Children participating in Take Your Children to Work Day hosted by the Office of Educational Programs.

Chapter 6

Natural and Cultural Resources

The Brookhaven National Laboratory (BNL) Natural Resource Management Program (NRMP) is designed to protect and manage flora and fauna and the ecosystems in which they exist.

The Laboratory's natural resource management strategy is based on understanding the site's resources and maintaining compliance with applicable regulations. The goals of the program include protecting, monitoring, and, where possible, restoring the ecosystems, conducting research, and communicating with personnel and the public on ecological issues. BNL focuses on protecting both Federal and New York State threatened and endangered species on-site, as well as continuing the Laboratory's leadership role within the greater Long Island Central Pine Barrens ecosystem. Monitoring to determine whether current or historical activities are affecting natural resources is also part of the program. In 2024, deer, vegetation, and soil sampling results were consistent with previous years' results. The program is described in the Natural Resource Management Plan (BNL 2021).

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL historic resources is established and maintained. Additional goals of the program include maintaining compliance with various historic preservation and archeological laws and regulations and ensuring the availability of identified resources for research and interpretation. The Cultural Resource Management Plan (CRMP) (BNL 2023) was updated in 2023 and reporting in this chapter fulfills reporting requirements specified in the CRMP.

6.1
Natural Resource Management Program (NRMP)

The NRMP at BNL promotes stewardship of the natural resources found at the Laboratory and integrates natural resource management and protection with BNL's scientific mission. The NRMP describes the program strategy, elements, and planned activities for managing the various natural resources found on-site. The NRMP is updated every five years, with the most recent update completed in 2021 (BNL 2021).

6.1.1 Identification and Mapping

An understanding of an environmental baseline is the foundation of natural resource management planning. BNL uses digital global positioning systems (GPS) and geographic information systems (GIS) to clearly relate various "layers" of geographic information (e.g., vegetation types, soil condition, habitat, forest health, etc.). This is done to gain insight into interrelationships between the biotic systems and physical conditions at the Laboratory.

Mapping associated with tracking impacts from the operation of the Long Island Solar Farm (LISF) at BNL continues to use GPS and GIS as tools to analyze changes to wildlife populations and vegetation. The Lab also has a contract with an aerial imaging service that provides high-definition images that are updated three times each year. This service allows tracking of visually evident changes in vegetation, hydroperiod, and infrastructure. The service includes aerial imagery dating back to 2014.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the BNL site. Through implementation of the NRMP, endangered and threatened species, as well as species of special concern, have been identified as having been resident at BNL during the past 30 years or are expected to be present on-site (see Table 6-1). New York State endangered animal species confirmed as currently inhabiting Laboratory property include the eastern tiger salamander (*Ambystoma t. tigrinum*) and the peregrine falcon (*Falco peregrinus*).

Table 6-1. Federal and New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL.

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	***Scientific Name***	**Status**	**BNL Status**
Insects			
Comet darner	*Anax longipes*	SGCN	Confirmed
Frosted elfin	*Callophrys iris*	T	Likely
New England bluet	*Enallagma laterale*	SGCN	Likely
Little bluet	*Enallagma minusculum*	T	Likely
Scarlet bluet	*Enallagma pictum*	T	Likely
Pine Barrens bluet	*Enallagma recurvatum*	T	Confirmed
Mottled duskywing	*Erynnis martialis*	SC	Likely
Persius duskywing	*Erynnis persius persius*	E	Likely
Pine barrens zanclognatha	*Zanclognatha martha*	SGCN	Confirmed
Black-bordered lemon moth	*Marimatha nigrofimbria*	SGCN	Confirmed
Fish			
Banded sunfish	*Enniacanthus obesus*	T	Confirmed
Swamp darter	*Etheostoma fusiforme*	T	Confirmed
Amphibians			
Marbled salamander	*Ambystoma opacum*	SC	Confirmed
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E	Confirmed
Fowler's toad	*Bufo fowleri*	SGCN	Confirmed
Four-toed salamander	*Hemidactylium scutatum*	SGCN	Confirmed
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC	Confirmed
Reptiles			
Worm snake	*Carphophis amoenus*	SC	Confirmed
Snapping turtle	*Chelydra serpentina*	SGCN	Confirmed
Spotted turtle	*Clemmys guttata*	SC	Confirmed
Northern black racer	*Coluber constrictor*	SGCN	Confirmed
Eastern hognose snake	*Heterodon platyrhinos*	SC	Confirmed
Stinkpot turtle	*Sternotherus odoratus*	SGCN	Confirmed
Eastern box turtle	*Terrapene carolina*	SC	Confirmed
Eastern ribbon snake	*Thamnophis sauritus*	SGCN	Confirmed
Birds (nesting, transient, or potentially present)			
Cooper's hawk	*Accipiter cooperii*	SC	Confirmed
Sharp-shinned hawk	*Accipiter striatus*	SC	Confirmed
Great egret	*Ardea alba*	SGCN	Confirmed
Whip-poor-will	*Caprimulgus vociferus*	SC	Confirmed
Northern harrier	*Circus cyaneus*	T	Confirmed
Black-billed cuckoo	*Coccyzus erythropthalmus*	SGCN	Confirmed
Northern bobwhite	*Colinus virginianus*	SGCN	Confirmed
Prairie warbler	*Setophaga discolor*	SGCN	Confirmed
Perigrine Falcon	*Falco peregrinus*	E	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	T	Confirmed
Wood thrush	*Hylocichla mustelina*	SGCN	Confirmed
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	Confirmed
Osprey	*Pandion haliaetus*	SC	Confirmed
Scarlet tanager	*Piranga olivacea*	SGCN	Confirmed
Glossy ibis	*Plegadis falcinellus*	SGCN	Confirmed
Brown thrasher	*Toxostoma rufum*	SGCN	Confirmed
Blue-winged warbler	*Vermivora pinus*	SGCN	Confirmed

(continued on next page)

Endangered plants that have been confirmed on the BNL site include Engelman spikerush (*Eleocharis engelmannii*), Ipecac spurge (*Euphorbia ipecacuanhae*), and dwarf huckleberry (*Gaylussacia bigeloviana*). Five other New York State endangered species have been identified at BNL in the past or are possibly present including: Persius duskywing (*Erynnis p. persius*), crested fringed orchid (*Plantathera cristata*), prostrate knotweed (*Polygonum aviculare ssp. buxiforme*), bracken fern (*Pteridium alquilinum var. pseudocaudatum*), and possum haw (*Viburnum nudum var. nudum*). Eight threatened species in New York State have been positively identified on-site and three other species are considered likely to be present. Threatened species include: two fish (banded sunfish [*Enneacanthus obesus*] and swamp darter (*Etheostoma fusiforme*); three plants (stiffleaved goldenrod (*Oligoneuron rigida*), stargrass (*Aletris farinosa*), and eastern showy aster (*Eurybia spectabilis*); the northern harrier (*Circus cyaneus*) is periodically seen in the fall; and the bald eagle (*Haliaeetus leucocephalus*) is routinely seen visiting the site. Insects listed as threatened include the Pine Barrens bluet (*Enallagma recurvatum*), a damselfly, which was confirmed at one of the many coastal plain ponds located on-site. Two other damselflies, the little bluet (*Enallagma minisculum*) and the scarlet bluet (*Enallagma pictum*), are likely to be present at one or more of the ponds on-site. The frosted elfin (*Callophrys irus*), a butterfly, has been historically present on-site due to its preferred habitat and host plant, wild lupine (*Lupinus perennis*); however, little lupine remains, and it is therefore unlikely this species can be found on-site. A number of other species that are listed as rare, of special concern, or exploitably vulnerable by New York State either currently inhabit the site, visit during migration, or have been identified historically. BNL has one federally

Table 6-1. Federal and New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL. *(concluded)*

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	***Scientific Name***	**Status**	**BNL Status**
Mammals			
Northern long-eared bat*	*Myotis septentrionalis*	FE	Confirmed
Plants			
Small-flowered false foxglove	*Agalinis paupercula*	R	Confirmed
Stargrass	*Aletris farinosa*	T	Confirmed
Butterfly weed	*Asclepias tuberosa ssp. interior*	V	Confirmed
Spotted wintergreen	*Chimaphila maculata*	V	Confirmed
Flowering dogwood	*Cornus florida*	V	Confirmed
Pink lady's slipper	*Cypripedium acaule*	V	Confirmed
Ground pine	*Dendrolycopodium obscurum*	V	Confirmed
Round-leaved sundew	*Drosera rotundifolia var. rotundifolia*	V	Confirmed
Marginal wood fern	*Dryopteris marginalis*	V	Confirmed
Engelman spikerush	*Eleocharis engelmannii*	E	Confirmed
Ipecac spurge	*Euphorbia ipecacuanhae*	E	Confirmed
Eastern showy aster	*Eurybia spectabilis*	T	Confirmed
Dwarf huckleberry	*Gaylussacia bigeloviana*	E	Confirmed
Winterberry	*Ilex verticillata*	V	Confirmed
Sheep laurel	*Kalmia angustifolia*	V	Confirmed
Narrow-leafed bush clover	*Lespedeza augustifolia*	R	Confirmed
Wild lupine	*Lupinus perennis*	R	Confirmed
Whorled loosestrife	*Lysimachia quadrifolia*	E	Confirmed
Bayberry	*Myrica pensylvanica*	V	Confirmed
Stiff-leaved goldenrod	*Oligoneuron rigida*	T	Confirmed
Cinnamon fern	*Osmunda cinnamomea*	V	Confirmed
Clayton's fern	*Osmunda claytoniana*	V	Confirmed
Royal fern	*Osmunda regalis*	V	Confirmed
Crested fringed orchid	*Plantathera cristata*	E	Likely
Green fringed orchid	*Platanthera lacera*	V	Confirmed
Prostate knotweed	*Polygonum aviculare ssp. buxiforme*	E	Possible
Bracken fern	*Pteridium alquilinum var. pseudocaudatum*	E	Possible
Swamp azalea	*Rhododendron viscosum*	V	Confirmed
Long-beaked bald-rush	*Rhynchospora scirpoides*	R	Confirmed
New York fern	*Thelypteris novaboracensis*	V	Confirmed
Marsh fern	*Thelypteris palustris var. pubescens*	V	Confirmed
Possum haw	*Viburnum nudum var. nudum*	E	Possible
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes: Information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data.
E = endangered, T = threatened, SC = species of special concern, R = rare, V = exploitably vulnerable, SGCN = species of greatest conservation need, FT = federally threatened, FE = federally endangered, *NLEB up-listed to federally endangered 03/31/23

endangered species, the northern long-eared bat (*Myotis septentrionalis*), that has historically been found within the forests of the Lab.

6.1.2 Habitat Protection and Enhancement

BNL has administrative processes in place to protect on-site habitats and natural resources. Activities to eliminate or minimize negative effects on endangered, threatened, or sensitive species are either incorporated into Laboratory procedures or into specific programs or project plans. Human access to critical habitats, when necessary, is limited, and habitats are enhanced to improve survival or increase populations. Routine activities, such as road maintenance, are not performed until the planned activities have been evaluated and determined to be unlikely to affect habitat.

Efforts are being made to restore on-site pine barrens through the use of prescribed fire and mechanical treatments. Sixty-nine acres have been mechanically treated and twenty-six acres burned in the northern portion of the Lab through 2024 in preparation for prescribed fire. Due to limitations in the number of suitable burn days and trained resources, it is difficult to burn at a large scale so areas adjacent to communities are prioritized as fuels mitigation can benefit the overall ecosystem and the wildlife that depend on it. One prescribed burn was attempted in 2024 but had to be shut down due to control issues and only 3.5 acres were burned.

6.1.2.1 Salamander Protection Efforts

Many safeguards are in place to protect eastern tiger salamander breeding areas. BNL natural resource staff must review any project planned near eastern tiger salamander habitats

and every effort is made to minimize impacts. A map of the breeding areas is reviewed when new projects are proposed. The current map incorporates buffer areas around tiger salamander habitats of 1,000 feet based on guidance from the New York State Department of Environmental Conservation (NYSDEC). Other efforts to protect this state endangered species include determining when adult salamanders are migrating toward breeding locations, when metamorphosis has been completed, and when juveniles are migrating after metamorphosis. Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with the NYSDEC, habitat surveys have been routinely conducted since 1999. Biologists conducting egg mass and larval surveys have confirmed that 26 on-site ponds are used by eastern tiger salamanders. Significant winter rains in December 2023 resulted in several ponds holding enough water to trigger salamander movements. Egg mass surveys for winter 2023-2024 were conducted in January and a total of 88 egg masses were documented in seven ponds. Other ponds were covered in ice or had insufficient water.

6.1.2.2 Banded Sunfish

Banded sunfish protection efforts include observing whether adequate water is present within areas currently identified as sunfish habitat, ensuring that vegetation in their habitat is not disturbed, and evaluating all activities taking place in ponds and the Peconic River on-site for potential impacts on these habitats. Drought conditions that lasted from 2015 through fall of 2023 likely resulted in the extirpation of the banded sunfish from the BNL site. The single known habitat held water throughout 2018 and by 2019 the pond had completely dried. A short survey by NYSDEC personnel in 2019 did not find sunfish in the pond. No additional effort has been made regionally with regard to the banded sunfish in 2024.

6.1.2.3 Migratory Birds

A total of 216 species of birds have been identified at BNL since 1948; at least 85 species are known to nest on-site. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. The Laboratory conducts routine monitoring of songbirds along seven permanent bird survey routes in various habitats on-site.

In 2024, monthly surveys were conducted starting at the end of April and extending through the end of August. These surveys identified 74 bird species which fell short of the 81 species identified in 2023. A total of 138 bird species have been identified in surveys in the past 25 years. Variations in the number and species identified during each survey may reflect the time of observation, variations in weather patterns between years, experience level and number of survey personnel, and possible changes in the environment.

The three most diverse transects on-site are by the LISF, the Peconic River, and through the eastern forested portion of the BNL property. The transects passing through the various forest types on-site (e.g., white pine, pine oak forest, and red maple-mesic heath forest) showed a less diverse bird community. Bird survey data are stored in an electronic database for future reference and study. Little data on the effects of a large, utility scale solar array such as the LISF are present within scientific literature. To assess the effects of the LISF on local bird populations, the collection of migratory bird data in both the Biology Field and Solar Farm transects is important. The LISF vegetation and the way it is managed may play a key role as habitat for migratory birds. The eastern bluebird (*Sialia sialis*) has been identified as a declining species of migratory birds in North America. This is due to loss of habitat and nest site competition from European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). BNL's NRMP includes habitat enhancement for the eastern bluebird. Since 2000, the Laboratory has installed more than 60 nest boxes around open grassland areas on-site to enhance their population. The LISF created nearly 200 acres of suitable habitat for the eastern blue bird. Forty boxes were installed around the northern-most portions of the LISF and are routinely used by bluebirds, house wrens, and tree swallows. Bluebirds have also benefited from natural nesting habitat resulting from the 2012 wildland fire that led to significant tree mortality. Bluebirds have been documented annually within the burned area since 2019.

Migratory birds occasionally cause safety and health concerns, particularly Canada geese (*Branta canadensis*) and several species of migratory birds that occasionally nest on buildings or in construction areas on-site. To control the goose population, the Laboratory manages nesting through egg oiling under an annual permit from the U.S. Fish & Wildlife Service. The population was estimated at approximately 60 birds in spring 2024 going into nesting season; however, a number of nests were missed in 2024 due to some limitations in staffing resulting in an increase in the population totals at the end of 2024.

6.1.2.4 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) has been increasing in population locally with more than a dozen known nest sites on Long Island. In 2024, bald eagles continued to be sighted in the area of the Sewage Treatment Plant (STP), the cell tower, near the National Weather Service offices, and other areas around the site. As the eagle population increases on Long Island, the potential for them to nest on the BNL site will increase as well.

6.1.2.5 Northern Long-eared Bat

As discussed in Section 6.1.1, the northern long-eared bat was federally listed as endangered in 2023. The activities most likely to impact this bat on the BNL site are building demolitions, any project involving tree clearing, and forest management activities such as prescribed fires, mechanical treatments, and forest thinning. Inspections for the presence of bats in buildings are typically conducted via visual surveys approximately 24 hours prior to demolition to verify the absence of bats.

In 2024, three buildings were demolished, and no bats were found prior to demolition. Four projects required formal consultation with the U.S. Fish & Wildlife Service because they involved tree removal and resulted in the issuance of a Biological Opinion and Statement of Incidental Take. One prescribed fire was attempted in 2024 but shut down due to control issues. Approximately 3.5 acres were burned. In addition, 23 acres were mechanically treated during the dormant season.

Five nights of mist netting were conducted during July 2024 in the areas where forest management is being conducted. No northern long-eared bats were captured. Acoustic surveys conducted around the Lab site also did not yield any northern long-eared bat detections. The need to continue bat monitoring will likely increase in the future as the little brown bat (*Myotis lucifugus*) and tri-colored bat (*Perimyotis subflavus*) have also been petitioned for listing.

6.1.3 Population Management

6.1.3.1 White-Tailed Deer

BNL consistently updates information on the resident population of white-tailed deer (*Odocoileus virginianus*). As there are no natural predators on-site and hunting is not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately one square mile. Normally, a population density of 10 to 30 deer per square mile is considered an optimum sustainable level for a given area. This would equate to approximately 80 to 250 deer inhabiting the BNL property under optimal circumstances. This was the approximate density in 1966, when BNL reported an estimate of 267 deer on-site (Dwyer 1966). The Laboratory has been conducting routine population surveys of white-tailed deer since 2000.

4-poster™ tick management system.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, and collision injuries to both humans and animals), species diversity (e.g., songbird species reduction due to selective grazing and destruction of habitat by deer), and property damage (e.g., collision damage to autos and browsing damage to ornamental plantings). Deer-related collisions on-site continued to be low in 2024, presumably due to deer management which, in addition to decreasing numbers, has also made deer more wary of humans causing them to avoid the central campus area more. High deer populations are a regional problem, and the Laboratory is just one area on Long Island with such an issue. Multiple east end towns are now managing deer populations either through culls (also known as deer harvests), hunting, or sterilization programs. Under BNL's permit for deployment of the 4-Poster™ tick management system issued by NYSDEC, the Laboratory is required to implement a deer management program. BNL has been implementing deer management since 2015 and conducting herd reductions annually since 2019.

In 2024, the herd was estimated at approximately 350 individuals at the beginning of the year and a cull was planned for two separate weekends in February and March 2024. A total of 123 animals were taken, which effectively brought the population to approximately 227 animals and succeeded in meeting the reduction goals of getting below 250 deer. With a reproductive rate at approximately 50%, however, the population at the end of 2024 was expected to be back up to nearly 350 individuals.

6.1.4 Compliance Assurance and Potential Impact Assessment

The National Environmental Policy Act (NEPA) review process at BNL ensures that environmental impacts of a proposed action or activity are adequately evaluated and addressed. The Laboratory uses NEPA reviews when identifying potential environmental impacts associated with site activities, especially projects that may result in physical alterations to the landscape and structures. As appropriate, stakeholders such as the Environmental Protection Agency (EPA), NYSDEC, Suffolk County Department of Health Services (SCDHS), and BNL's Community Advisory Council (CAC) are involved in reviewing major projects that have the potential for significant environmental impacts. Formal NEPA reviews are coordinated with the State of New York. An Environmental Assessment for the proposed modification of Building 870 to create the Clinical Alpha-Radionuclide Production facility was completed in 2024. See Chapter 3, Section 3.3 for more information.

6.2 Upton Ecological and Research Reserve

The Upton Ecological and Research Reserve (Upton Reserve) consists of 530 acres located on the eastern boundary of the BNL site. The reserve has been designated as an area for the protection of sensitive habitats and a place where researchers can study local ecosystems. The Upton Reserve is home to a wide variety of flora and fauna. It contains wetlands and is largely within the core preservation area of the Long Island Central Pine Barrens. Based on information from a 1994-1995 biological survey of the Laboratory, experts believe the reserve is home to more than 200 plant species and at least 162 species of mammals, birds, fish, reptiles, and amphibians (LMS 1995). The Upton Reserve is managed by BNL which also coordinates research projects that occur within the reserve and the larger Pine Barrens. After successfully establishing a Memorandum of

Understanding (MOU) with the State University of New York's School of Environmental Science and Forestry (SUNY-ESF), efforts to revisit the 2005-2006 forest health monitoring program resulted in the completion of monitoring during summer 2020 (see education programs below). The MOU with SUNY-ESF allows for greater levels of research within the Central Pine Barrens and the Upton Reserve. In 2023, a PhD student working with the Department of Sustainable Resources Management at SUNY-ESF began collecting data looking at the effects of fire on tick populations which is expected to continue through 2025.

Samuel Gilvarg, a graduate student from the State University of New York's College of Environmental Science and Forestry (SUNY ESF), holding an ethanol vial containing a tick specimen.

6.3 Monitoring Flora and Fauna

The Laboratory routinely conducts surveillance monitoring of flora and fauna to determine the effects of past and present activities on-site. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was mistakenly used in some BNL landscaping projects in the past, traces of Cs-137 attributable to past practices and worldwide fallout from above-ground nuclear bomb testing can be found in deer and other animals and plants. At the cellular level, Cs-137 takes the place of potassium (K), an essential nutrient. Most tables in this chapter listing Cs-137 also list analytical results for potassium-40 (K-40), a naturally occurring radioisotope of potassium that is commonly found in flora and fauna. Studies indicate that Cs-137 out-competes potassium when potassium salts are limited in the environment, which is typical on Long Island. Including K-40 in tables allows for a comparison with Cs-137 levels and is used, in part, to determine the accuracy of analytical results. The results of the annual sampling conducted under the flora and fauna monitoring program are described in the following sections.

6.3.1 Deer Sampling

White-tailed deer in New York State are typically large, with males weighing on average approximately 150 pounds; females typically weigh approximately 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The meat available for consumption from local deer ranges from 20 to 40 pounds per animal. Samples of meat and liver are taken from each deer, when possible, and are analyzed for Cs-137. Data are reported on a wet-weight basis, as that is the form most likely used for consumption.

Since 1996, BNL has routinely collected deer samples from on- and off-site areas. Most off-site samples are the result of car/deer accidents. The number of samples obtained each year varies depending on accidents between vehicles and deer and people reporting dead deer available for retrieval. In 2024, a total of 15 deer were taken both on and off the BNL site. Figure 6-1 shows the location of all deer samples taken within a five-mile radius of the Laboratory between 2019 and 2024. Most of the off-site samples are concentrated along Route 25 just north of BNL, whereas historically most on-site samples are collected near the Laboratory's main entrance gate and the developed portions of the site. The distribution of deer samples on-site is becoming more uniform across the site due to obtaining samples during annual deer population reduction efforts. Historically, samples tended to be from near the front gate due to collisions with cars entering or leaving the site. Based on more than two decades of sampling, deer taken from more than one mile from BNL are used for comparison with populations on and near the Laboratory that could acquire Cs-137 from a BNL source.

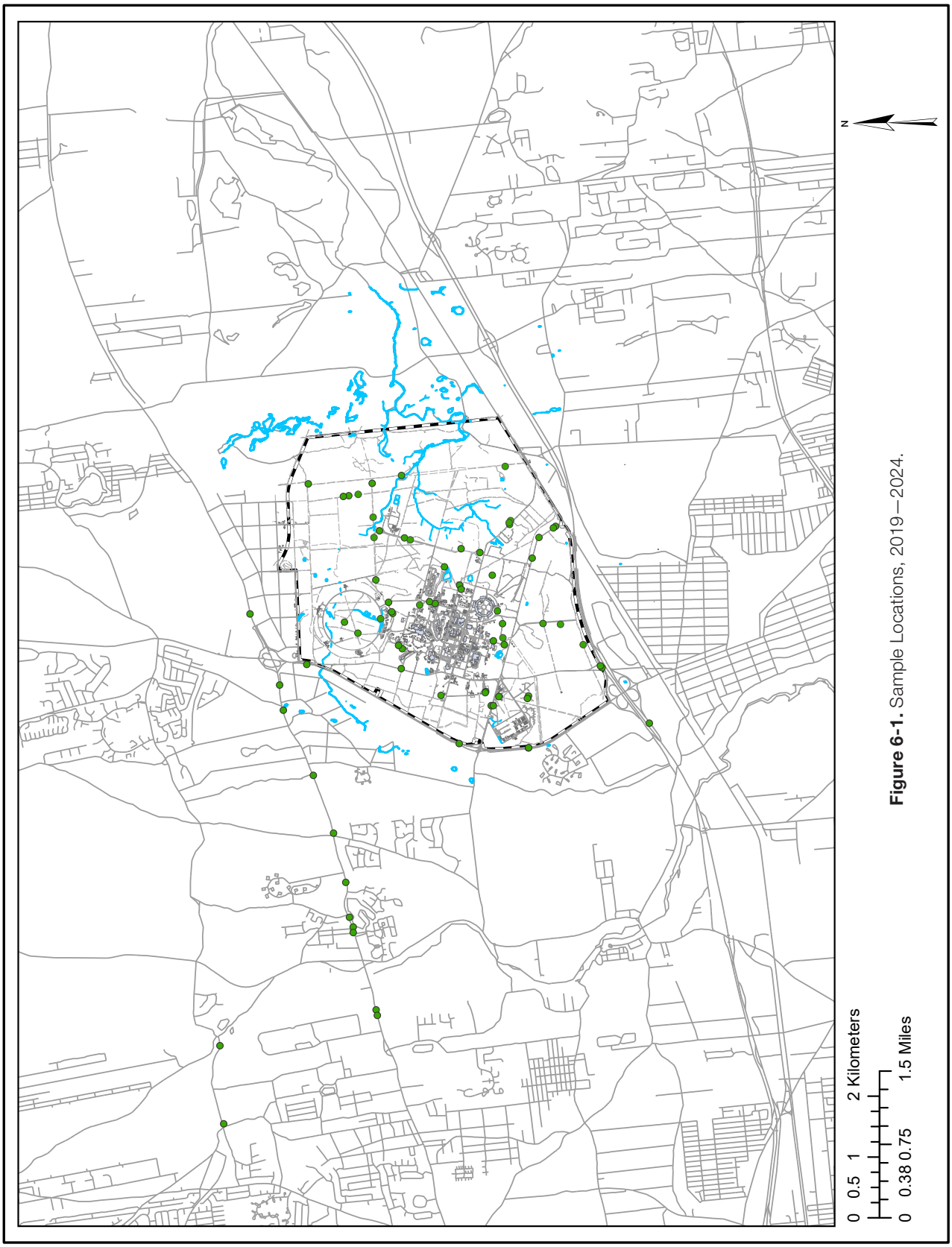


Figure 6-1. Sample Locations, 2019—2024.

In 2024, thirteen deer were obtained on-site, of which twelve were sampled as part of deer management efforts; there were no deer taken from off-site less than a mile from BNL, and two deer were taken greater than a mile from BNL. The two off-site deer and one of the on-site deer were due to deer/vehicle collisions. The analytical results of deer sampling are shown in Table 6-2. The samples taken as part of deer population reductions serve a dual purpose to provide data for surveillance and to determine the safe release of meat for consumption. During deer culling activities, every tenth deer taken is sampled for Cs-137 content in both meat and liver.

6.3.1.1 Cesium-137 in White-Tailed Deer

Based on historic and current data, white-tailed deer sampled at or near the Laboratory contain higher concentrations of Cs-137 than deer from greater than one mile off-site. This is most likely because the deer graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. Cs-137 in soil can be transferred to above-ground plant matter via root uptake, where it then becomes available to browsing and grazing animals or is consumed directly with soil while the animal is grazing. Remediation of contaminated soil areas on-site occurred under the Laboratory's Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) program, with all major areas of contaminated soil being remediated by September 2005.

In 2024, Cs-137 concentrations in deer meat samples were obtained from 13 deer on-site with a range of values from 0.07 pCi/g to 0.42 pCi/g, wet weight, and an arithmetic average of 0.22 pCi/g, wet weight, as shown in Table 6-2. The wet weight concentration is before a sample is dried for analysis and is the form most likely to be consumed. Dry weight concentrations are typically higher than wet weight values. The highest on-site sample in 2024 (0.42 pCi/g, wet weight) was twice that of the highest on-site sample reported in 2023 (0.21 pCi/g, wet weight) and 28 times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight). Higher values in deer are usually seen during the fall months immediately after plants stop growing and uptake ceases. By January, Cesium has usually been excreted.

Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within one mile of BNL and samples taken farther away (two samples in 2024) shown in Table 6-2, however no samples were collected within one mile of the Lab in 2024. Deer taken greater than one mile from the Lab were all non-detect for Cs-137.

Deer visiting a 4-poster™ device.

Table 6-2. Radiological Analysis of Deer Tissue (2024).

Location	Date	Distance Miles	Organ	K-40 pCi/g (wet)±95% C.I.	Cs-137 pCi/g (wet)±95% C.I.
BNL					
BNL Cull Sample 1 - Weaver Rd.	2/23/24	0	tissue	2.78±0.57	0.25±0.04
			liver	3.86±0.56	0.09±0.04
BNL Cull Sample 2 - East Margin Path	2/24/24	0	tissue	3.28±0.50	0.37±0.04
			liver	1.95±0.20	0.08±0.01
BNL Cull Sample 3 - Former Haz Waste Facility	2/24/24	0	tissue	2.94±0.57	0.31±0.04
			liver	3.02±0.22	0.09±0.01
BNL Cull Sample 4 - First St., south of STP	2/25/24	0	tissue	2.57±0.56	0.18±0.04
			liver	1.90±0.16	0.04±0.01
BNL Cull Sample 5 - Fawn Path	2/25/24	0	tissue	3.12±0.46	0.32±0.04
			liver	2.63±0.17	0.09±0.01
BNL Cull Sample 6 - East Fifth Ave.	2/26/24	0	tissue	3.29±0.62	0.20±0.04
			liver	2.62±0.17	0.04±0.01
BNL Cull Sample 7 - Former Haz Waste Facility	3/15/24	0	tissue	3.07±0.37	0.07±0.02
			liver	2.26±0.19	0.02±0.01
BNL Cull Sample 8 - South Boundary Rd.	3/16/24	0	tissue	3.56±0.38	0.22±0.03
			liver	2.4±0.11	0.05±0.01
BNL Cull Sample 9 - Forest Path	3/16/24	0	tissue	2.76±0.34	0.10±0.03
			liver	2.13±0.10	0.03±0.01
BNL Cull Sample 10 - Center of RHIC	3/17/24	0	tissue	2.55±0.57	0.16±0.04
			liver	1.80±0.11	0.03±0.00
BNL Cull Sample 11 - East Fire Break	3/18/24	0	tissue	2.6±0.57	0.42±0.05
			liver	2.73±0.25	0.13±0.01
BNL Cull Sample 12 - Forest Path	3/18/24	0	tissue	3.05±0.42	0.13±0.03
			liver	2.39±0.25	0.03±0.01
Renaissance Rd North of Rochester Ave.	6/14/24	0	tissue	3.12±0.61	0.07±0.04
			liver	2.15±0.16	0.03±0.01
< 1 Mile from BNL					
No samples taken				NA	NA
> 1 Mile from BNL					
West End of Artist Lake on Rt. 25	5/3/24	> 1 mile	tissue	3.30±0.37	ND
			liver	2.11±0.36	ND
Whiskey Rd. east of Coram Sweezeytown Rd.	12/4/24	> 1 mile	tissue	2.54±0.22	ND
			liver	2.36±0.20	ND
Tissue Averages					
All Samples (15)				2.97±0.48	0.19±0.03
BNL Average (13)				2.98±0.50	0.22±0.04
< 1 Mile Average (0)				NA	NA
> 1 Mile Average (2)				2.92±0.30	0.00±0.01
Cull Average (12)				2.96±0.49	0.23±0.04
Liver Averages					
All Samples (15)				2.42±0.21	0.05±0.01
BNL Average (13)				2.45±0.20	0.06±0.01
< 1 Mile Average (0)				NA	NA
> 1 Mile Average (2)				2.24±0.28	0.01±0.01
Cull Average (12)				2.24±0.21	0.06±0.01

Notes: All values are shown with a 95% confidence interval.
K-40 Occurs naturally in the environment and is presented as a comparison to Cs-137
All averages are the arithmetic average with confidence limits using a 2 sigma (95%) propogated error.
ND=non-detect

Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2024 from on-site, within one mile, combined on-site and within one mile, greater than one mile, and deer taken from culling. Figure 6-3 presents the ten-year trend of on-site and near off-site Cs-137 averages in deer meat. The 2024 average (0.19 pCi/g) is slightly higher than the 2023 value of 0.09 pCi/g, wet weight, and is significantly lower than the ten-year average. The higher averages shown for 2017 and 2018 are reflective of a significant number of samples taken in the fall when Cs-137 levels are typically higher. These sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, with the overall trend being downward from 2014 to 2024, and the ten-year average being 0.41 pCi/g.

The effectiveness of the BNL soil cleanup program and the reduction of Cs-137 in deer meat was evaluated by Rispoli, et al. (2014). The average Cs-137 content was shown to be statistically lower than before cleanup. Samples taken at distances greater than one mile from the BNL site were shown to remain consistent before and after cleanup, while the on-site and near off-site values were shown to decline. In 2017, while preparing for monitoring associated with the reduction of the deer population, the 10-year average for on-site deer samples was calculated to be 1.0 pCi/g, wet weight, and this value was used to establish an administrative release criterion for deer meat made available for donation. When possible, liver samples are taken concurrently with meat samples. The liver generally accumulates Cs-137 at a lower rate than muscle tissue. The typically lower values in liver allow the results to be used as a validity check for meat values (i.e., if liver values are higher than meat values, results can be considered questionable and should be confirmed).

In liver samples collected on-site in 2024, Cs-137 concentrations ranged from 0.02 to 0.13 pCi/g, wet weight, with an average of 0.06 pCi/g, wet weight. Cs-137 concentrations in liver samples taken from deer greater than one mile from site were determined to be non-detect. The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8.

The New York State Department of Health (NYSDOH) has formally considered the potential public health risks associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999).

As mentioned above, BNL has established an administrative release criterion of 1.0 pCi/g, wet weight, for meat from deer removed from the Laboratory and donated for consumption. A total of 123 deer were taken during population reductions in 2024. Meat samples were obtained from every tenth deer. Samples were sent for analysis and are included in Table 6-2.

The results ranged from 0.07 to 0.42 pCi/g, wet weight, with the arithmetic average being 0.23 pCi/g, wet weight. Since all samples were well below the 1.0 pCi/g, wet weight administrative limit, all 2,623 pounds of meat were donated to Island Harvest Food Pantry and to a local wildlife rehabilitator. With respect to the health of on-site deer based on their exposure to radionuclides, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day to even the most radiosensitive species in terrestrial ecosystems are unlikely to cause detrimental effects in animal populations (IAEA 1992). A deer containing a uniform distribution of Cs-137 within muscle tissue at the highest levels observed to date (11.74 pCi/g, wet weight, reported in 1996) would carry a total amount of approximately 0.2 µCi. That animal would receive an absorbed dose of approximately three millirad per day, which is only 3% of the IAEA threshold. The deer observed and sampled on-site appear to have no health effects from the level of Cs-137 found in their tissues.

Figure 6-2. Comparison of Cs-137 average values in deer flesh for on-site, near off-site, on-site + near off-site, off-site greater than 1 mile from the Laboratory, and from deer population reductions (cull). Ten-year average of on-site and near off-site deer flesh samples is 0.41 pCi/g, wet weight.

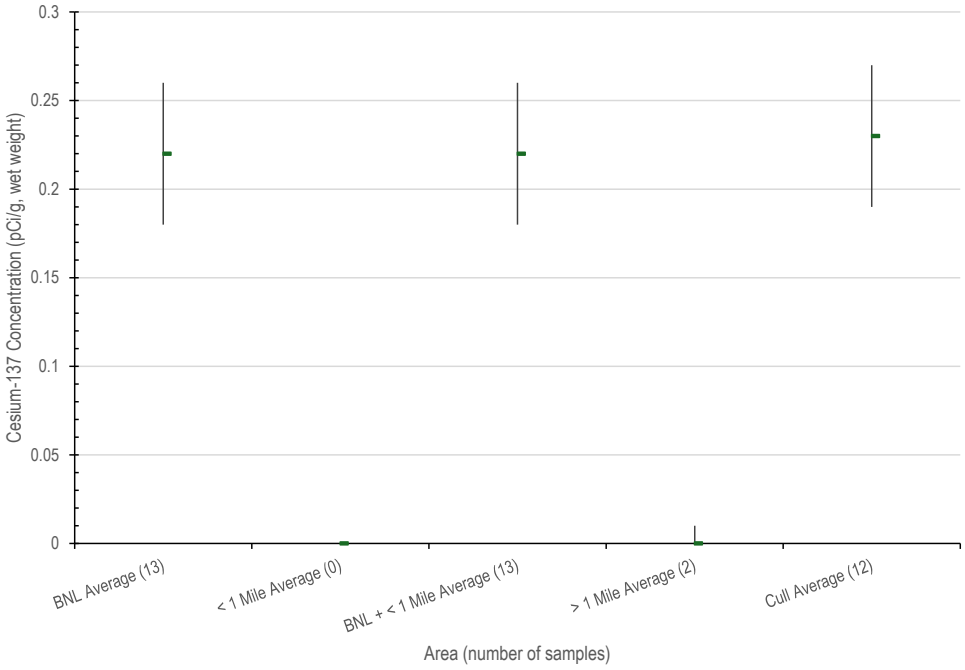
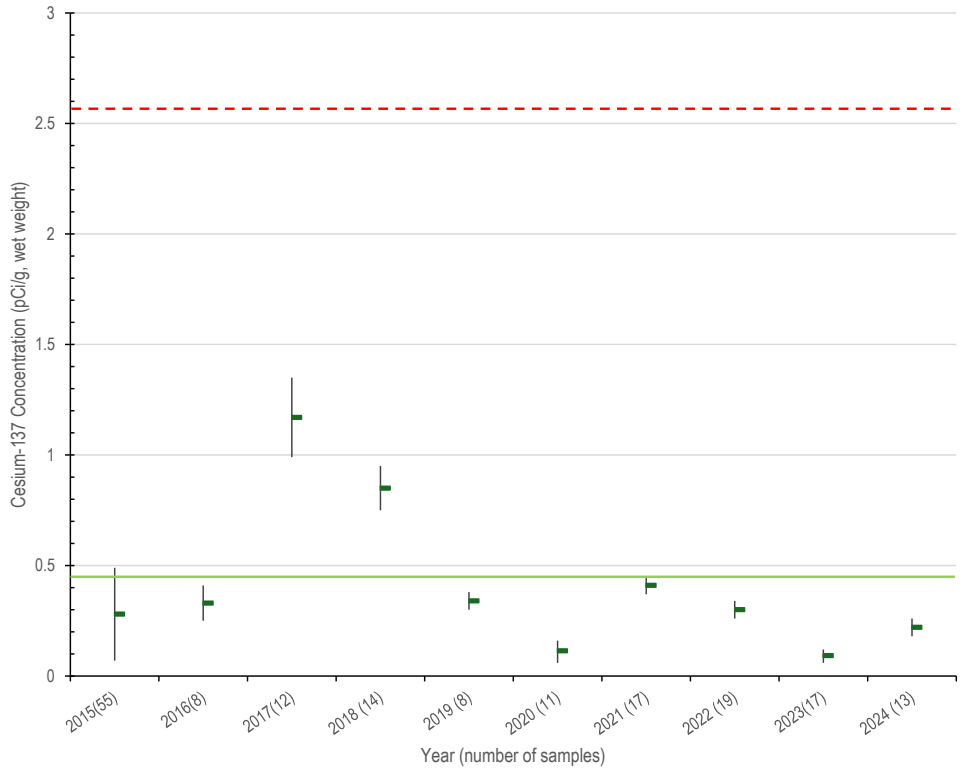


Figure 6-3. Ten-year trend in Cs-137 in deer flesh for samples taken at BNL and within 1 mile of the Laboratory. Average before clean-up (dashed line) 2.57 pCi/g wet weight. Ten-year average (solid line) 0.41 pCi/g wet weight.



6.3.2 Fish Sampling

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Fish are only sampled under the surveillance program when there is enough water to support a sufficient population of fish that can be sampled without harm to their population and that are of sufficient size for analysis. Based upon the 2021 CERCLA Five-Year Review (BNL 2021a) of the effectiveness of the environmental cleanup and the final supplemental cleanup of a small area within the river during 2017, the Laboratory has discontinued fish monitoring under the CERCLA program. In 2024, the fish population did not support sampling.

6.3.2.1 Fish Population Assessment

The relative sizes of fish caught during sampling events are tracked and modifications to future sampling events are made, as necessary, to ensure long-term health of the on-site fish populations. The combination of discontinuing STP discharges to the Peconic River and drought conditions results in high variability in the presence of water and flow sufficient enough to reach off-site portions of the river. On-site, water levels have receded, resulting in water being retained only in deeper open water areas. There was no documented off-site flow in 2024. For fish populations to survive and flourish, water levels must be substantial enough to allow migration of fish and maintain their presence for an extended period to replenish populations. As mentioned above, new criteria for the collection of fish samples have been developed. These criteria will guide the environmental monitoring approach for fish in the future. To determine if enough fish are present to support sampling, population assessments are conducted. In 2024, a population assessment was conducted in early June and resulted in no captures of any fish.

6.3.3 Vegetation Sampling

6.3.3.1 Grassy Plants and Soil

Table 6-3. Radiological Analysis of Grassy Vegetation and Associated Soils (2024).

Location/ Matrix	K-40 pCi/g±95% C.I.	Cs-137 pCi/g±95% C.I.
No-mow Area behind Berkner Hall		
Vegetation	4.70±0.79	ND
Soil*	6.03±1.05	0.17±0.06
Between East Saddle & East Margin Paths		
Vegetation	3.03±0.79	0.35±0.07
Soil*	5.40±0.72	0.17±0.04
North of North Fire Break & East Margin Path		
Vegetation	5.19±1.38	ND
Soil	3.53±0.59	0.64±0.08
Z-Path		
Vegetation	3.15±0.80	ND
Soil	3.86±0.83	ND
South Boundary between Upton & Fawn Path		
Vegetation	2.30±0.92	ND
Soil*	6.01±0.70	0.04±0.03
Field North of Bldg. 528		
Vegetation	3.52±0.67	ND
Soil	8.83±0.99	ND
RHIC North Pond		
Vegetation	4.33±0.94	ND
Soil	3.44±0.55	N2
No Mow Area corner of Renaissance & Rutherford		
Vegetation	3.92±0.89	ND
Soil	5.79±1.09	N2
South Boundary Rd. & Powerline Rd.		
Vegetation	4.16±0.93	ND
Soil	7.80±0.92	N2
Wetland South of East Fifth East of First Path		
Vegetation	3.31±0.83	ND
Soil*	5.58±0.93	0.18±0.06
NYSDEC Check Station (Control)		
Vegetation	3.39±0.83	N2
Soil	4.79±0.91	0.05±0.04

Notes: All values are shown with a 95% confidence interval.
Radiological values for soils are on a 'dry weight' basis.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected
N2 = Data qualified as Not Useable, indistinguishable from background.
* = estimated value for Cs-137 based on laboratory qualifiers.

During 2024, grassy vegetation samples were collected from ten locations around the Laboratory (Figure 6-4) and a control location at the NYSDEC hunter check station in Ridge, New York. All samples were analyzed for Cs-137 (see Table 6-3). Nine vegetation samples were undetected or indistinguishable from background

for Cs-137, and the remaining sample had a Cs-137 level of 0.35 pCi/g, dry weight. Five soil samples were undetected or levels of Cs-137 indistinguishable from background. The remaining six samples had Cs-137 levels ranging from 0.04 to 0.64 pCi/g, dry weight. All values were consistent with historic monitoring and knowledge of cleanup areas. Monitoring results for grassy vegetation and soils were utilized for the annual dose to biota analysis reported in Chapter 8.

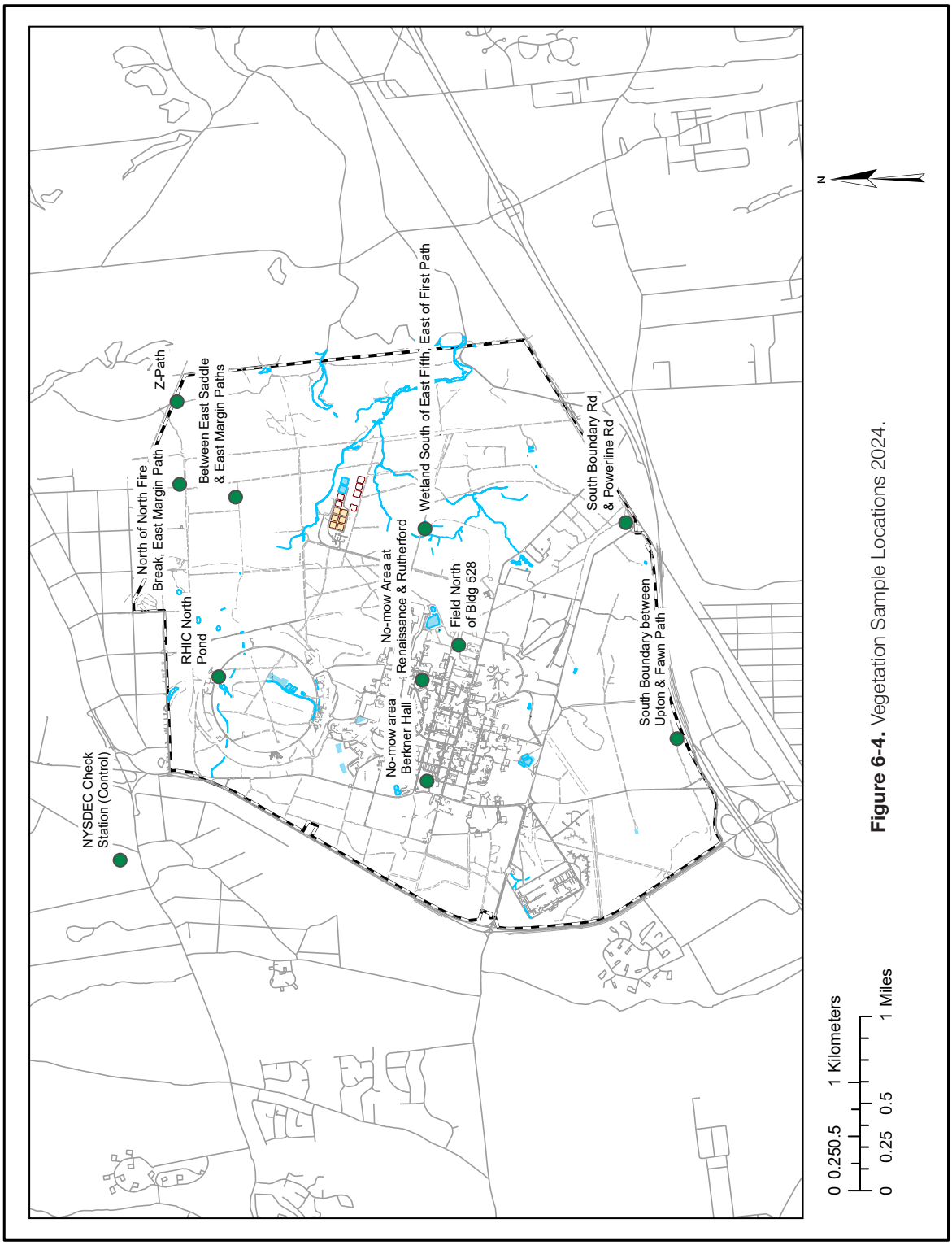


Figure 6-4. Vegetation Sample Locations 2024.

6.4 Other Monitoring

6.4.1 Basin Sediments

A five-year cycle for the collection of recharge basin sediment samples was established in 2003. There are 11 recharge basins that receive water discharges that are permitted under the Laboratory's State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-3 for outfall locations). The 11 basins were sampled in 2022, and the results were published in the 2022 Site Environmental Report. The next round of basin sediment sampling based on the five-year schedule will occur in 2027.

6.4.2 Precipitation Monitoring for Mercury

During 2024, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (Figure 4-2 for station locations). The samples were analyzed for total mercury (Table 6-4) using low-level mercury analysis. Mercury concentrations in precipitation have been measured at BNL since 2007. Analysis of mercury in precipitation is conducted to document mercury deposition that is attributable to off-site sources. This information has been used as a comparison to Peconic River monitoring data and aids in understanding the distribution of mercury within the Peconic River watershed. Mercury was detected in all the precipitation samples collected at both sampling stations. Mercury ranged from 3.74 ng/L at station S5 in January 2024 to 13.3 ng/L at station P4 in October 2024. The 13.3 ng/L concentration is three times lower than the highest value of 45.1 ng/L, recorded in 2017.

Table 6-4. Precipitation Monitoring (Mercury).

Location/Period	Mercury ng/L
P4	
1/8/24	4.11
4/3/24	7.03
7/12/24	11
10/9/24	13.3
S5	
1/8/24	3.74
4/3/24	8.61
7/12/24	11
10/9/24	11

Notes: Method detection limit for mercury is 0.2 ng/L.
P4 = precipitation sampler near BNL Apartment area.
S5 = precipitation sampler near BNL Sewage Treatment Plant.

6.5 Educational Programs

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants gain an understanding of the local ecosystems, foster an interest in science, and provide a meaningful experience for interns in preparation for further studies or a career. Wildlife programs are conducted at the Laboratory in collaboration with the Department of Energy (DOE), local agencies, colleges, and high schools. Ecological research is also conducted on-site to routinely update the natural resource inventory records, improve our understanding of the ecosystem, and guide management planning.

In FY24, eleven undergraduate interns and two graduate interns completed projects during the summer. Projects included bat acoustic monitoring, small mammal trapping, black turpentine beetle activity in pitch pine restoration treatments, fire and insect communities in pine barrens, wildlife camera trapping, and the impacts of fire and forest microclimates on tick populations.

Students trekking through the Long Island Pine Barrens to sample ticks on an experimental plot.

BNL participates in, coordinates, or hosts activities that support ecological education on Long Island. In 2024, the following programs were completed, or involved participation:

- Long Island Natural History Conference
- Open Space Stewardship Symposium (150 students, 40 posters)
- New York Wildfire & Incident Management Academy

The Day in the Life of a River program ran from September 19 to November 1, 2024. The Day in the Life of a River Program is a place-based educational experience where students and teachers collaborate with environmental professionals to collect scientific information capturing a snapshot of the health of the Long Island rivers and creeks. The Day in the Life of a River is a collaboration between the Central Pine Barrens Commission, the NYSDEC, and BNL, and supported by experts from the US Geological Survey, the Town of Brookhaven, Trout Unlimited, New York State Parks, and others. Approximately 2,500 students and teachers across five elementary, and 32 middle and high schools participated in the collection of environmental sample data and conducted real time scientific analyses for 11 rivers across Long Island.

6.6
Cultural Resource Activities

The BNL Cultural Resource Management Program ensures that the Laboratory fully complies with numerous cultural resource regulations. The BNL Cultural Resource Management Plan (CRMP) outlines those regulations and provides guidance for the protection and management of historic and cultural resources (BNL 2023). BNL's cultural resources include buildings and structures, World War I (WWI) earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records. As various cultural resources are identified, plans for their long-term stewardship are developed and implemented. The Cultural Resource Management Program ensures that the contributions BNL and the site have made to local and national history and culture are documented and available for interpretation.

In 2024, BNL hired its first full-time Cultural Resources Manager to meet the growing regulatory needs for compliance with the National Historic Preservation Act (NHPA) and for managing the historical collections relating to Camp Upton history and the scientific history at BNL. The cultural resource program purchased 14 new cabinets to support improved storage of scientific items in the collections, and four new museum quality display cases for the exhibition of objects and artifacts. Two of the museum display cases have been installed in the lobby of Berkner Hall and feature artifacts from the Camp Upton Collection.

WWI-era gas mask exhibited in new museum case in Berkner Hall.

Several kiosks were developed for compliance with Memoranda of Agreement (MOA) for the Brookhaven Medical Reactor (BMRR) Stack Removal project, Discovery Park (which included the 1960s Era Apartments Demolition project), and the 1940s Water Tower Demolition project. The kiosks provide historical information and imagery highlighting several aspects of BNL site history, including the WWI and II hospital area, roadways through the Camp Upton property, and medical research that took place at the BMRR and Medical Department. These kiosks are expected to be installed in 2025 around the Science and User Support Center (SUSC) and outside of Building 490. Completion of the artwork for the Water Tower kiosk is pending completion of the painting of the new tower.

Community outreach in 2024 included support for an exhibit and programming at the Bellport-Brookhaven Historical Society. Their 2024 summer exhibit, entitled *The Innovators: Inventors and Scientists of Bellport*, featured the histories of several scientists and inventors of Brookhaven National Laboratory and their families, particularly those that settled in the Bellport-Brookhaven area. BNL supported the exhibit with a loan of historic materials and with a lecture about BNL history entitled *Technology and the Future of Medicine*. In addition, two public-facing presentations were made in 2024 on the history of Camp Upton at the Sayville Library and the Middle Country Library. The Cultural Resource Management Program hosted one intern participating in the Science Undergraduate Laboratory Internship program in the summer of 2024. The undergraduate intern conducted historical research on magnet development for accelerator science at the Cosmotron, the Alternating Gradient Synchrotron (AGS), and the Relativistic Heavy Ion Collider (RHIC).

Inductees, preparing for World War I, train with bayonets at Camp Upton.

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