6 Natural and Cultural Resources

The Brookhaven National Laboratory (BNL) Natural Resource Management Program 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 and monitoring the ecosystem, 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 2017, deer, vegetation, and soil sampling results were consistent with previous years.

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.

6.1 NATURAL RESOURCE MANAGEMENT PROGRAM

The Natural Resource Management Program 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 Natural Resource Management Plan (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 being completed in 2016 (BNL 2016).

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.

In 2014, the southern pine beetle (SPB) was discovered at a number of locations on Long Island, including BNL. Mapping and tracking this native forest pest that rapidly colonizes and spreads through dense stands of pitch pines began in Spring 2015. The Laboratory has continued to work with the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Forest Service to map and track infestations on the Laboratory site. The efforts combine aerial surveys along with ground truthing surveys and mapping. The results of this effort are maintained within the GIS to track impacts to the forest.

Mapping associated with tracking impacts from the operation of the Long Island Solar Farm (LISF) at BNL continues to be entered into the GIS as a tool to analyze changes to wildlife populations and vegetation. In 2017,

Table 6-1. Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	**Scientific Name**	**State 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
Grasshopper sparrow	*Ammodramus savannarum*	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	*Dendroica discolor*	SGCN	Confirmed
Horned lark	*Eremophila alpestris*	SC	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
Mammals			
Northern long-eared bat**	*Myotis septentrionalis*	FT	Confirmed

continued on next page

natural resource personnel and interns looked at use of the LISF site by wildlife; pollinators; changes in bird use; and changes in vegetation.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the site. Through implementation of the NRMP, endangered, threatened, and 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). The only New York State endangered animal species confirmed as currently inhabiting Laboratory property is the eastern tiger salamander (*Ambystoma t. tigrinum*). Endangered plants that have been confirmed on the BNL site include Engelman spikerush (*Eleocharis engelmannii*), Ipecac spurge (*Euphorbia ipecacuanhae*), dwarf huckleberry (*Gaylussacia bigeloviana*), and whorled loosestrife (*Lysimachia quadrifoli*). Three other New York State endangered species have been identified at BNL in the past or are possibly present including: the Persius duskywing butterfly (*Erynnis p. persius*), crested fringed orchid (*Plantathera cristata*), and fireweed (*Erectites heiracifolia var. megalocarpa*).

Seven 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*]) and three plants (stiff-leaved goldenrod [*Oligoneuron rigida*], stargrass [*Aletris farinose*], and eastern showy

Table 6-1. Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need *(concluded).*

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	**Scientific Name**	**State Status**	**BNL Status**
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
Fireweed	*Erectites heiracifolia var. megalocarpa*	E	Possible
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:
Table information based on 6 NYCRR Part 182, NYCRR Part 193, and BNL survey data.
* Species added in 2015
E = endangered
F = federally threatened
R = rate
SC = species of special concern
SGCN = species of greatest conservation need
T = threatened
V = exploitably vulnerable

aster [*Eurybia spectabilis*]). The northern harrier (*Circus cyaneus*) is periodically seen in the fall. Insects listed as threatened include a damselfly, the Pine Barrens bluet (*Enallagma recurvatum*), 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 iris*), a butterfly, has been historically present on site due to its preferred habitat and host plant, wild lupine (*Lupinus perennis*).

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 historically has had no federally threatened or endangered species present on site. On October 2, 2013, the U.S. Fish & Wildlife Service (FWS) published a notice in the Federal Register that the northern longeared bat (*Myotis septentrionalis*) be listed as a threatened species on April 2, 2015, with an effective date of May 4, 2015. A draft rule under section 4(d) of the Federal Endangered Species Act was published concurrent to the determination of threatened status and provided guidance on management requirements. The draft 4(d) rule was finalized in early 2016. The northern longeared bat is known to be present at BNL, having been identified as the first case of white-nosed syndrome found on Long Island

in 2011. The bat has been added to the Laboratory's list of protected species. On January 11, 2017, the FWS published the final rule listing the rusty patched bumble bee (*Bombus affinis*) as an endangered species. The historic range of this bumble bee includes Long Island. In 2016, a researcher working on bumble bees identified a single specimen as the rusty patched bumble bee. However, no photos or specimens were taken and therefore the identification could not be corroborated. Subsequent searches in the area in 2017 did not yield evidence for its presence.

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 program 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.

6.1.2.1 Salamander Protection Efforts

Many safeguards are in place to protect eastern tiger salamander breeding areas. BNL 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 map is updated as new information concerning the salamanders is generated through research and monitoring. The current map incorporates buffer areas around tiger salamander habitats of 1,000 feet based on guidance from 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. During these times, construction and maintenance activities near their habitats are postponed or closely monitored.

Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with 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. In 2017, surveys confirmed the presence of salamanders in two of the 26 ponds. Long Island's drought continued into spring 2017, with virtually all on-site ponds remaining dry after winter snow and rains concluded. Ponds began holding water after rains during fall 2017.

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. Population estimates are periodically conducted within these waters to determine their current health. During the last population survey in 2011, approximately 6,400 banded sunfish were counted. In 2015, the only known pond with banded sunfish was nearly dry due to drought conditions. A very small depression remained wet throughout the year and may have harbored fish. However, this area was completely dry during 2016 due to continued drought conditions, with only minimal water through most of 2017. Regionally, NYSDEC determined that only a few populations of banded sunfish survived the drought and they will evaluate the need for restoration efforts after surveys in 2018.

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 2017, monthly surveys were conducted starting at the end of April and extending through the end of August. These surveys identified 72 bird species, compared to the 77 species identified in 2016 and 84 species in 2015. A total of 133 bird species have been identified in surveys in the past 17 years; 59 of these species were present in each of the past 17 years. Variations in the number and species identified during each survey may reflect the time of observation, variations in weather patterns between years, and possible changes in the environment.

The three most diverse transects pass near on-site wetlands near the LISF and the Peconic River. The four transects passing through the various forest types on site (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community. Bird survey data are stored in an electronic database for future reference and study. No known data on the effects of a large, utility-scale solar array such as the LISF are known 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 LISF transects is important. The LISF vegetation and the way it is managed may play a key role as habitat for migratory birds. One species, the indigo bunting (*Passerina cyanea*), was absent along the Biology Field transect in 2011, but was heard along the LISF transect in 2012, returned to the Biology Field transect in 2013, and has been present on both transects since 2014. This temporary absence is thought to be due to disturbance from construction activities while building the LISF.

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. Although many of these boxes were removed from service in 2010 in preparation for the construction of the LISF, the LISF created nearly 200 acres of suitable habitat for the eastern blue bird. Forty new boxes were installed around the northern most portions of the LISF in 2012 and are routinely used by bluebirds, house wrens, and tree swallows.

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. Approximately 12 years ago, it was determined that the resident Canada goose population at BNL reached large enough numbers that could result in health and safety issues. Beginning in 2007, under a permit from FWS, the Laboratory began managing the resident goose population by limiting the number of eggs that could hatch. Forty-five nests were treated during 2017 to reduce the number of goslings. The increase over the 20 nests that were treated in 2016 was due to geese that were hatched in 2014 reaching sexual maturity. During 2017, approximately 12 goslings were produced, with minimal survival due to predation. By the end of 2017, the resident goose population was estimated at just over 100 birds.

6.1.2.4 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) has been increasing in population locally on Long Island with eight known nest sites on the island. During 2017, bald eagles were sighted numerous times in the area of the Sewage Treatment Plant (STP), and a single juvenile was documented during the August bird survey. Adult bald eagles were noticed visiting deer carcasses that were purposely placed for camera trap studies. 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 added to the list of federally threatened species in 2015. BNL began planning for the eventual listing and put in place actions to minimize the likelihood of impacting this species. The two most likely

activities that could impact this bat are building demolition and prescribed fires. Inspections for the presence of bats are conducted in multiple ways prior to a building demolition. During spring, summer, and fall, ultrasonic acoustic monitoring is conducted around buildings scheduled for demolition to determine if there is bat activity. Regardless of the outcome of acoustic monitoring, a final internal inspection of the buildings is conducted approximately 24 hours prior to demolition to verify the absence of bats. For growing season prescribed fire, acoustic monitoring is done within the burn unit to determine if there is bat activity. If positive results are acquired, surveys of the entire burn unit are completed to identify potential roost trees and appropriate protections are put into place to ensure that bats are not impacted by fire. In 2017, only one building was demolished, and there was no impact to bats. Surveys ahead of prescribed fires in 2017 identified no roost trees.

6.1.3 Population Management

In addition to controlling resident Canada goose populations described above, the Laboratory also monitors or manages other populations, including species of interest, to ensure that they are sustained and to control invasive species.

6.1.3.1 Wild Turkey

The forested areas of BNL provide good nesting and foraging habitat for wild turkey (*Meleagris gallapavo*). In 2017, the on-site population was approximately 500 birds due to very successful nesting. Each year, NYSDEC manages a five-day hunting period during the week of Thanksgiving, and a youth-only hunt in May for several areas across Long Island, which typically results in over 100 birds taken.

6.1.3.2 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 ten 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 the white-tailed deer since 2000. The fall 2017 estimate provided a range of 250-300 animals after completion of culling during spring 2017 (see below).

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 (songbird species reduction due to selective grazing and destruction of habitat by deer), and property damage (collision damage to autos and browsing damage to ornamental plantings). Deer-related collisions on site are less common than in the past, presumably due to improved vehicular speed controls, employee training, and deer management practices.

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, hunting, or sterilization programs. In 2008, BNL began developing a deer management plan which included an option to reduce the population through culling. The planning effort included engagement of Laboratory employees and guests in discussions concerning the need and methods for deer management. In 2012, an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) was completed and sent to New York State for comment. The Final EA was completed in the spring of 2013. Additionally, 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. In February 2015, 300 animals were taken, effectively reducing the population to approximately 530 animals. Furthermore, as many as 100 additional animals did not survive the harsh

winter conditions which resulted in snow cover lasting more than 30 consecutive days. Estimates from fall 2016 surveys indicated that the population ranged between 400-500 animals. A second population reduction occurred in March 2017, with 202 animals being removed, bringing the herd to a range of 200-300 animals. As mentioned above, the population at the end of 2017, accounting for reproduction, was estimated at between 250 and 300 animals.

6.1.4 Compliance Assurance and Potential Impact Assessment

The 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 EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), BNL's Community Advisory Council, and the Brookhaven Executive Roundtable 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. There were no higher level NEPA reviews started or completed in 2017.

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 and the Foundation for Ecological Research in the Northeast (FERN). Funding is coordinated for research projects that occur within the reserve and the larger pine barrens area of Long Island. Research supported by FERN in 2017 included funding for investigative studies related to eastern box turtles (see discussion below).

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. In addition to surveillance monitoring, routine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-required monitoring results associated with post-cleanup monitoring of the Peconic River is also conducted. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was used in some BNL landscaping projects in the past, traces of Cs-137 attributable to past practices and world-wide fallout 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 radionuclide tables in this chapter 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 outcompetes 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 follow.

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. While most off-site samples are the result of car/deer accidents near the Laboratory, samples from deer taken by hunters beyond BNL boundaries or samples from car/deer accidents greater than one mile from BNL have also been made available for analysis. In 1998, a statistical analysis suggested that 40 deer from off site and 25 deer from on site are needed to achieve a statistically sound data set. The number obtained each year has not met this preferred level because sample availability depends on accidents between vehicles and deer and people reporting dead deer. In 2017, a total of 18 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 since 2013. Most of the off-site samples are concentrated along the William Floyd Parkway on the west boundary of BNL, whereas most on-site samples are collected near the Laboratory's main entrance gate and the developed portions of the site. This distribution is due to the fact that people on their way to work see and report dead deer. Also, vehicle collisions with deer on site occur primarily early or late in the day, when deer are more active and traffic to and from the Lab's Main Gate is greatest.

Based on more than a decade 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. In 2017, two deer were obtained on site, both from car/deer accidents, ten from off-site locations within one mile of the Laboratory, and six from greater than one mile from the BNL boundary. The analytical results of deer sampling are shown in Table 6-2. In addition to deer sampling, BNL conducted a population reduction of the deer herd with meat from the effort donated to food shelters. To ensure that Cs-137 levels were below State health recommendations, 41 composite samples were taken with analytical results shown in Table 6-3.

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. Cesium-137 in soil can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing/grazing animals or is consumed directly with soil while the animal is grazing. Remediation of contaminated soil areas on site has occurred under the Laboratory's CERCLA program, with all major areas of contaminated soil being remediated by September 2005.

In 2017, Cs-137 concentrations in deer meat samples were obtained from two deer on site with a range of values from 1.16 pCi/g, wet weight, to 1.34 pCi/g, wet weight, and an arithmetic average of 1.25 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 2017 (1.34 pCi/g, wet weight) was about 21 percent lower than the highest on-site sample reported in 2016 (1.69 pCi/g, wet weight) and nearly nine times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight).

Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within one mile of BNL (ten samples) and samples taken farther away (six samples), as shown in Table 6-2. Concentrations in meat samples taken within one mile ranged from 0.06 pCi/g, wet weight to 3.33 pCi/g, wet weight, with an arithmetic average of 1.15 pCi/g, wet weight. Because deer on site may routinely travel up to one mile off site, the arithmetic average for deer taken on site and within one mile of the Laboratory is also calculated; for 2017, this was 1.17 pCi/g, wet weight. The six deer sampled from greater than one mile from BNL had Cs-137

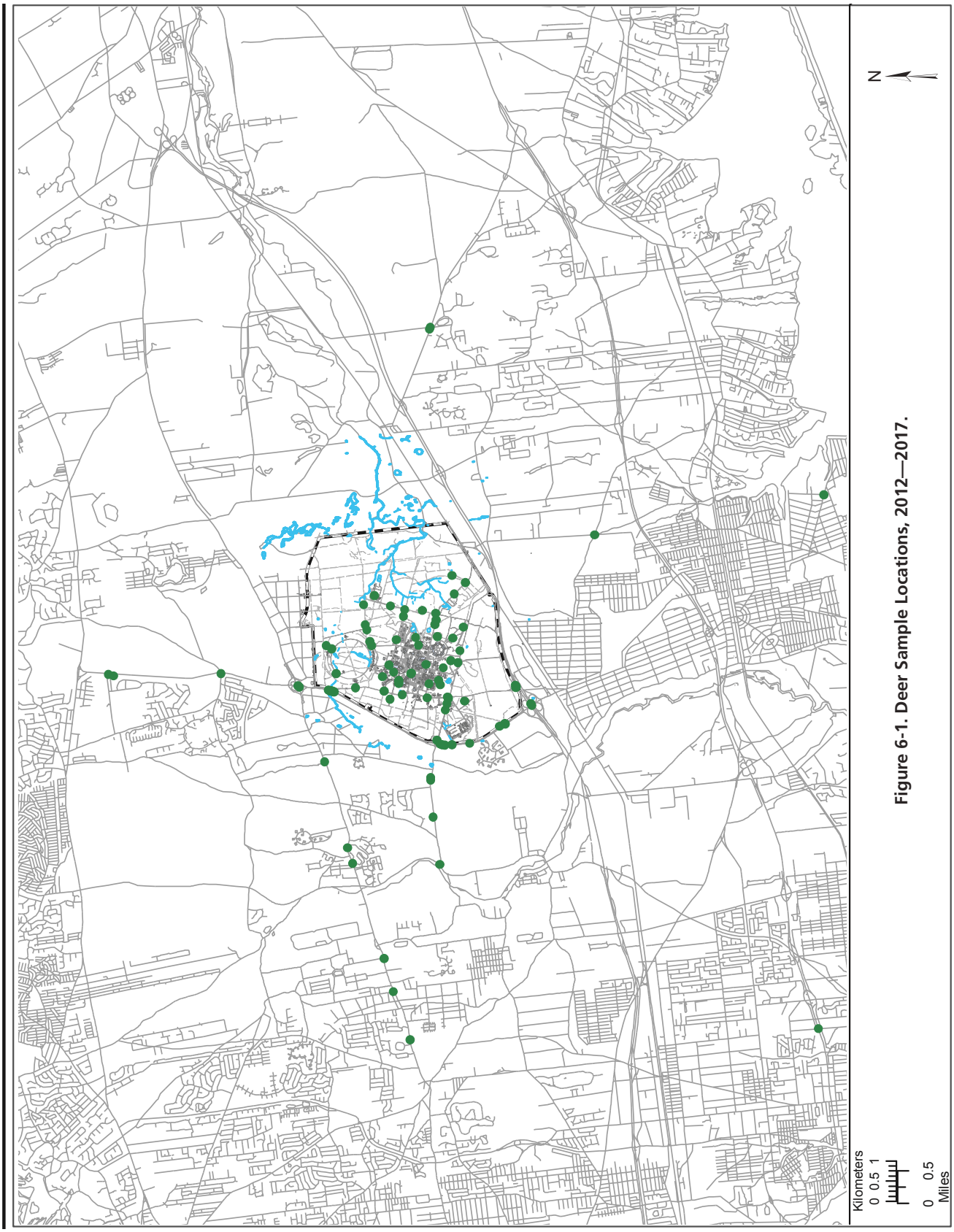


Figure 6-1. Deer Sample Locations, 2012—2017.

Table 6-2. Radiological Analyses of Deer Tissue. (2017)

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)
BNL				
East 5th and First St.	1/19/17	Flesh	2.99±0.46	1.16±0.07
	1/19/17	Liver	2.24±0.33	0.26±0.03
BNL Main Gate	11/13/17	Flesh	3.29±0.29	1.34±0.04
	11/13/17	Liver	2.97±0.27	0.51±0.03
< 1 Mile from BNL				
WFPKY at north gate	5/16/17	Flesh	2.88±0.13	0.10±0.01
	5/16/17	Liver	2.60±0.17	0.05±0.01
LIE Exit 68, Sika Deer	9/30/17	Flesh	3.41±0.36	0.88±0.05
	9/30/17	Liver	2.99±0.35	0.68±0.04
Longwood Rd near Junior High School	10/6/17	Flesh	3.00±0.43	0.19±0.03
WFPKY south of Main Gate	10/18/17	Flesh	2.99±0.37	3.33±0.09
	10/18/17	Liver	2.80±0.36	1.11±0.05
WFPKY south of Main Gate deer2	10/30/17	Flesh	3.43±0.48	0.86±0.06
WFPKY & Rte 25	10/30/17	Flesh	2.84±0.32	2.20±0.07
Rte 25 and WFPKY	11/8/17	Flesh	2.94±0.31	2.92±0.07
	11/8/17	Liver	2.81±0.26	1.25±0.04
WFPKY 1/2 mi. South of Main Gate	11/28/17	Flesh	2.69±0.33	0.30±0.03
	11/28/17	Liver	2.00±0.36	0.23±0.03
Longwood Rd. Near JHS	12/12/17	Flesh	2.50±0.36	0.06±0.01
	12/12/17	Liver	2.89±0.32	ND
LIE Service Rd at South Gate	12/29/17	Flesh	3.76±0.35	0.69±0.04
	12/29/17	Liver	2.50±0.32	0.23±0.02
> 1 Mile from BNL				
Middle Island at Sweezey Ln	2/6/17	Flesh	2.73±0.16	0.10±0.01
	2/6/17	Liver	1.48±0.13	0.04±0.01
Rte 25 and Woodlot, Ridge	5/16/17	Flesh	2.55±0.11	0.26±0.01
	5/16/17	Liver	3.23±0.18	0.12±0.01
Manorville, Rte 111	5/31/17	Flesh	2.67±0.33	0.25±0.03
	5/31/17	Liver	2.59±0.32	0.11±0.02
WFPKY at Wiskey Rd.	9/11/17	Flesh	2.83±0.20	0.02±0.01
Rte 111 Manorville	11/2/17	Flesh	2.88±0.26	2.91±0.06
	11/2/17	Liver	3.07±0.25	1.17±0.04
Moriches-Middle Island Rd & Barnes Rd	11/16/17	Flesh	2.93±0.29	0.51±0.03
	11/16/17	Liver	2.69±0.36	0.19±0.03
Averages by Tissue				
Flesh Averages				
All Samples (18)			2.96±1.38	1.00±0.19
BNL Average (2)			3.14±0.55	1.25±0.08
< 1 Mile Average (10)			3.04±1.12	1.15±0.16
BNL + < 1 Mile Average (12)			3.06±1.25	1.17±0.18
> 1 Mile Average (6)			2.77±0.59	0.67±0.08
Liver Averages				
All Samples (14)			2.63±1.10	0.43±0.11
BNL Average (2)			2.61±0.43	0.38±0.04
< 1 Mile Average (7)			2.66±0.83	0.51±0.09
BNL + < 1 Mile Average (9)			2.64±0.93	0.48±0.10
> 1 Mile Average (5)			2.61±0.58	0.33±0.05

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 = not detected

Table 6-3. Radiological Analysis of Batch Samples from Deer Cull Released for Donation (2017)

Batch Number	Collection Date	K-40 pCi/g (wet)±95% C.I.	Cs-137 pCi/g (wet)±95% C.I.
Day 1 Batch Sampling			
Batch #1	3/24/17	2.76±0.34	0.19±0.02
Batch #2		3.33±0.25	0.10±0.01
Batch #3		2.77±0.20	0.21±0.02
Batch #4		2.70±0.20	0.32±0.01
Batch #5		2.62±0.21	0.25±0.01
Batch #6		2.34±0.16	0.23±0.01
Batch #7		2.56±0.19	0.14±0.01
Day 2 Batch Sampling			
Batch #8	3/25/17	2.48±0.16	0.18±0.01
Batch #9		2.71±0.16	0.22±0.01
Batch #10		2.48±0.16	0.24±0.01
Batch #11		2.72±0.15	0.13±0.01
Batch #12		2.46±0.21	0.10±0.01
Batch #13		2.57±0.16	0.40±0.01
Batch #14		2.75±0.20	0.23±0.01
Batch #15		2.65±0.20	0.24±0.01
Day 3 Batch Sampling			
Batch #16	3/26/17	2.69±0.17	0.24±0.01
Batch #17		2.44±0.17	0.28±0.01
Batch #18		2.62±0.15	0.31±0.01
Batch #19		2.68±0.17	0.44±0.02
Batch #20		2.72±0.17	0.29±0.01
Batch #21		2.61±0.19	0.29±0.02
Batch #22		2.62±0.15	0.37±0.01
Batch #23		2.12±0.22	0.39±0.02
Batch #24		2.34±0.16	0.27±0.01
Batch #25		2.56±0.15	0.24±0.01
Batch #26		2.63±0.17	0.30±0.01
Batch #27		2.49±0.15	0.22±0.01
Day 4 Batch Sampling			
Batch #28	3/27/17	2.52±0.24	0.21±0.02
Batch #29		2.47±0.19	0.37±0.02
Batch #30		2.57±0.20	0.28±0.02
Batch #31		2.59±0.22	0.46±0.02
Day 5 Batch Sampling			
Batch #32	3/28/17	2.23±0.39	0.33±0.03
Batch #33		2.76±0.48	0.36±0.05
Day 6 Batch Sampling			
Batch #34	3/29/17	3.07±0.42	0.22±0.04
Batch #35		2.85±0.45	0.23±0.04
Batch #36		2.33±0.16	ND
Batch #37		2.35±0.27	0.06±0.01
Batch #38		2.85±0.47	0.49±0.05
Batch #39		2.66±0.56	0.19±0.04
Day 7 Batch Sampling			
Batch #40	3/30/17	2.88±0.47	0.32±0.04
Batch #41		3.40±0.67	0.22±0.07
Average Concentrations		2.63±1.79	0.26±0.15

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 = not detected

concentrations ranging between 0.02 pCi/g, wet weight, to 2.91 pCi/g, wet weight, with an arithmetic average of.0.67 pCi/g, wet weight. Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2017 from four different location groupings. Beginning in 2013, the average Cs-137 content from deer taken within one mile of the Laboratory was lower than the on-site average, and this pattern has been consistent for the past five years. While no definitive explanation can be given to the difference from past results, it could simply be an artifact of low sample numbers and randomness in sample acquisition. Although not shown on Figure 6-2, Cs-137 concentrations in four of the 12 meat samples taken both on and off site were below 0.5 pCi/g, wet weight.

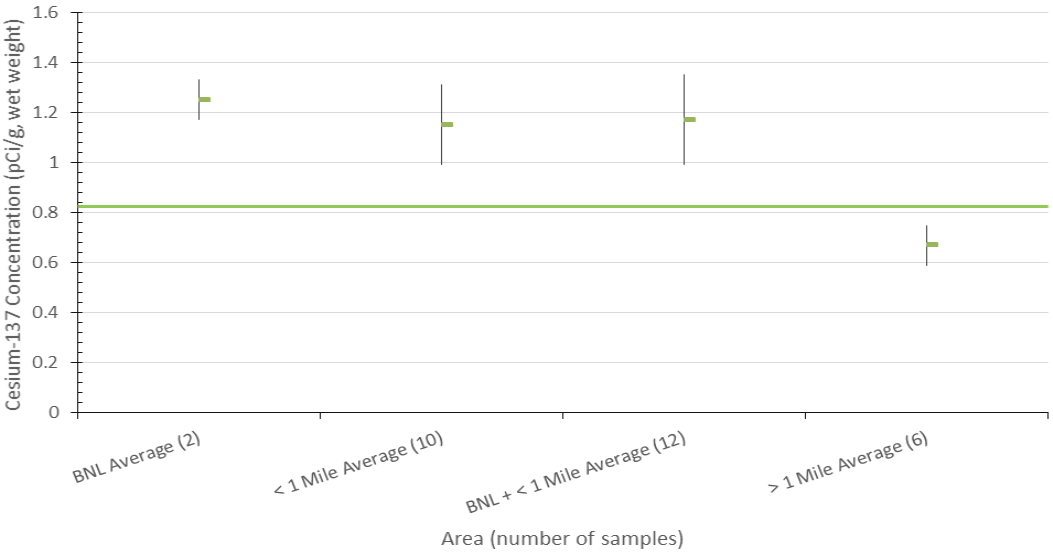
Figure 6-3 presents the ten-year trend of on-site and near off-site Cs-137 averages in deer meat. The 2017 average is approximately one-third lower than the 2008 average and is nearly four times higher than the 2015 value of 0.28 pCi/g wet weight, which was the lowest average seen since trending began in 2000. The higher averages shown are reflective of a significant number of samples taken in the fall when Cs-137 levels are typically higher. However, these sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, with the trend being downward from 2008 to 2017 and the ten-year average being 0.83 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 clean-up, while the on-site and near off-site values were shown to decline. In preparing for monitoring associated with the reduction of the deer population, the ten-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 to the Hunters for the Hungry program.

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 2017, Cs-137 concentrations ranged from 0.26 to 0.51 pCi/g, wet weight, with an average of 0.38 pCi/g, wet weight. The near off-site Cs-137 concentration in liver ranged from non-detect to 1.25 pCi/g, wet weight, with an arithmetic average for off-site liver samples within one mile of 0.51 pCi/g, wet weight. Liver samples from deer taken greater than one mile from BNL ranged from 0.04 pCi/g, wet weight to 1.17 pCi/g, wet weight with the arithmetic average being 0.33 pCi/g, wet weight. The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8.

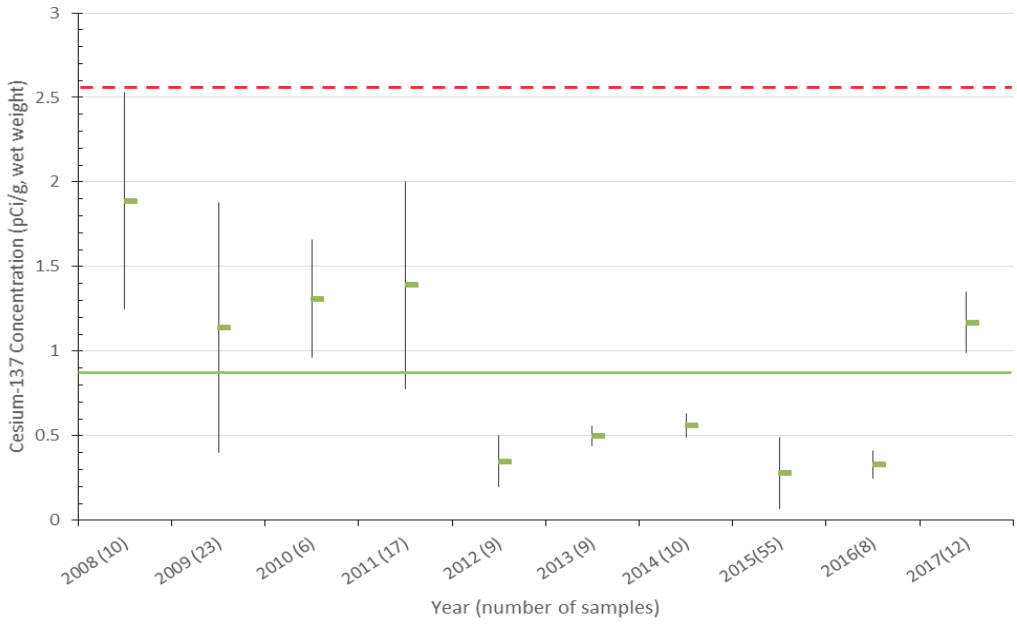
The New York State Department of Health (NYSDOH) has formally considered the potential public health risks associated with elevated Cs-137 levels in on-site deer, and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999). As mentioned above, BNL has established an administrative release criterion of 1.0 pCi/g, wet weight for meat donated from deer removed from the Laboratory and donated through the Hunters for the Hungry program. In 2017, the Lab removed 202 deer from the herd over a seven-day period. Composite samples were acquired during the process in which samples from five deer were combined in a composite sample. A total of 41 samples were sent for analysis. The results of the sampling are presented in Table 6-3. The Cs-137 content in the samples ranged from non-detect to 0.49 pCi/g, wet weight with an arithmetic average of 0.26 pCi/g, wet weight. The range and average were well below the 1.0 pCi/g, wet weight administrative release criteria, therefore all meat was donated.

With respect to the health of on-site deer based on their exposure to radionuclides, the International Atomic Energy Agency (IAEA)



Notes: Ten year average of onsite and near offsite deer flesh samples (solid line) is 0.83 pCi/g, wet weight.

Figure 6-2. Comparison of Cs-137 values in deer flesh for onsite, offsite within 1 mile, onsite and near offsite, and offsite greater than 1 mile from the Laboratory.



Notes: Ten year average (solid line) 0.83 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.

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 3 millirad per day, which is only three percent 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.

6.3.2 Other Animals Sampled

When other animals, such as wild turkey or Canada geese, are found dead along the roads of BNL and the immediate vicinity due to road mortality, they are tested for Cs-137. No other animals were sampled in 2017.

6.3.3 Fish Sampling

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Monitoring of the river has been conducted under the environmental surveillance program and the CERCLA post-cleanup program. Surveillance monitoring had occurred during even-numbered years and post-cleanup monitoring occurred in odd-numbered years. However, with the discontinuance of discharges from the STP to the Peconic River in September 2014 and current below average amounts of precipitation, the objectives for the fish monitoring program have changed to reflect the current intermittent presence of water in the on-site portions of the river. Fish are now only sampled under the surveillance program when there is sufficient 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 2016 CERCLA Five-year Review of the effectiveness of the environmental cleanup and the final supplemental cleanup of a small area within the river during 2017, the Laboratory intends to discontinue fish monitoring under the CERCLA program. Due to lack of water and fish within the on-site portions of the Peconic River, no fish were sampled in 2017.

6.3.3.1 Fish Population Assessment

The relative sizes of fish caught during annual 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. Successful sampling of sufficiently large fish for analysis from 2008 through 2015, even with low water levels in the on-site portion of the Peconic River, indicated that fish populations could maintain themselves. However, the combination of discontinuing STP discharges to the Peconic River and continued drought conditions have resulted in the on-site portions of the Peconic River to be totally dry and no longer able to support fish. The river remained dry throughout 2017. 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 of time 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.

6.3.4 Peconic River Post-Cleanup Monitoring

Approximately 20 acres of the Peconic River were remediated in 2004 and 2005 to remove sediments containing mercury and several other contaminants. To ensure that the cleanup provided adequate protection of human health and the environment, BNL conducted five years (2006-2010) of post-cleanup monitoring of the sediment, surface water, and fish. This monitoring effort identified approximately 0.39 acres in three small areas (PR-WC-06, PR-SS-15, and sediment trap areas) with mercury concentrations greater than the cleanup goal of 2.0 mg/kg. The three areas were remediated between November 2010 and February 2011. Based upon another five years of monitoring (2011-2015), it was determined that an additional area of approximately 2,600 square feet required remediation. This area was successfully cleaned up in July 2017, and a

final report was submitted to the regulators with a recommendation of no further monitoring.

6.3.5 Vegetation Sampling

6.3.5.1 Grassy Plants and Soil

During 2017, grassy vegetation samples were collected from 12 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 6-4). Cs-137 content in vegetation ranged from non-detectable to 10.0 pCi/g, wet weight in the area adjacent to the Former Hazardous Waste Management Facility wetland. The area is known to have residual Cs-137 levels below 23 pCi/g, dry weight in soils. This is confirmed as the associated soil contained a concentration of 10.8 pCi/g, dry weight of cesium. Other soil samples had Cs-137 levels from non-detect to 4.31 pCi/g, dry weight. All values were consistent with historic monitoring and knowledge of cleanup areas. Monitoring results for grassy vegetation and soils are utilized for the annual dose to biota analysis reported in Chapter 8.

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 permit (see Figure 5-3 for outfall locations). The 11 basins were sampled in 2017, and the samples were analyzed for radionuclides, semi-volatile organic compounds, PCBs and pesticides, and metals. The results of monitoring are discussed below.

Results of the radionuclide analyses were largely negative for gamma-emitting radionuclides. Cesium-137 is the primary radionuclide of concern as it is known to be present at multiple locations on the BNL site that were cleaned up by 2005. Cs-137 concentrations in basin sediments ranged from non-detect in eight of the eleven basins to a maximum of 0.08 pCi/g, dry weight in the Central Steam Facility outfall area. All detectable values were within historic

Table 6-4. Radiological analysis of grassy vegetation and associated soils

Location/Matrix	K-40 pCi/g±95% C.I.	Cs-137 pCi/g±95% C.I.
Corner Brookhaven & Fifth St.		
Vegetation	3.93±0.52	ND
Soil*	6.14±1.14	0.09±0.08
Corner Upton Rd & Cornell		
Vegetation	3.85±0.37	ND
Soil	5.85±1.17	0.25±0.10
Current Landfill		
Vegetation	3.39±0.67	ND
Soil*	5.78±1.00	0.16±0.05
Corner Upton Rd & Bell Ave.		
Vegetation	3.42±0.47	ND
Soil	5.49±1.27	0.25±0.08
No Mow Upton Rd. & Princeton, east side		
Vegetation	4.47±0.60	ND
Soil*	8.42±1.27	0.20±0.06
Railroad Spur at South Boundary		
Vegetation	5.66±0.67	ND
Soil	5.83±1.11	ND
Intersection East Fifth Ave. and First St.		
Vegetation	4.36±0.44	ND
Soil	5.57±1.24	0.42±0.11
Forest Path at outer RHIC Ring Rd.		
Vegetation	2.34±0.58	ND
Soil	4.64±0.88	ND
Ecology Field		
Vegetation	4.71±0.78	ND
Soil*	6.04±0.84	0.12±0.04
Outside FHWMF		
Vegetation	1.75±0.50	10.00±0.23
Soil	5.10±0.75	10.80±0.27
Inside FHWMF Sample 1		
Vegetation	4.75±0.77	ND
Soil	6.51±1.02	4.31±0.19
Inside FHWMF Sample 2		
Vegetation	5.84±0.80	ND
Soil	7.07±0.74	0.27±0.05
NYSDEC Game Farm (Control)		
Vegetation	4.99±0.82	ND
Soil	6.59±0.77	0.26±0.06

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
* = estimated value for Cs-137 based on laboratory qualifiers.

range for soils and are comparable to what is known from world-wide fall-out due to historic atmospheric testing of nuclear weapons.

Analysis of sediments for the presence of semi-volatile organic compounds resulted in no detections of any of these compounds. Polychlorinated biphenyl (PCB) and pesticide analysis showed low levels of Dichlorodiphenyl-trichloroethane (DDT) and its breakdown product, Dichlorodiphenyldichloroethylene (DDE), in basin HS. Values were estimated based on laboratory qualifiers at 0.85 µg/kg and 2.2 µg/kg, respectively. The PCB Aroclor 1254 was detected at an estimated 24 µg/kg in basin HN-S and Aroclor 1260 was detected in all basins except for HO, HS, HN-NS-1, and HN-N at concentrations less than 49 µg/kg. The highest concentrations of Aroclor 1260 were found in basins HW and CSF at concentrations of 49 µg/kg and 45 µg/kg, respectively. Both Aroclor 1254 and 1260 were known to be used historically at BNL.Concentrations of these PCBs are well below protection values of 3,200 µg/kg.

Results of metals analysis are presented in Table 6-5. All metals were detected at levels similar to BNL site background levels and below Suffolk County Department of Health Services cleanup levels and action levels. The only exception was the detection of chromium at 24 mg/kg at basin HT-E which was just above the county cleanup objective of 20 mg/kg, but well below the action level of 100 mg/kg. The next round of basin sediment sampling will occur in 2022 under the five-year schedule.

6.4.2 Mercury Monitoring of Precipitation

During 2017, 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 6-6). Until 2015, BNL had routinely analyzed precipitation for radiological content. However, with no emissions of significantly long-lived radionuclides from Laboratory operations, the monitoring program objectives were modified to remove testing of precipitation for radiological content beginning in 2016.

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 of the precipitation samples collected at both sampling stations. Mercury ranged from 2.07 ng/L at station S5 in January to 45.1 ng/L at station P4 in July. The 45.1 ng/L concentration is nearly two times higher than the previous high value of 24.6 ng/L, recorded in 2013.

6.5 WILDLIFE PROGRAMS

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem, 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 DOE, local agencies, colleges, and high schools. Ecological research is also conducted on site to routinely update the natural resource inventory records, gain a better understanding of the ecosystem, and guide management planning.

In 2017, BNL hosted 17 student interns and two faculty members within the Natural Resources program. Two of the interns worked with a faculty member from Hofstra University as part of the BNL Visiting Faculty Program (VFP), three worked under a faculty member from Southern University of New Orleans, and 12 interns participated in research associated with various projects including several related to the LISF, turtles, and pollinators. The Natural Resource program supported two Science Undergraduate Laboratory Internship (SULI) interns in the spring, and two in the fall, with the remaining 13 participating in the summer internship programs.

- The VFP team from Hofstra University continued a second year of gathering basic information on small mammals, tick loads, and the incidence of Lyme disease in the ticks. This work is being done in prepara-

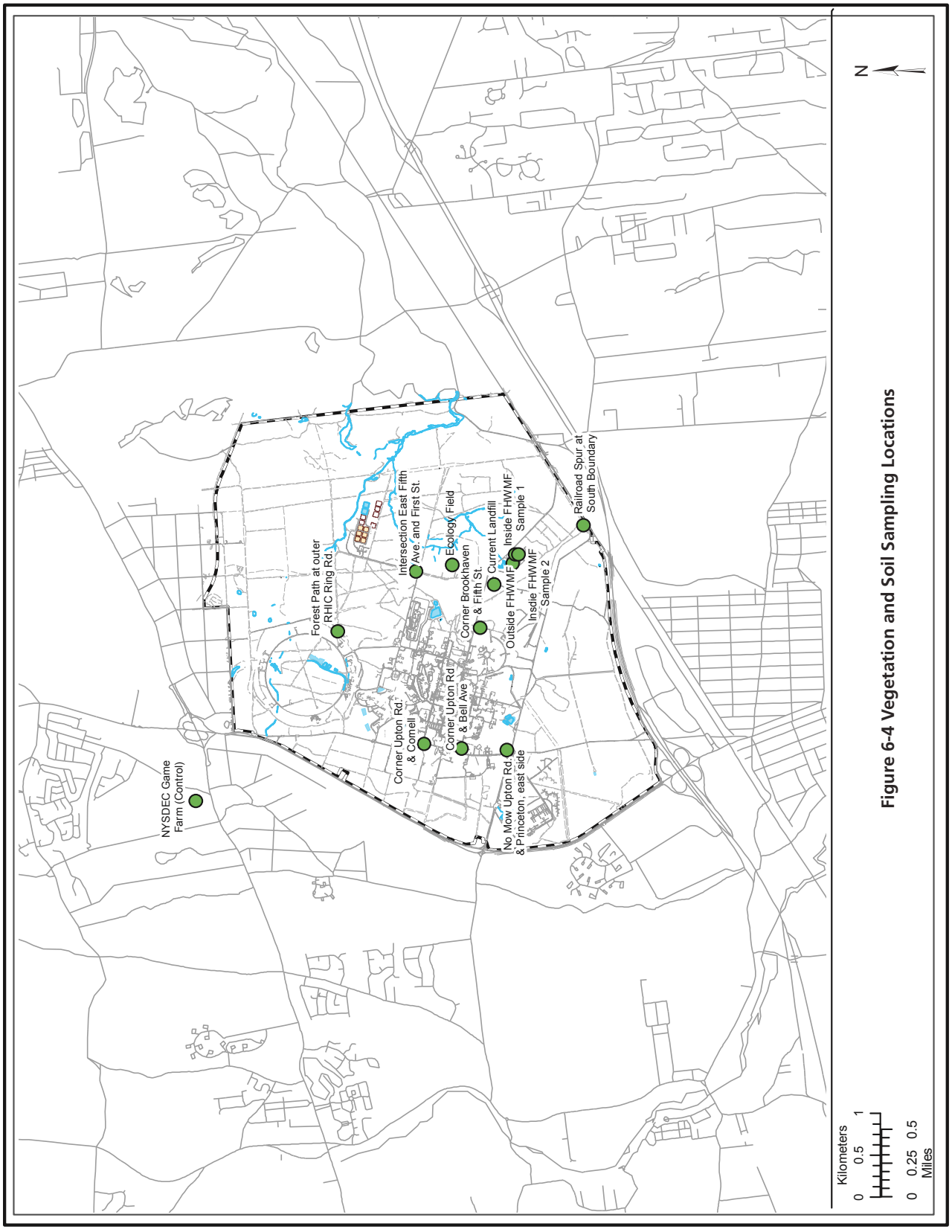


Figure 6-4 Vegetation and Soil Sampling Locations

Table 6-5. Metals analysis of Basin Sediments (2017).

												SCDHS	SCDHS	BNL Site
Basin	**HW**	**CSF**	**HZ**	**HO**	**HT-E**	**HT-W**	**HS**	**HN- NS-1**	**HN-S**	**HN- M**	**HN - N**	**Action Level**	**Clean-up Obj.**	**Background**
Metals	---------- mg/kg ----------													
Aluminum	2,300	2,800	3,100	770	1,900	760	2,000	2500	5,200	3,400	1,800	NS	NS	1,940-16,491
Antimony	0.24	0.29*	0.24	< MDL	< MDL	< MDL	1.8	< MDL	0.35	0.33	< MDL	NS	NS	ND-13.1
Arsenic	1	1.6	1.7	1.1	1.3	< MDL	1	0.68	1.9	1.1	0.58	30	6	0.64-1.9
Barium	5.8	15	16	13	87	5.3	6.1	9.4	22	14	6.7	4,000	820	4.3-37
Beryllium	0.08	0.11	0.13	< MDL	0.75	< MDL	0.06	0.08	0.17	0.11	0.06	240	47	ND-0.5
Cadmium	0.14	0.33	0.18	0.06	0.14	0.03	0.03	0.09	0.45	0.18	0.07	40	7.5	ND-1.5
Calcium	310	3,200	3,200	340	4,200	410	140	310	1,200	500	220	NS	NS	63-580
Chromium	5.2	5.5	6.4	2.3	24	2.6	2.8	5.1	9.9	7	4.5	100	20	3.6-14.2
Cobalt	0.88	3.3	1.9	1.1	14	0.6	0.88	1.2	3.2	1.9	0.85	NS	NS	1.1-4.1
Copper	5.7	24	68	8.1	150	37	4.8	25	84	55	23	8,500	1700	1.8-32
Iron	3,300	8,800	5,300	3,100	9,900	2,000	2,600	3,300	8,100	5,500	2,800	NS	NS	2,690-14,429
Lead	11	75	36	3.1	150	3.4	13	3	38	20	7.9	2000	450	1.4-32
Magnesium	300	1,600	2,200	260	2,200	310	220	540	1,300	860	380	NS	NS	470-2,122
Manganese	29	130	81	180	110	18	16	30	86	37	20	10,000**	10,000**	24-122
Mercury	0.02	0.01	0.02	< MDL	0.24	< MDL	< MDL	< MDL	0.02	0.02	< MDL	3.7	0.7	0.02-0.19
Nickel	3.3	12	6.8	6	5.6	3.2	2.6	4.2	10	6.5	3.3	650	130	4.65-11.4
Potassium	91	270	160	75	110	65	95	150	220	160	91	NS	NS	146-628
Selenium	< MDL	0.45	0.38	< MDL	2.6	< MDL	< MDL	< MDL	0.56	0.31	< MDL	6,800**	6,800**	ND-0.65
Silver	< MDL	< MDL	< MDL	< MDL	0.62	< MDL	< MDL	< MDL	0.14	0.09	< MDL	50	10	ND-2
Sodium	13	74	76	28	320	19	< MDL	18	65	34	12	NS	NS	ND-196
Thallium	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS	NS	ND-0.35
Vanadium	6.7	29	12	4.5	9.7	2.2	4.1	5.8	16	10	4.4	NS	NS	ND-26
Zinc	36	82	110	30	380	32	23	63	210	92	40	10,000**	10,000**	4.9-43

Notes:
* = estimated value based on analytical laboratory qualifiers
** = No SCDHS action level listed for this metal. Value used is NYSDEC recommended soil cleanup objective (6 NYCRR Part 375 - Industrial).
MDL = Method Detection Limit
SCDHS = Suffok County Department of Health Services
NS = value not specified

tion for coyotes (*Canis latrans*) migrating to Long Island. Once established, coyotes are expected to alter ecosystems due to competition with other carnivores.

- Work associated with the LISF involved tracking 24 eastern box turtles outfitted with transmitters to determine home range sizes. Many of the turtles were captured in or near the LISF to determine if they utilize habitats found in the facility. Since 2011, student interns have followed a total of 42 turtles; as a result, BNL is building a very good understanding of their habits. Turtles are also permanently marked to facilitate identification of individual turtles as part of a mark recapture effort. Radiotelemetry work included comparison of GPS data logging devices attached for one-week intervals to radiotelemetry surveys. Turtle research also looked at micro- and macro-habitat use.
- A graduate student from Hofstra University working with eastern box turtles to determine food partition and use within Pine Barrens habitats continued to look at food sources, and stable isotope distribution based on blood samples. Early work identified most sources of stable isotopes but a large source was not isolated based on typical food sources. An obvious source of nitrogen (identified using stable isotopes) is likely carrion. Summer 2017 investigations focused on this source and results are expected to be published in 2018.
- A second graduate student, from the State University of New York (SUNY) at Stony Brook, working with box turtles continued camera trapping and mark-recapture studies of box turtles to determine potential impact to box turtles based on expected impacts to meso-predators when coyotes become established on Long Island.
- Interns conducted pollinator surveys of no-mow areas established in 2016 to determine use by various species of bumble bees. Pollinator surveys were also conducted within the north array of the LISF to determine use. The north array had 26 different pollinator species using a variety of native and non-native flowers within the array. No-mow areas were highly variable regarding use by the few bumble bee species identified.
- BNL utilizes prescribed fire as part of its forest management. To accurately develop burn plans, data on vegetation and fuel loads is necessary. Interns continued work to collect and analyze fuel loads within current and planned burn units. Three growing season fires were conducted in 2017 and fire effects monitoring on vegetation are planned for 2018.
- BNL has significant data resources related to breeding bird surveys. Survey data was reviewed and compared by interns participating in the spring SULI program to determine if there was variation in species diversity and richness between wetland areas and upland areas. Wetland areas were determined to have statistically distinct diversity and richness compared to upland areas.

BNL continued working on establishing a Memorandum of Understanding (MOU) with SUNY School of Environmental Science and Forestry (ESF) located in Syracuse, NY. ESF conducts significant research in the natural sciences including wildlife and forestry. The concept of the MOU would encourage ESF to utilize the BNL site for Pine Barrens-related research. By the end of 2017, an MOU between BNL and ESF had been signed and meetings were scheduled to discuss the first round of research to be funded by ESF from funds received from the U.S. Department of Agriculture Forest Service. The initial research planning was to bring in the NYSDEC, U.S. Forest Service, Central Pine Barrens Commission, and BNL. The first meeting was scheduled for January 2018.

In 2017, BNL continued to participate in several events in support of ecological education programs including: providing on-site ecology tours; hosting the Long Island Natural History Conference; participation in the Eighth Annual Pine Barrens Discovery Day held at the Wertheim National Wildlife Refuge; and assisting the Central Pine Barrens Commission on "A Day in the Life of the Rivers," which allowed students from multiple school districts to acquire environmental and biological data about

Table 6-6 Precipitation Monitoring (Mercury)

Location/Period	Mercury ng/L
P4	
1/11/17	5.16
4/7/17	11
7/17/17	45.1
10/10/17	10.1
S5	
1/11/17	2.07
4/7/17	6.72
7/17/17	12.2
10/10/17	7.11

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.

ten different rivers on Long Island. On separate days, over 30 partner organizations and agencies, over 40 schools, and over 2,700 students collected scientific information for analysis to be used to portray the status of the rivers and estuary systems. These events provided students hands-on experience with field techniques in catching fish, invertebrate sampling, biodiversity inventory, and water chemistry.

In 2017, BNL entered its 13th year of the Open Space Stewardship Program (OSSP) and worked with 30 schools and over 3,000 students. The OSSP enables students to engage in activities to solve problems within their local community through scientific discovery, conservation, and stewardship. The effort integrates outdoor research with school curricula in language arts, civics, community service, and media arts. Participation in OSSP creates an opportunity for many students to enhance their educational experiences as well as to promote the realization that a career in science and technology is accessible with the proper academic coursework and interaction with teachers and field experts who have a passion for discovery and mentorship.

The Laboratory also hosts the annual New York Wildfire & Incident Management Academy, offered by NYSDEC and the Central Pine Barrens Commission. Using the Incident Command System of wildfire management, this academy trains firefighters in the methods of wildland fire suppression, prescribed fire, and fire analysis. BNL has developed and is implementing a Wildland Fire Management Plan that includes the use of prescribed fire for fuel and forest management, and worked with NYSDEC to conduct three growing season fires in northern and eastern sections of the BNL property. These first three successful fires provided significant experience and training for fire crews working in Pine Barrens habitat, improving capabilities of these crews to conduct and manage fire within the Long Island Central Pine Barrens.

6.6 CULTURAL RESOURCE ACTIVITIES

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with numerous cultural resource regulations. The Cultural Resource Management Plan for Brookhaven National Laboratory (BNL 2013) guides the management for all of the Laboratory's historical resources. 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. Achieving these goals will ensure that the contributions BNL and the site have made to our history and culture are documented and available for interpretation.

The Laboratory has four structures or sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor complex, the High Flux Beam Reactor complex, the 1960s-era efficiency apartments, and the WWI training trenches associated with Camp Upton. The trenches are examples of the few surviving WWI earthworks in the United States. Two buildings, Berkner Hall

and Chemistry, are architecturally significant. Other buildings have been identified as being important as examples of periods within the history of the BNL site, such as the Brookhaven Center (built during 1930s Civilian Conservation Corp era) and Building 120 (a former WWII era barracks building).

In 2017, BNL celebrated this landmark anniversary year with two events. The first was the 100th anniversary of the United States entering WWI and the construction of Camp Upton in 1917, and the second was the 70th anniversary of the establishment of BNL in 1947. These combined anniversaries were celebrated as "70 YEARS OF DISCOVERY – A CENTURY OF SERVICE." Cultural resource efforts were focused on the celebration throughout the year.

One of the first efforts regarding the 100th anniversary of the United States entering WWI was to work with the Suffolk County Historical Society and loan them several items from the Camp Upton Historical Collection for a display titled "Over Here and Over There," to give visitors a deeper understanding of America's wartime experience. The initial intent was for the display to be completed by the end of December; due to its success, the display was extended into 2018.

The second effort associated with both the 70th and 100th anniversaries was to focus the first Summer Sundays program on the history of Camp Upton and BNL. Several artifacts, such as uniforms, were placed in display cases at Berkner Hall and a dedicated display of WWI memorabilia from a local family was maintained in Building 400. Along with Camp Upton memorabilia displays, information about BNL's scientific history was presented by BNL employees who volunteered to share BNL's rich history with visitors.

Various other activities associated with the 70th and 100th anniversaries occurred throughout the year. Talks on the history of the BNL site and Camp Upton were provided to Summer Sundays groups, BNL audiences, and local libraries and historical societies. The Lab held a Lab-wide celebration of the 70th and 100th Anniversaries at Berkner Hall and a Lab-wide 70th Anniversary photo was taken with all interested employees as part of the photo. The final activity was a Veteran's Day ceremony held at the flag pole outside of Building 30 sponsored by the Brookhaven Veterans Association and attended by representatives of the Armed Forces, veterans, Dough Boy reenactors, and General Terpeluk, the last commanding general of the 77th Division. (The 77th Regional Readiness Command retired its colors in a 2008 ceremony held at BNL.) The ceremony included dedication of a 100th Anniversary plaque honoring all who served at Camp Upton.

The last cultural resource related item consisted of an article in the local newspaper, Newsday, under the series "Our Towns." The article, published on December 13, 2017, covered the combined celebrations and featured information on both Camp Upton and BNL.

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