6 Natural and Cultural Resources

The Brookhaven National Laboratory (BNL) Natural Resource Management Program is designed to protect and manage flora and fauna and the ecosystems in which they exist. The Laboratory's natural resource management strategy is based on understanding the site's resources and 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 2007, deer and fish sampling results were consistent with previous years. Vegetables grown in the BNL garden plot located near the on-site apartment complex continue to support historical analyses that there are no Laboratory-generated radionuclides in produce.

The Foundation for Ecological Research in the Northeast began the development of Freshwater Wetland Monitoring Protocols for the Long Island Central Pine Barrens. This work is discussed in greater detail in this chapter.

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. Additional details are discussed within this chapter.

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 prepared and issued a Natural Resource Management Plan (NRMP) (BNL 2003a). The NRMP describes the program strategy, elements, and planned activities for managing the various resources found on site.

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 2005, efforts were initiated to better understand the distribution of deer on site. A model of deer density was developed using the mapping and spatial analysis tools. The model enables resource managers to track changes in deer density over time, detect interactions between components of the ecosystem, and identify locations for management activities.

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			
Frosted elfin	*Callophrys iris*	T	Likely
Mottled duskywing	*Erynnis martialis*	SC	Likely
Persius duskywing	*Erynnis persius persius*	E	Likely
Pine Barrens bluet	*Enallagma recurvatum*	T	Confirmed
Fish			
Banded sunfish	*Enniacanthus obesus*	T	Confirmed
Swamp darter	*Etheostoma fusiforme*	T	Confirmed
Amphibians			
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E	Confirmed
Marbled salamander	*Ambystoma opacum*	SC	Confirmed
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC	Confirmed
Reptiles			
Spotted turtle	*Clemmys guttata*	SC	Confirmed
Eastern hognose snake	*Heterodon platyrhinos*	SC	Confirmed
Eastern box turtle	*Terrapene carolina*	SC	Confirmed
Eastern worm snake	*Carphophis amoenus*	SC	Confirmed
Birds (nesting, transient, or potentially present)			
Horned lark	*Eremophila alpestris*	SC	Likely
Whip-poor-will	*Caprimulgus vociferus*	SC	Likely
Vesper sparrow	*Pooecetes gramineus*	SC	Likely
Grasshopper sparrow	*Ammodramus savannarum*	SC	Confirmed
Northern harrier	*Circus cyaneus*	T	Confirmed
Cooper's hawk	*Accipiter cooperii*	SC	Confirmed
Osprey	*Pandion haliaetus*	SC	Confirmed
Sharp-shinned hawk	*Accipiter striatus*	SC	Confirmed
Plants			
Stargrass	*Aletris farinosa*	T	Confirmed
Butterfly weed	*Asclepias tuberosa*	V	Confirmed
Spotted wintergreen	*Chimaphila maculata*	V	Confirmed
Flowering dogwood	*Cornus florida*	V	Confirmed
Pink lady's slipper	*Cypripedium acaule*	V	Confirmed
Winterberry	*Ilex verticillata*	V	Confirmed
Sheep laurel	*Kalmia angustifolia*	V	Confirmed
Narrow-leafed bush clover	*Lespedeza augustifolia*	R	Confirmed
Ground pine	*Lycopodium obscurum*	V	Confirmed
Bayberry	*Myrica pensylvanica*	V	Confirmed
Cinnamon fern	*Osmunda cinnamomera*	V	Confirmed
Clayton's fern	*Osmunda claytoniana*	V	Confirmed
Royal fern	*Osmunda regalis*	V	Confirmed
Crested fringed orchid	*Plantathera cristata*	E	Likely
Swamp azalea	*Rhododendron viscosum*	V	Confirmed
Long-beaked bald-rush	*Rhynchospora scirpoides*	R	Confirmed
Stiff goldenrod	*Solidago rigida*	T	Confirmed
New York fern	*Thelypteris novaboracensis*	V	Confirmed
Marsh fern	*Thelypteris palustris*	V	Confirmed
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes:
* Table information is based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data. No federally listed Threatened or Endangered Species are known to inhabit the BNL site.
E = Endangered
R = Rare
SC = Species of Special Concern
T = Threatened
V = Exploitably Vulnerable

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the site. Through implementation of the NRMP, additional endangered, threatened, and species of special concern have been identified as having been resident at BNL during the past 30 years. The only New York State endangered species confirmed as now 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 the site in the past. Five New York State threatened species have been positively identified on site and two other species are considered likely to be present. The banded sunfish (*Enniacanthus obesus*), the swamp darter fish (*Etheostoma fusiforme*), and the stiff goldenrod plant (*Solidago rigida*) have been previously reported (BNL 2000). The northern harrier (*Circus cyaneus*) was seen hunting over open fields in November 2003. In 2005, the Pine Barrens bluet (*Enallagma recurvatum*) damselfly was confirmed at one of the many coastal plain ponds located on site. The frosted elfin butterfly (*Callophrys iris*) has been identified as possibly being at BNL, based on historic documentation and the presence of its preferred habitat and host plant (wild lupine). In addition, stargrass (*Aletris farinosa*) was reconfirmed to exist at BNL. Several other species that inhabit the site, visit during migration, or have historically been identified, are listed as rare, species of special concern, or exploitably vulnerable by New York State (Table 6-1).

6.1.2 Habitat Protection and Enhancement

BNL has precautions in place to protect on-site 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. 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 these 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. 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. 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 the New York State Department of Environmental Conservation (NYSDEC), habitat surveys have been conducted annually since 1999. Biologists conducting egg mass and larval surveys have confirmed 26 on-site ponds that are used by eastern tiger salamanders. The study procedure calls for all ponds that had egg masses during the spring surveys to be surveyed again in June and July to check for the presence of larval salamanders. Egg mass surveys of 26 ponds plus additional flooded depressions at the Laboratory were conducted in 2007. A PhD candidate and students working through the intern programs offered by DOE and BNL's Office of Education conducted surveys of tiger salamander ponds, drift fence surveys, and radio telemetry tracking around four ponds. The results of these studies show the extent of egg mass production, the importance of precipitation as a trigger for metamorphic salamanders leaving ponds, and the extent of movements by both adults and metamorphic tiger salamanders. Work toward a comprehensive understanding of eastern tiger salamander movements and habitat requirements began in 2004, with funding provided to SUNY Binghamton by NYSDEC. Continued research adds to the understanding of the needs of this state endangered species. Information acquired from all research is entered into a database, and portions of the data are linked to a GIS. These data are used to visualize distributions, track reproductive success, and identify areas for focused management or study.

6.1.2.2 Eastern Box Turtle

A radio telemetry study of the eastern box turtle (*Terrapene carolina*) was initiated in 2006 and continued in 2007 to investigate the amount of territory overlap between individual turtles. The study was initiated after repeatedly finding turtles with ear infections and the discovery of three sick turtles simultaneously in 2005. Two of the three turtles died and were subsequently necropsied, with tissues sent to a laboratory for virus isolation. Results confirmed the presence of an iridovirus known to affect turtles and amphibians, which posed a great concern, given the endangered status of some amphibians. As the three turtles were found in a primary breeding pond for tiger salamanders, further study was warranted. The radiotelemetry study confirmed significant amounts of overlap within the territories of five turtles outfitted with transmitters over both years. This overlap provides an indication of the likelihood of disease transmission between turtles. Additionally, all five turtles spent some time near the pond and could have released the virus to the water, where it could infect amphibians.

Associated with the radiotelemetry study was a study to isolate and identify the iridovirus within eastern box turtles found at BNL. Routine transects of various areas of the Laboratory were established and traversed in order to capture eastern box turtles. When a turtle was found, it was given a unique identification mark, and samples from the mouth and cloaca were taken using cotton swabs. The samples were later tested for iridovirus. Unfortunately, due to difficulties at the contract analytical laboratory, iridovirus could not be isolated in 2006. The study was continued with revisions in 2007 in

order to assess the potential for turtles to carry iridovirus and infect other reptiles or amphibians.Revisions included improved procedures for obtaining swab samples and alterations of lab procedures to improve the genetic analysis of samples. However, even with improved sampling, a single turtle in advanced stages of the disease only showed positive results on oral swabs and liver tissue analysis. Cloacal swabs of this animal and both oral and cloacal swabs of all other specimens had negative results, suggesting that swabbing may not be sufficient for early detection of infected animals (Snyder and Titus, 2007).

6.1.2.3 Other Species

As part of the eastern tiger salamander and herpetological surveys, information is being gathered on other species found on site. Including the tiger salamander (see Section 6.1.2.1), sightings of 26 species of reptiles and amphibians have been recorded over the past several years. The species include the northern red-back salamander (*Plethodon c. cinereus*), marbled salamander (*Ambystoma opacum*), four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Rana catesbiana*), green frog (*Rana clamitans*), pickerel frog (*Rana 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 eastern worm snake (*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. A population estimate of reproductive success of the banded sunfish in a protected pond was conducted in summer 2007 and compared to values obtained in a similar survey in 2005. Conservatively, approximately 3,000 fish remained in the pond after it nearly dried in 2005, based on overall estimates that summer. Hydrologic conditions were maintained throughout 2006 and into 2007. The population survey in 2007 resulted in an estimate of approximately 4,000 fish present. Differences in the two studies may have been responsible for the lower results in 2005. In addition, an increased number of brown bullhead (*Ictalurus nebulosus*) may have had a more significant negative impact on the sunfish population than previously expected.

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 six permanent bird survey routes in various habitats at BNL. In 2007, monthly surveys were conducted starting at the end of March and extending through the end of September. These surveys identified 69 songbird species, compared to 70 species in 2006 and 67 species during 2005. One of the species identified during the 2007 surveys had not been reported previously. A total of 111 songbird species have been identified during surveys in the past 8 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, or actual changes in the environment. The two most diverse transects pass near wetlands by the Biology Fields and the Peconic River. The four transects passing through the various forest types (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird

community. Data are stored in an electronic database that is linked to the Laboratory's GIS.

Canada geese (*Branta canadensis*) are a protected species under the Migratory Bird Treaty Act. BNL has a resident, year-round (non migrating) flock of approximately 120 birds that occasionally create problems due to their droppings, choice of nesting areas, and assertive defense of nests and offspring. When questions regarding migratory birds arise, BNL consults NYSDEC, U.S. Fish & Wildlife Services (FWS), and the United States Department of Agriculture Animal and Plant Health Inspection Service–Wildlife Services Division. Because Canada geese have protected status, they can only be managed under special FWS permits. In 2007, BNL began limited nest management through oiling or nest destruction. When nesting geese were identified as causing a safety problem due to defending of nests, the nests were destroyed. If nesting behavior was obvious, the eggs were oiled to prevent development. A total of 10 nests were either destroyed or oiled. Banding of geese in late June 2007 resulted in 37 newly banded birds. Surveys at the end of the summer prior to the arrival of migrant geese indicated a population of approximately 157 birds. Because of this significant increase in population, the Laboratory will likely take a more aggressive approach to goose management in the future.

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 the bluebird population. In 2007, the boxes were monitored approximately every 3 weeks during the breeding season to determine use and nesting success. Twenty-seven bluebird nests were observed; a sharp decline over past year's successes. Other birds using the houses included house wrens (*Troglodytes aedon*), black-capped chickadees (*Poecile atricapilla*), tufted titmouse (*Baeolophus bicolor*), and tree swallows (*Tachycineta bicolor*). House wrens were the only species that showed an increase in nesting success. Their success may explain, in part, the decline in bluebird nest success.

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, is now sufficiently large for NYSDEC to consider establishing a hunting season to maintain the population at a reasonable number.

6.1.3.2 White-Tailed Deer

BNL consistently updates information on the resident population of white-tailed deer (*Odocoileus virginianus*). As there are no natural predators on site and hunting is not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately 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 BNL property, under normal circumstances. This was the approximate density in 1966, when the Laboratory reported an estimate of 267 deer on site (Dwyer 1966). BNL has been conducting population surveys of the white-tailed deer since 2000. In February and March 2004, an aerial infrared survey was conducted of three properties, including Wertheim National Wildlife Refuge (south of BNL), Brookhaven National Laboratory, and Rocky Point Wildlife Area (northwest of BNL). The results indicated a population of 412 deer

on site and immediately off site. When a correction for survey accuracy was applied, the on-site population was estimated at 446 animals. This value was much lower than a ground-based estimate of 1,302, made at the same time using the existing methodology. Because there was a large discrepancy between methods, a review of the ground-based methodology was conducted and the method of estimating was refined. The new method uses the Laboratory's vegetation map and estimates the deer population based on the habitat in which deer are sighted during surveys. The result of this revised method indicated that the deer population was approximately 497, which is considered to be reasonably comparable to the aerial survey results. The next step taken was to apply the new population model to historic survey data. Most of the data resulted in a much lower estimate, with ranges from approximately 1,000 deer in 2001 to approximately 400 deer in 2005. The current population estimate is 392 deer, based on surveys conducted in November and December 2007. Note that the current estimate is still higher than the optimal range of 80 to 250 deer on an area the size of BNL.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, collision injuries—both human and animal), species diversity (songbird species reduction due to selective grazing and destruction of habitat by deer), and property values (damage to autos and browsing damage to ornamental plantings). In 2007, three deer-related collisions occurred on site, compared to 10 accidents in 2006 and 25 accidents documented in 2004. This downward trend in accidents is attributed to a major effort by BNL Safeguards and Security personnel to enforce the 30-mph speed limit on site. Additional emphasis on vehicle–deer safety is also thought to have helped reduce this type of accident. Deer health continues to be affected due to lack of food. Deer damage to vegetation around buildings continues to be a problem, but varies depending on the severity of the winter and the availability of browse in the lawns.

Because the high deer population is a regional problem, the Laboratory is working on the issue with other local jurisdictions. As part of this regional approach, an issue and decision paper was prepared for Laboratory management consideration late in 2007. Options for deer management are limited, and most are controversial. While a single regional approach would benefit the community, land managers, and the health of the deer population, individual land managing organizations like the Laboratory must implement a regional approach.

6.1.4 Compliance Assurance and Potential Impact Assessment

The National Environmental Policy Act (NEPA) review process at BNL is 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 Brookhaven 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.

6.2 UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, then-Secretary of Energy Bill Richardson and Susan MacMahon, 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 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 Bar-

rens. 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 forest-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 and is currently analyzing the data. One significant finding from the monitoring 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. Further information on the forest health initiative, as well as other activities of FERN, is available on the FERN website at www.fern-li.org. In 2007, FERN developed draft protocols for monitoring wetland health throughout the Pine Barrens. These protocols will likely be completed in 2008 and implemented sometime thereafter.

The Interagency Agreement that established the Upton Reserve specified the formation of a Technical Advisory Group (TAG), which includes a supervisory biologist for FWS and representatives from NYSDEC, Suffolk County Parks Department, the Central Pine Barrens Joint Policy and Planning Commission, DOE, BNL's Community Advisory Council, Brookhaven Executive Roundtable, Brookhaven Science Associates, and The Nature Conservancy. The TAG's primary responsibility was to develop a comprehensive NRMP for BNL. The TAG also developed criteria for soliciting and reviewing proposals and awarding funds for research that is conducted within the Upton Reserve. While most of the TAG's responsibilities have been met, the Laboratory intends to periodically ask for assistance in reviewing annual reports required under the NRMP, and to support the 5-year update of the plan, which is scheduled to begin late in 2008.

Research on oak tree defoliators that was initiated by FWS and the Upton Reserve is continuing at the Laboratory. Much of the oak forest on site and immediately east of BNL has been subject to repeated defoliation by gypsy moth and orange-striped oak moth. This double defoliation, if it occurs year after year, can kill large sections of oak forest. Beginning in 2003, death of tree oaks was documented. Due to continued defoliation, oak mortality is now estimated at greater than 25 percent in many areas in the northeast quadrant of the Laboratory. The amount of defoliation appeared to decrease in 2007, which was likely due to the decreased number of surviving oaks in the affected area.

Research supported by FERN in 2007 included an investigation into the microbial world of soils located within a number of the Forest Health Plots. Microbial research carried out by a scientist at Dowling College identified several new species of fungus and bacteria that had not previously been known. Future work in the area of microbial diversity is expected to identify additional new species across the Pine Barrens. Additionally, a faculty and student team and The Nature Conservancy surveyed approximately 30 ponds throughout eastern Long Island for variations in water quality in ponds near roads versus ponds far from roads. This work is discussed in more detail under Section 6.5, below.

6.3 MONITORING FLORA AND FAUNA

The Laboratory routinely monitors flora and fauna to determine the effects of past and present Laboratory activities. Because soil contaminated with cesium-137 (Cs-137), a radioactive isotope of cesium, was used in some BNL landscaping projects in the past, traces have now been found in deer and in other animals and plants. Most radionuclide tables in this chapter list data for both potassium-40 (K-40), a naturally occurring radioisotope of potassium, and Cs-137. Because K-40 occurs naturally in the environment, it is not uncommon in flora and fauna. It is presented as a comparison to Cs-137 because Cs-137 competes with potassium at a cellular level. General trends indicate that

Cs-137 will out-compete potassium when potassium salts are limited in the environment, which is the typical case on Long Island. In general, K-40 values do not receive significant discussion in the scientific literature due to this relationship and the fact that K-40 occurs naturally. 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 one-third 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 2007, as in recent years, an off-site deer-sampling program was conducted with the NYSDEC Wildlife Branch and FWS. While most off-site samples are from road-killed deer near the Laboratory, NYSDEC provides a few samples from hunters beyond BNL boundaries, yielding control data on deer living 1 mile or more from BNL. In addition, FWS occasionally informs Laboratory staff of deer that have died in or near the Wertheim National Wildlife Refuge and other FWS properties on Long Island. In all, three deer were obtained on site and eight were from off-site locations, ranging from adjacent to BNL along the William Floyd Parkway, to approximately 6.75 miles away (East Patchogue, New York).

BNL sampling technicians collect the samples and process them for analysis. Samples of meat, 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).

6.3.1.1 Cs-137 in White-Tailed Deer

White-tailed deer sampled at the Laboratory contain higher concentrations of Cs-137 than deer from greater than 1 mile off site (BNL 2000), probably 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 at BNL has occurred under the Laboratory's Environmental Restoration (ER) 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 has been characterized.

The number of deer obtained for sampling steadily increased between 1996 and 2004. However, the numbers of deer obtained between 2005 and 2007 are significantly lower. As mentioned above, the number of deer killed on site and available for sampling has decreased, most likely due to increased safety awareness, better enforcement of speed restrictions, and a smaller deer population. In 1998, a statistical analysis based on existing data suggested that 40 deer from off site and 25 deer from on site were 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 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 2003. 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

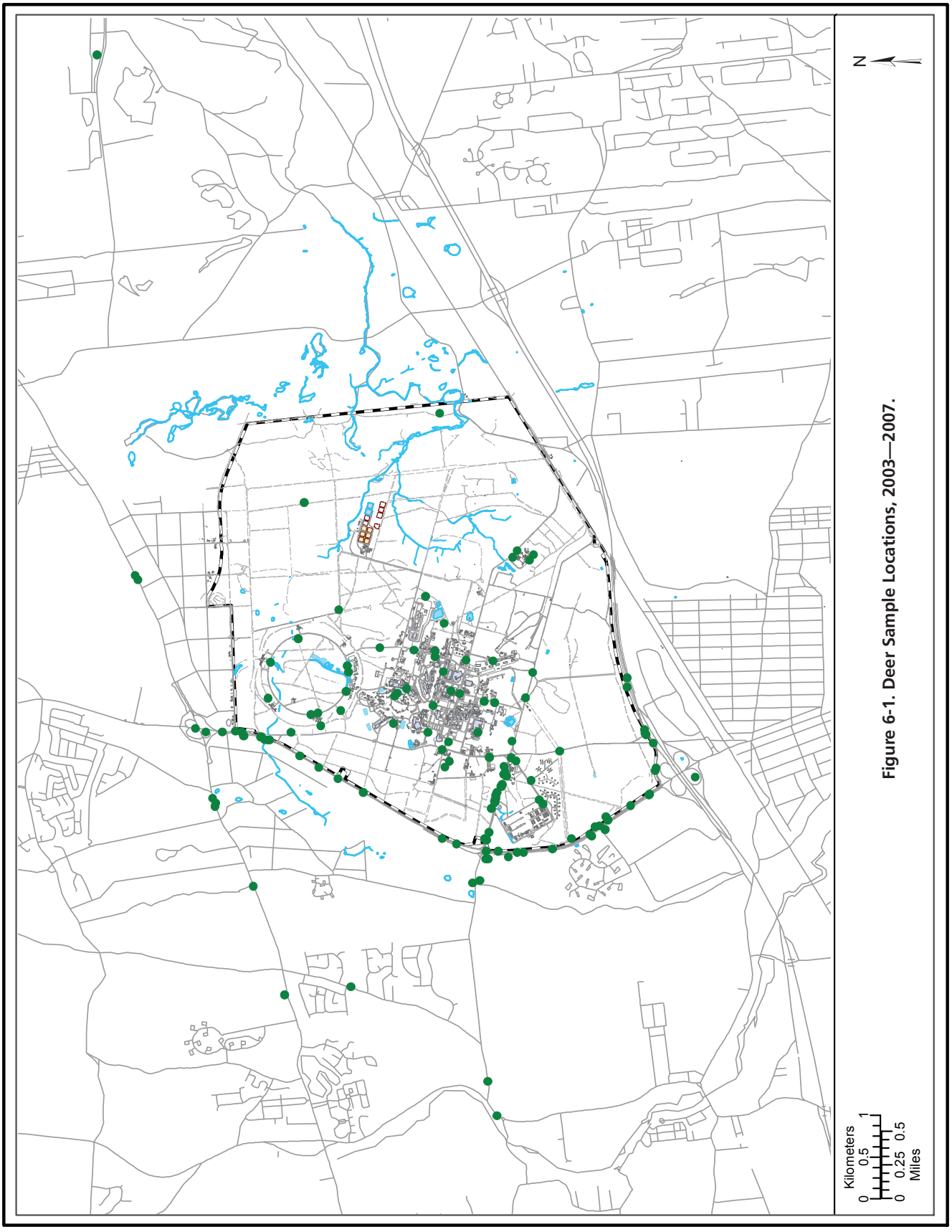


Figure 6-1. Deer Sample Locations, 2003—2007.

collisions with deer on site occur primarily early or late in the day, when deer are more active.

In 2007, Cs-137 concentrations in deer muscle ("meat") samples taken at BNL ranged from 0.01 to 0.25 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 maximum 2007 on-site concentration (0.25 pCi/g wet weight) was seventeen times lower than the highest level reported in 2006 (4.27 pCi/g wet weight), and is much lower than the highest level ever reported (11.74 pCi/g wet weight, in 1996). The arithmetic average concentration in on-site meat samples was 0.17 pCi/g, wet weight (see Table 6-2).

Cs-137 concentrations in off-site deer meat samples were separated into two groups: samples taken within 1 mile of BNL (four samples) and samples taken farther away (four samples) (see Table 6-2). Concentrations in meat samples taken within 1 mile ranged from 0.26 to 2.08 pCi/g wet weight, with an average of 0.81 pCi/g wet weight; concentrations in meat taken from greater than 1 mile ranged from 0.27 to 1.19 pCi/g wet weight, with an average of 0.61 pCi/g wet weight. Because deer on site may routinely travel up to 1 mile off site, the average for deer taken on site and within 1 mile of the Labora-

Table 6-2 Radiological Analyses of Deer Tissue (Flesh, Liver, Bone).

Sample Location	Collection Date	Tissue Type	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)
BNL, On Site					
Along gamma forest fence, just east of stump dump	02/13/07	Flesh	3.80 ± 0.31	0.25 ± 0.02	
		Liver	2.07 ± 0.18	0.06 ± 0.01	
		Bone			2.18 ± 0.30
Railroad Ave.	03/05/07	Flesh	3.20 ± 0.24	0.01 ± 0.01	
		Liver*	2.82 ± 0.20	0.01 ± 0.00	
		Bone			1.11 ± 0.22
Bldg 938, by BLIP	04/11/07	Flesh	3.63 ± 0.30	0.25 ± 0.02	
		Liver	2.22 ± 0.20	0.04 ± 0.01	
		Bone			2.81 ± 0.35
Offsite < 1 mile					
William Floyd Pkwy., across from north gate	01/23/07	Flesh	3.66 ± 0.25	0.26 ± 0.02	
		Liver	2.69 ± 0.19	0.06 ± 0.01	
		Bone			1.52 ± 0.28
William Floyd Pkwy., 1/4 mile south of main gate	08/07/07	Flesh	3.92 ± 0.51	0.50 ± 0.06	
		Bone			2.50 ± 0.33
William Floyd Pkwy., 1/2 mile north of main Gate	10/16/07	Flesh	3.50 ± 0.47	0.41 ± 0.05	
		Bone**			0.66 ± 0.24
Rte. 25, 1.5 miles east of William Floyd Pkwy.	10/25/07	Flesh	3.42 ± 0.43	2.08 ± 0.19	
		Liver	2.63 ± 0.40	0.51 ± 0.05	
		Bone			5.04 ± 1.00

(continued on next page)

Table 6-2 Radiological Analyses of Deer Tissue (Flesh, Liver, Bone) *(concluded).*

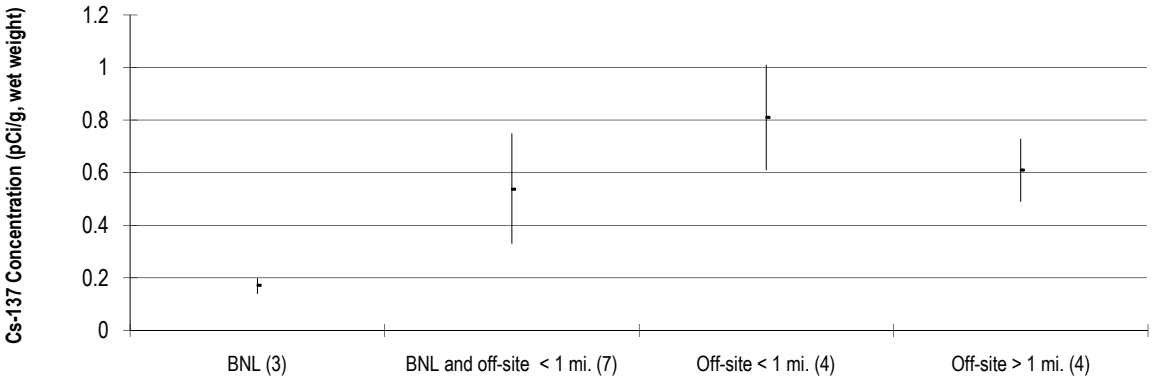
Sample Location	Collection Date	Tissue Type	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)
Offsite > 1 mile					
Sunrise Hwy., near Hospital Rd.	01/04/07	Flesh	3.69 ± 0.25	1.19 ± 0.10	
		Liver	2.79 ± 0.24	0.20 ± 0.02	
		Bone			1.94 ± 0.30
Wading Hollow Rd., Ridge	02/01/07	Flesh	3.54 ± 0.28	0.27 ± 0.03	
		Liver	2.63 ± 0.18	0.06 ± 0.01	
		Bone			1.19 ± 0.23
Yaphank-Middle Island Rd.	02/16/07	Flesh	3.50 ± 0.26	0.43 ± 0.04	
		Liver	2.57 ± 0.21	0.11 ± 0.01	
		Bone			1.89 ± 0.29
1/2 mile west of Longwood High School	04/04/07	Flesh	3.56 ± 0.26	0.55 ± 0.05	
		Liver	3.06 ± 0.22	0.17 ± 0.02	
		Bone			2.96 ± 0.34
Averages by Tissue					
Flesh					
Avg. for all samples (11)			3.58 ± 1.12	0.56 ± 0.24	
BNL on-site average (3)			3.54 ± 0.49	0.17 ± 0.03	
BNL on- and off-site < 1 mile avg. (7)			3.59 ± 0.99	0.54 ± 0.21	
Off site average (8 samples)			3.60 ± 1.00	0.71 ± 0.24	
Off-site < 1 mile average (4 samples)			3.63 ± 0.85	0.81 ± 0.20	
Off-site > 1 mile average (4 samples)			3.57 ± 0.53	0.61 ± 0.12	
Liver					
Avg. for all samples (9)			2.61 ± 0.70	0.14 ± 0.06	
BNL on-site average (3)			2.37 ± 0.34	0.04 ± 0.01	
BNL on- and off-site < 1 mile avg. (5)			2.49 ± 0.55	0.14 ± 0.05	
Off-site average (6)			2.73 ± 0.61	0.18 ± 0.06	
Off-site < 1 mile average (2)			2.66 ± 0.44	0.28 ± 0.05	
Off-site > 1 mile average (4)			2.76 ± 0.43	0.13 ± 0.03	
Bone					
Avg. for all samples (11)					2.16 ± 1.36
BNL on-site average (3)					2.03 ± 0.51
BNL on- and off-site < 1 mile avg. (7)					2.26 ± 1.22
Off-site average (8)					2.21 ± 1.26
Off-site < 1 mile average (4)					2.43 ± 1.11
Off-site > 1 mile average (4)					2.00 ± 0.59

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 and utilize estimated values for ND.
Confidence limits are 2σ sigma (95%) propogated error.
BLIP = Brookhaven Linac Isotope Producer
Cs-137 = cesium-137
K-40 = potassium-40
Sr-90 = strontium-90
* = estimated value for Cs-137
** = estimated value for Sr-90

tory is also calculated; for 2007, this was 0.54 pCi/g wet weight.

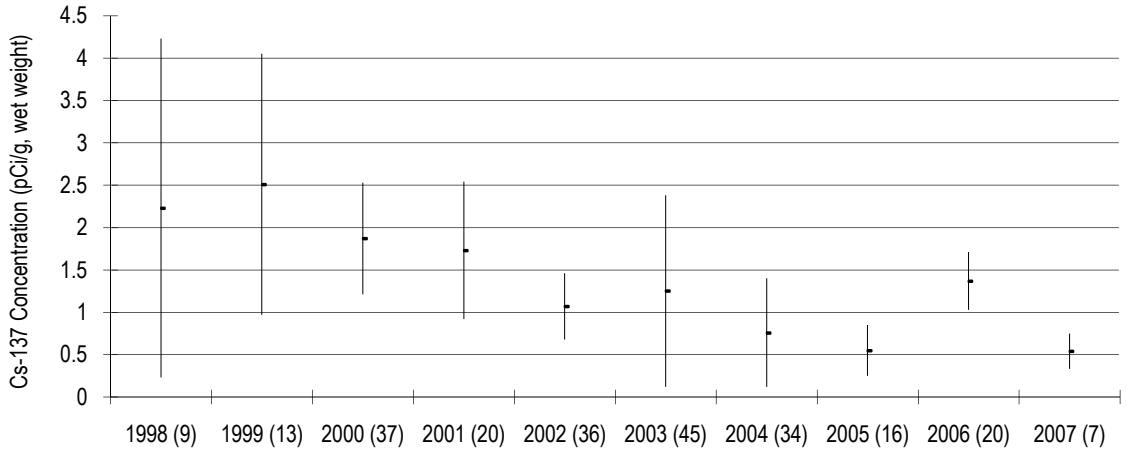
Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2007 from four different location groupings. Although the figure does not show this, 73 percent of all samples taken both on and off site are below 1 pCi/g wet weight (see Table 6-2).

Figure 6-3 presents the 10-year trend of on-site and near off-site Cs-137 averages in deer meat. While composed of a similar number of samples as in 1998, sampling in 2007 indicates a much narrower range of error and continues to indicate the effectiveness of cleanup actions across the Laboratory. In 2003, a seasonal pattern in Cs-137 concentrations in deer meat was noticed. This seasonality was present in earlier years and occurred again in 2006 (see Table 6-2). During the summer of 2004, a student in the Community College Intern Program re-



Notes: Averages are shown for samples collected at BNL, on site and off site within 1 mile, off site but within 1 mile of the boundary, and off site greater than 1 mile from the boundary.
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, 2007.



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.

Figure 6-3. Trend of Cs-137 Concentrations in Deer Meat at BNL and Within 1 Mile of BNL, 1998—2007.

viewed all data from 2000–2003, analyzed it 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 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, deer eat more and the vegetation is constantly growing, 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 three highest values seen in deer in 2006 (3.06, 4.00, and 9.51 pCi/g wet weight) from samples taken in October and November. By January or February, the Cs-137 in their tissues has been 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 2007, Cs-137 concentrations ranged from 0.01 to 0.06 pCi/g wet weight, with an average of 0.04 pCi/g wet weight. The off-site Cs-137 concentration in liver ranged from 0.06 to 0.51 pCi/g wet weight, with an average for all off-site liver samples of 0.18 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 about 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 2007, Sr-90 content ranged from 1.11 to 2.81 pCi/g dry weight in on-site samples. Sr-90 in off-site samples ranged from 0.66 to 5.04 pCi/g dry weight in samples taken within 1 mile of BNL, and 1.19 to 2.96 pCi/g dry weight in samples taken more than a mile from BNL. This overlap in values between all samples 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. BNL will continue to test for Sr-90 in bone to develop baseline information on this radionuclide and its presence in white-tailed deer.

6.3.2 Small Mammal Sampling

BNL discontinued small mammal sampling in 2007. The original goal of this sampling was to determine the suitability of small mammals, primarily squirrels, as a surrogate for deer sampling. This sampling was discontinued due to the difficulty of trapping squirrels, as well as difficulties in obtaining representative samples.

6.3.3 Other Animals Sampled

When other animals, such as wild turkey or Canada geese, are found dead along the roads of the Laboratory and the immediate vicinity due to road mortality, they are tested. In 2007, one goose and one turkey were sampled. Muscle from both birds was analyzed for Cs-137 content. Muscle from the goose indicated a Cs-137 value less than the minimum detection level (MDL) established by the analytical laboratory, and the muscle from the turkey had a value of 0.03 pCi/g wet weight. Bone from both birds was analyzed for Sr-90 with values of less than the MDL for the goose and 0.37 pCi/g dry weight for the turkey. These data continue to indicate that both species do not readily uptake these radionuclides from their diet.

6.3.4 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. Routine annual on-site sampling of fish resumed in 2007. 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 in 2007, numerous schools of fry of bass and sunfish were 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 earlier in the year to take advantage of periods when dissolved oxygen levels are higher, supporting the presence of fish.

As in the past, off-site fish sampling continued in 2007. All samples were analyzed for edible (fillet) content of each of the analytes reported. In 2007, various species of fish were collected off site from Swan Pond, Donahue's Pond, Forge Pond, Manor Road, and Lower Lake on the Carmans River (see Figure 5-8 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 in cooperation with NYSDEC and through a contract with the Cold Spring Harbor Fish Hatchery and Museum. One hundred and seventy-three samples were taken, representing eight species of fish.

6.3.4.1 Radiological Analysis of Fish

The species collected for radiological analysis in 2007 by the Laboratory and through contract labor included brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and black crappie (*Pomoxis nigromaculatus*). Gamma spectroscopy analysis was performed on all samples. When fish were not of sufficient mass to conduct all nonradiological 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. Information on the natural radioisotope K-40 is included as a comparison.

Cs-137 was detected at low levels in all samples from the Peconic River system, ranging from 0.04 pCi/g wet weight for pumpkinseed from Swan Pond to 0.24 pCi/g wet weight in a brown bullhead and chain pickerel from the Schultz Road area. In 2007, all fish taken from Lower Lake on the Carmans River (the non-Peconic control location) were too small for radiological analysis. Therefore, no data on this location are presented.

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). Cs-137 concentrations in brown bullhead collected at all locations along the Peconic River had values less than 0.24 pCi/g wet weight. Largemouth bass from the Peconic River showed Cs-137 levels of 0.16 pCi/g wet weight or less. Levels of Cs-137 in all fish species appear to be declining, compared with 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 2007 (see Figure 5-4 for a trend of Cs-137 discharges). 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 further decreases in Cs-137 levels in fish.

6.3.4.2 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 sampling events will be tracked, and modifications to future sampling events will be made as necessary to ensure long-term health of the on-site fish populations.

6.3.4.3 Nonradiological Analysis of Fish

In 1997, under BNL's Environmental Restoration Program Operable Unit (OU) V Remediation Project, fish from the Peconic River on site were analyzed for metals, pesticides, and PCBs. Since 2002, analysis has been limited to off-site fish. The timing of sampling has varied from year to year, as well as the sample preparation (whole-body, tissue separation, composite sampling). In 1997, sampling was performed during April through May; in 1999, sampling was performed during September through December. Since 2000, sampling has been performed from July through August. Additionally, there has been a wide variation in fish size; therefore, samples have had to be composite whole-body to obtain significant mass for analysis. These variables make the comparisons from year to year difficult, as there can be significant seasonal variations in feeding, energy consump-

Table 6.3. Radiological Analyses of Fish from the Peconic River System.

Species/Location	K-40	Cs-137
	pCi/g, wet weight	
BNL, On Site		
Brown bullhead 1a	3.24 ± 0.38	0.19 ± 0.03
Brown bullhead 1c	3.49 ± 0.41	0.14 ± 0.02
Brown bullhead 2c	4.23 ± 0.44	0.15 ± 0.03
Brown bullhead 3c	3.02 ± 0.33	0.09 ± 0.02
Brown bullhead 4c	2.89 ± 0.29	0.13 ± 0.01
Brown bullhead 5c	3.41 ± 0.42	0.10 ± 0.03
Brown bullhead 1d	2.75 ± 0.31	0.12 ± 0.02
Brown bullhead 2d	3.74 ± 0.49	0.15 ± 0.03
Brown bullhead 3d	3.22 ± 0.44	0.14 ± 0.02
Brown bullhead 4d	3.62 ± 0.37	0.13 ± 0.02
Brown bullhead 5d	3.14 ± 0.37	0.10 ± 0.02
Brown bullhead 6d	3.86 ± 0.45	0.21 ± 0.03
Chain pickerel 1a	3.48 ± 0.42	0.16 ± 0.02
Largemouth bass 1c	3.11 ± 0.43	0.16 ± 0.03
Pumpkinseed 1c	3.03 ± 0.57	0.05 ± 0.04
Pumpkinseed 1d	3.10 ± 0.52	0.11 ± 0.04
Schultz Road		
Brown bullhead 2	3.54 ± 0.39	0.14 ± 0.02
Brown bullhead 5	3.97 ± 0.45	0.24 ± 0.04
Brown bullhead 6	3.88 ± 0.44	0.21 ± 0.02
Brown bullhead 7	4.96 ± 0.68	0.22 ± 0.07
Brown bullhead 8	3.42 ± 0.50	0.09 ± 0.02
Chain pickerel 1	3.94 ± 0.48	0.24 ± 0.03
Largemouth bass	3.11 ± 0.49	0.13 ± 0.02
Donahue's Pond		
Black crappie 1	2.91 ± 0.68	0.08 ± 0.03
Bluegill 1	2.71 ± 0.79	0.08 ± 0.04
Brown bullhead 1*	2.97 ± 0.76	0.11 ± 0.04
Chain pickerel	2.98 ± 0.78	0.19 ± 0.06
Largemouth bass	3.11 ± 0.91	0.13 ± 0.05
Pumpkinseed 1	2.37 ± 0.59	0.08 ± 0.03
Swan Pond (Peconic River control location)		
Pumpkinseed*	2.27 ± 0.23	0.04 ± 0.01

Notes:
All samples analyzed as edible portions (fillets) except pumpkinseeds from Swan Pond,which were analyzed whole body composite.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
Cs-137 = cesium-137
K-40 = potassium-40
* = estimated value for Cs-137 based on analytical laboratory qualifiers.

tion, and incorporation of nutrients into various tissues. Beginning in 2005, all fish of sufficient size were analyzed as edible portions (fillets). Smaller fish, such as golden shiners, were composited for whole-body analysis. In 2007, fish sampling was moved to the spring months to lessen the effect of low oxygen levels on fish distributions. Nearly all samples were obtained between April and mid-June.

Table 6-4 shows the 2007 concentration of metals in fish. According to NYSDEC, none of the metal concentrations were considered capable of affecting the health of consumers of such fish. Due to the fact that values for arsenic, beryllium, cadmium, cobalt, silver, thallium, selenium, and vanadium were near or less than the MDL for the analytical procedure, they were not included in Table 6-4. Other metals tested but not included in the table include aluminum, antimony, and nickel, as most values reported for these metals were less than the MDL. Values that were above the MDL are discussed below. Since fish taken on site were generally of smaller size, samples were analyzed for mercury only.

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

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Zinc
	mg/kg							
BNL								
Chain pickerel 1a	NT	NT	NT	NT	NT	NT	0.859	NT
Chain pickerel/ Pumpkinseed	NT	NT	NT	NT	NT	NT	0.919	NT
Chain pickerel 2a	NT	NT	NT	NT	NT	NT	0.535	NT
Pumpkinseed 1a	NT	NT	NT	NT	NT	NT	1.350	NT
Brown bullhead 1a	NT	NT	NT	NT	NT	NT	0.362	NT
Brown bullhead 2a	NT	NT	NT	NT	NT	NT	0.504	NT
Brown bullhead 3a	NT	NT	NT	NT	NT	NT	0.435	NT
Brown bullhead 1c	NT	NT	NT	NT	NT	NT	0.296	NT
Brown bullhead 2c	NT	NT	NT	NT	NT	NT	0.261	NT
Brown bullhead 3c	NT	NT	NT	NT	NT	NT	0.423	NT
Brown bullhead 4c	NT	NT	NT	NT	NT	NT	0.389	NT
Brown bullhead 5c	NT	NT	NT	NT	NT	NT	0.275	NT
Brown bullhead 6c	NT	NT	NT	NT	NT	NT	0.283	NT
Brown bullhead 7c	NT	NT	NT	NT	NT	NT	0.275	NT
Brown bullhead 8c	NT	NT	NT	NT	NT	NT	0.394	NT
Brown bullhead 9c	NT	NT	NT	NT	NT	NT	0.342	NT
Brown bullhead 10c	NT	NT	NT	NT	NT	NT	0.275	NT
Largemouth bass 1c	NT	NT	NT	NT	NT	NT	1.050	NT
Largemouth bass 2c	NT	NT	NT	NT	NT	NT	0.489	NT
Pumpkinseed/Bluegill	NT	NT	NT	NT	NT	NT	0.346	NT
Brown bullhead 1d	NT	NT	NT	NT	NT	NT	0.205	NT
Brown bullhead 2d	NT	NT	NT	NT	NT	NT	0.284	NT
Brown bullhead 3d	NT	NT	NT	NT	NT	NT	0.219	NT
Brown bullhead 4d	NT	NT	NT	NT	NT	NT	0.344	NT
Brown bullhead 5d	NT	NT	NT	NT	NT	NT	0.420	NT
Brown bullhead 6d	NT	NT	NT	NT	NT	NT	0.217	NT

(continued on next page)

Table 6-4. Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake *(continued).*

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Zinc
	mg/kg							
Brown bullhead 7d	NT	NT	NT	NT	NT	NT	0.172	NT
Brown bullhead 8d	NT	NT	NT	NT	NT	NT	0.226	NT
Brown bullhead 9d	NT	NT	NT	NT	NT	NT	0.346	NT
Brown bullhead 10d	NT	NT	NT	NT	NT	NT	0.173	NT
Brown bullhead 11d	NT	NT	NT	NT	NT	NT	0.238	NT
Brown bullhead 12d	NT	NT	NT	NT	NT	NT	0.260	NT
Brown bullhead 13d	NT	NT	NT	NT	NT	NT	0.132	NT
Brown bullhead 14d	NT	NT	NT	NT	NT	NT	0.200	NT
Brown bullhead 15d	NT	NT	NT	NT	NT	NT	0.187	NT
Brown bullhead 16d	NT	NT	NT	NT	NT	NT	0.257	NT
Pumpkinseed 1d	NT	NT	NT	NT	NT	NT	0.581	NT
Bluegill	NT	NT	NT	NT	NT	NT	0.151	NT
Schultz Road								
Black crappie	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.339	6.25
Bluegill 1	NT	NT	NT	NT	NT	NT	0.152	NT
Bluegill 2	NT	NT	NT	NT	NT	NT	0.350	NT
Bluegill 3	NT	NT	NT	NT	NT	NT	0.222	NT
Brown bullhead 1	NT	NT	NT	NT	NT	NT	0.194	NT
Brown bullhead 2	0.282	0.102	0.451	6.84	<MDL	0.304	0.343	7.12
Brown bullhead 3	0.195	<MDL	<MDL	4.94	<MDL	<MDL	0.338	5.46
Brown bullhead 4	0.103	<MDL	<MDL	3.17	<MDL	<MDL	0.448	4.94
Brown bullhead 5	0.149	0.098	<MDL	3.42	<MDL	<MDL	0.253	4.41
Brown bullhead 6	0.144	<MDL	<MDL	4.03	<MDL	<MDL	0.294	5.02
Brown bullhead 7	0.132	<MDL	0.297	4.25	<MDL	<MDL	0.378	4.95
Brown bullhead 8	0.195	<MDL	<MDL	2.67	<MDL	<MDL	0.138	4.44
Brown bullhead 9	0.477	<MDL	<MDL	2.92	<MDL	0.373	0.170	5.78
Chain pickerel 1	0.124	<MDL	<MDL	<MDL	<MDL	<MDL	0.250	6.35
Chain pickerel 2	0.366	<MDL	<MDL	4.37	<MDL	1.42	0.465	12.7
Largemouth bass	0.107	<MDL	<MDL	<MDL	<MDL	<MDL	0.334	4.5
Pumpkinseed 2	0.155	0.112	<MDL	4.46	<MDL	0.235	0.261	5.87
Donahue's Pond								
Black crappie 1	<MDL	<MDL	0.298	2.48	0.12	<MDL	0.088	3.62
Black crappie 2	<MDL	<MDL	0.343	2.42	<MDL	0.207	0.064	4.57
Black crappie 3	<MDL	0.104	0.286	2.39	0.099	<MDL	0.135	2.36
Black crappie 4	<MDL	<MDL	0.296	2.47	0.11	<MDL	0.155	3.06
Bluegill 1	<MDL	<MDL	0.29	2.42	0.13	0.266	0.061	5.9
Bluegill 2	<MDL	<MDL	0.287	2.39	0.13	0.203	0.048	5.98
Bluegill 3	<MDL	<MDL	0.298	3.41	0.16	0.237	0.053	5.04

(continued on next page)

Table 6-4. Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake *(continued).*

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Zinc
	mg/kg							
Bluegill 4	0.275	<MDL	0.287	2.39	0.14	1.01	0.105	6.17
Bluegill 5	<MDL	<MDL	0.286	2.39	<MDL	<MDL	0.052	5.35
Bluegill 6	<MDL	<MDL	0.3	2.5	0.1	0.238	0.055	3.28
Bluegill 7	0.294	<MDL	0.3	2.77	0.13	1.42	0.088	6.82
Bluegill 8	<MDL	<MDL	0.298	2.49	0.11	<MDL	0.066	4.73
Bluegill 9	<MDL	<MDL	0.286	2.38	0.13	0.33	0.065	3.71
Bluegill 10	<MDL	<MDL	0.298	2.49	0.12	<MDL	0.082	3.78
Brown bullhead 1	<MDL	<MDL	0.299	2.38	0.79	<MDL	<MDL	4.28
Brown bullhead 2	0.16	<MDL	0.286	18.1	<MDL	0.543	0.028	3.55
Brown bullhead 3	0.119	0.107	0.286	3.18	0.16	0.247	0.038	3.16
Brown bullhead 4	<MDL	0.137	0.286	2.38	0.11	<MDL	0.037	5.12
Brown bullhead 5	<MDL	<MDL	0.286	2.38	0.19	<MDL	0.139	2.65
Brown bullhead 6	<MDL	<MDL	0.293	2.44	0.13	<MDL	0.081	3.51
Chain pickerel	0.122	<MDL	0.299	2.5	0.17	0.252	0.307	6.22
Largemouth bass	<MDL	<MDL	0.291	2.43	0.12	<MDL	0.133	3
Pumpkinseed 1	<MDL	<MDL	0.295	2.46	0.13	0.312	NV	6.55
Pumpkinseed 2	0.137	0.101	0.296	4.05	<MDL	0.295	NV	6.33
Pumpkinseed 3	<MDL	<MDL	0.294	2.45	0.16	<MDL	NV	4.45
Pumpkinseed 4	0.266	<MDL	0.299	3.81	0.14	0.419	NV	6
Pumpkinseed 5	<MDL	<MDL	0.295	2.46	0.13	<MDL	NV	5.77
Pumpkinseed 6	<MDL	<MDL	0.365	2.5	0.14	<MDL	NV	7.16
Pumpkinseed 7	<MDL	<MDL	0.297	2.48	0.31	<MDL	NV	5.33
Pumpkinseed 8	<MDL	<MDL	0.298	2.48	0.17	<MDL	NV	5.87
Pumpkinseed 9	<MDL	<MDL	0.297	2.48	<MDL	<MDL	NV	5.66
Pumpkinseed 10	<MDL	<MDL	0.287	2.39	0.12	<MDL	NV	4
Forge Pond								
Black crappie 1	<MDL	<MDL	0.516	3.41	<MDL	<MDL	0.266	6.34
Black crappie 2	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.155	5.21
Black crappie 3	0.142	<MDL	<MDL	3.2	<MDL	<MDL	0.172	5.99
Black crappie 4	<MDL	<MDL	<MDL	2.56	<MDL	<MDL	0.107	6.83
Brown bullhead 1	0.472	0.179	<MDL	16.1	<MDL	0.792	0.044	6.6
Brown bullhead 2	0.295	<MDL	<MDL	5.93	<MDL	0.334	0.089	7.05
Brown bullhead 3	0.335	<MDL	0.415	11.1	0.12	0.629	0.035	7.86
Brown bullhead 4	0.318	0.163	0.584	19.2	<MDL	1.82	0.026	7.58
Brown bullhead 5	0.112	<MDL	0.539	14	<MDL	0.369	0.041	8.18
Brown bullhead 6	0.199	0.099	<MDL	6.58	<MDL	0.283	0.027	5.5
Chain pickerel 1	0.128	0.102	<MDL	<MDL	<MDL	0.669	0.383	7.43
Chain pickerel 2	<MDL	<MDL	<MDL	4.47	<MDL	<MDL	0.346	13
Chain pickerel 3	<MDL	<MDL	<MDL	2.66	<MDL	<MDL	0.554	11.1

(continued on next page)

Table 6-4. Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake *(continued).*

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Zinc
	mg/kg							
Chain pickerel 4	<MDL	<MDL	<MDL	2.41	<MDL	<MDL	0.532	5.39
Chain pickerel 5	0.11	0.106	<MDL	3.34	<MDL	0.294	0.225	10.8
Golden shiner 1	13.4	0.254	0.743	31.4	<MDL	21.3	0.054	30.8
Golden shiner 2	4.18	0.197	0.911	34.2	<MDL	14.6	0.104	23.7
Golden shiner 3	9.16	0.276	0.397	28.4	0.11	17.3	0.061	27
Golden shiner 4	7.47	0.292	0.64	29.2	<MDL	11.1	0.055	20.8
Golden shiner 5	8.16	0.254	0.399	10.5	<MDL	8	0.040	18.9
Golden shiner 6	4.23	0.287	0.497	19.3	<MDL	7.34	0.075	30.8
Largemouth bass 1	0.138	0.129	<MDL	4.12	<MDL	0.222	1.040	5.28
Largemouth bass 2	<MDL	0.117	<MDL	2.6	<MDL	<MDL	0.580	4
Largemouth bass 3	0.208	<MDL	<MDL	5.65	<MDL	0.471	0.844	6.56
Largemouth bass 4	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.898	4.23
Largemouth bass 5	<MDL	0.102	<MDL	<MDL	<MDL	<MDL	0.287	4.83
Pumpkinseed 1	0.127	0.1	<MDL	6.55	<MDL	0.445	0.198	6.57
Pumpkinseed 2	0.307	<MDL	0.355	10.7	<MDL	0.652	0.334	13.4
Pumpkinseed 3	0.261	<MDL	<MDL	3.73	<MDL	0.286	0.293	8.99
Pumpkinseed 4	0.143	<MDL	<MDL	7.05	<MDL	<MDL	0.290	7.98
Pumpkinseed 5	0.297	0.129	<MDL	5.92	<MDL	0.314	0.204	12
Pumpkinseed 6	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.194	7.5
Yellow perch 1	0.151	<MDL	<MDL	<MDL	<MDL	0.43	0.087	5.75
Yellow perch 2	0.166	0.100	<MDL	3.22	<MDL	0.449	0.094	7.68
Yellow perch 3	0.22	0.153	0.324	7.67	<MDL	0.904	0.255	7.75
Yellow perch 4	0.2	<MDL	<MDL	3.98	<MDL	1.26	0.066	8.11
Yellow perch 5	<MDL	<MDL	<MDL	<MDL	<MDL	0.219	0.088	4.84
Swan Pond (Peconic River control location)								
Black crappie 1	0.172	<MDL	<MDL	<MDL	<MDL	0.718	0.086	7.32
Black crappie 2	0.645	0.134	0.309	2.6	<MDL	3.33	0.104	10.8
Black crappie 3	1.67	0.231	<MDL	<MDL	<MDL	10.4	0.121	9.59
Black crappie 4	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.097	6.53
Black crappie 5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.080	6.6
Brown bullhead 1	0.365	<MDL	0.737	10.1	<MDL	3.34	0.028	7.83
Brown bullhead 2	0.234	<MDL	0.415	5.81	<MDL	0.362	0.024	6.76
Brown bullhead 3	0.627	<MDL	0.591	7.4	<MDL	1.48	0.016	10.8
Brown bullhead 4	0.268	0.109	0.322	6.42	<MDL	0.517	0.027	6.77
Brown bullhead 5	0.304	<MDL	0.413	10.8	<MDL	0.595	0.006	6.72
Chain pickerel 1	<MDL	0.109	0.731	2.5	<MDL	0.906	0.149	11.8
Chain pickerel 2	<MDL	<MDL	0.503	3.7	<MDL	1.79	0.133	9.45
Chain pickerel 3	<MDL	0.099	0.304	4.04	<MDL	1.24	0.101	13.8
Chain pickerel 4	<MDL	0.202	0.544	2.76	<MDL	0.485	0.163	16.9
Largemouth bass 1	<MDL	<MDL	0.489	3.06	<MDL	<MDL	0.414	6.54

(continued on next page)

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

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Zinc
	mg/kg							
Largemouth bass 2	0.118	0.165	0.438	3.02	<MDL	<MDL	0.218	6.71
Largemouth bass 3	0.154	0.111	<MDL	<MDL	<MDL	0.54	0.196	7.38
Largemouth bass 4	0.151	<MDL	<MDL	<MDL	<MDL	0.59	0.171	7.61
Pumpkinseed 1	0.887	0.149	0.417	6.37	<MDL	4.96	0.059	16.3
Pumpkinseed 2	0.102	<MDL	<MDL	<MDL	<MDL	<MDL	0.067	7.33
Pumpkinseed 3	0.215	<MDL	<MDL	2.73	<MDL	0.687	0.071	14.7
Pumpkinseed 4	0.243	<MDL	<MDL	<MDL	<MDL	0.805	0.033	11.6
Pumpkinseed 5	0.164	<MDL	0.388	3.01	<MDL	0.702	0.041	13.3
Yellow perch 1	<MDL	<MDL	0.438	<MDL	<MDL	1.29	0.112	4.28
Yellow perch 2	0.114	0.163	0.511	2.74	<MDL	0.652	0.084	6.15
Yellow perch 3	<MDL	0.131	0.502	4.41	<MDL	0.49	0.115	8.43
Yellow perch 4	<MDL	<MDL	0.442	<MDL	<MDL	0.658	0.115	6.19
Yellow perch 5	0.158	0.186	0.453	<MDL	<MDL	1.4	0.074	7.18
Yellow perch 6	0.203	0.13	0.411	<MDL	<MDL	0.278	0.098	6.79
Lower Lake, Carmans River (control location)								
Bluegill 1	NT	NT	NT	NT	NT	NT	0.044	NT
Bluegill 2	NT	NT	NT	NT	NT	NT	0.042	NT
Bluegill 3	NT	NT	NT	NT	NT	NT	0.072	NT
Bluegill 4	NT	NT	NT	NT	NT	NT	0.041	NT
Bluegill 5	NT	NT	NT	NT	NT	NT	0.018	NT
Bluegill 6	NT	NT	NT	NT	NT	NT	0.030	NT
Bluegill 7	NT	NT	NT	NT	NT	NT	0.027	NT
Largemouth bass 1	NT	NT	NT	NT	NT	NT	0.161	NT
Largemouth bass 2	NT	NT	NT	NT	NT	NT	0.244	NT
Largemouth bass 3	NT	NT	NT	NT	NT	NT	0.073	NT
Largemouth bass 4	NT	NT	NT	NT	NT	NT	0.044	NT
Pumpkinseed 1	NT	NT	NT	NT	NT	NT	0.042	NT
Pumpkinseed 2	NT	NT	NT	NT	NT	NT	0.037	NT
Pumpkinseed 3	NT	NT	NT	NT	NT	NT	0.032	NT
Pumpkinseed 4	NT	NT	NT	NT	NT	NT	0.082	NT
Pumpkinseed 5	NT	NT	NT	NT	NT	NT	0.090	NT
Pumpkinseed 6	NT	NT	NT	NT	NT	NT	0.059	NT
Pumpkinseed 7	NT	NT	NT	NT	NT	NT	0.062	NT
Pumpkinseed 8	NT	NT	NT	NT	NT	NT	0.058	NT
Pumpkinseed 9	NT	NT	NT	NT	NT	NT	0.052	NT

Notes:
See Figure 5-8 for sampling locations.
All fish were analyzed as edible portions (fillets) except for golden shiners, which were analyzed as whole body-composite samples.
MDL = Minimum Detection Limit
NT = parameter not tested due to insufficient sample size.
Letters following sample numbers indicate specific on-site area designation associated with the Peconic River cleanup.

Due to its known health effects, mercury is the metal of highest concern. Mercury in on-site Peconic River samples ranged from 0.13 mg/kg in a brown bullhead to 1.35 mg/kg in a pumpkinseed. This compares to a range of 0.46 to 0.62 mg/kg in fish taken in 2006. The larger range in the 2007 on-site data is due to a larger sample size and larger range in fish size. Off-site Peconic River samples ranged from less than the MDL in a brown bullhead from Donahue's Pond to 1.04 mg/kg in a largemouth bass from Forge Pond. This range can be compared to 0.02 mg/kg in bluegill and golden shiner to 0.78 mg/kg in a brown bullhead taken from the Manor Road area in 2006. The highest 2007 mercury value in the control location on the Carmans River was 0.24 mg/kg. All mercury values were less than the 1.0 mg/kg consumption standard set by the U.S. Food and Drug Administration, with the exception of the one largemouth bass from Forge Pond, mentioned above.

Values for metals not shown in Table 6-4 because they were at or near MDL were as follows: antimony was found in various species in levels between 0.30 and 1.26 mg/kg throughout the Peconic River; arsenic and cadmium were not detected in any sample taken from the Peconic River; nickel was recorded in Peconic River fish at levels between 0.10 mg/kg in a yellow perch from Swan Pond and 2.93 mg/kg in a brown bullhead taken at Schultz Rd; selenium was found in a yellow perch from Swan Pond at 0.59 mg/kg; and silver was found in a range from 0.10 mg/kg in largemouth bass, yellow perch, and golden shiners to 0.20 mg/kg in brown bullhead from Swan Pond. These reported values and those presented in Table 6-4 are not considered to pose any health risks to humans or animals that might consume the fish.

Table 6-5 shows the results of pesticide and PCB analyses in fish. Only samples and compounds with detectable results are presented. Concentrations of DDE and DDD, which are breakdown products of the pesticide DDT, were found in low levels in both on- and off-site fish sampled in 2007. DDT was found in seven fish from both the Peconic River and Carmans River. DDT ranged from 3.01 µg/kg in a yellow perch to 8.20 µg/kg in a largemouth bass, both from Forge Pond. The levels of pesticides detected did not exceed any established health standards for the consumers of such fish and thus are not considered harmful. DDT was commonly used on Long Island before 1970.

PCBs were found at levels above the MDL in four fish samples taken from the Peconic River system. On site, Aroclor-1254 was found in a single sample at 252 µg/kg in a brown bullhead; off site, at 5.5 µg/kg estimated in a chain pickerel from Swan Pond, 16.5 µg/kg in a brown bullhead from Schultz Rd, and 28 µg/kg in a yellow perch taken from Forge Pond. Aroclor-1242 was found in a concentration of 12.8 µg/kg in the same chain pickerel taken at Swan Pond that also contained Aroclor-1254. Aroclor-1248 was found in two fish at a concentration of 16.1 µg/kg in a brown bullhead taken from Donahue's Pond and 0.01 µg/kg in the same yellow perch from Forge Pond that contained Aroclor-1254. Historically, PCBs have been found in both fish and sediment at BNL and periodically at other locations in the Peconic River. The cleanup of the Peconic River that was completed in 2005 removed most PCBs within the sediments.

PCB and pesticide testing will be discontinued in fish samples in 2008 except for fish taken on site at BNL, which will continue to be tested for PCBs. This reduction in analysis is based on several years of data that show mostly the presence of DDT and its breakdown products in low levels. PCB monitoring will continue on site to document the effectiveness of the Peconic River cleanup. The Laboratory may periodically test for PCBs and pesticides in fish to verify the presence/absence in fish tissue.

6.3.5 Aquatic Sampling

6.3.5.1 Radiological Analysis

Annual sampling of sediment, vegetation, and freshwater in the Peconic River and a control location on the Carmans River was conducted in 2007. See Chapter 5 for a discussion on water quality and monitoring, and Figure 5-8 for the locations of sampling stations. Additionally refer to Section 6.3.6 for a discussion of sediment and water analysis related to monitoring post-cleanup of the Peconic River. Because significant numbers of samples are now taken under

Table 6-5. Pesticide and PCB Analyses of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	4,4"-DDD	4,4"-DDE	4,4"-DDT	Dieldrin	Endrin aldehyde	Aroclor-1242	Aroclor-1248	Aroclor-1254
	µg/kg							
BNL, On Site								
Brown bullhead	NT	NT	NT	NT	NT	<MDL	<MDL	252
Schultz Road								
Black crappie	1.89*	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 3	5.26	0.01	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 1	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	16.5
Brown bullhead 4	3.36*	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 5	<MDL	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 6	2.81*	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 7	10.70	0.02	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 8	4.08	0.01	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass	4.93	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 2	1.54*	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Swan Pond (Peconic River control location)								
Black crappie 1	<MDL	5.47	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 2	<MDL	1.84*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 3	6.05	28.60	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 4	<MDL	3.76*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 5	<MDL	4.25	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 1	<MDL	0.01	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 2	53.80	0.07	4.12	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 3	4.62	10.10	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 4	3.13*	12.70	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 5	<MDL	3.58*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Chain pickerel 2	<MDL	<MDL	<MDL	<MDL	<MDL	12.8	<MDL	5.5*
Chain pickerel 3	<MDL	1.76*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 1	<MDL	9.66	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 2	<MDL	1.56*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 2	<MDL	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 3	<MDL	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 4	<MDL	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 5	<MDL	0.00	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Yellow perch 1	<MDL	2.38*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Yellow perch 5	<MDL	1.03*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Yellow perch 6	<MDL	3.83*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Donahue's Pond								
Bluegill 6	<MDL	3.27*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 3	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	16.1*	<MDL
Brown bullhead 5	<MDL	2.12*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 1	3.72*	3.48*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

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Table 6-5. Pesticide and PCB Analyses of Fish from the Peconic River System and Carmans River, Lower Lake *(concluded).*

Location/Species	4,4"-DDD	4,4"-DDE	4,4"-DDT	Dieldrin	Endrin aldehyde	Aroclor-1242	Aroclor-1248	Aroclor-1254
	µg/kg							
Forge Pond								
Black crappie 1	2.54*	6.54	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 2	1.38*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Black crappie 3	1.91*	3.24*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 1	13.60	27.40	<MDL	2.29*	<MDL	<MDL	<MDL	<MDL
Brown bullhead 2	3.2*	6.21	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 3	3.8*	7.39	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 4	3.11*	5.31	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 5	2.63*	4.91	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Brown bullhead 6	15.80	30.80	<MDL	2.1*	<MDL	<MDL	<MDL	<MDL
Chain pickerel 2	<MDL	1.95*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Chain pickerel 5	<MDL	4.07	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Golden shiner 1	34.00	24.60	<MDL	1.88*	<MDL	<MDL	<MDL	<MDL
Golden shiner 2	13.10	7.99	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Golden shiner 3	23.80	23.60	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Golden shiner 4	31.30	26.20	<MDL	3.61*	<MDL	<MDL	<MDL	<MDL
Golden shiner 5	32.70	21.10	<MDL	4.48	<MDL	<MDL	<MDL	<MDL
Golden shiner 6	23.10	21.90	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 1	1.46*	3.97*	8.20	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 5	0.00	3.47*	7.94	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 1	3.16*	10.00	7.84	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 2	4.48	6.86	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 3	2.54*	3.33*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 4	1.75*	2.59*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 6	<MDL	2.1*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Yellow perch 2	2.68*	5.56	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Yellow perch 3	15.80	48.60	3.01*	2.73*	<MDL	<MDL	<MDL	<MDL
Yellow perch 4	11.00	25.90	<MDL	1.56*	<MDL	<MDL	<MDL	<MDL
Yellow perch 5	4.09	9.87	<MDL	<MDL	<MDL	<MDL	0.01	28
Lower Lake, Carmans River (control location)								
Bluegill 2	2.18*	4.47	5.37	<MDL	1.69*	<MDL	<MDL	<MDL
Bluegill 5	2.03*	4.88	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Bluegill 7	<MDL	2.04*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 1	<MDL	1.52*	4.92	<MDL	<MDL	<MDL	<MDL	<MDL
Largemouth bass 4	<MDL	2.47*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 1	<MDL	1.49*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 2	<MDL	1.72*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pumpkinseed 6	<MDL	1.17*	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Notes:
Only samples showing detectable levels of pesticides and/or PCBs are presented.
All fish analyzed as edible portions (fillets) except for golden shiner, which were analyzed as whole body-composite samples.
MDL = Minimum Detection Limit
PCB = Polychlorinated biphenyls
NT = parameter not tested
* = estimated value based on laboratory qualifiers.

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	40.9 ± 3.72	ND
Water	ND	ND
Donahue's Pond		
Aquatic vegetation	0.35 ± 0.09	0.02 ± 0.00
Sediment	0.53 ± 0.36	0.06 ± 0.03
Water	ND	ND
Forge Pond		
Aquatic vegetation	1.93 ± 0.21	0.02 ± 0.01
Sediment	2.78 ± 0.45	0.14 ± 0.02
Swan Pond (Peconic River control location)		
Aquatic vegetation	2.97 ± 0.35	0.03 ± 0.01
Sediment	2.39 ± 1.13	1.04 ± 0.15
Lower Lake, Carmans River (control location)		
Aquatic vegetation	NR	ND
Sediment	NR	0.77 ± 0.20

Notes:
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected
NR = not reported
Aquatic vegetation is reported as wet weight except for BNL sample reported dry.
Sediment samples are reported on a dry weight basis.

this monitoring program, fewer samples are being taken through routine surveillance monitoring, to reduce duplication of effort.

Table 6-6 summarizes the radiological data. Low levels of Cs-137 were documented in sediments and vegetation at Donahue's Pond, Swan Pond, and Forge Ponds, while sediment samples taken at Lower Lake on the Carmans River only had low levels of Cs-137 detected.

6.3.5.2 Metals in Aquatic Samples

Metals analyses (Table 6-7) were conducted on aquatic vegetation and sediments from the Peconic River and Carmans River. Most of 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 thalium. In general, levels of these metals are either below detection limits, below action levels or cleanup objectives, or, like sodium, are fairly common in the environment. Beryllium was detected in sediment from Donahue's Pond at 1.11 mg/kg, which is just below the SCDHS cleanup objectives but well below action levels. Cadmium was found in sediments at Swan Pond at a concentration of 1.75 mg/kg which, like beryllium, is above cleanup objectives but well below SCDHS action levels. Lead was found to be above cleanup objectives at both control locations, but it was well below any action levels. Nickel was the only other metal to be found above cleanup objectives and was found at a concentration of 14.4 mg/kg in sediments from the Lower Lake control location.

6.3.5.3 Pesticides and PCBs in Aquatic Samples

Pesticides and PCBs analyses of aquatic samples continue to indicate the presence of DDT and its breakdown products in low levels in sediments of Swan Pond and Forge Pond. No pesticides or PCBs were detected in aquatic vegetation sampled at all locations. In general, DDT and its breakdown products appear to be slowly declining. Routine vegetation and sediment samples were not taken from on-site portions of the Peconic River, due to extensive post-cleanup monitoring associated with cleanup efforts.

6.3.6 Peconic River Post-Cleanup Monitoring

Sediment from the Peconic River was remediated in 2004 and 2005 to remove mercury and associated contaminants from the river. The cleanup of sections of the river on site focused on sediment in known depositional areas. The goal of the cleanup was to reduce the average mercury concentrations on site to less than 1 mg/kg, with an overall goal to reduce mercury concentrations in the remediated areas, both on site and off site, to less than 2 mg/kg. On-site remediation efforts resulted in a 96 per-

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

Location/ Sample Type	Aluminum	Barium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Vanadium	Zinc
	mg/kg													
BNL, On Site														
Aquatic vegetation	76.6	3.15	484	0.232	0.411	2.28	225	0.17	42.9	0.023	0.797	0.293	0.372	13.3
Water ug/L	245	17.8	6670	12.1	<MDL	19.3	1730	<MDL	50.5	<MDL	11.5	<MDL	2.1	33.6
Donahue's Pond														
Aquatic vegetation	40	56.8	427	0.162	1.07	0.364	807	0.66	155	<MDL	0.137	0.16	0.558	23.8
Sediment	4060	95.1	3140	8.71	3.47	5.55	7950	8.9	112	0.104	2.26	<MDL	20.9	10.5
Water ug/L	122	44.7	8360	2.4	3.5	7.1	7400	0.51	393	<MDL	<MDL	2.6	3.2	10
Forge Pond														
Aquatic vegetation	<MDL	26	1620	<MDL	<MDL	0.693	64	<MDL	90.6	NR	<MDL	<MDL	<MDL	5.12
Sediment	522	8.86	212	0.994	<MDL	3.94	745	4.4	11.7	NR	0.61	<MDL	1.47	10.1
Swan Pond (Peconic river control location)														
Aquatic vegetation	<MDL	12.5	2370	<MDL	<MDL	0.408	16.6	<MDL	380	NR	0.136	<MDL	<MDL	4.78
Sediment	4980	70.3	6340	18.2	5.39	30.1	8100	134	1780	NR	12.5	3.6	31.4	130
Lower Lake, Carmens River (control location)														
Aquatic vegetation	57.9	181*	14600	1.4*	0.22	2.3	260	<MDL	208	<MDL	1.3	<MDL	3.2	66.6*
Sediment	10900*	132*	3350	41.5*	9.6	20.6	11700	107	661	0.35	14.4	0.18	33.7	169*
SCDHS														
Action levels	N/A	N/A	N/A	100	N/A	500	N/A	400	N/A	2	1000	100	N/A	N/A
Cleanup Objectives	N/A	N/A	N/A	10	N/A	25	N/A	100	N/A	0.1	13	5	N/A	N/A

Notes:
See Figure 5-8 for sampling locations.
MDL = Minimum Detection Limit
NR = not reported
* = estimated value based on laboratory qualifiers.

cent reduction in average mercury concentrations in river sediments, from approximately 4.6 mg/kg to 0.2 mg/kg (Envirocon, 2005).

Cleanup of off-site locations focused on a more stringent cleanup target that would allow the greatest flexibility for use as County parkland or for potential development. Sediment was removed from ponded areas where methylation leading to bioaccumulation is most likely to occur, as well as other areas containing higher concentrations of contamination east of the BNL property line to sections of the river upstream and downstream of Manor Road. The cleanup goal was to reduce average mercury concentrations within the sediment to less than 0.75 mg/kg, with an overall mercury concentration goal of less than 2 mg/kg following the cleanup. Off-site remediation efforts resulted in a 95 percent reduction in average mercury concentrations in river sediments downstream of the BNL property line, from approximately 1.8 mg/kg to 0.09 mg/kg, excluding the Manor Road area, which had an 83 percent reduction, from 1.08 mg/kg to 0.19 mg/kg (Envirocon, 2005).

The Laboratory and DOE are committed to a multi-year post-cleanup sampling of sediment, surface water, fish, and wetland restoration. Sampling results for 2007 are summarized below. Detailed information on 2007 sampling results can be found in the 2007 Peconic River Monitoring Report (BNL, 2008).

6.3.6.1 Sediment Sampling

Sediment was sampled in June 2007 at 16 Peconic River sampling stations on site and 14 sampling stations off site. Ninety-seven percent of the 30 annual sediment samples collected in 2007 met the mercury clean-

up goal of 2.0 mg/kg. One sample exceeded the 2.0 mg/kg goal. The sample results were shared with NYSDEC, EPA, and SCDHS. In August 2007, additional sediment samples were taken from transects upstream and downstream of two stations that had concentrations of mercury higher than 2.0 mg/kg during the 2006 annual sediment sampling. The August 2007 sample results indicated that mercury concentrations exceeded 2.0 mg/kg in two relatively small areas. Further evaluation of these areas will include additional sediment and surface water sampling in 2008.

6.3.6.2 Water Column Sampling

Surface water was analyzed for total mercury and methylmercury at 20 Peconic River sampling stations (see Figure 6-4) and one reference station on the Connetquot River. Samples were taken in both June and August. The 2007 June and August concentrations of total mercury were generally less than the respective 2003 pre-cleanup total mercury concentrations. Although the June 2007 methylmercury concentrations were generally higher than the June 2003 pre-cleanup methylmercury concentrations, the August 2007 methylmercury samples were generally lower than the August 2003 concentrations. Methylmercury samples collected from the STP effluent indicated that the STP is not a significant source of methylmercury to the Peconic River. However, total mercury samples collected from the Peconic River upstream and downstream of the STP and from the STP effluent indicated that the STP effluent does add mercury to the Peconic River at concentrations greater than the total mercury concentration upstream of the STP.

6.3.6.3 Fish Sampling

In 2007, fish were collected from Area A downstream of the STP, Area C, Area D near North Street, Schultz Road, the Manor Road area, and Donahue's Pond. The average mercury concentration among all fish was 0.32 mg/kg. The EPA criterion for methyl mercury concentration in fish tissue is 0.3 mg/kg. The average PCB concentration in fish in 2007 for all locations was below the detection limit. The 2007 average value for Cs-137 was also substantially lower than previous values.

6.3.6.4 Wetland Sampling

The annual wetland invasive plant survey and removal operations were conducted by Roux Associates, Inc. during July 2007. Twenty-seven 42-gallon bags of Phragmites stalks and rhizomes were removed from the previously remediated sections of the Peconic River on BNL property, and 14 bags of Phragmites were removed from the off-site remediated sections of the river.

As of September 2006, the Laboratory met and exceeded the DEC Equivalency Permit requirements for "cover" growth in on-site marshy areas. A target percent cover of 65 percent in the low marsh was achieved, with an overall average for all 64 transects of 92 percent. No low marsh cleanup area had less than 79 percent cover, and percent cover of invasive species was less than the permit limit of 10 percent in any one wetland restoration. This was achieved with an average percent cover (for permit-specified invasive wetlands plants) of less than 1 percent across all cleanup areas.

In August, 2007, DEC toured the Peconic River wetlands and determined that the DEC Permit Equivalency conditions had been met. Monitoring of invasive species will continue until 2008, at which time BNL will evaluate all wetland restoration and invasive species surveys and control operations since completion of the cleanup in 2005. Based on the results of the evaluation, BNL may request EPA's approval that all Peconic River federal wetland restoration requirements have been met.

6.3.7 Vegetation Sampling

6.3.7.1 Garden Vegetables

On-site sampling of garden vegetables continued in 2007 (Table 6-8). Samples of zucchini, cucumber, tomato, pepper, and eggplant were analyzed for Cs-137 content. This radionuclide was not detected in any vegetable sample, but was detected in soils at very low levels (0.26 pCi/g). Sampling of off-site farm vegetation was discontinued in 2003 because historical data have consistently indicated the absence of BNL-

related radionuclides in off-site vegetation. Confirmatory sampling (done approximately every 5 years) will be conducted off site to obtain data on farm vegetables in 2008.

6.3.7.2 Grassy Plants

In 2003, grassy vegetation sampling was converted to a graded approach and was linked to other sampling programs. As an example of this approach, vegetation sampling would be conducted only if routine air sampling indicated that radionuclides had been released and deposited on soil and vegetation. Periodic confirmatory sampling of grassy vegetation was conducted in 2007. Results of this sampling are presented in Table 6-8.

Eleven samples of grassy vegetation from various lawn and cleanup areas across the Laboratory and one off-site sample for comparison were taken. None of the vegetation samples had detectable concentrations of Cs-137.

Table 6-8. Radiological Analyses of Garden Vegetables, Grassy Vegetation, and Associated Soils.

Location	Matrix	K-40 pCi/g	Cs-137 pCi/g
Garden Vegetables			
BNL Garden	Cucumber	1.69 ± 0.19	ND
	Eggplant	1.99 ± 0.33	ND
	Pepper	1.71 ± 0.21	ND
	Tomato	2.54 ± 0.26	ND
	Zuccini	1.58 ± 0.19	ND
	Soil	5.25 ± 0.98	0.26 ± 0.06
Grassy Vegetation			
Bldg. 490, back lawn	Vegetation*	14.1 ± 4.1	
	Soil	6.55 ± 0.59	0.29 ± 0.03
Bldg. 30, front lawn	Vegetation*	23.6 ± 7.5	ND
	Soil	10.80 ± 0.91	0.04 ± 0.01
Guest House, front lawn	Vegetation*	26.50 ± 6.10	ND
	Soil	6.25 ± 0.56	0.30 ± 0.03
NYSDEC Game Farm	Vegetation*	24.10 ± 7.25	ND
	Soil	4.77 ± 0.51	0.26 ± 0.03
Bldg. 515, front lawn	Vegetation*	14.90 ± 6.15	ND
	Soil	9.43 ± 0.72	4.47 ± 0.31
Bldg. 355, east lawn	Vegetation*	13.40 ± 6.41	ND
	Soil	9.41 ± 0.76	0.53 ± 0.04
Cornell Ave. and Upton Rd., no-mow area	Vegetation*	8.69 ± 4.53	ND
	Soil	5.16 ± 0.45	0.21 ± 0.02
650 Sump	Vegetation*	7.54 ± 4.08	ND
	Soil	5.74 ± 0.50	0.16 ± 0.02
North of 5th Ave.	Vegetation*	4.51 ± 3.03	ND
	Soil	6.42 ± 0.50	1.01 ± 0.08
Biology Fields	Vegetation*	11.30 ± 6.54	ND
	Soil	7.14 ± 0.57	0.09 ± 0.02
Near basin HTW	Vegetation*	9.96 ± 7.42	ND
	Soil	6.46 ± 0.63	0.18 ± 0.02

Notes:
Garden vegetables are reported as wet weight values.
Grassy vegetation is reported as dry weight values.
Cs-137 = cesium-137
K-40 = potassium-40
* = estimated value for K-40.

6.4 OTHER MONITORING

6.4.1 Soil Sampling

Soil sampling uses the same graded approach as that used for grassy vegetation sampling and was removed from the basic monitoring protocols in 2003. Confirmatory soil sampling was conducted along with the grassy vegetation sampling mentioned above. Soil samples from each location of a vegetation sample were taken and the results of the analysis are presented in Table 6-8. Soil concentrations of Cs-137 ranged from 0.04 to 4.47 pCi/g dry weight in various locations. This is compared to 0.26 pCi/g dry weight found at the NYSDEC game farm in Ridge. Most samples were considered to be at or below background levels, with the exception of the sample taken near Building 515. This location was one of the sites of landscape soil cleanup in 2000 and 2001. The elevated values are likely due to soil disturbance. A review of the data with the BNL Radiological Controls group indicated no concern for human activities on or adjacent to this location.

6.4.2 Basin Sediments

A 5-year testing cycle for basin sediment samples was established in 2003. There are 14 basins associated with outfalls that receive discharges permitted under the State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-6 for outfall locations). Basin sediments were sampled in 2007 and results are presented in Tables 6-9 and 6-10. Since there have not been radiological concerns with discharges to these basins, analysis of basin sediments was limited to PCBs, metals, and semi-volatile organic chemicals.

Table 6-9. Metals Analyses of Basin Sediment.

Analyte	HT-E	HT-W	HO EAST	HO WEST	HS	HW	HN-N	HN-M	HN-S	SCDHS Action Level	SCDHS Clean-up Obj.
					mg/kg						
Aluminum	1490	1040	644	731	3630	2380	1430	6400	1810	N/A	N/A
Antimony	0.15	< MDL	< MDL	< MDL	0.6	0.21	< MDL	0.08	< MDL	N/A	N/A
Arsenic	1.1	0.6	1.3	0.58	2.2	0.75	0.44	1.4	0.51	25	7.5
Barium	11.9	9.3	29.7	7.4	11	12.2	6.8	20.9	7.1	N/A	N/A
Beryllium	0.15	0.04	0.04	0.04	0.1	0.08	0.05	0.2	0.05	8	1.6
Cadmium	0.36	0.07	0.04	0.05	0.09	0.46	0.1	0.23	0.16	10	1
Calcium	2670	7430	292	611	539	13600	163	418	245	N/A	N/A
Chromium	6.6	3.1	1.7	5.7	4.9	10.4	4.8	4.9	3.7	100	10
Cobalt	2.9	1.1	2.1	2	1.3	2.3	0.61	1.4	0.91	N/A	N/A
Copper	66.7	60.9	6	6.1	10.2	11.6	14.1	33	25.5	500	25
Iron	3920	2610	5480	3300	4350	4590	4460	4390	3380	N/A	N/A
Lead	20.4	11.5	2	3.4	24.8	17.8	4	14.3	10	400	100
Magnesium	1550	4020	186	607	476	8020	203	624	408	N/A	N/A
Manganese	128	53.6	440	76.6	34.5	89.6	18.4	35.4	21.1	N/A	N/A
Mercury	0.03	0.02	< MDL	< MDL	0.02	0.02	0.01	0.02	0.01	2	0.1
Nickel	10.6	3.3	1.6	2.1	3.8	10.3	2.5	5.2	3.2	1000	13
Potassium	128	117	61.6	57.7	131	122	94.3	152	99.6	N/A	N/A
Silver	0.13	0.06	< MDL	< MDL	0.06	0.04	< MDL	0.06	0.04	100	5
Vanadium	12.1	3.8	3.6	3.6	8.1	10.7	4.5	6.6	5	N/A	N/A
Zinc	105	65.8	16.9	35	59.1	62.3	29.7	86.9	51	N/A	N/A

Notes:
See Figure 5-6 for basin locations.
MDL = Minimum Detection Limit
SCDHS = Suffolk Country Department of Health Services

Analysis of basin sediments for PCBs indicated the continued presence of Aroclor-1254 and Aroclor-1260 at concentrations of 56 and 96 µg/kg, respectively, in Basin HW (Weaver Road Basin). Aroclor-1254 was also present in basin HT-E at a concentration of 93 µg/kg. These values are within the range of values previously detected in this basin.

Results of metals analysis of basin sediments are presented in Table 6-9. Of all metals having SCDHS cleanup objectives, only chromium was detected slightly above the target of 10 mg/kg, with a value of 10.4 mg/kg in basin HW; this is well below the action level of 100 mg/kg. While not a matter of concern, basin HW showed a marked increased in values of calcium and magnesium, compared to values obtained in 2002. Calcium increased from 1,630 mg/kg in 2002 to 13,600 mg/kg in 2007. Magnesium increased from 1,400 mg/kg to 8,020 mg/kg in the same period. The increase in these two metals is likely due to stormwater runoff from the former warehouse area. Many of the old World War II–era warehouses have been demolished over the past several years as new facilities have been installed. The removal of concrete foundations left dust that was likely carried by stormwater to basin HW.

Analysis of basin sediments for semi-volatile organic compounds resulted in positive results for a number of compounds associated with road runoff and the combustion of fossil fuels. Table 6-10 presents the results of analysis and only shows compounds that were found in one or more ba-

sins. Several of the compounds listed were above SCDHS action levels in basins HO and HT-E. The sampling occurred late in the year and the basins could not be resampled before the end of the year. Therefore the basins were scheduled to be re-sampled early in 2008, in coordination with SCDHS.

6.4.3 Chronic Toxicity Tests

Under the SPDES discharge permit, BNL conducted chronic toxicity testing of the STP effluents. Results of this testing are discussed in Chapter 3, Section 3.6.1.1. Testing will continue in 2008.

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), and were analyzed for radiological content and total mercury. Four samples were taken from each of these two stations in 2007. Gross alpha activity measurements were above the MDL at both P4 and S5 in January 2007. Values were estimated at 1.67 and 1.71 pCi/L from the two stations, respectively.

Gross beta activity was measured in samples in all four quarters from both stations. 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 4.8 pCi/L, with an average of 3.84 pCi/L. Location S5

Table 6-10. Semi-Volatile Organic Compounds Analyses of Basin Sediments.

Analyte	HT-E	HT-W	HO EAST	HO WEST	HS	HW	HN-N	HN-M	HN-S	HN-New	SCDHS Action Level	SCDHS Cleanup Obj.
	ug/kg											
2-Methylnaphthalene	< MDL	540	< MDL	110*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	N/A	N/A
Acenaphthene	< MDL	1900	< MDL	660	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50000	50000
Anthracene	< MDL	1800	< MDL	780	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50000	50000
Benzo(a)anthracene	100*	3500	< MDL	1500	83*	48*	< MDL	47*	< MDL	< MDL	6000	3000
Benzo(a)pyrene	86*	2800	< MDL	1000	100*	57*	< MDL	65*	41*	< MDL	22000	11000
Benzo(b)fluoranthene	94*	2900	< MDL	1000	110*	56*	< MDL	72*	55*	< MDL	2200	1100
Benzo(ghi)perylene	< MDL	1200	< MDL	430	74*	47*	< MDL	< MDL	< MDL	< MDL	50000	50000
Benzo(k)fluoranthene	100*	2700	< MDL	1200	120*	60*	< MDL	73*	58*	< MDL	2200	1100
Bis(2-ethylhexyl)phthalate	130*	48*	< MDL	< MDL	< MDL	92*	< MDL	74*	< MDL	< MDL	N/A	N/A
Butyl benzyl phthalate	< MDL	< MDL	< MDL	< MDL	< MDL	23000*	< MDL	< MDL	< MDL	< MDL	N/A	N/A
Carbazole	< MDL	1500	< MDL	560	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	N/A	N/A
Chrysene	140*	4500	< MDL	1700	120*	70*	< MDL	82*	70*	< MDL	800	400
Dibenzo(a,h)anthracene	< MDL	480	< MDL	170*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50000	50000
Dibenzofuran	< MDL	1000	< MDL	280*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	N/A	N/A
Fluoranthene	190*	8700*	< MDL	3400	150*	93*	< MDL	110*	140*	< MDL	50000	50000
Fluorene	< MDL	1500	< MDL	500	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50000	50000
Indeno(1,2,3-cd)pyrene	< MDL	1400	< MDL	470	69*	< MDL	< MDL	< MDL	< MDL	< MDL	6400	3200
Naphthalene	< MDL	1100	< MDL	230*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	10000	10000
Phenanthrene	110*	8600*	< MDL	3100	44*	< MDL	< MDL	< MDL	66*	< MDL	50000	50000
Pyrene	160*	6500	< MDL	2400	130*	81*	< MDL	95*	100*	< MDL	50000	50000

Notes:
Basin locations are shown in Figure 5-6 in Chapter 5.
MDL = Minimum Detection Limit
SCDHS = Suffolk County Department of Health Services
N/A = not applicable
* = estimated values based on laboratory qualifiers.
Only analytes with positive detections in one or more basins are presented.

had a maximum gross beta activity level of 6.7 pCi/L, with an average of 4.53 pCi/L. Gross beta activity values were within the range of values historically observed at these two locations. Beryllium-7 (Be-7) was the only radionuclide found above detection levels in precipitation samples. Be-7 was found during the second quarter sampling period at 39.4 pCi/L in rain from station S5, and at 49.6 pCi/L in rain from station P4. Be-7 is produced in the atmosphere by cosmic radiation and is periodically found in precipitation.

Beginning in 2006, BNL began testing precipitation for low level mercury in order to document the effect of atmospheric deposition of mercury on the Peconic River. Low level mercury analysis of precipitation indicated that atmospheric deposition of mercury ranged from non-detectable quantities in samples taken in January and May from Stations P4 and S5 to 13.5 ng/L and 13.2 ng/L, respectively.

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 BNL 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 2007, the Environmental and Waste Management Services Division (EWMSD) and FERN hosted a total of 16 interns and one faculty member. Interns consisted of a high school intern, 11 undergraduate interns, and four school teachers during the summer. FERN also hosted two of the undergraduate interns for the development of Freshwater Wetland Health Monitoring Protocols. Two of the undergraduate interns worked with a faculty member from Southern University at New Orleans, as part of the Faculty and Student Teams Program. Interns worked on a variety of projects: surveying dragonflies and damselflies, radio tracking turtles, analyzing the water chemistry of coastal plain ponds, investigating turtle and amphibian diseases, investigating the loss of the southern leopard frog on Long Island, genetics of resident gray and red fox at BNL, and population health of the banded sunfish. Teachers conducted mark-recapture and distribution studies on tiger beetles and burying beetles. Teachers also participated in a week-long workshop in environmental monitoring under the Open Space Stewardship Program, which is managed by the BNL Office of Education Programs and partially funded by FERN. A limited discussion concerning each project is presented below.

An intern continued the long-term work on the identification and distribution of dragonflies and damselflies (Order *Odonata*) that was started in 2003, and expanded the project of using simple mark-recapture techniques for determining population estimates of dragonflies. These aquatic insects are common around the ponds and Peconic River on site. The distribution of aquatic insects is useful for monitoring the health of aquatic systems. In addition, results from the Odonate surveys will supplement the New York State Odonate Atlas. The number of species identified to date is 60. The state atlas project will continue for another year, as will the Laboratory's surveys for Odonates.

In 2005, three eastern box turtles were found in one of BNL's many ponds. All three turtles had a fairly common infection of the ear. The turtles were taken to a wildlife rehabilitator for treatment and care. Two of the turtles subsequently died of their infections and their tissues were sent for analysis. In the analysis, an iridovirus implicated in amphibian declines was isolated. This resulted in a summer intern project started in 2006 and continued in 2007, with the help of a high school intern, in which samples from eastern box turtles were taken for virus identification and a radio telemetry study was conducted to look at range overlap. Range overlap is important to determine the potential for infected turtles to encounter non-infected turtles and transmit the virus. The study was conducted by an intern from Maine and provided indication of significant territorial overlap between individual turtles within a given area. This poses a potential problem if any of the turtles is carrying a virus.

Another intern continued working with a Ph.D. candidate from Rutgers University on the distribution of the southern leopard frog and chytrid fungus on Long Island. The southern leopard frog has had precipitous population declines, and the focus was to attempt to find existing populations of this frog and to document whether or not chytrid fungus is present in other frog species across Long Island. Unfortunately, the southern leopard frog still has not been found in any of the water bodies investigated. A second part of this work was to look at the potential effectiveness of reintroduction of the frog through cage rearing experiments which looked at the growth and survival of larvae in different wetlands.

Two interns revisited a project conducted in 2005 to look at the population health of the banded sunfish in an isolated pond on site. This effort is necessary to ensure the continued presence of this New York State threatened species and potentially use the protected population as a source for reintroductions in the future. This project is expected to be expanded with the help of the NYSDEC Inland Fisheries unit in 2008 to verify the distribution of this rare fish across eastern Long Island in preparation for establishing a recovery plan.

The Faculty and Student Team (FaST), along with an intern under the Science Undergraduate Laboratory Internship (SULI) program, conducted extensive tests of approximately 30 ponds across eastern Long Island looking at metals in sediments and at water quality parameters. The work facilitates the development of criteria for selecting ponds for wetland health monitoring based on their distance from disturbing factors like roads and development. This work is also important in assessing the long-term effects of acid rain.

Four teachers participating in the Academies Creating Teacher Scientists (ACTS) program worked on developing simple outdoor experiments that can be utilized with biology and environmental classes. The teachers established mark-recapture studies on several species of tiger beetles and with burying beetles. As mentioned above, the teachers also attended a week-long workshop under the Open Space Stewardship Program (OSSP) called "Gaining Research Experience in the Environment (GREEN) Institute," where they shared their expertise with approximately 20 other teachers participating in OSSP so they could discuss the program within their home schools. The OSSP is expected to grow throughout Suffolk County to foster a sense of stewardship in students and to gather much-needed environmental data on numerous open space parcels throughout the county.

Another of the undergraduate students continued working on a project to isolate genetic material from fox droppings. This non-invasive genetic technique is being utilized to look at the inter-relatedness of numerous fox families living on site, and to try to distinguish between red and gray fox. The gray fox is known to live on site, but is rarely seen. Once thought to be extirpated from Long Island, a gray fox that had been struck by a car was found on site in 2004. Using non-invasive genetics techniques may also allow researchers to estimate population size and distribution of these two species.

FERN hosted two summer students who assisted in the development and testing of monitoring protocols for determining the health of wetlands within the Long Island Central Pine Barrens. The students' work, along with the monitoring protocols, is available on the FERN website at www.fern-li.org.

Members of EWMSD and other BNL departments volunteered as speakers for schools and civic groups and provided on-site ecology tours. EWMSD also hosted several environmental events in association with Earth Day. In October, BNL hosted the Twelfth Annual Pine Barrens Research Forum for ecosystems researchers to share and discuss their results.

The Laboratory also hosted the annual Wildland Fire Academy, offered by NYSDEC and the Central Pine Barrens Commission. Using the Incident Command System of wildfire management, this academy trains fire fighters in the methods of wildland fire suppression, prescribed fire, and fire analysis. BNL has developed and is implementing a Wildland Fire Management Plan. While plans were prepared for conducting a prescribed fire during the Academy, the

conditions did not meet the requirements of the prescription. Post-fire monitoring on previous fires that was conducted in 2007 indicates that prescribed fires have been somewhat effective at opening up the understory to allow forest regeneration. The Laboratory intends to continue the use of prescribed fire for fuel and forest management in the future, and is working with NYSDEC and The Nature Conservancy to prepare additional prescriptions for a larger portion of the northern and eastern sections of the BNL property.

6.6 CULTURAL RESOURCE ACTIVITIES

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with the numerous cultural resource regulations. The Cultural Resource Management Plan for Brookhaven National Laboratory (BNL, 2005) guides the management of all of BNL'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 Laboratory'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 being 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 complex, the High Flux Beam Reactor complex, and the WWI training trenches associated with Camp Upton. The BNL trenches are examples of the few surviving WWI earthworks in the United States.

Cultural resource management activities performed in 2007 include identifying additional equipment artifacts associated with the HFBR and BGRR, and electronically scanning the diary of a World War I soldier for website posting.

Outreach activities consisted of providing presentations on Laboratory cultural resources and tours of the WWI trenches to several small groups, and participating in local fairs.

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