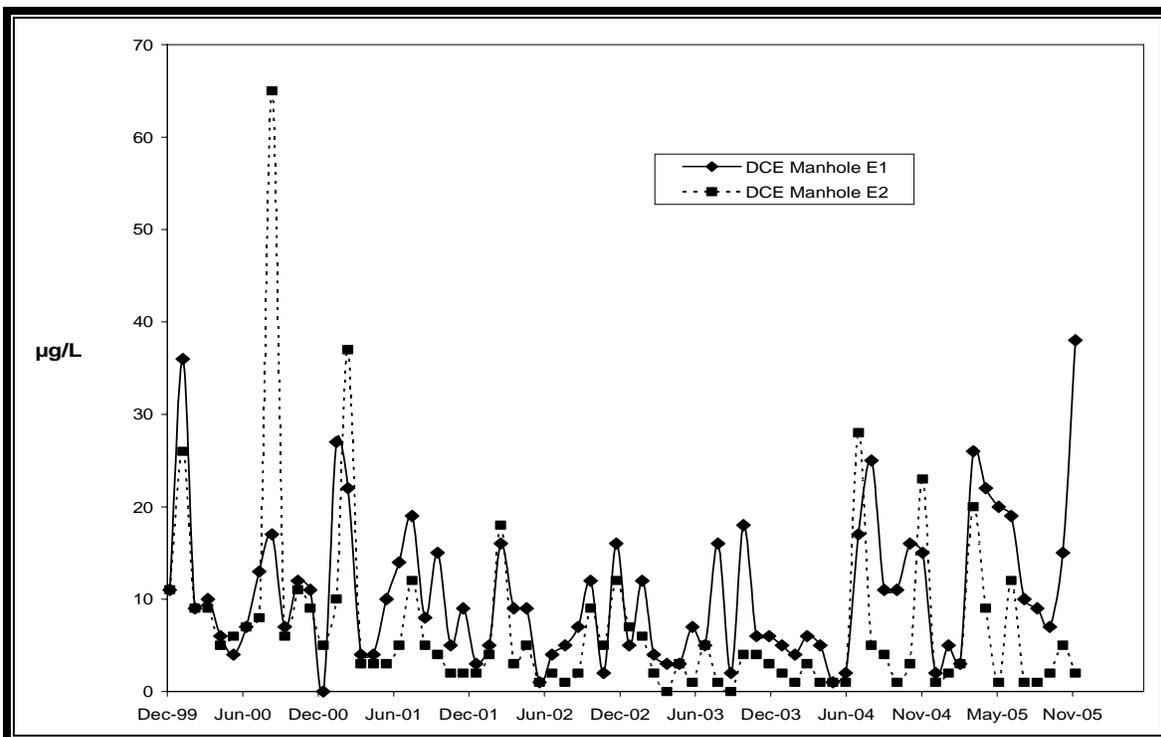


FIGURE 6.9 Manholes E1 and E2 cis-1,2-Dichloroethene Levels, 2000 to 2005

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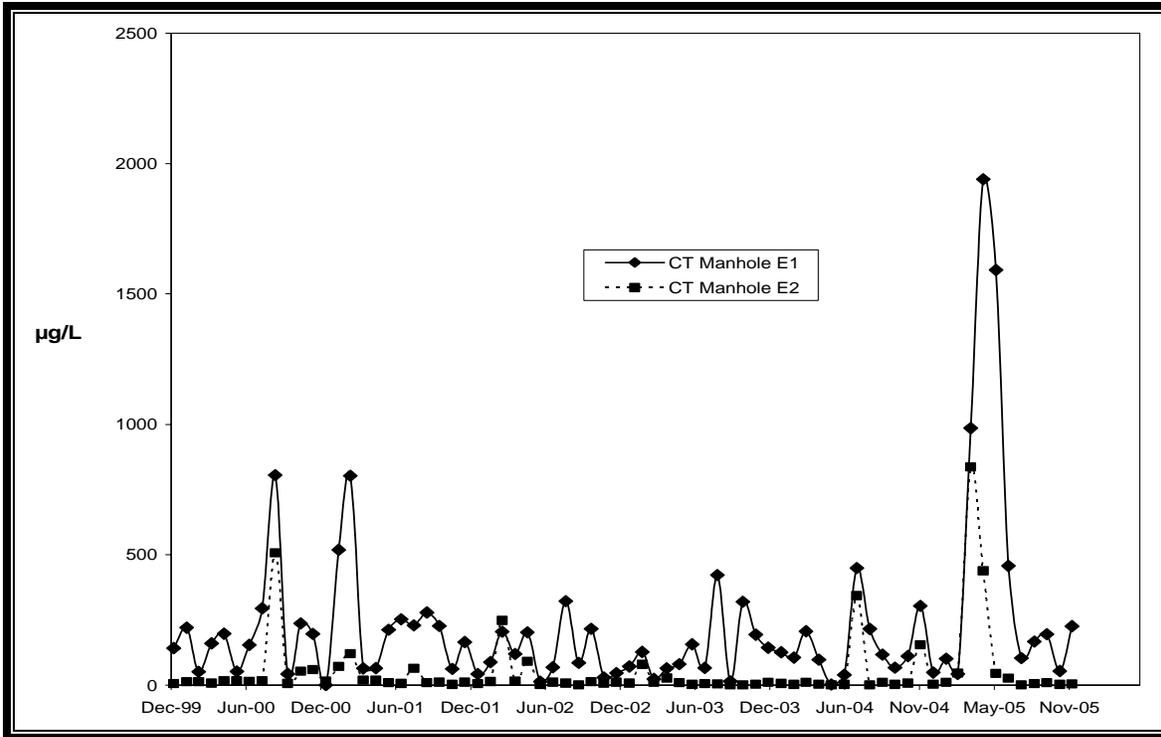


FIGURE 6.10 Manholes E1 and E2 Carbon Tetrachloride Levels, 2000 to 2005

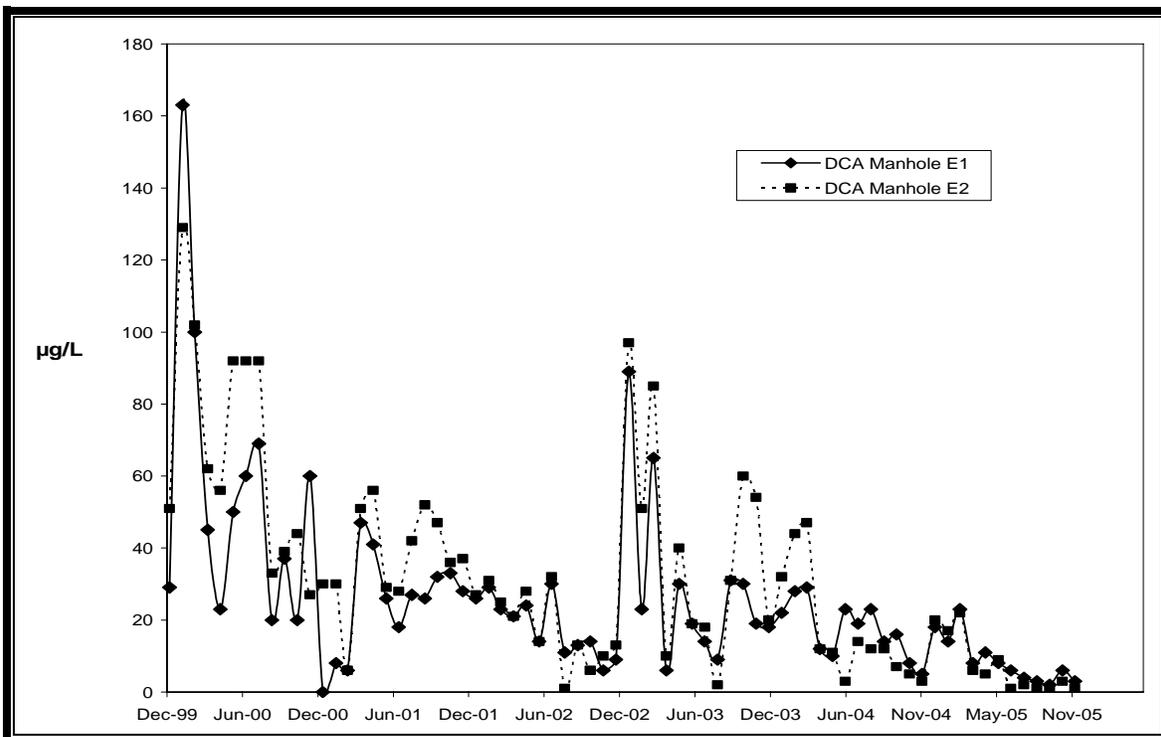


FIGURE 6.11 Manholes E1 and E2 1,1-Dichloroethane Levels, 2000 to 2005

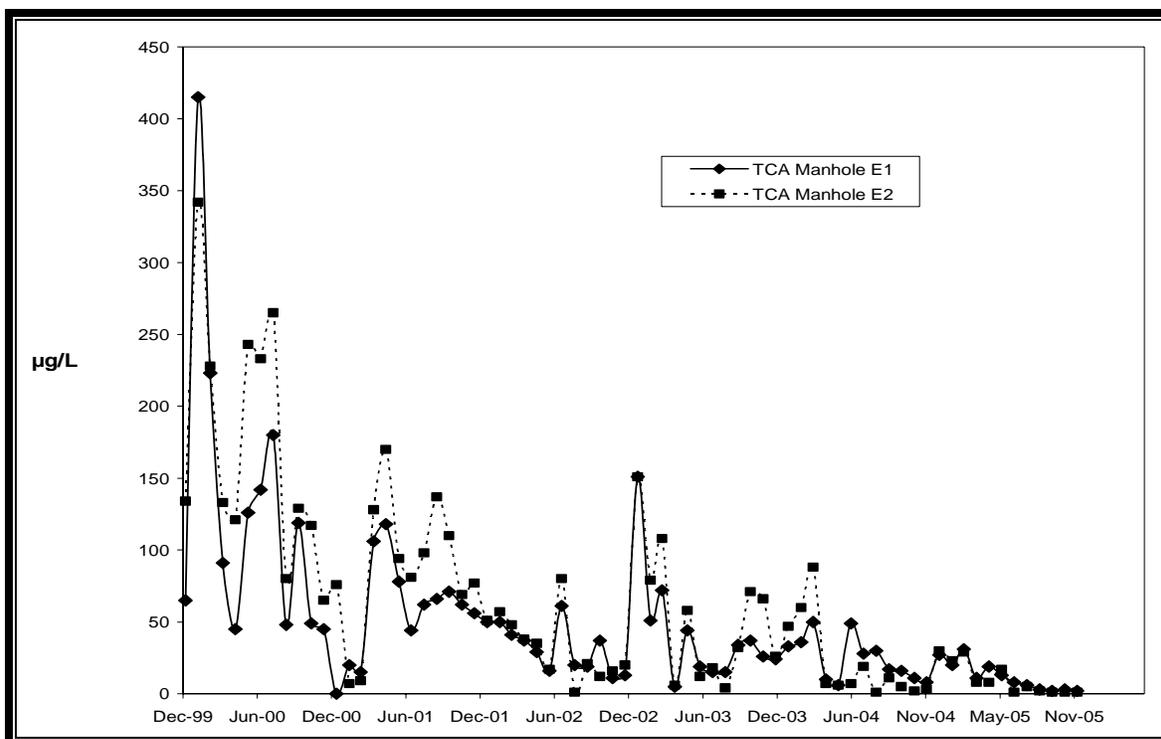


FIGURE 6.12 Manholes E1 and E2 1,1,1-Trichloroethane Levels, 2000 to 2005

than 100 to 1,129 pCi/L, which is well below the WQS of 20,000 pCi/L. Well 319031 was dry during two quarters. As in the past, strontium-90 was noted at the detection limit one quarter in Well 319031.

Water from the 317/319 Area groundwater collection system is pumped to Manhole 2E. Manhole 1E is connected to the footing drain system around the operating vault. In addition to VOCs, the manhole water is analyzed for hydrogen-3 and gamma-ray-emitting radionuclides. Table 6.18 gives the hydrogen-3 results. Although the hydrogen-3 concentrations are relatively high, the volume is fairly low. Because hydrogen-3 concentrations are generally higher in Manhole 2E, the source of the hydrogen-3 appears to be the 319 Area groundwater pumping system. No gamma-ray-emitting radionuclides were detected in any samples. The water in Manhole 2E is pumped to the LWTP.

6.2.3. Phytoremediation Groundwater Monitoring

The soil treatment action completed in 1998 resulted in the removal of approximately 80% of the subsurface contaminants. The final corrective action in the 317/319 Area was the deployment of phytoremediation in 1999. Phytoremediation (phyto) is a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soils, degrade and/or sequester them, and transpire water vapor and some volatile constituents into the atmosphere. To monitor the source term, a number of monitoring wells were

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installed in the phyto plantation area to measure the progress of contaminant removal from the subsurface. The monitoring wells are shown in Figure 6.13.

Samples are collected quarterly from the phyto wells and analyzed for VOCs and hydrogen-3. Table 6.19 gives the analytical results only for wells from which measurable concentrations were obtained. Wells that were dry or contained levels of organics that were all below the quantification limit were excluded. The results in the table are the annual average of the quarterly results, and those values that exceed the applicable standards are indicated in bold type.

Most of the monitoring results are from within the 317 Area French Drain. Although portions of the area were treated using a soil mixing process with zero-valent iron addition, this treatment was effective at removing about 80% of the VOCs. The data in Table 6.19 indicate that small pockets of elevated VOCs remain to be treated by the phytoremediation process. For example, the areas around Wells 317151, 317181, 317321, and 317331 appear to contain elevated levels of a number of VOCs. Although the concentrations of a significant number of the VOCs are substantially above the standards, which are the targets for cleanup, examination of the individual quarterly results indicates that the concentrations of a number of VOCs are gradually decreasing as a result of natural attenuation and phytoremediation.

6.2.4 Extraction Well Monitoring

The groundwater management system in the 317/319 Area includes 25 extraction wells installed to intercept the flow of contaminated groundwater off the Argonne site. A line of extraction wells was installed near the 317 Area south fence and south of the 319 Area landfill. The wells were installed at approximately 10-m (30-ft) intervals at a depth of 10 to 15 m (30 to 50 ft) in the shallow porous zones. The discharges from the extraction wells are routed to a pump house, where the water is pumped to a lift station. The groundwater is then transferred by force main to the Argonne WTP. The locations of the extraction wells are shown in Figure 6.14.

Monitoring of the individual extraction wells is conducted annually to determine the concentrations of contaminants in the groundwater near the Argonne property line. Samples are analyzed for VOCs and selected radionuclides. The concentrations of most of the parameters

TABLE 6.18

Hydrogen-3 Concentrations in Manhole
Water Samples, 2005
(concentrations in pCi/L)

Month Collected	Manhole 1E	Manhole 2E
Jan.	— ^a	—
Feb.	573	566
March	510	458
April	1,229	1,121
May	1,079	3,202
June	1,220	798
July	6,885	17,660
Aug.	958	364
Sept.	727	892
Oct.	4,712	4,599
Nov.	7,025	8,168
Dec.	4,043	5,346

^a Dash indicates no discharge during month.

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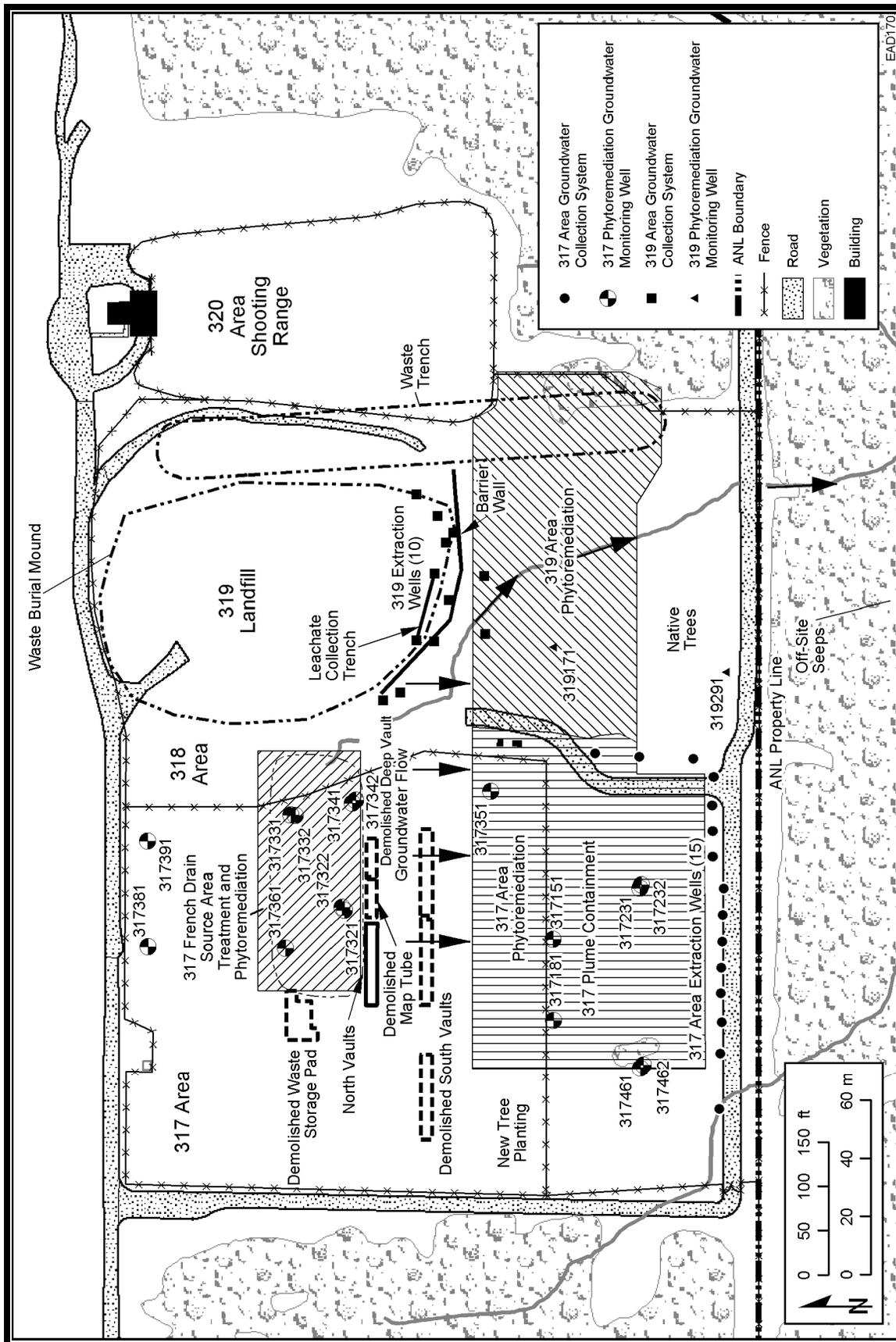


FIGURE 6.13 Phytoremediation Monitoring Wells

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TABLE 6.19

Annual Average Concentrations of Phytoremediation Well Water Constituents, 2005

Parameter	Well No.										Standard
	317151	317181	317321	317322	317331	317332	317341	317342	317351	317462	
VOC (µg/L)											
1,1,1-Trichloroethane	2,822^a	10,023	<1	<1	162,034	14,674	2	1,123	2	311	200
1,1-Dichloroethane	330	5,067	<1	3,258	9,182	3,833	16	998	2	2,594	700
1,1-Dichloroethene	45	175	<1	30.5	4,136	180	<1	24.0	<1	43	7
1,2-Dichloroethane	23	190	265	66.5	3,025	303	3.0	44	<1	102	5
1,1,2-Trichloroethane	<1	<1	<1	<1	49	<1	<1	<1	<1	<1	0.5
1,4-Dioxane	<1	<1	<1	1,292	<1	4,875	151	1,280	<1	<1	1
4-Methyl-2-pentanone	<1	<1	45,216	3,421	949	<1	<1	<1	<1	<1	NA ^b
Acetone	<1	<1	6,420	857	<1	<1	<1	68	31	<1	0.5
Benzene	<1	<1	13,110	844	501	36	0.5	4.7	<1	<1	5
1,2,4-Trimethylbenzene	<1	<1	135	<1	<1	<1	<1	<1	<1	<1	NA
Carbon tetrachloride	<1	<1	296,630	86	<1	<1	1.5	<1	255	<1	5
Chloroethane	<5	54	<5	94	<5	53.5	1.3	8.0	<5	26	NA
Chloromethane	29	<5	<5	15	<5	<5	<5	<5	<5	<5	NA
Chloroform	16.7	70.3	8,739	1,709	806	24	5.3	3.0	350	<1	0.2
cis-1,2-Dichloroethene	16.7	520	352	34,257	20,448	1,895	4.5	58.0	5	48	70
Dichlorodifluoromethane	<1	<1	<1	78	87	37	2.3	<1	<1	<1	1,400
Ethylbenzene	<1	<1	148	<1	<1	<1	<1	<1	<1	<1	700
Ethylether	<1	<1	336	71	<1	<1	15.5	<1	<1	<1	1,400
Methylene chloride	<1	<1	2,670	2,075	233	<1	12	8	9	<1	5
Tetrachloroethene	33	604	739	240	51	<1	0.5	<1	355	<1	5
Toluene	<1	548	1,141	49	<1	<1	<1	<1	<1	<1	1,000
trans-1,2-Dichloroethene	<1	48	<1	427	1,246	153	0.5	6.0	<1	<1	100
Trichloroethene	654	749	30,876	582	47,398	1,005	<1	65	5	43	5
Trichlorofluoromethane	<1	<1	3,905	271	112	15	<1	<1	<1	<1	NA
Vinyl chloride	<1	<1	<1	2,900	237	48	0.3	2	<1	<1	2
Xylene (total)	<1	<1	368	<1	<1	<1	<1	<1	<1	<1	10,000
Hydrogen-3 (pCi/L)	275	477	1,425	658	230	246	315	901	846	280	20,000

^a Bold type indicates that the value exceeds applicable standards.

^b NA = not applicable.

were below laboratory detection limits. To provide a comparison of these concentrations with concentrations of the same parameters measured in the phytoremediation wells, Table 6.20 presents the range of concentrations for each parameter.

Examination of Table 6.20 shows that, although several extraction wells contained VOCs at concentrations that exceeded the groundwater quality standards (cleanup levels), these exceedances were orders of magnitude lower than the measured concentrations in the phytoremediation wells (see Section 6.2.3.). The extraction wells appear to be effective at preventing migration of contaminated groundwater from the Argonne site.

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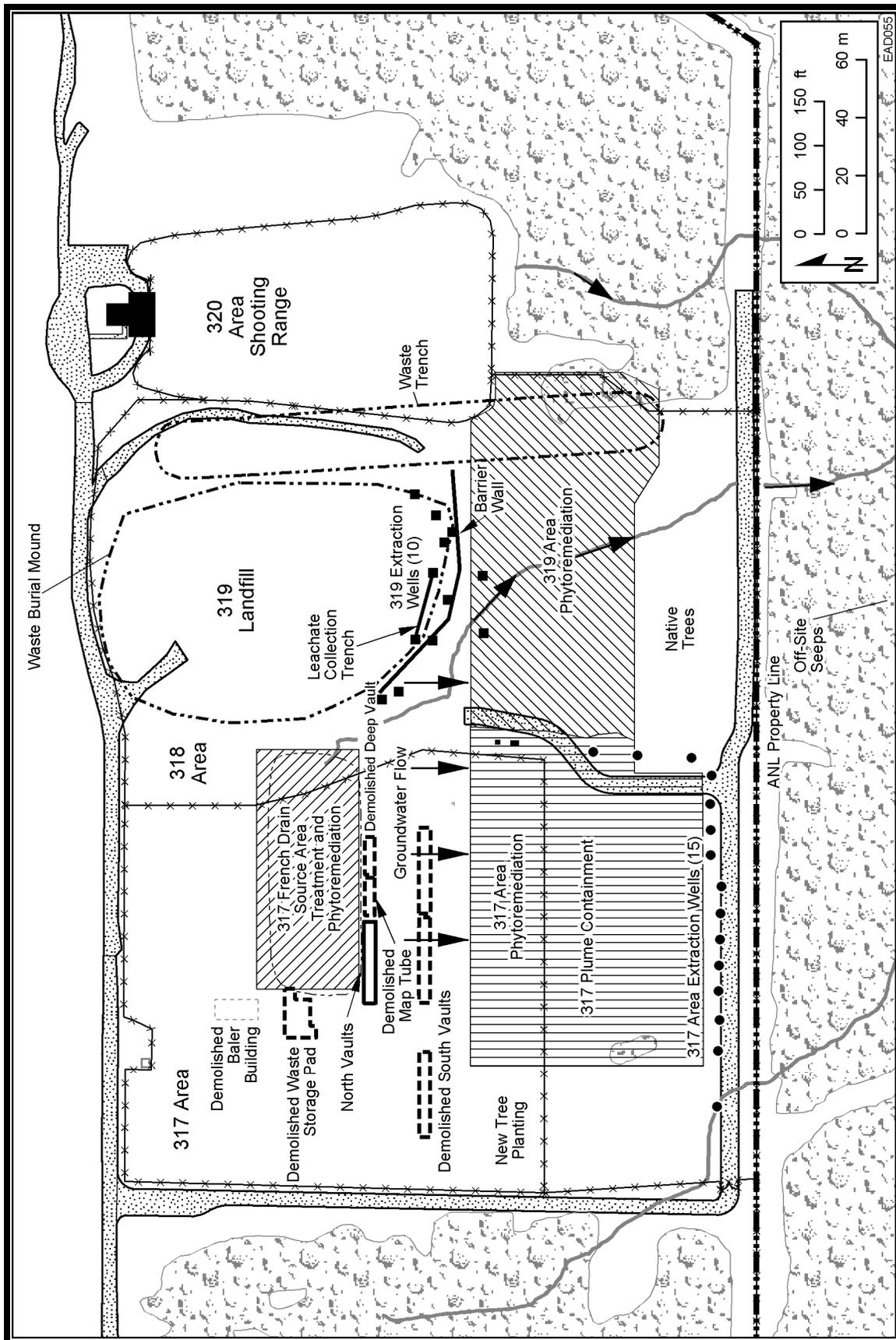


FIGURE 6.14 Extraction Wells

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TABLE 6.20

Range of VOC Concentrations in the 317/319
Extraction Wells, 2005

Parameter	Range (µg/L)	Standard
1,1,1-Trichloroethane	<1–314	200
1,1-Dichloroethane	<1–111	700
1,1-Dichloroethene	<1–6	7
1,2-Dichloroethane	<1–2	5
1,4-Dioxane	<1–89	1
Acetone	<1–78	700
Benzene	<1	5
Carbon tetrachloride	<1–4	5
Chloroethane	<5	NA ^a
Chloroform	<1–3	0.2
cis-1,2-Dichloroethene	<1–286	70
Methylene chloride	<1–11	5
Tetrachloroethene	<1–2	5
Trichloroethene	<1–14	5
Xylene (total)	<1	5
Hydrogen-3	<100–74,250	20,000

^a NA = not applicable.

In addition to the VOCs, the extraction well water was also analyzed for gross alpha, gross beta, gamma-ray emitters, isotopic uranium, plutonium-238 and 239, and hydrogen-3. All radiological constituents, except hydrogen-3, were not detected or were within the range of normal ambient concentrations. The hydrogen-3 concentrations ranged from 100 to 74,250 pCi/L; most of the elevated hydrogen-3 concentrations were found in groundwater from the extraction wells just south of the 319 Landfill. Although some of these concentrations exceed the Class 1 Ground Water Quality Standard for hydrogen-3, concentrations in the past have been much higher.

6.2.5 ENE Landfill Groundwater Monitoring

In September 2001, Argonne completed the remediation of the ENE Landfill by consolidating all of the waste and constructing a cap over the waste material. Five wells were installed (ENE031, ENE041, ENE051, ENE061, and ENE071) to facilitate monitoring of the groundwater around the landfill. Two of the wells (ENE061 and ENE071) were installed upgradient of the landfill, and the other three wells (ENE031, ENE041, and ENE051) were installed immediately downgradient of the landfill. Four other wells (ENE011, ENE012, ENE013D, and ENE021D) were installed as part of the 317/319/ENE RCRA Facility

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Investigation (RFI) in 1996 and are located south and east of the landfill. The well locations are shown in Figure 6.15.

The purpose of the groundwater monitoring at the ENE Landfill is to verify that chemical contaminants found in the landfill contents, which were all below their respective migration-to-groundwater levels (as found in 35 IAC Part 742 [i.e., Tiered Approach to Corrective Action Objectives]), are not of concern with regard to shallow groundwater. The contaminants in the landfill were of concern because of their ingestion risks and not their migration-to-groundwater risks. The cap placed over the landfill contents was designed to prevent exposure to future site workers and not to prevent the percolation of groundwater (i.e., an impermeable cover).

During the second quarter of 2004, steps were taken to fulfill the conditions of IEPA approval of the Groundwater Monitoring Plan for the ENE Area Landfill at Argonne. In addition to the five currently sampled wells, Wells ENE011, ENE012, ENE013D, and ENE021 were added to the quarterly monitoring program. All samples were analyzed filtered and unfiltered. Parameters to be analyzed on a quarterly basis were established, with data reported electronically to IEPA. The parameters are total polychlorinated biphenyls (PCBs) and filtered and unfiltered arsenic, chromium, lead, manganese, nickel, and selenium; see Table 6.21.

During 2005, results of groundwater monitoring were found to exceed the Groundwater Remediation Objectives (GROs) for lead, manganese, nickel, and chromium, but no concentrations above the standard were detected for total PCBs from the nine wells. The data show that total metals results were higher than dissolved metals results, indicating that solids contributed to the elevated metals.

In past sampling events, the majority of the metals results exceeding the GROs were for total (unfiltered) metals, which indicates that suspended soil particles in the water contributed to the exceedances. During 2005, Argonne utilized low-flow sampling methods that produced more representative samples and greatly reduced the number of exceedances for metals. In future sampling events, Argonne intends to use low-flow sampling to continue providing quality samples for analysis. Monitoring at the ENE Landfill will be conducted for a minimum of 15 years, as required by the landfill closure permit issued by the IEPA.

6.2.6. Monitoring of the Seeps South of the 300 Area

In spring 1996, during the RFI of the 317/319 Area, a series of groundwater seeps was discovered in a network of steeply eroded ravines in the Waterfall Glen Forest Preserve south and southeast of the 317 and 319 Areas. Three seeps (SP01, SP02, and SP04) are located about 200 m (600 ft) south of the 319 Area; two other seeps (SP03 and SP05) are located about 360 m (1,200 ft) south of the 317 Area and are considered clean background seeps. The locations are shown in Figure 6.16. The seeps are in ravines that are located in a pristine, heavily wooded section of the forest preserve. The ravines carry storm water drainage from the 317 and 319 Areas. Storm water flow has eroded the soil deep enough to expose a shallow sandy layer

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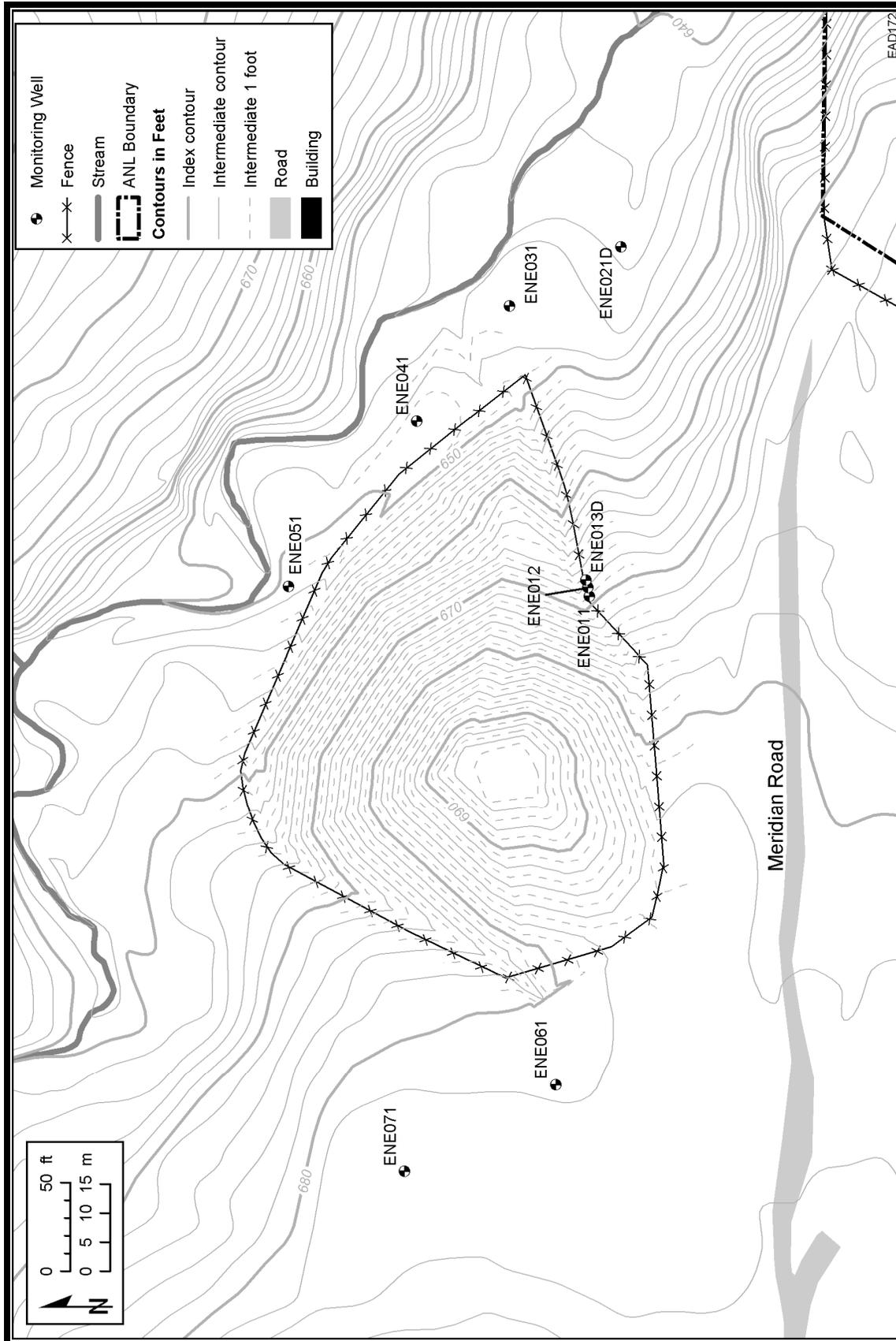


FIGURE 6.15 ENE Area Groundwater Monitoring Wells

TABLE 6.21
Annual Average Concentration of ENE Landfill Well Water Constituents, 2005^a

Metal	Well No.											Standard
	ENE-011	ENE-012	ENE-013D	ENE-021D	ENE-031	ENE-041	ENE-051	ENE-061	ENE-071	ENE-071	Standard	
Arsenic-filtered	<3.0	<3.0	4.8	<3.0	3.5	<3.0	<3	<3	<3	<3	<3	50
Arsenic-unfiltered	<3.0	<3.0	7.0	4.0	8.1	3.5	<3	<3	<3	<3	<3	50
Chromium-filtered	<24	<24	<24	<24	<24	<24	<24	<24	<24	<24	<24	100
Chromium-unfiltered	<24	30	<24	152.7^b	67.4	<24	39.7	75.0	51.7	51.7	100	
Lead-filtered	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	7.5
Lead-unfiltered	4	6.7	5.6	<2.8	32.6	8.3	2.1	108.3	78.5	78.5	7.5	
Manganese-filtered	<10	<10	30.1	89.0	238.2	21.5	45.7	37.6	262.5	262.5	150	
Manganese-unfiltered	144.8	226.5	30.0	152.2	2,028.0	1,104.5	1,728.8	4,766.3	2,846.3	2,846.3	150	
Nickel-filtered	58.8	38.5	42.9	44.7	47.0	49.5	48.7	58.5	85.0	85.0	100	
Nickel-unfiltered	24.0	29.3	24.8	25.4	106.2	33.0	112.3	258.4	130.5	130.5	100	
Selenium-filtered	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	50	
Selenium-unfiltered	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	50	
PCB-total	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	

^a Concentrations in µg/L.

^b Bold type indicates that values exceed the GRO.

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containing groundwater. Water emanating from the exposed sandy layer flows to the nearby ravine, where it forms a small rivulet in the bottom of the ravine. Approximately 30 m (100 ft) downstream of the seep area, the affected water from the seeps is no longer visible because it drains back into the soil in the bed of the ravine. During extended dry-weather conditions, the flow disappears completely. The IEPA has designated this area as AOC-G — Off-Site Groundwater Seeps.

Initial samples were collected from these seeps and analyzed for metals, VOCs, and selected radionuclides. Two groundwater seeps contained measurable levels of three VOCs: carbon tetrachloride, chloroform, and tetrachloroethene. Carbon tetrachloride and tetrachloroethene concentrations exceeded the Class I Groundwater Quality Standards. The other three seeps did not contain any quantifiable VOCs. Three of the five seeps, including the two containing the VOCs, were found to contain hydrogen-3 at measurable concentrations. Since the initial samples were collected, monthly samples were obtained through the end of 1997, and quarterly samples were collected until the end of 1998. These results are summarized in the 1998 Site Environmental Report.¹¹

During 2005, Seeps SP01, SP02, and SP04 were sampled quarterly for VOCs and hydrogen-3. VOCs were noted in each seep during each quarter. As in previous years, Seep SP04 showed the highest levels of all three VOCs (carbon tetrachloride, chloroform, and tetrachloroethene) for each quarter. The data are presented in Table 6.22. The hydrogen-3 and VOC results are consistent with past data, which indicate a gradual decline in hydrogen-3 concentrations and consistent VOC levels (with the exception of VOCs in SP04) since measurements began in 1996 (see Figures 6.17 and 6.18).

Monitoring was also conducted quarterly in the forest preserve at an artesian well located about 2,000 m (6,000 ft) southwest of the 317 Area (location 3E in Figure 1.1). All hydrogen-3 concentrations were below the detection limit of 100 pCi/L. This finding suggests that any subsurface contaminant movement has not extended to this location and indicates a western limit to the migration.

6.2.7. Groundwater Monitoring at the GMZ Area

From December 1994 through September 1996, Argonne conducted a RCRA Facility Investigation (RFI) at the 317/319/ENE Area. The results of that investigation are summarized in the July 1997 RFI report.²⁷ Remedial actions for 319 Area SWMUs (SWMU No. 2, which is the 319 Area Landfill, and SWMU No. 18, which is the 319 Area French Drain) are based on that report. In addition, the July 1997 reports entitled *Determination of Corrective Action Report [DCAR] for the 319 Area Landfill and French Drain*²⁸ and *Conceptual Design Report [CDR] for the 319 Area Landfill and French Drain*²⁹ also described remedial actions for the area.

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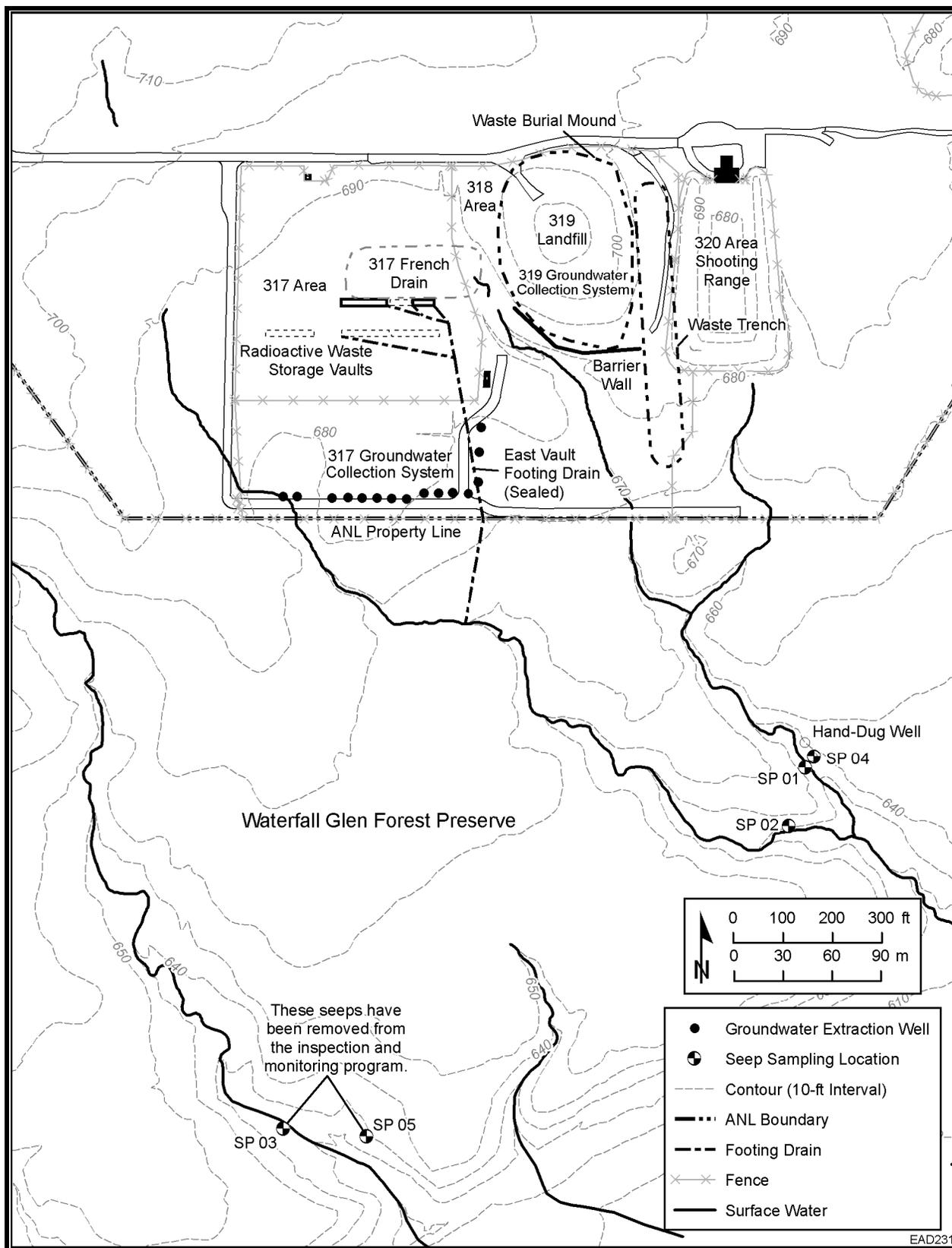


FIGURE 6.16 Seep Locations South of the 317/319 Area

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TABLE 6.22

Contaminant Concentrations in Seep Water, 2000 to 2005

Site	Date Collected	Hydrogen-3 (pCi/L)	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)
SP01	03/21/00	706	5	2	<1
	06/07/00	1,425	6	2	<1
	08/21/00	1,178	8	2	<1
	11/03/00	1,120	7	2	<1
	01/31/01	640	5	1	<1
	05/15/01	633	7	1	<1
	09/07/01	555	4	1	<1
	11/02/01	645	6	2	<1
	01/28/02	614	2	<1	<1
	04/18/02	383	2	1	<1
	07/30/02	242	4	2	<1
	11/13/02	250	7	4	<1
	03/25/03	203	<1	<1	<1
	05/13/03	128	3	1	<1
	08/14/03	187	<1	1	<1
	12/08/03	198	<1	1	<1
	02/11/04	161	9	3	<1
	05/03/04	178	7	2	<1
	08/03/04	114	7	2	<1
	10/25/04	114	8	2	<1
01/24/05	160	9	2	<1	
05/02/05	<100	5	1	<1	
09/27/05	<100	6	<1	1	
12/05/05	<100	5	2	1	
SP02	03/21/00	1,998	1	<1	<1
	06/07/00	1,124	1	<1	<1
	08/21/00	625	3	<1	<1
	11/03/00	1,348	2	<1	<1
	01/31/01	1,383	2	<1	<1
	05/15/01	340	2	<1	<1
	09/07/01	619	2	<1	<1
	11/02/01	626	2	<1	<1
	01/28/02	572	7	2	<1
	04/18/02	274	<1	<1	<1
	07/30/02	188	1	<1	<1
	11/13/02	326	1	<1	<1
	03/25/03	361	<1	<1	<1
	05/13/03	256	1	<1	<1
	08/14/03	273	<1	<1	<1
	12/08/03	248	1	1	<1
	02/11/04	394	3	1	<1
	05/03/04	228	3	1	<1
	08/03/04	175	2	<1	<1
	10/25/04	111	2	<1	<1
01/24/05	192	2	<1	<1	
05/02/05	146	2	<1	<1	
09/27/05	120	2	<1	<1	
12/05/05	Dry	Dry	Dry	Dry	
SP04	03/21/00	Dry	Dry	Dry	Dry
	06/07/00	1,043	179^a	18	7
	08/21/00	435	301	28	9
	11/03/00	323	194	23	6
	01/31/01	418	221	22	6
	05/15/01	124	208	25	7

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TABLE 6.22 (Cont.)

Site	Date Collected	Hydrogen-3 (pCi/L)	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)
SP04 (Cont.)	09/07/01	117	145	54	7
	11/02/01	183	148	23	6
	01/28/02	409	152	20	5
	04/18/02	<100	143	20	7
	07/30/02	<100	180	26	6
	11/13/02	116	118	43	6
	03/25/03	Dry	Dry	Dry	Dry
	05/13/03	<100	39	10	2
	08/14/03	<100	137	33	4
	12/08/03	Dry	Dry	Dry	Dry
	02/11/04	164	188	23	6
	05/03/04	185	192	20	5
	08/03/04	<100	214	25	6
	10/25/04	<100	229	32	6
	01/24/05	101	235	26	5
	05/02/05	110	243	28	6
	09/27/05	<100	204	30	7
12/05/05	Dry	Dry	Dry	Dry	

^a Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

The Groundwater Monitoring Zone (GMZ) was proposed in the DCAR and CDR. Condition 20.b of the IEPA approval letter for these documents³⁰ required that Argonne submit a proposal to establish a GMZ for the 319 Area. The GMZ proposal was submitted to the IEPA in September 1999. The proposal detailed the rationale for establishing a GMZ and for extending it to include other SWMUs in the same area. The IEPA approved the GMZ in a letter dated November 27, 2000.³¹

The GMZ is located in the 317 and 319 Areas (317/319 Area), and consists of:

AOC-G: Off-Site Groundwater Seeps (south of the 317/319/ENE Area),

SWMU No. 2: 319 Area Landfill,

SWMU No. 11: 317 Area French Drain, and

SWMU No. 18: 319 Area French Drain.

The GMZ, using specific monitoring wells, defines the extent of contamination in the 317/319 area and measures approximately 8.9 ha (22 acres). Figure 6.19 shows the locations of perimeter monitoring wells in the Groundwater Management Zone within the 317/319 Area and adjacent forest preserve property.

6. GROUNDWATER PROTECTION

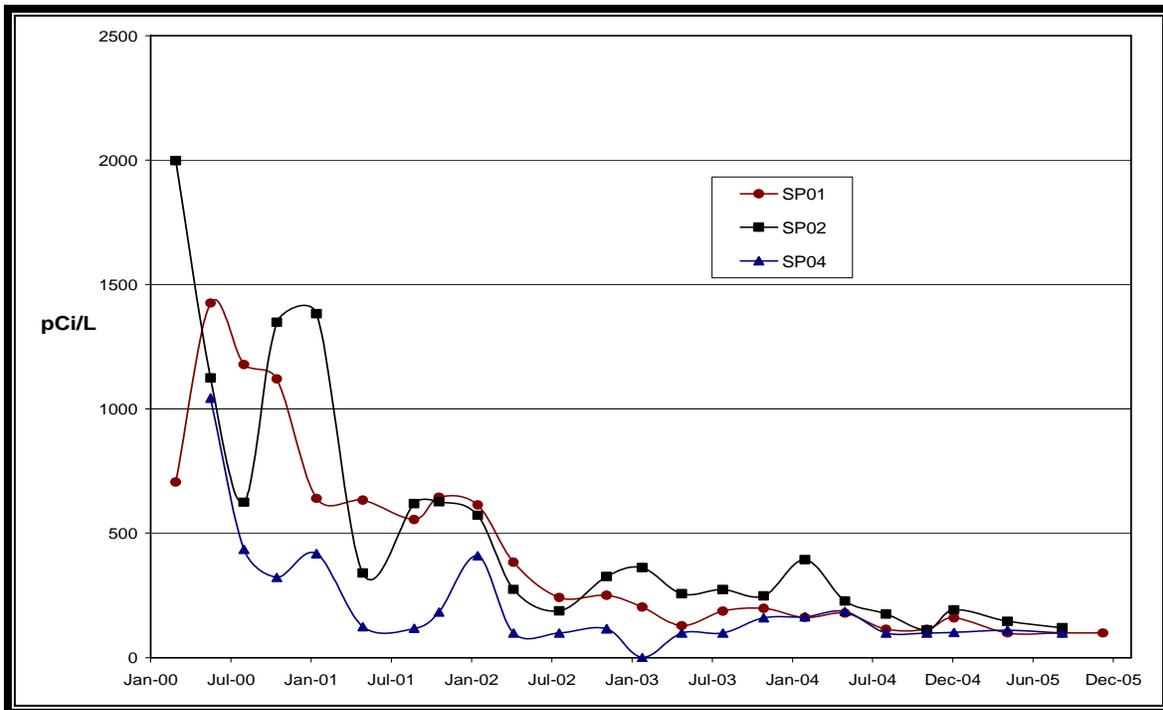


FIGURE 6.17 Hydrogen-3 Concentrations in Seep Water, 2000 to 2005

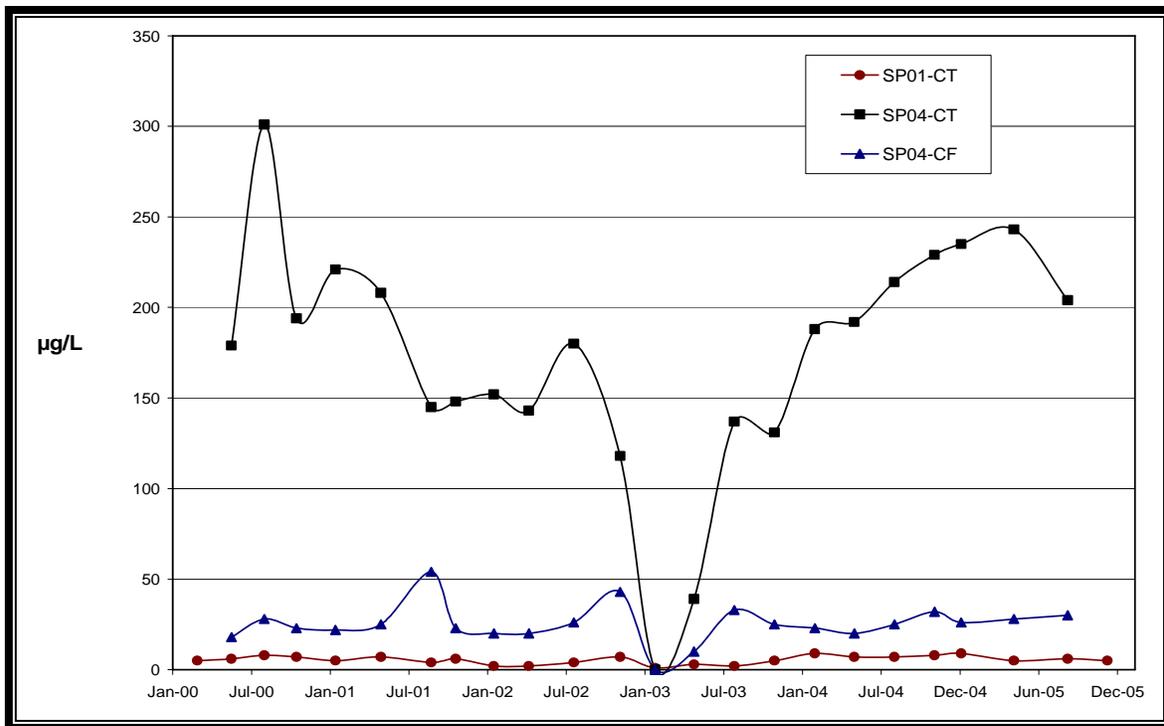


FIGURE 6.18 Carbon Tetrachloride and Chloroform Concentrations in Seep Water, 2000 to 2005

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Sample collection at the GMZ area was initiated in 2000, and is conducted semiannually from the 11 wells mentioned previously. These data are transmitted to the IEPA in the quarterly report associated with the collection period. The purpose of this monitoring is to track the movement of contaminated groundwater and to determine the rate at which contaminant levels are decreasing. Monitoring results in 2005 indicate that the GMZ is showing the boundary of contamination. The analysis of groundwater samples for contaminants reveals some detectable VOCs and tritium, with the outer boundary wells showing no data exceeding GROs.

The analytical results collected in Table 6.23 indicate that 1,4-dioxane is present above its detection limits and Tier 1 value in one of the bedrock monitoring wells (317951), which is installed near bedrock GMZ Monitoring Well 317121D, located south of the 317 Area. The average 1,4-dioxane concentration at this location is 17 µg/L, which is slightly higher than the concentration of 9.0 µg/L found in 317121D. Argonne concluded that the presence of 1,4-dioxane in the bedrock aquifer is the result of migration through the glacial till overlying the bedrock, and not the result of deteriorating well construction, as previously believed. Though Monitoring Wells 317951 and 319961 (upgradient of existing dolomite wells) were not included in the original proposal, they will continue to be monitored with data reported in appropriate quarterly report.

6.3. Sanitary Landfill

The 800 Area is the site of the Argonne sanitary landfill. The 8.8-ha (21.8-acre) landfill, which is located on the western edge of the Argonne property (Figure 1.1), received waste from 1966 until September 1992 and was operated under IEPA Permit No. 1981-29-OP, which was issued on September 18, 1981. The landfill received general refuse, construction debris, boiler house ash, and other nonradioactive solid waste. The landfill was being closed pursuant to Permit No. 1992-002-SP and Supplemental Permit Nos. 1994-506-SP, 1997-295-SP, 1998-017-SP, 1999-107-SP, 1999-476-SP, and 2002-194-SP. On March 25, 2004, the IEPA notified DOE that all future groundwater activities at the 800 Area Landfill will be carried out under the corrective action provisions (Section V) of Argonne's RCRA Part B permit.

6.3.1. French Drain

The landfill area was used for the disposal of certain types of liquid wastes from 1969 to 1978. The wastes were poured into a French drain that consisted of a corrugated steel pipe placed in a gravel-filled pit dug into an area previously filled with waste. The liquid waste was poured into the drain and allowed to permeate into the gravel, and then into the soil and fill material. Available documentation indicates that 109,000 L (29,000 gal) of liquid waste was placed in this drain. Most of this material was used oil or used machining coolant (oil-water emulsion). Some of the wastes disposed of in this manner would currently be defined as hazardous wastes. The presence of volatile and other toxic organic compounds has been confirmed by extensive characterization activities conducted at the landfill. Measurable amounts of these materials were identified in leachate but not in groundwater near the landfill.

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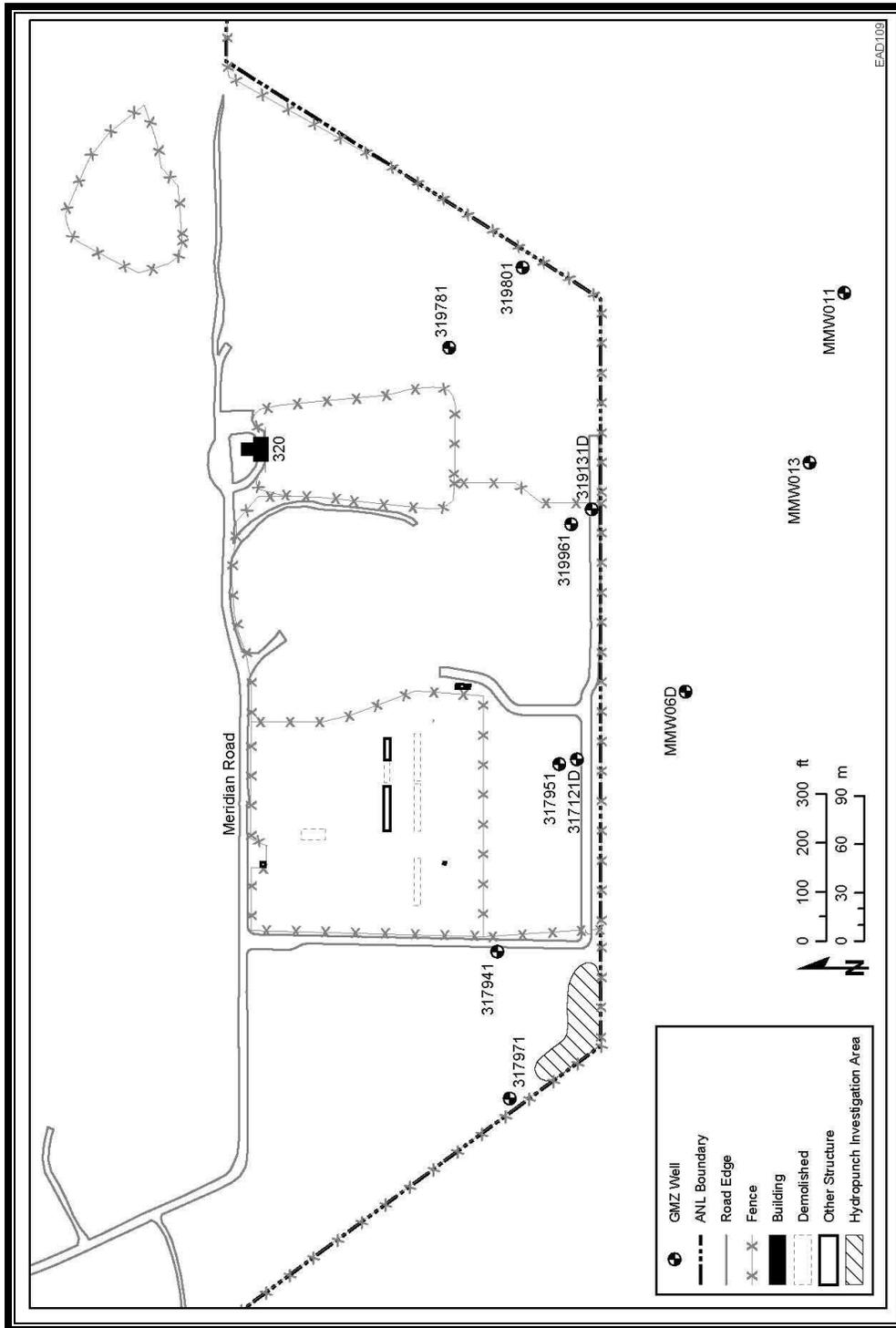


FIGURE 6.19 Locations of Perimeter Monitoring Wells in the Groundwater Management Zone within the 317/319 Area and Adjacent Forest Preserve Property

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TABLE 6.23

Annual Average Results from the GMZ Monitoring Wells, 2005
(concentrations in µg/L, except tritium)

Parameter	Monitoring Well No.						GRO
	319781	317951	319961	317121D	319131D	319801	
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	0.7	<1.0	200
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	700
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Carbon tetrachloride	<1.0	<1.0	0.7	<1.0	0.4 J ^a	<1.0	5.0
Chloroform	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
cis-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	70
Methylene chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Trichloroethene	<1.0	<1.0	<1.0	<1.0	0.3 J	<1.0	5.0
Vinyl chloride	<2.0	<2.0	<1.0	<1.0	<1.0	<2.0	2.0
bis(2-ethylhexyl)phthalate	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	6.0
Nitrobenzene	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.5
Alpha-BHC	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
1,4-Dioxane	<1.0	17^b	0.7	9.0	1.0	<1.0	1.0
Tritium (pCi/L)	<100	245	1,160	336	920	<100	20,000

Parameter	Monitoring Well No.						GRO
	317941	317971	MW06	MW011	MW013	Blank	
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	200
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	700
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Carbon tetrachloride	<1.0	<1.0	0.6	<1.0	<1.0	<1.0	5.0
Chloroform	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.2
cis-1,2-Dichloroethene	3.5	<1.0	<1.0	<1.0	<1.0	<1.0	70
Methylene chloride	<1.0	<1.0	4.0	5 B ^a	4.0	<1.0	5.0
Tetrachloroethene	<1.0	<1.0	0.3	<1.0	<1.0	<1.0	5.0
Trichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Vinyl chloride	11.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0
bis(2-ethylhexyl)phthalate	<3.0	<3.0	NS ^c	NS	NS	<3.0	6.0
Nitrobenzene	<3.5	<3.5	NS	NS	NS	<3.5	3.5
Alpha-BHC	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
1,4-Dioxane	4.0	<1.0	<1.0	<1.0	2.0	<1.0	1.0
Tritium (pCi/L)	1,303	<100	<100	<100	<100	<100	20,000

^a Definition of data qualifier: B = compound also found in the method blank; J = estimated concentration.

^b Bold type indicates that the value exceeds the groundwater remediation objective.

^c NS = Not sampled due to low water volume.

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6.3.2. Monitoring Studies

During October 1992, 15 stainless steel wells, 800161 through 800203D, were installed around the landfill as part of the IEPA-approved closure plan. Wells 800172 and 800182 are consistently dry. The 13 active wells are required to be monitored as part of the IEPA-approved groundwater monitoring program, effective January 1995. These wells are set in five clusters. Each cluster consists of a shallow, medium, and deep well (see Figure 6.20 and Table 6.24).

In late spring of 1999, an environmental remediation project was completed that resulted in the extension of the landfill cap in the north portion of the landfill to cover some recently identified waste material. As part of this project, the landfill cap, perimeter road, and fence were moved 15 m (50 ft) north and Monitoring Wells 800161, 800162, and 800163D were replaced. Sampling of the replacement wells — 800381, 800382, and 800383D — commenced in July 1999.

IEPA Supplemental Permit No. 1999-107-SP, effective June 16, 1999, provided for (1) the installation and addition of 3 new upgradient groundwater monitoring wells (800271, 800272, and 800273D) and (2) the addition of 10 new downgradient groundwater monitoring wells (800281, 800291, 800301, 800311, 800321, 800331, 800341, 800351, 800361, and 800371). Sampling of these wells commenced in October 1999. Table 6.24 provides information on these wells, and Figure 6.20 shows their locations. Wells 800272 and 800311 have been dry since installation.

6.3.2.1. Sample Collection

The same well water sample collection procedure described for the 300 Area was used for the landfill area. Each well is sampled annually for SVOCs, PCBs, pesticides, and herbicides. In accordance with the IEPA-approved groundwater monitoring plan, collection of both filtered and unfiltered samples for analysis of numerous parameters (e.g., metals, chloride, and sulfate) is required during the second quarter. Volatile organics are monitored each quarter, although VOC monitoring is only required by permit during the second quarter. Beginning in April 2003, a low-flow technology was used for groundwater sampling in Well 800191. The IEPA informed Argonne that the technology was not approved, and low-flow sampling at Well 800191 ceased during the fourth quarter. Well 800191 was replaced with a new well, which was sampled by using an IEPA-approved low-flow technology. Low-flow technology allows samples to be collected without disturbing the sediment which typically is the cause of elevated metal concentrations. Wells 800281 and 800381 were sampled by using low-flow technology beginning October 2003. Low-flow sampling technology was initiated during the third quarter for Wells 800201 and 800361 and during the fourth quarter for Wells 800171, 800271, 800291, and 800301.

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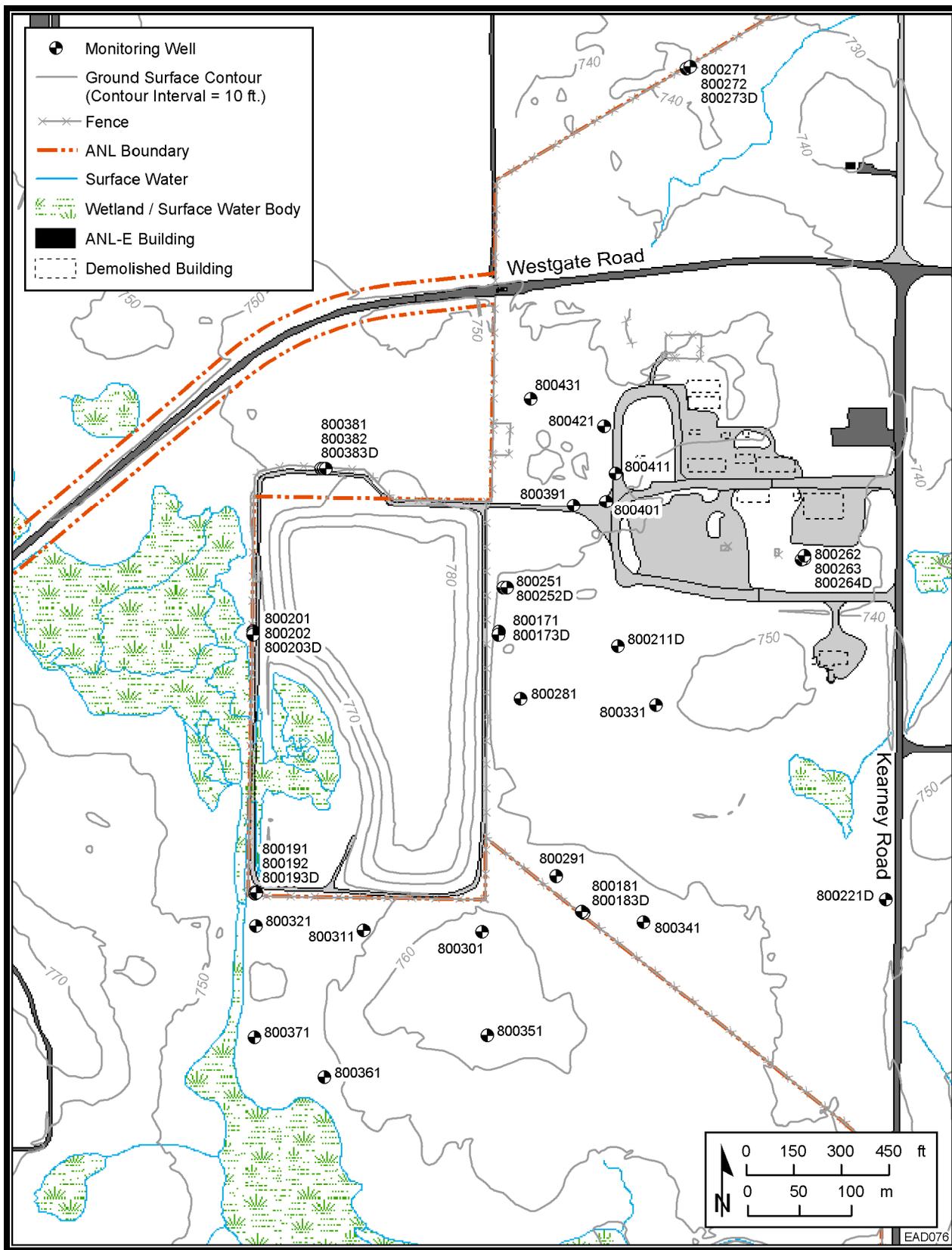


FIGURE 6.20 Monitoring Wells in the 800 Area

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TABLE 6.24

Groundwater Monitoring Wells: 800 Area Landfill

ID Number ^a	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^b	Date Drilled
800171	7.62	228.42	222.32–220.80	0.05/SS	10/92
800173D	39.62	228.40	192.13–189.09	0.05/SS	10/92
800181	10.67	230.52	221.37–219.85	0.05/SS	10/92
800183D	49.99	230.37	183.43–180.38	0.05/SS	10/92
800191	4.63	227.38	224.43–222.90	0.05/SS	10/92
800192	18.29	227.40	210.63–209.11	0.05/SS	10/92
800193D	46.02	227.34	184.40–181.35	0.05/SS	10/92
800201	10.67	227.93	218.78–217.26	0.05/SS	10/92
800202	18.38	227.92	211.07–209.54	0.05/SS	10/92
800203D	38.40	227.92	192.63–189.47	0.05/SS	9/92
800271	4.57	225.62	223.18–221.65	0.05/SS	8/99
800272	13.72	225.61	213.42–211.90	0.05/SS	8/99
800273D	37.49	225.61	191.78–188.12	0.05/SS	8/99
800281	3.96	227.66	225.52–224.00	0.05/SS	9/99
800291	7.01	230.49	225.00–223.48	0.05/SS	9/99
800301	7.62	232.53	226.51–224.91	0.05/SS	9/99
800311	13.72	227.41	217.35–214.31	0.05/SS	9/99
800321	4.27	227.93	225.26–223.66	0.05/SS	9/99
800331	5.18	227.93	224.27–222.75	0.05/SS	9/99
800341	3.96	229.97	227.53–226.01	0.05/SS	9/99
800351	11.89	232.75	223.91–220.86	0.05/SS	9/99
800361	7.01	227.24	222.12–220.52	0.05/SS	9/99
800371	9.75	227.50	219.27–217.44	0.05/SS	9/99
800381 ^c	7.31	231.11	227.44–224.40	0.05/SS	6/99
800382 ^c	19.20	231.18	215.33–212.28	0.05/SS	6/99
800383D ^c	44.50	231.24	190.39–187.35	0.05/SS	6/99

^a Wells identified by a “D” are deeper wells monitoring the dolomite bedrock aquifer.

^b Inner diameter (m)/well material (SS = stainless steel).

^c Replacement wells used after July 1, 1999.

6.3.2.2. Sample Analyses — 800 Area

The 800 Area sample analyses were performed by using SOPs written, reviewed, and issued as controlled documents by members of EQO-AS. These SOPs reference protocols in EPA-SW-846.²⁶ Fifteen metals were analyzed by using inductively coupled plasma atomic emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was determined by means of cold vapor atomic absorption spectroscopy. VOCs were determined by using a purge-and-trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. SVOCs were determined by using solvent extraction followed by gas chromatography-mass spectroscopy detection. PCBs and pesticides were determined by means of solvent extraction followed by gas chromatography-electron capture detection. TDS were determined gravimetrically. Sulfate determination was performed by using a turbidimetric technique, while chloride was determined by means of titrimetry. Ammonia nitrogen was determined by using distillation followed by an ion-selective electrode technique.

Some analyses were performed at an off-site contractor laboratory. EPA-SW-846²⁶ procedures were specified and used. Cyanide and phenol were determined by distillation followed by a spectrophotometric measurement. Total organic carbon (TOC) and total organic halogen (TOX) were determined by using combustion techniques followed by infrared detection and coulometric titration, respectively. Chlorinated organic compounds and carbamate pesticides were analyzed by extractions followed by gas and liquid chromatography techniques, respectively.

The 800 Area groundwater radiological analyses were performed by using SOPs written, reviewed, and issued as controlled documents by members of EQO-AS. Hydrogen-3 was determined by means of distillation followed by a beta liquid scintillation counting technique. Cesium-137 was determined by using gamma-ray spectrometry.

6.3.2.3. Basis for Evaluation of Analytical Results

For filtered samples, the permit requires the comparison of the individual results with a background data set (derived from well nest 800271, 800272, and 800273D) that represents at least 20 quarters of data. For comparison of the 2005 data, Argonne used 21 quarters of data covering the period from the fourth quarter of 1999 through the fourth quarter of 2004. The statistical evaluation was conducted by using the procedures outlined in the permit for the shallow upgradient well results (800271) and the deep upgradient well results (800273D). The intermediate well, 800272, was dry during the entire period.

For unfiltered samples, the results are compared to the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater (35 IAC Part 620.410).

6.3.2.4. Results of Analyses

Descriptions of each well, field parameters measured during sample collection, and the results of chemical and radiological analysis of samples from the wells in the 800 Area are

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presented in Tables 6.25 to 6.48. All radiological and inorganic analysis results are shown in these tables. The analytical methods used for organic compounds could be used to identify and quantify all of the compounds contained in the CLP Target Compound List. However, the vast majority of these compounds were not detected in the samples. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 5 µg/L.

The IEPA has mandated that Argonne utilize the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater (35 IAC Part 620.410) for comparison with groundwater quality results for all unfiltered parameters.

In general, groundwater quality at the 800 Area Landfill appears to be related to the level of turbidity in the sample. A low-flow sampling technology is now used for eight wells to reduce the effect of turbidity on measured parameter levels. The application of a clay cap to the landfill, which was completed in October 1993, may prevent migration of contaminants from the glacial drift. Comparison of a number of years' monitoring results indicates that several parameters consistently exceed the WQSs at selected wells.

The constituents most commonly detected at elevated levels (filtered samples) and at levels above the WQS (unfiltered samples) in the shallow wells are chloride, iron, lead, manganese, sulfate, and TDS. Figure 6.21 shows the trend for unfiltered manganese WQS exceedances for the shallow wells. When comparing unfiltered results of bailer-sampled wells with low-flow-technology sampled wells, it appears that reduced turbidity has a noticeable effect on measured parameter levels. Further studies are continuing with IEPA approval to further evaluate the low-flow sampling technique.

Field Parameters. Field parameters include well and water depth information, pH, specific conductance, and water temperature. These parameters are measured each quarter. No standards exist for comparative purposes, with the exception of pH. However, results are consistent from quarter to quarter and are similar to results obtained in previous years.

Filtered Routine Indicator Parameters. Filtered routine indicator parameters include ammonia nitrogen, arsenic, cadmium, chloride, iron, lead, manganese, mercury, sulfate, and TDS. These parameters are measured each quarter. As noted in past years, manganese is the most persistent elevated parameter noted in the shallow wells. Manganese concentrations were elevated in 5 of the 16 shallow wells. Elevated levels were noted in at least one quarter in Wells 800191, 800201, 800281, 200301, and 800381. Manganese levels ranged from <0.010 to 1.3 mg/L, chloride levels ranged from 2 to 231 mg/L, TDS levels ranged from 369 to 2,593 mg/L, and sulfate levels ranged from 22 to 1,245 mg/L.

Historically, fewer indicator parameters are found in the intermediate wells, and those are detected infrequently. Elevated levels of manganese were measured during all quarters in Well 800192. Iron concentrations were elevated during two quarters in Well 800192.

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TABLE 6.25

Groundwater Monitoring Results, Sanitary Landfill Well 800381, 2005

Parameter	Unit	Date of Sampling				
		Jan. 25	Jan. 25	April 19	July 26	Nov. 1
Water elevation ^a	m	229.15	229.15	229.81	227.06	226.15
Temperature	°C	9.0	9.0	15.4	16.6	13.0
pH	pH	6.92	6.92	7.01	7.30	7.01
Redox	mV	19	19	0	-20	-21
Conductivity	µmhos/cm	1,189	1,189	1,301	1,385	1,120
Chloride ^b	mg/L	23	23	23	36	41
Sulfate ^b	mg/L	349	349	267	353	198
TDS ^b	mg/L	1,109	1,117	1,043	1,183	930
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.033	0.032	0.042	0.053	0.087
Boron ^c	mg/L	0.0713	0.0676	0.0588	0.0457	0.0490
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^c	mg/L	0.386	0.345	0.703	0.583	0.673
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.238^d	0.242	0.202	0.227	0.131
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.0351	0.0364	0.0260	0.0196	0.0226
Ammonia nitrogen ^b	mg/L	0.15	0.15	<0.05	<0.05	0.07
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.031	0.032	0.045	0.056	0.088
Boron ^b	mg/L	0.0543	0.0568	0.0448	0.0510	0.0631
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	0.167	1.00
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.244	0.242	0.216	0.253	0.152
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.031	0.025	0.015	0.015	<0.008
Nitrate ^c	mg/L	- ^e	-	0.2	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100	<100
Chloride ^c	mg/L	26	26	26	36	39
Fluoride ^c	mg/L	-	-	0.399	-	-
Sulfate ^c	mg/L	347	355	248	359	156
TOCs ^c	mg/L	3.2	3.3	3.2	3.6	2.9
TOCs ^c	mg/L	3.2	3.2	3.2	3.6	2.8
TOCs ^c	mg/L	3.3	3.3	3.2	3.5	2.8
TOCs ^c	mg/L	3.3	3.2	3.3	3.5	2.8
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	-	<0.020

^a Well point elevation = 224.40 m (AMSL); ground surface elevation = 231.11 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

^e A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.26

Groundwater Monitoring Results, Sanitary Landfill Well 800382, 2005

Parameter	Unit	Date of Sampling			
		Jan. 10	April 4	July 5	Oct. 5
Water elevation ^a	m	219.53	220.14	219.72	218.86
Temperature	°C	10.4	14.0	15.2	14.5
pH	pH	7.22	7.05	7.24	7.36
Redox	mV	0	1	-15	-46
Conductivity	µmhos/cm	845	924	982	909
Chloride ^b	mg/L	106	106	113	106
Sulfate ^b	mg/L	84	79	79	78
TDS ^b	mg/L	697	660	754	776
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.118	-	-
Boron ^c	mg/L	-	0.0732	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	3.66	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.106	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.011	-	-
Ammonia nitrogen ^b	mg/L	0.10	0.46	0.56	0.37
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.125	0.122	0.122	0.130
Boron ^b	mg/L	0.0529	0.0541	0.0451	0.0520
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	1.9855	2.6900	2.1751	0.8619
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.114	0.105	0.122	0.118
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	110	-	-
Fluoride ^c	mg/L	-	0.331	-	-
Sulfate ^c	mg/L	-	77	-	-
TOCs ^c	mg/L	2.8	3.0	3.3	3.7
TOCs ^c	mg/L	3.0	3.0	3.3	3.9
TOCs ^c	mg/L	3.0	2.9	3.3	3.3
TOCs ^c	mg/L	2.8	2.9	3.3	3.9
TOXs ^c	mg/L	0.023	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 212.28 m (AMSL); ground surface elevation = 231.18 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.27

Groundwater Monitoring Results, Sanitary Landfill Well 800383D, 2005

Parameter	Unit	Date of Sampling			
		Jan. 10	April 4	July 5	Oct. 5
Water elevation ^a	m	192.15	192.44	192.21	191.73
Temperature	°C	10.6	13.6	14.6	13.7
pH	pH	6.97	7.10	7.32	7.21
Redox	mV	13	-1	-20	-29
Conductivity	µmhos/cm	1,160	1,216	1,181	1,137
Chloride ^b	mg/L	203	176	176	165
Sulfate ^b	mg/L	126	134	136	132
TDS ^b	mg/L	913	887	1,066	913
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.068	-	-
Boron ^c	mg/L	-	0.1723	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	1.87	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.057	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.0131	-	-
Ammonia nitrogen ^b	mg/L	0.46	0.80	0.73	0.93
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.074	0.070	0.069	0.075
Boron ^b	mg/L	0.1516	0.1543	0.1424	0.1630
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	1.11	1.23	1.20	1.45
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.049	0.048	0.051	0.049
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	0.007	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	193	-	-
Fluoride ^c	mg/L	-	0.474	-	-
Sulfate ^c	mg/L	-	132	-	-
TOCs ^c	mg/L	2.1	2.0	2.1	1.9
TOCs ^c	mg/L	2.1	2.0	2.0	1.9
TOCs ^c	mg/L	2.1	2.0	2.0	2.0
TOCs ^c	mg/L	2.1	2.0	2.1	2.0
TOXs ^c	mg/L	0.025	<0.020	<0.020	<0.020
TOXs ^c	mg/L	0.023	0.021	0.029	0.025

^a Well point elevation = 187.35 m (AMSL); ground surface elevation = 231.21 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.28

Groundwater Monitoring Results, Sanitary Landfill Well 800171, 2005

Parameter	Unit	Date of Sampling				
		Jan. 31	April 25	July 25	July 25	Nov. 1
Water elevation ^a	m	226.84	226.94	224.54	224.54	223.70
Temperature	°C	9.4	11.7	14.5	14.5	12.1
pH	pH	6.90	7.06	7.42	7.42	7.26
Redox	mV	19	0	-27	-27	-37
Conductivity	µmhos/cm	780	1,088	1,099	1,099	1,078
Chloride ^b	mg/L	23	121	95	113	129
Sulfate ^b	mg/L	92	62	80	84	78
TDS ^b	mg/L	630	850	873	891	952
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.052	0.063	0.065	0.062	0.068
Boron ^c	mg/L	0.1306	0.1211	0.1266	0.1332	0.1432
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^c	mg/L	0.151	0.173	0.475	0.206	0.133
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.084	0.055	0.087	0.041	0.094
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.010	<0.008	0.011	0.010	0.013
Ammonia nitrogen ^b	mg/L	0.08	6.30	0.20	<0.05	<0.05
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.053	0.064	0.058	0.064	0.070
Boron ^b	mg/L	0.1190	0.1106	0.1105	0.1214	0.1291
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.066	0.038	0.043	0.080	0.137
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.0669	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	- ^d	0.70	-	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100	<100
Chloride ^c	mg/L	8	8	142	110	157
Fluoride ^c	mg/L	-	0.214	0.232	-	-
Sulfate ^c	mg/L	88	75	63	83	98
TOCs ^c	mg/L	2.4	3.0	2.2	2.6	2.6
TOCs ^c	mg/L	2.3	3.0	2.3	2.7	2.6
TOCs ^c	mg/L	2.3	3.0	2.3	2.7	2.6
TOCs ^c	mg/L	2.3	3.1	2.3	2.7	2.6
TOXs ^c	mg/L	<0.020	<0.020	<0.020	0.027	0.038
TOXs ^c	mg/L	<0.020	<0.020	0.021	-	0.048

^a Well point elevation = 220.80 m (AMSL); ground surface elevation = 228.42 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.29

Groundwater Monitoring Results, Sanitary Landfill Well 800173D, 2005

Parameter	Unit	Date of Sampling			
		Jan. 17	April 5	July 19	Oct. 5
Water elevation ^a	m	192.52	192.91	192.22	192.23
Temperature	°C	10.0	16.0	17.2	13.5
pH	pH	7.75	7.00	7.27	6.85
Redox	mV	5	4	-23	-12
Conductivity	µmhos/cm	1,228	1,360	1,404	1,303
Chloride ^b	mg/L	265	194	228	248
Sulfate ^b	mg/L	117	87	110	99
TDS ^b	mg/L	928	927	1,015	1,045
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.004	-	-
Barium ^c	mg/L	-	0.082	-	-
Boron ^c	mg/L	-	0.1509	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	2.74	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.059	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.046	-	-
Ammonia nitrogen ^b	mg/L	0.6	1.0	1.0	1.0
Arsenic ^b	mg/L	0.004	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.090	0.083	0.077	0.089
Boron ^b	mg/L	0.1335	0.1450	0.1358	0.1358
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	2.18	1.30	0.271	0.802
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.078	0.056	0.062	0.065
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	231	-	-
Fluoride ^c	mg/L	-	0.513	-	-
Sulfate ^c	mg/L	-	93	-	-
TOCs ^c	mg/L	4.0	3.6	3.6	3.4
TOCs ^c	mg/L	4.1	3.4	3.6	4.5
TOCs ^c	mg/L	4.2	3.5	3.6	4.4
TOCs ^c	mg/L	4.1	3.8	3.5	4.5
TOXs ^c	mg/L	0.031	0.026	<0.020	0.022
TOXs ^c	mg/L	0.050	0.028	<0.020	0.035

^a Well point elevation = 189.09 m (AMSL); ground surface elevation = 228.40 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.30

Groundwater Monitoring Results, Sanitary Landfill Well 800181, 2005

Parameter	Unit	Date of Sampling		
		Jan. 17	April 3	July 11
Water elevation ^a	m	226.13	228.54	221.54
Temperature	°C	10.1	10.3	11.8
pH	pH	7.06	7.91	7.49
Redox	mV	-10	-47	-26
Conductivity	µmhos/cm	1,303	539	956
Chloride ^b	mg/L	7	8	7
Sulfate ^b	mg/L	205	62	99
TDS ^b	mg/L	831	451	622
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.004	-
Barium ^c	mg/L	-	0.012	-
Boron ^c	mg/L	-	0.0166	-
Cadmium ^c	mg/L	-	<0.0002	-
Chromium ^c	mg/L	-	<0.043	-
Cobalt ^c	mg/L	-	<0.017	-
Copper ^c	mg/L	-	<0.021	-
Iron ^c	mg/L	-	0.791	-
Lead ^c	mg/L	-	<0.002	-
Manganese ^c	mg/L	-	0.045	-
Mercury ^c	mg/L	-	<0.0002	-
Nickel ^c	mg/L	-	<0.035	-
Selenium ^c	mg/L	-	<0.003	-
Silver ^c	mg/L	-	<0.001	-
Zinc ^c	mg/L	-	0.011	-
Ammonia nitrogen ^b	mg/L	0.16	<0.05	0.06
Arsenic ^b	mg/L	<0.003	0.004	0.004
Barium ^b	mg/L	0.0413	0.0137	0.0236
Boron ^b	mg/L	0.031	<0.016	<0.016
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.020	<0.020	<0.020
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	0.031
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100
Chloride ^c	mg/L	-	8	-
Fluoride ^c	mg/L	-	1.106	-
Sulfate ^c	mg/L	-	59	-
TOCs ^c	mg/L	2.3	2.5	2.7
TOCs ^c	mg/L	2.2	2.5	2.7
TOCs ^c	mg/L	2.2	2.6	2.7
TOCs ^c	mg/L	2.3	2.5	2.5
TOXs ^c	mg/L	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020

^a Well point elevation = 219.85 m (AMSL); ground surface elevation = 230.52 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.31

Groundwater Monitoring Results, Sanitary Landfill Well 800183D, 2005

Parameter	Unit	Date of Sampling			
		Jan. 17	April 13	July 11	Oct. 10
Water elevation ^a	m	192.51	192.85	192.57	192.46
Temperature	°C	11.1	11.4	14.1	12.0
pH	pH	6.92	7.41	7.02	7.08
Redox	mV	-1	-19	-1	-22
Conductivity	µmhos/cm	1,276	1,032	1,263	1,061
Chloride ^b	mg/L	113	112	147	140
Sulfate ^b	mg/L	156	139	139	136
TDS ^b	mg/L	796	826	955	963
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.041	-	-
Boron ^c	mg/L	-	0.1776	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	0.986	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.023	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	<0.008	-	-
Ammonia nitrogen ^b	mg/L	0.20	0.94	1.0	1.1
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.047	0.042	0.047	0.048
Boron ^b	mg/L	0.1675	0.1563	0.1636	0.1637
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.594	0.467	0.441	0.632
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.016	0.014	0.015	0.016
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	140	-	-
Fluoride ^c	mg/L	-	0.467	-	-
Sulfate ^c	mg/L	-	140	-	-
TOCs ^c	mg/L	2.4	2.4	2.6	3.0
TOCs ^c	mg/L	2.4	2.4	2.6	2.7
TOCs ^c	mg/L	2.3	2.5	2.6	2.7
TOCs ^c	mg/L	2.4	2.5	2.7	2.7
TOXs ^c	mg/L	0.029	<0.020	0.021	<0.020
TOXs ^c	mg/L	0.029	<0.020	<0.020	<0.020

^a Well point elevation = 180.38 m (AMSL); ground surface elevation = 230.37 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.32

Groundwater Monitoring Results, Sanitary Landfill Well 800191, 2005

Parameter	Unit	Date of Sampling		
		Jan. 12	April 13	July 6
Water elevation ^a	m	226.34	226.42	225.12
Temperature	°C	10.0	9.2	11.0
pH	pH	6.80	6.79	6.82
Redox	mV	5	13	11
Conductivity	µmhos/cm	1,536	1,465	1,410
Chloride ^b	mg/L	121	60	49
Sulfate ^b	mg/L	334	366	309
TDS ^b	mg/L	1,033	1,063	1,040
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	– ^d	<0.003	–
Barium ^c	mg/L	–	0.086	–
Boron ^c	mg/L	–	0.0718	–
Cadmium ^c	mg/L	–	<0.0002	–
Chromium ^c	mg/L	–	<0.043	–
Cobalt ^c	mg/L	–	<0.017	–
Copper ^c	mg/L	–	<0.021	–
Iron ^c	mg/L	–	6.22^e	–
Lead ^c	mg/L	–	<0.002	–
Manganese ^c	mg/L	–	1.33	–
Mercury ^c	mg/L	–	<0.0002	–
Nickel ^c	mg/L	–	<0.035	–
Selenium ^c	mg/L	–	<0.003	–
Silver ^c	mg/L	–	<0.001	–
Zinc ^c	mg/L	–	0.023	–
Ammonia nitrogen ^b	mg/L	0.52	1.4	1.9
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.108	0.084	0.093
Boron ^b	mg/L	0.0618	0.0477	0.0448
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	2.18	5.37	3.24
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	1.26	1.30	1.28
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.017	0.010	0.014
Nitrate ^c	mg/L	–	<0.1	–
Phenols ^c	mg/L	<0.005	0.009	<0.005
Hydrogen-3 ^c	pCi/L	161	<100	124
Chloride ^c	mg/L	–	61	–
Fluoride ^c	mg/L	–	0.564	–
Sulfate ^c	mg/L	–	368	–
TOCs ^c	mg/L	6.1	6.2	6.8
TOCs ^c	mg/L	6.0	6.2	6.6
TOCs ^c	mg/L	6.0	6.3	6.7
TOCs ^c	mg/L	6.0	6.2	6.7
TOXs ^c	mg/L	<0.020	0.033	0.042
TOXs ^c	mg/L	<0.020	<0.020	0.024

^a Well point elevation = 222.90 m (AMSL); ground surface elevation = 227.38 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.33

Groundwater Monitoring Results, Sanitary Landfill Well 800192, 2005

Parameter	Unit	Date of Sampling				
		Jan. 12	April 18	July 6	Oct. 6	Oct. 6
Water elevation ^a	m	222.80	222.80	221.22	219.61	219.61
Temperature	°C	10.6	13.0	16.7	11.8	11.8
pH	pH	6.62	6.89	6.78	6.77	6.77
Redox	mV	16	14	12	13	13
Conductivity	µmhos/cm	1,456	1,278	1,479	1,462	1,462
Chloride ^b	mg/L	85	94	85	81	78
Sulfate ^b	mg/L	340	267	262	260	279
TDS ^b	mg/L	1,028	1,126	1,138	1,178	1,200
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	– ^d	0.036	–	–	–
Barium ^c	mg/L	–	0.987	–	–	–
Boron ^c	mg/L	–	0.1570	–	–	–
Cadmium ^c	mg/L	–	<0.0002	–	–	–
Chromium ^c	mg/L	–	<0.043	–	–	–
Cobalt ^c	mg/L	–	<0.017	–	–	–
Copper ^c	mg/L	–	<0.021	–	–	–
Iron ^c	mg/L	–	52.19^e	–	–	–
Lead ^c	mg/L	–	0.0025	–	–	–
Manganese ^c	mg/L	–	0.263	–	–	–
Mercury ^c	mg/L	–	<0.0002	–	–	–
Nickel ^c	mg/L	–	<0.035	–	–	–
Selenium ^c	mg/L	–	<0.003	–	–	–
Silver ^c	mg/L	–	0.005	–	–	–
Zinc ^c	mg/L	–	0.018	–	–	–
Ammonia nitrogen ^b	mg/L	0.80	3.1	1.4	0.87	0.81
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.420	0.454	0.400	0.460	0.492
Boron ^b	mg/L	0.0518	0.0609	0.0361	0.0637	0.0592
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	0.022	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	7.02	11.71	1.42	11.67	12.82
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.202	0.206	0.157	0.193	0.201
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.014	0.009	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	–	<0.1	–	–	–
Phenols ^c	mg/L	<0.005	0.036	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	362	319	299	324	323
Chloride ^c	mg/L	–	95	–	–	–
Fluoride ^c	mg/L	–	0.496	–	–	–
Sulfate ^c	mg/L	–	267	–	–	–
TOCs ^c	mg/L	30.0	10.0	30.0	15.0	15.0
TOCs ^c	mg/L	30.0	11.0	30.0	15.0	15.0
TOCs ^c	mg/L	30.0	10.0	30.0	15.0	15.0
TOCs ^c	mg/L	30.0	10.0	29.0	15.0	15.0
TOXs ^c	mg/L	0.033	<0.020	0.033	<0.020	0.022
TOXs ^c	mg/L	0.022	0.022	0.028	<0.020	0.023

^a Well point elevation = 209.11 m (AMSL); ground surface elevation = 227.40 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.34

Groundwater Monitoring Results, Sanitary Landfill Well 800193D, 2005

Parameter	Unit	Date of Sampling			
		Jan. 12	April 18	July 6	Oct. 6
Water elevation ^a	m	192.80	192.90	192.59	192.44
Temperature	°C	10.7	13.1	14.2	11.7
pH	pH	6.91	7.20	6.98	7.01
Redox	mV	-1	-9	2	-1
Conductivity	µmhos/cm	1,377	1,130	1,385	1,291
Chloride ^b	mg/L	131	161	162	123
Sulfate ^b	mg/L	176	137	156	188
TDS ^b	mg/L	884	951	935	914
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.060	-	-
Boron ^c	mg/L	-	0.1708	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	1.89	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.030	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	<0.008	-	-
Ammonia nitrogen ^b	mg/L	0.17	0.88	0.91	0.81
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.060	0.062	0.064	0.059
Boron ^b	mg/L	0.1579	0.1580	0.1508	0.1649
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	1.00	1.12	1.12	1.08
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.029	0.023	0.025	0.022
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	189	-	-
Fluoride ^c	mg/L	-	0.508	-	-
Sulfate ^c	mg/L	-	159	-	-
TOCs ^c	mg/L	2.7	2.6	3.0	2.8
TOCs ^c	mg/L	2.8	2.8	3.0	2.6
TOCs ^c	mg/L	2.8	2.8	3.1	2.7
TOCs ^c	mg/L	2.8	2.5	2.9	2.7
TOXs ^c	mg/L	<0.020	0.024	0.026	0.023
TOXs ^c	mg/L	0.024	<0.020	0.031	<0.020

^a Well point elevation = 181.35 m (AMSL); ground surface elevation = 227.34 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.35

Groundwater Monitoring Results, Sanitary Landfill Well 800201, 2005

Parameter	Unit	Date of Sampling			
		Jan. 26	April 26	July 26	Nov. 2
Water elevation ^a	m	225.00	225.33	224.07	223.05
Temperature	°C	8.5	11.4	19.6	11.8
pH	pH	7.37	7.14	7.28	7.17
Redox	mV	-6	-6	-17	-31
Conductivity	µmhos/cm	831	905	1,024	927
Chloride ^b	mg/L	15	16	19	18
Sulfate ^b	mg/L	80	65	78	80
TDS ^b	mg/L	774	754	753	781
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	0.007	0.005	0.004	<0.003
Barium ^c	mg/L	0.271	0.244	0.249	0.266
Boron ^c	mg/L	0.0616	0.0537	0.0529	0.0548
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^c	mg/L	5.36^d	3.48	3.20	3.16
Lead ^c	mg/L	0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.281	0.139	0.140	0.248
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.027	0.019	0.017	0.022
Ammonia nitrogen ^b	mg/L	3.6	4.1	2.1	2.5
Arsenic ^b	mg/L	0.0060	0.0060	<0.003	<0.003
Barium ^b	mg/L	0.267	0.255	0.221	0.267
Boron ^b	mg/L	0.0509	0.0472	0.0431	0.0439
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	2.66	3.27	1.04	1.30
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.266	0.148	0.136	0.233
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.010	<0.008	0.009	0.019
Nitrate ^c	mg/L	- ^e	0.58	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	100	<100
Chloride ^c	mg/L	14	16	19	18
Fluoride ^c	mg/L	-	0.359	-	-
Sulfate ^c	mg/L	83	64	77	70
TOCs ^c	mg/L	31.0	28.0	29.0	32.0
TOCs ^c	mg/L	31.0	29.0	29.0	32.0
TOCs ^c	mg/L	31.0	29.0	29.0	32.0
TOCs ^c	mg/L	31.0	29.0	28.0	32.0
TOXs ^c	mg/L	<0.020	<0.020	<0.020	0.026
TOXs ^c	mg/L	<0.020	<0.020	-	0.034

^a Well point elevation = 217.26 m (AMSL); ground surface elevation = 227.93 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

^e A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.36

Groundwater Monitoring Results, Sanitary Landfill Well 800202, 2005

Parameter	Unit	Date of Sampling			
		Jan. 10	April 6	July 18	Oct. 18
Water elevation ^a	m	218.56	219.15	218.64	218.43
Temperature	°C	9.7	11.5	14.8	11.2
pH	pH	7.30	7.40	7.29	7.03
Redox	mV	-4	-15	-20	-24
Conductivity	µmhos/cm	807	838	893	832
Chloride ^b	mg/L	30	29	29	31
Sulfate ^b	mg/L	83	75	74	70
TDS ^b	mg/L	638	647	665	662
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.204	-	-
Boron ^c	mg/L	-	0.0893	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	6.49^e	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.103	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.014	-	-
Ammonia nitrogen ^b	mg/L	2.3	2.5	2.4	2.4
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.186	0.188	0.169	0.194
Boron ^b	mg/L	0.0741	0.0768	0.0707	0.0743
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	4.89	5.03	4.29	5.16
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.098	0.097	0.096	0.095
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	112
Chloride ^c	mg/L	-	29	-	-
Fluoride ^c	mg/L	-	0.306	-	-
Sulfate ^c	mg/L	-	74	-	-
TOCs ^c	mg/L	12.0	12.0	13.0	12.0
TOCs ^c	mg/L	12.0	12.0	13.0	12.0
TOCs ^c	mg/L	12.0	12.0	13.0	12.0
TOCs ^c	mg/L	12.0	12.0	13.0	12.0
TOXs ^c	mg/L	<0.020	<0.020	0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	0.021	<0.020

^a Well point elevation = 209.54 m (AMSL); ground surface elevation = 227.93 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.37

Groundwater Monitoring Results, Sanitary Landfill Well 800203D, 2005

Parameter	Unit	Date of Sampling				
		Jan. 10	April 6	April 6	July 18	Oct. 18
Water elevation ^a	m	195.57	192.92	192.92	192.33	192.50
Temperature	°C	10.6	14.7	14.7	13.6	11.5
pH	pH	7.02	7.10	7.10	7.17	6.95
Redox	mV	10	0	0	-11	-18
Conductivity	µmhos/cm	950	991	991	930	850
Chloride ^b	mg/L	116	132	145	81	65
Sulfate ^b	mg/L	43	43	43	34	38
TDS ^b	mg/L	678	689	696	648	625
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	<0.003	-	-
Barium ^c	mg/L	-	0.113	0.115	-	-
Boron ^c	mg/L	-	0.1780	0.1784	-	-
Cadmium ^c	mg/L	-	<0.0002	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	<0.043	-	-
Cobalt ^c	mg/L	-	0.108	0.110	-	-
Copper ^c	mg/L	-	<0.021	<0.021	-	-
Iron ^c	mg/L	-	0.474	0.712	-	-
Lead ^c	mg/L	-	<0.002	<0.002	-	-
Manganese ^c	mg/L	-	0.054	0.056	-	-
Mercury ^c	mg/L	-	<0.0002	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	<0.003	-	-
Silver ^c	mg/L	-	<0.001	<0.001	-	-
Zinc ^c	mg/L	-	0.037	0.028	-	-
Ammonia nitrogen ^b	mg/L	1.8	2.0	2.1	2.2	1.3
Arsenic ^b	mg/L	0.005	<0.003	0.003	<0.003	<0.003
Barium ^b	mg/L	0.126	0.113	0.120	0.109	0.126
Boron ^b	mg/L	0.1457	0.1539	0.1499	0.1620	0.1635
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	0.068	0.068	0.067	0.104	0.062
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	2.05	0.554	1.23	0.061	0.671
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.031	0.044	0.046	0.043	0.032
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100	<100
Chloride ^c	mg/L	-	170	169	-	-
Fluoride ^c	mg/L	-	0.408	0.477	-	-
Sulfate ^c	mg/L	-	43	41	-	-
TOCs ^c	mg/L	5.2	4.9	5.1	4.8	4.7
TOCs ^c	mg/L	5.3	4.9	5.1	4.9	4.6
TOCs ^c	mg/L	5.1	4.9	5.1	4.8	4.6
TOCs ^c	mg/L	5.2	4.9	5.1	4.8	4.6
TOXs ^c	mg/L	<0.020	<0.020	0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 189.47 m (AMSL); ground surface elevation = 227.93 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.38

Groundwater Monitoring Results, Sanitary Landfill Well 800271, 2005

Parameter	Unit	Date of Sampling			
		Jan. 19	April 26	July 26	Nov. 2
Water elevation ^a	m	225.13	225.11	223.09	222.40
Temperature	°C	8.3	8.2	16.3	12.6
pH	pH	6.81	7.51	7.48	7.42
Redox	mV	2	-24	-30	-44
Conductivity	µmhos/cm	665	446	614	566
Chloride ^b	mg/L	2	3	3	4
Sulfate ^b	mg/L	41	22	44	40
TDS ^b	mg/L	390	369	436	418
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.018	0.015	0.017	0.022
Boron ^c	mg/L	0.0707	0.0567	0.0427	0.0683
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^c	mg/L	0.053	0.340	0.174	0.545
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	<0.010	<0.010	<0.010	0.022
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.014	0.011	0.009	0.012
Ammonia nitrogen ^b	mg/L	0.13	1.3	<0.01	0.06
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.016	0.015	0.016	0.018
Boron ^b	mg/L	0.0572	0.0456	0.0320	0.0616
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	- ^d	2.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	2	3	3	4
Fluoride ^c	mg/L	-	0.243	-	-
Sulfate ^c	mg/L	43	32	46	43
TOCs ^c	mg/L	1.3	1.6	1.5	1.4
TOCs ^c	mg/L	1.2	1.4	1.6	1.8
TOCs ^c	mg/L	1.4	1.4	1.6	2.1
TOCs ^c	mg/L	1.3	1.3	1.8	1.3
TOXs ^c	mg/L	<0.020	<0.020	0.034	<0.020
TOXs ^c	mg/L	<0.020	<0.020	-	<0.020

^a Well point elevation = 221.65 m (AMSL); ground surface elevation = 225.62 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.39

Groundwater Monitoring Results, Sanitary Landfill Well 800273D, 2005

Parameter	Unit	Date of Sampling			
		Jan. 17	April 5	July 19	Nov. 2
Water elevation ^a	m	191.91	192.70	192.45	192.32
Temperature	°C	9.2	13.3	14.4	10.8
pH	pH	7.51	7.14	7.69	7.00
Redox	mV	-12	-3	-35	-23
Conductivity	µmhos/cm	837	935	968	845
Chloride ^b	mg/L	81	106	98	63
Sulfate ^b	mg/L	136	104	125	107
TDS ^b	mg/L	654	696	744	735
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.004	-	-
Barium ^c	mg/L	-	0.037	-	-
Boron ^c	mg/L	-	0.1711	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	1.48	-	-
Lead ^c	mg/L	-	<0.002	-	-
Manganese ^c	mg/L	-	0.015	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.016	-	-
Ammonia nitrogen ^b	mg/L	0.40	0.79	0.86	0.78
Arsenic ^b	mg/L	0.004	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.042	0.042	0.040	0.041
Boron ^b	mg/L	0.1593	0.1600	0.1505	0.1539
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	1.05	1.05	0.639	0.508
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	0.011	0.011
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	102	-	-
Fluoride ^c	mg/L	-	0.477	-	-
Sulfate ^c	mg/L	-	104	-	-
TOCs ^c	mg/L	1.2	1.3	1.4	1.4
TOCs ^c	mg/L	1.2	1.3	1.4	1.4
TOCs ^c	mg/L	1.2	1.3	1.4	1.4
TOCs ^c	mg/L	1.2	1.4	1.4	1.5
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	0.028	<0.020	<0.020	<0.020

^a Well point elevation = 188.12 m (AMSL); ground surface elevation = 225.61 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.40

Groundwater Monitoring Results, Sanitary Landfill Well 800281, 2005

Parameter	Unit	Date of Sampling		
		Jan. 18	April 13	July 13
Water elevation ^a	m	226.96	227.32	225.25
Temperature	°C	6.3	9.1	15.1
pH	pH	6.63	6.84	6.64
Redox	mV	12	10	20
Conductivity	µmhos/cm	1,292	1,254	1,328
Chloride ^b	mg/L	23	70	76
Sulfate ^b	mg/L	135	116	85
TDS ^b	mg/L	772	785	956
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.065	0.054	0.024
Boron ^c	mg/L	0.2433	0.1928	0.0376
Cadmium ^c	mg/L	<0.0002	0.0003	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	0.081
Iron ^c	mg/L	0.240	0.023	0.353
Lead ^c	mg/L	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.233^d	0.286	0.062
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.034	0.015	0.026
Ammonia nitrogen ^b	mg/L	0.14	0.12	0.09
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.067	0.059	0.074
Boron ^b	mg/L	0.2293	0.1913	0.2991
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.242	0.288	1.08
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.015	0.011	0.013
Nitrate ^c	mg/L	- ^e	<0.1	-
Phenols ^c	mg/L	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	249	111	204
Chloride ^c	mg/L	20	70	80
Fluoride ^c	mg/L	-	0.262	-
Sulfate ^c	mg/L	133	113	88
TOCs ^c	mg/L	2.1	1.9	2.9
TOCs ^c	mg/L	2.1	2.0	3.0
TOCs ^c	mg/L	2.1	2.1	3.0
TOCs ^c	mg/L	2.1	1.9	3.0
TOXs ^c	mg/L	0.034	0.024	0.070
TOXs ^c	mg/L	0.024	0.030	0.072

^a Well point elevation = 224.00 m (AMSL); ground surface elevation = 227.66 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

^e A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.41

Groundwater Monitoring Results, Sanitary Landfill Well 800291, 2005

Parameter	Unit	Date of Sampling			
		Jan. 11	April 18	July 13	Oct. 12
Water elevation ^a	m	229.08	228.97	227.17	225.86
Temperature	°C	7.1	13.6	14.3	11.9
pH	pH	6.96	7.07	7.01	6.99
Redox	mV	-4	-4	0	-2
Conductivity	µmhos/cm	1,155	1,159	1,096	1,114
Chloride ^b	mg/L	7	9	9	8
Sulfate ^b	mg/L	208	171	184	190
TDS ^b	mg/L	741	768	775	792
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.022	0.016	0.074	0.023
Boron ^c	mg/L	0.0523	0.0381	0.3135	0.0381
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	0.034	<0.021
Iron ^c	mg/L	0.448	0.388	0.195	0.400
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.140	0.074	1.06^d	0.069
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.022	<0.008	0.026	0.010
Ammonia nitrogen ^b	mg/L	0.10	0.11	0.07	0.09
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.020	0.019	0.021	0.020
Beryllium ^b	mg/L	0.029	0.030	<0.016	0.027
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.170	<0.021	<0.021	0.030
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.128	0.052	0.057	0.063
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	- ^e	<0.1	-	-
Phenols ^c	mg/L	<0.005	0.017	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	7	10	9	8
Fluoride ^c	mg/L	-	0.448	-	-
Sulfate ^c	mg/L	210	180	182	186
TOCs ^c	mg/L	2.0	2.2	2.1	2.1
TOCs ^c	mg/L	2.0	2.4	2.1	2.1
TOCs ^c	mg/L	2.0	2.2	2.1	2.1
TOCs ^c	mg/L	2.0	2.3	2.1	2.1
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 223.52 m (AMSL); ground surface elevation = 230.49 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

^e A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.42

Groundwater Monitoring Results, Sanitary Landfill Well 800301, 2005

Parameter	Unit	Date of Sampling				
		Jan. 10	Jan. 10	April 19	July 12	Oct. 10
Water elevation ^a	m	227.15	227.15	232.14	229.43	227.34
Temperature	°C	8.5	8.5	14.4	12.6	13.0
pH	pH	6.83	6.83	6.87	6.80	6.89
Redox	mV	3	3	6	11	5
Conductivity	µmhos/cm	1,117	1,117	1,109	1,095	1,053
Chloride ^b	mg/L	7	6	8	8	8
Sulfate ^b	mg/L	212	194	149	193	161
TDS ^b	mg/L	739	730	722	790	732
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	0.003	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.020	0.022	0.021	0.025	0.023
Boron ^c	mg/L	0.0615	0.0606	0.0622	0.0548	0.0496
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	0.030	0.022	<0.021
Iron ^c	mg/L	1.14	1.20	0.705	1.22	0.862
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.146	0.149	0.137	0.162^d	0.146
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.020	0.015	0.021	0.015	0.009
Ammonia nitrogen ^b	mg/L	0.07	0.10	0.12	0.07	0.20
Arsenic ^b	mg/L	0.003	0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.020	0.020	0.021	0.022	0.021
Boron ^b	mg/L	0.0441	0.0452	0.0436	0.0342	0.0443
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	1.28	1.35	0.457	0.908	0.778
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.143	0.138	0.138	0.159	0.137
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	- ^e	-	<0.1	-	-
Phenols ^c	mg/L	<0.005	<0.005	0.015	0.006	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100	<100
Chloride ^c	mg/L	6	8	8	8	7
Fluoride ^c	mg/L	-	-	0.377	-	-
Sulfate ^c	mg/L	203	117	149	189	156
TOCs ^c	mg/L	1.4	1.3	1.5	1.5	1.5
TOCs ^c	mg/L	1.3	1.3	1.5	2.1	1.4
TOCs ^c	mg/L	1.3	1.2	1.4	1.5	1.3
TOCs ^c	mg/L	1.2	1.2	1.4	1.5	1.3
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 224.91 m (AMSL); ground surface elevation = 232.53 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

^e A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.43

Groundwater Monitoring Results, Sanitary Landfill Well 800321, 2005

Parameter	Unit	Date of Sampling		
		Jan. 6	April 6	July 11
Water elevation ^a	m	226.75	226.85	224.31
Temperature	°C	8.8	9.0	14.2
pH	pH	6.99	6.83	6.69
Redox	mV	-6	12	17
Conductivity	µmhos/cm	1,619	2,380	2,540
Chloride ^b	mg/L	21	28	37
Sulfate ^b	mg/L	460	675	1,245
TDS ^b	mg/L	1,110	1,465	2,593
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-
Barium ^c	mg/L	-	0.024	-
Boron ^c	mg/L	-	0.0613	-
Cadmium ^c	mg/L	-	<0.0002	-
Chromium ^c	mg/L	-	<0.043	-
Cobalt ^c	mg/L	-	<0.017	-
Copper ^c	mg/L	-	<0.021	-
Iron ^c	mg/L	-	7.07^e	-
Lead ^c	mg/L	-	0.0032	-
Manganese ^c	mg/L	-	0.118	-
Mercury ^c	mg/L	-	<0.0002	-
Nickel ^c	mg/L	-	<0.035	-
Selenium ^c	mg/L	-	<0.003	-
Silver ^c	mg/L	-	<0.001	-
Zinc ^c	mg/L	-	0.038	-
Ammonia nitrogen ^b	mg/L	0.06	<0.05	0.15
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.013	0.013	0.012
Boron ^b	mg/L	0.0573	0.0379	0.0325
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.01	<0.01	<0.01
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	0.009	<0.008
Nitrate ^c	mg/L	-	<0.1	-
Phenols ^c	mg/L	0.026	<0.005	0.009
Hydrogen-3 ^c	pCi/L	<100	<100	<100
Chloride ^c	mg/L	-	32	-
Fluoride ^c	mg/L	-	0.703	-
Sulfate ^c	mg/L	-	848	-
TOCs ^c	mg/L	2.1	2.6	2.8
TOCs ^c	mg/L	2.0	2.4	2.9
TOCs ^c	mg/L	1.9	2.2	3.0
TOCs ^c	mg/L	2.0	2.5	2.8
TOXs ^c	mg/L	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	0.026	<0.020

^a Well point elevation = 223.66 m (AMSL); ground surface elevation = 227.93 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.44

Groundwater Monitoring Results, Sanitary Landfill Well 800331, 2005

Parameter	Unit	Date of Sampling				
		Jan. 5	April 11	April 11	July 5	Oct. 17
Water elevation ^a	m	227.47	227.45	227.45	225.62	223.77
Temperature	°C	9.6	10.4	10.4	11.9	12.1
pH	pH	7.12	7.31	7.31	7.18	7.09
Redox	mV	-13	-15	-15	-10	-9
Conductivity	µmhos/cm	970	951	951	869	908
Chloride ^b	mg/L	6	7	7	6	6
Sulfate ^b	mg/L	174	130	130	118	133
TDS ^b	mg/L	618	598	580	559	611
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.006	0.004	-	-
Barium ^c	mg/L	-	0.077	0.049	-	-
Boron ^c	mg/L	-	0.0848	0.0633	-	-
Cadmium ^c	mg/L	-	0.0002	<0.0002	-	-
Chromium ^c	mg/L	-	0.031	<0.024	-	-
Cobalt ^c	mg/L	-	<0.017	<0.017	-	-
Copper ^c	mg/L	-	0.029	<0.021	-	-
Iron ^c	mg/L	-	25.71^e	12.40	-	-
Lead ^c	mg/L	-	0.0163	0.0081	-	-
Manganese ^c	mg/L	-	0.533	0.245	-	-
Mercury ^c	mg/L	-	<0.0002	<0.0002	-	-
Nickel ^c	mg/L	-	0.042	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	<0.003	-	-
Silver ^c	mg/L	-	<0.001	<0.001	-	-
Zinc ^c	mg/L	-	0.099	0.054	-	-
Ammonia nitrogen ^b	mg/L	0.07	0.15	0.07	0.09	<0.05
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.037	0.032	0.032	0.038	0.039
Boron ^b	mg/L	0.028	0.023	0.023	<0.016	0.028
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	0.020	<0.010	0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.015	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	<0.1	-	-
Phenols ^c	mg/L	0.094	0.007	0.008	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	101	109
Chloride ^c	mg/L	-	7	7	-	-
Fluoride ^c	mg/L	-	0.439	0.476	-	-
Sulfate ^c	mg/L	-	125	132	-	-
TOCs ^c	mg/L	1.2	1.4	1.6	2.3	1.9
TOCs ^c	mg/L	1.2	1.4	1.6	2.4	1.7
TOCs ^c	mg/L	1.3	1.4	1.4	2.3	1.8
TOCs ^c	mg/L	1.2	1.4	1.5	2.5	1.7
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	0.028	<0.020	<0.020

^a Well point elevation = 222.75 m (AMSL); ground surface elevation = 227.93 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.45

Groundwater Monitoring Results, Sanitary Landfill Well 800341, 2005

Parameter	Unit	Date of Sampling			
		Jan. 5	April 6	July 5	Oct. 25
Water elevation ^a	m	229.86	229.74	227.87	226.60
Temperature	°C	7.9	7.4	10.9	11.8
pH	pH	6.99	7.38	7.32	7.10
Redox	mV	-5	-20	-16	-10
Conductivity	µmhos/cm	1,128	1,110	1,030	1,026
Chloride ^b	mg/L	12	13	12	13
Sulfate ^b	mg/L	260	193	201	263
TDS ^b	mg/L	739	732	713	736
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	<0.003	-	-
Barium ^c	mg/L	-	0.039	-	-
Boron ^c	mg/L	-	0.0310	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	5.91^e	-	-
Lead ^c	mg/L	-	0.0035	-	-
Manganese ^c	mg/L	-	0.106	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.034	-	-
Ammonia nitrogen ^b	mg/L	0.07	0.12	0.08	0.12
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.032	0.030	0.032	0.040
Boron ^b	mg/L	0.021	<0.016	<0.016	0.023
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	<0.010	<0.010	0.020
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.017	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	0.35	-	-
Phenols ^c	mg/L	0.053	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	13	-	-
Fluoride ^c	mg/L	-	0.482	-	-
Sulfate ^c	mg/L	-	191	-	-
TOCs ^c	mg/L	2.1	2.3	3.4	2.7
TOCs ^c	mg/L	2.1	2.3	3.3	2.7
TOCs ^c	mg/L	2.1	2.4	3.3	2.7
TOCs ^c	mg/L	2.1	2.4	3.3	2.5
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	0.023	<0.020

^a Well point elevation = 226.01 m (AMSL); ground surface elevation = 229.97 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.46

Groundwater Monitoring Results, Sanitary Landfill Well 800351, 2005

Parameter	Unit	Date of Sampling			
		Jan. 6	April 11	July 5	Oct. 12
Water elevation ^a	m	226.12	229.67	227.56	225.34
Temperature	°C	8.3	11.2	11.9	10.8
pH	pH	6.92	7.19	7.09	7.17
Redox	mV	-1	-9	-5	-14
Conductivity	µmhos/cm	949	945	923	920
Chloride ^b	mg/L	3	4	3	3
Sulfate ^b	mg/L	58	51	51	48
TDS ^b	mg/L	548	549	565	766
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.005	-	-
Barium ^c	mg/L	-	0.093	-	-
Boron ^c	mg/L	-	0.0978	-	-
Cadmium ^c	mg/L	-	<0.0002	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	<0.021	-	-
Iron ^c	mg/L	-	7.36^e	-	-
Lead ^c	mg/L	-	0.0035	-	-
Manganese ^c	mg/L	-	0.121	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.020	-	-
Ammonia nitrogen ^b	mg/L	0.06	0.35	0.38	0.37
Arsenic ^b	mg/L	0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.083	0.088	0.084	0.086
Boron ^b	mg/L	0.0826	0.0836	0.0683	0.0795
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.471	1.45	0.396	0.393
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.023	0.023	0.025	0.025
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	0.032	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	4	-	-
Fluoride ^c	mg/L	-	0.374	-	-
Sulfate ^c	mg/L	-	50	-	-
TOCs ^c	mg/L	1.6	1.6	2.5	4.1
TOCs ^c	mg/L	1.4	1.6	2.5	2.8
TOCs ^c	mg/L	1.4	1.7	2.5	3.8
TOCs ^c	mg/L	1.5	1.7	2.6	4.2
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	0.021	<0.020

^a Well point elevation = 220.86 m (AMSL); ground surface elevation = 232.75 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

6. GROUNDWATER PROTECTION

TABLE 6.47

Groundwater Monitoring Results, Sanitary Landfill Well 800361, 2005

Parameter	Unit	Date of Sampling				
		Jan. 11	April 20	July 12	July 12	Oct. 10
Water elevation ^a	m	225.89	226.55	223.57	223.57	221.83
Temperature	°C	9.0	11.8	14.2	14.2	13.4
pH	pH	6.65	6.96	7.02	7.02	7.04
Redox	mV	11	-1	-1	-1	-2
Conductivity	µmhos/cm	941	899	868	868	843
Chloride ^b	mg/L	13	16	12	14	16
Sulfate ^b	mg/L	184	121	137	131	122
TDS ^b	mg/L	623	582	613	590	617
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^c	mg/L	0.025	0.023	0.026	0.028	0.026
Boron ^c	mg/L	0.0524	0.0381	0.0178	0.0170	0.0163
Cadmium ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^c	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^c	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^c	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^c	mg/L	0.023	0.038	0.082	0.054	0.048
Lead ^c	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^c	mg/L	0.097	0.089	0.061	0.063	0.046
Mercury ^c	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^c	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^c	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^c	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^c	mg/L	0.057	0.045	0.023	0.022	0.025
Ammonia nitrogen ^b	mg/L	<0.05	3.7	0.08	0.08	<0.05
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.025	0.023	0.024	0.025	0.023
Boron ^b	mg/L	<0.016	0.018	0.022	0.021	0.018
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.098	0.091	0.063	0.064	0.039
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	0.042	0.032	0.014	0.015	0.016
Nitrate ^c	mg/L	- ^d	<0.1	-	-	-
Phenols ^c	mg/L	<0.005	0.007	0.008	0.015	<0.005
Hydrogen-3 ^c	pCi/L	<100	206	<100	<100	<100
Chloride ^c	mg/L	13	15	12	16	20
Fluoride ^c	mg/L	-	0.376	-	-	-
Sulfate ^c	mg/L	171	112	130	127	123
TOCs ^c	mg/L	1.6	1.8	1.8	1.7	2.0
TOCs ^c	mg/L	1.7	1.8	1.7	1.7	1.9
TOCs ^c	mg/L	1.6	1.8	1.7	1.7	1.9
TOCs ^c	mg/L	1.6	1.8	1.7	1.7	1.8
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 220.52 m (AMSL); ground surface elevation = 227.24 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.48

Groundwater Monitoring Results, Sanitary Landfill Well 800371, 2005

Parameter	Unit	Date of Sampling			
		Jan. 6	April 5	July 5	Oct. 18
Water elevation ^a	m	218.87	218.89	218.81	218.16
Temperature	°C	9.6	11.8	11.8	10.4
pH	pH	6.89	7.02	6.97	6.93
Redox	mV	0	0	2	-1
Conductivity	µmhos/cm	1,278	1,191	1,111	1,195
Chloride ^b	mg/L	2	2	2	2
Sulfate ^b	mg/L	293	263	213	280
TDS ^b	mg/L	876	869	807	879
Cyanide (total) ^c	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic ^c	mg/L	- ^d	0.011	-	-
Barium ^c	mg/L	-	0.090	-	-
Boron ^c	mg/L	-	0.1717	-	-
Cadmium ^c	mg/L	-	0.0003	-	-
Chromium ^c	mg/L	-	<0.043	-	-
Cobalt ^c	mg/L	-	<0.017	-	-
Copper ^c	mg/L	-	0.044	-	-
Iron ^c	mg/L	-	29.38^e	-	-
Lead ^c	mg/L	-	0.0192	-	-
Manganese ^c	mg/L	-	0.494	-	-
Mercury ^c	mg/L	-	<0.0002	-	-
Nickel ^c	mg/L	-	<0.035	-	-
Selenium ^c	mg/L	-	<0.003	-	-
Silver ^c	mg/L	-	<0.001	-	-
Zinc ^c	mg/L	-	0.132	-	-
Ammonia nitrogen ^b	mg/L	<0.05	0.35	0.18	0.34
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.033	0.028	0.030	0.029
Boron ^b	mg/L	0.1062	0.1005	0.0872	0.0979
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	0.252	<0.021	0.165
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.028	0.052	0.010	0.064
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Selenium ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc ^b	mg/L	<0.008	<0.008	<0.008	<0.008
Nitrate ^c	mg/L	-	<0.1	-	-
Phenols ^c	mg/L	0.020	<0.005	<0.005	<0.005
Hydrogen-3 ^c	pCi/L	<100	<100	<100	<100
Chloride ^c	mg/L	-	2	-	-
Fluoride ^c	mg/L	-	0.534	-	-
Sulfate ^c	mg/L	-	276	-	-
TOCs ^c	mg/L	1.4	1.5	2.2	3.3
TOCs ^c	mg/L	1.3	1.5	2.0	3.2
TOCs ^c	mg/L	1.6	1.4	2.3	3.2
TOCs ^c	mg/L	1.5	1.5	2.0	3.4
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020
TOXs ^c	mg/L	<0.020	<0.020	<0.020	<0.020

^a Well point elevation = 217.44 m (AMSL); ground surface elevation = 227.50 m (AMSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A dash indicates that no samples were collected.

^e Bold type indicates that the unfiltered sample exceeds the State of Illinois Groundwater Quality Standard.

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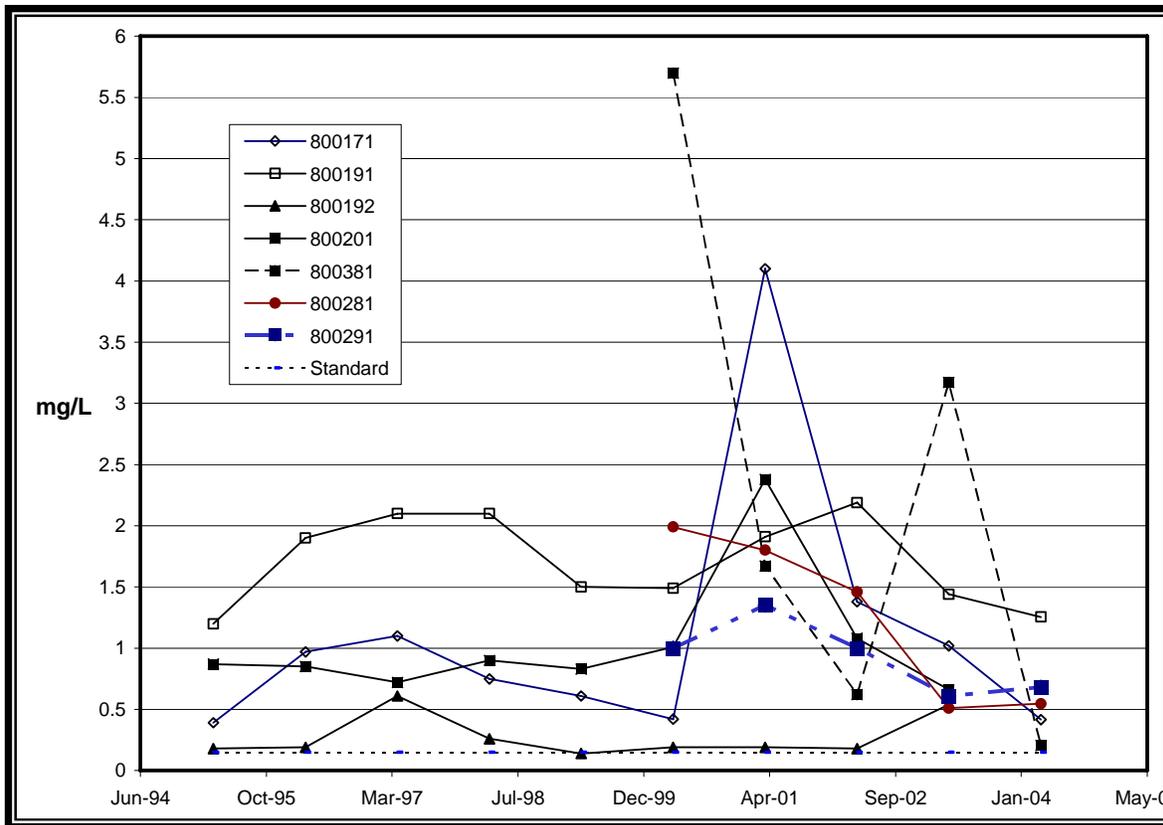


FIGURE 6.21 800 Well Manganese Results

Chloride, manganese, sulfate, and TDS were frequently noted in the deep wells. Iron levels ranged from 0.47 to 2.74 mg/L, chloride levels ranged from 63 to 265 mg/L, sulfate levels ranged from 34 to 188 mg/L, TDS levels ranged from 625 to 1,066 mg/L, and manganese levels ranged from 0.015 to 0.059 mg/L. These concentration ranges are similar to those measured for these parameters over the past few years.

Unfiltered Routine Indicator Parameters. These parameters include cyanide, phenols (total recoverable), TOC, and TOX and are measured each quarter. All measured unfiltered routine indicator parameters were below the appropriate WQS values, where applicable.

Unfiltered Inorganic Parameters. These parameters, which are measured unfiltered only during the second quarter, are measured for all wells and every quarter in Wells 800171, 800201, 800271, 800281, 800291, 800301, 800361, and 800381 as part of a permit-required study. All samples were analyzed for arsenic, barium, boron, cadmium, chloride, chromium, cobalt, copper, cyanide, fluoride, iron, lead, manganese, mercury, nickel, nitrate as nitrogen, selenium, silver, sulfate, and zinc. Boron, cadmium, cobalt, copper, cyanide, fluoride, mercury, nickel, nitrate as nitrogen, selenium, silver, sulfate, and zinc were all below the WQS. Iron, lead, and manganese results are similar to those noted in previous years.

6. GROUNDWATER PROTECTION

Iron concentrations exceeded the WQS (5 mg/L) in Wells 800191, 800192, 800201, 800202, 800321, 800331, 800341, 800351, and 800371. The iron levels ranged up to 52.19 mg/L. These elevated levels are likely to be the result of suspended soil particles in the sample.

Lead concentrations exceeded the WQS (0.0075 mg/L) in Wells 800331 and 800371. Lead levels ranged up to 0.0192 mg/L. These elevated levels are also likely to be the result of suspended soil particles in the sample.

Manganese exceedances of the WQS were similar to those noted in 2004. Manganese concentrations exceeded the WQS (0.15 mg/L) in Wells 800191, 800192, 800201, 800281, 800291, 800301, 800331, 800371, and 800381. Manganese levels in these wells ranged up to 1.08 mg/L. Elevated manganese levels are common across the Argonne site.

Organic Parameters. Each well was sampled quarterly and analyzed for VOCs. As in 2004, VOCs were not detected in any wells in 2005.

Radioactive Constituents. Samples collected from the 800 Area Landfill monitoring wells were also analyzed for hydrogen-3. The results are shown in Tables 6.25 to 6.48. Although the disposal of radioactive materials was prohibited in the sanitary landfill, concentrations of hydrogen-3 were detected during at least one quarter in Wells 800191, 800192, 800202, 800281, 800331, and 800361, which are mostly located east and southwest of the landfill. Hydrogen-3 concentrations ranged from <100 to 362 pCi/L.

As previously mentioned, the general groundwater flow direction in the shallow glacial drift is to the southeast, with a minor component to the west. Seasonal variations are known to exist. The wells in the southwest corner of the landfill area are adjacent to a stream that may be influencing subsurface water flow on the western side of the landfill area. All results are summarized in the 2005 annual summary assessment of the groundwater monitoring program for the 800 Area Landfill, which was sent to the IEPA in July 2006.

6.4. CP-5 Reactor Area

The CP-5 reactor was an inactive research reactor located in Building 330 (see Figure 1.1). The CP-5 5-MW research reactor was used from 1954 until operations ceased in 1979. In addition to the reactor vessel, the CP-5 complex contained several large cooling towers and an outdoor equipment yard for storing equipment and supplies. The reactor and associated yard area have been decommissioned. A single exploratory monitoring well was installed in 1989 in the yard immediately behind the reactor building, just outside the reactor fuel storage area of the complex. Two wells were installed as part of a full characterization study of the yard, which took place during 1993. The three wells have been sampled quarterly since 1995 and analyzed for radionuclides, metals, VOCs, SVOCs, pesticides, herbicides, and PCBs. A deep well was installed during June 1997 to determine whether there had been any vertical migration of hydrogen-3 to the dolomite from the CP-5 reactor.

6. GROUNDWATER PROTECTION

The yard area surrounding the CP-5 reactor structure was classified as a SWMU and was therefore investigated for groundwater releases under the RCRA Part B permit requirements. As part of this investigation, Wells 330051 and 330052 were installed in May 2000 northeast of the CP-5 complex. To improve the understanding and delineation of the CP-5 hydrogeology and groundwater flow direction, five additional wells were installed during February 2003 in the drift surrounding the CP-5 study area. Also, Well 330031 was abandoned and replaced with a new well with a shorter screen, allowing monitoring of the saturated zone within the drift. These six additional wells were incorporated into the Argonne routine groundwater monitoring program during the second quarter of 2004. Data collection from the old and new wells will allow determination of groundwater flow direction within the drift and determination of the extent of potential metals and radionuclide contamination. Table 6.49 characterizes all wells in this area (see Figure 6.22 for locations).

Descriptions of each well, field parameters measured during sample collection, and the results of chemical and radiological analysis of samples from the wells in the 330 Area are presented in Tables 6.50 to 6.58. All radiological and inorganic analysis results are shown in these tables.

Field Parameters. Field parameters include such items as well and water depth information, pH, specific conductance, and temperature of water. These parameters are measured each quarter. Water from four wells (330051, 330061, 330081, and 330091) had elevated

TABLE 6.49

Groundwater Monitoring Wells: 330 Area/CP-5 Reactor

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^a	Date Drilled
330011	6.1	227.23	224.2–220.98	0.05/PVC	8/89
330021	5.8	227.75	226.3–221.7	0.05/SS	9/93
330031 ^b	5.2	227.13	225.6–221.0	0.05/SS	9/93
330012D	41.5	227.08	191.7–185.65	0.05/SS	6/97
330021R	11.9	227.04	216.6–215.15	0.05/PVC	2/03
330031R	9.8	227.65	219.4–217.89	0.05/PVC	2/03
330051	7.0	226.72	221.2–219.7	0.05/PVC	5/00
330052 ^c	10.7	226.66	217.5–215.98	0.05/PVC	5/00
330061	9.7	227.11	218.8–217.36	0.05/PVC	2/03
330071	8.8	226.64	219.3–217.8	0.05/PVC	2/03
330081	4.5	226.60	223.5–222.03	0.05/PVC	2/03
330091	3.8	227.07	224.7–223.26	0.05/PVC	2/03

^a Inner diameter (m)/well material (PVC = polyvinyl chloride, SS = stainless steel).

^b Well abandoned and replaced with new well.

^c Well not sampled.

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conductivity levels. The elevated conductivity levels in Wells 330051 and 330061 may be due to elevated chloride levels from road salt. The elevated levels in Wells 330081 and 330091 appear to be related to intrusion of chloride into the groundwater from a road salt storage facility near the wells.

Filtered Routine Indicator Parameters/Metals. High levels of chloride were noted in Wells 330051, 330061, 330081, and 330091. Chloride levels in these four wells ranged from 632 to 12,423 mg/L. As previously mentioned, it appears that road salt intrusion from roadways and a salt storage area are responsible for the elevated chloride levels associated with the high conductivity of the water.

Barium, iron, manganese, nickel, and zinc are the most frequently noted parameters in wells in the CP-5 vicinity. It appears that these elevated levels are associated with disturbance of silt in the well bottom during sampling, thereby increasing the turbidity of the sample. Argonne has determined that the use of low-flow sampling techniques results in low-turbidity samples containing significantly reduced levels of these parameters.

Barium was noted during each quarter in each well in the CP-5 monitoring network. Levels ranged from 0.03 to 0.17 mg/L. Iron was noted during at least one quarter in six of the wells. Iron levels in all wells ranged from less than 0.02 to 3.2 mg/L. Manganese was detected during each quarter in all the wells except Wells 330011 and 330012D, and levels ranged from less than 0.01 to 5.4 mg/L. Nickel was noted during each quarter in Wells 330021, 330031R, 330081, and 330091, and during at least one quarter in the remaining wells. Nickel levels ranged from less than 0.035 to 0.46 mg/L. Zinc was also noted at low levels in nine of the wells during at least one quarter. Zinc levels in these wells ranged from less than 0.008 to 0.13 mg/L.

Radioactive Constituents. Hydrogen-3 was detected during each quarter in all wells except Wells 330021, 330081, and 330012D. The levels of hydrogen-3 in these wells ranged from less than 100 to 36,600 pCi/L. These levels exceed the WQS (20,000 pCi/L) in Well 330031R. Strontium-90 was detected during each quarter in Wells 330011 and 330091, and during three quarters in Wells 330012D, 330021, and 330081. The levels of strontium-90 in these wells ranged from less than 0.25 to 0.94 pCi/L. These levels are well below the WQS (8 pCi/L). No gamma-ray-emitting radionuclides were detected above the detection limit of 1 pCi/L.

The CP-5 was a heavy-water-moderated reactor. During its operational life, several incidents occurred that released small amounts of this heavy water containing high concentrations of hydrogen-3 to the environment. In addition, the normal operation released significant amounts of water vapor containing hydrogen-3 from the main ventilation system. This water may have condensed and fallen to the ground in the form of precipitation. These activities are believed to be responsible for the residual amounts of hydrogen-3 now found in the groundwater.

6. GROUNDWATER PROTECTION

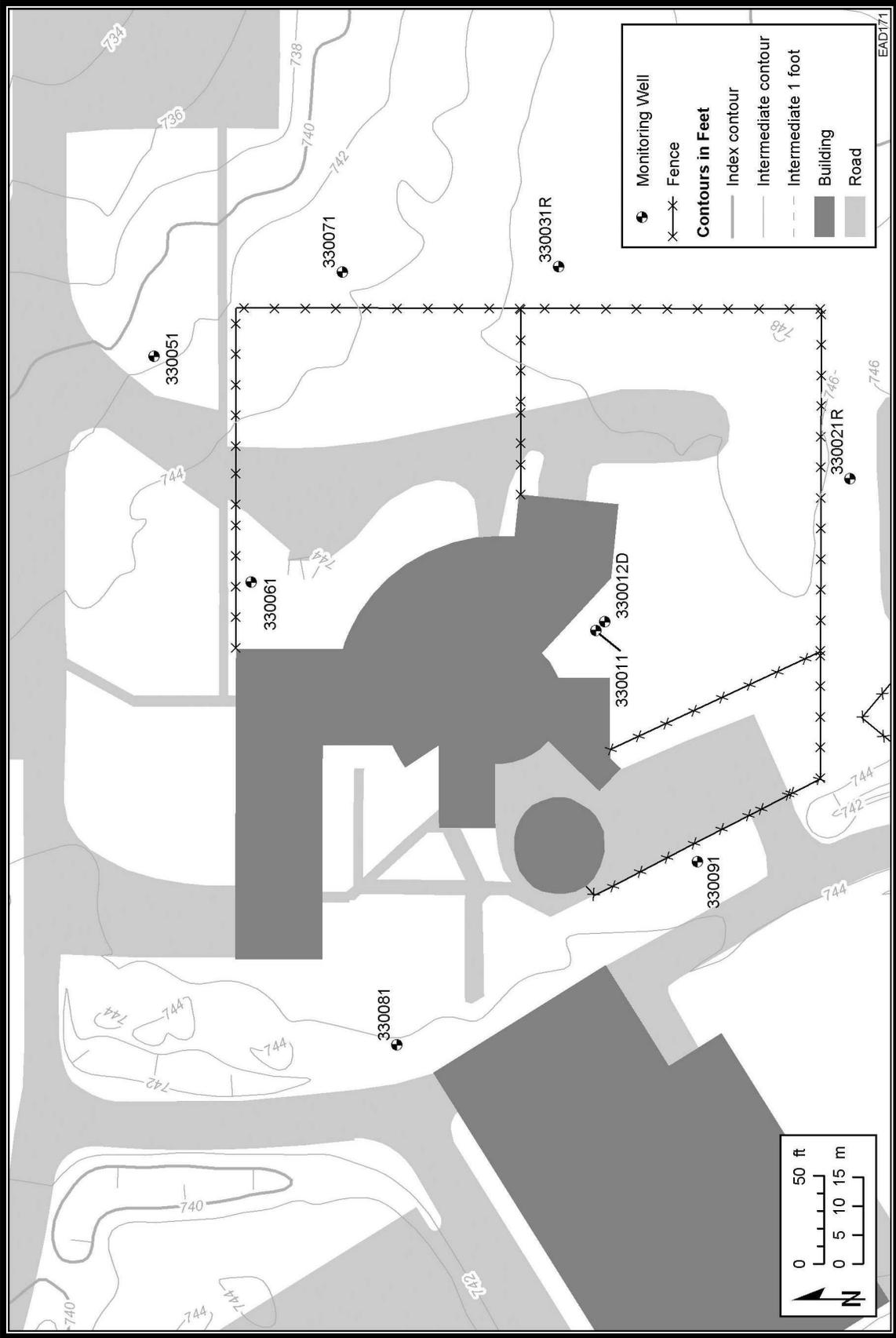


FIGURE 6.22 Monitoring Wells in the CP-5 Reactor Area

6. GROUNDWATER PROTECTION

TABLE 6.50

Groundwater Monitoring Results, 300 Area Well 330011, 2005

Parameter	Unit	Date of Sampling			
		Feb. 24	May 4	Sept. 15	Dec. 14
Water elevation ^a	m	226.07	225.80	223.93	222.66
Temperature	°C	9.0	12.2	14.8	13.2
pH	pH	7.27	7.42	6.50	7.49
Redox	mV	1	-21	12	-24
Conductivity	µmhos/cm	906	941	877	1,063
Chloride ^b	mg/L	56	68	53	57
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.050	0.053	0.050	0.051
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	<0.010	0.360	0.365	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.047	0.049	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	2,199	1,938	857	1,144
Strontium-90	pCi/L	0.48	0.85	0.51	0.47

^a Well point elevation = 220.98 m (AMSL); ground surface elevation = 227.23 m (AMSL); casing material = steel.

^b Filtered sample.

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TABLE 6.51

Groundwater Monitoring Results, 300 Area Well 330012D, 2005

Parameter	Unit	Date of Sampling			
		Feb. 24	May 4	Sept. 15	Dec. 14
Water elevation ^a	m	191.32	191.40	191.09	191.05
Temperature	°C	11.9	14.3	13.5	11.0
pH	pH	7.38	7.52	6.58	7.57
Redox	mV	-5	-26	9	-29
Conductivity	µmhos/cm	820	883	878	1,057
Chloride ^b	mg/L	28	28	33	49
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.053	0.055	0.058	0.058
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.113	0.106	0.128	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.024	0.026	0.024	<0.010
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.043	0.046	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	117	<100	572	1,068
Strontium-90	pCi/L	<0.25	0.29	0.38	0.94

^a Well point elevation = 185.50 m (AMSL); ground surface elevation = 227.08 m (AMSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.52

Groundwater Monitoring Results, 300 Area Well 330021, 2005

Parameter	Unit	Date of Sampling		
		Feb. 24	May 4	May 4
Water elevation ^a	m	227.38	226.56	226.56
Temperature	°C	8.6	10.4	10.4
pH	pH	7.14	7.57	7.57
Redox	mV	4	-21	-21
Conductivity	µmhos/cm	739	831	831
Chloride ^b	mg/L	68	74	73
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.030	0.030	0.030
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.375	0.182	0.165
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.111	0.092	0.090
Silver ^b	mg/L	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.040	0.041
Cesium-137	pCi/L	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	<100	<100	<100
Strontium-90	pCi/L	0.39	0.35	0.37

^a Well point elevation = 221.65 m (AMSL); ground surface elevation = 227.54 m (AMSL); casing material = stainless steel.

^b Filtered sample.

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TABLE 6.53

Groundwater Monitoring Results, 300 Area Well 330031R, 2005

Parameter	Unit	Date of Sampling				
		Feb. 24	May 11	Sept. 12	Sept. 12	Dec. 14
Water elevation ^a	m	223.78	223.32	221.36	221.36	220.03
Temperature	°C	10.9	10.5	13.2	13.2	10.6
pH	pH	7.24	7.47	7.31	7.31	7.30
Redox	mV	-2	-22	-31	-31	-14
Conductivity	µmhos/cm	1,080	1,058	1,098	1,098	1,335
Chloride ^b	mg/L	111	116	116	111	140
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.066	0.057	0.056	0.057	0.057
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	0.031	0.030	0.811
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.135	0.075	0.275	0.315	0.150
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.108	0.459	0.332	0.384	0.188
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.054	0.055	0.053	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	35,250	35,990	33,740	33,770	36,660
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25	<0.25

^a Well point elevation = 217.89 m (AMSL); ground surface elevation = 227.65 m (AMSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.54

Groundwater Monitoring Results, 300 Area Well 330051, 2005

Parameter	Unit	Date of Sampling		
		Feb. 24	May 11	Sept. 12
Water elevation ^a	m	223.50	222.84	221.12
Temperature	°C	11.7	11.1	14.4
pH	pH	7.04	7.02	6.95
Redox	mV	8	0	-13
Conductivity	µmhos/cm	2,270	2,210	2,400
Chloride ^b	mg/L	755	665	632
Arsenic ^b	mg/L	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.088	0.082	0.086
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.032	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.090	0.115	0.296
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.042	<0.035	0.058
Silver ^b	mg/L	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.061	0.063
Cesium-137	pCi/L	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	221	213	205
Strontium-90	pCi/L	<0.25	<0.25	<0.25

^a Well point elevation = 219.71 m (AMSL); ground surface elevation = 226.72 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.55

Groundwater Monitoring Results, 300 Area Well 330061, 2005

Parameter	Unit	Date of Sampling			
		Feb. 23	May 10	Sept. 7	Dec. 14
Water elevation ^a	m	221.70	221.43	220.10	219.28
Temperature	°C	14.0	15.3	15.6	12.2
pH	pH	6.79	6.94	7.35	7.02
Redox	mV	21	-1	-36	2
Conductivity	µmhos/cm	2,810	2,770	3,090	3,490
Chloride ^b	mg/L	866	734	690	879
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.0604	0.061	0.061	0.064
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	0.0014
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	0.024	0.027	<0.021
Iron ^b	mg/L	0.872	0.726	1.350	0.363
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.133	0.101	0.159	0.138
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.026	<0.035	0.049	0.206
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.086	0.094	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	1,096	1,068	1,114	1,134
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25

^a Well point elevation = 217.28 m (AMSL); ground surface elevation = 227.11 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.56

Groundwater Monitoring Results, 300 Area Well 330071, 2005

Parameter	Unit	Date of Sampling			
		Feb. 23	May 11	Sept. 7	Dec. 14
Water elevation ^a	m	223.47	222.74	220.37	218.82
Temperature	°C	10.0	10.4	13.7	10.6
pH	pH	7.24	7.43	7.45	7.30
Redox	mV	-2	-20	-40	-12
Conductivity	µmhos/cm	715	726	755	895
Chloride ^b	mg/L	7	8	7	9
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.056	0.054	0.041	0.058
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	0.0003	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.044	0.041	0.112	0.030
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	<0.035	<0.035	<0.035	<0.035
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.041	0.033	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	465	462	426	407
Strontium-90	pCi/L	<0.25	<0.25	<0.25	<0.25

^a Well point elevation = 217.80 m (AMSL); ground surface elevation = 226.64 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.57

Groundwater Monitoring Results, 300 Area Well 330081, 2005

Parameter	Unit	Date of Sampling			
		Feb. 23	May 10	Sept. 7	Dec. 14
Water elevation ^a	m	224.44	224.20	224.55	224.01
Temperature	°C	10.0	12.0	18.7	12.3
pH	pH	6.84	7.16	7.28	7.41
Redox	mV	16	-7	-33	-26
Conductivity	µmhos/cm	4,400	4,620	4,000	3,830
Chloride ^b	mg/L	2,040	1,540	1,129	1,038
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.003
Barium ^b	mg/L	0.169	0.158	0.118	0.102
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	<0.021	<0.021	<0.021
Iron ^b	mg/L	0.499	<0.021	<0.021	0.595
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	0.195	0.096	0.103	0.197
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.411	0.115	0.071	0.435
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.004	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.068	0.053	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	215	213	<100	105
Strontium-90	pCi/L	0.51	0.33	<0.25	0.27

^a Well point elevation = 222.03 m (AMSL); ground surface elevation = 226.60 m (AMSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.58

Groundwater Monitoring Results, 300 Area Well 330091, 2005

Parameter	Unit	Date of Sampling			
		Feb. 23	May 10	Sept. 7	Dec. 14
Water elevation ^a	m	225.33	224.94	225.08	224.70
Temperature	°C	8.5	11.5	19.4	12.4
pH	pH	6.72	6.78	6.78	6.63
Redox	mV	24	16	-4	22
Conductivity	µmhos/cm	16,300	23,000	25,000	31,400
Chloride ^b	mg/L	10,849	9,201	9,186	12,423
Arsenic ^b	mg/L	<0.003	<0.003	<0.003	<0.030
Barium ^b	mg/L	0.096	0.172	0.187	0.250
Beryllium ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium ^b	mg/L	<0.0002	0.0016	0.0022	0.0031
Chromium ^b	mg/L	<0.043	<0.043	<0.043	<0.043
Cobalt ^b	mg/L	<0.017	<0.017	<0.017	<0.017
Copper ^b	mg/L	<0.021	0.028	0.024	<0.021
Iron ^b	mg/L	0.054	0.078	<0.021	3.169
Lead ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Manganese ^b	mg/L	2.60	4.53	4.07	5.40
Mercury ^b	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Nickel ^b	mg/L	0.065	0.171	0.040	0.453
Silver ^b	mg/L	<0.001	<0.001	<0.001	<0.001
Thallium ^b	mg/L	<0.002	<0.002	<0.002	<0.002
Vanadium ^b	mg/L	<0.053	<0.053	<0.053	<0.053
Zinc ^b	mg/L	<0.008	0.129	0.121	<0.008
Cesium-137	pCi/L	<2.0	<2.0	<2.0	<2.0
Hydrogen-3	pCi/L	817	955	1,324	1,012
Strontium-90	pCi/L	0.69	0.64	0.50	0.54

^a Well point elevation = 223.26 m (AMSL); ground surface elevation = 227.07 m (AMSL); casing material = PVC.

^b Filtered sample.

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The original Well 330031 was replaced in February 2003 with Well 330031R. The screen length of the original well was from 0.6 to 6 m (2 to 20 ft) below the ground surface. This allowed for the infiltration of surface water into the well and resulted in erratic data. The replacement well was screened at 8 to 9 m (27 to 32 ft) below the surface to eliminate surface water infiltration and to target a potentially contaminated permeable zone.

Before replacement, Well 330031 had hydrogen-3 concentrations that averaged 260 pCi/L. After the replacement well was installed in February 2003, the hydrogen-3 concentrations averaged 3,330 pCi/L for the balance of 2003 — about a factor of 10 increase. The first quarter results in 2004 revealed that hydrogen-3 concentrations increased by another factor of 10, to 43,670 pCi/L, and averaged 37,860 pCi/L for all of 2004 and 2005.

In July 1964, a rupture of the heat exchanger at CP-5 caused the primary water in the reactor to contaminate the secondary cooling water. After the rupture was repaired, the contaminated cooling water was disposed of by diluting it, in batches, with large amounts of ordinary, uncontaminated wastewater and processing the mixture through the regular wastewater disposal system. This discharge was conducted over a period of about three months. The contaminated cooling water was pumped to a sewer of the laboratory wastewater system, which was located close to the CP-5 cooling towers. The sewer line ran east to the CP-5 facility fence and then north to Bluff Road where it connected to a larger line and eventually flowed to the Laboratory Wastewater Treatment Plant. A manhole existed at the point where the sewer line turned north. This manhole is located within 10 meters of Monitoring Well 330031R. It would not take much leakage from the sewer line/manhole to account for the concentrations of hydrogen-3 in the monitoring well. The hydrogen-3 appears to have existed at this location since 1964 and has decreased primarily due to radioactive decay, indicating that there is very little migration of this hydrogen-3.

6.5 Groundwater Summary

This chapter collects the information on groundwater monitoring results and supports the Argonne groundwater management strategy. Sample collection focuses on those areas that have the potential to impact groundwater and the analytical results demonstrate the degree of compliance to applicable groundwater standards and limits. The Argonne groundwater monitoring program is summarized in Table 6.59. Because of program integration, the wells monitoring, sampling events, analyses, results, and nondetectable results overlap among monitoring purposes.

6. GROUNDWATER PROTECTION

TABLE 6.59

Summary of Groundwater Monitoring by Area, 2005

	Argonne Site	East Area	317/319 Area	800 Area
Number of wells	87	38	179	73
Wells monitored	4	13	56	28
Sampling events	16	52	224	112
Analyses	122	66	674	1,344
Results	1,040	263	4,533	8,540
% Nondetects	97	90	91	82

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Quality Assurance (QA) plans exist for both radiological and nonradiological analyses. These QA documents were prepared in accordance with DOE Order 414.1C³² and discuss who is responsible for QA and for auditing analyses. Both documents are supplemented by operating manuals.

7.1. Sample Collection

Many factors enter into an overall QA program other than the analytical quality control. Representative sampling is of prime importance. Appropriate sampling protocols are followed for each type of sampling being conducted. Water samples are pretreated in a manner designed to maintain the integrity of the analytical constituent. For example, samples for trace radionuclide analyses are acidified immediately after collection to prevent hydrolytic loss of metal ions and are filtered to reduce leaching from suspended solids.

The monitoring wells are sampled by using the protocols listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.²⁵ The volume of water in the casing is determined by measuring the water depth from the surface and the depth to the bottom of the well. This latter measurement also determines whether siltation has occurred that might restrict water movement in the screened area. For those wells in the glacial drift that do not recharge rapidly, the well is emptied and the volume removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled by bailing with a Teflon[®] bailer. In a number of wells, low-flow sampling equipment has been installed to minimize the turbidity created by sampling with a bailer.

Samples for parameters such as priority pollutants are collected, and field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured per well volume while purging. For samples in the porous saturated zone, which recharges rapidly, three well volumes are purged by using submersible pumps. If field parameters are measured, samples are collected as soon as these readings stabilize. All samples are placed in precleaned bottles, labeled, and preserved. All field measurement and sampling equipment is cleaned by field rinsing with Type II deionized water. The sample log-in information is transferred to the analytical laboratory along with a computer disk that generates a one-page list of all samples. This list acts as the chain-of-custody transfer document.

7.2. Radiochemical Analysis and Radioactivity Measurements

The documentation for radiological analyses is contained in the EQO-AS procedure manual. All nuclear instrumentation is calibrated with standard sources obtained from or traceable to the National Institute of Standards and Technology (NIST). The equipment is checked with secondary counting standards to ensure proper operation. Samples are periodically analyzed in duplicate or with the addition of known amounts of a radionuclide to check precision and accuracy. When a nuclide is not detected, the result is given as “less than” (<) the detection

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limit by the analytical method used. The detection limits are chosen so that the measurement uncertainty at the 95% confidence level is equal to the measured value. The air and water detection limits for all radionuclides for which measurements were made in 2005 are given in Table 7.1.

The relative error in a result decreases with increasing concentration. At a concentration equal to twice the detection limit, the error is approximately 50% of the measured value; at 10 times the detection limit, the error is approximately 10% at the 95% confidence level.

Average values are accompanied by a plus-or-minus (\pm) limit value. Unless otherwise stated, this value is the standard error at the 95% confidence level calculated from the standard deviation of the average. The \pm limit value is a measure of the range in the concentrations encountered at that location. It does not represent the conventional uncertainty in the average of repeated measurements on the same or identical samples. Because many of the variations observed in environmental radioactivity are not random but occur for specific reasons (e.g., seasonal variations), samples collected from the same location at different times are not replicates. The more random the variation in activity at a particular location, the closer the confidence limits will represent the actual distribution of values at that location. The averages and confidence limits should be interpreted with this in mind. When a \pm value accompanies an individual result in this report, it represents the statistical counting error at the 95% confidence level.

In 2005, Argonne participated in the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the Radiological and Environmental Sciences Laboratory (RESL). The program consists of semiannual distribution of three different sample matrices containing combinations of radionuclides that are analyzed. The results are listed in Table 7.2 and 7.3.

The Argonne performance on the MAPEP intercomparison samples resulted in 98% (73 out of 74) of the analyses being in the MAPEP acceptable range.

TABLE 7.1

Air and Water Detection Limits		
Nuclide or Activity	Air (fCi/m ³)	Water (pCi/L)
Americium-241	— ^a	0.001
Beryllium-7	5	—
Californium-249	—	0.001
Californium-252	—	0.001
Cesium-137	0.1	2
Curium-242	—	0.001
Curium-244	—	0.001
Hydrogen-3	—	100
Lead-210	1	—
Neptunium-237	—	0.001
Plutonium-238	0.0001	0.001
Plutonium-239	0.0001	0.001
Radium-226	—	0.02
Radium-228	—	0.02
Strontium-89	0.1	2
Strontium-90	0.01	0.25
Thorium-228	0.001	—
Thorium-230	0.001	—
Thorium-232	0.001	—
Uranium-234	0.001	0.01
Uranium-235	0.001	0.01
Uranium-238	0.001	0.01
Uranium – natural	0.02	0.2
Alpha	0.2	0.2
Beta	0.5	1

^a A dash indicates that a value is not required.

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TABLE 7.2

Summary of May MAPEP Intercomparison Samples, 2005

Analyte	Matrix	Units ^a	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Am-241	Air filter	Bq/filter	0.10	0.10	0.07–0.13	Acceptable
Cs-134	Air filter	Bq/filter	3.00	3.51	2.46–4.56	Acceptable
Cs-137	Air filter	Bq/filter	2.12	2.26	1.58–2.94	Acceptable
Co-57	Air filter	Bq/filter	5.21	4.92	3.44–6.40	Acceptable
Co-60	Air filter	Bq/filter	3.65	3.03	2.12–3.94	Acceptable with Warning
Mn-54	Air filter	Bq/filter	3.14	3.33	2.33–4.33	Acceptable
Pu-238	Air filter	Bq/filter	0.20	0.20	0.14–0.25	Acceptable
Pu-239/240	Air filter	Bq/filter	0.16	0.17	0.12–0.21	Acceptable
Sr-90	Air filter	Bq/filter	1.24	1.35	0.95–1.76	Acceptable
U-233/234	Air filter	Bq/filter	0.34	0.34	0.24–0.44	Acceptable
U-238	Air filter	Bq/filter	0.34	0.35	0.25–0.46	Acceptable
Zn-65	Air filter	Bq/filter	2.87	3.14	2.20–4.08	Acceptable
Am-241	Soil	Bq/kg	119	109	76–142	Acceptable
Cs-134	Soil	Bq/kg	685	759	531–987	Acceptable
Cs-137	Soil	Bq/kg	340	315	221–410	Acceptable
Co-57	Soil	Bq/kg	262	242	169–315	Acceptable
Co-60	Soil	Bq/kg	241	212	148–276	Acceptable
Mn-54	Soil	Bq/kg	551	485	340–631	Acceptable
Pu-238	Soil	Bq/kg	0.98	0.48	NA ^b	Acceptable
Pu-239/240	Soil	Bq/kg	100	90	63–116	Acceptable
K-40	Soil	Bq/kg	649	604	423–785	Acceptable
Sr-90	Soil	Bq/kg	616	640	448–832	Acceptable
U-233/234	Soil	Bq/kg	57.0	62.5	43.8–81.3	Acceptable
U-238	Soil	Bq/kg	235	249	174–324	Acceptable
Zn-65	Soil	Bq/kg	837	810	567–1,053	Acceptable
Am-241	Water	Bq/L	1.68	1.72	1.20–2.24	Acceptable
Cs-134	Water	Bq/L	102	127	89–165	Acceptable
Cs-137	Water	Bq/L	320	332	232–432	Acceptable
Co-57	Water	Bq/L	232	227	159–295	Acceptable
Co-60	Water	Bq/L	254	251	176–326	Acceptable
H-3	Water	Bq/L	285	280	196–364	Acceptable
Mn-54	Water	Bq/L	317	331	232–430	Acceptable
Pu-238	Water	Bq/L	0.02	0.02	NA	Acceptable
Pu-239/240	Water	Bq/L	2.14	2.40	1.68–3.12	Acceptable
Sr-90	Water	Bq/L	0.02	0.02	NA	Acceptable
U-233/234	Water	Bq/L	3.52	3.24	2.27–4.21	Acceptable
U-238	Water	Bq/L	3.64	3.33	2.33–4.33	Acceptable
Zn-65	Water	Bq/L	475	496	347–645	Acceptable

^a Bq = Becquerel, kg = kilogram, L= liter.

^b NA = not assigned; no acceptance limits were assigned for the radionuclide.

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TABLE 7.3

Summary of October MAPEP Intercomparison Samples, 2005

Analyte	Matrix	Units ^a	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Am-241	Air filter	Bq/filter	0.153	0.158	0.11–0.21	Acceptable
Cs-134	Air filter	Bq/filter	3.56	3.85	2.70–5.01	Acceptable
Cs-137	Air filter	Bq/filter	3.02	3.23	2.26–4.20	Acceptable
Co-57	Air filter	Bq/filter	6.40	6.20	4.34–8.06	Acceptable
Co-60	Air filter	Bq/filter	2.96	2.85	2.00–3.71	Acceptable
Mn-54	Air filter	Bq/filter	4.08	4.37	3.06–5.68	Acceptable
Pu-238	Air filter	Bq/filter	0.098	0.097	0.07–0.13	Acceptable
Pu-239/240	Air filter	Bq/filter	0.090	0.090	0.06–0.12	Acceptable
Sr-90	Air filter	Bq/filter	2.10	2.25	1.58–2.93	Acceptable
U-233/234	Air filter	Bq/filter	0.269	0.273	0.19–0.35	Acceptable
U-238	Air filter	Bq/filter	0.291	0.283	0.20–0.37	Acceptable
Zn-65	Air filter	Bq/filter	3.24	4.33	3.03–5.63	Acceptable with Warning
Am-241	Soil	Bq/kg	84.0	81.1	57–105	Acceptable
Cs-134	Soil	Bq/kg	548	568	398–738	Acceptable
Cs-137	Soil	Bq/kg	492	439	307–571	Acceptable
Co-57	Soil	Bq/kg	582	524	367–681	Acceptable
Co-60	Soil	Bq/kg	334	287	201–373	Acceptable
Mn-54	Soil	Bq/kg	517	439	307–571	Acceptable
Pu-238	Soil	Bq/kg	64.0	61.0	42.6–79.0	Acceptable
Pu-239/240	Soil	Bq/kg	1.38	<0.15	ND ^a	Not Acceptable
K-40	Soil	Bq/kg	660	604	423–785	Acceptable
Sr-90	Soil	Bq/kg	707	757	530–984	Acceptable
U-233/234	Soil	Bq/kg	42	52.5	37–68	Acceptable
U-238	Soil	Bq/kg	146	168	118–218	Acceptable
Zn-65	Soil	Bq/kg	950	823	576–1,070	Acceptable
Am-241	Water	Bq/L	2.26	2.23	1.56–2.90	Acceptable
Cs-134	Water	Bq/L	134	167	117–217	Acceptable
Cs-137	Water	Bq/L	318	333	233–433	Acceptable
Co-57	Water	Bq/L	277	272	190–354	Acceptable
Co-60	Water	Bq/L	251	261	183–339	Acceptable
H-3	Water	Bq/L	534	527	369–685	Acceptable
Mn-54	Water	Bq/L	396	418	293–543	Acceptable
Pu-238	Water	Bq/L	1.47	1.91	1.34–2.48	Acceptable with Warning
Pu-239/240	Water	Bq/L	2.12	2.75	1.93–3.58	Acceptable with Warning
Sr-90	Water	Bq/L	8.27	8.98	6.29–11.7	Acceptable
U-233/234	Water	Bq/L	4.15	4.10	2.87–5.33	Acceptable
U-238	Water	Bq/L	4.04	4.26	2.98–5.54	Acceptable

^a Bq = Becquerel, kg = kilogram, L = liter, ND = not detected.

7.3. Chemical Analysis

The documentation for nonradiological analyses is contained in the EQO-AS procedure manual. All samples for NPDES and groundwater are collected and analyzed in accordance with EPA regulations found in 40 CFR Part 136,²⁰ EPA-600/4-84-017,³³ and EPA-SW-846.²⁶

Standard reference materials traceable to the NIST exist for most inorganic analyses (see Table 7.4) and are replaced annually. Detection limits are determined with techniques listed in 40 CFR Part 136²⁰ and are given in Table 7.5. In general, the detection limit is the measure of the variability of a standard material measurement at 5 to 10 times the instrument detection limit as measured over an extended time period. Recovery of inorganic metals, as determined by “spiking” unknown solutions, must be within the range of 75 to 125%. The precision, as determined by analysis of duplicate samples, must be within 20%. These measurements must be taken for at least 10% of the samples. Comparison samples for organic constituents were formerly available from the EPA. They are now commercially available under the Cooperative Research and Development Agreement that exists between the EPA and commercial laboratories. In addition, standards are available that are certified by the American Association for Laboratory Accreditation, under a Memorandum of Understanding with the EPA. Many of these standards were used in this work. At least one standard mixture is analyzed each month; Tables 7.6 and 7.7 show the 2005 results for VOCs and SVOCs, respectively. The recoveries listed are those required by the respective methods.

7.4. NPDES Analytical Quality Assurance

Argonne conducts the majority of the analyses required for inclusion in the DMR. These analyses are conducted in accordance with EPA-approved methods set out in 40 CFR Part 136.²⁰ To demonstrate the capabilities of the Argonne laboratory for these analyses, the EPA requires that Argonne participate in the DMR-QA program. An EPA-accredited provider sends a series of intercomparison samples to Argonne annually, and the ensuing analytical results are submitted to the provider for review. The proficiency of the laboratory is determined by comparing the analytical results for the submitted samples with the provider values. The Argonne laboratory has consistently performed very well on these tests. In 2005, all results were acceptable, with the exception of biochemical oxygen demand. A corrective action statement was prepared and forwarded to the EPA provider and the IEPA. The results of these analyses are shown in Table 7.8.

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TABLE 7.4

Standard Reference Materials Used for Inorganic Analysis	
Constituent	Reference Material ^a
Antimony	VHG-ASBH-100
Arsenic	VHG-AASN-100
Barium	VHG-PBAN-100
Beryllium	VHG-ABEN-100
Boron	VHG-PBW-100
Cadmium	VHG-ACDN-100
Chromium	VHG-ACRH-100
Cobalt	VHG-PCON-100
Copper	VHG-ACUN-100
Iron	VHG-AFEN-100
Lead	VHG-APBN-100
Manganese	VHG-AMNN-100
Mercury	VHG-AHGN-100
Nickel	VHG-ANIN-100
Selenium	VHG-ASEN-100
Silver	VHG-AAGN-100
Thallium	VHG-ATLN-100
Vanadium	VHG-PVN-100
Zinc	VHG-AZNN-100
Sulfate	HACH 891-49
Chloride	ORION 941708
Fluoride	ORION 940907

^a VHG = VHG Labs, Inc.; HACH = Hach Company; ORION = Orion, Inc.

TABLE 7.5

Detection Limit for Metals Analysis, 2005		
Constituent	Detection Limit (mg/L)	
	AA ^a	ICP ^b
Antimony	0.0030	NA ^c
Arsenic	0.0030	0.076
Barium	NA	0.012
Beryllium	0.0002	0.013
Boron	NA	0.017
Cadmium	0.0002	0.015
Chromium	0.015	0.043
Cobalt	NA	0.017
Copper	0.011	0.021
Hexavalent chromium ^d	0.006	NA
Iron	0.040	0.021
Lead	0.0020	0.086
Manganese	0.015	0.010
Mercury	0.0001	NA
Nickel	0.030	0.035
Selenium	0.0030	0.121
Silver	0.0010	NA
Thallium	0.0020	0.082
Vanadium	NA	0.053
Zinc	0.010	0.008

^a AA = atomic absorption spectroscopy.

^b ICP = inductively coupled plasma-atomic emission spectroscopy.

^c NA = not analyzed.

^d Colorimetric measurement.

TABLE 7.6

Quality Check Sample Results: Volatile Analyses, 2005

Constituent	Recovery ^a (%)	Quality Limit (%)
Benzene	112	73-126
Bromobenzene	110	76-133
Bromodichloromethane	103	50-140
Bromoform	76	57-156
Butylbenzene	96	71-125
sec-Butylbenzene	98	71-145
t-Butylbenzene	101	69-134
Carbon tetrachloride	99	86-118
Chlorobenzene	96	80-137
Chloroform	112	68-120
o-Chlorotoluene	95	81-146
p-Chlorotoluene	103	73-144
1,2-Dibromo-3-chloropropane	81	36-154
Dibromochloromethane	96	68-130
1,2-Dibromoethane	103	75-149
Dibromomethane	120	65-143
1,2-Dichlorobenzene	103	59-174
1,3-Dichlorobenzene	91	84-143
1,4-Dichlorobenzene	98	58-172
1,1-Dichloroethane	111	71-142
1,2-Dichloroethane	126	70-134
1,1-Dichloroethene	114	18-209
cis-1,2-Dichloroethene	122	85-124
trans-1,2-Dichloroethene	111	67-141
1,2-Dichloropropane	101	19-179
1,3-Dichloropropane	114	73-145
1,1-Dichloropropene	116	71-133
Ethyl benzene	96	84-130
Isopropylbenzene	102	70-144
4-Isopropyltoluene	111	72-140
Methylene chloride	114	D-197 ^b
n-Propylbenzene	91	78-139
1,1,1-Tetrachloroethane	95	88-133
Tetrachloroethene	90	84-132
Toluene	108	81-130
1,1,1-Trichloroethane	97	68-149
1,1,2-Trichloroethane	106	70-133
Trichloroethene	108	91-135
1,2,3-Trichloropropane	95	50-158
1,2,4-Trimethylbenzene	103	80-144
1,3,5-Trimethylbenzene	101	76-142
o-Xylene	98	79-141
p-Xylene	96	74-138

^a Average of two determinations.

^b D denotes that the compound was detected.

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TABLE 7.7

Quality Check Sample Results:
Semivolatile Analyses, 2005

Constituent	Recovery ^a (%)	Quality Limit (%)
2-Fluorophenol ^b	70.5	21–100
Phenol-d5 ^b	44.5	10–94
Phenol	43.8	17–100
2-Chlorophenol	102.0	36–120
1,3-Dichlorobenzene	73.3	33–95
1,4-Dichlorobenzene	77.7	37–106
n-Nitroso-n-propylamine	50.1	24–198
Nitrobenzene-d5 ^b	88.6	35–114
1,2,4-Trichlorobenzene	96.7	57–129
4-Chloro-3-methylphenol	90.0	41–128
2-Fluorobiphenyl ^b	80.0	43–116
2-Methylnaphthalene	98.2	45–113
Acenaphthene	95.7	47–145
2,4-Dinitrotoluene	59.8	48–127
2,4,6-Tribromophenol ^b	89.5	10–123
Pentachlorophenol	96.1	38–152
Pyrene	98.3	70–100
Terphenyl-d14 ^b	84.2	33–141

^a Average of three independent determinations.

^b Required surrogates.

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TABLE 7.8

Summary of DMR-QA Intercomparison Samples, 2005

Analyte	Units ^a	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Antimony	µg/L	461	491	343–592	Acceptable
Arsenic	µg/L	358	407	340–478	Acceptable
Barium	µg/L	235	244	211–275	Acceptable
Beryllium	µg/L	154	164	138–185	Acceptable
Boron	µg/L	1,404	1,390	1,140–1,620	Acceptable
Cadmium	µg/L	344	341	291–388	Acceptable
Chromium	µg/L	679	675	588–763	Acceptable
Cobalt	µg/L	731	730	642–818	Acceptable
Copper	µg/L	444	445	403–490	Acceptable
Iron	µg/L	314	310	271–355	Acceptable
Lead	µg/L	517	468	407–528	Acceptable
Manganese	µg/L	555	552	495–613	Acceptable
Mercury	µg/L	3.30	2.96	1.84–4.15	Acceptable
Nickel	µg/L	322	321	285–362	Acceptable
Selenium	µg/L	650	716	568–829	Acceptable
Silver	µg/L	161	159	136–182	Acceptable
Thallium	µg/L	377	351	273–429	Acceptable
Vanadium	µg/L	590	597	523–668	Acceptable
Zinc	µg/L	881	871	748–1,000	Acceptable
Biochemical oxygen demand	mg/L	212	110	55.6–164	Not acceptable
Chemical oxygen demand	mg/L	160	178	137–202	Acceptable
Ammonia nitrogen	mg/L	9.91	9.58	7.08–12.0	Acceptable
Total residual chlorine	mg/L	0.89	0.88	0.635–1.10	Acceptable
Total cyanide	mg/L	0.62	0.70	0.439–0.968	Acceptable
pH	S.U.	6.47	6.48	6.28–6.68	Acceptable
Total phenolics	mg/L	0.66	0.65	0.353–0.943	Acceptable
Total suspended solids	mg/L	54.8	57.6	45.5–65.3	Acceptable
Grease & oil	mg/L	41.8	42.0	26.0–52.2	Acceptable
Fathead minnow acute toxicity	LC ₅₀	25.3	20.8	<6.25–41.4	Acceptable
Water flea acute toxicity	LC ₅₀	11.5	32.2	<6.25–68.2	Acceptable

^a µg/L = micrograms/liter, mg/L = milligrams/liter, S.U. = standard units, LC₅₀ = the calculated effluent concentration at which 50% of the test organisms are killed in a specified time period.

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