Argonne National Laboratory-East

Summary
Site Environmental Report
for Calendar Year 2002

ANL-03/2 (Summary)

Argonne National Laboratory is operated by The University of Chicago
for the U.S. Department of Energy under Contract W-31-109-Eng-38.

A message from the students

By Bryan Stubya and Robin Kuprewicz

We're the *Biology II: Research Questions in Biology* classes at Downers Grove South (DGS) High School. We put together this handy little non-technical summary of the Argonne National Laboratory-East Site Environmental Report for 2002. Argonne is a high-tech research facility that monitors its impact and involves students in its work. What better way to learn about nature in our everyday world? Our class has been studying ecosystems and how humans affect them. We have taken trips to Argonne and to Treehaven, which is run by University of Wisconsin at Stevens Point in Tomahawk, Wisc., so this project is right up our "estuary."

Argonne and the Biology II classes at DGS work together in teams to promote scientific analysis of actual data and scientific writing. We are learning to fine-tune our scientific writing skills while helping the community. Argonne publishes its Site Environmental Report every year, but it is a very technical read, and most of the public simply does not want to wade through all of that detailed information. Our classes read the report and created this booklet to help everyone learn about Argonne and the lab's effects on the surrounding environment. As DGS senior Ying-Ying Sze said, "By participating, we help bring awareness of Argonne to the community."

We have been studying ecosystems since September, and Argonne's many different ecosystems, such as its prairie and wetlands, have helped us learn about the different organisms that live there. We learned about garden spiders and grasshoppers commonly found in the prairie, about big blue stem and other prairie plants, and about dragonflies and cattails in the wetlands. We learned how to appreciate and see ecological interactions among living things. By creating this report, we are learning how to recognize and apply concepts that describe science and technology and their roles in society, such as Argonne's roles in the nation and the community, and the relationships between living things and their environments.

The "Biology II: Research Questions in Biology" class at Downers Grove South High School. Front row, left to right: Colleen Toomey, Elizabeth Scatena, Desiree Smith. Second row: Mrs. Kathleen Luczynski, Bryan Stubya, Alexandria Gunn, Robin Kuprewicz, Matthew Patton, Adam Monfre, Nicole Griffin. Top row: Jessica Morrison, Erika Lebedevs, Lindsay Jirik, Lauren Rektorski, Ying Ying Sze, Kathryn Runyon, Daly Thottukandathil. Not shown: George Chakonas and Jessica Mendrala.

As we went about creating this booklet, we had the help of Argonne staff, mainly Dr. Golchert and Mr. Baurac, as well as Mrs. Dombrowski, the Assistant Curriculum Advisor for District 99, and our teacher, Mrs. Luczynski. They all worked very hard with us to make this booklet as understandable and accurate as possible for the public use. "This project took a lot of work," said DGS senior Bryan Stubya, "and the finished project shows all the effort we all put into it."

For more information about Argonne's Site Environmental Report, contact Norbert Golchert at (630) 252-3912 or *ngolchert@anl.gov*. For more information about Argonne and its programs, visit the laboratory's World Wide Web site at *www.anl.gov* or contact Communications & Public Affairs at (630) 252-5575. Photos by George Joch and Dave Jacqué (page 6). The text was edited by David Baurac. Design and layout by Dave Jacqué.

TABLE OF CONTENTS

What is Argonne?

Desiree Smith

Do you remember that Neil Diamond song, "Forever in Blue Jeans?" If you are wondering what Argonne National Laboratory is, you need only sing that song. Argonne is one of the nation's largest research and development laboratories. Argonne's Ph.D.s are in blue jeans because they're busy researching and developing many areas of science to better the surrounding community, as well as the nation.

Argonne performs research and development in many areas of science and technology. General fields of research at Argonne include, but are not limited to, biosciences, biotechnology, chemical engineering, chemistry, decision and information sciences, energy systems and technology, high energy physics, materials science, math and computer science, nuclear reactors, physics, and environmental science. Argonne is not, and never has been, a weapons laboratory.

At Argonne's Intense Pulsed Neutron Source, scientists from Argonne, universities, industry and other government laboratories study the structure of solid and liquid materials.

Argonne's Missions

Several missions provide focus for Argonne scientists. Basic research helps better understand the world, and applied research helps protect and improve it. For example, the prairies of Argonne provide sites for environmental studies that provide valuable information about invader species and the food webs within ecosystems.

Argonne also operates world-class research facilities, such as the Advanced Photon Source (APS), which is a national research facility funded by the U.S. Department of Energy (DOE). Scientists use high brilliance X-rays from the APS for basic and applied research in many fields.

Argonne also seeks to ensure our energy future. Currently, scientists and engineers are developing cleaner and more efficient energy sources, such as fuel cells and advanced electric power generation. Argonne has spent much of its history on developing nuclear reactor technology. That research is now being applied to American and Soviet nuclear reactors to improve the safety and life of the reactors.

Other Argonne research seeks to improve the way we manage our environment. For example, Argonne scientists created a new catalyst that could help carmakers eliminate 95 percent of nitrogen-oxide emitted by diesel engines by the year 2007. Research and development solutions such as these will help protect our ecosystems.

History of Argonne

The beginnings of Argonne were at the University of Chicago in 1942 in the Metallurgical labora-

Continued ▶

▶ **Continued**

tory, where the world's first nuclear reactor was built and tested. In 1946, Argonne was named the first national laboratory and a few years later moved to the current Argonne-East site in DuPage County. Argonne was created for the purpose of developing nuclear reactors for peaceful purposes, mainly as an energy resource. Argonne's long-standing goals have been to conduct basic and applied research in the national interest, to build and operate large one-of-a-kind research facilities, and to further scientific education. Since 1997, 27 new spin-off companies have been created as a result of Argonne employees and their work.

Location, Topography and Climate

Argonne-East occupies 1,500 acres in DuPage County and is about 25 miles southwest of the Chicago Loop. The area is partially wooded and was formerly prairie and farmland. The main stream that crosses the Argonne-East site is Sawmill Creek, which drains to the Des Plaines River. Freund Brook crosses the center of the Argonne-East site, and this stream is relatively steep.

The population surrounding Argonne-East has grown quickly over the last 30 years as former farmland became suburban housing. Meteorologically important features for this report are wind direction and speed, temperature, and precipitation. On average, the majority of winds during 2002 blew from the southwest and at speeds of 6-10 plus miles per hour. Compared to the historical average, precipitation levels in the area for 2002 were about 5 percent lower. Annual average temperature during 2002 was about 2 degrees higher than the historical average.

Environmental Setting

The main recreational site near Argonne-East is a nearby forest preserve, Waterfall Glen. The public uses this area for hiking, skiing, biking, and horseback riding.

The diverse wildlife at Waterfall Glen also attracts visitors. Many visit to see the oak, hickory, and maple forests, as well as the fields and small ponds near Argonne. Birds make up about 50 percent of the terrestrial vertebrates on the Argonne-East site.

Freund Brook crosses the Argonne site and discharges into Sawmill Creek, which runs through the eastern portion of Argonne-East. Treated Argonne-East sanitary and laboratory wastewater, as well as residential and commercial water collection, run off into Sawmill Creek. Sawmill Creek discharges into the DesPlaines River. Neither Sawmill Creek nor the DesPlaines River is used much for recreation or industry.

Waterfall Glen Forest Preserve surrounds the Argonne-East site.

Budget and Employment

Argonne's annual operating budget is more than $500 million, which supports about 200 research projects. Today, the laboratory has more than 3,500 employees, 1,400 of whom are scientists and engineers, and 700 of whom hold doctorate degrees.

Current research

Bryan Stubya and Robin Kuprewicz

Argonne National Laboratory has always been a pioneer in the science and technology community. Argonne's current projects maintain this long-standing tradition. Argonne has pioneered the design, construction and operation of large, national research facilities, such as the Advanced Photon Source. Argonne is also a leader in parallel computers, the U.S. Department of Energy's Generation IV nuclear energy project, and many other areas of scientific and engineering research and education.

Advanced Photon Source

The Advanced Photon Source (APS) is the nation's brightest source of X-rays for research. Scientists from industry, academia and other government laboratories all around the nation use APS X-rays to study materials, metals, alloys, chemicals, biological molecules, and even insects and how they breathe. It was used recently, in cooperation with the Health Research Institute in Naperville, to examine six strands of hair from the famous composer, Ludwig van Beethoven. Beethoven suffered from years of chronic abdominal pain and depression, yet the cause of his misery was never known. Research at the APS found that the lead levels in Beethoven's hair were 100 times normal. Possible origins of his lead poisoning include water from the health spas he frequented, lead-lined dishes, and lead crystal.

The Generation IV Project

The Generation IV project is a global effort led by Argonne (in association with the Idaho National Engineering and Environmental Laboratory) to develop safer, more reliable nuclear reactors to help meet future growth in electricity demand. Over the next 20 years, electricity demand is projected to grow by 40 percent in the United States and by 70 percent in the rest of the world. The plan is to develop advanced nuclear power plant designs that can help the world to meet energy needs while at the same time minimizing greenhouse-gas emissions that can contribute to global climate change. New power plants are to be built to new standards starting around 2030. Many nations are participating in the project, including Argentina, Brazil, Canada, France, Japan, Korea, South Africa, Switzerland, the United Kingdom, and the United States.

Parallel Computers

Argonne is a world leader in developing parallel computers. These computers are networked together by the hundreds, but the networks work much faster than a regular network connection. This system of computers is able to break down a large problem and turn it into many smaller problems that can be solved faster by coordinating the efforts of all their central processing units into one giant problem-solving system. The parallel computers can be used to predict weather, calculate chemical reactions from basic principles, and to simulate conditions immediately after the Big Bang.

Environmental Research

Climate-change data from Argonne-managed facilities are improving scientists' ability to predict climate trends. Argonne oversees three outdoor weather laboratories called Cloud and Radiation Testbed (CART) sites. The CART sites are located in the Southern Great Plains in Kansas and Oklahoma, in the Tropical Western Pacific covering Australia, Papua New Guinea and Nauru, and on the North Slope of Alaska. They support the U.S. Department of Energy's Atmospheric Radiation Measurement program, which supplies data to researchers to improve computer models that forecast climate change.

Science Education

In addition to carrying out world-class research, Argonne helps educate the next generation of scientists and engineers. Argonne's science education program is the largest at any Department of Energy science laboratory. Students can receive answers to science questions through Argonne's Ask-a-Scientist service online at www.netwon.dep.anl.gov/. Argonne's Women in Science and Technology program sponsors an annual "Science Careers in Search of Women" conference to help high school girls learn about careers in science and technology. Argonne's annual Rube Goldberg machine contest sponsors Chicago-area high school teams in a competition to build and run the zaniest machine to perform some simple task. Our Biology II class was among 1,500 K-12 students who visit Argonne annually.

Environmental monitoring

Adam Monfre, Lindsay Jirik

Every action performed today directly affects our tomorrow. Environmental monitoring helps to ensure a safe and productive future for Argonne and its surrounding area. Argonne's monitoring program tests for compliance to governing laws and regulations for the site. If exceedances are found, Argonne works with regulatory agencies to identify and eliminate the causes of the problem.

Migrating geese rest in the pond at Argonne-East's Building 201 before continuing their southward journey.

The Argonne Site Environmental Report defines and summarizes Argonne's activities during the year to monitor and protect its environment. The report describes different laws and regulations that Argonne complies with, reports any exceedances, and describes plans and actions taken to eliminate problems.

Environmental monitoring is performed as mandated by the federal government for the National Emission Standards for Hazardous Air Pollutants, which regulates air emissions for the entire United States; the Clean Water Act, which affects Argonne in protecting Sawmill Creek and the Des Plaines River; the Clean Air Act, which requires compliance in various areas, including pollution caused from boilers; and the Resource Conservation and Recovery Act (RCRA), which addresses the proper treatment, storage or disposal of hazardous waste and the remediation of sites associated with the release of hazardous waste.

These laws and regulations are important because they ensure progress towards a better future. Environmental monitoring at Argonne is carried out by employees and managers. Monitoring methods vary, depending on what is being examined. Most testing, however, is done through sampling. The results ensure compliance and identify possible problems that may require fixing.

What Is Monitored?

All environmental aspects of Argonne activities need to be monitored to ensure that the site is not causing adverse effects on the environment. Water, air, and emissions from laboratories and buildings are monitored continually throughout the year to check for contaminants that might impact the environment. The data collected are analyzed and then used to ensure compliance with regulations. If exceedances are identified, proper action will be taken as mandated by the government. In 2002, Argonne collected 2,007 samples and performed 26,026 analyses. No major exceedances were found, although at various times, measurable levels of hydrogen-3, strontium-90, plutonium-239, and americium-241 were detected in Sawmill Creek. In the sediment, evidence was found of elevated levels of plutonium-239 and americium-241. Radiation dosages for these elements were measured and were found to well within safe standards. Wells were also monitored, and all concentrations of chemicals were well within the safe levels.

Wildlife is also monitored. Argonne complies with the Endangered Species Act, the goal of which is to protect threatened or endangered animals and plants from extinction. There are no known endangered or threatened species on the actual Argonne site, but the surrounding Waterfall Glen Forest Preserve is home to three federally listed endangered species and one threatened species.

Land Restoration

Argonne is working with the Chicago Wilderness Partnership organizations to protect and preserve the surrounding wildlife. Some continuing efforts deal with enhancing the oak woodland, savanna, wetland, and prairie habitats on site. Argonne is working towards restoring the surrounding area.

Argonne also works with the Illinois Environmental Protection Agency (IEPA) for proper removal of

Continued ▶

Continued ▶

asbestos and PCBs on site. All these efforts help to ensure that Argonne activities do not harm the surrounding community.

The Resource Conservation and Recovery Act (RCRA) aims to ensure that hazardous waste is properly treated, stored, and disposed of in a manner that is environmentally responsible. The RCRA amendments of 1984 set restrictions on land disposal of hazardous waste. Disposal and removal requirements are specified in a RCRA permit to Argonne. The IEPA monitors compliance to this permit, which helps assure that Argonne's waste handling and disposal do not hurt the environment.

Water Monitoring

Jessica Morrison and Alex Gunn

Many people in the DuPage area have been to the beautiful Waterfall Glen Forest Preserve, but few of them know anything about Sawmill Creek, a major source of information for Argonne in its quest to keep the waters safe and clean.

What is the Clean Water Act?

The Clean Water Act was established in 1977 as an amendment to the Federal Water Pollution Control Act of 1972. The Clean Water Act works to restore and maintain good water quality throughout the country. The goal of the act is to make water safe for fishing and public swimming.

Argonne is part of the Clean Water Action Plan, which helps reduce and eliminate critical water-quality problems. The Clean Water Action Plan is helping to reduce public health threats, strengthen control of polluted runoff, and make water quality information more accessible to the public. The plan is basically a voluntary commitment by federal agencies to improve water quality.

Argonne complies with the Clean Water Act almost fully. There were only six exceedances out of 1,600 measurements in 2002. Two of these exceedances were from road salt, and four were residual chlorine exceedances.

How does Argonne monitor for contamination in its water?

Argonne takes samples from Sawmill Creek to test for contamination. Sawmill Creek is a natural creek that runs across the Argonne site. It is fed by storm water. During periods of draught, most of the water in the creek south of Argonne is composed of wastewater discharged from the Argonne site.

Argonne takes samples downstream from where Argonne discharge enters the stream. Each sample is tested for pH and for 17 metal contaminants using several tests. Fifteen of the metals were tested using inductively coupled plasma emission spectroscopy. Other tests are graphite furnace spectroscopy, cold vapor atomic absorption spectroscopy and ion-electrode tests for specific metals. If there is a problem on any given day, Argonne must notify the Illinois Environmental Protection Agency.

How do the people at Argonne keep the water clean?

Argonne uses two different wastewater treatment systems. The first system is the sanitary system. The second is the laboratory system.

The sanitary system collects and cleans water from everyday uses, such as bathrooms. This water is treated with a biological system that uses primary clarifiers, trickling filters, final clarifiers, and slow sand filters to clean the water.

The laboratory system cleans water from labs, including those that may contain radioactive materials. This water is collected in retention tanks and then sent to Argonne's Laboratory Wastewater Treatment Plant. This plant uses aeration, solids-contractor clarification, and pH adjustment to clean the laboratory water. Sometimes other methods must also be used to clean the water thoroughly; these include powder-activated carbon addition, alum addition, and polymer addition or adjustment.

So what effect does Argonne have on Sawmill Creek?

Argonne's discharge into Sawmill Creek does add small amounts of metals to Sawmill Creek. However, the levels of these metals do not exceed General Use Water Quality Standards.

Air monitoring

Colleen Toomey and Lauren Rektorski

Breathe in. Breathe out. Some parts of the world have better breathing air than others. Argonne National Laboratory complies with strict limits and regulations on their releases to the air

Clean Air Act

The government put together the Clean Air Act (CAA) to keep the public safe from air pollutants and radiation. The CAA is a federal law that sets emission limits for air pollutants and determines operating criteria for hazardous pollutants. It only applies to major emissions sources. Because Argonne is a major source, this act requires Argonne to obtain an environmental permit for air pollutants and to monitor them. This operating permit covers emissions of all regulated air pollutants at the facility.

Air Monitoring

Argonne monitors its air emissions to estimate radiological releases that could occur if the high-efficiency particulate air (HEPA) filters failed. The air-monitoring program consists of effluent monitoring and environmental surveillance of contaminants in the air. Effluent monitoring mainly includes continuous monitoring of airborne radionuclides and conventional pollutants from stacks. Environmental surveillance includes continuous direct collection of airborne pollutants on filters at selected stations located around the Argonne perimeter and off-site analysis of the collected particulate matter for radionuclides.

Collecting and analyzing air filter samples determine the radioactive content of airborne particles. Particle samples are collected at 13 locations around the Argonne perimeter and at six off-site locations approximately five miles from Argonne.

Argonne's DuPage County site contains a number of sources of conventional air pollutants, including a steam plant; one commercial and one private gasoline station; two alkali metal reaction booths; a dust collection system; research facilities for testing engines; and fire training activities. Argonne's permit under the CAA requires Argonne to submit a quarterly report listing any exceedances beyond allowed emissions.

NESHAP

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, record keeping and operational and reporting requirements, for activities that emit certain hazardous air pollutants. In 2002, the U.S. Environmental Protection Agency (EPA) proposed a number of additional NESHAPs that could have potential impacts on Argonne operations. Specifically, NESHAPs were proposed to regulate emissions from institutional boilers, reciprocal internal combustion engines, and engine testing facilities.

The only NESHAP standards that currently affect Argonne are those for asbestos and radionuclides. Asbestos-containing materials include lining around pipes and tanks, fireproofing floors and roofs, etc. Radionuclide emissions points are ventilation systems for hot cell facilities for storage and handling of radioactive materials, ventilation systems for particle accelerators, and several ventilation systems associated with the Building 350, which houses the U.S. Department of Energy's New Brunswick Laboratory.

Radioactive material released from Argonne emissions is extremely small; the maximum off-site dose that anyone might have received was 0.039 millirem, about 1/250th the dose from a chest X-ray, which is about 10 millirem.

NESHAP Emissions

Many Argonne buildings contain large amounts of asbestos-containing material, such as thermal insulation around pipes and tanks, spray-applied fireproofing, floor tile, and asbestos-cement panels. The material is removed as necessary during renovations or maintenance of equipment and facilities. Argonne maintains an asbestos abatement program designed to ensure compliance with all regulatory requirements. Asbestos is removed by specially trained crews for smaller projects or by outside contractors for larger projects. All removal work is performed in accordance with both NESHAP and Occupational Safety and Health Administration requirements governing worker safety. In 2002, approximately 79 cubic meters of asbestos-containing material were removed from Argonne.

Groundwater monitoring

Kathy Runyon and Daly Thottukandathil

Wouldn't you like to know exactly where your drinking water comes from? Until a few years ago, if you lived in the communities surrounding Argonne, your drinking water came from the ground. This groundwater provided the water for community and individual residences' wells, which basically means you may drink whatever you put into the ground.

Many regulations require that Argonne monitor the groundwater under its site. Some regulations come from the U.S. Department of Energy and the U.S Environmental Protection Agency. The purpose of monitoring is to identify any contaminated groundwater, track its movement, and determine whether the contamination is increasing, decreasing, or staying the same.

Former Potable System

Before 1997, most of Argonne's water came from four wells on the Argonne site. Lake Michigan now provides Argonne with high-quality water. The pre-1997 wells had such naturally high levels of total dissolved solids (TDS; i.e., dissolved salts or "hard" water) that it was difficult for Argonne to consistently comply with the regulatory TDS limits at one of several outfalls on the Argonne site. The switch to Lake Michigan water has solved this problem, because the level of TDS in the Lake Michigan water is well below the limit. Now, Argonne uses the wells only as back-up systems in case a problem arises with the water in Lake Michigan.

Argonne monitors groundwater by collecting and analyzing samples from the former on-site wells. Samples from each well are tested for alpha and beta radioactivity, for hydrogen-3, and for strontium-90. Alpha and beta radioactivity tests are monitored closely for signs of raduim-226, radium-228, and isotopic uranium. Tests also check for volatile organic compounds (VOCs), such as industrial cleaning fluids or solvents. The results of all the radioactivity tests were within their normal range, and no VOCs were detected in Argonne's groundwater.

Sanitary Landfill

The sanitary landfill was a landfill on the western edge of Argonne-East. From 1966 to 1992, the landfill received waste such as general refuse, construction debris, boiler house ash, and other non-radioactive solid waste. This is the place where all solids and wastes were placed to isolate them from the environment.

From 1969 to 1978, liquid wastes at Argonne's on-site sanitary landfill were poured into a French drain, essentially a rock-lined hole in the ground, for disposal. About 109,000 liters of liquid were disposed into this drain. The liquid matter included used oil, used machine coolant, and other hazardous liquid wastes. VOCs and other toxic organic compounds have been identified as leaching from the former landfill, but there has not been any in the groundwater near the landfill.

CP-5 Area

The three wells near the former research reactor, Chicago Pile-5 (CP-5), have been sampled and analyzed for chemicals. (Shut down in 1979, CP-5 was a small reactor used to study the structure of materials.) Analysis of data from the existing wells, as part of Argonne's corrective action program under the Resource Conservation and Recovery Act, indicated the presence of metals and concluded that the existing wells were not best situated or installed for studying metals in the ground water around CP-5. New, better designed wells will be installed near CP-5.

319/319 Area

The 319-area in Argonne's southeast corner contains an inactive landfill, which was used for disposal of a variety of solid wastes. A well in that area has been found to contain small amounts of hydrogen-3 and strontium-90.

Summary of Results

Most of the results from the groundwater samples collected on the Argonne site did not exceed the State of Illinois Class 1 Groundwater Quality Standards. In the 800 area wells near Argonne's northwest corner, manganese, chloride, iron, and total dissolved solids exceeded the Illinois standard. Some of these exceedances were due to road salt used to keep Argonne's roads safe for employees and visitors during winter.

Radiation

By Matt Patton

Whether you know it or not, radiation is everywhere. Everyday people soak up radiation from things like the sun, medicines, radioactive minerals that have always been part of the environment, and even a small amount left over from nuclear weapons testing that ended decades ago. Radiation can have both positive and negative effects on people. Radiation is also used as a crucial component of many medical and technological types of equipment.

Radiation comes from the decay of unstable atoms called radionuclides. There are three main forms of radiation decay: alpha, beta, and gamma.

Alpha decay occurs when an alpha particle, which is made of two protons and two neutrons, is spontaneously emitted from the nucleus of an atom with approximately 82 or more protons. This form of decay is the least harmful to people and can barely penetrate your layers of dead skin. However, it can be extremely dangerous if it gets inside of your body via an open wound or ingestion. Once inside the body, this form of decay will affect only a small area of cells, but because it is so concentrated, it can do a large amount of damage to those cells.

Beta decay is composed of electrons emitted by spontaneous change of a neutron into a proton and an electron. This form of decay is just slightly more dangerous than alpha decay but can only penetrate roughly 2 cm (not quite an inch) into living tissue. This form of decay tends to spread out once inside the body, and its damage is then spread out over a large number of cells. Therefore the damage it causes to each individual cell is small.

The final form of decay, gamma, occurs when the nucleus of an atom spontaneously gives off high-energy photons (light energy). This form of decay is far deadlier than any other and in a large enough dose is capable of killing a person.

Natural sources of radiation are far more numerous than man-made sources. They include the sun, the ground, and the water. Radiation from the sun is called cosmic radiation, because it comes from outer space. This is the most deadly form of natural radiation, because people are exposed to it almost all the time. Have you ever gotten a really bad sunburn? The burn itself is from the radiation that the sun emits.

Terrestrial radiation comes from the ground. This kind of radiation is given off by naturally occurring radioactive elements in the ground, such as radon, potassium 40, and certain isotopes of thorium and uranium.

Man-made sources of radiation include medicine and medical equipment, consumer products, energy production, and nuclear weapons production and testing. Medical radiation comes from equipment like X-ray machines and certain sterilizing techniques used to keep things like replacement heart valves clean. Consumer-product radiation comes from things such as watch dials, tobacco products, smoke detectors, and TV screens.

The amount of radiation given off from each source can be measured in a unit called a millisievert (abbreviated mSv/y). People absorb radiation from natural sources everyday. The annual average dose a person gets is 3.0 mSv/y. Cosmic rays from the sun, account for 0.3 mSv/y per year. Another 0.3 mSv/y comes from the terrestrial radiation i.e. rocks and minerals, 0.4 mSv/y comes from internal radiation such as food and drinks, and the largest amount of radiation comes from naturally occurring radon gas, a whopping 2.0 mSv/y.

People also absorb radiation from many different man-made sources, although much less in total than from natural sources. Each year the average person receives only 0.63 mSv/y of radiation from man-made sources, about one-fifth the annual average dose. The largest amount of this comes from X-rays, like the kind you would get when you go the dentist, doctor or hospital. These make up 0.39 mSv/y of the total amount per year. Another 0.14 mSv/y comes from medicines, such as pills and shots; 0.1 mSv/y comes from consumer products, such as luminous watch dials, TVs, and smoke detectors; and less than 0.03 mSv/y comes from leftover nuclear radiation from atmospheric testing during the cold war.

The only signs that someone has been exposed to excessive radiation can be skin deformities, radiation poisoning, and cancer-like symptoms. A sunburn is an example of radiation that may be absorbed over many days, but only shows itself when the skin can no longer safely absorb more. A good way to protect yourself from radiation is to wear sun block when you go outside. This

Continued ▶

Continued ▶
does not only count for those hot summer days, but also for those cold, sunny days. You can get burned just as easily on a cold day as a hot day. Sunburns can be cured with products like aloe vera, but for more severe radiation exposure, there is no cure. They can be treated like cancer, but unlike cancer cannot be removed. A good way to protect yourself from more severe radiation is to wear a lead-lined vest while you're getting an X-ray. This will protect the more vital areas of your body from the potentially dangerous radiation emitted from the machines.

Radiation, however deadly, can help people. One thing the government has been doing for a number of years is using radioactive elements to power their satellites. The Pioneer 10 Spacecraft was launched from earth in 1972, powered by four radioisotope thermoelectric generators or RTGs. Early in 2003, the Jet Propulsion Laboratory's Deep Space Network received the last message from the satellite; it had been traveling and sending back scientific data for almost 31 years.

Medicine is one of the main areas where radiation is useful. Medical professionals treat things such as replacement heart valves and plastic hip replacements with radiation to make sure they are perfectly clean. They also use radiation in machines such as X-rays. In the case of X-rays, the patient is exposed to just enough to show what the medical professional needs, but the dose is kept as low as possible.

One new use for radiation is food irradiation. Foods, such as meat and other perishable items, are exposed to minute amounts of radiation to kill any bacteria and to prolong the food's shelf life. This is big news for schools that will have the choice of adding irradiated beef to their 2004 menus.

Environmental Radiological Program

By Jessica Mandrala and Ying Ying Sze

Argonne's main goal in their environmental radiological program is to monitor the amounts and effects of radioactivity in and around Argonne's DuPage County site. The program focuses on radionuclide concentrations, including measurements of alpha rays, beta rays, and gamma rays from radionuclides. Argonne monitors radioactivity in air, water, and soil on and off site, including areas in Darien, Downers Grove, Wheaton, and at Sawmill Creek and the Des Plaines River.

Air

Argonne monitors air radiation by taking continuous samples on the laboratory's perimeter and also at the various off-site locations listed above. The samples are collected weekly from permanent monitoring stations. In the lab, every sample is tested for alpha, beta, and gamma activity. In 2002, the annual average alpha and beta activity was lower for on-site samples than for off-site samples. This can be explained by the fact that off-site samples were sometimes changed every two weeks instead of one. Also, the off-site samples were located within "municipal complexes" and were exposed to higher levels of airborne material, containing naturally occurring radiation, as opposed to the Argonne-perimeter samples, which were taken in fields and grassy areas away from buildings and highways.

Water

Liquid wastewater at Argonne is collected into holding tanks. When a tank is full, it is sampled and tested for alpha and beta radioactivity. If the radioactivity exceeds the limit, then the tank is processed by evaporation.

After treatment, Argonne-East's wastewater is discharged into Sawmill Creek, which runs through the Argonne site into the Des Plaines River. Water samples from Sawmill Creek are taken upstream and downstream from the Argonne discharge point. The Des Plaines River is also tested upstream and downstream from the Sawmill Creek discharge point. Both Sawmill Creek and Des Plaines River concentrations of hydrogen-3 and other radionuclides were within safe limits.

Bottom Sediment

The bottom sediment in Sawmill Creek is tested at several locations between the Argonne discharge point and the Des Plaines River. Samples are dried, ground, mixed and tested. Only very low concentrations of several radionuclides were found.

Continued ▶

Estimated Dose to a Hypothetical Individual, 2002 (mrem/yr)

Pathway	ANL-E Estimate	Applicable Standard
Air	0.039	10 (EPA)
Air total	0.039	None
Water	0.016	4 (EPA)*
Direct radiation	0.010	25 (NRC)
Maximum dose	0.065	100 (DOE)

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

▶ **Continued**

Argonne does not have any operating nuclear reactors, but it does have several facilities that produce fast neutrons. Four environmental neutron monitors were placed on the Argonne site in January of 2002. A fifth dosimeter was placed off site to monitor background neutrons. Airborne pathways depend on wind speed and direction. All neutron doses were within safe standards.

Sources of Radiation at Argonne

A few buildings at Argonne emit radiation in their air exhausts. For example, Building 200 has radioactive contamination from a nuclear fuel evaluation program, and Building 212 emits higher levels of hydrogen-3 because of its hydrogen-3 recovery studies. Other buildings that have radioactive air emissions include 205, 350, 375, 411, and 415.

Under the requirements of the National Emission Standards for Hazardous Air Pollutants, the total dose limit for 2002 is 10 mrem/yr — about the equivalent of a single medical X-ray — for all radiological emissions from Argonne, including hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, and radon-220. The total dose from Argonne during the year was 0.039 mrem, about 1/250th of the allowable limit.

Summary of Airborne Radioactive Emissions from ANL-E Facilities, 2002

Building	Nuclide	Half-Life	Released (Ci)	Released (Bq)
200	Radon-220	56 s	29.71	1×10^{12}
205	Hydrogen-3	12.3 yr	0.19	6.9×10^{9}
212	Hydrogen-3	12.3 yr	9.18	3.4×10^{11}
(Alpha Gamma	Hydrogen-3 (gas)	12.3 yr	91.8	3.4×10^{12}
Hot Cell Facility)	Krypton-85	10.7 yr	25.9	9.6×10^{11}
	Radon-220	56 s	0.41	1.5×10^{9}
350 (NBL)	Uranium-234	2.4×10^{5} yr	2.8×10^{-7}	1.0×10^{0}
	Uranium-238	4.5×10^{9} yr	2.8×10^{-7}	1.0×10^{0}
	Plutonium-238	87.7 yr	3.0×10^{-7}	1.1×10^{0}
	Plutonium-239	2.4×10^{4} yr	1.4×10^{-5}	5.2×10^{3}
	Plutonium-240	6.6×10^{4} yr	2.2×10^{-6}	8.1×10^{2}
	Plutonium-241	14.4 yr	6.7×10^{-6}	2.5×10^{2}
	Plutonium-242	3.8×10^{5} yr	1.0×10^{-8}	3.7×10^{-1}
375 (IPNS)	Carbon-11	20 m	1459.7	5.4×10^{13}
	Argon-41	1.8 h	94.4	3.5×10^{11}
411/415 (APS)	Carbon-11	20 m	0.15	5.5×10^{9}
	Nitrogen-13	10 m	10.90	4.0×10^{11}
	Oxygen-15	122 s	1.19	4.4×10^{10}

Population Dose within 80 km, 2002

Radionuclide	Person-rem
Hydrogen-3	0.18
Carbon-11	1.95
Nitrogen-13	<0.01
Oxygen-15	<0.01
Argon-41	0.57
Krypton-85	<0.01
Antimony-125	<0.01
Iodine-125	<0.01
Iodine-129	<0.01
Cesium-134	<0.01
Cesium-137	<0.01
Cerium-144	<0.01
Europium-154	<0.01
Europium-155	<0.01
Radon-220	<0.01
Uranium-234	<0.01
Uranium-238	<0.01
Plutonium-238	<0.01
Plutonium-239	0.07
Plutonium-240	0.01
Plutonium-241	<0.01
Plutonium-242	<0.01
Americium-241	<0.01
Curium-242	<0.01
Curium-244	<0.01
Total	2.8
Natural sources	2.7 X 10^6

Radionuclides in Sawmill Creek Water, 2002

Activity	Location[1]	Samples	Concentration (pCi/L)			Dose (mrem)		
			Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	16K	12	1.5 ± 2.1	0.3	3.7	-[2]	-	-
(Nonvolatile)	7M	51	1.0 ± 1.2	0.2	3.6	-	-	-
Beta	16K	12	8 ± 6	4	13	-	-	-
(Nonvolatile)	7M	51	9 ± 4	5	15	-	-	-
Hydrogen-3	16K	12	< 100	< 100	102	< 0.0046	< 0.0046	0.0047
	7M	51	< 100	< 100	307	< 0.0046	< 0.0046	0.0141
Strontium-90	16K	12	< 0.25	< 0.25	0.42	< 0.024	< 0.024	0.040
	7M	51	0.35 ± 0.19	< 0.25	0.71	0.033	< 0.024	0.067
Cesium-137	16K	12	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
	7M	51	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
Uranium-234	16K	12	0.832 ± 1.129	0.160	1.857	0.158	0.030	0.353
	7M	51	0.465 ± 0.512	0.130	1.063	0.088	0.025	0.202
Uranium-238	16K	11	0.740 ± 0.954	0.130	1.343	0.124	0.022	0.226
	7M	50	0.414 ± 0.474	0.093	0.963	0.070	0.016	0.162
Neptunium-237	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	7M	51	< 0.0010	< 0.0010	0.0015	< 0.0028	< 0.0028	0.0044
Plutonium-238	16K	12	< 0.0010	< 0.0010	0.0045	< 0.0028	< 0.0028	0.0125
	7M	51	< 0.0010	< 0.0010	0.0019	< 0.0028	< 0.0028	0.0053
Plutonium-239	16K	12	< 0.0010	< 0.0010	0.0054	< 0.0031	< 0.0031	0.0171
	7M	51	< 0.0010	< 0.0010	0.0028	< 0.0031	< 0.0031	0.0087
Americium-241	16K	12	0.0013 ± 0.0022	< 0.0010	0.0035	0.0043	< 0.0033	0.0115
	7M	51	0.0016 ± 0.0080	< 0.0010	0.0264	0.0053	< 0.0033	0.0869
Curium-242 and/or	16K	12	< 0.0010	< 0.0010	0.0028	< 0.0007	< 0.0007	0.0019
Californium-252	7M	51	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or	16K	12	< 0.0010	< 0.0010	0.0014	< 0.0034	< 0.0034	0.0046
Californium-249	7M	51	< 0.0010	< 0.0010	0.0024	< 0.0034	< 0.0034	0.0081

[1] Location 16K is upstream from the Argonne-East site. Location 7M is downstream from the Argonne-East wastewater outfall.
[2] A hyphen indicates no CEDEs for alpha and beta.

Habitat management

Nikki Griffin and George Chakonas

Argonne contains much wildlife diversity because of its unique location. Argonne is an ecotone, an area where many ecosystems come together and overlap. In Argonne's case, the prairie, forests, and wetlands come together to create an ecotone. Argonne and the surrounding areas contain five types of amphibians, seven types of reptiles, 40 species of summer resident birds, and 25 types of mammals.

Argonne is trying to eliminate many of the invader species that threaten the ecosystems' native wildlife. A fairly well known invader species is Queen Ann's Lace. This plant has taken over our wetlands and prairies. Invader species can be more powerful than they might seem.

Yellow goldfinch drawn by Jessica Morrison

Vegetation

The forest on and around Argonne contains sugar maples, red oaks, and basswood. Argonne's prairie areas contain big blue stem, prairie dock, and other forms of vegetation. The fields are dominated by blue grass. Argonne has a long tradition of managing the vegetation on its DuPage county site. For one thing, in 1953 Argonne planted three million pine trees to stop soil erosion across the site, which had formerly been mainly farmland.

Wildlife Management Research

A major wildlife issue at Argonne is the periodic over abundance of deer that roam the site. To cope with this problem, the U.S. Department of Energy (DOE) set up a program in 1995 to monitor and thin the herd as needed. Deer overpopulation creates traffic hazards that threaten human life, diminishes the health of the deer due to lack of food, causing many deer to starve, and threatens the survival of native plant species that the deer eat. DOE's program has stabilized the number of deer in and around Argonne.

The deer control program meets the requirements set by the Deer Population Control Permit. The target density of the white tail deer is 15 deer per square mile. In 2002, 47 deer needed to be removed.

Argonne staff monitor the deer's health by testing the deer that have been removed. The deer's health is evaluated primarily by tracking their weight. Testing shows that the deer's overall health has improved since the program began in 1995.

Deer tissue is also monitored occasionally for radioactive substances. This testing is especially important, because the meat from eliminated deer is sent to charities to help feed the poor.

One of the purposes of the deer management program is to balance the deer-to-vegetation ratio. In the fall, staff survey the woody vegetation in the forests. In the spring, they survey the herbaceous vegetation and tree seedlings. The surveys help to verify that the deer population is not too large for the natural vegetation available to support the herd.

Wetland

Argonne is currently implementing a wetland protection plan. If a wetland is destroyed or removed, this plan requires that it will be replaced by one of equal or greater size. For example, a few wetlands that were destroyed during construction of the Advanced Photon Source were replaced by new wetlands of equal or greater size.

Argonne monitors and manages these new wetlands to ensure that they provide quality habitat for wildlife.

Environmental Cleanup

Erika Lebedevs and Elizabeth Scatena

Argonne's environmental remediation program follows the regulations and standards set by the U.S. Department of Energy (DOE) and the Illinois Environmental Protection Agency (IEPA). Argonne is responsible for assessing and cleaning up the release of hazardous materials from inactive waste sites. Argonne suggests proposals for remediating specific sites at Argonne-East. These proposals aim to improve a site or to maintain it, if it already meets the standards set by DOE or the IEPA.

After intensive analysis duing fiscal year 2002, Argonne's environmental remediation program arrived at several recommendations for future monitoring of different locations at Argonne-East. Out of the 11 sites monitored, six completed final cleanup fieldwork, four completed assessment or design work, and one still has continued remediation activity plans for the future.

Phytoremediation

Argonne is using phytoremediation to clean groundwater, wastewater, and contaminated soils in the southeastern corner of the Argonne-East site. Phytoremediation is low in cost and uses various green plants, such as shrubs, woody species, and grasses to remove contaminants from soil and water. Phytoremediation profits from the plants' root systems. Argonne's phytoremediation project has planted trees with deep roots in a multi-year project to clean up groundwater about 30 feet below the surface. In 2002, Argonne added two monitoring wells to better define the western-most edge of the contaminated groundwater plume in the phytoremediation area.

Lime Sludge

Another remediation project at Argonne-East is finding a useful way to dispose of lime sludge left over from decades of treating hard water. Because the sludge has value to farmers as a soil treatment, Argonne is donating and selling the sludge through a distributor to farmers, who use it as a soil conditioner. Using the sludge in this manner has kept about 100,000 cubic meters of waste out of landfills.

Summary

As a result of these and other remediation activities, Argonne has saved an estimated $7.7 million. Due to these efforts, Argonne won a DOE National Pollution Prevention Award in 2002.

The table below represents the different areas that were looked over for remediation. It explains the specific work done at each site and whether or not Argonne requested a no-further-action (NFA) ruling from the IEPA. An NFA request means that Argonne believes the specific area on site has been cleaned up to meet or exceed regulatory guidelines and requires no further action; the IEPA responds to NFA requests by investigating and either agreeing or requiring further action.

Site Name	Site Number	FY 2002 Work Scope	NFA Requested
Newly Identified Suspected Waste Landfill	SWMU (Solid Waste Management Unit) No. 744	IEPA approved remedial design and remediation fieldwork was completed. Construction report submitted to the IEPA requesting NFA for the soil portion. A separate request will be submitted to the IEPA for NFA relative to groundwater.	Yes
Lime Sludge Pond	Former SWMU No. 8	Removed an additional 15,000 cubic yards of lime sludge from the lagoon.	No
Bldg. 34 Mixed Liquid Waste Treatment	SWMU No. 150	The IEPA granted NFA for soil. Groundwater remediation fieldwork was completed and the construction report was submitted to the IEPA requesting NFA.	Yes
Bldg. 330 Yard with Mixed Material for Decommissioning	SWMU No. 151	Prepared supplemental groundwater investigation work plan, which received IEPA approval.	No