Natural and Cultural Resources 6

The Brookhaven National Laboratory 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 on maintaining compliance with applicable regulations. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with staff and the public on ecological issues. BNL focuses on protecting 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 this program. In 2012, deer and fish sampling results were consistent with previous years. Vegetables grown in the BNL garden plot continue to support historical analyses that there are no Laboratory-generated radionuclides in produce.

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL and DOE 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 to on-site personnel and the public for research and interpretation.

6.1 NATURAL RESOURCE MANAGEMENT PROGRAM

The purpose of the Natural Resource Management Program at BNL is to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource management and protection with BNL's scientific mission. To meet this purpose, the Laboratory uses a Natural Resource Management Plan (NRMP) to describe the program strategy, elements, and planned activities for managing the various resources found on site. The NRMP was first developed through wide participation with local agencies providing professional input as participants of a Technical Advisory Group. The first iteration of the NRMP was approved in 2003, with recommendations for review and update every 5 years. The current NRMP (BNL 2011) is the result of changes made based on experience and knowledge gained through the implementation of the earlier version and incorporates the principles of adaptive management.

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 2012, a catastrophic forest fire was started on the northern part of BNL property, burning approximately 300 acres on site and an additional 700 acres off site. Within 2 days of the fire, Laboratory personnel began recording the extent of the fire using GPS, established photo points, and began tracking both damage and post-fire recovery. Maps of the fire and photo locations were entered into the GIS for future reference. No radiological areas were involved in the fire. Air monitoring Station P-9 was involved in the fire, and monitoring data from that station, both on the day of the fire and one week later, indicated no impacts.

Work associated with tracking impacts from the construction of the Long Island Solar Farm (LISF) located on site (also referred to as the solar farm) continue to be entered into the GIS as a tool to assist analysis of changes to wildlife populations and 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. The only New York State endangered species confirmed as currently inhabiting Laboratory property is the eastern tiger salamander (*Ambystoma t. tigrinum*). Additionally, the New York State endangered Persius duskywing butterfly (*Erynnis p. persius*) and the crested fringed orchid (*Plantathera cristata*) have been identified on site in the past.

Three additional endangered plants were added to the BNL list in 2012, including the Engelman spikerush (*Eleocharis engelmannii*), dwarf huckleberry (*Gaylussacia bigeloviana*), and whorled loosestrife (*Lysimachia quadrifolia*). Six New York State threatened species have been positively identified on site and three other species are considered likely to be present. Fish species, including the banded sunfish (*Enneacanthus obesus*) and swamp darter (*Etheostoma fusiforme*), and plants, including the stiff goldenrod (*Solidago rigida*) and stargrass (*Aletris farinose*), have been previously reported in 2000. The northern harrier (*Circus cyaneus*) was seen hunting over open fields in November 2003 and along the Peconic River in October 2010. In 2005, the Pine Barrens bluet (*Enallagma recurvatum*), a damselfly, was confirmed at one of the many coastal plain ponds located on site. Two other threatened 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 identified as possibly being at BNL, based on historic documentation and the presence of 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 (see Table 6-1).

6.1.2 Habitat Protection and Enhancement

BNL has precautions in place to protect onsite habitats and natural resources. Activities to eliminate or minimize negative effects on sensitive or critical species are either incorporated into Laboratory procedures or into specific program or project plans. Environmental restoration projects remove pollutant sources that could contaminate habitats; human access to critical habitats is limited; and in some cases, habitats are enhanced to improve survival or increase populations. Even routine activities such as road maintenance are not performed until they have been duly evaluated and determined to be unlikely to affect habitat.

6.1.2.1 Salamander Protection Efforts

To safeguard eastern tiger salamander breeding areas, a map of the locations is reviewed when new projects are proposed. Distribution of the map is limited to protect the salamander from exploitation by collectors and the pet trade. The map is routinely updated as new information concerning the salamanders is generated through research and monitoring. The most recent update extends the buffer area around tiger salamander habitat from 800 feet to 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. During these times, construction and maintenance activities near their habitats are postponed or closely monitored. BNL environmental protection staff must review any project planned near eastern tiger salamander habitats, and every effort is made to minimize impacts.

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 26 on-site ponds that are used by eastern tiger salamanders. Egg mass surveys confirmed the presence of salamanders in 3 of 26 ponds in 2012. Dry conditions on Long Island resulted in most ponds remaining dry throughout the year. Whenever possible, ponds with documented egg masses from the spring surveys are revisited in June and July to check for the presence of larval salamanders. When new information is obtained, it is entered into the GIS and used to visualize distributions, track reproductive success, and identify areas for focused management or study.

Protection of the eastern tiger salamander was a key component of the Environmental Assessment (EA) conducted for the LISF project. The unique shape of the project, in part, came about due to the need to provide sufficient, viable habitat for the tiger salamander within the area to be developed. In 2010, the LISF completed habitat enhancement to improve one of BNL's tiger salamander ponds; the enhancements to the pond are intended to allow it to retain water for longer periods of time to support larval development. The enhanced pond is currently being managed to remove invasive plants that moved into the pond from surrounding areas. Several areas of the solar farm have maintained standing water since construction, and these areas have been monitored for use by amphibians.

6.1.2.2 Other Species

A number of other species are found at the Laboratory, including 25 species of reptiles and amphibians that have been observed and recorded over the past several years. These species include: the northern red-back salamander

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

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	Confirmed
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
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
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

(continued on next page)

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

Common Name	Scientific Name	State Status	BNL Status
Plants (cont'd.)			
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
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 orchis*	*Platanthera lacera*	V	Confirmed
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
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes:
* Table information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data. No federally listed threatened or endangered species are known to occur at BNL.

E = endangered
T = threatened
SC = species of special concern
R = rare
V = exploitably vulnerable
SGCN = species of greatest conservation need

(*Plethodon c. cinereus*), marbled salamander (*Ambystoma opacum*), four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), wood frog (*Lithobates sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Lithobates catesbiana*), green frog (*Lithobates clamitans*), pickerel frog (*Lithobates palustris*), Fowler's toad (*Bufo woodhousei fowleri*), eastern spadefoot toad (*Scaphiopus holbrooki*), snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys p. picta*), musk turtle (*Sternotherus odoratus*), spotted turtle (*Clemmys guttata*), eastern box turtle (*Terrapene c. carolina*), northern black racer (*Coluber constrictor*), eastern ribbon snake (*Thamnophis s. sauritus*), eastern garter snake (*Thamnophis s. sirtalis*), northern water snake (*Nerodia s. sipedon*), northern ring-necked snake (*Diadophis puctatus edwardsi*), brown snake (*Storeria d. dekayi*), northern red-bellied snake (*Storeria occiptiomaculata*), and the eastern wormsnake (*Carphophis amoenus*). This list indicates that BNL has one of the most diverse herpetofaunal assemblages on Long Island.

Banded sunfish protection efforts include observing whether adequate flow in the Peconic River is maintained within areas currently identified as sunfish habitat, ensuring that existing vegetation in their habitat is not disturbed, and evaluating all activities taking place on the river for potential impacts on these habitats. Population estimates are periodically conducted within various waters on site to determine the current health of the banded sunfish. The last estimate was conducted in 2011, with a population of approximately 6,400 fish.

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 (a new route was established in 2010 in the vicinity of the LISF).

In 2012, monthly surveys were conducted starting at the end of May and extending through the end of August. Two routes associated with the solar farm were monitored biweekly from mid-May through mid-September. These surveys identified 69 songbird species, comparable to the 62 species surveyed in 2011 and 71 species during 2010. A total of 129 bird species have been identified in surveys in the past 13 years; 45 of these species were present each year. Variations in the number and species identified reflect the time of sampling, variations in weather patterns between years, and actual changes in the environment. The two most diverse transects pass near on-site wetlands by the former Biology Fields (now 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.

Data are stored in an electronic database. In 2012, BNL began working with a statistician to analyze 12 years of collected data to determine trends and link data to habitat. This effort will likely result in one or more papers being developed for publication in peer-reviewed journals.

No known data on the effects of a utility-scale solar array are known within scientific literature. To assess the effects of the on-site solar farm on local bird populations, the collection of migratory bird data in both the Biology Field transect and the solar farm transect is important. The LISF is predicted to improve habitat for some migratory birds over time, as understory vegetation begins to grow below the arrays and deer are kept out of the area. One species, indigo bunting (*Passerina cyanea*), was absent along the Biology Field transect in 2011, but was heard along the solar farm transect in 2012. This temporary absence is thought to be due to disturbance from construction activities at the solar farm.

The eastern bluebird (*Sialia sialis*) has been identified as one of the declining species of migratory birds in North America. This decline is due to loss of habitat and to 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 56 nest boxes around open grassland areas on site to enhance their population. Many of these boxes were removed from service in 2010 in preparation for the construction of the LISF. After completion, the LISF created nearly 200 acres of suitable habitat for the eastern blue bird; therefore, 40 additional boxes were installed around the northern most portions of the solar farm in 2012, with an additional 40 planned for installation or replacement of older boxes in 2013.

Migratory birds occasionally cause safety and health concerns. Birds that typically are of concern include Canada geese (*Branta canadensis*) and several species of migratory birds that occasionally nest on buildings or in construction areas. Over the past several years, the resident Canada goose population began increasing with the potential to reach large numbers that could result in health and safety issues at BNL. In 2007, under a permit from the U.S. Fish & Wildlife Service (FWS), the Laboratory began managing the resident goose population. In 2012, 20 nests were treated, but a number of nests were missed and approximately 12 goslings were produced. The overall population has declined to around 100 individuals, mostly through off-site hunting in the fall.

In April 2012, a Cooper's hawk (*Accipiter cooperii*) flew through an open roll-up door at the construction site of the National Synchrotron Light Source II (NSLS-II) and was trapped. Environmental Protection (EP) staff, working with a falconer and other resources, attempted to either encourage the bird to fly out of the building or to trap the bird for release. Because Cooper's hawks are forest canopy fliers, the rafters of the NSLS-II were similar to native habitat, allowing the bird to fly throughout the facility, but never coming low enough to identify an escape route. After several weeks, the hawk became tired and dehydrated, eventually landing on the floor where it was captured. It was transported to a local veterinary hospital, but did not survive. In August, researchers working around the on-site meteorological tower noticed a bird of prey on the ground and called EP staff for assistance. The bird, an immature Osprey (*Pandion haliaetus*), had an injured wing. It was captured and transported to a local veterinary hospital; its injuries were too great and it could not be saved.

To further educate BNL facility managers and other environmental and safety personnel about migratory birds, a module on the Migratory Bird Treaty Act and other bird regulations was prepared. This additional training is anticipated to result in continued timely notification of bird issues for early resolution.

6.1.3 Population Management

The Laboratory also monitors and 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*). The on-site population was estimated at 60 to 80 birds in 1999 and had grown to approximately 500 birds in 2004. Since 2004, the population appears to have stabilized at approximately 300 birds. The population across Suffolk County, Long Island, was determined to be of sufficient size to support hunting in 2009. The annual hunt (5 days) results in over 100 birds taken annually in Suffolk County, with little or no evidence of effects on the BNL turkey population. Turkey hunting on Long Island has been so successful that NYSDEC began holding a spring youth hunt in 2012.

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 currently not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately 1 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 property, under normal 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 population surveys of the white-tailed deer since 2000. In 2004, based on results of aerial infrared surveys, BNL adjusted the methods for estimating its deer population. The method utilizes GIS data layers for vegetation to adjust deer counts based on habitat. The deer population increased to an estimated 800 deer by December 2008. In 2009, the deer population increased to an estimated 893 animals in the spring and began declining in the fall. By December 2009, the population estimate was 731. This decrease is, in part, supported by the increased number of car–deer accidents reported on site during October and November of that year.

To gain additional information on deer populations, an aerial deer survey was conducted in March 2010 with a count of 226 deer, which when corrected for expected errors, resulted in a population estimate of 310 animals. This survey is very similar to the aerial surveys conducted in February and March 2004. The much lower numbers estimated are due largely to continued poor health and winter mortality. Deer surveys were not conducted in the fall of 2010 due to the start of construction of the LISF, which impeded access to the three survey routes used on site. Based on births of fawns during summer 2011, the deer population was roughly estimated to be between 450 and 500 animals (55–61 deer per square mile). This increase in population was evidenced by more car/deer accidents and one bicyclist/deer accident. Routine surveys resumed in 2012 with a winter/spring estimate of over 500 animals and a fall 2012 estimate of greater than 600 animals.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, collision injuries to both human and animal), species diversity (songbird species reduction due to selective grazing and destruction of habitat by deer), and property values (collision damage to autos and browsing damage to ornamental plantings). In 2012, there were fewer deer-related collisions on site as compared to 2011, but more than the one accident in 2010.

High deer populations are a regional problem, and the Laboratory is just one area on Long Island with such an issue. By 2012, several governmental entities on eastern Long Island began working to manage deer populations.

In 2008, the BNL Policy Council approved moving forward with deer management planning with the first step being the engagement of Laboratory employees and guests in discussions concerning the need and methods for deer management. This planning process has been ongoing since 2008, with several delays due to higher-priority projects needing National Environmental Policy Act (NEPA) coverage.

In 2012, an EA under NEPA was completed and sent to NY State for comment. The Final EA is expected to be completed in early 2013.

6.1.4 Compliance Assurance and Potential Impact Assessment

The NEPA review process at BNL is a key to ensuring that environmental impacts of a proposed action or activity are adequately evaluated and addressed. The Laboratory will continue to use NEPA (or NEPA-like) processes under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Environmental Restoration Program when identifying potential environmental impacts associated with site activities, especially with physical alterations. As appropriate, stakeholders such as EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), BNL's Community Advisory Council, and the BNL 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. As discussed previously, in 2012, BNL started an EA for the proposed management of white-tailed deer on the BNL site. A summary of NEPA reviews is provided in Chapter 3.

6.2 UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, then-Secretary of Energy Bill Richardson and Susan MacMahon, the Acting Regional Director of Region 5 FWS, dedicated 530 acres of Laboratory property as an ecological research reserve. The property was designated by DOE as the Upton Ecological and Research Reserve (Upton Reserve) and was managed by FWS until 2005 under an Interagency Agreement (DOE–FWS 2000). The Upton Reserve, on the eastern boundary of BNL, 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).

A transition from FWS management of the Upton Reserve to management by BNL and the Foundation for Ecological Research in the Northeast (FERN) occurred in 2005. During that year, FERN initiated its first pine barrens–wide monitoring program to assess the health of the various forest types within the Pine Barrens, followed by a continuation of the effort in 2006. FERN established 91 permanent plots over the 2-year period of the monitoring program. One significant finding from that study is the lack of forest regeneration. In virtually every forest type, there is a lack of survival of trees from seedlings through to saplings. This is likely a result of either deer over-abundance or lack of sunlight penetrating to the understory. The Laboratory was able to utilize three of the forest health plots as controls for the establishment of deer exclosures (areas fenced off to prevent entry by deer) to further study the effects of deer on forest ecosystems. A fourth exclosure was established in 2012 in the area burned by the April 2012 wild fire. Much of FERN's activities have transitioned to providing seed money to initiate research within the pine barrens and other Long Island ecosystems.

Research supported by FERN in 2012 included continued investigation into the microbial world of soils located within the pine barrens and experimental areas on site. Microbial research carried out by a scientist from Dowling College, New York, has identified several new species of fungus and bacteria, resulting in publications. Funding was also provided by FERN for bat and horseshoe crab larvae research. Information on these projects and others is provided in Section 6.5.

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, CERCLA required monitoring results associated with post-cleanup monitoring of the Peconic River are now addressed in the Site Environmental Report. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was used in some BNL landscaping projects in the past, traces have now been found in deer and in 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 list data for both Cs-137 and potassium-40 (K-40), a naturally occurring radioisotope of potassium. Because K-40 is naturally in the environment, it is commonly found in flora and fauna. In general, K-40 values do not receive significant discussion in the scientific literature because it occurs naturally. Studies indicate that Cs-137 out-competes K and K-40 when potassium salts are limited in the environment, which is typical on Long Island. 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 typically are large, with males weighing, on average, about 150 pounds; females typically weigh 1/3 less, approximately 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The available meat on local deer ranges from 20 to 40 pounds per deer. This fact has implications for calculating the potential radiation dose to consumers of deer meat containing Cs-137, because smaller deer do not provide sufficient amounts of venison to support the necessary calculations.

In 2012, as in recent years, an on- and off-site deer-sampling program was conducted. While most off-site samples are the result of car/deer accidents near the Laboratory, in most years, samples from deer taken by hunters beyond BNL boundaries or samples from car/deer accidents greater than 1 mile from BNL are used. Based on more than a decade of sampling, deer taken from more than 1 mile from BNL represent background. In all, four deer were obtained on site and five deer were from off-site locations within 1 mile of the Laboratory. No deer samples were obtained from areas greater than 1 mile in 2012. The results of deer sampling are presented in Table 6-2.

BNL sampling technicians collect the samples and process them for analysis. Samples of meat (flesh), liver, and bone are taken from each deer, when possible. The meat and liver are analyzed for Cs-137 and the bone is analyzed for strontium-90 (Sr-90). Meat and liver data are reported on a wet-weight basis, and bone data are reported as dry weight.

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 1 mile off site (BNL 2000), most likely because they graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. Cs-137 in soil can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals.

Removal of contaminated soil areas on site has occurred under the Laboratory's cleanup program. All major areas of contaminated soil were remediated by September 2005. In addition, all buildings at the former Hazardous Waste Management Facility (HWMF) were removed in 2003, and the cleanup of the remainder of the facility was completed by fall 2005. Subsequent to the completion of cleanup at the former HWMF, additional minor contamination outside that facility was found and characterized, and the majority of that contamination was removed in 2009. Further characterization of the area surrounding the former HWMF was performed in late 2009, with a portion of the work completed in 2010 to allow use of the area for the LISF. Further characterization of perimeter soils is expected in 2013.

The number of deer obtained for sampling steadily increased between 1996 and 2004. However, the numbers of deer obtained from 2005 to 2012 were significantly lower. In 1998, a statistical analysis based on existing data suggested that 40 deer from off site and 25 deer from on site are needed to achieve a statistically sound data set. Since that analysis was completed, BNL has attempted to obtain the required number of deer. The number obtained each year has varied due to the sampling method, which depends on vehicle and deer accidents and people reporting dead deer. The number of deer hit

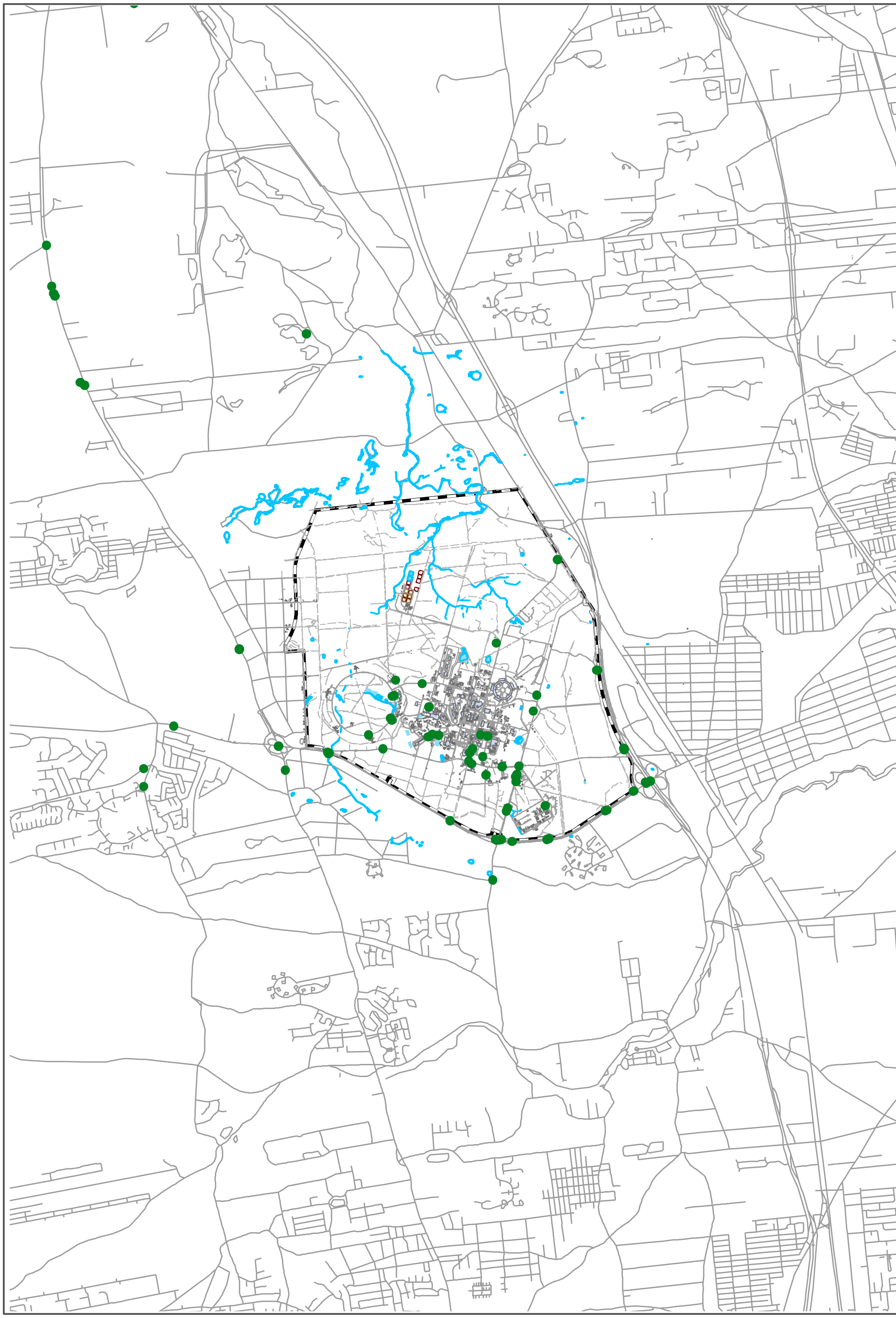


Figure 6-1. Deer Sample Locations, 2008—2012.

Table 6-2. Radiological Analyses of Deer Tissue (2012).

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)
BNL, On Site					
Bldg. 931	03/15/12	flesh	3.10±0.32	0.14±0.02	
		liver	1.97±0.26	0.03±0.01	
		bone			ND
Bldg. 50	03/16/12	flesh	3.68±0.36	0.02±0.01	
		bone			3.99±0.63
Bldg. 931	04/12/12	flesh	2.90±0.31	0.03±0.01	
		liver	2.89±0.30	0.03±0.01	
		bone*			1.42±0.38
East Princeton	09/27/12	flesh	3.54±0.33	0.27±0.02	
		liver	2.29±0.27	0.09±0.01	
		bone			ND
Offsite < 1 mile					
William Floyd Parkway at North Gate	01/26/12	flesh	3.23±0.33	0.76±0.07	
		bone*			1.75±0.44
William Floyd Parkway at Long Island Expressway	02/03/12	flesh	3.14±0.34	0.35±0.03	
		bone*			1.36±0.46
William Floyd Parkway	02/13/12	flesh	3.05±0.29	0.07±0.01	
		liver	2.34±0.33	0.03±0.01	
		bone			ND
William Floyd Parkway, 1/2 mile south of BNL Main Gate	04/21/12	flesh	3.07±0.31	0.02±0.01	
		bone			ND
William Floyd Parkway, 1/2 mile south of BNL Main Gate	11/06/12	flesh	3.27±0.29	1.52±0.12	
		liver	2.60±0.24	0.41±0.03	
		bone			2.57±0.70
Averages by Tissue					
Flesh Averages					
All Samples (9)			3.22±0.96	0.35±0.15	
BNL Average (4)			3.31±0.66	0.12±0.03	
< 1 Mile Average (5)			3.15±0.70	0.54±0.15	
BNL + < 1 Mile Average (9)			3.22±0.96	0.35±0.15	
Liver Averages					
All Samples (5)			2.42±0.63	0.12±0.04	
BNL Average (3)			2.38±0.48	0.05±0.02	
< 1 Mile Average (2)			2.47±0.41	0.22±0.04	
BNL + < 1 Mile Average (5)			2.42±0.63	0.12±0.04	
Bone Averages					
All Samples (9)					1.60±2.13
BNL Average (4)					1.63±1.39
< 1 Mile Average (5)					1.57±1.61
BNL + < 1 Mile Average (9)					1.60±2.13

(continued on next page)

Table 6-2. Radiological Analyses of Deer Tissue (2012) *(concluded).*

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)

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. Confidence limits are 2 sigma (95%) propogated error.
* = estimated value for Sr-90

Cs-137 = cesium-137
K-40 = potassium-40
ND = Non-detected
Sr-90 = strontium-90

by vehicles varies widely from year to year, depending on the population of deer present near major roadways and the traffic density. Figure 6-1 shows the location of all deer samples taken within a 5-mile radius of the Laboratory since 2008. Most of the off-site samples are concentrated along the William Floyd Parkway on the west boundary of BNL, whereas the concentration on site is near the front gate area and the constructed portions of the Laboratory. This distribution is most likely due to the fact that people on their way to work see and report dead deer. 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 front gate is greatest.

In 2012, Cs-137 concentrations in deer meat (flesh) samples were obtained from four deer on site with a range of values from 0.02 pCi/g, wet weight, to 0.27 pCi/g, wet weight, and an arithmetic average of 0.12 pCi/g, wet weight. 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 2012 (0.27pCi/g, wet weight) was 10 times lower than the highest on-site sample reported in 2011 (3.08 pCi/g wet weight) and 43 times lower than the highest level ever reported (11.74 pCi/g, wet weight, in 1996).

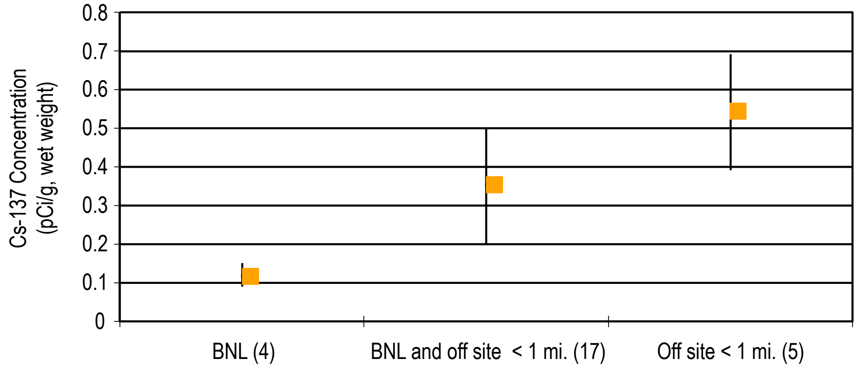
Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within 1 mile of BNL (five samples) and samples taken farther away (no samples in 2012), as shown in Table 6-2. Concentrations in meat samples taken within 1 mile ranged from 0.02 to 1.52 pCi/g, wet weight, with an arithmetic average of 0.54 pCi/g, wet weight. Because deer on site may routinely travel up to 1 mile off site, the arithmetic average for deer taken on site and within 1 mile of the Laboratory is also calculated; for 2012, this was 0.35 pCi/g, wet weight.

Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2012 from three different location groupings. Although not shown on the figure, 89 percent of all meat samples taken both on and off site are below 1 pCi/g, wet weight.

Figure 6-3 presents the 10-year trend of on-site and near off-site Cs-137 averages in deer meat. While similar in number to the samples taken in 2007, samples from 2012 indicate a similar range of error. The average is approximately 40 percent lower than the 2007 average, and is the lowest average seen since trending began in 2000. Although these sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, the trend is slightly upward from 2003 to 2012, and likely reflects the seasonality of sample acquisition. In 2003, a seasonal pattern in Cs-137 concentrations in deer meat was noticed. This seasonality was present in data from earlier years and occurred again in 2012. Deer sampled from October to December typically have higher Cs-137 values than samples obtained in the spring and summer.

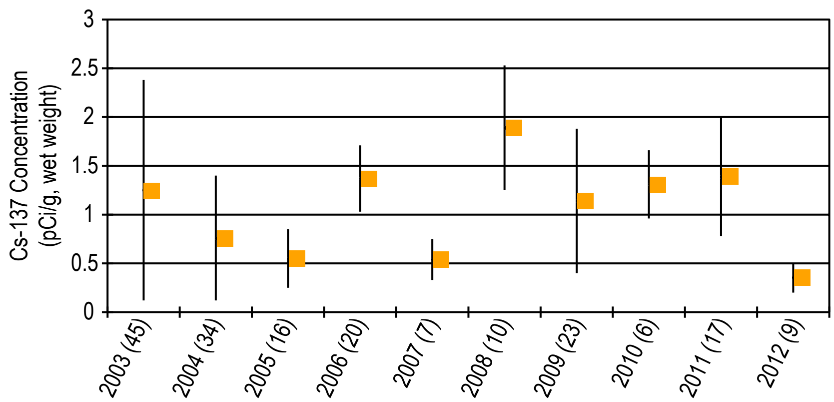
During the summer of 2004, a student in the Community College Intern Program reviewed all data from 2000–2003, analyzed the data statistically, and determined that there was a statistical seasonal variation in values for deer both on site as well as far off site (Florendo 2004). This seasonality is likely due to diet and the biological processing of Cs-137.

From January through May, deer have a



Notes: Averages are shown for samples collected at BNL, on site and off site within 1 mile, and off site but within 1 mile of BNL.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = Cesium-137

Figure 6-2. Comparison of Cs-137 Average Concentrations in Deer Meat, 2012.



Notes: Averages are shown for samples collected at BNL, and within 1 mile.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = cesium-137

Figure 6-3. Ten-Year Trend of Cs-137 Concentrations in Deer Meat.

limited food supply—mostly dry vegetation from the previous year's growth (with a fixed concentration of Cs-137 because plants are dormant). In the summer and fall (July through mid-December), deer eat more and the vegetation is constantly growing and taking up nutrients and contaminants from the soil. In summer and fall, deer feeding on vegetation growing in soil containing Cs-137 are more likely to obtain a continuous supply, which is incorporated into their tissues. This increased concentration of Cs-137 in tissues is evidenced by the highest value seen in deer in 2012 (1.52 pCi/g, wet weight) from a sample taken in November 2012. By late-January to February, the Cs-137 in tissues is eliminated through biological processes. The levels of Cs-137 in deer tissue during June through early August are not well known, as there are few vehicle/deer accidents at this time of year.

When possible, liver samples are taken concurrently with meat samples. 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 2012, Cs-137 concentration ranged from 0.03 to 0.09 pCi/g, wet weight, with an average of 0.05 pCi/g, wet weight. The off-site Cs-137 concentration in liver ranged from 0.03 to 0.41 pCi/g, wet weight, with an arithmetic average for all off-site liver samples of 0.22 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 risk associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999).

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 3 millirad per day, which is only 3 percent of the threshold evaluated by IAEA. The deer observed and sampled on site appear to have no health effects from the level of Cs-137 found in their tissues.

6.3.1.2 Strontium-90 in Deer Bone

BNL began testing deer bones for Sr-90 content in 2000. In 2012, Sr-90 content ranged from non-detectable to 3.99pCi/g, dry weight, in samples taken on site. Sr-90 in off-site samples taken within 1 mile of BNL ranged from non-detectable to 2.57 pCi/g, dry weight. There is significant overlap across all values, which suggests that Sr-90 is present in the environment at background levels, probably as a result of worldwide fallout from nuclear weapons testing. Sr-90 is present at very low levels in the environment, is readily incorporated into bone tissue, and may concentrate over time. With 13 years of Sr-90 data providing a sound baseline indicating on- and off-site values having overlapping distributions, the Laboratory has made a decision to discontinue to test for Sr-90 in white-tailed deer bone, starting in 2013.

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 and Sr-90 content in bone, when possible. In 2012, two turkeys were found dead from various traumas. A sample of the breast meat was sent for radiological analysis, and Cs-137 content was detected at 0.03 pCi/g, wet weight in one, and 0.20 pCi/g, wet weight in the other. A single goose was found hit by a car, and breast meat was sent for analysis resulting in a non-detection for Cs-137. All three animals also had a piece of bone sent for Sr-90 analysis, with all results being non-detected.

6.3.3 Fish Sampling

In collaboration with the NYSDEC Fisheries Division, BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Large areas of open water on site resulting from the cleanup of the Peconic River have resulted in sufficient habitat to support larger fish. During sampling activities, numerous schools of fry of bass and sunfish have been noticed. While low-dissolved oxygen levels continue to be a problem for fish, the deeper pools provide areas of cooler, more highly oxygenated water for long-term survival. Fish were sampled early in 2012 to take advantage of periods when dissolved oxygen levels are higher, supporting the presence of fish.

All samples were analyzed for edible (fillet) content of each of the analytes reported. Samples collected on site were from Area D of the Peconic River near the site boundary. Various species of fish were also collected off site from Swan Pond, Donahue's Pond, Forge Pond, and Lower Lake on the Carmans River (see Figure 5-7 for sampling stations). Swan Pond is a semi-control location on the Peconic River system (a tributary of the Peconic not connected to the BNL branch), and Lower Lake on the Carmans River is the non-Peconic control site. Sampling is carried out under a permit from NYSDEC by BNL's sampling team. Sampling is also separated into samples taken as part of BNL's routine surveillance monitoring program and those taken as part of the post cleanup monitoring for the Peconic River cleanup project (primarily for mercury analysis). As a result of a 5-year review process completed in 2011, monitoring between the two programs, with the exception of Lower Lake on the Carmans River, is alternated with surveillance monitoring occurring in even-numbered years and post-cleanup monitoring occurring in odd-numbered years. Therefore, data presented for 2012 is based on routine surveillance monitoring of the Peconic River. Data for 2013 will consist of post-cleanup monitoring of fish from four Peconic River locations, as well as surveillance monitoring of fish from Lower Lake on the Carmans River. Post-cleanup monitoring will likely consist of fewer samples than in the past.

6.3.3.1 Radiological Analysis of Fish

The species collected for radiological analysis in 2012 included brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*). Gamma spectroscopy analysis was performed on all samples. When fish were not of sufficient mass to conduct all non-radiological and radiological analyses, samples of the same species were composited to gain sufficient volume for radiological analysis. Table 6-3 presents specific information on the sampling location, species collected, and analytical results. All sample results are presented as wet weight concentrations, and information on the naturally occurring radioisotope K-40 is included as a comparison.

Cs-137 was measured at levels ranging from non-detected to 0.30 pCi/g, wet weight, from the Peconic River system, and all samples from the Carmans River were non-detectable levels. Detectable levels in fish ranged from 0.06 pCi/g, wet weight, in two brown bullhead taken from Donahue's Pond to 0.30 pCi/g, wet weight, in a brown bullhead taken from Area D. This is compared to the highest recent value of 0.78 pCi/g, wet weight, in a composite sample of bluegill (*Lepomis macrochirus*) taken from Forge Pond in 2011.

To account for the different feeding habits and weights of various species, it is important to compare species with similar feeding habits (i.e., bottom feeders such as brown bullhead should be compared to other bottom feeders). This comparison within different feeding guilds extends to other potential contaminants and is not limited to comparisons for radionuclides. Cs-137 concentrations in brown bullhead collected at all locations along the Peconic River had values less than 0.30 pCi/g, wet weight. Largemouth bass, the top predator from the Peconic River, showed Cs-137 levels of 0.28 pCi/g, wet weight, or less. Levels of Cs-137 in all fish species appear to be declining, compared to historic values.

Though it is clear from discharge records and sediment sampling that past BNL operations have contributed to anthropogenic (human-caused) radionuclide levels in the Peconic River system, most of these radionuclides were released between the late 1950s and early 1970s. Concentrations continue to decline over time through natural decay. Cs-137 has a half-life of 30 years. No Cs-137 was released from the BNL Sewage Treatment Plant (STP) to the Peconic River between 2003 and 2012. Additionally, the cleanup of both on- and off-site portions of the Peconic River in 2004 and 2005 removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Removal of this contamination is expected to result in continued decreases in Cs-137 levels in fish.

6.3.3.2 Fish Population Assessment

BNL suspended fish sampling on site in 2001 because prior fish sampling had depleted the population and limited the remaining fish to smaller sizes. Sampling resumed in 2007 when multiple schools of small fish were observed throughout the on-site portions of the river. The relative sizes of fish caught during annual

Table 6-3. Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	K-40	Cs-137
	pCi/g	
BNL, On Site		
Area D		
Largemouth Bass	2.65±1.14	0.28±0.10
Largemouth Bass	3.14±0.73	0.23±0.05
Brown Bullhead	3.56±0.67	0.19±0.05
Brown Bullhead	3.37±0.85	0.30±0.07
Brown Bullhead	3.50±0.80	0.18±0.06
Brown Bullhead	3.81±0.67	0.18±0.07
Black Crappie (composite)	2.90±1.18	0.22±0.07
Donahue's Pond		
Largemouth Bass	3.33±0.84	0.12±0.05
Largemouth Bass	3.57±0.84	0.12±0.04
Brown Bullhead	3.15±0.62	0.09±0.04
Brown Bullhead	3.15±0.78	0.09±0.04
Brown Bullhead	2.72±0.66	0.06±0.04
Brown Bullhead	3.53±0.69	0.06±0.04
Brown Bullhead	2.21±1.33	ND
Black Crappie	2.29±1.51	0.21±0.10
Black Crappie	2.96±1.00	ND
Black Crappie	3.38±1.18	ND
Forge Pond		
Largemouth Bass	3.81±1.00	ND
Largemouth Bass	2.75±1.45	ND
Largemouth Bass	2.34±1.29	ND
Largemouth Bass	4.31±0.96	ND
Largemouth Bass	2.13±1.34	ND
Largemouth Bass	2.96±1.12	ND
Brown Bullhead	3.32±0.96	ND
Yellow Perch	2.79±0.84	0.13±0.06
Yellow Perch	3.15±0.94	ND
Yellow Perch	4.20±1.26	ND
Yellow Perch	3.49±1.01	0.12±0.08
Black Crappie	2.55±1.12	ND
Black Crappie	2.52±1.09	ND
Black Crappie	4.32±1.02	ND

(continued)

Table 6-3. Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake *(concluded)*.

Location/Species	K-40	Cs-137
	pCi/g	
Swan Pond		
Largemouth Bass	4.80±1.08	ND
Largemouth Bass	1.61±1.27	ND
Largemouth Bass	3.21±1.34	ND
Largemouth Bass	3.95±1.38	ND
Largemouth Bass	ND	ND
Chain Pickerel	3.54±1.65	ND
Chain Pickerel	3.18±1.34	ND
Yellow Perch	4.66±1.08	ND
Lower Lake, Carmans River		
Largemouth Bass	2.82±0.59	ND
Largemouth Bass	3.23±0.77	ND
Largemouth Bass	3.30±0.54	ND
Largemouth Bass	2.90±0.58	ND
Largemouth Bass	2.46±0.58	ND
Largemouth Bass	4.14±0.86	ND
Brown Bullhead	3.56±0.56	ND
Brown Bullhead	4.32±0.85	ND

Notes:
All samples analyzed as edible portions (fillets).
Cs-137 = cesium-137
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137
K-40 = potassium-40
ND = not detected, based on analytical laboratory qualifiers

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 2012 indicated that populations are maintaining themselves and can continue to support annual sampling in 2013.

6.3.3.3 Non-Radiological Analysis of Fish

Beginning in 2005, all fish of sufficient size have been analyzed as edible portions (fillets). Smaller fish, such as golden shiners are no longer taken for analysis. In 2007, fish sampling was moved to the spring months, when possible,

Table 6-4. Surveillance Monitoring Metals Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	Barium	Copper	Iron	Manganese	Mercury	Silver	Zinc
	mg/kg						
BNL - Area D							
Largemouth Bass	<MDL	0.293	<MDL	0.261	1.08	<MDL	5.15
Largemouth Bass	<MDL	<MDL	<MDL	0.311	1.05	<MDL	5.3
Black Crappie (composite)	0.13	<MDL	<MDL	0.326	0.106	<MDL	4.63
Brown Bullhead	0.21	0.402	8.77	0.363	0.227	<MDL	6.33
Brown Bullhead	0.188	0.356	9.04	0.444	0.265	<MDL	5.69
Brown Bullhead	0.132	0.33	<MDL	0.318	0.126	<MDL	4.49
Brown Bullhead	0.172	0.318	8.92	0.441	0.338	<MDL	4.66
Donahue's Pond							
Largemouth Bass	0.181	<MDL	<MDL	0.53	0.329	<MDL	6.11
Largemouth Bass	<MDL	<MDL	<MDL	0.259	0.934	<MDL	7.11
Black Crappie	2.49	<MDL	<MDL	4.72	0.877	<MDL	9.24
Black Crappie	0.1	<MDL	<MDL	0.295	0.49	<MDL	5.74
Black Crappie	<MDL	<MDL	<MDL	0.221	0.171	<MDL	5.43
Brown Bullhead	0.282	<MDL	13.6	0.228	0.382	<MDL	4.58
Brown Bullhead	0.604	<MDL	<MDL	0.366	0.286	<MDL	5.09
Brown Bullhead	0.351	<MDL	<MDL	0.268	0.534	<MDL	6.9
Brown Bullhead	0.446	<MDL	8.92	0.25	0.379	<MDL	5.56
Brown Bullhead	0.633	<MDL	<MDL	0.271	0.129	<MDL	5.2
Forge Pond							
Largemouth Bass	0.11	<MDL	<MDL	0.281	0.169	<MDL	4.55
Largemouth Bass	<MDL	<MDL	<MDL	<MDL	0.45	0.116	5.84
Largemouth Bass	0.185	0.351	<MDL	0.697	0.152	<MDL	5.79
Largemouth Bass	<MDL	<MDL	<MDL	0.273	0.0866	0.0965	5.4
Largemouth Bass	<MDL	<MDL	<MDL	0.227	0.15	<MDL	5.2
Largemouth Bass	<MDL	0.325	<MDL	0.218	0.132	0.119	6.4
Black Crappie	0.0967	0.363	<MDL	0.186	0.117	<MDL	6.1
Black Crappie	0.102	<MDL	31.5	0.285	0.0917	0.122	6.82
Black Crappie	<MDL	0.284	<MDL	0.184	0.0806	0.107	6.67
Yellow Perch	0.105	0.325	<MDL	0.378	0.137	0.116	6.67
Yellow Perch	0.105	0.321	<MDL	0.266	0.0498	<MDL	6.82
Yellow Perch	0.106	<MDL	<MDL	0.242	0.175	<MDL	5.83
Yellow Perch	<MDL	<MDL	<MDL	0.3	0.137	0.109	7.25
Brown Bullhead	0.261	0.388	7.91	0.239	0.0739	<MDL	6.62
Swan Pond (Peconic River control location)							
Largemouth Bass	<MDL	0.328	<MDL	0.419	0.348	<MDL	4.7
Largemouth Bass	<MDL	<MDL	<MDL	0.661	0.211	<MDL	5.01
Largemouth Bass	<MDL	<MDL	<MDL	0.36	0.26	<MDL	4.19
Largemouth Bass	<MDL	<MDL	<MDL	0.358	0.261	<MDL	4.34

(continued on next page)

Table 6-4. Surveillance Monitoring Metals Analysis of Fish from the Peconic River System and Carmans River, Lower Lake *(concluded).*

Location/Species	Barium	Copper	Iron	Manganese	Mercury	Silver	Zinc
	mg/kg						
Largemouth Bass	0.128	<MDL	<MDL	0.377	0.396	<MDL	4.9
Chain Pickerel	0.121	<MDL	<MDL	0.978	0.173	<MDL	7.46
Chain Pickerel	0.128	<MDL	<MDL	4.62	0.223	<MDL	8.1
Yellow Perch	0.0957	<MDL	<MDL	0.642	0.13	<MDL	6.14
Lower Lake, Carmans River (control location)							
Largemouth Bass	0.107	0.344	<MDL	0.223	0.661	<MDL	4.85
Largemouth Bass	<MDL	0.282	<MDL	0.234	0.287	<MDL	3.84
Largemouth Bass	<MDL	<MDL	<MDL	0.182	0.136	<MDL	4.75
Largemouth Bass	0.098	<MDL	<MDL	0.277	0.0428	<MDL	5.72
Largemouth Bass	<MDL	0.339	<MDL	0.267	0.111	<MDL	7.45
Largemouth Bass	0.114	7.78	<MDL	1.97	0.0898	<MDL	11.3
Brown Bullhead	0.342	0.305	<MDL	0.324	0.0708	<MDL	4.16
Brown Bullhead	0.318	<MDL	<MDL	0.364	0.0338	<MDL	4.67

Notes:
See Figure 5-7 for sampling locations.
All fish were analyzed as edible portions (fillets).
MDL = Minimum Detection Limit

to lessen the effect of low oxygen levels on fish distributions. All samples for surveillance monitoring of the Peconic River were obtained between April and mid-June.

Table 6-4 shows the 2012 concentrations of metals in fish taken for surveillance monitoring within the Peconic River and Lower Lake on the Carmans River. Due to the fact that values for aluminum, antimony, arsenic, beryllium, cadmium, cobalt, silver, selenium, thallium, and vanadium were near or less than the minimum detection level (MDL) for the analytical procedure, they were not included in Table 6-4. Additionally, metals common to biological process including calcium, magnesium, potassium, and sodium are also not presented in Table 6-4. Chromium and nickel are the only other metals tested but not included in the table, as most values reported for these metals were less than the MDL.

Chromium was detected in a single sample of a black crappie from Donahue's Pond at a concentration of 0.205 mg/kg. Nickel values that were above the MDL and without laboratory qualifiers were as follows: two largemouth bass taken from Lower Lake measured 0.139 and 0.232 mg/kg, respectively, and a brown bullhead from the same location measured 0.165 mg/kg. These reported values and those presented in Table 6-4, excluding mercury, are not considered to pose any health risks to humans or other animals that may consume fish. Fish taken both on and off site are important to the post-cleanup monitoring program; they are analyzed for mercury and the data are presented comparatively in Table 6-5.

Due to its known health effects, mercury is the metal of highest concern. Surveillance monitoring data are provided in Table 6-4 for Area D, Donahue's Pond, Forge Pond, Swan Pond, and Lower Lake on the Carmans River. During 2012, mercury ranged from 0.106 mg/kg in a composite sample of black crappie to 1.08 mg/kg in a largemouth bass at Area D; 0.129mg/kg in a brown bullhead to 0.934 mg/kg in a largemouth bass at Donahue's Pond; from 0.0498 mg/kg in a yellow perch to 0.45 mg/kg in a largemouth bass at Forge Pond; from 0.13 mg/kg in a yellow perch to 0.396 mg/kg in a largemouth bass at Swan Pond; and from 0.0338 mg/

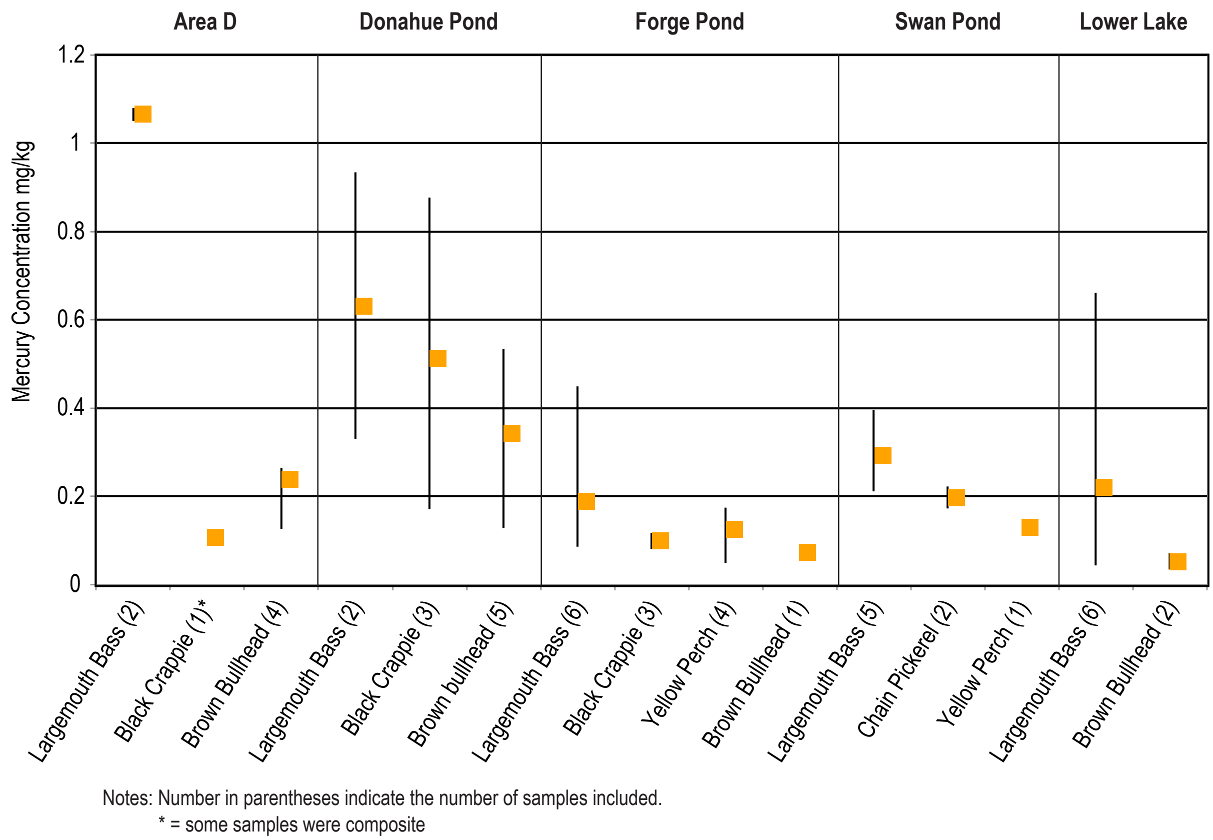


Figure 6-4. Peconic River and Lower Lake, Carmans River Mercury Distribution in Fish Species (Minimum, Maximum, and Average Values).

kg in a brown bullhead to 0.661 mg/kg in a largemouth bass from Lower Lake on the Carmans River.

Monitoring data for mercury analysis in fish is presented in Table 6-5 and is shown as a range of results by species and area sampled to reduce the size of the table. The data are presented graphically in Figure 6-4. Data are typically compared to the EPA mercury water criterion of 0.3 mg/kg. Samples taken for mercury analysis in the main channel of the Peconic River historically sampled as part of the post clean-up monitoring came from Area D on site and Donahue's Pond off site. A total of 17 samples were taken from the two locations with an average of 0.45 mg/kg. When the entire main stem samples from the Peconic River are combined (inclusion of Forge Pond samples), the average is 0.31 mg/kg. As a comparison to the main portion of the river, mercury values for Swan Pond (eight samples) average 0.25 mg/kg and Lower Lake on the Carmans River (eight samples) average 0.18 mg/kg.

In comparing data from location to location along the Peconic River from year to year, a wide range of values are seen between locations and both within and between species. The presented data are from larger fish, which allow for the analysis of all metals of interest, as well as radiological analysis for Cs-137 and K-40. Data are also presented graphically in Figure 6-4 and in a similar manner as in the past to facilitate comparison from year to year.

Pesticide analyses in fish was discontinued in 2008, since several years of sampling detected pesticides in only a few fish far off site. PCB analyses in fish was also discontinued from surveillance monitoring, but continued to be completed for fish collected on site. All fish taken from Area D on site in 2012 were analyzed for polychlorinated biphenyls (PCBs) and all values received were less than the method detection limit. The cleanup of the Peconic River that was completed in 2005 and

Table 6-5. Mercury Analysis of Fish from the Peconic River System and Lower Lake, Carmans River.

Location/Species (number)	Mercury mg/kg Min	Max	Avg
BNL, On Site			
Area D			
Largemouth Bass (2)	1.05	1.08	1.07
Black Crappie (1)*	0.11	0.11	0.11
Brown Bullhead (4)	0.13	0.34	0.24
Donahue's Pond			
Largemouth Bass (2)	0.33	0.93	0.63
Black Crappie (3)	0.17	0.88	0.51
Brown Bullhead (5)	0.13	0.53	0.34
Forge Pond			
Largemouth Bass (6)	0.09	0.45	0.19
Black Crappie (3)	0.08	0.12	0.10
Yellow Perch (4)	0.05	0.18	0.12
Brown Bullhead (1)	0.07	0.07	0.07
Swan Pond			
Largemouth Bass (5)	0.21	0.40	0.30
Chain Pickerel (2)	0.17	0.22	0.20
Yellow Perch (1)	0.13	0.13	0.13
Lower Lake			
Largemouth Bass (6)	0.04	0.66	0.22
Brown Bullhead (2)	0.03	0.07	0.05
River Averages (all fish)			
Peconic River			
Main River (31)	0.05	1.08	0.31
Swan Pond (8)	0.13	0.40	0.25
Carmans River			
Lower Lake, Carmans River (8)	0.03	0.66	0.18

Notes:
All samples were analyzed as edible portions (fillets), including composite samples.
Area letter designation refers to Peconic River cleanup areas on site.
* = one or more samples in the average were composite samples

Table 6-6. Radiological Analyses of Aquatic Vegetation and Sediment from the Peconic River and Carmans River system, Lower Lake.

Location/Sample Type	K-40 (pCi/g)	Cs-137 (pCi/g)
BNL, On Site		
Aquatic vegetation	3.2 ± 0.36	ND
Aquatic vegetation	3.57 ± 0.41	ND
Aquatic vegetation	2.67 ± 0.33	ND
Aquatic vegetation	3.94 ± 0.58	ND
Sediment - ST1-80-U20	NP	0.42 ± 0.12
Sediment - PR-WC-06-D1-L50	3.4 ± 1.3	5.48 ± 0.69
Area D, Off Site		
Sediment - PR-SS-15-U1-L65-O	5.7 ± 1.2	0.72 ± 0.13
Donahue's Pond		
Aquatic vegetation	2.02 ± 0.25	0.04 ± 0.01
Sediment	2.94 ± 0.63	0.11 ± 0.04
Forge Pond		
Aquatic vegetation	2.99 ± 0.4	ND
Sediment	2.31 ± 0.31	0.06 ± 0.02
Swan Pond (Peconic River control location)		
Aquatic vegetation	2.32 ± 0.26	0.02 ± 0.01
Sediment	1.84 ± 0.85	0.83 ± 0.12
Lower Lake, Carmans River (control location)		
Aquatic vegetation	2.82 ± 0.64	ND
Sediment	3.71 ± 0.89	0.42 ± 0.09

Notes:
Aquatic vegetation values are reported as wet weight.
Sediment values are reported as dry weight.
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected based on analytical laboratory qualifiers
NP = not provided by analytical laboratory

the supplemental cleanup completed in 2011 removed most PCBs within the sediments. Although BNL has discontinued most pesticide and PCB monitoring, the Laboratory may periodically test for PCBs and pesticides in fish to verify the presence/absence in fish tissue.

6.3.4 Aquatic Sampling

6.3.4.1 Radiological Analysis

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was conducted in 2012. (See Chapter 5 for a discussion on water quality and monitoring, and Figure 5-7 for the locations of sampling stations. Additionally, refer to Section 6.3.5 for a discussion of sediment and water analysis related to monitoring post-cleanup of the Peconic River.) Because annual analysis of sediment and water samples are being taken under the post-cleanup monitoring, fewer samples are being taken under the surveillance monitoring program to reduce duplication of effort.

Table 6-6 summarizes the radiological data. Cs-137 was not detected in any on-site aquatic vegetation samples in 2012 and was detected at levels near the detection limit at off-site locations. As in the past, low levels of Cs-137 were detected in sediments at Donahue's Pond, Swan Pond, Forge Pond, and Lower Lake on the Carmans River.

6.3.4.2 Metals in Aquatic Samples

Metals analyses, as shown in Table 6-7, were conducted on aquatic vegetation and sediments from the Peconic River and Lower Lake on the Carmans River. The data indicate metals at background levels. The standard used for comparison of sediments is the SCDHS soil cleanup objectives for heavy metals. Vegetation results are compared to soil cleanup standards, because metals in vegetation may accumulate via uptake from sediment. In general, metals are seen in vegetation at levels lower than in associated sediment.

Other metals analyzed for, but not listed in Table 6-7, include antimony, arsenic, beryllium, cadmium, magnesium, potassium, selenium, sodium, and thallium. In general, levels of these metals are either below detection limits, below action levels, or like sodium, are common in the environment. Cadmium was found in sediments at Lower Lake with a concentration of 0.98mg/kg and was consistent with past values. Chromium was found in sediment at Lower Lake with a concentration of 50 mg/kg, which is below action levels.

6.3.5 Peconic River Post-Cleanup Monitoring

Approximately 20 acres of sediment from the Peconic River were remediated in 2004 and 2005 to remove mercury and associated contaminants from the river. To ensure that the cleanup provided adequate protection of human health and the environment, monitoring of the sediment, surface water, and fish was performed for 5 years (2006–2010). The mercury concentrations from the monitoring 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 cleaned between November 2010 and February 2011 (see Section 6.3.5.4). The 2012 sediment and surface water results follow.

During the 5-year review process in 2011, all data and accomplishments related to the Peconic River cleanup and subsequent monitoring were summarized and reviewed. BNL recommended to the various regulatory agencies that reduced monitoring should take place beginning in 2012, and all future reporting of post-cleanup monitoring results would be documented in the annual BNL Site Environmental Report; this is the first year that data for the post-cleanup monitoring is provided in the SER as the primary method of reporting.

6.3.5.1 Sediment Sampling

Sediment was sampled in May 2012 at three Peconic River locations associated with the supplemental cleanup areas (See Tables 6-6 and 6-7). During the 5-year review, a recommendation was made and approved by the regulators to reduce sampling from 33 sampling locations to only the locations associated with the three supplemental cleanup areas.

Radiological analysis of sediments at the three locations (Table 6-6) indicate that low levels of Cs-137 are present, ranging from 0.42 pCi/g to 5.48 pCi/g. Analysis of sediment for mercury (Table 6-7) resulted in values ranging from 0.25 mg/kg to 3.6 mg/kg. As noted in past reports, the cleanup of mercury in the Peconic River has been considered successful, and roughly 88 percent of all Cs-137 was co-located with mercury. The single sample from location PR-WC-06-D1-L50 is a good example of this co-locality, as values for both mercury and Cs-137 are higher than other values. While the value for mercury is above the 2.0 mg/kg goal for the

Table 6-7. Metals Analysis of Aquatic Vegetation and Sediment from the Peconic River System and Lower Lake, Carmans River.

Location/ Sample Type	Aluminum	Barium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Vanadium	Zinc
	mg/kg													
BNL, On Site														
Aquatic vegetation	15.3	2.4	825	< MDL	< MDL	1.48	21	< MDL	26.7	0.0564	0.341	< MDL	< MDL	4.36
Aquatic vegetation	7.26	8.07	1210	< MDL	< MDL	1.98	73	< MDL	12.9	< MDL	0.149	< MDL	< MDL	5.19
Aquatic vegetation	< MDL	4.31	1620	< MDL	< MDL	1.92	22.6	< MDL	99.4	< MDL	0.287	< MDL	< MDL	6.97
Aquatic vegetation	10.2	5.32	2990	< MDL	< MDL	1.91	52.6	< MDL	64.1	< MDL	0.158	< MDL	< MDL	6.75
Sediment - ST1-80-U20	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.38	NT	NT	NT	NT
Sediment - PR-WC-06-D1-L50	NT	NT	NT	NT	NT	NT	NT	NT	NT	3.6	NT	NT	NT	NT
Area D, Off Site														
Sediment - PR-SS-15-U1-L65-O	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.25	NT	NT	NT	NT
Donahue's Pond														
Aquatic vegetation	< MDL	4.26	422	< MDL	< MDL	< MDL	33.1	< MDL	15	< MDL	< MDL	< MDL	< MDL	1.54
Sediment	1830	23.5	1220	7.39	3.44	5.59	2900	14.6	30.3	0.114	2.95	0.604	28.6	34.1
Forge Pond														
Aquatic vegetation	< MDL	16.8	880	< MDL	< MDL	1.05	45	< MDL	96.6	< MDL	< MDL	< MDL	< MDL	5.07
Sediment	442	5.23	55.7	0.73	< MDL	0.474	320	3.25	9.1	< MDL	0.283	< MDL	0.861	2.12
Swan Pond (Peconic River control location)														
Aquatic vegetation	< MDL	14.2	1960	< MDL	< MDL	< MDL	22.5	107	100	< MDL	< MDL	< MDL	< MDL	4.57
Sediment	6660	99.1	8540	16.7	2.88	21.7	7070	< MDL	2190	0.187	10.8	< MDL	29.5	92.5
Lower Lake, Carmans River (control location)														
Aquatic vegetation	6.66	47.7	2930	< MDL	0.168	< MDL	70	0.151	214	< MDL	< MDL	< MDL	< MDL	6.41
Sediment	5200	123	3760	50	5.73	11.9	12100	67.8	749	< MDL	7.42	0.823	27.8	102
SCDHS														
Action Levels	SNS	4000	N/A	100	N/A	8500	N/A	2000	N/A	3.7	650	50	N/A	N/A
Cleanup Objectives	SNS	820	N/A	20	N/A	1700	N/A	450	N/A	0.7	130	10	N/A	N/A

Notes:
MDL = Method Detection Limit
N/A = not applicable
SCDHS = Suffolk County Department of Health Services
SNS = Standard Not Specified

cleanup, it is below SCDHS action levels and does not significantly alter the overall average of mercury in sediments from numerous post cleanup samples.

6.3.5.2 Water Column Sampling

Surface water was analyzed in June and July 2012 for total mercury and methyl mercury at 6 of the 15 Peconic River sampling stations (Table 6-8). Water column sampling locations are shown in Figure 6.5. A sample of the treated STP was also collected during each round of sampling. Nine stations could not be sampled in June and July due to either being dry or having low water levels. The maximum total mercury concentrations in the June (55.9 ng/L) and July (49.1 ng/L) STP effluent samples were typical of what has been seen since efforts at mercury minimization have been implemented. The total mercury concentrations generally trended downwards, with minor fluctuations at increasing distance downstream from the STP until reaching concentrations of 6.5 ng/L (June 2012) and 3.3 ng/L (July 2012) at sampling stations west of the cranberry bogs, about 4.77 miles downstream of the STP outfall.

Methyl mercury is the form of mercury that is bio-available to aquatic organisms. Methyl mercury was detected in STP effluent samples in June at a concentration of 0.03 ng/L and was not detected in a July sample. Between the station downstream of the STP and the BNL boundary, the June methyl mercury concentrations fluctuated between 1.4 ng/L and 0.81 ng/L, and the July concentrations fluctuated between 0.36 ng/L and 3.9 ng/L. The 3.9 ng/L measured at PR-WC-06 was higher than it had measured at the same location in August 2011 (0.88 ng/L); this is a result of higher methylation due to wet/dry cycles in the sediments. The methyl mercury values from downstream of the BNL boundary to the station west of the cranberry bogs (PR-WCS-04) fluctuated between 0.7 ng/L and 0.32 ng/L in June (which is consistent with or lower than 2011 measurements) and between 1.6 ng/L and 0.42 ng/L in July. The 1.6 ng/L measured at PR-WC-03 in July is higher than the 0.67 ng/L measured in August 2011, again likely attributed to methylation resulting from the wet/dry cycling in the sediments. As evidenced by the number of stations too shallow or dry for sampling (9 of 15 stations), 2012 was a fairly dry year. Alternating wet/dry periods often facilitate the methylation of mercury.

6.3.5.3 Fish Sampling

In 2012, fish were not collected under the post cleanup monitoring for the Peconic River. Results of fish taken under the surveillance monitoring program are discussed in Sections 6.3.3. Following the 5-year review, it was recommended that fish sampling be conducted every other year, with the next round of post cleanup fish monitoring to be conducted in 2013 and results reported in the annual BNL Site Environmental Report.

6.3.5.4 Remedial Actions

Three areas (PR-WC-06, Sediment Trap, and PR-SS-15) that were cleaned up between November 2010 and February 2011 were replanted with native Peconic River plants transplanted from previously remediated sections of the river. The restoration has been successful in meeting the requirements of the NYSDEC wetlands equivalency permit, but must be monitored and managed to remove invasive species for up to 3 more years in order to meet federal requirements.

6.3.6 Vegetation Sampling

6.3.6.1 Farm and Garden Vegetables

On-site sampling of garden vegetables was conducted in 2012. The data on garden vegetables are presented in Table 6-9. Samples of corn, string beans, cucumber, green pepper, and eggplant were analyzed for Cs-137 content. Cs-137 was not detected in any vegetables sampled from the on-site garden, but was detected in soils from the garden at a very low level (0.17 pCi/g). This value for Cs-137 in soil is consistent with historic values and background levels resulting from worldwide fallout from historic above-ground nuclear testing. Ten years of monitoring at the BNL garden area has provided a sufficient baseline showing no impact from any historic or recent operations. There are no other sources of radiological contamination

Table 6-8. Post Cleanup Peconic River Water Column Monitoring.

			June 2012			July 2012		
			Mercury	Methyl Mercury	TSS	Mercury	Methyl Mercury	TSS
Location	Station Description	Dist from STP (miles)	ng/L		mg/L	ng/L		mg/L
PR-WC-15	Upstream of Forest Path	-0.17	SW	SW	SW	SW	SW	SW
PR-WC-14	Upstream of Sewage Treatment Plant	-0.13	SW	SW	SW	SW	SW	SW
PR-WC-13	Upstream of Sewage Treatment Plant	-0.07	SW	SW	SW	D	D	D
PR-WC-12-D7	Downstream of Sump	-0.04	11.4	1.2	6	3.4	1.2	2
STP-EFF-UVG	Grab Sample	0	55.9	0.03	1	49.1	ND	ND
PR-WC-11DS	50" downstream of outfall	0.01	SW	SW	SW	SW	SW	SW
PR-WC-10	West of Station HMN	0.3	69.3	1.4	10	37.1	0.36	ND
PR-WC-09	Downstream of Station HMN	0.56	SW	SW	SW	SW	SW	SW
PR-WC-08	South of Area B	0.78	39	0.5	10	33.1	0.88	24
PR-WC-07	South of Area C	0.96	SW	SW	SW	SW	SW	SW
PR-WC-06	South of Area D	1.1	27.4	0.81	18	39.1	3.9	66
PR-WC-05	Downstream of Station HQ	1.46	D	D	D	D	D	D
PR-WC-04	2nd downstream of Station HQ	1.7	SW	SW	SW	SW	SW	SW
PR-WC-03	3rd west of Schultz Rd.	2.1	44.4	0.7	12	45.7	1.6	38
PR-WC-02	2nd west of Schultz Rd.	2.52	SW	SW	SW	SW	SW	SW
PR-WCS-04	West of Cranberry Bogs	4.77	6.5	0.32	4	3.3	0.42	2

Notes:
See Figure 6-5 for Peconic River water sampling locations.
D = dry river
SW = water too shallow to sample
ND = not detected based on lab qualifiers
NT = not tested
NS = not sampled during period

available from operations. The surveillance monitoring of garden vegetables will be discontinued beginning in 2013. Farm vegetables from area farms will be sampled on their routine 5-year cycle in 2013.

6.3.6.2 Grassy Plants

Grassy vegetation sampling around the Laboratory was conducted in 2012. Vegetation was sampled from 10 locations around the Laboratory (see Figure 6-6) in areas where contaminated soils had been removed during the environmental cleanup process. All samples were analyzed for Cs-137 content. Data are presented in Table 6-9. The grassy vegetation samples had levels of Cs-137 ranging from non-detectable to 0.39 pCi/g, wet weight, which is consistent with past sampling efforts. Grassy vegetation sampling is utilized for the annual dose to biota analysis reported in Chapter 8.

6.4 OTHER MONITORING

6.4.1 Soil Sampling

Soil sampling was conducted at the same 10 locations where grassy vegetation was sampled in 2012. Soil samples were analyzed for Cs-137 and the data are presented in Table 6-9.

Cs-137 content in soils ranged from 0.14 pCi/g to 43.9 pCi/g. Most values were consistent with past the soil analysis and indicative of the success of the cleanup operations in the areas. The one high value is from a wetland area

Table 6-9. Radiological Analysis of Garden Vegetables, Grassy Vegetation, and Associated Soils.

Location/Sample	K-40	Cs-137
	pCi/g	
BNL Garden		
Corn	1.89 ± 0.20	ND
String Beans	2.6 ± 0.26	ND
Cucumber	1.76 ± 0.18	ND
Green Pepper	1.67 ± 0.17	ND
Eggplant	2.12 ± 0.24	ND
Soil	6.15 ± 0.67	0.17 ± 0.03
BNL Grassy Vegetation and Soils		
Bldg. 30 Lawn		
Vegetation	4.91 ± 0.67	ND
Soil	4.6 ± 0.78	0.39 ± 0.06
Bldg. 490, South side		
Vegetation	5.19 ± 0.74	ND
Soil	5.71 ± 0.90	0.10 ± 0.05
Bldg. 515, Front Lawn		
Vegetation	6.05 ± 0.71	0.13 ± 0.03
Soil	6.55 ± 1.01	1.51 ± 0.16
Bldg. 725, East Lawn		
Vegetation	7.09 ± 0.83	ND
Soil	5.73 ± 0.99	0.14 ± 0.05
STP, Sand Filter Bed 8		
Vegetation	3.22 ± 0.55	0.35 ± 0.05
Soil	4.69 ± 0.76	0.38 ± 0.08
STP Sand Filter Bed 7		
Vegetation	3.78 ± 0.63	0.05 ± 0.03
Soil	3.81 ± 0.69	0.23 ± 0.05
FHWMF, Wetland		
Vegetation	3.28 ± 0.45	0.06 ± 0.02
Soil	5.93 ± 1.01	0.47 ± 0.08
Vegetation	5.46 ± 0.87	0.39 ± 0.06
Soil	5.18 ± 0.93	43.9 ± 3.63
FHWMF		
Vegetation	3.3 ± 0.61	0.04 ± 0.03
Soil	6.76 ± 1.09	0.80 ± 0.11
Vegetation	4.16 ± 0.52	0.24 ± 0.03
Soil	4.63 ± 0.82	0.51 ± 0.07

Notes:
Soil results are reported as dry weight values.
Vegetation results are reported as wet weight values.
See Figure 6-6 for sample locations.
Cs-137 = cesium-137
FHWMF = Former Hazardous Waste Management Facility
K-40 = Potassium-40

outside the former HWMF fence. However, the value of 43.9 pCi/g is below the cleanup goal of 67 pCi/g established for the FHWMF. This area was not part of the CERCLA cleanup that was completed in 2005.

Since 2005, several investigations of areas of radiologically-contaminated soil surrounding the former HWMF, referred to as the former HWMF Perimeter Area, have been conducted to determine the extent and nature of contamination. These investigations identified radiological contamination along Brookhaven Avenue, within a contiguous area northeast of the former HWMF (approximately 18,750 square feet), as well as several other discrete locations within wooded areas along the perimeter of the former HWMF boundaries. The contamination is believed to be a result of historical operations associated with the transfer and management of wastes to and within the former HWMF and stormwater runoff from contaminated soils within the facility.

To date, the cleanup of identified radiological contamination surrounding the former HWMF has occurred, and was documented in two phases since being discovered in 2005 (Phase I and II). Additional discrete areas of soil contamination within the former HWMF perimeter area that were not addressed in Phase I and II investigations will be included in Phase III efforts. The area containing the 43.9 pCi/g Cs-137 is scheduled for further characterization as part of Phase III.

6.4.2 Basin Sediments

A 5-year testing cycle for basin sediment samples was established in 2003. There are 11 basins associated with outfalls that receive discharges permitted under the State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-5 for outfall locations). Basin sediments were sampled in 2012 and results are presented in Tables 6-10 through 6-12.

Although there have not been any radiological concerns with discharges to these basins, sediments were analyzed for radiological components. Samples taken from Basins CSF, HT-W, and HN-M had detectable levels of Cs-137 ranging from 0.06 pCi/g, dry weight, at Basin

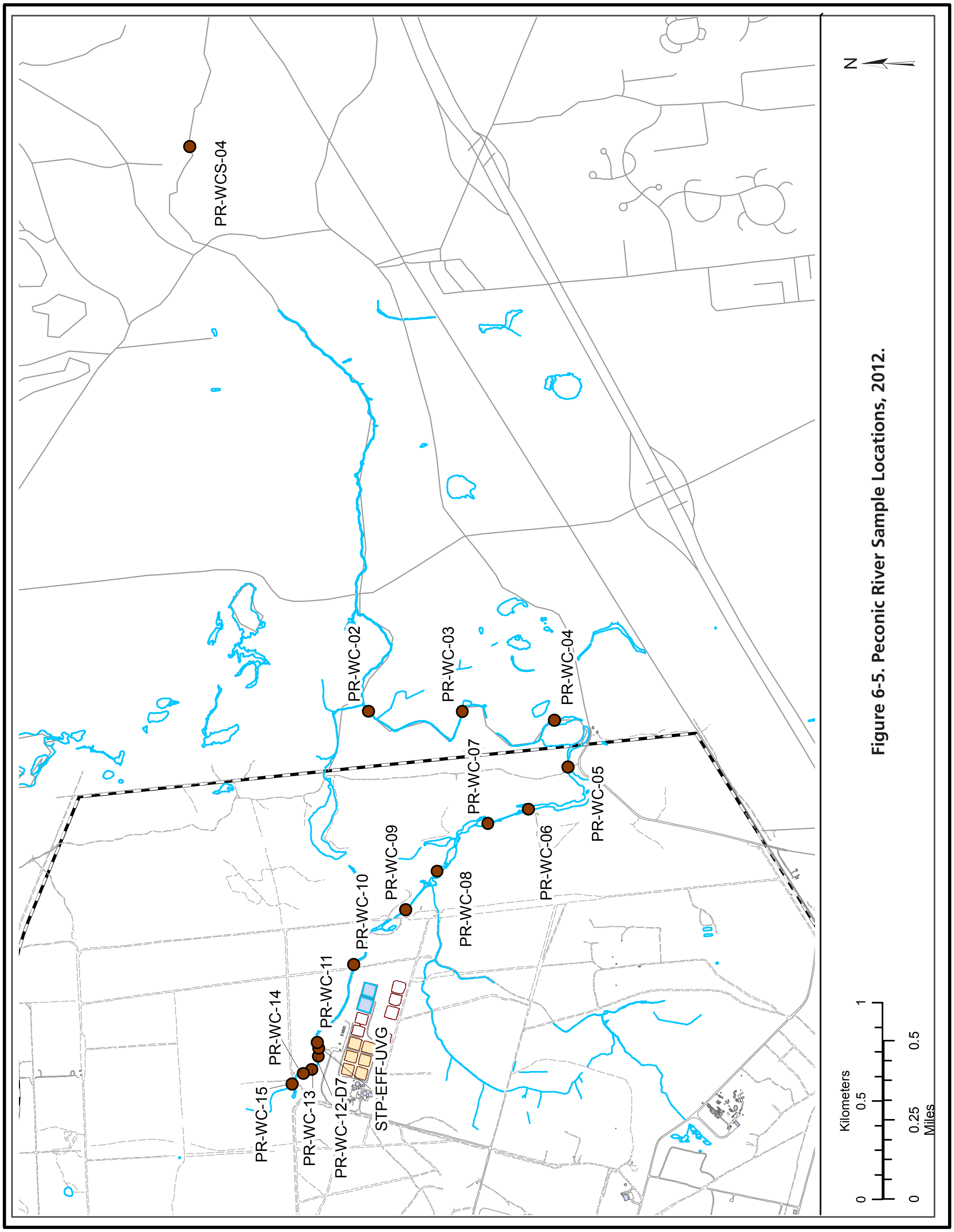


Figure 6-5. Peconic River Sample Locations, 2012.

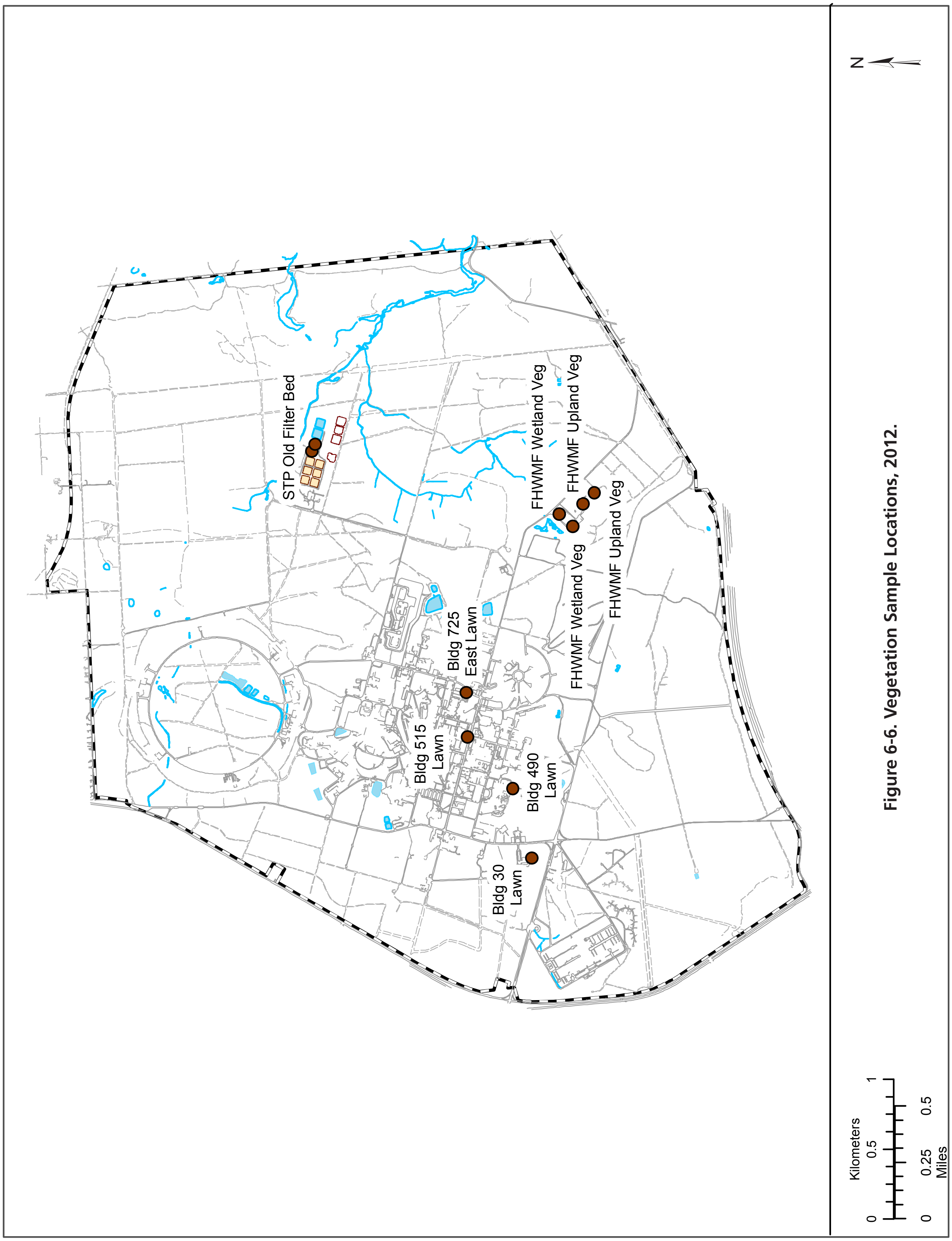


Figure 6-6. Vegetation Sample Locations, 2012.

CSF to 0.17 pCi/g, dry weight, at Basin HT-W. The other eight basins had no detectable levels. The values seen in basin sediments are consistent with historic monitoring and soil/vegetation monitoring discussed above.

Metals analysis of basin sediments is presented in Table 6-10 and data are compared to SCDHS action levels or NYSDEC recommended soil cleanup objectives (6 NYCRR Part 375-Industrial), where appropriate. Review of the data show that all metals results were less than SCDHS action levels or NYSDEC Part 375-Industrial levels, and many of the results are well within the typical background concentrations for natural soils.

Semi-volatile organic compound (SVOC) results are presented in Table 6-11. Most of the SVOC results were less than the method detection limit for several of the contaminants. Results below MDLs are not shown. With the exception of Basin HT-W, the results showed most basins to have low-level detections of SVOCs consisting mostly of polycyclic aromatic hydrocarbons (PAHs), which are petroleum breakdown products and most likely attributable to road runoff and the combustion of fossil fuels. Basin HT-W had several PAHs at higher concentrations, but below SCDHS action levels. Four PAHs were detected at concentrations ranging from two to nine times higher than SCDHS action levels. Work planning to resample and further characterize Basin HT-W was initiated at the end of 2012, with expectations for sampling in early 2013. Results of this sampling and any necessary corrective actions will be presented in the annual BNL Site Environmental Report for 2013.

PCBs analysis are presented in Table 6-12. Low levels of the pesticide DDT and its breakdown products were detected in several basins, as were breakdown products of Endrin. Detections of long-lived organochlorine pesticides, which are chlorinated hydrocarbons used extensively from the 1940s through the 1960s in agriculture and mosquito control, continue to be detected long after their use has stopped. Analysis of basin sediments for PCBs indicated the continued presence of low levels of Aroclor-1254 and 1260 from historic use at BNL, which are within the range of values previously detected in the basins. The next round of routine basin sampling will be completed in 2017.

6.4.3 Chronic Toxicity Tests

Under BNL's SPDES discharge permit, the Laboratory conducted chronic toxicity testing of STP effluents. The results of the chronic toxicity tests are discussed in Chapter 3, Section 3.6.1.1. Testing will continue in 2013.

6.4.4 Radiological and Mercury Monitoring of Precipitation

As part of the BNL Environmental Monitoring program, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (see Figure 4-3 for station locations). Samples were analyzed for radiological content and total mercury (see Table 6-13). A total of four samples were taken from each of these two stations in 2012 and tested for radiological parameters. Gross alpha activity measurements were above the MDL at P4 in the first two and last quarter of 2012, and the first quarter at S5 in 2012.

Gross beta activity was measured in samples the first two and last quarter at P4 and all four quarters at S5 in 2012. In general, radioactivity in precipitation comes from naturally occurring radionuclides in dust and from activation products that result from solar radiation. Location P4 had a maximum gross beta activity level of 6.71 pCi/L. Location S5 had a maximum gross beta activity level of 7.3 pCi/L. Gross beta activity values were within the range of historically observed values at these two locations. Beryllium-7 (Be-7) was not detected at either P4 or S5 in 2012.

Analysis of mercury in precipitation is completed to document the range of mercury deposition that occurs on site. This information is compared to Peconic River monitoring data and aids in understanding the sources of mercury within the Peconic River. Mercury was detected

Table 6-10. Metals analysis of Basin Sediments.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN- M	HN - N	SCDHS Action Level	BNL Site Background
Metals	mg/kg												
Aluminum	2,170	4,050	2,440	1,640	5,640	1,350	5,940	947	1,940	2,640	4,170	NS	1,940-16,491
Antimony	0.29*	0.68	0.26*	0.22*	0.9	0.58*	0.36*	0.16*	0.23*	0.29*	0.15*	NS	ND-13.1
Arsenic	1.0*	2.3	1.3	1.1*	4.6	0.88*	1.5	0.27*	0.74*	0.65*	0.86*	30	0.64-1.9
Barium	11.7	30.5	10.7	25.5	57.8	15.7	19.2	3.8	6.9	10.8	18.1	4,000	4.3-37
Beryllium	0.11*	0.15	*	0.071*	0.31	0.054*	0.15	0.024*	0.049*	0.068*	0.11	240	ND-0.5
Cadmium	0.031*	1.3	0.13	0.1	1.3	0.099	0.086	0.057	0.11	0.19	0.14	40	ND-1.5
Calcium	906	4,320	465	518	5,220	1,530	601	163*	262	286	325	NS	63-580
Chromium	3.1	13.7	4.8	4.1	28.2	5.4	6.8	1.9	4.3	5	5.7	100	3.6-14.2
Cobalt	0.95	4.5	1.3	2.3	10	0.95	1.5	0.37	0.88	1.4	1.3	NS	1.1-4.1
Copper	4.2	47.5	19.3	19	251	101	8.6	7.6	20.1	40	59.6	8,500	1.8-32
Iron	2,930	8,990	4,020	4,600	13,500	3,450	5,640	1,220	3,150	3,880	4,650	NS	2,690-14,429
Lead	3.6	556	18.5	9	89.8	13.2	14.7	3	8.9	13.5	19.2	2000	1.4-32
Magnesium	582	2170	480	496	3210	791	677	209	419	626	575	NS	470-2,122
Manganese	61.3	117	37.8	299	128	29.9	42.2	11.8	24	24.6	26.9	10,000**	24-122
Mercury	0.024*	0.046	0.047	< MDL	0.081	0.022*	0.25*	< MDL	0.017*	0.031*	< MDL	3.7	0.02-0.19
Nickel	2	44.8	3.1	5.4	31.1	3.6	4.2	1.4	2.7	4.4	3.9	650	4.65-11.4
Potassium	152	290	139	132	356	122	238	77.3	112	148	169	NS	146-628
Selenium	0.51*	0.51*	0.38*	< MDL	0.93	< MDL	0.43*	< MDL	0.30*	0.19*	0.31*	6,800**	ND-0.65
Silver	< MDL	0.14*	0.043*	< MDL	0.71	0.13*	0.056*	0.018*	0.044*	0.058*	0.12*	50	ND-2
Sodium	58.6*	107*	44.2*	46.3*	407	61.3*	56.7*	17.0*	19.4*	31.6*	25.9*	NS	ND-196
Thallium	0.19*	0.12*	< MDL	< MDL	0.24B	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS	ND-0.35
Vanadium	5.2	97.2	7.1	7.4	42.7	5.5	11.4	2.4	5.8	8	9.2	NS	ND-26
Zinc	13.1	210	50.9	44.9	612	83.1	42.9	24.3	44.4	67.4	48.4	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
NS = value not specified
NYCRR = New York Codes, Rules, and Regulations
NYSDEC = New York State Department of Environmental Conservation
SCDHS = Suffolk County Department of Health Services

Table 6-11. Analytical Results of Basin Sediment sampling for Semivolatile Organic Compounds.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN-M	HN-N	SCDHS Action Level
Contaminants	ug/kg											
Naphthalene	< MDL	< MDL	< MDL	< MDL	< MDL	2,600	< MDL	< MDL	< MDL	< MDL	< MDL	NS
2-Methylnaphthalene	< MDL	< MDL	< MDL	< MDL	< MDL	1,400	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Acenaphthene	< MDL	< MDL	140*	< MDL	< MDL	5,800	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Dibenzofuran	< MDL	< MDL	73*	< MDL	< MDL	3,400	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Dibenzo(a,h)anthracene	< MDL	76*	180*	< MDL	94*	2,700	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Fluorene	< MDL	< MDL	140*	< MDL	< MDL	4,600	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Pyrene	230*	330*	970	160*	390*	31,000**	120*	< MDL	81*	98*	< MDL	200,000
Phenanthrene	140*	170*	1,100	110*	260*	38,000**	< MDL	< MDL	< MDL	46*	< MDL	200,000
Anthracene	< MDL	48*	240*	< MDL	68*	6,400	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Carbazole	< MDL	< MDL	170*	< MDL	55*	6,800	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Fluoranthene	320*	560	1,800	290*	700	47,000**	140*	< MDL	130*	150*	< MDL	200,000
Butyl benzyl phthalate	160*	< MDL	< MDL	< MDL	83*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Benzo(a)anthracene	170*	340*	920	130*	280*	18,000**	88*	< MDL	60*	68*	< MDL	2,000
Chrysene	150*	370	960	140*	340*	18,000**	98*	< MDL	70*	76*	< MDL	2,000
bis(2-Ethylhexyl)phthalate	71*	150*	83*	77*	430*	140*	< MDL	< MDL	< MDL	64*	< MDL	NS
Benzo(b)fluoranthene	210*	540	1,200	210*	440*	19,000**	170*	34*	100*	130*	< MDL	3,400
Benzo (k)Fluoranthene	85*	200*	440	71*	150*	5,500	60*	< MDL	42*	41*	< MDL	3,400
Benzo (a) pyrene	150*	340*	740	130*	250*	14,000**	100*	< MDL	61*	73*	< MDL	44,000
Indeno (1,2,3-cd) pyrene	150*	300*	510	110*	240*	11,000**	94*	40*	53*	58*	< MDL	16,000
Benzo (ghi) perylene	130*	310*	460	110*	300*	7,000	69*	70*	48*	55*	< MDL	200,000

Notes:
* = estimated value based on analytical laboratory parameters
** = value is based on a dilution of the original sample
MDL = method detection limit
NS = action level not specified
NYCRR = New York Codes, Rules, and Regulations
SCDHS = Suffolk County Department of Health Services

in all eight precipitation samples and at both sampling stations. Mercury ranged from 2.92 ng/L at station S5 in October to 11.6 ng/L at station P4 in July.

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 and to foster interest in science. 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 update the current natural resource inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2012, EPD and FERN hosted 13 interns and 2 faculty members. Two of the interns worked with a faculty member from Dowling College as part of the BNL Visiting Faculty Program (VFP) and a third student worked with a statistician, also from Dowling College.

The VFP Intern team continued ongoing work on soil microbial studies of Pine Barrens soils. The intern working with the statistician worked on a statistical analysis of 12 years' worth of migratory bird data collected as part of the Natural Resource Management program. Undergraduate interns worked on box turtle home range determination and resource use, flying squirrel radiotelemetry surveys and genetics, acoustic surveys of bats, and impact assessments of the LISF. A limited discussion concerning each project is presented below and, where possible, associated papers and posters are available at *www.bnl.gov/esd/wildlife/research.asp.*

Work associated with the LISF involved tracking 26 eastern box turtles outfitted with transmitters to determine home range sizes and use of the solar farm by turtles. Many of the turtles were captured in or near the LISF in order to determine if they utilize habitats found in the facility. None of the turtles outfitted with transmitters stayed within the confines of the solar farm. Several turtles remained in the vicinity, while others moved significant distances. By the end of the summer, many of the transmitters glued to the turtles had fallen off; the

Table 6-12. Results of Analysis of Basin Sediments for Pesticides and PCBs.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN-M	HN-N	6 NYCRR Part 375
Pesticide/PCB	ug/kg											
Chlordane	< MDL	12*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDD	0.31*	0.37*	1.1*	< MDL	2.6*	0.39*	0.35*	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDE	1.6*	1.4*	3	0.75*	< MDL	1.8*	1.5*	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDT	1.4 *	2.0**	1.6*	< MDL	< MDL	< MDL	1.3*	< MDL	< MDL	< MDL	< MDL	NS
Endrin aldehyde	< MDL	2.2**	< MDL	0.65*	< MDL	2.2*	0.65*	< MDL	0.47*	0.60*	< MDL	NS
Endrin ketone	< MDL	< MDL	< MDL	0.51*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Aroclor 1254	< MDL	< MDL	< MDL	< MDL	210	< MDL	23*	12*	6.6*	25*	< MDL	3,200
Aroclor 1260	< MDL	< MDL	13*	16*	62	180	12*	< MDL	6.4*	17*	< MDL	3,200

Notes:
* = estimated value based on laboratory qualifiers
** = value has greater than 40 percent difference between original and confirmation analysis results
GW = Groundwater
MDL = method detection limit
NYCRR = New York Codes, Rules, and Regulations

Table 6-13. Precipitation Monitoring (Radiological and Mercury).

Location/ Period	Be-7	Gross Alpha	Gross Beta	Mercury
	pCi/L			ng/L
P4				
01/12/12	–	–	–	4.04
01/31/12	ND	1.40± 0.69	5.4 ± 1.1	–
04/03/12	–	–	–	8.89
04/30/12	ND	1.03 ± 0.64	2.25 ± 0.82	–
07/11/12	–	–	–	11.6
07/31/12	ND	ND	ND	–
10/10/12	–	–	–	8.14
10/31/12	ND	3.6 ± 1.2	6.7 ± 1.3	–
S5				
01/12/12	–	–	–	7.4
01/31/12	ND	3.3 ± 1.0	7.3 ± 1.3	–
04/03/12	–	–	–	8.65
04/30/12	ND	ND	1.47 ± 0.75	–
07/11/12	–	–	–	9.73
07/31/12	ND	ND	2.04 ±0.77	–
10/10/12	–	–	–	2.92
10/31/12	ND	ND	2.33 ± 0.82	–

Notes:
Method detection limit for mercury is 0.2 ng/L.
– = parameter not tested on date
Bd-7 = Beryllium-7
ND = not dected
P4 = precipitation sampler near BNL Apartment area
S5 = precipitation sampler near BNL Sewage Treatment Plant

transmitters were cleaned and were either re-deployed or put into storage for re-deployment in 2013.

A second function of following turtles outfitted with transmitters was to begin to determine what foods they eat and if it affects home range, and also to determine reproductive success. Turtles will be tracked for up to 6 years to gain long-term data on home range and reproduction.

Interns also conducted surveys in and around the LISF to begin to understand the relationship and impacts of this facility on the local ecosystems. Data was gathered on paired transects for vegetation during the summer and fall growing seasons; paired small mammal trapping grids and moveable cameras were used to look at use of fence penetrations. Paired transects for vegetation allow comparison of vegetation growth and establishment inside and outside of the LISF. Interior transects were established based on vegetative assemblage that existed prior to construction. Paired trapping grids were established to compare small mammal population in the core of the facility to core habitats outside of the facility, and to compare recruitment of small mammals from the forest to the immediate interior of the solar farm (one grid on either side of the LISF fence). Wildlife cameras were placed for 2-week periods on individual openings along the fence line to document wildlife use of the fence. Initial review of photos suggests that all species expected to use the opening are doing so.

To facilitate analysis of data, placement of transects, placement of trapping grids, and placement of cameras, a summer intern conducted a GIS mapping project in which all openings were mapped and a detailed GIS map of the LISF was created.

Work on soil microbes continued in cooperation with a microbiologist from Dowling College and several students interns. Interns worked on isolating novel microbes from pine barrens soils, as well as looking at radio-resistant bacteria isolated from soils in the Gamma Forest on site to determine ecological effects of radiation on the ecosystem. The Gamma Forest was an area that was exposed to a gamma radiation source between 1961 and 1978.

A radio-telemetry study on southern flying squirrels was completed in 2012. This last year of a 3-year study looked at home range and habitat use in diverse habitats across the BNL site. Eleven squirrels were fitted with radio collars and tracked for approximately 12 weeks. In total, 26 were tracked over the 3-year study. Data continues to be reviewed in order to prepare a manuscript for publication. When possible, cheek swabs were taken to continue a genetic study of this cryptic species. Initial results of mitochondrial DNA suggest significant variance in the squirrel's genetics. To get a better understanding of this variation, BNL and others will seek genetic material from museum specimens, as well as new materials from limited trapping events in 2013 and beyond.

In early March 2011, an individual bat was found on the ground outside a building at BNL.

The bat appeared to have discoloration on the fur around its muzzle, which triggered a call to NYSDEC to report a possible incidence of white-nose syndrome. White-nose syndrome is a recently identified fungal infection impacting bats throughout the northeast and Midwest. The bat was identified as northern bat (*Myotis septentrionalis*) and was the first recorded incidence of white-nose syndrome on Long Island. This event resulted in BNL working with NYSDEC to establish permanent acoustical survey routes on Long Island. These survey routes were again monitored in 2012, and the Laboratory worked with a bat specialist to capture and document bats on site and at the Wertheim National Wildlife Refuge using mist-netting. BNL work also allowed comparison of bat use between burned and unburned areas associated with the April 2012 wildfire on site and between the LISF and forested areas to the north of the facility. Results from mist netting suggest that bat populations on Long Island have not been as severely impacted as those in other areas of the northeast. This raises several questions as to why the impacts are less.

Members of EPD and other Laboratory departments volunteered as speakers for schools and civic groups and provided on-site ecology tours. EPD also hosted several environmental events in association with Earth Day. In October, BNL hosted the Seventeenth Annual Pine Barrens Research Forum for ecosystems researchers to share and discuss their results. BNL and FERN participated in the Third Annual Pine Barrens Discovery Day held in association with the Tri-Hamlet Celebration at the Wertheim National Wildlife Refuge. In addition, BNL and several environmental groups began working together to develop the Long Island Nature Organization (*www.longislandnature.org*) and hosted the first annual Long Island Natural History conference in November.

The Laboratory also hosted 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. Post-fire monitoring of the April wildfire indicated that prescribed fires have been somewhat effective at reducing fuel loads and reducing fire severity of wildfire. BNL intends to continue the use of prescribed fire for fuel and forest management in the future, and is working with NYSDEC to prepare additional prescriptions for a larger portion of the northern and eastern sections of the Laboratory property.

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 2005) guides the management of all of the Laboratory's historical resources. Along with achieving compliance with applicable regulations, one of the major goals of the CRM program is to fully assess both known and potential cultural resources. The range of the BNL's cultural resources includes 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 three structures or sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the WWI training trenches associated with Camp Upton. The trenches are examples of the few surviving WWI earthworks in the United States.

In 2012, BNL completed revisions to the CRMP and prepared the plan for submission to the New York State Historic Preservation Office for review. Other cultural resource activities conducted in 2012 included the loan of the

"Atoms for Peace" art work, a BGRR model, and period material from the 1950s to the Long Island Museum located in Stony Brook, New York for a display titled "Long Island America's 1950s Frontier; a presentation of the history of the BNL site to the Bellport Historical Society; and a talk on the natural history of the BNL site with a focus on the historical aspects of human use of the site given at the First Annual Natural History Conference.

In October 2012, the American Chemical Society's NY Section named the BNL Chemistry Building (Building 555) a Historical Chemical Landmark. This designation was presented during a ceremony at the facility along with several talks presented in the Hamilton Seminar room located in the building. The designation was given in recognition to the significant contribution by BNL scientists for the development of 18FDG, the first successful radiotracer for positron emission tomography that continues to be used worldwide for brain research and cancer diagnosis.

REFERENCES AND BIBLIOGRAPHY

BNL. 2000. *1999 Site Environmental Report.* BNL-52553. Brookhaven National Laboratory, Upton, NY.

BNL. 2011. *Natural Resource Management Plan for Brookhaven National Laboratory*. BNL-96320-2011. Brookhaven National Laboratory, Upton, NY.

BNL. 2005. *Cultural Resource Management Plan for Brookhaven National Laboratory*. BNL-73839-2005. Brookhaven National Laboratory, Upton, NY. March 2005.

DOE-FWS. 2000. *Interagency Agreement Number AI02-01CH1107* Between the U.S. Department of Interior, U.S. Fish & Wildlife Service, Long Island National Wildlife Refuge Complex, and the U.S. Department of Energy Chicago Operations Office Brookhaven Group.

Dwyer, Norval. 1966. *Brookhaven National Laboratory. Long Island Forum* (reprint), West Islip, NY.

Florendo, Esperanza. 2004. *Seasonal Food Intake Affecting Cs-137 Levels in White-tailed Deer at Brookhaven National Laboratory*. CCI Paper. Brookhaven National Laboratory.

IAEA. 1992. *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards. Technical Report Series No. 332*. International Atomic Energy Agency, Vienna.

LMS. 1995. *Phase II Sitewide Biological Inventory Report, Final*. Lawler, Matusky & Skelly Engineers. Pearl River, NY.

NYSDOH. 1999. *Deer Meat Contaminated with Cesium-137 at Brookhaven National Laboratory*. Bureau of Environmental Radiation Protection, New York State Department of Health, Albany, NY.

Intentionally Left Blank