ANL-14/02 (Summary)

Summary Site Environmental Report

for Calendar Year 2013

Environment, Safety, and Quality Assurance Division

About Argonne National Laboratory

Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC under contract DE-AC02-06CH11357. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne and its pioneering science and technology programs, see www.anl.gov.

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For more information about Argonne's Site Environmental Report, contact Theresa Davis, 630.252.6077 or tmdavis@anl.gov.

For more information about Argonne and its programs, visit the laboratory's website at www.anl.gov or contact Communications, Education, and Public Affairs, at 630.252.5575.

Katherine Obmascik edited the text. Photos by Mark Lopez. Graphic design by Michele Nelson.

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JAMIE BARNES AND EMILY LORENZ

A MESSAGE FROM THE STUDENTS

Hello!

We are the seniors of Downers Grove South High School who were selected to write the 2013 Summary Site Environmental Report for Argonne National Laboratory.

Throughout the writing process, we learned more about Argonne than many people know. We learned how long they've been around, what they do, and how they do it. We learned about Argonne's accomplishments in the past and what they're working toward in the future.

The hardest part of writing for Argonne was wanting to include everything they do. It was sometimes difficult to decide what to leave out since there was not enough room in the report to describe everything. Some things were difficult to understand because what Argonne does is very complex and interesting. Argonne's monitoring program is very detailed, and deciding which details were the best to discuss was something many people would find difficult.

As high school students, we strove to write the best report we could. Knowing that many would read this made us try hard to put everything in terms that anyone can understand, while making it interesting to read about what Argonne does and how it affects the surrounding community.

We hope you like what we have put together and we hope that you appreciate what Argonne does after you read it. They are making history in the scientific community and doing amazing work that should not be taken for granted.

BIOLOGY II – RESEARCH TOPICS IN BIOLOGY STUDENTS FROM DOWNERS GROVE SOUTH HIGH SCHOOL
From left: *Back row: Kate Troyer (teacher), Guadalupe Valdivia, Rachel Stepp, Jamie Barnes, Austin Alvarado, Katrina Nicdao*
Front Row: *Savannah Winkler, Emily Lorenz, Alexis Carpello, Rachel Petro, Brandon Reed*

EMILY LORENZ AND JAMIE BARNES

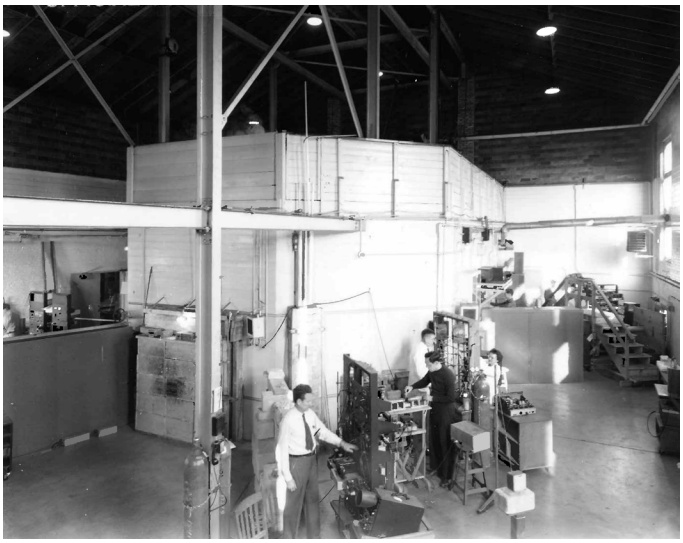
WHAT IS ARGONNE?

Argonne National Laboratory, located 25 miles southwest of Chicago, Illinois, is a place for world-renowned scientists and engineers to pursue innovative and practical research to create a foundation of knowledge and learning on the leading edge in many areas. Using state-of-the-art facilities, scientists, engineers, and researchers from around the world conduct experiments to explore deep questions that affect our nation and people throughout the world.

Aerial photograph of Argonne

THE CREATION OF ARGONNE

Argonne came into existence in 1942, during World War II. It was a product of the Manhattan Project, which was created to develop the world's first nuclear bomb to use during the war. Its first goal was to achieve a self-sustaining nuclear reaction, which succeeded on Dec. 2, 1942, on the University of Chicago campus. This work was deemed too dangerous to perform in a heavily populated area, so the location was moved to a more isolated area, southwest of Chicago, and renamed Argonne. In 1946, Argonne National Laboratory was created with the goal of conducting cooperative research in nucleonics, the study of the atom's nucleus and ways to generate power from the atom. Argonne became a research and testing facility and quickly began creating and testing some of the United States' first nuclear reactors. Some of its early accomplishments were designing and building the Chicago Pile 3 (CP-3) research reactor and the Experimental Breeder Reactor I, which, in 1951, was the first nuclear reactor to generate electricity. Argonne scientists also continued their research in physics and chemistry. Argonne chemists discovered the 99th and 100th elements in the periodic table of elements in 1955 and continued to make strides in the world of science by opening new fields of study.



CP-3 Reactor

Another research study involved storing nuclear waste in an underground room similar to a tunnel. These "tunnels" are carved into salty material, creating an underground repository. Studies are being undertaken to determine new ways to dispose of nuclear waste and minimize potential leakage.

WHAT ARGONNE IS TODAY

Argonne is a national research facility made up of 3,398 employees, including 1,395 scientists and engineers, with 750 PhDs, who focus on many topics including energy, biological and environmental systems, and national security. Argonne designs, builds, and operates scientific user facilities that are used by scientists from around the world. Argonne currently includes 15 scientific research divisions and 5 national user facilities. The Argonne site houses a variety of laboratories, fabrication shops, advanced computing centers, particle accelerators, support facilities, and office buildings.

ARGONNE'S MISSION

Argonne's mission is to deliver innovative research and technology that helps meet the needs of our nation. Argonne also works frequently with universities, other national laboratories, and industries to gain new knowledge and create useful new technologies. They seek ways to maintain a healthy environment while supplying sustainable and safe energy.

ARGONNE'S GOALS

Argonne hopes to lead the world in providing scientific and engineering solutions to the big questions and problems of our time: sustainable energy, a healthy environment, and a secure nation. Argonne strives to inform and educate its workers, neighbors, and visitors, not only from the surrounding community, but from all corners of the globe. Argonne continues to push scientific boundaries to solve complex problems and gather new and useful findings.

continued... What is Argonne?

IMPACT OF ARGONNE

Argonne has an annual budget of $760 million. Argonne's budget, which is provided primarily by the U.S. Department of Energy (DOE), funds many different things, including numerous research projects and equipment. The work they do benefits not only the surrounding community, but the world we live in.

Community: Argonne protects the surrounding community's ecosystem. With a clean ecosystem, the area is healthier and more appealing to the eye.

World: Argonne's research focuses on matters that affect people's everyday lives throughout the world. One important area is transportation science, which devises ways we can make different modes of transportation greener and, in the long run, cheaper; an idea benefiting everyone.

BRANDON REED

ENVIRONMENTAL MANAGEMENT SYSTEM

ARGONNE'S ENVIRONMENTAL MANAGEMENT SYSTEM

Why exactly does Argonne have an EMS, and why is this important, if not essential? EMS stands for Environmental Management System. An EMS is a tool that is used by the management team at Argonne to monitor the impacts that Argonne's work has on the environment and to identify ways to improve the environment near Argonne. It allows Argonne to safely operate while keeping the environment's well-being in mind. Argonne's EMS includes several key elements that are necessary for its success. Argonne must take action to make continuous improvements to the environment. Argonne must prevent pollution from entering the environment, as well as safely handle any waste it generates.

Argonne evaluates its activities to identify any operations that could result in potential harm to the environment. When Argonne finds any activities with the potential for environmental impact, it uses the EMS to make sure that potentially harmful effects do not occur. Argonne has determined that its air emissions, wastewater discharges, waste generation and management, and pollution prevention activities are significant environmental aspects that require management through the EMS.

Argonne strives to meet and exceed goals for improving its environmental, energy, and economic performance. Argonne utilizes a Site Sustainability Plan (SSP) to track progress toward achieving these goals.

The SSP ensures that Argonne meets its goals for conserving electricity and water, reducing greenhouse gas emissions, and utilizing greener practices throughout the facility. These goals will be achieved by utilizing renewable energy sources to lower the greenhouse gas output, which will also aid in making Argonne more environmentally friendly and sustainable.

Argonne's Site Sustainability Plan

Argonne's current carbon footprint is 318,142 metric tons of CO_2 per year. This is lower than the 2008 measurement, which was 339,030 metric tons per year. During 2013, purchased power was the main contributor to the carbon footprint at 69% of the total. Natural gas used to generate steam was second at 16%. Transportation-related emissions were 6% of the carbon footprint. Other emissions from the facilities made up 8% of the carbon footprint. The remaining 1% of the footprint was from on-site and off-site emissions from landfills and wastewater.

Water use at Argonne is very important and necessary; however, Argonne has a goal to reduce the amount of water that it uses. Part of this goal includes reducing the current potable water (fresh drinking water) usage by 26% by 2020. By the end of 2012, however, Argonne had already reduced its potable water consumption by 32%, which far exceeded expectations. The goal for reducing the water consumption for industrial usage is 20% by the year 2020. At the end of 2013, the usage of water for industrial purposes had decreased by 17%. At the current rate, the 20% goal will be easily met by the year 2020.

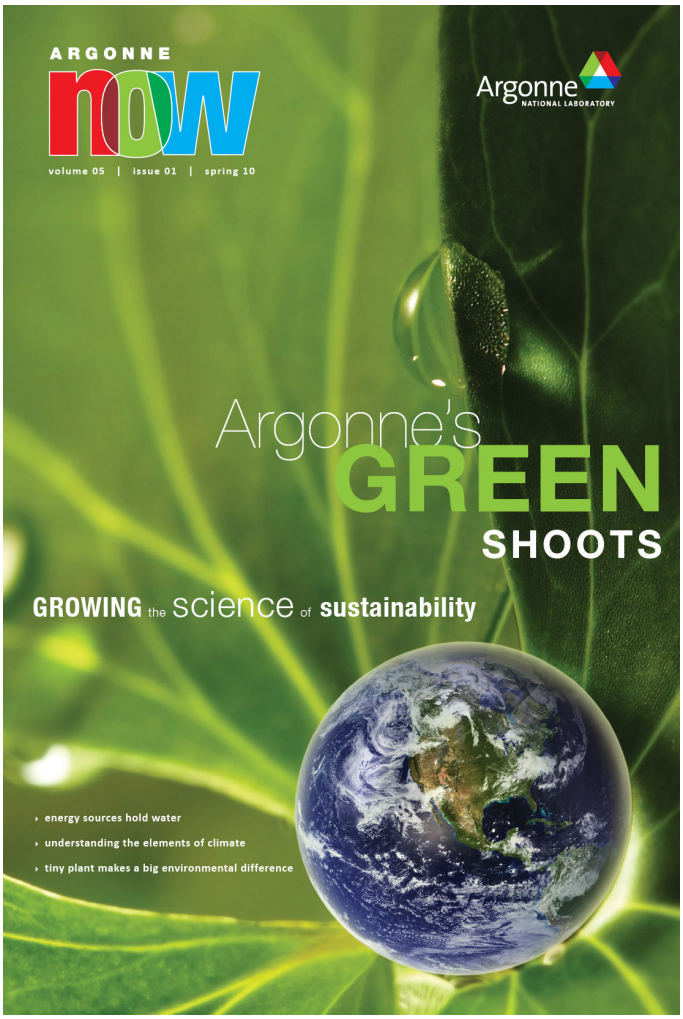
Argonne is constantly monitoring its operations and facilities to minimize pollution. Argonne has implemented a site-wide waste minimization/pollution prevention program. This program tracks the generation of waste and recyclable materials. Argonne compares this production rate with the acceptable goals set by its SSP. New ways to increase recycling and reduce waste production are explored each year.

Argonne is currently utilizing a solid waste recycling program to effectively reduce and recycle a wide range of materials. The materials and amounts recycled are shown in Table 1. This program has resulted in substantial savings for Argonne. During 2013, Argonne received $68,000 for its recycled paper and scrap metal. Argonne will continue to use this system to aggressively minimize waste and to maximize collections of recyclable material.

TABLE 1 – MATERIALS RECYCLED (2013)

MATERIAL	AMOUNT RECYCLED (tons)
Mixed office paper	279
Aluminum (70%), steel (10%), glass (10%), and plastic (10%)	86
Asphalt, concrete, and construction debris	223
Scrap metal	129
Computer components (PCs)	28
Computer monitors	16
Toner cartridges	8.6
Batteries	0.2
Engine lubricating oils	7.9
Fluorescent lightbulbs	0.6
Lead/acid batteries	1.3
Transparencies	0.01

Argonne conducts public outreach activities and events to educate its employees and the public on the status of environmental programs and efforts to promote environmental awareness. Examples of outreach include tours of Argonne facilities, the *Argonne Now* magazine, and the use of social media. Argonne hosts many tours of its facilities for schools, colleges, business groups, and community groups. *Argonne Now* is a publication that features stories about scientific breakthroughs at Argonne and what they mean for our everyday lives. A copy of *Argonne Now* is sent twice a year to subscribers. Past copies are available on Argonne's web site. Members of the community may also educate themselves via social media by communicating with scientists on Facebook, YouTube, LinkedIn, Pinterest, Flickr, and Twitter.



Cover of the Spring 2010 Argonne Now magazine

continued... Environmental Management System

During 2013, Argonne received several prestigious awards for its pollution prevention and sustainability programs. One of these was the 2013 DOE Sustainability Award for "Building 214—High Performance Building Upgrades." Building 214 became Argonne's sixth building to meet the high performance and sustainable building requirements. Another award given to Argonne was the 2013 Illinois Governor's Sustainability Award, Office of the Governor/Illinois Sustainable Technology Center (ISTC), Honorable Mention. This was awarded to Argonne for its implementation of solar panels, a wind turbine generator, sustainable employee commuting options, and water and energy conservation measures.

Sustainability awards received by Argonne

RACHEL STEPP

CURRENT RESEARCH

INTRODUCTION

Have you ever wondered about what kind of process scientists go through to develop different kinds of medicines? Or how people can make machines and electronics more environmentally friendly? The purpose of doing research at Argonne is to solve national issues by using innovative science to create a stronger economy and a healthier environment.

RESEARCH FACILITIES FOR USERS

Argonne has multiple research facilities that are used by researchers and scientists from all over the world to make new discoveries and innovations. These facilities include:

The Advanced Photon Source – The Advanced Photon Source (APS) is a very complex machine that uses high-energy X-ray beams to show how different materials function and are structured. A wide variety of research is done here, ranging from health and environmental studies to energy and materials research.

The Advanced Photon Source

The Center for Nanoscale Materials – The Center for Nanoscale Materials (CNM) is a user facility that provides many resources for scientists researching the properties of different kinds of materials. Research here involves designing and putting together materials and structures on the nanoscale level. New discoveries made here can be used to create stronger and lighter materials for more efficient machines and devices.

The Argonne Leadership Computing Facility – The Argonne Leadership Computing Facility (ALCF) is supported by the U.S. Department of Energy. Its purpose is to provide cutting-edge computer technology for researchers to solve national problems with computer-made simulations and models. This facility is home to Argonne's supercomputer, Mira, a very powerful computer that is used by many to create complex models of things like airplanes and even human beings.

The Mira computer

Transportation Research and Analysis Computing Center – Argonne's Transportation Research and Analysis Computing Center (TRACC) is funded by the U.S. Department of Transportation to conduct important research on transportation technology. Projects are often simulation-based, so that researchers can see how different variables can affect the safety of transportation. For example, determining the amount of damage that could be caused in a car accident, or evaluating how well a bridge can hold up in different load situations.

Computer simulation of a vehicle collision

Argonne Tandem Linac Accelerator System – The Argonne Tandem Linac Accelerator System (ATLAS) is a superconducting linear accelerator for heavy ions at energies in the vicinity of the Coulomb barrier (the amount of energy needed for two atomic nuclei to merge). Scientists can study the properties of different kinds of nuclei at this energy level. About 200–300 users perform research at this facility each year and learn about nuclear reactions related to astrophysics and nuclear structure.

PAST SUCCESSES

In past years, Argonne has completed many successful research projects. In the early years, Argonne was the world leader in research that led to the production of power from nuclear reactors. Argonne experiments helped design most of the commercial reactors currently used throughout the world for electric power generation. Argonne designed the reactor for the world's first nuclear-powered submarine, the U.S.S. Nautilus.

Scientists here have been able to determine the structure of the human adenovirus that makes us sick with a cold. Knowing how this virus works can help other scientists find new ways to treat illness or prevent people from getting sick in the future.

At the APS, researchers have figured out how a hormone helps different kinds of plants adapt to a lack of heat or water. With this information, plants can be engineered to withstand drought and cold which can, in turn, help stop food shortages.

The production of cement has become a greener process thanks to the research done at Argonne. Scientists have been able to learn about the nanostructure of the major ingredients in cement, leading to changes in how the material is made so it can be stronger and more eco-friendly.

CURRENT RESEARCH

Electric Car Batteries – Since many people rely on their cars for daily transportation, it's important that cars are made to be as efficient as possible. By studying the different chemical reactions that occur inside lithium-ion batteries, scientists at Argonne can determine how to make these batteries hold more energy and last for longer periods of time.

Argonne researcher testing an electric car

Sustainable Energy and Technology – People use different kinds of technology every day, whether it's using a cell phone to make a call, a machine to determine a patient's vital signs, or a flashlight to see in the dark. There are concerns about the amount of energy it takes to use all these devices. Researchers at Argonne have been looking into different power sources to make technology more efficient. One of these alternatives is solar energy. Scientists have been working to understand the different reactions occurring in solar cells. By understanding how these reactions happen, scientists can develop more eco-friendly electronics.

Solar cells research

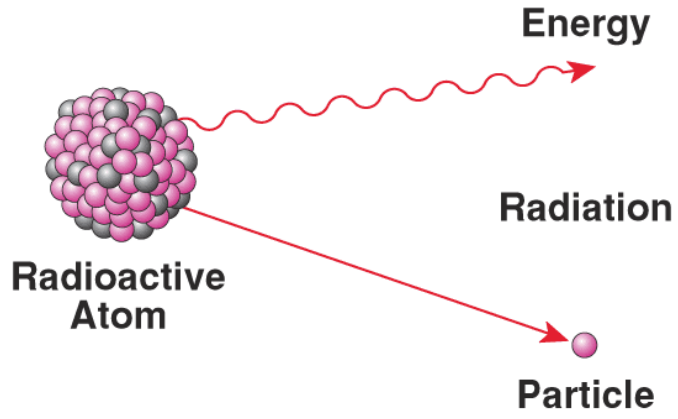
Alloys and Composites – At Argonne, the properties of advanced alloys and composites are being researched so that they can be more easily controlled and used in different manufacturing methods. An alloy is a material that is made of at least one metal element and at least one other metal or a nonmetal element. A composite is a material made of two different kinds of materials that are closely bound together. Alloys and composites are both created to be stronger and lighter than other commonly used materials. By studying and understanding the way these materials work, scientists can then use them to create better turbines and other energy-producing systems.

Carbon Sequestration – Researchers at Argonne are studying the process of carbon sequestration, which involves the removal of carbon from the atmosphere and storing it in the ocean or under the earth. The purpose of this research is to have a better understanding of this process so that scientists can find better ways to remove carbon from the atmosphere. Doing this can help with our planet's climate change issue.

ALEXIS CARPELLO

RADIATION

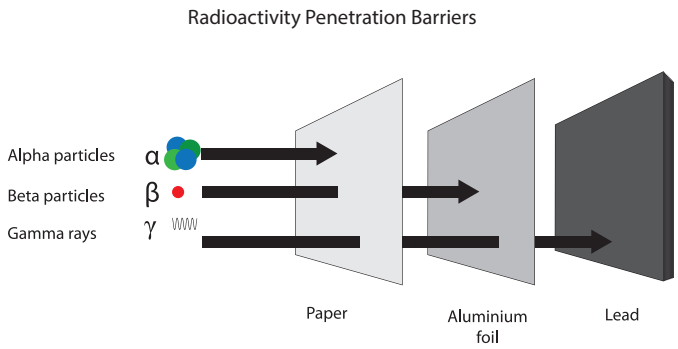
Most people label radiation as a dangerous form of energy, but few people actually know about the useful tasks radiation does on a daily basis. There are several types of radiation and the amount of risk they pose depends on the type. Common examples of radiation that are used in everyday life are light and heat. The type of radiation discussed in this report is known as nuclear ionizing radiation. This form of radiation comes from the sun, outer space, and man-made sources like X-ray machines, nuclear reactors, and radioactive chemicals.



Radiation

IONIZING RADIATION

Nuclear radiation is ionizing radiation that is released when unstable atoms give off energy as they change to a more stable form (decay). The three types of ionizing radiation are alpha, beta, and gamma. Alpha radiation occurs when two neutrons and two protons, or a positively charged helium atom, are emitted from an unstable atom. Alpha radiation particles have the least ability to penetrate matter. Most alpha radiation is stopped by the skin because the alpha particle is large compared to other forms of radiation. However, alpha radiation can still be very dangerous if ingested into a person's body. Beta radiation particles, which consist of highly energized electrons, are much smaller than neutrons and protons; their small size means they can penetrate more easily than alpha radiation, but they can be stopped by clothes. Gamma radiation consists of a high-energy photon, which is essentially a wave of energy that can penetrate deep into material. Special heavy shielding is needed to stop gamma rays. X-rays are a form of ionizing radiation, similar to gamma rays, but they are rarely found in the environment.



Alpha, Beta, and Gamma radiation penetration

MEASUREMENT OF IONIZING RADIATION

Radiation can be measured using several methods, such as the familiar Geiger counter. When radiation hits a Geiger counter, an electronic pulse is created that produces the well-known clicking sound. Many smaller, more sensitive methods of detecting radiation have been developed in recent years. Film badges (also called thermoluminescent dosimeters) are devices worn by individuals to measure the amount of radiation the person is exposed to over a period of time. They can also be used to measure the level of radiation inside a building or in the environment.

The amount of radiation present is measured in units of curies (Ci). Very small amounts of radiation, such as radiation in the environment, are usually expressed in picocuries or pCi (one trillionth of a curie). The amount of radiation in a liquid can be expressed as pCi/L, which is the amount of radiation present in one liter of liquid. Radiation absorbed by a person over a period of time is known as the radiation dose. Dose is most commonly measured in units of rems (abbreviated from Roentgen Equivalent in Man). Small doses are expressed as millirems (or one thousandth of a rem). The strength of radiation in an area is expressed in units of millirems/hour or millirems/year, which indicates the amount of dose per unit of time. The total dose is calculated by multiplying the strength of the radioactivity a person is exposed to from a source by the total time they are exposed to that source. For example, if someone were exposed to a 20 mrem/hour source for 10 hours, they would receive a total dose of 200 mrem. Very low doses, like the ones discussed in this report, are expressed in units of mrem/year, which is the total amount of radiation a person would absorb in an entire year.

WHAT ARE RISKS OF RADIATION?

Radiation is constantly a part of everyone's life, whether we know it or not. Remember when your parents told you not to look into the sun? The reason is the ultraviolet (UV) rays given off by the sun are a type of radiation that can damage your eyesight. Most of the radiation we receive daily is not harmful to us because the dose of the radiation is so low that our cells can actually repair themselves thoroughly.

According to the radiation protection standards in the United States, any type of radiation carries some type of risk. The most harmful type of radiation to someone's body is ionizing radiation. Ionizing radiation can make chemical changes in cells that could kill the cells or cause them to become cancerous. Radiation sickness is an outcome of an individual receiving an extreme amount of radiation. Radiation sickness is a serious illness and is sometimes fatal; however, it is rare to get radiation sickness. Symptoms that occur initially are nausea and vomiting. The more rapidly the symptoms appear, the greater the amount of radiation an individual was exposed to. Some adverse effects from too much radiation may not be noticed right away, but instead, years later, and could potentially cause cancer. However, most of the radiation you are exposed to everyday is not the type that can cause potential harm under normal circumstances.

One common use of nuclear radiation is to produce X-rays and conduct medical scans to see muscles, tissues, and bones inside of our bodies. This radiation has the potential of becoming harmful to someone if they are exposed to large amounts of radiation over many years. However, radiologists and X-ray technologists have been trained to use the minimum amount of radiation to achieve the results that they need.

HOW DOES ARGONNE NATIONAL LABORATORY USE RADIATION?

At Argonne, there are many research facilities that rely on nuclear radiation to conduct research. One of these is the Advanced Photon Source (APS) facility. The APS uses extremely high-powered X-rays to do experiments of many different types. This facility is an extremely valuable research tool because it is used not only by Argonne scientists, but by researchers from universities, industrial firms, other national laboratories, and medical schools. The research topics that scientists at the APS investigate include: materials science; biological science; chemical science; agricultural science; environmental science; geoscience; atomic, molecular, and optical physics; and lastly, development of novel instrumentation. This shows why radiation is so beneficial to scientists who are doing research at the APS.

HOW DO YOU CONTROL THE AMOUNT OF RADIATION THAT YOU RECEIVE?

Every person receives a small dose of radiation every day. It's easier than you might think for people to reduce the amount of radiation they receive in their bodies. Lessening the total amount of time an individual is exposed to radiation can benefit them greatly. Another way is to use something to absorb the radiation before it hits the body. This is called shielding. One common way of shielding is to use sunscreen while outside to reduce the amount of UV rays your skin absorbs. Radon gas is a dangerous, naturally occurring radioactive gas that comes from the earth. Exposure to radon causes most of the radiation exposure to a person from natural sources during their lifetime. Having radon sensors in your home is a precautionary way to inform yourself

continued... Radiation

of inadvertent exposure to dangerous radiation. Keeping radon levels low in houses by improving ventilation is one of the best ways to reduce an individual's exposure to radiation. Minimizing the amount of X-rays and computerized tomography (CT) scans an individual has during their lifetime is also an extremely important way to reduce radiation dose. An individual having numerous X-rays and CT scans can potentially receive too much radiation that can possibly cause radiation sickness. Knowing the risks and the precautions to take while being exposed to radiation from all sources helps to provide a safer environment for everyone.

SAVANNAH WINKLER

RADIATION MONITORING

Most people do not realize how much radiation they come into contact with every day. That is why Argonne scientists monitor radiation levels at their site to inform both the DOE and the surrounding community that the levels of radioactive pollutants are properly controlled. Due to the use of radiation on-site, Argonne has a radiological monitoring program that complies with DOE Orders O 435.1 "Radioactive Waste Management," O 458.1 "Protection of the Public and the Environment," and O 231.1B "Environment, Safety and Health Reporting," along with other regulations. The goal of these orders is to minimize the radiation and radioactive materials that are released into the environment.

Ionizing radiation occurs when energy is emitted from an unstable atom as subatomic particles or waves. Some of these particles or waves can have a high level of energy and can cause damage to living organisms. Radionuclides, or radioisotopes, are the unstable forms of chemical elements that radioactively decay, which causes nuclear radiation. Argonne monitors for radioactive material in air, water, and sediment samples, and measures gamma radiation released from the site, to evaluate the site's radiological impact. Airborne radiation comes from the exhaust of Argonne's nuclear facilities, listed in Table 2. As shown in Table 2, buildings like the APS, Bldg 203 Californium Rare Isotope Breeder Upgrade (CARIBU), Bldg 211 Linear Accelerator (LINAC), as well as Buildings 200, 212, and 366, are all monitored for radioactive emissions. The nuclides detected, their half-lives, and the amounts of radiation released in units of curies (Ci) are shown. These results are used to estimate the potential airborne radiation dose to nearby residents. The potential dose amounts are measured in units of millirem per year (mrem/yr). The maximum airborne radiation dose to a hypothetical resident near Argonne, assuming they were outdoors the entire year, was only 0.006 mrem/yr, far below the allowable radiation dose of 10 mrem/yr.

TABLE 2 AIRBORNE RADIOACTIVE EMISSIONS FROM ARGONNE FACILITIES, 2013

BUILDING	NUCLIDE	HALF-LIFE	AMOUNT RELEASED (Ci)
200	Radon-220	56 s	30.0
203 (CARIBU)	Xenon-138	14 min	0.1
211 (LINAC)	Hydrogen-3	12.3 yr	4.4×10^{-8}
	Beryllium-7	53 day	8.0×10^{-7}
	Carbon-11	20 min	2.8×10^{-2}
	Nitrogen-13	10 min	2.5
	Oxygen-15	122 s	0.6
	Chlorine-38	37 min	3.2×10^{-4}
	Chlorine-39	56 min	1.4×10^{-3}
212 (AGHCF)	Hydrogen-3	12.3 yr	0.1
	Strontium-90	28.8 yr	1.4×10^{-10}
	Antimony-125	2.7 yr	1.5×10^{-8}
	Iodine-129	1.6×10^{7} yr	5.0×10^{-9}
	Radon-222	3.8 days	0.1
	Americium-241	432.7 yr	6.3×10^{-12}
366 (AWA)	Nitrogen-13	10 min	1.6×10^{-10}
	Chlorine-39	56 min	3.2×10^{-12}
	Argon-41	1.8 hr	8.8×10^{-13}
411/415 (APS)	Carbon-11	20 min	0.6
	Nitrogen-13	10 min	28.0
	Oxygen-15	122 s	3.0

Radioactive particles in the air at Argonne are measured by eleven air samplers. The airborne emissions are sampled continuously and the filters are changed weekly. Alpha and beta radiation, and gamma-emitting radionuclides, are measured in the air-filter samples. Table 3 shows the results from 2013 which includes both perimeter and off-site locations. The data show lower levels of alpha radioactivity at Argonne in the perimeter samples compared to the background samples, but both sets of results are essentially the same since they are within the relative error of the measurements. The beta radioactivity, beryllium-7, and lead-210 in perimeter samples were greater than the off-site samples, but similar to normal background amounts.

Argonne scientist collecting an air filter sample

TABLE 3 RADIATION IN AIR, 2013

Location	Alpha Activity fCi/m^3	Beta Activity fCi/m^3	Beryllium-7 fCi/m^3	Lead-210 fCi/m^3
Perimeter	1.48	23.56	124	28
Off-Site	1.66	18.80	69	15

Another source of airborne release of radioactive material is Argonne's phytoremediation system. Implemented in Area 317/319 to clean up contaminated groundwater, phytoremediation is a natural process in which arboraceous plants (trees) remove pore water and dissolved chemicals from subsurface soil, reduce the amount of contaminants, and release them as water vapor into the atmosphere. Approximately 700 poplar trees and 200 willow trees were planted to aid in this process. The groundwater also contains low concentrations of tritium, a radioactive isotope of water. The amount of radiation released from the phytoremediation system is very small. The potential dose from this source was estimated to be only 0.00000002 mrem/year.

Surface and subsurface water can transport radioactive material into Sawmill Creek, which is where most of Argonne's stormwater and treated wastewater is discharged. Sawmill Creek empties into the Des Plaines River. Argonne monitors the radionuclides in effluents from the Argonne wastewater treatment plant, in Sawmill Creek, and in the Des Plaines River. Daily samples are collected to ensure that discharges to the creek are regulated. Table 4 shows the amount of radioactivity released to surface water in 2013. The amounts shown are very low and indicate that Argonne is complying with DOE Order 458.1, which requires that the best available treatment be provided for radioactivity in surface water. The monitoring of total radioactivity released to surface water in 2013 shows that all annual averages were far below any of the DOE standards. Two perimeter locations that Argonne also monitors for radioactivity are stormwater outfalls at Location 7J (the 319 Area Landfill stormwater discharge outfall) and Location 11D (the 800 Area Landfill storm water discharge outfall). The only radioactivity found was at Location 7J, where a small amount of the radionuclide strontium-90 was detected. The strontium-90 may have come from past releases of leachate from that landfill. A leachate collection system has been addressing this release since its construction in 1996. Since 1996, there has been a steady, significant decrease in the radionuclide concentration.

TABLE 4 TOTAL RADIOACTIVITY RELEASED TO SURFACE WATER, 2013

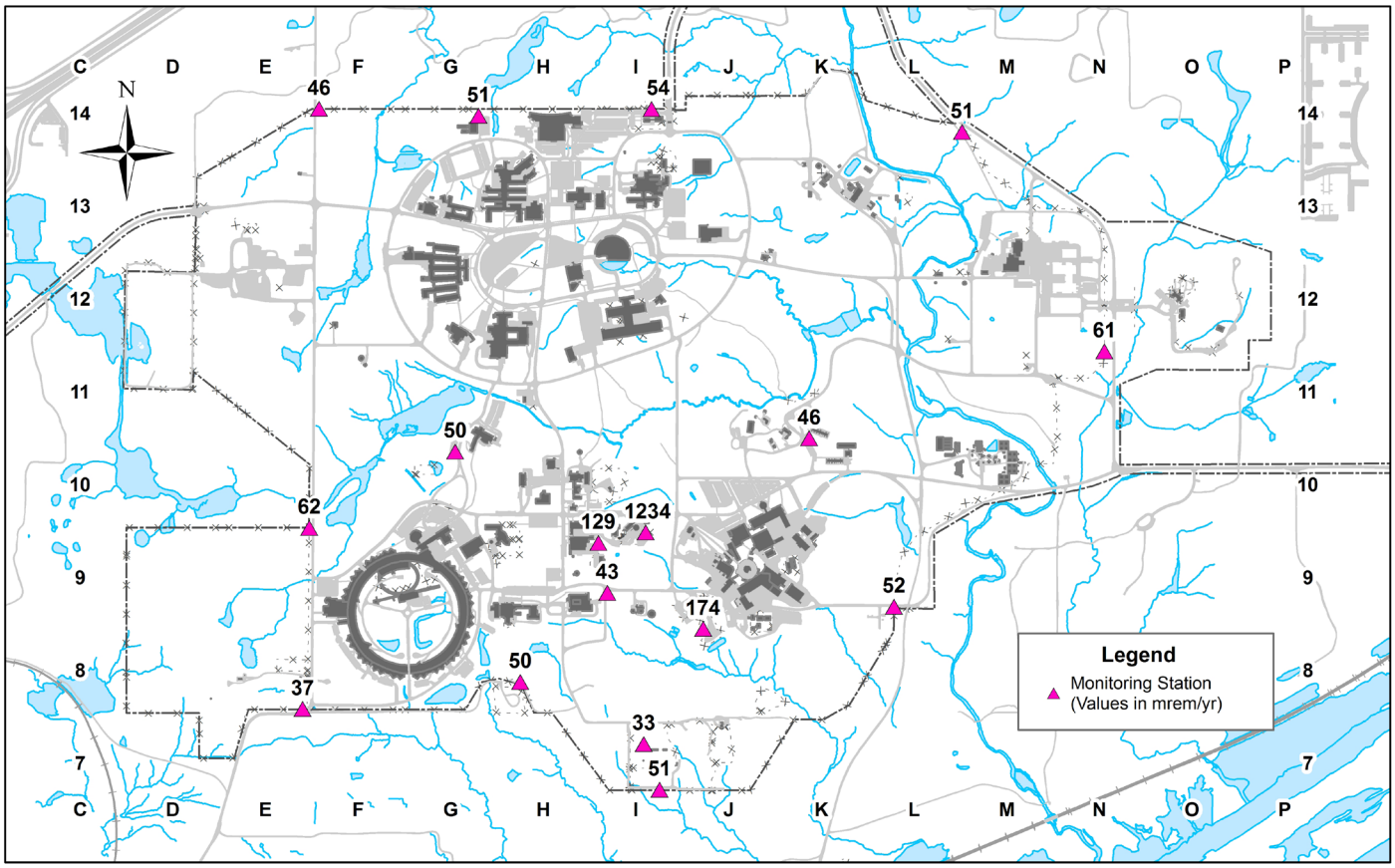
RADIONUCLIDE	WTP OUTFALL (Ci)
Hydrogen-3	0.057
Strontium-90	0.0003
Uranium-234	0.0003
Uranium-238	0.0002
Other transuranics	<0.0001
Total	0.058

Another discharge monitored was radioactive materials in bottom sediment in Sawmill Creek. These samples were collected at various locations above and below the wastewater outfall. The results are summarized in Table 5. The data indicate that the small amount of americium-241 and plutonium-239 found may have come from past discharges in Argonne wastewater.

TABLE 5 RADIONUCLIDES IN SAWMILL CREEK SEDIMENT, 2013								
LOCATION	CONCENTRATION (pCi/g)					CONCENTRATION (fCi/g)		
	K-40	Cs-137	Ra-226	Th-228	Th-232	Pu-238	Pu-239	Am-241
Upstream	13.02	<0.01	1.24	0.61	0.52	0.44	0.81	0.02
25 m above outfall	6.88	<0.01	0.63	0.34	0.28	0.14	1.03	0.86
At outfall	8.38	<0.01	0.61	0.38	0.35	0.17	1.93	0.16
50 m below outfall	7.73	<0.01	0.50	0.35	0.30	0.03	1.64	1.13
100 m below outfall	7.01	<0.01	0.56	0.36	0.26	0.46	6.20	1.42
Des Plaines River	12.21	0.05	0.64	0.60	0.47	0.27	10.31	2.50

External penetrating gamma radiation at Argonne's boundaries is also measured. The monitoring stations are shown in the map, below. Table 6 shows the data for off-site locations. The off-site samples indicated an average dose of 57 mrem/yr, which was similar to the 58 mrem/yr of last year's findings. All of the off-site measurements, with the exception of the Orland Park location, had levels similar to the range of the natural background. The on-site measurements in Table 6 show that all perimeter locations were essentially the same as the off-site background. The radiation levels at three on-site areas near facilities that process and store radioactive wastes were higher than background.

TABLE 6 ENVIRONMENTAL PENETRATING RADIATION AT OFF-SITE LOCATIONS, 2013	
LOCATION	AVERAGE DOSE RATE (mrem/yr)
Lemont	50
Oak Brook	63
Orland Park	72
Woodridge	50
Palos Park	48
Off-Site Average	57



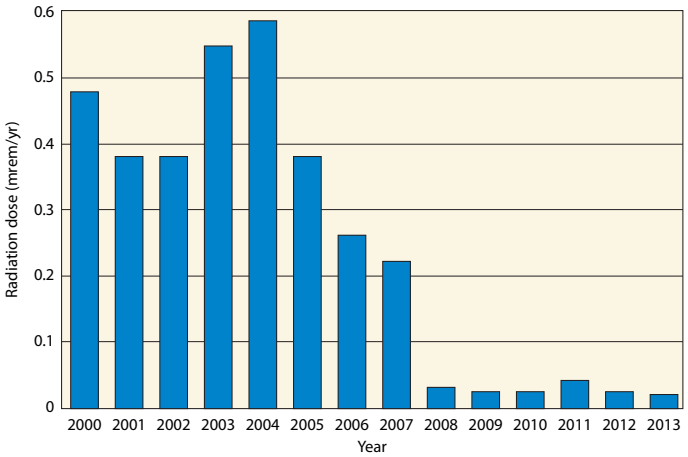
Individual and perimeter monitoring stations measuring airborne radioactive emissions during 2013

The potential dose for individuals exposed to radiation from Argonne through the air, water, and external direct pathways was estimated and the results are shown in Table 7. The table contains the total estimated dose to a hypothetical individual based on the amount of radiation measured in 2013. Comparing Argonne data with the applicable standards, the estimated dose levels for all types of radiation exposures are much lower than the applicable federal standards set by the U.S. Environmental Protection Agency (EPA), U.S. Nuclear Regulatory Commission (NRC), and the DOE. The estimated dose was compared to the annual average dose equivalent in the U.S. population from natural and man-made sources of 624 mrem/yr. Argonne's estimated maximum dose was 0.014 mrem/yr, which is very small compared to the national average dose of 624 mrem/yr. The extremely wide margin between the Argonne dose estimates and the average dose shows that the radiation from Argonne does not endanger the health or safety of citizens living near Argonne. The bar chart shows the change in airborne radiation dose since the year 2000. It also shows that a significant decrease in radiation dose has occurred since 2007. One way this reduction has been achieved is through the Radiation Safety Program, which utilizes the ALARA principle (an acronym for as low as reasonably achievable), monitoring, improved work practices, using equipment to minimize radiation release, and controlled access to sites where radiation is used.

Downers Grove South students investigate Argonne's restored prairie

TABLE 7 SUMMARY OF THE ESTIMATED DOSE TO A HYPOTHETICAL INDIVIDUAL, 2013

PATHWAY	ARGONNE ESTIMATE (mrem/yr)	APPLICABLE STANDARD (mrem/yr)
Air total	0.006	10 (EPA)
Water	0.007	4 (EPA)
Direct radiation	<0.001	25 (NRC)
Maximum dose	0.014	100 (DOE)
Average annual U.S. dose	624	



Change in radiation dose since 2000

GUADALUPE VALDIVIA AND AUSTIN ALVARADO

ENVIRONMENTAL NONRADIOLOGICAL MONITORING

Many different kinds of experiments and research are conducted at Argonne. Some of these activities have the potential to release chemicals and waste products into the environment. Argonne monitors both radioactive and nonradioactive wastes that are byproducts of its research. The environmental nonradiological monitoring program at Argonne focuses on the monitoring of nonradioactive waste material discharges.

TYPES OF NON-RADIOLOGICAL CHEMICALS MONITORED

Argonne is responsible for complying with regulations that control the release of chemicals into air, water, and soil to ensure environmental health and safety. Along with national regulations and environmental laws, facilities such as Argonne must follow state laws that are created and enforced by the Illinois Environmental Protection Agency. Argonne complies with the Clean Air Act and the Clean Water Act to maintain the health and safety of surrounding communities (both natural and populated areas). Without these laws, facilities would be able to discharge dangerous amounts of hazardous chemicals into the atmosphere with serious environmental consequences.

Any chemicals discharged from the Argonne facility are carefully controlled by the staff to minimize negative environmental impacts. Nonradioactive volatile organic chemicals, fuels, and combustion products are some of the chemicals that Argonne must monitor and maintain below safe levels. Some specific chemicals that have been found in Argonne's wastewater include bromodichloromethane, chloroform, acetone, ethanol, and 2-propanol. Table 8 shows the concentrations of these chemicals during 2013.

TABLE 8 CHEMICALS IN LABORATORY INFLUENT WASTEWATER, 2013

COMPOUND (CONCENTRATIONS IN µg/L)	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Chlorination By-Products												
Bromodichloromethane	<1	1	1	2	1	<1	1	1	<1	<1	<1	1
Bromoform	<1	1	2	<1	<1	<1	2	1	1	<1	8	6
Chloroform	<1	<1	1	2	1	1	1	2	1	1	<1	2
Dibromochloromethane	<1	1	<1	1	1	<1	1	1	1	<1	1	2
Laboratory Chemicals												
2-Butanone	–[a]	–	0.9	–	–	3	–	–	–	–	–	–
2-Propanol	–	–	182	49	6	110	194	11	95	42	5	60
4-Methyl-2-Pentanone	–	–	–	–	–	–	–	–	–	2	–	–
Acetaldehyde	–	–	–	–	–	–	–	–	27	20	–	16
Acetone	–	28	216	93	12	331	53	74	46	30	7	30
Ethyl Ether	–	–	25	–	–	–	–	–	–	–	–	–
Ethanol	–	–	–	–	–	31	–	–	–	111	–	65
Tetrahydrofuran	–	–	–	–	–	–	3	–	–	–	–	–

[a]A dash indicates the compound was not detected in the sample. Detection limits range from 1 to 5µg/L.

WASTEWATER DISCHARGES

Before Argonne's wastewater can be discharged into a stream, it must first go through one of the wastewater treatment plants. There are two independent wastewater treatment plants at Argonne. The sanitary wastewater treatment plant (SWTP) treats wastewater from toilets, sinks, and showers. The laboratory wastewater treatment plant (LWTP) treats wastewater from research and industrial buildings. In the LWTP plant, wastewater is first stored in tanks before it is treated and mixed with SWTP treated wastewater. The LWTP wastewater is treated by adding chemicals that remove contaminants, while the sanitary wastewater in the SWTP is cleaned by bacteria that remove organic material from the wastewater.

Outfalls are pipes that discharge treated wastewater into a body of water, like a stream or wetlands. Argonne's main outfall is at Sawmill Creek, and additional outfalls exist throughout the site that discharge stormwater.

Argonne collects samples of treated wastewater and storm water and analyzes pH levels, temperature, dissolved oxygen, and other parameters to meet the requirements of the National Pollutant Discharge Elimination System wastewater permit. Samples are required to be taken daily, weekly, and monthly to ensure that the wastewater meets the permit requirements on a day-to-day basis.

Argonne scientists collecting wastewater samples

Despite the fact that Argonne treats its wastewater and monitors it for non-radiological materials, during 2013 there were some minor issues that caused the wastewater to exceed the standards in the permit. On three occasions, Outfall 001 experienced a concentration of dissolved oxygen lower than the limit. For dissolved oxygen, more is better, so a low concentration is not good. This most likely occurred because of the hot weather; when the wastewater is warm, the solubility of oxygen in the water decreases, and the rate at which dissolved oxygen is consumed by bacteria in the treatment plant increases, lowering the concentration below the limit. There were two chemicals that were repeatedly detected in untreated wastewater samples caused by laboratory operations. Those chemicals were 2-propanol (isopropyl alcohol) and acetone. These chemicals are associated with on-site use of solvents to clean glassware and maintain equipment. Both chemicals were found at very low concentrations in untreated wastewater and the treatment plants removed both of them.

KATRINA NICDAO

GROUNDWATER MONITORING

Clean water is crucial for all living creatures. Contaminated water can affect a person's health, especially someone who has medical problems. Groundwater is water that collects underneath the ground, in layers of earth called aquifers, as it flows down from the surface. Groundwater quality affects human health because water obtained from the ground is often used for drinking. It is critical to actively monitor and protect groundwater to safeguard human health. Groundwater monitoring is the process of collecting groundwater samples from different areas so the groundwater quality can be measured, thus protecting the overall health of the community from harmful contaminants.

BACKGROUND INFORMATION

Argonne is required to monitor groundwater to ensure the health of people and to provide a safe environment for them to enjoy. Groundwater monitoring wells have been installed to monitor the aquifer and collect samples. Groundwater is monitored for contamination that could potentially be hazardous to humans and animals. After samples from the groundwater wells are collected, analyses are performed using EPA-approved analytical methods. Methods used for radiological analysis are approved by the DOE. To determine if the groundwater is safe, it is tested for several parameters such as pH, turbidity, temperature, toxic metals, and organic chemicals. When this is accomplished, the data are analyzed and the measure of each parameter is compared to groundwater quality standards. The analyzed data indicates if the groundwater is clean or if it is in need of improvement. To monitor the groundwater, samples are collected using pumps or bailers.

In areas where the groundwater contains a lot of silt, a different technique, known as low-flow purging, is used. Groundwater monitoring is used to track the progress of restoration actions in areas that have contaminated groundwater. Groundwater is monitored to record the movement of contaminated groundwater and to see if it is moving toward uncontaminated areas. Monitoring the contaminated groundwater allows scientists to determine the chance of contamination spreading into regions where the groundwater is not affected. In addition, monitoring groundwater assists in making sure that the concentrations of contaminants are decreasing.

The areas where groundwater is monitored are manholes and monitoring wells in the 317/319 Area, several old landfills, the site of an old nuclear reactor, and one drinking water well. Argonne collects groundwater samples from manholes in the 317 Area once a month and analyzes them for volatile organic compounds (VOCs) and hydrogen-3. Wells surrounding three landfills are monitored four times each year to ensure contamination from within the landfills has not migrated. Some of the landfills were used to dispose of chemically hazardous wastes that could possibly harm the environment if they were released from the landfills. Although no radioactive waste was disposed of, radiologically contaminated equipment was disposed of, so the monitoring program also checks for radioactive material in groundwater. The wells associated with the on-site landfill will continue to be monitored until proof is obtained that groundwater quality is not being impacted by the landfills.

continued... Groundwater Monitoring

RESULTS OF MONITORING ARGONNE WELLS

Results show amounts of dissolved inorganic matter above the groundwater quality standards in the shallow wells at two of the landfills. This was thought to have come from the soil around the wells or from the salt spread onto the roads during the winter months. Road salt from nearby streets could travel down to the wells, which could alter the results of tests in the wells. Wells near roadways had higher concentrations of measured analytes than the background wells, which are farther from roadways and paved areas. There was no evidence of toxic chemicals in the groundwater under the 800 Area Landfill. A few of the wells had relatively high amounts of conductivity, chloride, or total dissolved solids (TDS). The parameters that were higher than the standards are due to nature or other factors not related to the landfills. Groundwater did not have any VOCs, polychlorinated biphenyls (PCBs), or pesticides in the samples collected. Measurements showed the dissolved salts were significantly less in deeper wells than in shallow wells due to the greater depth of the wells. Except for the 317/319 Area, the results of the sampling of the deeper bedrock monitoring wells did not surpass groundwater quality standards. In the 317/319 Area, the groundwater contained several VOCs above groundwater quality standards.

Argonne also monitors a groundwater well that had been previously used to supply drinking water. Before Argonne started using water from Lake Michigan as its water supply, water was supplied by four potable water supply wells that provided the needed water. Since switching to Lake Michigan water in 1997, wells 1, 2, and 4 have been shut down, leaving only well No. 3 to be monitored and used as a backup water supply. No contamination was found in this well in 2013.

Argonne also samples an artesian well located near the Des Plaines River in the Waterfall Glen Forest Preserve. The sample results show that no hydrogen-3 was detected in 2013.

CONCLUSION

On the whole, the results of monitoring show that groundwater quality in Argonne is good and the only groundwater contamination observed was in the 317/319 Area. Contamination was limited primarily to the shallow monitoring wells.

RACHEL PETRO

WILDLIFE AND HABITAT MANAGEMENT

It isn't often that you can find prairies and large, healthy pieces of land around industrialized areas. This is why Argonne's land management and habitat restoration team is so special. Every year, Argonne sets annual goals they must achieve to restore damaged land, remove invasive species, and replenish healthy vegetation in stressed habitats.

Land Management is the process of taking care of land while keeping its biodiversity high and controlling threats to the land's resources. Habitat restoration is helping to preserve biodiversity by taking special care to protect endangered species and unique communities, and by renewing and restoring damaged ecosystems.

It is important to protect habitats because there is always a high risk of them being damaged by construction and invasive species. In fact, according to Argonne, their annual goal is to treat 30 to 60 acres to reduce invasive species and transform 3 to 5 acres of pasture grass into a healthy prairie.

WHAT IS MANAGED AND/OR RESTORED?

The way that things are disposed of at Argonne is the result of a carefully thought-out process. For instance, water used at Argonne can not just simply be tossed out. Depending on where the water is used on-site determines how it is disposed. Sanitary wastewater is water that comes from cafeteria sinks, restrooms, and sanitation facilities. This type of water is managed by a treatment system that consists of primary and secondary clarifiers, trickling filters, and slow sand filters. The other type of wastewater generated on-site could contain radioactive material, so it is kept away from sanitary wastewater. It is first analyzed and placed into retention tanks. It is treated using pH adjustment, aeration, and a solids-contact clarifier to remove particles from the wastewater. The reason for taking care of something as common as wastewater is to prevent any bad effects it may have on the environment if it were not treated properly. Even water can be harmful! If it contained hazardous or radioactive material and were to be improperly disposed of, it could harm habitats and the environment.

One of the laws that makes habitat restoration a high priority at Argonne is the Endangered Species Act. This act requires federal agencies to assess the area affected by a proposed project to determine whether it contains any threatened or endangered species. If so, the Endangered Species Act will protect those species against projects that could potentially harm them. Although neither endangered nor federally listed threatened species have been found on the land at Argonne or within the Waterfall Glen Forest Preserve (a nature preserve surrounding Argonne), one federally listed endangered plant species and one federally listed threatened plant species have been found. Those species are leafy prairie clover (Dalea foliosa) and lakeside daisy (Tetraneuris herbacea). A picture of the lakeside daisy is shown on the next page. One state-listed endangered animal species, the black-crowned night heron (Nycticorax nycticorax), and the

state-listed threatened Kirtland's snake (Clonophis kirtlandi) are also found near Argonne. With endangered species nearby, the Endangered Species Act comes into play. As mentioned earlier, this Act helps to protect the endangered species from destruction due to human activity, including construction. Therefore, prior to starting a project, the land must be surveyed and the project studied to make sure any adverse impacts are minimized.

Lakeside daisy

RESTORATION

At Argonne, there are three aspects of the natural environment that are monitored. Those are the floodplains, wildlife, and wetlands. The floodplain areas are located near Sawmill Creek, Freund Brook, and Wards Creek. These areas, due to flooding, are not used for development, but rather for conservation use. If a project needs to be built in a floodplain, the developer must show that the project cannot take place in any other area. In addition, the floodplain areas are protected by federal laws that restrict changes to and occupancy of floodplains.

The second aspect that is monitored is wildlife. Many times, wildlife, such as the white-tailed deer, may overpopulate, creating traffic hazards and ecological damage caused by overgrazing of deer-sensitive herbaceous species. Argonne made an agreement with the U.S. Department of Agriculture, establishing a target of maintaining a population of 15 deer per square mile. Since the agreement, which began in 1995, the white-tailed deer population has been maintained at safe levels. The population of exotic all-white fallow deer in the Argonne area has decreased to only a few individuals.

The final aspect is wetlands. The Argonne site contains approximately 50 acres of wetlands that must be managed properly. The goal of monitoring and managing these wetlands is to minimize the impacts on the wetlands associated with Argonne's research. If damage to any of the wetland areas caused by construction projects or other man-made activities cannot be avoided, it is Argonne's duty to replace the damaged wetlands or restore the areas that were damaged.

COMMUNITY IMPACT

Argonne has created a positive impact on the surrounding community because a huge part of its environmental management efforts focus on minimizing and managing any waste products that are being released into the environment such as greenhouse gases, wastewater, waste from radioactive and chemical experiments, and pollutants. By minimizing and managing waste, Argonne is protecting habitats and keeping the surrounding land safe and healthy.

Downers Grove South students during a field trip at Argonne

Students discuss wetland plant characteristics

Environment, Safety, and Quality Assurance Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 201
Lemont , IL 60439
www.anl.gov

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