BROOKHAVEN
NATIONAL
LABORATORY

SITE ENVIRONMENTAL REPORT 2000

Chapter 6

Natural and Cultural Resources

Brookhaven National Laboratory (BNL) has a wildlife management program to protect and manage flora and fauna and their habitats. The Laboratory's wildlife management strategy is based on an understanding of the resources onsite, ensuring compliance with applicable regulations, protecting and monitoring the ecosystem, conducting research, and communicating with staff and the public. BNL focuses on protection of New York State threatened and endangered species, as well as the role of BNL within the greater Long Island Central Pine Barrens ecosystem. Monitoring to determine whether current or historical activities have impacted wildlife is also part of this program. In 2000, deer and fish sampling results were consistent with previous years. Local farm grown produce and vegetables grown in the new BNL garden plot continue to support historical analysis that there is no Laboratory-generated radionuclides in farm produce. Vegetation monitoring did not indicate any radiological contamination above background levels. Goose fecal analysis indicates that geese may be concentrating low levels of cesium-137 in their droppings. Basin sediment and soil sampling shows no indication of contaminants above what has been observed in the past, with the exception of some higher levels of heavy metals detected at the Central Steam Facility. In 2000, BNL moved forward with its Cultural Resources Management Program by establishing a work plan for developing a Cultural Resources Management Plan. Work progressed on the development of a history video on the Brookhaven Graphite Research Reactor Complex which was determined to be eligible for inclusion on the National Register of Historic Places. Additionally, work was completed on a building survey to determine the potential historic value of BNL's buildings in accordance with the requirements of Section 110 of the National Historic Preservation Act.

6.1 WILDLIFE MANAGEMENT PROGRAM

The purpose of the wildlife management program at BNL is to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource protection with the Laboratory's mission. In 1998, BNL developed a Wildlife Management Plan that describes the program strategy, elements, and planned activities. This plan was updated in 1999 to incorporate comments from the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC) (Naidu 1999). The plan and related natural resources information about the Laboratory can be found at the Environmental Services Division website at <http://www.bnl.gov/wildlife/>. The program elements and some of the associated activities are summarized in this chapter.

6.1.1 IDENTIFICATION AND MAPPING OF NATURAL RESOURCES

An understanding of the environmental baseline is the starting point for wildlife management planning. The Central Pine Barrens Commission conducted a natural resources inventory of the BNL site based on data collected from 1970 to 1990. This mapping process has identified environmentally sensitive areas and significant wildlife communities. BNL is in the process of updating this inventory.

As noted in Chapter 1, a wide variety of vegetation, birds, reptiles, amphibians, and mammals reside onsite at BNL. The only New York State endangered species that inhabits BNL property is the tiger salamander (*Ambystoma t. tigrinum*) (see Figure 6-1). Three New York State threatened species have been identified: the banded sunfish (*Enneacanthus obesus*) (see Figure 6-2), the swamp darter (*Etheostoma fusiforme*) (see Figure 6-3), and the stiff goldenrod (*Solidago rigida*), a plant. In addition, several species that inhabit the BNL site, or visit during migration, are listed as "rare," "species of special concern," or "exploitably vulnerable" (see Table 6-1).

6.1.2 HABITAT PROTECTION AND ENHANCEMENT

Activities to eliminate or minimize negative impacts on sensitive or critical species are either incorporated into BNL procedures or into specific program or project plans. Environmental restoration efforts remove pollutant sources that could contaminate habitats. Access to critical habitats is restricted. A map of tiger salamander breeding locations is maintained and reviewed when new projects are proposed to ensure that the projects do not negatively affect the breeding areas. The map is limited in distribution in order to protect the tiger salamander from being exploited by collectors and the pet trade. In some cases, habitats are enhanced to improve survival or increase populations. Routine activities (e.g., road maintenance) that are not expected to impact habitats are allowed to proceed.

Figure 6-1. Tiger Salamander *(Ambystoma t. tigrinum)*.

Figure 6-2. Banded Sunfish *(Enneacanthus obesus)*. This fish was released immediately after the picture was taken.

Figure 6-3. Swamp Darter (*Etheostoma fusiforme***).** This fish was released immediately after the picture was taken.

Efforts to protect the tiger salamander include determining when adult salamanders are migrating toward breeding locations, when

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

Common Name	Scientific Name	State Status
Fish		
Banded sunfish	*Enneacanthus obesus*	T
Swamp darter	*Etheostoma fusiforme*	T
Amphibians		
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E
Marbled salamander	*Ambystoma opacum*	SC
Reptiles		
Spotted turtle	*Clemmys guttata*	SC
Eastern box turtle	*Terrapene carolina*	SC
Eastern hognose snake	*Heterodon platyrhinos*	SC
Birds (nesting or common)		
Horned lark	*Eremophila alpestris*	SC
Whip-poor-will	*Caprimulgus vociferus*	SC
Vesper sparrow	*Pooecetes gramineus*	SC
Grasshopper sparrow	*Ammodramus savannarum*	SC
Plants		
Butterfly weed	*Asclepias tuberosa*	V
Spotted wintergreen	*Chimaphila maculata*	V
Flowering dogwood	*Cornus florida*	V
Pink lady's slipper	*Cypripedium acaule*	V
Winterberry	*Ilex verticillata*	V
Sheep laurel	*Kalmia angustifolia*	V
Narrow-leafed bush clover	*Lespedeza augustifolia*	R
Ground pine	*Lycopodium obscurum*	V
Bayberry	*Myrica pensylvanica*	V
Cinnamon fern	*Osmunda cinnamomera*	V
Clayton's fern	*Osmunda claytoniana*	V
Royal fern	*Osmunda regalis*	V
Swamp azalea	*Rhododendron viscosum*	V
Stiff goldenrod	*Solidago rigida*	T
New York fern	*Thelypteris novaboracensis*	V
Marsh fern	*Thelypteris palustris*	V
Virginia chain-fern	*Woodwardia virginica*	V

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

metamorphosis has been completed, and when juveniles are migrating after metamorphosis. During these times, construction and/or maintenance activities near tiger salamander habitats must be reviewed by BNL environmental protection staff, and every effort is made to minimize impacts. Water quality testing is conducted as part of the routine monitoring of water basins. These data are used to assess the quality of water prior to the breeding cycle. In cooperation with NYSDEC, limited habitat surveys were conducted in 2000. Comprehensive surveys of known and suspected tiger salamander habitats were completed with one additional breeding habitat identified, bringing the total known breeding locations to fifteen. All ponds identified as having egg masses during the spring surveys were surveyed again in June and July to determine reproductive success by presence of larval salamanders. Forty-eight larvae were seen, or captured and released, in four of the ponds in which egg masses were found. The results of these surveys will help determine the length of the breeding period and provide the information needed to determine a window for construction activities in and around the breeding areas. The information may also identify possible activities that could be affecting this species and changes in site use that are needed. The map of the breeding areas will be updated periodically to include any new observations.

As part of the tiger salamander surveys, incidental information is recorded on other amphibian species located in and around the tiger salamander habitat. Other species recorded include the northern redback salamander (*Plethodon c. cinereus),* spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Rana catesbiana*), green frog (*Rana clamitans*), and Fowler's toad (*Bufo fowleri*).

Banded sunfish protection efforts include ensuring that adequate flow of the river is maintained within areas currently identified as sunfish habitat, ensuring that existing vegetation in the sunfish habitat is not disturbed, and evaluating all river remediation efforts for potential impacts on these habitats. An additional banded sunfish population was identified in August 2000, and an additional New York threatened species, the swamp darter, was found co-located with banded sunfish at the new location. Additional surveys of the river and other habitats onsite will be conducted in 2001 to monitor the population status of these two protected species.

BNL's Wildlife Management Plan also calls for habitat enhancement. In 1999, all readily available data were compiled to establish BNL's bird list. A total of 216 species have been identified at BNL since 1948, of which at least 85 are known to nest onsite. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. In 2000, the Laboratory established five permanent bird survey routes through various habitats and began routine monitoring of songbird populations. The results of these surveys are presented in Table 6-2. The surveys started in May 2000 and were carried out monthly through October 2000. Future songbird surveys will be conducted from March through October. The 2000 surveys resulted in the identification of 73 species during the year, of which 23 species were counted only once and are likely to be migrants stopping at BNL for a short period of time. The two most diverse transects pass near wetlands by the Biology Fields and the Peconic River. The three transects passing through the various forest types (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community. In addition to songbird surveys, BNL also participates in the annual Christmas Bird Count conducted by the Audubon Society. BNL has participated in the count for several years, but the results have not been reported until now. The 2000 Christmas Bird Count for BNL was conducted on December 27 and resulted in the identification of 24 species of birds wintering at BNL.

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 nest site competition by the European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). In 2000, BNL installed 26 bluebird boxes around open grassland areas of the site to enhance the bluebird population. The boxes were monitored approximately every three weeks during the breeding season to determine use and nesting success. Bluebirds used seven of the installed boxes, with each pair producing at least one brood. House wrens (*Troglodytes aedon*) used five of the installed boxes. As part of BNL's efforts to improve habitat for this species, more than 40 bluebird boxes were presented as awards at Earth Day events in April and to Environmental Services Division employees. BNL intends to install up to 20 more boxes onsite in 2001, and present additional boxes as awards for the Site Environmental Report artwork contest and to employees providing an outstanding contribution to environmental protection of BNL.

6.1.3 POPULATION MANAGEMENT

The Laboratory also monitors and manages other species populations as necessary to ensure that they are sustained and to control invasive species. For example, the Laboratory monitors populations of "species of interest," such as the wild turkey (*Meleagris gallopavo*). The onsite population of wild turkeys was estimated to be between 60 and 80 birds in 1999 and 200 birds by the end of 2000. The wild turkeys onsite are apparently doing well, as approximately one half of the estimated population is composed of juvenile birds. The large increase in the turkey population is likely due to a heavy crop of acorns that sustained the population through the winter of 1999-2000. Updated population reports are periodically sent to NYSDEC to assist with their population estimates. The population will continue to be monitored to determine reproductive success.

BNL is currently updating information on the onsite white-tailed deer (*Odocoileus virginianus*) population. Since there are no natural predators onsite and hunting is not permitted at BNL, there are no significant pressures on the population to migrate beyond their typical home range of approximately one mile. A 1992 study indicated that the population of deer onsite exceeded 700, or approximately 85 per square mile (2.59 square kilometers) (Thomlinson 1993). Normally a population density of 10 to 30 per square mile is considered an optimum sustainable level for a given area. This would equate to approximately 83 – 247 deer inhabiting the BNL property under normal circumstances. This number was likely seen in 1966 when the Laboratory reported an estimate of 267 deer onsite (Dwyer 1966). The current estimate, based on surveys conducted between November and December 2000, is 1,942 deer, or

Table 6-2. Results of BNL Songbird Surveys Conducted During 2000.

Common Name	Scientific Name	Transect Name				
		Biology Fields	Peconic River	North Transect	East Trenches	South Transect
American Crow	*Corvus brachyrhynchos*	X	X	X	X	X
American Redstart	*Setophaga ruticilla*	X				
American Robin	*Turdus migratorius*	X	X	X	X	X
Baltimore Oriole	*Icterus galbula*	X		X	X	
Black-and-White Warbler	*Mniotilta varia*	X	X	X		
Black-billed Cuckoo	*Coccyzus erythropthalmus*	X	X	X		X
Black-capped Chickadee	*Poecile atricapillus*	X	X	X	X	X
Black-throated Green Warbler	*Dendroica virens*		X			
Blue Jay	*Cyannocitta cristata*	X	X	X	X	X
Blue-winged Warbler	*Vermivora pinus*					X
Brown Creeper	*Certhia americana*		X		X	X
Brown Thrasher	*Toxostoma rufum*	X	X			
Brown-headed Cowbird	*Molothrus ater*	X			X	X
Canada Goose	*Branta canadensis*		X		X	
Carolina Wren	*Thryothorus ludovicianus*				X	
Cedar Waxwing	*Bombycilla cedrorum*	X	X			
Chestnut-sided Warbler	*Dendroica pensylvanica*		X			
Chipping Sparrow	*Spizella passerina*	X	X	X	X	X
Common Grackle	*Quiscalus quiscula*	X	X	X	X	X
Common Yellowthroat	*Geothlypis trichas*	X	X			
Dark-eyed Junco	*Junco hyemalis*		X			
Downy Woodpecker	*Picoides pubescens*	X		X		X
Eastern Bluebird	*Sialia sialis*	X				
Eastern Kingbird	*Tyranus tyranus*					X
Eastern Phoebe	*Sayornis phoebe*		X			
Eastern Towhee	*Pipilo erythrophthalmus*	X	X	X	X	X
Eastern Wood Peewee	*Contopus virens*	X	X	X	X	X
European Starlings	*Sturnus vulgaris*	X			X	X
Field Sparrow	*Spizella pusilla*	X				
Fox Sparrow	*Passerella iliaca*		X			
Golden Eagle	*Aquila chrysaetos*			X		
Golden-crowned Kinglet	*Regulus satrapa*		X			
Goldfinch	*Carduelis tristis*	X	X		X	
Grasshopper Sparrow	*Ammodramus savannarum*	X				
Grey Catbird	*Dumetella carolinensis*	X	X	X	X	X
Herring Gull	*Larus argentatus*	X				
Horned Lark	*Eremophila alpestris*	X				
House Wren	*Troglodytes aedon*	X	X		X	
Killdeer	*Charadrius vociferus*		X			
Magnolia Warbler	*Dendroica magnolia*	X	X			
Mallard Duck	*Anas platyrhyncos*		X			
Mourning Dove	*Zenaida macroura*	X	X	X	X	X
Nashville Warbler	*Vermivora ruficapilla*	X	X			

(continued on next page)

Table 6-2 Results of BNL Songbird Surveys Conducted During 2000 *(concluded)*.

Common Name	Scientific Name	Transect Name				
		Biology Fields	Peconic River	North Transect	East Trenches	South Transect
Northern Bobwhite	*Colinus virginianus*	X	X		X	X
Northern Cardinal	*Cardinalis cardinalis*	X	X	X	X	X
Northern Flicker	*Colaptes auratus*	X	X	X	X	X
Northern Mockingbird	*Mimus polyglottos*	X				
Northern Parula	*Parula americana*	X				
Northern Rough-winged Swallow	*Steligdopteryx serripennis*		X			
Ovenbird	*Seiurus aurocapillus*	X	X		X	
Pine Warbler	*Dendroica pinus*		X		X	X
Prairie Warbler	*Dendroica discolor*	X		X		
Red-bellied Woodpecker	*Melanerpes carolinus*	X	X			X
Red-breasted Nuthatch	*Sitta canadensis*	X	X	X	X	
Red-eyed Vireo	*Vireo olivaceus*	X	X	X		X
Red-tailed Hawk	*Buteo jamaicensis*	X		X		
Red-winged Blackbird	*Agelaius phoeniceus*	X	X		X	
Ring-billed Gull	*Larus delawarensis*					X
Rose-breasted Grossbeak	*Pheucticus ludovicianus*	X				
Ruby-crowned Kinglet	*Regulus calendula*	X	X			
Scarlet Tanager	*Piranga olivacea*	X				X
Sharp-shinned Hawk	*Accipiter striatus*	X				
Tree Swallow	*Tachycineta bicolor*	X				
Tufted Titmouse	*Baeolophus bicolor*	X	X	X	X	X
Veery	*Catharus fuscescens*		X			X
White-breasted Nuthatch	*Sitta carolinensis*		X	X	X	X
White-eyed Vireo	*Vireo griseus*	X				
White-throated Sparrow	*Zonotrichia albicollis*		X		X	X
Wild Turkey	*Meleagris gallopavo*				X	X
Wood Thrush	*Hylocichla mustelina*	X	X		X	X
Yellow Warbler	*Dendroica petechia*		X			
Yellow-bellied Sapsucker	*Sphyrapicus varius*		X			
Yellow-billed Cuckoo	*Coccyzus americanus*	X	X		X	X
Totals		50	48	23	31	32

approximately 236 deer per square mile. Age class comparisons from the 2000 population survey suggest that the deer population nearly doubled in 2000. This large increase in the deer population is likely due to an abundance of food available from the massive crop of acorns present and available during the 1999-2000 winter and what appeared to be an extended breeding season. In 2000, fawns were born starting in early April with late births occurring at the end of July and early August.

Overpopulation can affect both animal and human health (e.g., animal starvation, deer ticks transmit Lyme disease), decrease species diversity such as song birds (due to selective grazing and destruction of habitat), and can also result in increased property damage (grazing on ornamentals) and traffic accidents as the animals forage into developed areas for food. Reduction of property damage due to deer/vehicle collisions is one aspect considered in planning deer population management. In 2000 there were 24 deer/vehicle collisions reported onsite. This is a dramatic increase over the four deer/vehicle collisions reported in 1999. The abrupt increase in deer/vehicle accidents began to occur in May 2000 as fawns and young deer started venturing out into the open areas of the Laboratory. As the deer population increased, so did reports of deer eating shrubbery on the developed portions of the Laboratory. By the end of 2000, evidence of severe browsing on ornamental shrubs was documented throughout the site. While not a threat to human health, the damage to shrubbery may result in the need to replace shrubs at substantial cost to BNL. Options for managing the deer population continue to be evaluated, and BNL continues to work with state regulators to determine the best method for controlling the deer population.

6.1.4 COMPLIANCE ASSURANCE AND POTENTIAL IMPACT ASSESSMENT

The National Environmental Policy Act (NEPA) review process at BNL is one of the keys to ensuring that environmental impacts of a proposed action/activity are adequately evaluated and addressed. BNL will continue to use NEPA, or NEPA-like values under the Comprehensive Environmental Response, Compensation and Liability Act (Environmental Restoration Program), as the process for identifying potential environmental impacts associated with site activities (especially physical alterations). As appropriate, stakeholders such as the EPA, NYSDEC, Suffolk County Department of Health Services, the Nature Conservancy, the Town of Brookhaven, the Community Advisory Council, and local environmental advocacy groups are involved in reviewing major projects which have potential significant environmental impacts.

6.2 ESTABLISHMENT OF THE UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, Secretary of Energy Bill Richardson, and Susan MacMahon, Acting Regional Director of Region Five U.S. Fish and Wildlife Service (FWS) dedicated 530 acres (214 hectares) of the Laboratory property as an ecological research reserve. The property was designated by DOE as the Upton Ecological and Research Reserve (see Figure 1-7 in Chapter 1) and is to be managed by the U.S. Fish and Wildlife Service under an Interagency Agreement between the Department of Energy and FWS (DOE-FWS 2000). The Upton Reserve, located on the eastern edge of BNL (see Figure 6-4), is home to a wide variety of flora and fauna. It contains wetlands and is partly within the core preservation area of the Long Island Central Pine Barrens. Based on information from the 1994-1995 biological survey of BNL, it is expected that over 200 plant species may be found within the reserve, and more than 162 species of mammals, birds, fish, reptiles and amphibians (LMS 1995). In establishing the Upton Reserve, DOE committed to provide the FWS with $1,000,000 over a five-year period for the management of the reserve. In the first year of its existence, the FWS will hire two biologists, formally establish the boundary and post the area. They will also begin baseline biological survey work, initiate basic research, and conduct educational programs. The supervisory biologist from the FWS will serve as a member of a Technical Advisory Group to be established to assist BNL with the development of a Natural Resource Management Plan. Additional information concerning the establishment of the Upton Reserve may by found on the Internet at <http://www.bnl.gov/esd/reserve.htm>.

6.2.1 TECHNICAL ADVISORY GROUP

The Interagency Agreement establishing the Upton Ecological and Research Reserve also made provisions for the establishment of the Technical Advisory Group to provide technical input in the development of a comprehensive Natural Resource Management Plan for the management of both the Upton Reserve and the remainder of the BNL property. This comprehensive plan will replace the existing Wildlife Management Plan. The Technical Advisory Group will also develop criteria for the solicitation, review, and award of research funds for proposals on research to be conducted within the Upton Reserve. BNL expects participation on the Technical Advisory Group to include representatives from the NYSDEC, Suffolk County Parks Department, Peconic Estuary Program, Central Pine Barrens Joint Policy and Planning Commission, FWS, DOE, Citizens Advisory Council, Brookhaven Executive Roundtable, U.S. National Park Service, Brookhaven Science

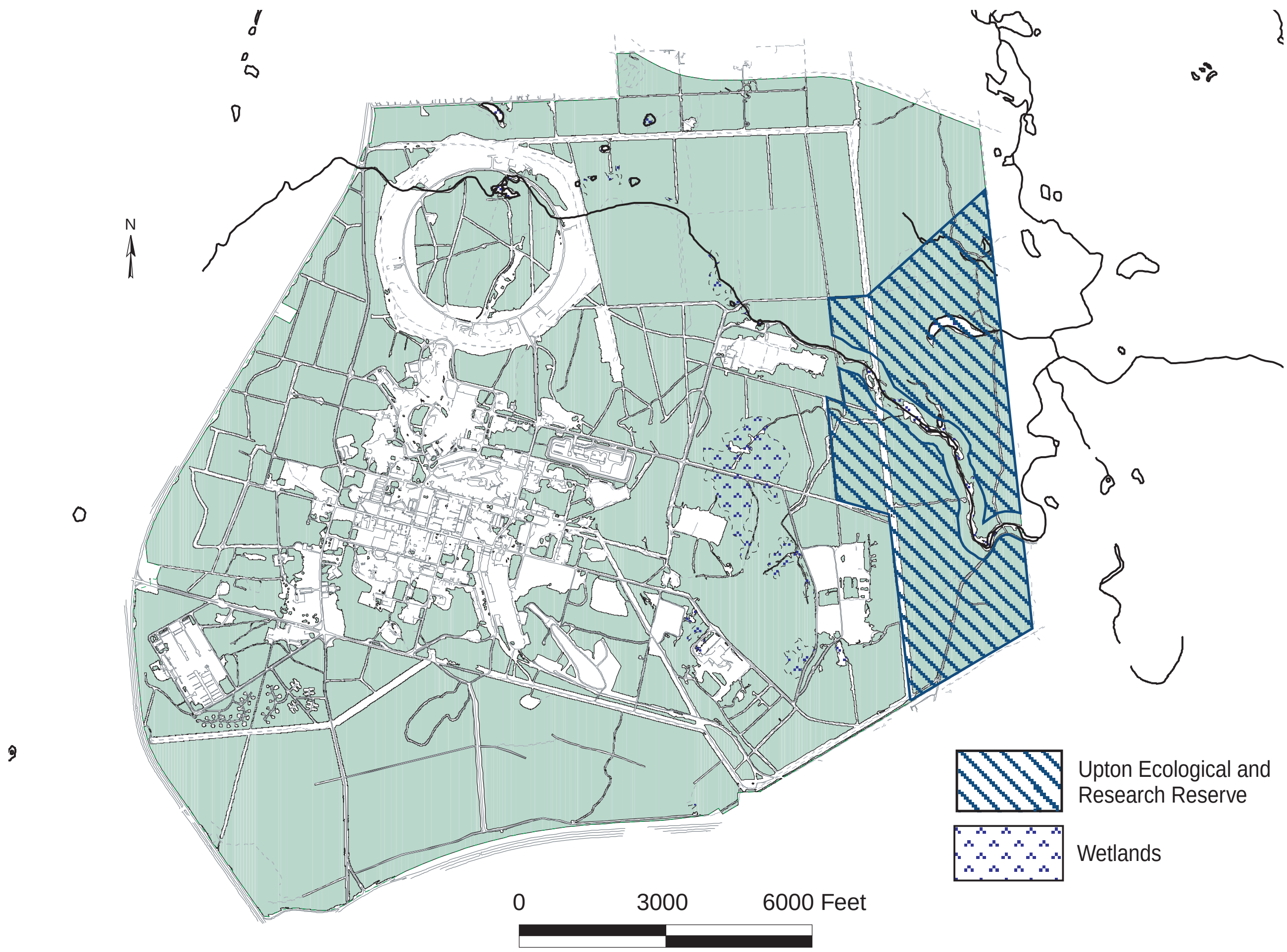

Figure 6-4. BNL Site Map Indicating the Boundary of the Upton Ecological and Research Reserve.

Associates, and The Nature Conservancy. Letters to the various agencies and organizations requesting formal participation in the Technical Advisory Group were mailed in December 2000. The formation and first meeting of the Group is planned for early 2001.

6.3 FLORA AND FAUNA MONITORING ACTIVITIES

BNL conducts routine monitoring of flora and fauna in order to determine whether past or present activities conducted by the Laboratory have had any impacts on the surrounding environment. Due to the distribution of soils contaminated with cesium-137 in some of the landscaped areas, some contamination is found in deer, and possibly other plants and animals. The sections below describe the results of the annual sampling conducted under the flora and fauna monitoring program.

6.3.1 DEER SAMPLING

Deer in New York State typically grow to large sizes, with average weights of males at approximately 150 pounds; females are one third less at about 100 pounds. However, deer on Long Island tend to be much smaller in size, with an average weight of less than 80 pounds. The available meat on local deer ranges from 20 to 40 pounds per deer.

In 2000, as in recent years, an offsite deer sampling program was again conducted in cooperation with the NYSDEC Wildlife Branch. NYSDEC samples provide data on deer moving beyond BNL boundaries, where they can be legally hunted. This program also provides control data on deer living in locations that are distant from BNL. In addition to samples taken offsite by NYSDEC, samples were obtained from road kill near BNL and hunter donations were obtained from Laboratory employees. The total number of samples obtained near the BNL site increased from past years due to a large number of deer/vehicle accidents both on and off the site, and the increased donations from hunters. In all, 28 deer samples were obtained onsite and 21 were gathered from offsite locations.

BNL has been monitoring radionuclide levels in deer onsite since 1992. Onsite samples were collected primarily from deer killed in vehicle accidents. Samples were analyzed for gamma-emitting radionuclides; the results are shown in Table 6-3. It has been previously established that deer taken on the BNL site contain concentrations of cesium-137 (half-life = 30 years) at levels above those taken from offsite. This is most likely the result of deer grazing on vegetation growing in soils where elevated cesium-137 levels are known to exist. Cesium-137 in these soils can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals. Removal of contaminated soil areas has occurred under the site Environmental Restoration Program. All major areas of contamination in lawn soils were remediated in 2000. Some soil contamination is still present in areas that are part of Operable Units I/VI and V. The Record of Decision for Operable Units I and Radiologically Contaminated Soils was issued on October 5, 1999 (BNL 1999). The cleanup of areas covered by this Record of Decision is scheduled and will be completed based on availability of funds. A Record of Decision for Operable Unit V has not yet been signed. In 2000, a decision was made to separate the cleanup of the Sewage Treatment Plant (STP) from the Peconic River cleanup.

All data obtained since 1992 were presented in the *1999 Site Environmental Report* (BNL 2000) including the distribution of cesium-137 levels in deer versus distance from the Laboratory was presented. Cesium-137 concentrations decrease sharply beyond one mile (1.6 kilometers) from the BNL boundary. This indicates that deer feeding on Laboratory property have the potential to migrate short distances offsite and also supports the estimates of the deer home range being one square mile.

The maximum onsite concentration of cesium-137 detected in all deer meat samples was 7.31 pCi/g (0.27 Bq/g) wet weight (the concentration prior to drying for analysis). The arithmetic average concentration of all onsite samples of meat in which cesium-137 was detected was 1.48 pCi/g (0.05 Bq/g). This can be compared with the maximum and average cesium-137 concentrations in meat recorded in offsite samples of 7.57 and 2.07 pCi/g (0.28 and 0.08 Bq/g), respectively. Cesium-137 concentrations in offsite deer were separated into two groups: those samples taken within one mile of BNL and samples taken greater than one mile from BNL (see Table 6-3). Cesium-137 concentrations in deer meat samples taken within one mile of BNL range from 0.28 – 7.57 pCi/g (0.01 – 28 Bq/g), while concentrations in deer meat taken from greater than one mile ranged from being nondetectable to 3.60 pCi/g (0 – 0.13 Bq/g). Figure 6-5 compares the ranges of cesium-137 concentrations in meat samples from onsite and offsite deer collected since 1996. The maximum cesium-137 concentration in liver samples collected onsite was 1.21 pCi/g (0.04 Bq/g) and the average was 0.39 pCi/g (0.01 Bq/g). Cesium-137 concentrations in offsite deer liver samples were similar in range as that seen in meat samples in both subpopulations.

Figure 6-6 presents the trends in arithmetic averages of both onsite and offsite cesium-137 concentrations in deer meat samples taken from 1996 through 2000. The downward trend in cesium-137 concentrations in onsite samples could be indicative of two factors: (1) a more accurate estimate based on an increased number of samples taken per year, and (2) a larger number of young deer taken in 2000, which resulted in lower concentrations of cesium-137 accumulating in tissues. The trend in cesium-137 concentrations in offsite samples indicates a leveling off of cesium-137 around 2.00 pCi/g (0.07 Bq/g). The arithmetic average of the 23 samples taken since 1996 from locations greater than one mile from BNL is 0.69 pCi/g (0.03 Bq/g). The onsite average concentration of cesium-137 of 1.48 pCi/g (0.05 Bq/g) is therefore 2.14 times greater than the average offsite concentration from deer located more than one mile from the Laboratory.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8. The New York State Department of Health has formally assessed the potential public health risk associated with the elevated cesium-137 levels in onsite deer and deter-

Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000).

Sampling Location	Collection Date	Tissue	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)	Sr-90 (pCi/g, wet weight)
BNL					
AGS area	01/08/00	Flesh	3.13 ± 0.90	1.81 ± 0.35	
		Liver	1.80 ± 0.45	0.39 ± 0.08	
Princeton Ave.	04/19/00	Flesh	1.92 ± 0.34	0.37 ± 0.06	
		Liver	2.09 ± 0.37	0.16 ± 0.03	
Princeton Ave.	04/25/00	Flesh	4.15 ± 1.11	1.70 ± 0.36	
		Liver	2.97 ± 0.75	0.24 ± 0.06	
Near main gate	05/02/00	Flesh	2.25 ± 0.38	0.52 ± 0.09	
RHIC near 12 o'clock outside of ring	05/18/00	Flesh	2.75 ± 0.50	0.84 ± 0.15	
		Flesh*	2.89 ± 0.49	0.97 ± 0.17	
RHIC Bldg. 1005	05/24/00	Flesh	2.42 ± 0.40	1.07 ± 0.18	
		Liver	2.41 ± 0.42	0.44 ± 0.08	
RHIC near 2 o'clock outside of ring	05/31/00	Flesh	4.35 ± 1.01	1.88 ± 0.39	
		Liver	2.80 ± 1.06	0.34 ± 0.11	
RHIC near 2 o'clock outside of ring	06/01/00	Flesh	2.67 ± 0.46	1.17 ± 0.20	
RHIC near 6 o'clock	06/20/00	Flesh	2.41 ± 0.42	0.29 ± 0.05	
		Flesh*	2.85 ± 0.48	0.37 ± 0.06	
RHIC near 6 o'clock	06/20/00	Liver	2.37 ± 0.42	0.13 ± 0.03	
Near Bldg. 535	06/27/00	Flesh	2.88 ± 0.48	0.21 ± 0.04	
		Liver	2.09 ± 0.36	0.06 ± 0.01	
Railroad & East Fifth Ave.	06/29/00	Flesh	2.75 ± 0.46	0.53 ± 0.09	
SE corner, 7th & Brookhaven Ave.	08/11/00	Flesh	2.69 ± 0.44	0.07 ± 0.02	
		Flesh*	2.40 ± 0.45	0.03 ± 0.01	
		Bone			1.08 ± 0.16
West of main gate Princeton Ave.	09/18/00	Flesh	2.64 ± 0.44	1.78 ± 0.30	
		Liver	3.18 ± 0.83	0.41 ± 0.12	
		Bone			3.00 ± 0.24
AGS Ring	10/25/00	Flesh	2.30 ± 0.39	0.61 ± 0.10	
		Liver	3.37 ± 1.01	0.27 ± 0.12	
		Bone			0.69 ± 0.08
Bldg. 933	10/25/00	Flesh	3.90 ± 0.85	0.32 ± 0.08	
		Liver	4.45 ± 1.20	0.14 ± 0.06	
		Bone			1.36 ± 0.19
North side of Princeton Ave.	10/31/00	Flesh	2.52 ± 0.45	1.64 ± 0.28	
at motor vehicle garage		Liver	2.44 ± 0.43	1.21 ± 0.21	
		Bone			1.29 ± 0.13
Brookhaven Ave. north side	10/31/00	Flesh	6.98 ± 1.54	7.31 ± 1.45	
		Liver	1.44 ± 0.34	0.95 ± 0.21	
		Bone			1.57 ± 0.14
Princeton Ave. 200 ft. east of main gate	11/03/00	Flesh	2.02 ± 0.37	1.44 ± 0.25	
		Bone			1.72 ± 0.18
Peconic River Rd.	11/07/00	Flesh	3.01 ± 0.50	4.87 ± 0.81	
		Bone			4.34 ± 0.31
Brookhaven Ave. near Hazardous Waste Facility	11/15/00	Flesh	5.85 ± 1.23	3.86 ± 0.77	
		Liver	2.58 ± 0.94	0.73 ± 0.19	
		Bone			1.65 ± 0.15

(continued on next page)

Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000) *(continued)*.

Sampling Location	Collection Date	Tissue	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)	Sr-90 (pCi/g, wet weight)
Railroad St. south of Brookhaven Ave.	11/15/00	Flesh	2.59 ± 0.43	0.67 ± 0.12	
		Bone			1.11 ± 0.12
Pinceton Ave. 200' west of main gate	11/18/00	Flesh	2.64 ± 0.45	4.72 ± 0.80	
		Bone			3.98 ± 0.52
Princeton Ave. west bound lane at main gate	12/04/00	Flesh	2.51 ± 0.44	0.87 ± 0.15	
		Flesh*	3.16 ± 0.75	1.20 ± 0.23	
		Liver	3.18 ± 0.91	0.32 ± 0.11	
		Bone			3.58 ± 0.51
Princeton Ave. west bound,	12/27/00	Flesh	2.38 ± 0.42	0.43 ± 0.07	
north of motor vehicle garage		Liver	2.23 ± 0.50	0.12 ± 0.03	
		Bone			1.34 ± 0.31
Offsite < 1 mile					
Wm. Floyd Pkwy, 1/2 mile north of main gate	01/11/00	Flesh	2.38 ± 0.44	0.77 ± 0.13	
		Flesh*	4.18 ± 1.09	1.76 ± 0.37	
		Liver	1.86 ± 0.33	0.25 ± 0.04	
Wm. Floyd Pkwy, 1/4 mile north of main gate	04/27/00	Flesh	2.05 ± 0.37	0.35 ± 0.06	
Wm. Floyd Pkwy, 1/4 mile south of main gate	07/13/00	Flesh	1.98 ± 0.35	0.28 ± 0.05	
		Liver	2.60 ± 0.45	0.15 ± 0.03	
South Gate ramp to Wm. Floyd Pkwy	09/22/00	Flesh	3.39 ± 0.72	2.21 ± 0.39	
		Liver	1.93 ± 0.43	0.62 ± 0.14	
		Bone			2.22 ± 0.23
South gate LIE Service Rd	10/02/00	Flesh	2.96 ± 0.49	0.68 ± 0.12	
		Liver	2.53 ± 0.67	0.26 ± 0.07	
		Bone			1.87 ± 0.19
Wm. Floyd Pkwy, east side main gate	10/31/00	Flesh	2.69 ± 0.46	7.57 ± 1.28	
		Liver	2.35 ± 0.46	5.46 ± 0.94	
		Bone			3.03 ± 0.27
Wm. Floyd Pkwy.	11/03/00	Flesh	2.35 ± 0.41	4.99 ± 0.84	
		Bone			4.61 ± 0.54
Wm. Floyd Pkwy.	11/08/00	Flesh	2.15 ± 0.39	7.41 ± 1.26	
		Heart	2.46 ± 0.79	5.50 ± 0.97	
		Bone			4.30 ± 0.49
Wm. Floyd Pkwy.	11/12/00	Flesh	2.67 ± 0.45	2.50 ± 0.42	
		Liver	4.50 ± 2.23	2.56 ± 0.60	
		Bone			3.47 ± 0.51
Wm. Floyd Pkwy. north bound, south of main gate	12/05/00	Flesh	2.22 ± 0.38	2.06 ± 0.35	
		Flesh*	2.37 ± 0.42	1.94 ± 0.33	
		Liver	2.08 ± 0.37	0.85 ± 0.15	
		Bone			1.40 ± 0.37
Offsite > 1 mile					
Railroad Ave., Center Moriches	05/20/00	Flesh	2.25 ± 0.39	0.14 ± 0.03	
		Flesh*	2.06 ± 0.37	0.13 ± 0.03	
		Bone			5.88 ± 0.59
River Rd., Calverton (east of Grumman)	09/08/00	Flesh	1.66 ± 0.28	3.47 ± 0.59	
		Bone			4.60 ± 0.55

(continued on next page)

Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000) *(concluded)*.

Sampling Location	Collection Date	Tissue	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)	Sr-90 (pCi/g, wet weight)
Kingsfield, ME	11/18/00	Flesh	5.83 ± 1.05	3.60 ± 0.62	
		Flesh*	2.52 ± 0.45	1.36 ± 0.23	
Margaretsville, NY	11/22/00	Heart	1.92 ± 0.34	0.14 ± 0.03	
		Liver	3.49 ± 0.85	0.15 ± 0.07	
		Bone			1.79 ± 0.40
Cooksburg, NY	11/25/00	Flesh	1.73 ± 0.31	ND	
		Liver	4.28 ± 1.13	ND	
		Bone			3.92 ± 0.53
Cooksburg, NY	11/25/00	Flesh	3.05 ± 0.76	0.08 ± 0.03	
		Liver	2.34 ± 0.40	ND	
		Bone			0.90 ± 0.29
Potter Hollow, NY	12/08/00	Flesh	1.55 ± 0.26	0.01 ± 0.00	
		Liver	4.89 ± 0.95	ND	
		Bone			1.44 ± 0.40
Potter Hollow, NY	12/08/00	Flesh	1.87 ± 0.31	0.01 ± 0.00	
		Liver	1.75 ± 0.30	ND	
		Bone			1.46 ± 0.39
Averages by Tissue					
Flesh					
Average for all samples	49 samples		2.83 ± 0.55	1.73 ± 0.31	
BNL Onsite Avg.	28 samples		3.04 ± 0.59	1.48 ± 0.27	
BNL Onsite & Offsite < 1 mile Avg.	40 samples		2.91 ± 0.56	1.85 ± 0.33	
Offsite Avg.	21 samples		2.57 ± 0.48	2.07 ± 0.36	
Offsite Avg. < 1 mile	12 samples		2.62 ± 0.50	2.71 ± 0.47	
Offsite Avg. >1 mile	9 samples		2.50 ± 0.47	1.10 ± 0.19	
Liver					
Average for all samples	27 samples		2.74 ± 0.69	0.71 ± 0.15	
BNL Onsite Avg.	15 samples		2.63 ± 0.66	0.39 ± 0.10	
BNL Onsite & Offsite < 1 mile Avg.	22 samples		2.60 ± 0.68	0.73 ± 0.16	
Offsite Avg.	12 samples		2.88 ± 0.71	1.29 ± 0.25	
Offsite Avg. < 1 mile	7 samples		2.55 ± 0.71	1.45 ± 0.28	
Offsite Avg. >1 mile	5 samples		3.35 ± 0.73	0.15 ± 0.07	
Bone					
Average for all samples	27 samples				2.50 ± 0.33
BNL Onsite Avg.	13 samples				2.05 ± 0.23
BNL Onsite & Offsite < 1 mile Avg.	20 samples				2.38 ± 0.28
Offsite Avg.	14 samples				2.92 ± 0.41
Offsite Avg. < 1 mile	7 samples				2.99 ± 0.37
Offsite Avg. >1 mile	7 samples				2.86 ± 0.45

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate sample or analysis

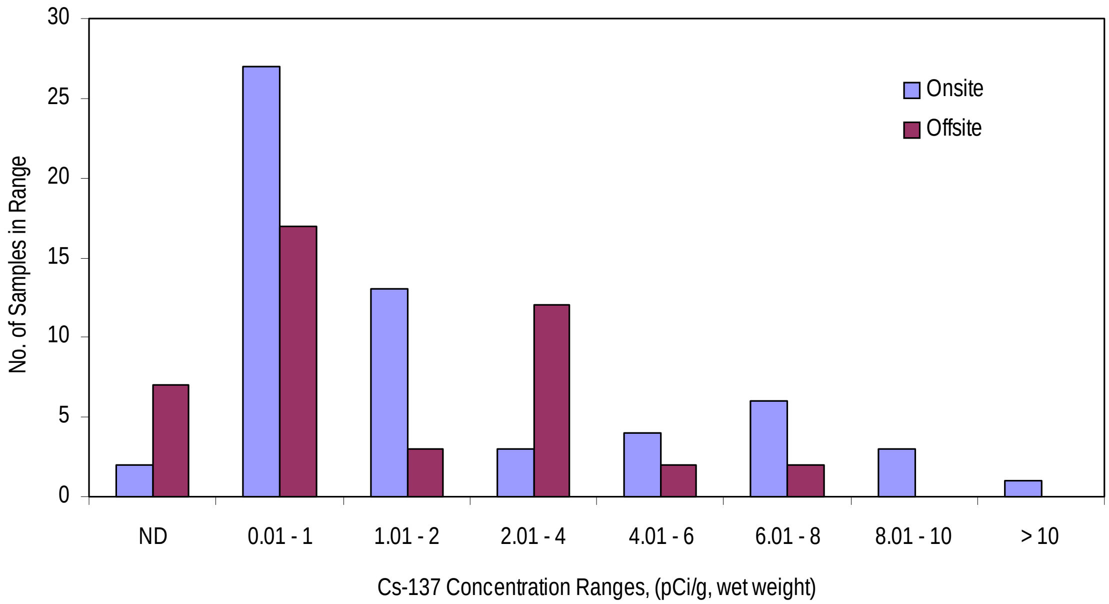

Figure 6-5. Ranges of Cesium-137 Concentrations in Deer Samples Collected Onsite and Offsite (1996-2000).

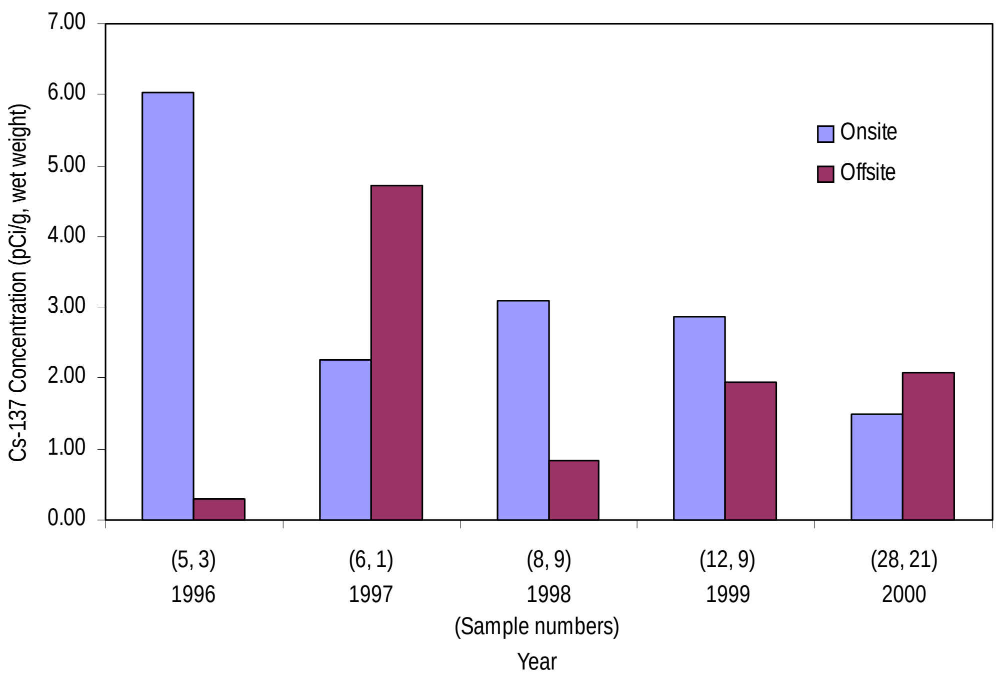

Figure 6-6. Cesium-137 Average Concentrations in Meat Taken From Onsite and Offsite Deer (1996-2000).

mined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999). Their report may be accessed at <http://www.bnl.gov/wildlife/deer_issues.htm/>.

With respect to the health of the onsite deer population, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day (1 mGy/d), 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 cesium-137 at the highest levels observed to date would carry a total body burden of about 0.2 μCi (0.007 MBq). Under these conditions, an animal would receive an absorbed dose of approximately 3 millirad per day (0.03 mGy/d), which is only 3% of the threshold evaluated by the IAEA. Deer observed and sampled onsite appear to be healthy.

BNL began testing bone (when available) for strontium-90 content during 2000. Strontium-90 ranged from 0.69 to 4.34 pCi/g (0.03 – 0.16 Bq/g) in onsite samples, 1.40 to 4.61 pCi/g (0.05 – 0.17 Bq/g) in samples taken within one mile of BNL, and 0.90 to 5.88 pCi/g (0.03 – 0.22 Bq/g) in samples taken from locations greater than a mile from BNL. This overlap in values between all samples suggests that strontium-90 is present in the environment at background levels and is likely a result of worldwide fallout from nuclear weapons testing. Strontium-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 strontium-90 in bone to build baseline information on this radionuclide and its presence in deer.

6.3.2 SMALL MAMMAL SAMPLING

BNL instituted small mammal sampling in 2000 to determine the suitability of using small mammals, primarily squirrels, as a surrogate for deer sampling. Squirrels are readily trapped and tend to eat similar food items compared to deer. Offsite samples were obtained from a licensed trapper located west of the William Floyd Parkway, while onsite samples came from various locations around BNL. Squirrels were sent to an offsite lab for dissection and analysis. The meat was separated from the bone and tested for gamma-emitting radionuclides, while the bone was tested for strontium-90. Results of the testing are presented in Table 6-4. Cesium-137 in offsite samples ranged from less than the minimum detection level to 0.72 pCi/g (0.03 Bq/g). Onsite samples contained cesium-137 ranging from 0.27 to 12.40 pCi/g (0.01 – 0.46 Bq/g). Strontium-90 at 1.45 pCi/g (0.05 Bq/g) was found in the bone of a single opossum taken near Building 533. The cesium levels in two squirrels were high, 10.90 and 12.40 pCi/g (0.40 and 0.46 Bq/g), compared to all other samples including deer (see Table 6-3). The source of the contamination is unknown at this time for the squirrel taken at the current landfill (closed). The squirrel taken near the Sewage Treatment Plant is likely to have acquired cesium-137 from eating vegetation growing in the contaminated soils there. Small mammals will continue to be sampled to obtain added information about their usefulness in environmental surveillance and to better define where they may be acquiring cesium-137 from the environment.

6.3.3 GOOSE FECAL MATERIAL

The Laboratory has a resident population of Canada geese (*Branta Canadensis*) that fluctuates between 80 and 120 birds. Canada geese are tend to feed on green grasses and weedy plants, and may ingest soil as they pull young plants out of the ground. In 2000, BNL initiated the sampling of goose fecal material along with sampling of lawn grasses to determine if there was potential for the Canada goose population to pick up cesium-137 contamination that has been historically present in some of the landscape soils. Table 6-5 displays the data from the radiological analysis of the goose fecal material as well as grass taken in the area where the fecal material was obtained. A sample of grass clippings from the Weaver Drive pond area was the only one that showed any level of cesium-137 present. However, goose fecal material showed low levels of cesium-137 ranging from 0.07 pCi/g to 0.64 pCi/g (0.003 Bq/g to 0.02 Bq/g) in various locations onsite at BNL. This suggests that geese feeding on the lawns at BNL have at least the potential to concentrate cesium-137 in their digestive tract. At present there are no data about cesium-137 in the geese. BNL will continue to look at cesium-137 levels in fecal material and compare it to levels found in lawn vegetation. If sampling of geese were warranted, then the Laboratory would acquire the necessary licenses before obtaining samples.

6.3.4 FISH SAMPLING

BNL, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection and analysis of fish from the Peconic River and surrounding fresh water bodies. In 2000, various species of fish were collected from onsite portions of the Peconic River, as well as from offsite locations such as Swan Pond, Donahue's Pond, and

Table 6-4. Radiological Analysis of Small Mammals (CY 2000).

Location	Species	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)	Sr-90 (pCi/g, wet weight)
BNL				
BNL	Woodchuck	21.60 ± 4.00	0.40 ± 0.24	ND
BNL - Current Landfill	Squirrel	8.93 ± 1.05	10.90 ± 1.53	ND
BNL- Bldg. 533	Opossum	7.08 ± 1.13	0.56 ± 0.09	1.45 ± 0.51
BNL	Squirrel	7.82 ± 0.82	12.40 ± 0.21	ND
BNL- Ball fields	Squirrel	10.40 ± 1.23	0.80 ± 0.09	ND
BNL- Bldg. 533	Squirrel	10.50 ± 1.18	1.62 ± 0.11	ND
BNL- Bldg. 475	Squirrel	12.10 ± 0.72	0.78 ± 0.03	ND
BNL- Bldg. 533	Squirrel	8.69 ± 1.04	0.56 ± 0.07	ND
BNL- Bldg. 533	Squirrel	7.94 ± 1.03	0.27 ± 0.06	ND
BNL- Bldg. 533	Squirrel	7.30 ± 0.98	0.58 ± 0.06	ND
Offsite				
William Floyd Highway	Squirrel	5.47 ± 0.76	0.72 ± 0.06	ND
William Floyd Highway	Squirrel	8.17 ± 0.89	<MDL	ND
William Floyd Highway	Squirrel	11.50 ± 1.49	<MDL	ND
William Floyd Highway	Squirrel	6.39 ± 0.85	0.63 ± 0.08	ND
William Floyd Highway	Squirrel	4.71 ± 0.65	0.58 ± 0.06	ND

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
MDL = Minimum Detection Limit

Table 6-5. Radiological Analysis of Goose Fecal Material and Associated Grass Clippings (CY 2000).

Location	Material	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)
BNL			
Weaver Drive	Goose droppings	19.14 ± 5.94	ND
	Goose droppings*	4.70 ± 2.95	ND
	Grass	2.39 ± 0.61	0.05 ± 0.02
Bldg. 464	Goose droppings	7.89 ± 1.69	0.37 ± 0.10
	Grass	16.60 ± 4.66	ND
Bldg. 490	Goose droppings	5.37 ± 1.03	0.07 ± 0.03
	Grass	4.93 ± 1.14	ND
West Ballfield	Goose droppings	6.02 ± 4.65	ND
	Grass	20.26 ± 8.34	ND
Rutherford and Lawrence	Goose droppings	0.79 ± 0.25	0.64 ± 0.29
	Grass	3.94 ± 0.90	ND
Offsite			
Spring Lake, Middle Island	Goose droppings	4.75 ± 1.11	ND
	Grass	3.92 ± 0.72	ND

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate sample

Forge Pond (see Figure 6-7 for geographic locations). Control location samples were taken from Lower Lake on the Carmans River. Sampling onsite and on the Carmans River is carried out through a contract with Cold Springs Harbor Fish Hatchery and Museum. The annual sampling onsite over the past several years has resulted in the requirement to take more fish of a smaller size to obtain a sample sufficiently large to complete all analyses desired. Because the fish population onsite is not maturing, BNL intends to suspend onsite sampling, beginning in 2001, for up to three years to allow the onsite fish populations to recover and mature. Annual population and size estimates will be conducted to track the recovery. Offsite sampling will continue as in the past. All samples were analyzed for whole body content of each of the analytes reported; and in most instances, the samples were a composite of several fish to ensure adequate sample size for analysis.

6.3.4.1 RADIOLOGICAL ANALYSIS OF FISH

Brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), creek chubsucker (*Erimyzon oblongus*), and golden shiner (*Notemigonus crysoleucas)* species were collected in 2000 by BNL and NYSDEC for radiological analysis. Gamma spectroscopy analysis was performed on all samples. Specific information regarding the sampling point, species collected, and analytical results is presented in Table 6-6. All sample results are presented as wet weight concentrations.

Cesium-137 was identified in onsite samples at levels ranging from 0.86 pCi/g (0.03 Bq/g) in creek chubsuckers, to 1.30 pCi/g (0.05 Bq/g) in a brown bullhead. The highest level of cesium-137 found in offsite fish was 0.66 pCi/g (0.02 Bq/g) in a largemouth bass from Donahue's Pond. Cesium-137 was not detected in any of the fish taken from the Carmans River.

In 2000, BNL initiated testing for Strontium-90. Strontium-90 is readily deposited in bone. Stronium-90 was not detected in any of the onsite fish but was found at the highest detected level of 1.82 pCi/g (0.07 Bq/g) in largemouth bass taken from Donahue's Pond. Since this is the first year of testing for strontium-90, no substantial conclusions can be made from these data. Because fish were analyzed for whole body content, values for strontium-90 may vary widely as seen in the data presented here. These variations result from random pieces of bone included in the aliquot of the sample used for the analysis. The lack of detected levels in BNL onsite samples may also be due to the small size of the fish used to generate a composite sample. Younger fish would have less bone mass than older fish. BNL will continue to test for strontium-90 in offsite samples in order to build baseline values for future comparisons.

Concentrations of naturally occurring potassium-40 (a radionuclide common to soil and vegetation) were observed to be very consistent between the Peconic River and control location fish,

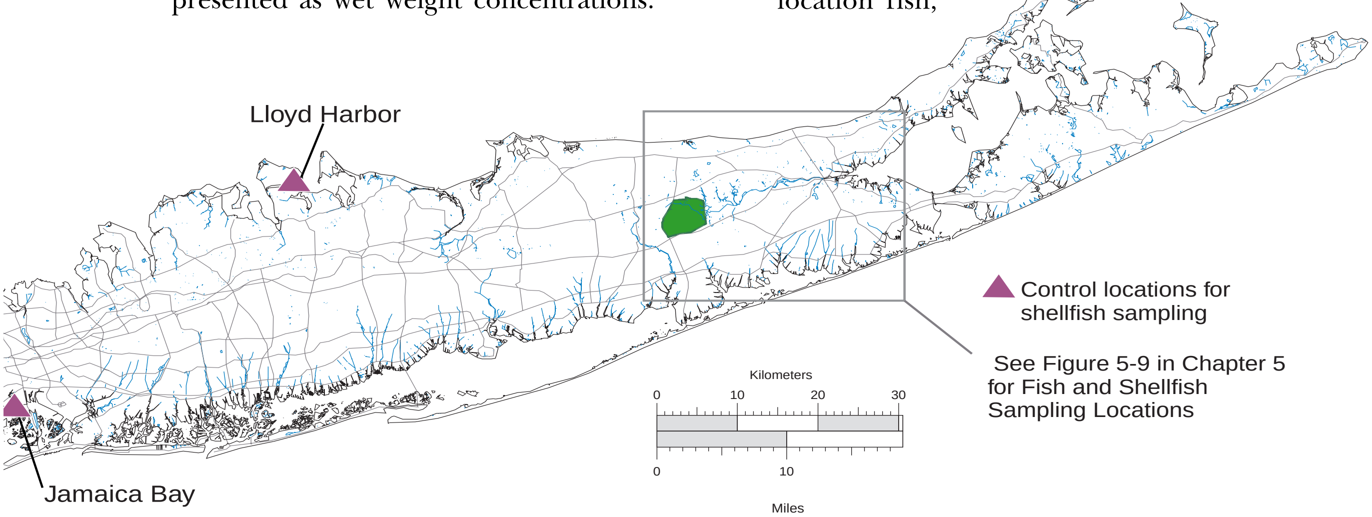

Figure 6-7. Area of Sampling Locations for Fish and Shellfish Taken in CY 2000.

Table 6-6. Radiological Analysis of Fish from the Peconic River System and Control Locations (CY 2000).

Fish/Sample Type	K-40 (pCi/g, wet weight)	Cs-137 (pCi/g, wet weight)	Sr-90 (pCi/g, wet weight)
BNL HM-EA			
Brown bullhead/composite	9.97 ± 1.25	1.30 ± 0.16	<MDL
Pumpkinseed/composite	7.81 ± 1.04	1.19 ± 0.14	<MDL
Chain Pickerel/composite	10.51 ± 1.24	1.13 ± 0.17	ND
Chubsucker/composite	9.87 ± 2.48	0.86 ± 0.24	<MDL
Swan Pond			
Pumkinseed/composite	8.90 ± 1.14	<MDL	0.79 ± 0.15
Brown Bullhead/whole body	11.40 ± 1.57	0.51 ± 0.05	1.30 ± 0.10
Largemouth Bass/composite	7.98 ± 1.26	0.44 ± 0.10	<MDL
Donahue's Pond			
Brown bullhead/composite	10.10 ± 1.42	0.50 ± 0.09	1.37 ± 0.12
Largemouth Bass/composite	9.19 ± 1.33	0.66 ± 0.10	1.82 ± 0.17
Pumpkinseed/composite	6.94 ± 1.21	0.34 ± 0.08	1.39 ± 0.13
Forge Pond			
Brown Bullhead/composite	9.64 ± 1.42	0.29 ± 0.07	<MDL
Largemouth Bass/composite	8.58 ± 1.23	0.45 ± 0.08	0.60 ± 0.08
Lower Lake, Carmans River			
Golden Shiners/composite	8.08 ± 1.38	ND	ND
Bluegill/composite	8.05 ± 1.13	<MDL	ND
Bass/composite	8.97 ± 1.28	<MDL	ND
Pumpkinseed/composite	8.36 ± 1.20	<MDL	<MDL
Brown bullhead/composite	9.50 ± 1.53	ND	<MDL

Notes:
See Figure 6-7 for sampling locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
ND = Not Detected

validating the comparability of the data. The only anthropogenic (human-made) radionuclide found in any fish sample, control or otherwise, was cesium-137.

Some cesium-137 is detectable in the environment worldwide as a result of global fallout from past aboveground nuclear weapons testing. This is evident when examining the analytical results of control location (Swan Pond and Carmans River) fish from past and present years. In the past, cesium-137 values up to 0.43 pCi/g (0.02 Bq/g) were found in yellow perch (*Perca flavescens*) flesh taken from Swan Pond. Current levels are no higher than 0.51 pCi/g (0.02 Bq/g) in brown bullheads, while fish from the Carmans River show either less than minimum detection limits or none at all. In order to account for the different feeding habits and weights of various species, it is important to compare species with similar feeding habits. In general, cesium-137 concentrations in bullheads collected near the BNL Sewage Treatment Plant outfall were elevated in comparison to the control locations. The elevations became less pronounced with increasing distance from the Sewage Treatment Plant outfall (see the Donahue's Pond and Forge Pond values in Table 6-6). Cesium-137 values in fish from both Donahue's Pond and Forge Pond are roughly equivalent to those seen at Swan Pond.

Though it is clear from discharge records and sediment sampling that historical BNL operations have contributed to anthropogenic radionuclide levels in the Peconic River system, most of these radionuclides (with the exception of tritium) were released between the late 1950s and early 1970s.

6.3.4.2 NONRADIOLOGICAL ANALYSIS OF FISH AND SHELLFISH

In 1997, under the Operable Unit V remediation project, the BNL Environmental Restoration Program conducted sampling and analysis of fish samples from the Peconic River for metals, pesticides, and polycholorinated biphenyls (PCBs). Results indicated that the levels found were not considered to have a health impact on fish or humans. However, DOE directed that the sampling of fish for pesticides, metals, and PCBs should be incorporated into the annual environmental sampling program. This analysis was conducted in 1999 and again in 2000. 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 the April-May period, in 1999 sampling was performed during the September-December, and in 2000 sampling occurred in the July-August period. This along with wide variations in fish size, and the need for composite as well as whole body samples to obtain significant mass for analysis, makes the comparison more tenuous as seasonal variations in feeding, energy consumption, and incorporation of nutrients in tissues by fish can be significant.

Table 6-7 shows the concentration levels of metals in fish and shellfish (clams and mussels) for 2000. None of the metal concentrations were considered to be capable of impacting the health of the consumers of such fish or clams, with the exception of mercury. In comparing the metals results from 1997 to 2000 for those species that were analyzed during all periods, it was found that mercury levels in the 2000 onsite samples were higher than those found in 1997. Mercury was found in chain pickerel at 3.72 mg/kg and in brown bullhead catfish at 3.01 mg/kg. Both samples were whole body composites composed of several small fish. The level of mercury in these two samples is above the consumption standard of 1.0 mg/kg set by the U.S. Food and Drug Administration. This could be the result of seasonal difference in the sampling (spring vs. summer), significant differences in the size of fish caught during the different seasons, and/or whole body composites versus tissue sampling (fillet and skin viscera sampling). Although the level of mercury in these fish is high, the likelihood of these fish being eaten is very low. There is no fishing allowed onsite at BNL and the samples were composites made up of fish that are below legal limits for retaining.

Table 6-8 shows the concentration levels of detected pesticides in fish for 2000. The levels do not exceed any standards that constitute health impacts on the consumers of such fish and, therefore, are not considered harmful. No pesticides were detected in onsite samples. The pesticides DDD and DDE were detected at low levels at several offsite locations. These pesticides are breakdown products of DDT which was commonly used before 1970. Chlordane and Dieldrin were also commonly used pesticides and show up at offsite locations in low levels.

Table 6-9 presents the concentration levels of PCBs in fish for 2000. No PCBs were found in offsite fish. However, the PCBs Aroclor 1254 and Aroclor 1260 were found in all onsite samples. Historically, these two compounds were commonly used in electrical equipment onsite at BNL. Present levels are similar to or higher than those seen in 1999. With small numbers of samples for comparison, it is difficult to assess what would be considered an average value. The variation in results may be due to differences in laboratory procedures, sample types (whole body, composites, or tissues), fish sizes, or they may be a true reflection of PCBs present in the fish. However, at the observed levels, these concentrations should not pose a health hazards as fishing is not permitted onsite and all onsite samples were whole body composites made up of fish too small to be legally retained for consumption.

6.3.5 MARINE/ESTUARINE SAMPLING

Annual sampling for clams, sediment, and seawater in the Peconic Bay, Flanders Bay, Indian Point, Jamaica Bay, and Lloyd Harbor (control location) was conducted in 2000 (see Figure 6-7). Stakeholder concern that BNL's discharges have affected the clamming industry were the basis for continuing this sampling program. The NYSDEC Marine Fisheries Branch has continued to assist BNL in coordinating the sampling with local baymen. Table 6-10 summarizes the radiological data. The naturally occurring radionuclide potassium-40 continues to be the only radionuclide observed in these samples. In 2000, estuarine vegetation located at Indian Point was once

Table 6-7. Metals Analysis of Fish and Shellfish From the Peconic River System and Control Locations (CY 2000).

Location	Matrix	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Na	Zn
		ppm (mg/kg, wet weight)													
BNL HM-EA	Brown Bullhead	ND	<MDL	<MDL	<MDL	7.16	103.00	<MDL	<MDL	3.01	ND	<MDL	ND	3770	<MDL
	Pumpkinseed	ND	11.20	ND	ND	4.56	32.60	<MDL	4.14	1.28	ND	2.46	ND	4310	<MDL
	Chain Pickerel	ND	17.30	<MDL	ND	5.83	71.30	<MDL	11.90	3.72	ND	3.89	ND	4730	<MDL
	Chubsucker	ND	23.60	ND	ND	7.66	62.20	<MDL	10.90	0.96	0.53	3.72	ND	4270	<MDL
Peconic Bay	Clams	2.61	<MDL	0.51	<MDL	3.19	<MDL	<MDL	14.90	ND	<MDL	<MDL	<MDL	5340	13.00
Flanders Bay	Clams	2.21	<MDL	<MDL	ND	1.05	<MDL	ND	2.12	ND	0.57	0.44	ND	3460	6.44
Indian Point	Mussels	1.72	<MDL	<MDL	<MDL	1.81	<MDL	<MDL	13.30	NT	<MDL	0.70	<MDL	4040	9.15
Forge Pond	Mussels	0.52	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	ND	0.54	ND	291	<MDL
Lloyd Harbor	Clams	1.08	<MDL	<MDL	<MDL	2.89	<MDL	0.51	12.90	ND	0.61	<MDL	<MDL	3990	14.10
Jamaica Bay	Clams	1.97	<MDL	<MDL	<MDL	2.29	<MDL	<MDL	<MDL	ND	0.58	0.48	1.04	2830	<MDL
Forge Pond	Brown Bullhead	0.56	<MDL	ND	<MDL	2.26	<MDL	ND	<MDL	NT	ND	0.85	<MDL	1250	<MDL
	Pumpkinseed	<MDL	<MDL	ND	<MDL	1.30	<MDL	<MDL	<MDL	NT	ND	0.89	ND	1110	<MDL
	Largemouth Bass	0.63	<MDL	ND	<MDL	<MDL	<MDL	ND	<MDL	NT	ND	1.00	ND	815	<MDL
Swan Pond	Pumpkinseed	<MDL	3.33	ND	0.44	<MDL	<MDL	<MDL	24.50	<MDL	ND	0.85	ND	1320	30.80
	Brown Bullhead	<MDL	0.97	ND	ND	1.20	<MDL	ND	9.39	<MDL	ND	0.51	ND	822	6.48
	Bass	ND	<MDL	ND	<MDL	ND	<MDL	ND	2.49	<MDL	ND	0.54	ND	1510	10.40
Donahue's Pond	Brown Bullhead	ND	<MDL	ND	<MDL	0.59	<MDL	<MDL	<MDL	<MDL	ND	0.65	ND	910	<MDL
	Largemouth Bass	ND	<MDL	ND	<MDL	ND	<MDL	0.58	<MDL	<MDL	ND	0.65	ND	1140	<MDL
	Pumpkinseed	<MDL	<MDL	ND	0.47	<MDL	<MDL	<MDL	<MDL	<MDL	ND	0.78	ND	1570	<MDL
Carmans River	Golden Shiners	<MDL	<MDL	ND	<MDL	<MDL	<MDL	ND	8.78	<MDL	ND	0.60	ND	900	<MDL
	Brown Bullhead	0.80	<MDL	ND	<MDL	0.79	<MDL	<MDL	<MDL	<MDL	ND	1.13	<MDL	1050	<MDL
	Bluegill	<MDL	<MDL	ND	0.65	ND	<MDL	ND	24.60	<MDL	ND	0.84	ND	1450	<MDL
	Largemouth Bass	ND	<MDL	ND	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	ND	1.01	ND	1320	<MDL
	Pumpkinseed	<MDL	<MDL	ND	<MDL	0.49	<MDL	ND	<MDL	<MDL	ND	0.89	ND	1480	<MDL
MDL (varies by sample aliquot)		0.20	0.04	0.07	0.08	0.16	0.84	0.13	0.09	0.00	0.13	0.36	0.09	4.66	0.21

Notes:
See Figure 6-7 for sampling locations.
MDL = Minimum Detection Limit
NT = Not Tested
ND = Not Detected

Table 6-8. Pesticides Analysis in Fish and Shellfish From the Peconic River System and Control Locations (CY 2000).

Location	Matrix	Dieldrin	4,4'-DDE	4,4'-DDD	4,4'-DDT	gamma-Chlordane	alpha-Chlordane
		µg/g (ppm)					
BNL HM-EA	Brown Bullhead	ND	ND	ND	ND	ND	ND
	Pumpkinseed	ND	ND	ND	ND	ND	ND
	Chain Pickerel	ND	ND	ND	ND	ND	ND
	Chubsucker	ND	ND	ND	ND	ND	ND
Peconic Bay	Clams	ND	ND	ND	ND	ND	ND
Flanders Bay	Clams	ND	ND	ND	ND	ND	ND
Indian Point	Mussels	ND	ND	ND	ND	ND	ND
Forge Pond	Mussels	ND	0.027	0.006	<MDL	<MDL	ND
Lloyd Harbor	Clams	ND	ND	ND	ND	ND	ND
Jamaica Bay	Clams	ND	ND	ND	ND	ND	ND
Forge Pond	Brown Bullhead	ND	0.016	<MDL	ND	ND	ND
	Pumpkinseed	ND	0.009	ND	<MDL	ND	ND
	Largemouth Bass	ND	0.016	<MDL	ND	ND	ND
Donahue's Pond	Brown Bullhead	ND	<MDL	<MDL	ND	ND	ND
	Largemouth Bass	ND	0.020	0.008	<MDL	ND	ND
	Pumpkinseed	<MDL	0.017	0.008	<MDL	ND	ND
Swan Pond	Pumpkinseed	ND	0.039	0.022	ND	ND	ND
	Brown Bullhead	ND	ND	ND	ND	ND	ND
	Largemouth Bass	ND	0.018	0.012	ND	ND	ND
Carmans River	Golden Shiners	ND	0.066	0.028	<MDL	<MDL	0.004
	Brown Bullhead	ND	0.040	0.019	<MDL	<MDL	0.006
	Bluegill	ND	0.023	0.007	<MDL	<MDL	<MDL
	Bass	ND	0.054	0.018	<MDL	ND	ND
	Pumpkinseed	ND	0.059	0.013	<MDL	ND	ND

Notes:
See Figure 6-7 for sampling locations.
MDL = Minimum Detection Limit
ND = Not Detected

again sampled. Additionally sediment and/or water samples were obtained from Peconic Bay, Flanders Bay, and Indian Point. The results indicated that potassium-40 was the only radionuclide observed in marine or estuarine vegetation, water, and sediment. No BNL generated radionuclides have ever been detected in marine samples since 1992 when sampling began.

6.3.6 AQUATIC SHELLFISH, VEGETATION, WATER, AND SEDIMENT SAMPLING

Samples of freshwater mussels, vegetation, sediments, and water were taken at several locations within the Peconic River and the Carmans River (see Figure 6-8 and Table 6-10). Cesium-137 was detected at low levels in sediments from Swan Pond and Donahue's

Table 6-9. PCB Analysis of Fish Sampled From the Peconic River at the Sewage Treatment Plant (CY 2000).

PCB	BNL HM-EA Brown Bullhead	Pumpkin-seed	Chain Pickerel	Chubsucker
	µg/g (ppm)			
Aroclor-1016	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND
Aroclor-1254	2.050*	0.59	1.340*	1.130
Aroclor-1260	0.956	0.425*	0.602*	0.383*

Notes:
ND = Not Detected
*Estimated value based on lab qualifiers.

Table 6-10. Radiological Analysis Results for Shellfish, Aquatic Vegetation, Water, and Sediments (CY 2000).

Location and Sample Type	K-40 pCi/g (wet weight)	Cs-137 pCi/g (wet weight)
Peconic Bay		
Clams	11.20 ± 1.62	ND
Water	211 ± 51	ND
Sediments*	13.50 ± 1.75	<MDL
Flanders Bay		
Clams	11.60 ± 1.61	ND
Water	290 ± 54	ND
Indian Point		
Mussels	8.01 ± 1.12	ND
Salicornia	18 ± 1.39	ND
Water	313 ± 57	ND
Sediments*	6.66 ± 1.12	ND
Connecticut Avenue		
Mussels	1.60 ± 0.72	ND
Forge Pond		
Mussels	1.11 ± 0.74	ND
Aquatic vegetation	0.83 ± 0.21	0.04 ± 0.01
Donahue's Pond		
Aquatic vegetation	8.27 ± 2.12	0.71 ± 0.11
Water	ND	ND
Sediments*	3.69 ± 0.80	0.30 ± 0.06
Swan Pond		
Aquatic vegetation	16.2 ± 1.35	ND
Water	ND	ND
Sediments*	1.56 ± 0.880	0.46 ± 0.14
Lower Lake, Carmans River[(a)]		
Aquatic vegetation	8.95 ± 2.66	ND
Water	ND	ND
Sediments*	2.41 ± 0.46	<MDL
Lloyd Harbor[(a)]		
Clams	13.3 ± 1.37	ND
Water	ND	ND
Sediments*	15.00 ± 0.87	<MDL
Jamaica Bay[(a)]		
Clams	6.95 ± 1.27	ND

Notes:
See Figure 6-7 for locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
ND = Not Detected
* Sediment values are for dry weights.
[(a)]Background locations

Pond, and in aquatic vegetation from Forge Pond and Donahue's Pond. These levels were similar to what was seen in the fish at these locations.

6.3.7 VEGETATION SAMPLING

Farm vegetable sampling resumed in 2000. Samples were collected from area farms surrounding BNL as well as from an onsite garden (Figure 6-9). Samples were submitted for radiological analysis and the results are presented in Table 6-11. As in the past, no radionuclides attributable to BNL operations were observed in farm produce. A small level of cesium-137 (0.52 pCi/g [0.02 Bq/g]) was found in chard grown in the BNL garden. Potassium-40, which occurs naturally, was the only radionuclide detected in all of the farm produce sampled. BNL also established vegetation sampling of grassy vegetation (see Table 6-12) near air monitoring stations to support the surveillance monitoring associated with these points. Grassy vegetation was also sampled in lawn areas where geese tend to graze for comparison with goose fecal sampling (see section 6.3.3 above). Vegetation sampling is carried out to determine if depositional material is accumulating on plant surfaces and soils and whether there is uptake by the vegetation. In 2000, the only radionuclide found in grassy vegetation was cesium-137. The highest level of cesium-137, 0.65

Figure 6-8. Sampling Freshwater Mussels From the Peconic River.

pCi/g (0.02 Bq/g), was found at Station S6 near the former Hazardous Waste Facility which is known to have cesium contamination in the soils. The other two areas where cesium-137 was detected had levels slightly above the detection limit.

6.4 BASIN SEDIMENT SAMPLING

BNL sampled sediments in many of the recharge basins located onsite (see Figure 5-7, map of outfall locations). Basin sediment sampling occurs on a two-year cycle. Samples were taken to a depth of six inches and broken down into subsamples consisting of soils from 0 – 2, 2 – 4, and 4 – 6 inches in depth. Sediments were analyzed for volatile organic compounds, semivolatile organic compounds, polychlorinated biphenols (PCBs), metals, and gamma emitting radionuclides. The subsections below describe the sampling results.

6.4.1 ORGANIC ANALYSIS OF BASIN SEDIMENTS

Analysis of basin sediments showed no evidence of volatile organic compounds. However, two basins, the Central Steam Facility (CSF), and the channel leading to Basin HN had detectable levels of several semivolatile organic compounds that result from the breakdown of road oils. Table 6-13 presents the data on those areas with detected levels of the semivolatile organic compounds present. All compounds are well below the cleanup objectives published by Suffolk County Department of Health Services under Article 12 of the Suffolk County Sanitary Code with the exception of chrysene that was found at the CSF outfall. Chrysene was detected at a maximum of 600 ppb at a depth of 4 – 6 inches at this outfall. However, this level is below the 800 ppb action level set by Suffolk County Article 12 standards for cleanup.

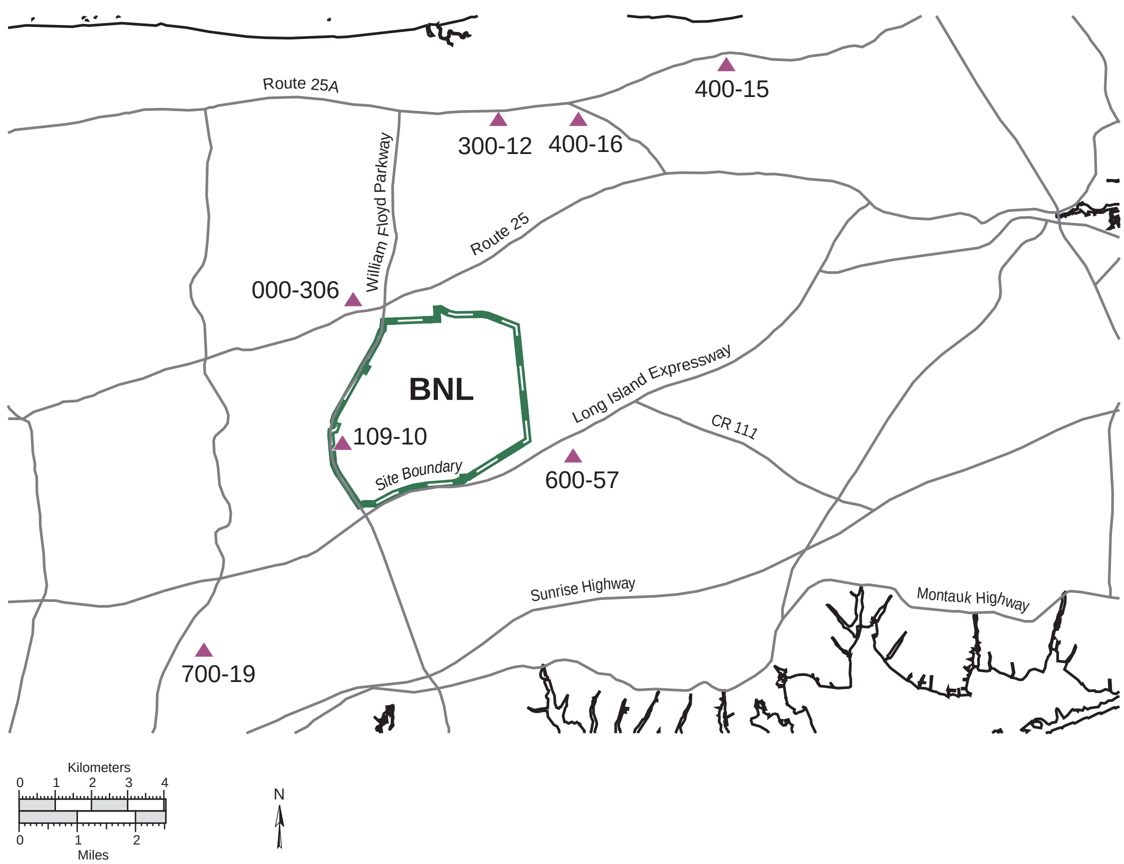

Figure 6-9. Farm and Garden Sampling Locations.

Table 6-11. Radiological Analysis of Farm and Garden Produce (CY 2000).

Location		K-40 pCi/g (wet weight)	Cs-137 pCi/g (wet weight)
BNL - Garden	Chard	0.21 ± 0.05	0.52 ± 0.27
	Yellow squash	1.31 ± 0.22	ND
	Tomato	1.38 ± 0.22	ND
	Cucumber	3.22 ± 0.55	ND
	Lettuce	4.23 ± 1.01	ND
	Tomato	1.70 ± 0.27	ND
	Sunflower	2.03 ± 0.47	ND
	Corn	2.00 ± 0.66	ND
BNL-Vegetation			
N. of Berkner	Apple	0.91 ± 0.16	ND
Biology Field	Corn	2.96 ± 0.99	ND
Lewins Farm	Strawberry	2.59 ± 0.69	ND
	Potato	5.80 ± 1.19	ND
	Potato*	3.88 ± 0.85	ND
	Yellow squash	1.77 ± 0.34	ND
	Yellow squash*	3.82 ± 0.75	ND
	Cucumber	1.10 ± 0.18	ND
	String bean	1.97 ± 0.33	ND
	Peach	1.32 ± 0.21	ND
	Cauliflower	2.87 ± 0.46	ND
	Broccoli	6.89 ± 1.40	ND
	Pumpkin	2.44 ± 0.47	ND
	Apple	0.92 ± 0.16	ND
	Apple*	0.76 ± 0.13	ND
Edwards Ave.	Strawberry	0.27 ± 0.07	ND
Lenny Bruno's Farm	Pepper	1.86 ± 0.31	ND
	Cucumber	1.90 ± 0.42	ND
	Tomato	1.46 ± 0.24	ND
	String bean	1.84 ± 0.40	ND
	Zuchini	2.28 ± 0.37	ND
May's Farm	Cabbage	1.54 ± 0.34	ND
	Pumpkin	2.58 ± 0.38	ND
	Cauliflower	2.48 ± 0.53	ND
	Broccoli	3.29 ± 0.54	ND
Cornell Cooperative	Corn	1.81 ± 0.38	ND
	Corn*	2.70 ± 0.89	ND

Notes:
See Figure 6-9 for sampling locations.
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate Sample

Table 6-12. Radiological Analysis of Grassy Vegetation (CY 2000).

Location	K-40 pCi/g, (wet weight)	Cs-137 pCi/g (wet weight)
BNL		
E. of Bldg. 490	4.93 ± 1.14	ND
W. Ballfield	20.26 ± 8.34	ND
Weaver Rd.	2.39 ± 0.61	0.05 ± 0.02
P4 area	3.04 ± 0.57	ND
S6 area	15.96 ± 3.93	0.65 ± 0.27
P7 area	ND	ND
S5 area	3.92 ± 0.68	0.02 ± 0.01
P2	1.11 ± 0.32	ND
P9	9.47 ± 2.66	ND
Lawrence & Rutherford	3.94 ± 0.90	ND
Bldg. 464	16.60 ± 4.66	ND
Spring Lake, Middle Island*	3.92 ± 0.72	ND
NYSDEC Checkstation, Ridge	2.24 ± 0.55	ND

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Control location

Basin sediments also showed the presence of PCBs in Basins HS and HW. Table 6-14 gives the results of PCB analysis for these two basins. Both basins have Aroclor 1254 and Aroclor 1260. Aroclor 1260 was present at the highest levels, 2200 ppb, in Basin HW at a depth of 4 – 6 inches. These two basins have historic evidence of PCBs and were investigated under BNL's CERCLA remedial investigation/feasibility studies. The levels seen were and continue to be below the action levels for cleanup set by Suffolk County Article 12. Since these two basins are within the interior portions of the Laboratory they are considered to have restricted access. These two basins will continue to be sampled periodically and monitored for the PCB levels.

6.4.2 METALS ANALYSIS OF BASIN SEDIMENTS

Results of metals analysis in the basins are presented in Table 6-15. The results show that metals are mostly below the minimum detection limit in most basins at all depths and are below any standards requiring cleanup, or are below established health standards. There are

Table 6-13. Semivolatile Organic Compound Analysis Results for Basin Sediments (CY 2000).

Semivolatile Organic Compound	HS Basin	HW Basin		HX West	CSF			HN Channel
	4 - 6"	0 -2"	2 - 4"	4 - 6"	0 -2"	2 - 4"	4 - 6"	0 -2"
	µg/kg (ppb)							
3-Methylphenol/4-Methylphenol	ND	1200	<MDL	ND	ND	ND	ND	ND
Phenanthrene	<MDL	<MDL	<MDL	400	420	460	480	<MDL
Fluoranthene	420	750	610	<MDL	810	870	1100	1000
Pyrene	<MDL	570	<MDL	<MDL	520	640	780	740
Benzo[a]anthracene	<MDL	<MDL	<MDL	<MDL	380	410	500	<MDL
Chrysene	<MDL	<MDL	<MDL	<MDL	450	500	600	<MDL
bis(2Ethylhexyl)phthalate	<MDL	720	<MDL	ND	450	580	680	770
Benzo[b]fluoroanthene	<MDL	<MDL	<MDL	<MDL	370	480	490	<MDL
Benzo[k]fluoranthene	<MDL	<MDL	<MDL	<MDL	380	<MDL	580	<MDL
Benzo[a]pyrene	<MDL	<MDL	<MDL	<MDL	<MDL	380	440	<MDL

Notes:
See Chapter 5, Figure 5-7 for basin locations.
Only chemicals for which there was at least one detection are listed on this table.
MDL = Minimum Detection Limit
ND = Not Detected

Table 6-14. PCB Analysis Results of Basin Sediments (CY 2000).

PCB	Basin HS			Basin HW		
	0 -2"	2 - 4"	4 - 6"	0 -2"	2 - 4"	4 - 6"
	µg/kg (ppb)					
Aroclor-1016	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND
Aroclor-1254	160	98	170	730	360*	ND
Aroclor-1260	67	44	74	1600	2000	2200

Notes:
See Chapter 5, Figure 5-7 for basin locations.
ND = Not Detected
* Estimated value based on lab qualifiers.

exceptions to be noted. Several metals are at levels that are above cleanup objectives, but below regulatory action levels requiring cleanup. Those metals with the highest level detected and location are cadmium (5.4 ppm at the CSF, 4 - 6″ depth), copper (253 ppm at the CSF, 4 - 6″ depth), mercury (0.59 ppm at Basin HW, 0 - 2″ depth), and nickel (419 ppm at the CSF, 4 - 6″ depth). Although not above cleanup standards, vanadium was detected at the CSF outfall at levels higher than at any other sampling location. The likely source for these high values is boiler washout as vanadium is a common by-product of oil combustion. In addition to the previously mentioned metals, lead was found at the CSF outfall above cleanup action levels. The highest level of lead observed was 8,600 ppm in soils located in the sample interval 4 – 6 inches deep. This level is higher than has been seen in the past at this location. BNL intends to conduct further sampling in 2001 in the area of the CSF outfall to better delineate the extent of the lead in sediments.

6.4.3 RADIOLOGICAL ANALYSIS OF BASIN SEDIMENTS

Radiological analysis of basin sediments was conducted to detect gamma-emitting radionuclides. Table 6-16 lists the basins and radionuclides detected at the various depths. All radionuclides detected are either naturally occurring or were at levels that are considered to be background. Those radionuclides that are anthropogenic in nature are cobalt-60 and cesium-137. Cobalt-60 contamination is likely a result of past operations at BNL, but levels were lower than action levels and do not require remediation. Cesium-137 is likely a result of worldwide fallout from past aboveground nuclear weapons testing. Beryl-

Table 6-15. Metals Analysis Results of Basin Sediments (CY 2000).

Metal	HO East 0 - 2"	HO East 2 - 4"	HO East 4 - 6"	HP West 0 - 2"	HP West 2 - 4"	HP West 4 - 6"	HS 0 - 2"	HS 2 - 4"	HS 4 - 6"	HW 0 - 2"	HW 2 - 4"	HW 4 - 6"
	mg/kg (ppm)											
Aluminum	617	462	497	577	633	817	3750	4520	4960	7290	4330	6310
Antimony	<MDL	<MDL	ND	ND	<MDL	ND	ND	ND	ND	<MDL	ND	<MDL
Arsenic	<MDL	<MDL	ND	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Barium	<MDL	<MDL	<MDL	144	45.6	23.8	<MDL	13.8	<MDL	<MDL	<MDL	28.5
Beryllium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cadmium	<MDL	ND	ND	<MDL	ND	ND	<MDL	<MDL	<MDL	2.8	1.3	<MDL
Calcium	1890	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	1630	687	728
Chromium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cobalt	<MDL	<MDL	<MDL	6.1	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Copper	6.3	3.2	3.2	32.1	14.1	10.8	11.5	11.3	13	48.9	21.4	13.8
Iron	3370	2180	1700	6740	3360	2600	4000	7080	5410	9080	5270	6820
Lead	1.8	2.2	1.1	2.2	1.5	2.1	15.3	16.9	16.6	106	51.5	49.1
Magnesium	1200	<MDL	<MDL	<MDL	<MDL	<MDL	654	897	875	1400	716	758
Manganese	183	117	104	1690	445	239	46.1	63.2	64.6	71	38.6	53.3
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.59	0.22	ND
Nickel	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	5.1	5	15.9	7.8	6.7
Potassium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Selenium	<MDL	ND	ND	0.94	<MDL	<MDL	ND	<MDL	ND	<MDL	<MDL	<MDL
Silver	<MDL	<MDL	<MDL	<MDL	<MDL	0.11	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Sodium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	46.9	<MDL	<MDL	<MDL
Thalium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	9.3	16.1	12.3	28.4	14.9	16.2
Zinc	10.8	6.8	6.9	6.7	3.7	4.5	63	63.7	68.6	233	107	56.1

Metal	HX West 0 - 2"	HX West 2 - 4"	HX West 4 - 6"	CSF 0 - 2"	CSF 2 - 4"	CSF 4 - 6"	HN Channel 0 - 2"	HN Channel 2 - 4"	HN Channel 4 - 6"	HN Center Basin 0 - 2"	HN Center Basin 2 - 4"	HN Center Basin 4 - 6"
	mg/kg (ppm)											
Aluminum	655	609	457	5990	7500	9400	5490	2100	1270	2200	1370	1180
Arsenic	<MDL	ND	ND	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Barium	<MDL	<MDL	<MDL	114	161	346	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Beryllium	<MDL	<MDL	<MDL	<MDL	<MDL	0.66	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cadmium	ND	ND	ND	1.9	2.5	5.4	<MDL	<MDL	ND	<MDL	ND	ND
Calcium	<MDL	<MDL	<MDL	2090	2880	4970	3930	1180	<MDL	<MDL	<MDL	<MDL
Chromium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cobalt	<MDL	<MDL	<MDL	9	12.8	22.9	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Copper	3.5	<MDL	<MDL	80.7	120	253	192	61.1	27.4	35.8	14.4	5.8
Iron	3760	1650	1160	9210	13400	19800	9010	4200	3260	3360	2980	2340
Lead	1.9	1.1	0.7	3380	3420	8600	53.7	15.8	7.7	11.4	6.2	2.5
Magnesium	<MDL	<MDL	<MDL	1480	2080	3850	2840	865	<MDL	581	<MDL	<MDL
Manganese	82.3	37.3	22	134	180	275	82.3	40.4	38.6	33.1	43.5	26.2
Mercury	ND	ND	ND	0.13	0.17	0.34	<MDL	ND	ND	ND	ND	ND
Nickel	<MDL	<MDL	<MDL	151	226	419	11.2	<MDL	<MDL	<MDL	<MDL	<MDL
Potassium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Selenium	<MDL	ND	ND	0.65	1.1	1.4	1.1	<MDL	<MDL	ND	<MDL	<MDL
Silver	<MDL	<MDL	ND	<MDL	<MDL	<MDL	<MDL	<MDL	ND	<MDL	<MDL	ND
Sodium	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Thalium	ND	ND	ND	ND	ND	ND	<MDL	ND	ND	ND	ND	ND
Vanadium	<MDL	<MDL	<MDL	535	674	1530	21.8	<MDL	<MDL	6.8	<MDL	<MDL
Zinc	3	<MDL	<MDL	280	373	776	382	128	54.3	50.4	19.2	12.5

Notes:
See Chapter 5, Figure 5-7 for basin locations.
MDL = Minimum Detection Limit
ND = Not Detected
Light shading = Samples with levels above cleanup objectives but below cleanup action levels.
Dark shading = Samples with levels above cleanup action levels.

lium levels seen in basin sediments is naturally occurring and originates from atmospheric ionization resulting from solar flare activity. Beryllium-7 is also noted in precipitation data discussed below in Section 6.5.

6.5 SOIL SAMPLING

Soil sampling was expanded in 2000. Historically soil samples were obtained at farm locations where farm produce was collected. This practice continued in 2000 with the addition of soil sampling at locations where grassy vegetation was sampled. Since many of the soil sampling points are in the vicinity of air monitoring stations, the sampling of soil and vegetation supports air monitoring. Over time, soil sampling may provide indications of deposition of potential radiological contaminants. Soil samples were analyzed for gamma emitting radionuclides. Table 6-17 is provided to show the sampling results of the radiological analysis of soils. All radionuclides detected, with the exception of cesium-137, are found naturally in Long Island soils. Higher levels of some of the radionuclides, such as lead-212, lead-214, bismuth-214, and potassium-40, in some of the farm locations are likely due to the addition of fertilizers to soils for growing crops. Cesium-137 concentrations were below 0.50 pCi/g (0.02 Bq/g) at all locations. These levels are considered to be background resulting from worldwide fallout from historic aboveground nuclear weapons testing.

6.6 TOXICITY TESTING AT THE SEWAGE TREATMENT PLANT

Under the State Pollutant Discharge Elimination System discharge permit, BNL conducted toxicity testing for the Sewage Treatment Plant effluent. Two species of fish are evaluated - the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). Results from this testing program are presented in Chapter 3.

6.7 PRECIPITATION MONITORING

As part of the Environmental Monitoring Program, precipitation samples were collected approximately quarterly at air monitoring Stations P4 and S5 (see Chapter 4, Figure 4-4 for station locations) and analyzed for radiological content. Four samples were taken from each of these two stations in 2000. Gross alpha activity measurements above the minimum detection limit were found in samples taken in August and November. The samples from the P4 location showed a maximum of 2.82 pCi/L activity, while the samples from the S5 location had a maximum activity level of 5.49 pCi/L. Both of these values are within the range of historic values reported for gross alpha activity. Gross beta activity was measured in four samples at each of the sampling locations. Location P4 had a maximum activity level of 48.30 pCi/L, with an average of 16.87 pCi/L. Location S5 had a maximum of 87.00 pCi/L, with the average activity of 29.07 pCi/L. Gross beta activity values were within the range of values historically observed at these two locations. Tritium was not detected in any of the samples from either location. Gamma analysis of samples taken in April and August showed the presence of beryllium-7 at a maximum of 52.2 pCi/L at Station P4 in April and 37.4 pCi/L in August at Station S5. Beryllium-7 is a naturally occurring radionuclide resulting from solar flare activity.

6.8 WILDLIFE MANAGEMENT EDUCATION, OUTREACH, AND RESEARCH

BNL sponsors a variety of educational and outreach activities on natural resources. These programs are designed to provide an understanding of the ecosystem and foster interest in science. They are conducted at the Laboratory in collaboration with DOE, local agencies, colleges, and local high schools. Ecological research is also conducted onsite to update the current natural resources inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2000, the Environmental Services Division (ESD) hosted two student fellowships, one during the spring and one during the summer. Both students were from Puerto Rico and both conducted research on the tiger salamander. The data gained from their studies has furthered BNL's understanding of the distribution and reproductive success of the tiger salamanders located on BNL property. One of the students was also responsible for the development of BNL's Natural Resources webpage located at <http://www.bnl.gov/wildlife/> (see Figure 6-10). The information provided on this web page gives the reader a broad understanding of the natural resources found at BNL.

Table 6-16. Radiological Analysis Results of Basin Sediments (CY 2000).

Location and Sample Depth	Be-7 pCi/g (dry)	K-40 pCi/g (dry)	Co-60 pCi/g (dry)	Cs-137 pCi/g (dry)	Tl-208 pCi/g (dry)	Pb-212 pCi/g (dry)	Bi-214 pCi/g (dry)	Pb-214 pCi/g (dry)	Ac-228 pCi/g (dry)	Th-232 pCi/g (dry)
Basin HO East										
0 - 2"	ND	ND	ND	0.03 ± 0.03	0.13 ± 0.04	0.38 ± 0.06	ND	0.34 ± 0.06	0.37 ± 0.07	0.35 ± 0.16
2 - 4"	ND	1.57 ± 1.34	ND	ND	ND	ND	ND	0.41 ± 0.19	ND	ND
4 - 6"	ND	2.32 ± 1.02	ND	ND	0.12 ± 0.07	0.25 ± 0.11	ND	ND	ND	ND
Basin HP West										
0 - 2"	ND	2.95 ± 0.59	ND	ND	0.25 ± 0.05	0.72 ± 0.11	0.91 ± 0.11	0.90 ± 0.12	1.02 ± 0.14	1.31 ± 0.37
2 - 4"	ND	2.67 ± 0.55	ND	ND	0.15 ± 0.04	0.40 ± 0.07	0.35 ± 0.07	0.40 ± 0.07	0.42 ± 0.08	0.65 ± 0.21
4 - 6"	ND	3.19 ± 0.63	ND	ND	0.11 ± 0.03	0.35 ± 0.06	0.24 ± 0.05	0.25 ± 0.05	0.36 ± 0.07	ND
Basin HS Basin										
0 - 2"	1.47 ± 0.42	5.29 ± 0.99	ND	0.16 ± 0.05	0.14 ± 0.05	0.46 ± 0.09	ND	0.32 ± 0.13	0.47 ± 0.10	0.44 ± 0.23
2 - 4"	0.40 ± 0.17	ND	ND	0.11 ± 0.03	0.13 ± 0.03	0.40 ± 0.07	ND	0.31 ± 0.11	0.40 ± 0.08	0.43 ± 0.18
4 - 6"	ND	5.69 ± 1.99	ND	ND	0.37 ± 0.15	0.93 ± 0.26	0.81 ± 0.22	0.82 ± 0.25	ND	ND
Basin HW Basin										
0 - 2"	1.31 ± 0.91	5.00 ± 1.49	ND	0.21 ± 0.09	0.23 ± 0.11	0.42 ± 0.18	ND	0.62 ± 0.17	ND	ND
2 - 4"	ND	4.89 ± 0.89	ND	0.14 ± 0.04	0.19 ± 0.05	0.63 ± 0.10	0.46 ± 0.08	0.48 ± 0.13	0.60 ± 0.10	0.72 ± 0.27
4 - 6"	ND	4.66 ± 0.85	ND	0.12 ± 0.04	0.24 ± 0.05	0.64 ± 0.10	0.51 ± 0.08	0.62 ± 0.08	0.56 ± 0.09	0.67 ± 0.24
Basin HX West										
0 - 2"	ND	1.58 ± 0.46	ND	ND	0.08 ± 0.03	0.23 ± 0.07	ND	0.19 ± 0.06	ND	ND
2 - 4"	ND	ND	ND	ND	0.05 ± 0.02	0.17 ± 0.04	ND	0.16 ± 0.05	ND	ND
4 - 6"	ND	2.11 ± 1.14	ND	ND	ND	ND	ND	ND	ND	ND
CSF										
0 - 2"	ND	4.28 ± 1.63	ND	0.39 ± 0.11	0.25 ± 0.13	0.55 ± 0.17	ND	0.48 ± 0.17	ND	ND
2 - 4"	ND	4.65 ± 0.86	ND	0.22 ± 0.05	0.19 ± 0.05	0.60 ± 0.10	0.47 ± 0.08	0.54 ± 0.09	0.49 ± 0.11	ND
4 - 6"	ND	5.13 ± 0.91	ND	0.24 ± 0.05	0.18 ± 0.04	0.61 ± 0.09	0.49 ± 0.08	0.58 ± 0.09	0.60 ± 0.10	0.68 ± 0.25
HN Channel										
0 - 2"	2.02 ± 0.47	3.95 ± 0.73	0.12 ± 0.02	0.23 ± 0.05	0.14 ± 0.04	0.46 ± 0.08	0.28 ± 0.06	0.37 ± 0.07	0.51 ± 0.09	0.50 ± 0.20
2 - 4"	0.27 ± 0.19	2.50 ± 0.52	0.04 ± 0.02	0.06 ± 0.03	0.17 ± 0.04	0.42 ± 0.07	0.25 ± 0.05	0.25 ± 0.05	0.42 ± 0.08	0.44 ± 0.22
4 - 6"	ND	2.75 ± 0.61	ND	ND	0.11 ± 0.04	0.37 ± 0.08	ND	0.20 ± 0.13	ND	ND
Basin HN Center										
0 - 2"	0.99 ± 0.30	3.39 ± 0.72	0.06 ± 0.02	0.03 ± 0.03	0.15 ± 0.05	0.39 ± 0.07	ND	0.21 ± 0.11	ND	ND
2 - 4"	ND	ND	ND	ND	0.10 ± 0.03	0.34 ± 0.06	ND	0.15 ± 0.09	0.34 ± 0.08	ND
4 - 6"	ND	2.73 ± 1.42	ND	ND	0.27 ± 0.12	0.56 ± 0.24	ND	ND	ND	ND

Notes:
See Chapter 5, Figure 5-7 for basin locations.
All values shown with a 95% confidence interval.
ND = Not Detected

Table 6-17. Radiological Analysis Results of Soil Samples (CY 2000).

Location	K-40 pCi/g (dry weight)	Cs-137 pCi/g (dry weight)	Tl-208 pCi/g (dry weight)	Bi-212 pCi/g (dry weight)	Pb-212 pCi/g (dry weight)	Bi-214 pCi/g (dry weight)	Pb-214 pCi/g (dry weight)	Ac-228 pCi/g (dry weight)	Th-232 pCi/g (dry weight)
BNL									
Garden	3.91 ± 0.79	0.28 ± 0.06	0.19 ± 0.05	ND	0.49 ± 0.09	0.34 ± 0.07	0.34 ± 0.07	ND	ND
Bldg. 464 Lawn	5.63 ± 1.65	0.35 ± 0.13	0.36 ± 0.12	ND	0.77 ± 0.18	ND	0.73 ± 0.21	ND	ND
Bldg. 490 Lawn	4.93 ± 0.90	0.20 ± 0.05	0.20 ± 0.04	0.51 ± 0.21	0.65 ± 0.10	0.56 ± 0.09	0.48 ± 0.08	0.72 ± 0.11	0.68 ± 0.27
Weaver Dr.	5.72 ± 1.01	0.27 ± 0.06	0.26 ± 0.06	0.66 ± 0.20	0.64 ± 0.10	0.53 ± 0.08	0.58 ± 0.09	0.70 ± 0.10	1.01 ± 0.29
West Ballfields	7.21 ± 1.25	0.27 ± 0.05	0.29 ± 0.06	0.58 ± 0.19	0.85 ± 0.12	0.66 ± 0.09	0.72 ± 0.10	0.76 ± 0.11	0.78 ± 0.28
Lawrence and Rutherford	4.08 ± 1.43	0.28 ± 0.09	0.23 ± 0.11	ND	0.51 ± 0.20	ND	0.41 ± 0.16	ND	ND
Biology Fields	7.38 ± 1.26	0.17 ± 0.04	0.28 ± 0.05	ND	0.87 ± 0.13	0.58 ± 0.08	0.58 ± 0.09	0.85 ± 0.11	1.00 ± 0.30
P4	4.67 ± 0.85	0.09 ± 0.03	0.21 ± 0.05	ND	0.66 ± 0.10	0.46 ± 0.07	0.53 ± 0.08	0.59 ± 0.10	0.74 ± 0.30
S6	3.88 ± 0.73	0.09 ± 0.04	0.17 ± 0.04	ND	0.46 ± 0.08	0.32 ± 0.07	0.37 ± 0.07	ND	0.61 ± 0.20
P7	7.86 ± 1.98	0.10 ± 0.07	0.30 ± 0.12	ND	0.84 ± 0.18	ND	ND	ND	1.10 ± 0.66
S5	3.19 ± 0.68	0.19 ± 0.05	0.19 ± 0.05	ND	0.38 ± 0.09	ND	0.30 ± 0.10	ND	0.52 ± 0.23
P2	2.89 ± 0.61	ND	0.11 ± 0.03	ND	0.35 ± 0.06	0.23 ± 0.05	0.20 ± 0.05	0.28 ± 0.06	0.33 ± 0.19
P9	ND	ND	0.21 ± 0.05	0.61 ± 0.16	0.69 ± 0.11	0.44 ± 0.08	0.43 ± 0.12	0.67 ± 0.09	0.71 ± 0.18
Offsite									
Bruno Farm	7.53 ± 1.95	0.31 ± 0.16	0.40 ± 0.16	ND	1.00 ± 0.31	ND	0.72 ± 0.25	ND	ND
Cornell Coop	10.20 ± 2.52	0.50 ± 0.22	0.67 ± 0.24	ND	2.22 ± 0.52	1.57 ± 0.34	1.48 ± 0.33	2.02 ± 0.56	ND
May's Farm	5.06 ± 0.89	0.09 ± 0.03	0.26 ± 0.06	0.51 ± 0.17	0.84 ± 0.12	0.53 ± 0.08	0.53 ± 0.16	0.68 ± 0.10	0.79 ± 0.31
Lewin Farm	6.83 ± 1.25	ND	0.34 ± 0.07	ND	0.98 ± 0.16	0.68 ± 0.12	0.66 ± 0.16	0.99 ± 0.16	0.80 ± 0.38
NYSDEC Game Farm	3.66 ± 0.69	0.08 ± 0.03	0.19 ± 0.04	ND	0.52 ± 0.08	0.39 ± 0.07	0.41 ± 0.07	0.54 ± 0.10	0.60 ± 0.23

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected

Figure 6-10. Neftali Hernandez Presenting ESD's New Natural Resources Webpage.

In addition to hosting student fellowships, members of ESD and other departments volunteer as speakers and give guest lectures at schools and civic groups. ESD also hosted activities in association with the thirtieth Anniversary of Earth Day in 2000 and provided activities to educate Laboratory employees and the general public on the environment and conservation. BNL hosted the Fifth Annual Pine Barrens Research Forum in October providing a venue for researchers conducting work on pine barrens ecosystems to share their results and interact with each other.

6.9 CULTURAL RESOURCE MANAGEMENT ACTIVITIES

The cultural resource management program is being developed to ensure that the Laboratory fully complies with the numerous cultural resource requirements. In 2000, BNL developed a work plan that will guide the development of a formal Cultural Resources Management Plan, that in turn will guide the management of all of BNL's cultural resources. These resources include World War I trenches, Civilian Conservation Corps features such as the white pine groves, World War II buildings, and historic structures associated with high-energy physics and other science conducted at the Laboratory.

In 2000, BNL received concurrence from the New York State Historic Preservation Officer (NYSHPO) that the Brookhaven Graphite Research Reactor (BGRR) Complex was eligible for inclusion in the National Register of Historic Places. Because this complex is undergoing decontamination and decommissioning, it is likely that some features of this complex may be adversely affected by the decontamination and decommissioning activities. Therefore, DOE and the NYSHPO entered into a Memorandum of Agreement to mitigate the potential negative effects of the decontamination and decommissioning process. This Memorandum of Agreement specifies the development of a history video about the BGRR, a researchers guide, and, pending funding, an interactive CD-ROM. The BGRR history video and the archiving of BGRR related documents began in 2000 and will continue in 2001.

Section 110 of the National Historic Preservation Act requires that government agencies conduct surveys of their properties to identify those buildings, structures, and features that are potentially eligible for inclusion in the National Register of Historic Places. In 2000, BNL established a contract with the Institute for Long Island Archaeology located at the State University of New York at Stony Brook to conduct a building-by-building survey of all 440 buildings located at BNL. The results of this survey should be available early in 2001.

In the course of fieldwork related to the natural resources program, additional World War I trenches were identified. These trenches were used as part of the training necessary to prepare the American Expeditionary Forces for battle in Europe during World War I. The trenches located at BNL may be the only remaining training trenches in the United States from that era.

BNL also began developing its *Site Master Plan* for future development at the Laboratory. As part of this plan an area was selected for the development of a Camp Upton Historic Museum Complex. This complex would house artifacts and buildings from both World War I and World War II Camp Upton, as well as information from the Civilian Conservation Corp. The proposed Camp Upton Historic Museum Complex was formally recognized on November 30, 2000 as a Save America's Treasures project, which is a White House Millennium Council initiative. With this designation, the project is eligible to compete for matching funds in support of its development.

With the permanent shut down of the High Flux Beam Reactor (HFBR) in November 1999, BNL began placing the reactor into a safe and secure shut down configuration. As part of this process, discussions began about the significant scientific achievements the HFBR contributed to science, its unique design, and its place in the BNL landscape. As a result of these discussions, the High Flux Beam Reactor was thought to be of major significance and the paperwork required under Section 106 of the National Historic Preservation Act was initiated to determine whether this facility was eligible for inclusion in the National Register of Historic Places. The paperwork was being finalized for submission to DOE at the close of 2000 and will likely be submitted to the NYSHPO in 2001.

REFERENCES

BNL. 1999. *Record of Decision: Operable Unit I and Radiologically Contaminated Soils.* BNL/OU1/12.1/1-57 05-OCT-99. Brookhaven National Laboratory, Upton, New York. October 1999.

BNL. 2000. *1999 Site Environmental Report.* BNL-52553. Brookhaven National Laboratory, Upton, New York. August 2000.

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

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

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

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

Naidu, J.R. 1999. *Brookhaven National Laboratory Wildlife Management Plan.* BNL-52556. Brookhaven National Laboratory, Upton, New York. September 22, 1999.

NYSDOH. 1996. *Radioactive Contamination in the Peconic River.* Bureau of Environmental Radiation Protection, New York State Department of Health, Albany, New York.

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

Thomlinson, W. 1993. *Deer Population Estimate for BNL Site.* Summer Project Report. Brookhaven National Laboratory, Upton, New York. March 1993.